

# Impacts of a rise in electricity tariff on prices of other products in Vietnam

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## ABSTRACT

This study examines the impacts of increasing electricity tariff to the long run marginal cost on prices of other products using a static input–output approach. It is found that such an increase would drive up the prices of all other products. Although the aggregate price impact from such an increase is not large, it would be socially difficult to implement this increase at one time, particularly given that Vietnam is facing high inflation rate. A roadmap for electricity tariff increase is thus discussed.

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## 1. Introduction

Vietnam is a developing country in South East Asia. During 1990–2005, Vietnam experienced high growth in GDP, on average 7.54% per year, which resulted in strong demand for electricity, 13% per year in the same period. As an emerging economy, electricity demand in the coming period (2005–2025) is expected to continue to grow at a significant rate. The Institute of Energy forecasted that electricity demand would increase from 45,603 GWh in 2005 to 381,163 GWh, at an average annual growth rate of 11%, and, consequently, total power generation capacity would grow from 11,198 MW in 2005 to 85,000 MW by 2025 (IE, 2006). Such rapid development raises a number of questions to the Government of Vietnam, such as (i) how to secure funds to finance such an aggressive power source development,<sup>1</sup> and (ii) how to manage the power sector effectively and efficiently then. To address these problems the Government of Vietnam plans to restructure the power sector.<sup>2</sup> The roadmap which has been approved by the Prime Minister specifies that the power market in Vietnam will be established through three sequential developments: *competitive generation power market, competitive wholesale power market and competitive retail power market*. Phase

I starts in 2009, phase II in 2017 and phase III in 2024 (PM, 2006a). To do this, however, the electricity retail tariff to users, and subsequently the purchasing price for power from power producers must be increased first. This is because the weighted average retail electricity tariff in Vietnam in 2006 was only 870 Dong/kWh (5.5 US cent/kWh), which is generally lower than that of most countries and therefore not attractive for local and foreign enterprises to invest in new generating capacity in Vietnam (IE, 2006; JICA, 2007). This requirement has been recognized by the Government of Vietnam (Vnexpress, 2007). As a response to this, the Government of Vietnam plans to increase the price of electricity to the long run marginal cost (LRMC) of 7.5 US cent/kWh, or 2 US cents per kWh over the present average tariff (IE, 2006).

This action will definitely have impacts on prices of products of other sectors of the economy. Considering that Vietnam is integrating more intensively and extensively into the world economy and has been experiencing high annual growth in GDP, examination of these impacts is regarded as an important task for the development of the power sector and the economy. The objective of this paper is, therefore, to try to investigate the impacts of such an increase in the electricity tariff on the prices of other sectors. It proceeds as follows. Section 2 presents the static I–O model employed to this specific task. Section 3 discusses the results. Section 4 summarizes and concludes.

## 2. Methodology

Because electricity is used to produce most goods and services, higher electricity price can affect the prices of other sectors of an economy both directly and indirectly.

The I–O model describes the interdependence of all sectors in the production and consumption of products. It shows the input

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<sup>1</sup> Necessary fund for power source and power network development is estimated at around 4.5 billion USD per year, while the electricity sales revenue of EVN in 2005 was only 2.4 billion USD (IE, 2006).

<sup>2</sup> The power sector of Vietnam is currently dominated by the Electricity of Vietnam (EVN), a government-owned utility. EVN operates and owns power plants built to date and has shares in a number of independent power plants (IPPs). EVN has a monopoly role in transmission and sales of electricity. Electricity retail tariff in Vietnam is, however, governed by the Government and the Government of Vietnam maintains uniform national electricity tariff across the country (IE, 2006).

requirement for a sector and at the same time specifies how that sector distributes its production output to other sectors. In this regard, the I–O model is able to analyze the relationships among sectors, evaluate the impacts from one sector to other sectors, and thus can be used to quantify the effects from the electricity sector.

The I–O model was first proposed by Leontief in 1936. Since then it has been applied to various areas (Wilting, 1996). It has also been widely applied in energy-related contexts including electricity. Using the I–O model, Pfaffenberger et al. (2003) examined the impacts from the development of renewable energy technologies such as wind turbine and solar photovoltaic on the economy of Germany in terms of creating jobs. Pachauri and Spreng (2006) also used the I–O model to determine the indirect energy requirements of Indian households. Liang et al. (2007) used the I–O model to estimate the regional energy requirements and CO<sub>2</sub> emission in China. Han et al. (2004) applied the I–O model to investigate the role of four electric power sectors in the Korean national economy.

The I–O model has been introduced at some universities in Vietnam since the mid-1960s (Dong et al., 2006). However, until 1989 the first national I–O table of 54 sectors was made. To date, three national I–O tables have been created. The latest table consisting of 112 sectors for 2000 was released in 2003. There have been several studies applying those I–O tables. For example, Bo (2002) applied the I–O table to examine the role of the construction sector in the national economy. Tuyet and Ishihara (2006) used the I–O tables of 1996 and 2000 to examine the changes in energy intensities of different sectors between 1996 and 2000. There is, however, no application of these tables to the electricity sector.

With salient features in impact investigation and related applications as described above, in this research, the I–O model is chosen to examine the impacts from electricity tariff increase on the prices of other sectors in Vietnam. For this purpose, the following section will focus on the description of the I–O model and its adaptability to this specified task.

### 2.1. The general framework of I–O model

The I–O model is a set of linear equations, which represents the relationships among sectors of an economy over a stated period of time, say, a year. The I–O model for an economy consisting of  $n$  sectors can be expressed as

$$X_i = \sum_{j=1}^n X_{ij} + F_i = \sum_{j=1}^n a_{ij}X_j + F_i \quad (1)$$

or

$$X_j = \sum_{i=1}^n X_{ij} + V_j = \sum_{i=1}^n r_{ij}X_i + V_j \quad (2)$$

where  $X_i$  is the total gross output of sector  $i$  ( $i = 1, \dots, n$ );  $a_{ij}$ , defined as the delivery from sector  $i$  to  $j$  ( $X_{ij}$ ) per unit of sector  $j$ 's output ( $X_j$ ) are known as direct input or technical coefficients;  $r_{ij}$  are direct output coefficients, obtained by dividing the purchase by sector  $i$  from sector  $j$  by  $X_i$  total gross input of sector  $i$ ,  $F_i$  is final demand for sector  $i$ , and  $V_j$  is the value added in sector  $j$ .

Eq. (1) shows that the total production of any sector is equal to the sector's products used by all sectors in the economy plus the amount demanded for final use by consumer, exports, investment and government minus imports. Eq. (2) indicates that the total production of any sector is equal to the total purchase made by the sector from all sectors in the economy plus value added (i.e., wages, salaries, profit, taxes, etc.) in this sector.

### 2.2. Inter-industry linkages analysis

Eq. (2) can be expressed in matrix form as

$$X' = RX' + V \quad (3)$$

or

$$X' = (I - R)^{-1}V \quad (4)$$

where  $R$  is the direct output coefficient matrix,  $I$  is the identity matrix. The elements of inverse matrix represent the total direct and indirect requirements by sector per unit of value added. A prime (') denotes the transpose of the given matrix.

Eq. (4) could be used to examine the impacts of an exogenously given change in value added  $V$  (for example 1 Dong increase in the wage of the electricity sector),  $\Delta V$

$$\Delta X' = (I - R)^{-1}\Delta V \quad (5)$$

Eq. (4), however, cannot exactly assess the impacts from a change in the activity of a specific sector (the electricity sector for example) on the production activities of other sectors since that sector itself is part of the I–O matrix. To address this, that sector must be treated externally and is included in the value added (Miller and Blair, 1985). Adding superscript  $*$  to the new matrices and superscript  $E$  to the vector related to the examined sector gives  $X'^* = (I - R^*)^{-1}(V^* + R^E X^E)$ . The assumption  $\Delta V^* = 0$  (no change in the value added) yields

$$\Delta X'^* = (I - R^*)^{-1}R^E \Delta X^E \quad (6)$$

### 2.3. Leontief price model

The structural relationships between sectors in an economy are, however, more accurately measured in physical units. At least, this would eliminate the influences of prices.<sup>3</sup> Then, by reading across any column in the I–O table, one can regard the constitution of each sector as the cost structure of the production activity of each sector and analyze price impacts based on this fact. This is the Leontief price model (Han et al., 2004; Miller and Blair, 1985). However, in reality, most countries, including Vietnam, do not publish I–O tables in physical units. So, to be able to use the Leontief price model, it is necessary to assume that unit prices of all sectors are one Dong. In this sense, the I–O table in monetary unit can be regarded as that in physical unit and the effects that are estimated would be the relative one. Eq. (6) now becomes

$$\Delta P^* = (I - R^*)^{-1}R^E \Delta P^E \quad (7)$$

Eq. (7) can be used to investigate the effects of a change in electricity price on the prices of other sectors.

### 2.4. Data preparation and assumptions

To investigate the effects of an increase in electricity tariff on the prices of other sectors in Vietnam, we use the I–O table for

<sup>3</sup> For example, a steel manufacturer may use 700 kWh of electricity in making 1 ton of steel. Whether the price of a kWh of electricity is 1 USD per kWh or 1.5 USD per kWh, the production needs of electricity in making 1 ton of steel will most likely not be changed. But under 1 USD price, the cost of electricity inputs into 1 ton of steel will be 700 USD, whereas at 1.5 USD per kWh, the cost will be 1050 USD. Thus, the  $a_{ij}$  representing electricity used by steel will change with the price of electricity, even though the basic structural relationship is unchanged (Miller and Blair, 1985).

**Table 1**

Effects from a 36% rise in electricity tariff to prices of other sectors

	Sector	Direct effect (%)	Indirect effect (%)	Overall effect (%)
1	Cultivation	0.155	0.201	0.355
2	Livestock	0.236	0.228	0.464
3	Agricultural services	1.794	0.445	2.239
4	Forestry	0.185	0.080	0.264
5	Fishery	0.521	0.179	0.700
6	Mining	0.975	0.111	1.087
7	Processed meat and oil	0.122	0.247	0.370
8	Candy and milk products	0.247	0.326	0.573
9	Processed fruits and vegetables	1.956	0.282	2.238
10	Alcohol, beer and other drinks	0.643	0.330	0.974
11	Processed coffee and tea	0.446	0.199	0.644
12	Cigarette and tobaccos	0.120	0.265	0.386
13	Processed seafood	0.354	0.506	0.860
14	Rice processing	0.196	0.329	0.524
15	Glass, ceramics	0.376	0.323	0.699
16	Building materials	0.877	0.541	1.418
17	Pulp and paper	1.030	0.375	1.405
18	Processed wood	0.414	0.227	0.641
19	Basic chemicals	0.391	0.056	0.447
20	Fertilizer	0.383	0.142	0.525
21	Pesticide	0.099	0.075	0.174
22	Veterinary medicine	0.086	0.212	0.298
23	Health medicine	0.145	0.091	0.237
24	Processed rubber	0.500	0.239	0.738
25	Soap and toilet preparation	0.224	0.283	0.507
26	Plastic	0.426	0.169	0.595
27	Paint and other chemicals	0.187	0.130	0.317
28	Health instruments	0.286	0.084	0.370
29	Home appliances	0.282	0.269	0.551
30	Motor vehicles and bikes	0.117	0.165	0.282
31	General purpose machinery	0.075	0.060	0.136
32	Automobiles	0.194	0.139	0.333
33	Electrical equipment	0.125	0.141	0.266
34	Non-ferrous and ferrous metal	0.654	0.301	0.955
35	Textiles	0.445	0.368	0.812
36	Leather	0.088	0.319	0.407
37	Animal feeds	0.288	0.371	0.659
38	Printing activities and publishing	0.267	0.442	0.709
39	Other physical goods	0.306	0.204	0.510
40	Gasoline, lubricant and gas	0.147	0.011	0.159
41	Electricity	–	–	–
42	Water	1.703	0.104	1.808
43	Construction	0.249	0.513	0.763
44	Trade and repair services	0.131	0.140	0.271
45	Hotel and restaurants	0.436	0.202	0.639
46	Transportation	0.080	0.121	0.202
47	Post and telecommunication	0.124	0.113	0.237
48	Banking	0.326	0.064	0.389
49	Other services	0.377	0.157	0.534
	Weighted average of sectoral price impact	0.330	0.230	0.560

2000. This I–O table consists of 112 sectors and is the latest available (GSO, 2003). To facilitate the calculation and also to conform to customer classification of the electricity sector, these 112 sectors are aggregated into 49 sectors as shown in Table 1. As the adopted I–O table is several years old now, to use it for the present context it must be assumed that there were no economic structure and technological changes in the mean time.

### 3. Results and discussions

Table 1 shows the impacts from a rise of 2 US cent per kWh in electricity tariff, from 5.5 to 7.5 US cent/kWh, or 36% on the prices of other sectors. It can be seen that the impacts to individual sectors are not big. The largest price increase occurs in the agricultural services sector, with 2.239%. There are only three sectors with the price increase of more than 1.5%. Forty-two sectors or more than four-fifth of the total number of sectors have

the price increase of less than 1%. The aggregate price increase<sup>4</sup> is just 0.56%.

Sixty-five per cent of these effects are related to the amount of electricity that are consumed directly by these sectors, while the rest represents the indirect part hidden in other inputs also used by these sectors.

These increase in prices would lead to an increase in the household expenditure. The average increase is estimated at 0.96%, which is expected to be higher for rural households due to a higher share of electricity expense in their annual expenditure.

Although, these effects are not large and could be, in reality, even smaller as sectors could cut the benefit or rearrange their activities in favor of other factors of production including labor and capital, there are impacts from other sectors such as the

<sup>4</sup> The aggregate price increase is calculated as the average of sectoral price impact with consideration of total output of each sector.

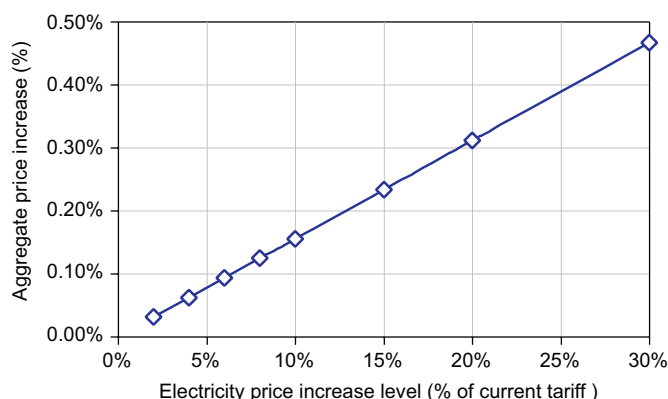


Fig. 1. Aggregate price increase as a function of electricity price increase level.

**Table 2**  
Comparison of impacts of four infrastructural sectors

Sector	Value (%)
Electricity	0.56
Water	0.12
Telecommunication	0.30
Transportation	0.34

petroleum sector and the food sector. These factors and other factors, during the last 3 years, have led to high consumer price index (CPI). The CPI in 2004, 2005 and 2006 were 9.5%, 8.4% and 6.6%, respectively (GSO, 2007a), while the corresponding GDP growth rates were 7.8%, 8.4% and 8.2% (GSO, 2007b). Thus, we propose that the increase in the electricity price be gradual, or in other words, there should be a road map for electricity tariff increase. Along with electricity price increase, attention should be paid to other financial incentives such as special loans, preferential interest rate, preferential land use fee or exemption from import tax for power projects. These incentives would help bring down the investment cost to investors and thus relieve the pressure of electricity price increase to the government. As the amount of increase is a big question to be decided by the decision makers, to give them a hint regarding this, the aggregate price increase as a function of electricity price increase level is provided in Fig. 1 and the aggregate price increase by the other infrastructure sectors, including the water sector, the telecommunication sector and the transportation sector, given the same price increase level is provided in Table 2.

#### 4. Summary and conclusions

Electricity plays an important role in the socio-economic development of Vietnam. At present, the electricity tariff in Vietnam is quite low (the weighted average price is 5.5 US cent per kWh), which does not ensure a reliable long-term supply of electricity. The Government of Vietnam thus plans to raise the electricity tariff to the LRMC of 7.5 US cent/kWh. This study examines the impacts of such an increase in the prices of other sectors using the static I–O approach. It is found that such an increase would drive up the prices of all other sectors. The highest increase is expected to fall into the agriculture services sector, followed by the processed fruits and vegetables sector. Although

the aggregate price impact from such an increase is not large, it has been shown that it would be socially difficult to implement this increase at one time, particularly given that Vietnam is facing high inflation rate. It is thus proposed that the increase in electricity tariff be gradual. As a hint to policy makers regarding roadmap making for electricity tariff increase, the aggregate price increase as a function of electricity increase level has been performed. The study also recommends that attentions be paid to financial incentives such as special loans, preferential interest rate or exemption from import tax for power projects, as these would relieve the pressure of electricity price increase.

It is expected that this study would provide energy planners and policy makers with useful information on the impacts of electricity price increase. Based on these results, planners and policy makers can visualize proper policies to support socio-economic development while enhancing the security of the energy system. From the methodological point of view, this study has shown the applicability of I–O model for the power sector. From this, other applications to the power sectors, such as examination of the impacts of electricity shortage, investment...or similar applications to other sectors, could be performed.

However, caution should be taken in using these results. The I–O table used in this analysis is actually for the year 2000. The present economic structure might be different from that of 2000. These results are also limited by the assumptions of the I–O model: (i) fixed input/output ratio, and (ii) fixed input ratio, due to the linearity of the model. It is proposed that improvement of this study in the coming period by using new I–O table<sup>5</sup> and considering changes in the composition and proportion of inputs as well as extending the scope of effects be carried out.

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<sup>5</sup> The I–O table for 2007 is expected to be available in late 2009.

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