On the welfare effect of retail electricity subsidy in Vietnam

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Abstract

Purpose – This research investigates how subsidy programs in Vietnam's residential electricity market affect consumers' well-being.

Design/methodology/approach – Two perspectives are employed: cash transfer and quantity-based subsidy. The effectiveness of cash transfer is measured in three ways: benefit incidence, beneficiary incidence and materiality. The quantity-based subsidy is established under the increasing block rate pricing, with the first two block rates being lower than the marginal cost. To improve the quantity-based subsidy, the research examines the consumer surplus under four proposals.

Findings – The results show that both types of subsidies are ineffective in supporting the poor.

Research limitations/implications – In order to achieve a more equal distribution among households, the subsidy program should remove all subsidized blocks and reflect the full marginal cost. Changes should be made to the price structure regarding both marginal price and intervals.

Practical implications – To mitigate the impact of the quantity-based subsidy, the government should improve the cash transfer by reducing extortion and improving targeting efficiency, especially for poor households living in rented houses.

Originality/value – This paper is the first to discuss the welfare effect of the electricity subsidy in Vietnam. First, it comprehensively evaluates the cash transfer subsidy in Vietnam. Second, it suggests a modification in the residential electricity tariff.

Keywords Vietnam retail electricity market, Block rate pricing, Welfare effect, Demand function, Cash transfer, Quantity-based subsidy

Paper type Research paper

1. Introduction

The Vietnamese government has made significant efforts to improve electricity access and affordability for residential households. In the early 1990s, electricity was scarce, and the electrification rate was less than 50% (Asian Development Bank, 2011). However, within a decade, this rate grew to 77% by 2001, and in 2019, electrification reached 99.4%, higher than the world average of 90.1% (World Bank, n.d.). In terms of affordability, the government implemented interventions to keep the marginal cost for residential usage at VND1,622 per kWh, only covering 73% of the long-run marginal cost of VND2,100 per kWh (Asian Development Bank, 2016). This low cost has helped make the residential electricity

JEL Classification — D12, D63, Q41, Q48

tariff in Vietnam among the lowest in Southeast Asia and only higher than that of the Lao PDR and Myanmar (Poch and Tuy, 2012).

Despite the improvements in access and affordability, inequality in electricity consumption across households has become a concern. While households spend only 6% of their income on electricity bills, this rate has grown faster than income, which puts a great burden on poor households (Ha-Duong and Nguyen, 2021; Nguyen *et al.*, 2019). As a result, the inequality in electricity expenditure is more severe than income inequality (Son and Yoon, 2020). To address this matter, authorities support poor households through two channels: cash transfer and quantity-based subsidy. For the first channel, they offer a fixed amount of VND50,000 per month to recognize poor households. For the second channel, they construct an increasing block rate tariff in which the first two block rates are below the marginal cost.

This study examines the residential electricity subsidy in Vietnam in terms of cash transfer and quantity-based subsidy. We evaluate the cash transfer performance from three perspectives: benefit incidence, beneficiary incidence and materiality, following Komives *et al.* (2005). About the quantity-based subsidy, we provide policy recommendations on the tariff to mitigate the inequality in electricity expenditure across households with various income levels. To do this, we analyze the consumer surplus change under four proposals. The first plan is the tariff proposed by Vietnam Electricity (EVN) in 2020, which was supposed to replace the existing tariff. The second plan widens the subsidized block interval to better capture poor households. The third plan inherits the spirit of the second plan but also extends the interval in the high block to compensate for the loss in the second plan. The final plan removes the subsidy in the first two blocks and adds the social cost of health and the environment to electricity production.

The analysis in this paper is derived from the 2015 Vietnam Household Registration Study (HRS) (World Bank, 2015). This survey collected responses from 5,000 households in Ha Noi, Ho Chi Minh, Binh Duong, Da Nang and Dak Nong. While many topics in the HRS overlapped with the Vietnam Household Living Standard Survey (VHLSS) (i.e. education, health care, employment, assets, housing, income, expenditure and social inclusion and social protection), the survey has two features that distinguish it from the VHLSS. First, it has a section for household registration procedures. Second, it focuses on temporary residents as this group accounts for 44% of the total sample.

Early studies on electricity in Vietnam mainly focused on the effect of rural electrification on households' characteristics, such as income or children's education (Asian Development Bank, 2011; Khandker *et al.*, 2009). More recently, the focus has shifted to energy security, energy poverty and electricity inequality, as analyzed by Baulch *et al.* (2018), Dapice *et al.* (2022), Le *et al.* (2023), Nguyen *et al.* (2019) and Son and Yoon (2020). The performance of the electricity sector and consumer satisfaction have also been intensively studied (Ha-Duong and Nguyen, 2017, 2021). Other papers investigated the electricity demand function, focusing on finding the appropriate instrument variables to overcome the endogeneity. For example, Nguyen (2019) adopted previous analyses and chose the predicted quantity price as the instrument, or Le (2020) utilized the household registration system to establish unique instruments for Vietnam. This paper contributes to the existing literature by examining the effectiveness of cash subsidies and providing policy recommendations for a more equitable tariff system, filling a gap in the current research on electricity in Vietnam.

The remainder of this paper is organized as follows. Section 2 reviews the framework to examine the performance of cash transfer and its application to Vietnam. Section 3 describes the methodology to measure the welfare effect under different scenarios using the price elasticity of demand estimated in the demand function. Section 4 empirically estimates the demand function and measures the consumer welfare impact. Section 5 provides some key policy recommendations. Section 6 concludes the paper and proposes some topics for further research.

2. The analysis of cash transfer

2.1 The framework for assessing cash transfer

Cash transfer (cash subsidy) can be viewed as social assistance since the government guarantees poor households access to basic amenities. Following the framework of Komives *et al.* (2005), we assess the performance of the cash transfer in Vietnam in three dimensions: benefit incidence, beneficiary incidence and materiality. This framework has been widely used in subsidy evaluation of public utilities, such as electricity (McRae, 2015), water (Andres *et al.*, 2019) or public transport (Serebrisky *et al.*, 2009).

2.1.1 Benefit incidence. This dimension addresses the performance of a subsidy in covering the poor population. Specifically, it compares the ratio of the poor population receiving the subsidy to the proportion of the poor population in the whole population. It can also be interpreted as the average subsidy that a poor household receives to the average subsidy that a random household in the sample gets. To calculate this dimension, we use the targeting performance indicator Ω (see Equation (1)). A good value of Ω should be at least 1. For more clarification, suppose that 20% of the population is poor and they receive 20% of the total subsidy, Ω will be 1.

$$\Omega = \frac{S_P/P}{S_H/H} = \frac{S_P}{S_H} \cdot \frac{P}{H} \tag{1}$$

where S_P is the value of the subsidy that poor households receive;

P is the number of poor households;

S_H is the value of the subsidy that all households receive;

H is the total number of households.

2.1.2 Beneficiary incidence. Once the performance of the subsidy in covering the poor population is defined, its effectiveness in reaching eligible households is evaluated. To measure this beneficiary incidence, we use two indicators: exclusion errors (proportion of poor households excluded from the subsidy) and the percentage of beneficiaries in each income quintile.

2.1.3 Materiality. The subsidy's size relative to household income is investigated by examining the percentage of the subsidy's value over the average income of poor households.

2.2 The performance of cash transfer in Vietnam

2.2.1 An overview of cash transfer and beneficiaries in Vietnam. The Vietnamese government provides a monthly lump sum cash subsidy of VND50,000 to registered poor households as electricity support (EVN, 2016). Eligibility requires the person to obtain permanent residence status in their house and has a monthly income below VND1,100,000 (rural) or VND1,300,000 (urban).

Beneficiaries are assessed in three categories: households below the poverty threshold, households recognized as poor and listed as such and households recognized poor households receiving the subsidy. The absolute values are 735, 145 and 87 households, respectively. When converted to percentages, 15.51% of the total households were poor, of which only 19.62% were recognized by authorities. Finally, among those recognized as poor households, only 60% received the subsidy. These low rates indicate the Vietnamese authorities' ineffectiveness in targeting and reaching the poor within the community.

2.2.2 The performance of cash transfer in Vietnam.   2.2.2.1 Benefit incidence. We calculated the targeting performance for poor households, regardless of their record in the poor list, and obtained a value of $\Omega = 0.262$ (Equation (1)). This result suggests that the cash

transfer program in Vietnam has not progressed well as the subsidy does not fully cover the poor population.

2.2.2.2 *Beneficiary incidence*. Our calculations show that the errors of exclusion in Vietnam are significantly high, with 87.47% of the poor households not receiving the subsidy. When considering the recognized poor households, 40.28% did not receive the subsidy. Regarding the distribution across the income quintiles, the first quintile revealed the highest proportion of those receiving the subsidy (10.47%), but the other quintiles also had beneficiaries (i.e. 2nd quintile: 2.67%; 3rd quintile: 1.17%; 4th quintile: 0.77%), even in the highest quintile (5th quintile: 0.74%).

2.2.2.3 *Materiality*. The electricity subsidy, equivalent to VND50,000, equals about 1.27% of a poor household's average income (VND3,491,905). The size of the subsidy is extremely small; therefore, its contribution to the cost-of-living mitigation of a poor household is limited.

In summary, cash transfer performance in Vietnam is inefficient from three perspectives. Benefit incidence shows that the subsidy's value does not cover the entire poor population. Beneficiary incidence indicates a low proportion of poor households receiving the subsidy and high leakage to the ineligible. Moreover, materiality reveals that the subsidy's value is insignificant relative to income, rendering it ineffective in supporting the poor.

3. An overview of the quantity-based subsidy
3.1 The increasing block-rate tariff
The block-rate tariff charges different marginal prices for different blocks of consumption. Equation (2) demonstrates the marginal price in a block-rate tariff structure, in which p_j is the marginal price of block j, q_1 is the quantity consumed and q_{1k} ($1 \leq k \leq n$) are the thresholds. If $p_1 < p_2 < \ldots < p_n$, it denotes an increasing block-rate tariff. In contrast, $p_1 > p_2 > \ldots > p_n$ denotes a decreasing block-rate tariff.

$$p_j = \begin{cases} p_1 \; if \; 0 \leq q_1 \leq q_{11} \\ p_2 \; if \; q_{11} \leq q_1 \leq q_{12} \\ \quad \ldots \\ p_n \; if \; q_{n-1} \leq q_1 \leq q_n \end{cases} \tag{2}$$

The increasing block-rate tariff is a quantity-based subsidy as the marginal prices for the first blocks are lower than the marginal cost. It assumes that poor households consume within the subsidized blocks, which are below the average of middle- and high-income households. The main advantage of this tariff is that it guarantees all households access to a certain quantity of utility (Komives *et al.*, 2005).

In Vietnam, the first two blocks of the residential electricity tariff (up to 100 kWh) are subsidized, with marginal prices lower than the retail electricity marginal cost of VND1,622.01 per kWh (see Table 1). Approximately 46.05% of poor households absorbed the entire subsidy since their consumption was below 100 kWh.

3.2 The baseline model specification
A standard residential electricity demand function, shown in Equation (3), includes the price of electricity, household income, the price of electricity substitutes and the temperature (Narayan and Smyth, 2005). The expected signs for all the variables except for the price are positive.

$$lnQ_i = \alpha_0 + \alpha_1 lnY_i + \alpha_2 lnP_i + \alpha_3 lnS_i + \alpha_4 lnTM_i + \varepsilon_i \tag{3}$$

where lnQ_i is the natural log of quantity consumed;

lnY_i is the natural log of income;

lnP_i is the natural log of price;

lnS_i is the natural log of the price of substitute energy;

$lnTM_i$ is the natural log of weather;

ε_i is the error term and is assumed to be normally distributed, which is $\varepsilon_i \sim N(0, \sigma^2)$.

The model in this study followed the standard model shown in Equation (3) with modifications in the natural log of substitute energy, the natural log of weather and sets of households and area-specific variables:

$$lnQ_i = \beta_0 + \beta_1 lnP_i + \beta_2 lnY_i + \beta_3 lnS_i + \hbar_i + \eta_i + \varepsilon_i \tag{4}$$

3.2.1 Natural log of price (lnP_i). The type of price chosen is one of the most critical questions in studying the block-rate tariff (Hewitt and Hanemann, 1995); however, no concrete answer has been given. Early studies in the 1970s, inspired by Howe and Linaweaver (1967), used marginal price. However, since Taylor (1975) and Nordin (1976) were published, the price choice was the marginal price and an additional variable that reflected the lump sum transfers in the block-rate tariff structure.

While marginal pricing is commonly used to analyze block-rate tariffs, it unrealistically assumes that consumers fully comprehend the marginal price when consuming the product. Ito (2014) found that consumers do not seem to respond to marginal or expected marginal prices but to the average price. Shin (1985) showed that the average price should be calculated from the bill, not the average of all marginal prices the consumers face.

This study used the average price derived from the electricity bill instead of the marginal price, based on the work of Ito (2014) and Shin (1985). In Vietnam, there are two price systems: the official block-rate tariff regulated by the EVN and the unofficial flat price that depends on landlords. According to the World Bank and Vietnam Academy of Social Sciences (2016), the average price of the unofficial flat price system is VND2,884, higher than the final block tariff in the official system.

3.2.2 Natural log of quantity (lnQ_i). Unfortunately, the quantity of electricity consumed was not reported in the survey; therefore, it would be derived from the electricity bill. Regarding the households that pay the flat price, the quantity is simply the division of the expenditure by the flat price (VND2,884). For households that are subject to the block-rate tariff, the quantity is calculated using Equation (6), in which Q denotes the quantity consumed and $P_1, P_2, \ldots, P_6$ indicate the marginal price with respect to the block.

Block rate	Interval (kWh)	Marginal price (VND1,000 per kWh)	To the residential marginal cost (%)
1	0–50	1.484	91.49
2	51–100	1.533	94.51
3	101–200	1.786	110.11
4	201–300	2.242	138.22
5	301–400	2.503	154.31
6	401+	2.587	159.49

Table 1.
Residential electricity tariffs in Vietnam

Source(s): Ninh Thuan's Department of Industry and Trade (2015)

$$Monthly\ expenditure = \begin{cases} P_1 Q \ if\ 0 \le Q \le 50 \\ 50P_1 + (Q - 50)P_2 \ if\ 51 \le Q \le 100 \\ 50P_1 + 50P_2 + (Q - 100)P_3 \ if\ 101 \le Q \le 200 \\ 50P_1 + 50P_2 + 100P_3 + (Q - 200)P_4 \ if\ 201 \le Q \le 300 \\ 50P_1 + 50P_2 + 100P_3 + 100P_4 + (Q - 300)P_5 \ if\ 301 \le Q \le 400 \\ 50P_1 + 50P_2 + 100P_3 + 100P_4 + 100P_5 + (Q - 400)P_6 \ if\ Q \ge 401 \end{cases} \quad (5)$$

3.2.3 Natural log of income (lnY_i). The total income was not reported in the survey, but the wage and non-wage incomes are available. Therefore, the income is calculated from the sum of these two components. The wage income is the monthly salary of household members who work in organizations. The non-wage income comprises non-agriculture business; asset leasing; agriculture, forestry and fisheries; remittances; loan interest; capital contribution and other income.

3.2.4 Natural log of price of substitutes (lnS_i). Electricity is reasonably assumed to be substituted in cooking and lighting. Hence, close substitutes (gasoline and other fuels, including oil, wood and coal) were examined. Since the demand for these types of energy is inelastic (Espey, 1998; Labandeira *et al.*, 2017; Havranek *et al.*, 2012), it is feasible to use the expenditure for these types of fuels as an approximation of the price of substitutes.

3.2.5 Households – related variables ($\hbar_i$). Household-specific characteristics are examined, including the number of household members, house size and a list of dummy variables reflecting whether a household owns electric appliances.

3.2.6 Area-related variables (η_i). The area-related variables include the indicators of areas (urban/rural) and the province in which the house is located. Since the data were collected in five provinces, these variables also capture the effect of temperature.

3.3 The choice of the econometric model

The residential electricity demand function (4) follows the standard demand model, in which quantity is the function of price. However, economic theory also demonstrates the impact of quantity on price. Hence, the problem of simultaneity arises. Since price and quantity are jointly determined, the ordinary least squares (OLS) regression would lead to biased and inconsistent estimation (Hill *et al.*, 2018; Wooldridge, 2013).

Two econometric models are usually applied to tackle this issue. The first is the discrete/ continuous choice with a two-error model, which applies specifically to the block-rate tariff. This model was first proposed in studying the impact of the tax rate on labor supply (Burtless and Hausman, 1978) and was then widely used in the demand function of water block-rate pricing (Hewitt and Hanemann, 1995; Rietveld *et al.*, 2000). This model assumes that the demand function is linear within a block but is kinked when moving from one block to another.

The second model is the instrument variables with two-stage least squares (IV/2SLS) estimation. This model does not separate the specific problem of the block-rate tariff from the typical joint determination in the demand function but treats them as the general problem of endogeneity. In utility demand studies, this model is often used in research on electricity (Halvorsen, 1976; Taylor, 1975).

This study applied the IV/2SLS model to address endogeneity for two reasons: First, it follows previous papers examining the electricity demand function. Second, it has also been used in articles on Vietnam's retail electricity demand function (Ha-Duong and Nguyen, 2017; Le, 2020). To estimate the IV/2SLS model, instrument variables are compulsory.

3.4 The choice of instrument variables

A good instrument variable must theoretically satisfy three conditions. First, it must not directly affect the outcome variables, and therefore, it must not appear as an explanatory variable. Second, it must not correlate with the error term or, in other words, any unobservable factors that explain the outcome variables. Finally, it must correlate with the endogenous variable.

This study applied the choice of instrument variables from Le (2020), which was explicitly defined for Vietnam. These are "the company/person to whom the household pays the electricity bill" and "the residence status." As a requirement of relevant instrument variables, they should affect only the electricity price. Moreover, they should neither associate with the electricity quantity nor correlate with any unobserved factors in the model (4).

3.4.1 The person to whom the household pays the electricity bill. As mentioned earlier, households that pay EVN directly are subject to the block-rate tariff, while those that pay landlords are more likely to pay the flat price. The HRS shows that all households that pay the bill to landlords pay the flat price.

3.4.2 Residence status. The Law on Residence of Vietnam states that an individual's residence status is granted in the property owned by this person or their parents. Rental property is also accepted in very limited circumstances, constrained by a formal agreement between the renter and the landlord (The National Embassy, 2020). As a result, temporary residents are more likely to live in a rental house and thus be subject to a flat price. In contrast, permanent residents live in their own houses and pay the block-rate price. From the HRS, out of the households that pay the flat price, only 1.86% are permanent residents; the remaining are temporary residents.

3.5 Consumer welfare effect measurement

Consumer surplus has been widely used in studying the welfare effect despite being controversial (Cohen *et al.*, 2016; Hausman, 1981; Kim, 1997). This study adopted the welfare effect under reforms by measuring the change in the consumer surplus. This approach was also used by BuShehri and Wohlgenant (2012), who studied the welfare effect in Kuwait under the reform in residential electricity.

Figure 1 illustrates the example of consumer surplus loss in the case of price increases. When the price increases from P_1 to P_2, the quantity demand decreases from Q_1 to Q_2. As a result, the consumer surplus loss will be the area of the blue trapezoid, which is

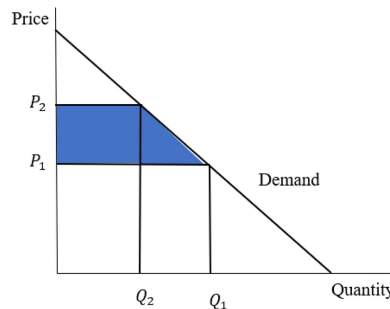$$CW = 0.5(P_2 - P_1)(Q_1 + Q_2) \tag{6}$$

Source(s): Authors' work

The quantity changed in this study was calculated through the price elasticity of demand. This indicator illustrates the percentage change in the quantity demanded when there is a 1% change in the price. Since the demand function is the log-log form, the estimate for the price (β_1) is also the elasticity.

To establish the consumer welfare effect, three assumptions are made:

(1) The demand function is linear: This can be achieved because, as indicated above, consumers react to the average price instead of the (expected) marginal price.

(2) Any change in the threshold is equivalent to a change in price; thus, the equilibrium moves along the curve, but the curve itself remains unchanged.

(3) Consumers maintain their level of consumption when the new price structure is announced but will adapt consumption when they receive the bill.

Under these three assumptions, the consumer surplus change for one household was calculated as follows: Whenever there is a change in the price, consumers do not change the quantity consumed immediately. However, when they receive their bills, they will evaluate the new average price (derived from the bill) with the old average price and modify the quantity consumed. The new quantity will be calculated using the price elasticity of demand. This quantity is the final quantity (Q_2). Once the quantity has been calculated, the expenditure will be re-calculated, and the average price will be re-computed because the price should be derived from the bill. This is the final price (P_2). After calculating the consumer surplus change for each household, the total welfare effect can then be calculated by the sum of the consumer surplus change in the corresponding groups.

4. Result estimation

4.1 Descriptive statistics

We used the full sample to estimate the demand function. For the analysis of the consumer surplus, we divided our sample into three sub-samples based on income levels: low-, middle- and high-income households. Specifically, low-income households refer to poor households, which we defined in Section 2. Hence, the terms low-income and poor households can be used interchangeably. There are two reasons for this: first, we want to avoid confusion, and second, as poor households account for 18.36% of our sample, it is not much different from the usual 20% threshold. Our high-income households are in the fifth quintile of household incomes, commonly used in reports by Vietnamese authorities (e.g. GSO, 2019). The remaining households are classified as middle-income households.

Table 2 presents means and standard deviations for some important variables in model (4). On average, low-income households use 154.05 kWh per month, while middle- and high-income households consume more with 213.62 kWh and 240.36 kWh, respectively. The average electricity price and expenditure follow this pattern as well. Regarding households' incomes, the mean value of high-income households is three times higher than that of middle-income households and nine times higher than that of low-income households. Additionally, more than half of the sample live in urban areas.

4.2 Model estimation

Table 3 shows the estimations from the OLS and the IV/2SLS results. Under the IV/2SLS model, key variables have expected signs and are statistically significant. The coefficient for the electricity price (the elasticity of demand) is −1.152, which indicates that, on average, holding other variables constant, a 1% increase in price leads to a decrease in the quantity demanded by −1.152%. The absolute value of elasticity greater than 1 shows that the

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	Whole sample	Low-income households	Middle-income households	High-income households
Electricity expenditure	346.19	325.25	423.05	561.57
(thousand VND)	(505.34)	(372.26)	(486.43)	(614.55)
Electricity quantity	192.33	154.05	186.28	240.36
(kWh)	(199.82)	(152.16)	(192.34)	(241.67)
Electricity average price	2.15	1.91	2.18	2.25
(thousand VND)	(0.56)	(0.52)	(0.57)	(0.52)
Households' income	14,542	3,942	10,928	33,912
(thousand VND)	(12,774)	(3,261)	(5,069)	(14,438)
Electricity substitutes expenditure	138.00	133.42	133.48	153.33
(thousand VND)	(113.00)	(118.98)	(106.93)	(124.43)
Area	0.41	0.45	0.39	0.44
(reference: urban)	(0.49)	(0.50)	(0.49)	(0.50)
House size	83.5	79.97	79.2	99.57
(m^2)	(91.70)	(81.74)	(89.96)	(102.01)
Number of members	3.47	3.68	3.32	3.76
(persons)	(1.61)	(1.88)	(1.50)	(1.67)

Note(s): Standard deviations are reported in parentheses
Source(s): Authors' calculation

Table 2.
Descriptive statistics

electricity quantity demanded is sensitive to the change in price. Moreover, the demand change with respect to income is inelastic since its elasticity is less than 1. This finding is consistent with Bose and Shukla (1999), Csereklyei (2020) and Holtedahl and Joutz (2004), who also found that residential electricity demand is income-inelastic for the US, India, Taiwan, Organisation for Economic Co-operation and Development (OECD) countries and the European Union nations.

Standard hypothesis tests in an IV/2SLS model are examined in Table 3. The Wu–Hausman test for endogeneity concluded that the model was endogenous. Different tests to explore the strength of the instrument variables were also conducted. The results from the weak instrument test and the instrument validity test (the Sargan test) indicated that at a 5% significance level, both instrument variables were strongly and jointly valid.

4.3 The welfare effect under four proposals

4.3.1 An overview of the four proposals. This section introduces the four proposals for measuring the welfare effect: one proposal by EVN and three by the authors.

4.3.1.1 Proposal 1. In 2020, EVN proposed a new price structure to the Ministry of Industry and Trade (MOIT) to replace the existing one, which had been in use since 2015. Under the new plan, the number of blocks was reduced from 6 to 5. The marginal price was also increased to reflect the increase in the retail marginal cost, from VND1,622.01 per kWh to VND1,864.44 per kWh (Ngọc Linh, 2020). The new price structure is shown in Table 4 (panel A) along with the proportion to the marginal cost and the marginal price when inflation is excluded. Under the new structure, only the first block is subsidized. Moreover, if inflation is considered, the 2020 price, on average, is only 1% higher than the 2015 price. Therefore, the new price structure can be viewed as redistributing welfare but not as gaining producer surplus.

4.3.1.2 Proposal 2. This proposal modifies the interval of the 2015 price structure in order to subsidize the average electricity quantity consumed by poor households. Currently, a poor household consumes 154.05 kWh per month, while the figure for a non-poor household is 200 kWh. In addition, the proportion of poor households whose consumption falls under the

	OLS	IV/2SLS	
		First stage	Second stage
Dependent variables	lnQ_i	lnP_i	lnQ_i
Natural log of price	$-0.239^{***}(0.109)$		$-1.152^{***}(0.053)$
Whom the respondent pays the electricity bill to (reference: directly to the electricity company)			
- Owner of rented house		0.560^{***} (0.004)	
- Other household living together		$-0.002(0.010)$	
Household registration status (reference: permanent)			
- Temporary		$-0.011^{***}(0.003)$	
Natural log of income	$0.008^{***}(0.010)$	$0.007^{***}(0.001)$	$0.046^{***}(0.053)$
Natural log of price of substitutes	$0.044^{***}(0.007)$	$0003^{***}(0.001)$	$0.043^{***}(0.007)$
House size	0.001^{***} (0.000)	0.0002^{***} (0.000)	0.001^{*} (0.000)
Number of persons	0.120^{***} (0.006)	0.011^{***} (0.001)	0.109^{***} (0.006)
Area (reference: urban)			
- Rural	-0.028 (0.021)	-0.003 (0.003)	-0.050^{*} (0.022)
Province (reference: Ha Noi)			
- Da Nang	-0.293^{***} (0.029)	-0.037^{***} (0.004)	-0.399^{***} (0.030)
- Dak Nong	-0.308^{***} (0.034)	-0.087^{***} (0.004)	-0.556^{***} (0.036)
- Binh Duong	-0.272^{***} (0.030)	-0.007^{*} (0.004)	-0.228^{***} (0.031)
- Ho Chi Minh	-0.111^{***} (0.028)	0.002 (0.004)	-0.107^{***} (0.029)
Ownership of appliances	Yes	Yes	Yes
Constant	$5.240^{***}(0.109)$	$0.533^{***}(0.014)$	$5.608^{***}(0.113)$
Observations	4,731	4,731	4,731
F-statistics test			7326.116^{***}
Wu–Hausman test			3007.978^{***}
Sargan test			2.479

Note(s): lnQ_i and lnP_i denote the natural logarithm of quantity and the natural logarithm of price, respectively. The ownership of appliances indicates whether a household has specific appliances, including air conditioners, washing machines and dryers, vacuum cleaners, dehumidifiers, water purifiers, water heaters, gas cookers, induction cookers, electric cookers, rice cookers, pressure cookers, microwave ovens, baking ovens and fruit juicing/pressing machines. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively
Source(s): Authors' calculations

subsidized blocks is 46.05%. If the subsidized block is extended from 100 to 150 kWh, 60.5% of poor households will be fully covered. This study chose the new threshold as 150 kWh instead of 155 kWh since 150 is a rounding number. Also, if 155 kWh is chosen instead of 150 kWh, the percentage of poor households that are fully subsidized rises by only 0.82%, which is negligible. Table 4 (panel B) summarizes the new structure of the tariff.

Interval (kWh)	Marginal price (VND1000 per kWh)	To the retail price	Marginal price (exclude inflation) (VND100 per kWh)
		Panel A: Proposal 1 from EVN	
0–100	1.678	90%	1.474
101–200	2.014	108%	1.769
201–400	2.629	141%	2.309
401–700	2.983	160%	2.620
701+	3.132	168%	2.751

| | Panel B: Proposal 2,3 and 4 | | |
	Proposal 2	Proposal 3	Proposal 4
0–50	1.484	1.484	1.958
51–100	1.533	1.533	1.958
101–150	1.533	1.533	2.156
151–200	1.786	1.786	2.156
201–300	2.242	2.242	2.706
301–400	2.503	2.503	3.021
401+	2.587	2.587	3.123

| Panel C: The change in EVN's revenue under four proposals (thousand VND) | | | | | |
	Original tariff	Proposal 1	Proposal 2	Proposal 3	Proposal 4
Revenue	2,063,602	1,820,250	1,776,571	1,894,527	2,785,797
Change in the revenue		−243,352	−287,031	−169,075	722,195
Profit	587,709	360,337	378,116	402,826	647,072
Change in the profit		−227,372	−209,593	−84,883	59,363

Source(s): Proposal 1: Ngọc Linh (2020), authors' calculations; proposals 2, 3, 4: authors' calculations

Table 4.
The tariff under four proposals

4.3.1.3 Proposal 3. Proposal 3 is an extension of proposal 2 in the sense that the interval for block 4 is narrowed to 201–250 kWh to cover part of the loss from increasing the subsidized interval. The threshold chosen is 250 kWh since the average electricity usage of a high-income household in Vietnam is 240 kWh. Table 4 (panel C) summarizes the new tariff structure of this proposal.

4.3.1.4 Proposal 4. Proposal 4 sets the marginal price for the first two blocks equal to the marginal cost. As a result, the number of blocks decreases from 6 to 5. The subsidy is removed, but consumers still receive benefits since they do not pay the markup for their first block consumption. Besides markup elimination, this proposal also captures the negative externalities of electricity production on health and the environment. According to Biegler (2009), the social cost of electricity production is the combination of different costs from different sources. This study adopted the cost structure from Biegler (2009) with a modification to the 2015 price. Regarding the cost structure for Vietnam, data from the International Energy Agency (2021) were used. In sum, the external cost of electricity production in Vietnam is VND336 per kWh, which brings the marginal cost to VND1,958 per kWh. Table 4 (panel D) summarizes the new tariff reflecting the changes in subsidy and the marginal cost.

4.3.2 Results of the welfare effect under the four proposals. The welfare effect measures the performance of the four proposals compared to the original tariff. Table 4 (panel E) shows the revenue and the profit changes of EVN in the four proposals. In general, all proposals except proposal 4 reduce the revenue as well as the profit of EVN, with the greatest loss coming from proposal 1, which EVN offered.

Table 5 explores the percentage change in price (considering inflation) of the four proposals. Generally, the tariff was designed as a higher quantity consumed faced a higher marginal price. Regarding proposal 1, the price structure is not optimal because the decrease in the marginal price for the lower intervals is small. Furthermore, the price for the interval (201, 300) falls sharply, even though it is considered as high consumption (the average usage of a non-poor household is around 200 kWh).

The consumer welfare effect is shown in Table 5. Overall, all proposals except proposal 4 increase the consumer surplus, in which the largest increase is from proposal 1 and the smallest increase is from proposal 3. Regarding the first three proposals, while they improve the welfare for consumers, the benefit is distributed unequally: High-income households receive the most benefits, followed by middle-income households, and low-income households receive the least benefits. In terms of proposal 4, it leads to a great loss of the consumer surplus, with the largest loss coming from high-income households and then middle-income households.

5. Policy implications
5.1 The government should continue cash transfer to the eligible
A cash subsidy for eligible households is needed to compensate for the increased expenditure. Improving the targeting effectiveness is crucial to ensure that the subsidy benefits those who need it the most. From our analysis, about 20.24% of the subsidy is currently leaked to ineligible households, so reducing exclusion can help redistribute the subsidy to eligible households, increasing its value for each recipient.

Comparison of the price of the four proposals with the original price structure

		Proposal 1		Proposal 2		Proposal 3		Proposal 4	
Block	Original structure	Absolute value	Change in price (%)	Absolute value	Change in price (%)	Absolute value	Change in price (%)	Absolute value	Change in price (%)
0–50	1.484	1.474	−0.67	1.484	–	1.484	–	1.958	31.94
51–100	1.533	1.474	−6.88	1.533	–	1.533	–	1.958	27.72
101–150	1.786	1.769	−0.94	1.533	−14.17	1.533	−14.17	2.156	20.72
151–200	1.786	1.769	3.01	1.786	–	1.786	–	2.156	20.70
201–250	2.242	2.309	−7.73	2.242	–	2.242	–	2.706	20.70
251–300	2.242	2.309	−7.73	2.242	–	2.503	−13.42	3.021	20.72
301–400	2.503	2.309	1.29	2.503	–	2.503	–	3.123	20.74
401–700	2.587	2.620	6.35	2.587	–	2.587	–	3.123	20.74
701+	2.587	2.751	6.35	2.587	–	2.587	–	3.482	20.74

Comparison of the consumer welfare effect under the four proposals

		Proposal 1	Proposal 2	Proposal 3	Proposal 4
Total consumer surplus change (VND)		39,731	18,591	17,966	−512,169
	Low	5,525	2,333	2,264	−62,494
	Middle	25,650	11,232	10,858	−316,319
	High	8,556	5,026	4,844	−133,356
Per household (VND)					
	Low	7.527	3.178	3.084	−85.142
	Middle	8.465	3.707	3.583	−104.396
	High	8.848	5.198	5.009	−137.907
Source(s): Authors' calculations					

Table 5.
Comparisons among four proposals

5.2 Tariff reform is necessary
Proposals 2 and 3 show that modifying intervals alone does not benefit low-income households as much as middle- and high-income households as the latter group tends to consume more electricity. Therefore, any quantity-based subsidy will be most beneficial to this group. Proposal 1 suggests that changes in both quantity and price are most effective for achieving equity. Removing subsidies from the first blocks leads to a more equal welfare distribution, as seen in proposal 4, where low-income households experience the least loss compared to high-income households.

5.3 Poor households renting accommodation should receive more support
In Vietnam, the district budget is used for educational and social assistance expenditures related to cash transfer. Since fiscal responsibilities are heavily decentralized, transferring the assigned budget within a province can be challenging (Morgan and Trinh, 2016). Therefore, local authorities are less likely to provide support to temporary residents, making them ineligible for most forms of social assistance.

Regarding quantity-based subsidies, temporary households mainly pay a flat price that is typically higher than the official tariff. As a result, they consume less electricity but have a higher expenditure. For instance, a poor household paying the flat price uses 54.646 kWh, which costs them VND173,400. In contrast, a poor household living in their permanent registered house consumes 145.974 kWh and pays VND277,300. On average, a poor household living in their own house consumes 176.13% more but only pays 59.92% more than a household renting accommodation.

Thus, poor households living in rented houses should receive more support from the government. One possible solution is to transfer the burden of social assistance from subnational to national budgets. The national authorities may not have been able to do this in the past due to a lack of information about residence status, but this issue can be addressed as the national population database is currently under implementation.

6. Concluding remarks
This paper investigates the residential electricity subsidy in Vietnam from two perspectives: cash transfer and quantity-based subsidy. For cash transfer, we apply the framework of Komives *et al.* (2005) to evaluate the subsidy in three dimensions: benefit incidence, beneficiary incidence and materiality. Overall, cash transfer in Vietnam is ineffective as it does not fully cover the poor population, and the subsidy coverage depends heavily on the poor list, which records few poor households. The size of the subsidy is also small compared to the income of these households. While we believe cash transfer should be continued, it needs to be reformed, with specific attention paid to poor households living in rented accommodation. In terms of the quantity-based subsidy, we estimate the price elasticity of demand through the demand function and then measure the consumer welfare effect under four scenarios to provide some recommendations to improve the official tariff. Some critical policy implications are as follows: (1) to gain better welfare distribution, the marginal price in the first block should reflect the full marginal cost; (2) both the interval and the marginal price should be modified and (3) removing the subsidized blocks improves the distributional equity.

We also identify several potential research areas for further exploration of the residential electricity tariff in Vietnam.

(1) This study was limited to poor households. To provide more insightful policies, the study could be extended its scope to other vulnerable groups, such as households living in remote areas or minority groups.

(2) The current increasing block-rate pricing plan does not encourage conservation as high-income households benefit from consuming over subsidized blocks. Other forms of tariffs, such as time-of-use, time-of-day or real-time pricing, can be considered to improve welfare and conservation. Access to micro-data from EVN can help explore this examination.

References

Andres, L.A., Thibert, M., Lombana Cordoba, C., Danilenko, A.V., Joseph, G. and Borja-Vega, C. (2019), "Doing more with less: smarter subsidies for water supply and sanitation", World Bank, Washington, DC, available at: http://hdl.handle.net/10986/32277 (accessed 22 April 2023).

Asian Development Bank (2011), *Viet Nam's Success in Increasing Access to Energy through Rural Electrification*, Asian Development Bank, Manila.

Asian Development Bank (2016), *Viet Nam: Energy Sector Assessment, Strategy, and Road Map*, Asian Development Bank, Manila.

Baulch, B., Do, T.D. and Le, T.H. (2018), "Constraints to the uptake of solar home systems in Ho Chi Minh City and some proposals for improvement", *Renewable Energy*, Vol. 118, pp. 245-256.

Biegler, T. (2009), *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*, The Australian Academy of Technological Sciences and Engineering (ATSE), Victoria.

Bose, R.K. and Shukla, M. (1999), "Elasticities of electricity demand in India", *Energy Policy*, Vol. 27 No. 3, pp. 137-146.

Burtless, G. and Hausman, J.A. (1978), "The effect of taxation on labor supply: evaluating the Gary negative income tax experiment", *The Journal of Political Economy*, Vol. 86 No. 6, pp. 1103-1130.

BuShehri, M.A. and Wohlgenant, M.K. (2012), "Measuring the welfare effects of reducing a subsidy on a commodity using micro-models: an application to Kuwait's residential demand for electricity", *Energy Economics*, Vol. 34 No. 2, pp. 419-425.

Cohen, P., Hahn, R., Hall, J., Levitt, S. and Metcalfe, R. (2016), "Using big data to estimate consumer surplus: the case of Uber", Working Paper No. 22627, National Bureau of Economic Research, Massachusetts, available at: https://doi.org/10.3386/w22627 (accessed 22 April 2022).

Csereklyei, Z. (2020), "Price and income elasticities of residential and industrial electricity demand in the European Union", *Energy Policy*, Vol. 137, 111079.

Dapice, D., Le, P.V. and Le, T.H. (2022), "Phase change: getting to a sustainable energy future in Vietnam", in *Handbook of Energy and Environmental Security*, Academic Press, pp. 109-125.

Espey, M. (1998), "Gasoline demand revisited: an international meta-analysis of elasticities", *Energy Economics*, Vol. 20 No. 3, pp. 273-295.

EVN (Vietnam Electricity) (2016), "Electricity charge applicable to poor, low-income households", available at: https://en.evn.com.vn/d6/news/ELECTRICITY-CHARGE-APPLICABLE-TO-POOR-LOW-INCOME-HOUSEHOLDS-9-28-265.aspx (accessed 22 May 2022).

General Statistics Office (GSO) (2019), "Result of the Viet Nam household living standards survey 2018", General Statistics Office, Ha Noi, available at: https://www.gso.gov.vn/wp-content/uploads/2020/05/VHLSS2018.pdf (accessed 22 May 2021).

Ha-Duong, M. and Nguyen, H.S. (2017), "Is electricity affordable and reliable for all in Vietnam?", *Paper Presented at the Tenth Vietnam Economist Annual Meeting – VEAM 2017*, August 2017, Ho Chi Minh, available at: https://hal-enpc.archives-ouvertes.fr/hal-01572126/file/main.pdf (accessed 6 October 2021).

Ha-Duong, M. and Nguyen, H.S. (2021), "Subjective satisfaction and objective electricity poverty reduction in Vietnam, 2008-2018", *Fulbright Review of Economics and Policy*, Vol. 1 No. 1, pp. 43-60.

Halvorsen, R. (1976), "Demand for electric energy in the United States", *Southern Economic Journal*, Vol. 42 No. 4, pp. 610-625.

Hausman, J.A. (1981), "Exact consumer's surplus and deadweight loss", *The American Economic Review*, Vol. 71 No. 4, pp. 662-676.

Havranek, T., Irsova, Z. and Janda, K. (2012), "Demand for gasoline is more price-inelastic than commonly thought", *Energy Economics*, Vol. 34 No. 1, pp. 201-207.

Hewitt, J.A. and Hanemann, W.M. (1995), "A discrete/continuous choice approach to residential water demand under block rate pricing", *Land Economics*, Vol. 71 No. 2, pp. 173-192.

Hill, R.C., Griffiths, W.E. and Lim, G.C. (2018), *Principles of Econometrics*, Wiley.

Holtedahl, P. and Joutz, F.L. (2004), "Residential electricity demand in Taiwan", *Energy Economics*, Vol. 26 No. 2, pp. 201-224.

Howe, C.W. and Linaweaver, F.P. (1967), "The impact of price on residential water demand and its relation to system design and price structure", *Water Resources Research*, Vol. 3 No. 1, pp. 13-32.

International Energy Agency (2021), "Viet Nam", available at: https://www.iea.org/countries/viet-nam (accessed 16 October 2021).

Ito, K. (2014), "Do consumers respond to marginal or average price? Evidence from nonlinear electricity pricing", *American Economic Review*, Vol. 104 No. 2, pp. 537-563.

Khandker, S.R., Barnes, D.F., Samad, H.A. and Minh, N.H. (2009), "Welfare impacts of rural electrification: evidence from Vietnam", Working Paper No. 5057, World Bank Policy Research Working Paper, available at: https://doi.org/10.1029/WR003i001p00013 (accessed 6 October 2021).

Kim, H.Y. (1997), "Inverse demand systems and welfare measurement in quantity space", *Southern Economic Journal*, Vol. 63 No. 3, pp. 663-679.

Komives, K., Foster, V., Halpern, J. and Wodon, Q. (2005), *Water, Electricity, and the Poor: Who Benefits from Utility Subsidies?*, World Bank, Washington, DC.

Labandeira, X., Labeaga, J.M. and López-Otero, X. (2017), "A meta-analysis on the price elasticity of energy demand", *Energy Policy*, Vol. 102, pp. 549-568.

Le, V.P. (2020), "Electricity price and residential electricity demand in Vietnam", *Environmental Economics and Policy Studies*, Vol. 22, pp. 509-535.

Le, T.H., Han, P., Le, H.C. and Bui, M.T. (2023), "Electricity market development in Vietnam: historical trends and future outlooks", *Utilities Policy*, Vol. 81, 101510.

McRae, S. (2015), "Infrastructure quality and the subsidy trap", *American Economic Review*, Vol. 105 No. 1, pp. 35-66.

Morgan, P.J. and Trinh, L.Q. (2016), "Fiscal decentralization and local budget deficits in Viet Nam: an empirical analysis", Working Paper No. 613, ADBI, available at: https://www.adb.org/publications/fiscal-decentralization-local-budget-deficits-viet-nam (accessed 6 October 2021).

Narayan, P.K. and Smyth, R. (2005), "The residential demand for electricity in Australia: an application of the bounds testing approach to cointegration", *Energy Policy*, Vol. 33 No. 4, pp. 467-474.

Ngọc Linh (2020), "[INFOGRAPHIC] Proposing new retail electricity price", available at: https://vtv.vn/kinh-te/infographic-de-xuat-bieu-gia-ban-le-dien-moi-20200813064349065.htm (accessed 2 September 2021) (in Vietnamese).

Nguyen, H.S. (2019), "Exploring the determinants of household electricity demand in Vietnam in the period 2012-16", available at: https://www.theses.fr/2019SACLA013.pdf (accessed 24 February 2022).

Nguyen, T.T., Nguyen, T.T., Hoang, V.N., Wilson, C. and Managi, S. (2019), "Energy transition, poverty and inequality in Vietnam", *Energy Policy*, Vol. 132, pp. 536-548.

Ninh Thuan's Department of Industry and Trade (2015), "Electricity prices apply from March 16, 2015", available at: https://www.ninhthuan.gov.vn/chinhquyen/soct/Pages/Gia-ban-dien-ap-dung-tu-ngay-16-thang-3-nam-2015.aspx (accessed 21 August 2021) (in Vietnamese).

Nordin, J.A. (1976), "A proposed modification of Taylor's demand analysis: comment", *The Bell Journal of Economics*, Vol. 7 No. 2, pp. 719-721.

Poch, K. and Tuy, S. (2012), "Cambodia's electricity sector in the context of regional electricity market integration", in Wu, Y., Shi, X. and Kimura, F. (Eds), *Energy Market Intergration in East Asia: Theories, Electricity Sector and Subsidies*, Economic Research Institute for ASEAN and East Asia (ERIA), pp. 141-172.

Rietveld, P., Rouwendal, J. and Zwart, B. (2000), "Block rate pricing of water in Indonesia: an analysis of welfare effects", *Bulletin of Indonesian Economic Studies*, Vol. 36 No. 3, pp. 73-92.

Serebrisky, T., Gómez-Lobo, A., Estupiñán, N. and Muñoz-Raskin, R. (2009), "Affordability and subsidies in public urban transport: what do we mean, what can be done?", *Transport Reviews*, Vol. 29 No. 6, pp. 715-739.

Shin, J.S. (1985), "Perception of price when price information is costly: evidence from residential electricity demand", *The Review of Economics and Statistics*, pp. 591-598.

Son, H. and Yoon, S. (2020), "Reducing energy poverty: characteristics of household electricity use in Vietnam", *Energy for Sustainable Development*, Vol. 59, pp. 62-70.

Taylor, L.D. (1975), "The demand for electricity: a survey", *The Bell Journal of Economics*, Vol. 6 No. 1, pp. 74-110.

The National Embassy (2020), "Law on residence, 68/2020/QH14", available at: https://thuvienphapluat.vn/van-ban/Quyen-dan-su/Law-68-2020-QH14-Residence-460517.aspx (accessed 21 August 2021).

Wooldridge, J.M. (2013), *Introductory Econometrics: A Modern Approach*, Cengage Learning, OH.

World Bank (2015), "Household registration study 2015", available at: https://microdata.worldbank.org/index.php/catalog/2729 (accessed 21 August 2022).

World Bank and Vietnam Academy of Social Sciences (2016), *Vietnam's Household Registration System*, Hong Duc Publishing House, Hanoi.

World Bank (n.d.), "Access to electricity (% of population)", available at: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS (accessed 21 August 2022).

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