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Power Using, Economic Structure and Sustainable Development in the Vietnamese Economy

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ABSTRACT: Electricity is an essential element for the production and the consumption in any economy. Electricity can be generated by thermoelectricity, hydroelectricity, nuclear power, solar power and wind power, etc.Each method of electricity production can make the level of greenhouse gas emissions of the economy differently. This study adopted Input - Output analysis method to examine the electricity requirments and greenhouse gas emissions in the Vietnamese economy.

KEYWORDS: Green house gas, economy, clectriccity, input-output, structure

1. INTRODUCTION

Energy consumption plays an important role in the analysis of supply and demand of products, which is an important input in the formation process of any goods and services. The most suitable tool to enable one to track the flow of energy through the economy is usually an analysis based on input - output system, John Peet[(5)]on 1993 in his research proposed Input - Output Energy Analysis. The philosophical origin of Input – Output analysis in economics dates back to physicists in France in the time of Louis XV in the eighteenth century. At that time, François Quesnay developed and proposed a model called the "Economic Schema", for describing the material exchange between different sectors of the economy. The technique as it is now known was developed by Leontief [(6)] in the 1930's, 1940's of the 20th century and has since been greatly expanded.

The input - output system is a useful and most relevant tool in analyzing the economic and environmental effects of electricity, this problem is a specific application area of input - output analysis, where attention is focused on focuses on the energy requirment of production and final demand in an economy. It also allows an assessment of the energy needs to produce the final products;

The essence of the W. Leontief's input - output model is a system of linear functions, with the number of functions being the number of sectors in the Input – Output table. There have been many debates which linear function or nonlinear function is better. Some people believed that Input - Output system is linear function rather than nonlinear function,.However, they seem to forget that the nonlinearity requiresthe linearity to solve the problem at the end.For example, thecalculation of the length or area of a curve requires that Riemann has linearized by taking a partition of n segments (n->∞), then which restores the old functional nonlinearity by smoothing the partition (Riemann integral).

These problems have been generalized by John Peet's techniques in the Input - Output model on 1993 that provids a valuable means of associating physical factors with value factors in an economy. Especially, when it modified to the Input – Output form, which explicitly incorporates the energy use and the economic structure.The study adopted the updated Input - Output table on 2016 and the CO2 waste data in Hung, Trinh's study [(4)] on 2019. A number of industries surveyed industries in the model as shown on Appendix 1.

Approarch

The first significant work published in this field was by Wright [(15),] who estimated that the energy costs of goods and services based on Input - Output panel data in the UK and US.Pick and Becker [(14)] also carried out similar calculation in the UK. Both assumed an uniform energy tax rate for all economic sectors, as a means of converting values into their average energy flows. They also specify a zero energy value for imports.

The standard equation of input – output system has the form:

$$X= (I – A)^{-1}.Y \quad (1)$$

With: X is a vector of output. Y is a vectorx of final demand, $I - A)^{-1}$ is Leontief inverse matrix that present output requirement induced by a unit increase of final demand.

The equation (1) presents the input – output table at competitive – import type, In order to move the Input – Output table from the competitive – import type to non – competitive import type the equation (1) can be written as below:

$$X= (I – A^d)^{-1}.Y^d \quad (2)$$

In this case A^d is a coefficient matrix of domestic direct input and Y^d is a vector of domestic final demand

Set up: X* is diagonal matrix with diagonal element is element of vector X and ratios of value added (v) was difined as below:

$v = V.(X^*)^{-1}$

We have:

$$V = v. X = v. (I – A^d)^{-1}.Y^d \quad (3)$$

$v. (I – A)^{-1}$present thevalue added induced by a unit increase of final demanf

Similarly, what the basic method used is that the total energy E is the product of the matrix/vector of the energy coefficient (e) per output (X) and output:

$$E = e. X = e.(I – A^d)^{-1}.Y^d \quad (4)$$

The coefficient vector (or matrix) can be derived from a direct intermediate input coefficient matrix or it can also be in the form of a hybrid unit of matter and value. $e.(I – A)^{-1}$ represents the energy demand for a unit of final demand.

From equations (2), (3) and (4) can estimate that the induced impacts of each factor of domestic final demand to output, value added and energy or environmentalare as follows:

Output induced by domestic final demand: $\sum_i^n X \div \sum_i^n Y^d$

Value added induced by domestic final demand: $V \div \sum_i^n Y^d$

Energy (or environmental) induced by domestic final demand: $F \div \sum_i^n Y^d$

To be explicit about total output requirement for energy demand and other sectors, the coefficient matrix of intermediate input A can be divided into submatrices:

$$A=\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \quad (5)$$

Where: $A_{ij}$is sub-matrix of A matrix that presents sectors group $_j$ use products of sectors group i for intermediate input., The Leontief inversed the matrix B that is also divided according to matrix A as follow:

$$B= (I – A)^{-1} = \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} \quad (6)$$

So, ∑in is the total outputrequirement for an unit increase of the final demand of sectors group i, it includes output requirement of themselves (B_{ii}) and rest of sectoes of economy (B_{ij})

In the case of research focusing on the electricity sector as shown on Appendix 2, which is possible to establish a relationships affecting the environment. Assuming let δ1 be the green house gas emission factor of thermal power, δ2 is the green house gas emission factor of hydroelectricity, etc. δ4 is the green house gas emission factor of the power distribution. Let δ* be a diagonal matrix with diagonal elements δi

$$\delta=\begin{bmatrix} \partial 1 & & \\ & & \\ & & \partial 4 \end{bmatrix} \quad (7)$$

And the green house gas waste matrix from sectors in the economy emitted when using the input of electricity is set up as follows

$$C = \delta.B_{21} \quad (8)$$

RESULTS

Below Table 1 presents a structure of the Vietnamese economy on both the supply side and the demand side. Calculations from the competitive import type and the non-competitive import type input output table shows that the ratio of the intermediate

inputs to the output of the whole economy is about 71%, which means that every USD100.00 on output created USD29.00 is the value added, which the compensation of the employees is USD 16.00. Indirect tax minus the subsidies is USD3.00USD10.00of the gross operating surplus.In addition, it also shows that the most industries in the manufacturing industry group has a very high proportion of intermediate inputs in the production value.These ratios partly sugguests that the production of the manufacturingsectors of Vietnam is largely outsourcing.

On the demand side, the needs of industries no. 2 and no. 10 are very large as, the domestic production cannot meet these industries needs. The demand for imports of these products is very high. Therefore, , increasing the production of these two industries is not only produce a better growth for the economy, but also limits to the imports. Currently, the products of Vietnam's timber logging industry are basically in low value industry. To improve value, , it is necessary to increase the tree planting with taking care of forests as well as investing in farmers. As a result, the harvested timber will meet the international standards in order to increase the value of timber export.

Surprisingly, the share of value added in production value of the electricity sector is the highest among the sectors surveyed in the model, Power used for intermediate demand accounts for 84% and only 16% for final demand in the total demand of the electricity industry.The selling price of the electricity has 11 times increased (or up 221%).

Table 1. Structure of Vietnam economic

Unit: Times

Industry Code	**Supply size**				**Demand size**				
	Rate of domestic intermediate inputs	Rate of Import intermediate input	Rate of intermediate inputs in input	Rate of value adde	Rate of domestic intermediate demand	Rate of import intermediate dema	Rate of total intermediate demand	Rate of final demand	Rate of domestic final demand
1	0.430	0.0517	0.482	0.518	0.999	0.000	0.999	0.001	0.001
2	0.301	0.3465	0.648	0.352	0.683	1.846	**2.529**	-1.529	0.317
3	0.445	0.1355	0.581	0.419	0.727	0.115	0.842	0.158	0.273
4	0.720	0.0972	0.817	0.183	0.595	0.027	0.622	0.378	0.405
5	0.614	0.1466	0.761	0.239	0.620	0.001	0.621	0.379	0.380
6	0.412	0.2119	0.624	0.376	0.481	0.130	0.611	0.389	0.519
7	0.777	0.112	0.890	0.110	0.479	0.000	0.479	0.521	0.521
8	0.491	0.257	0.748	0.252	0.369	0.223	0.593	0.407	0.631
9	0.529	0.287	0.816	0.184	0.592	0.164	0.756	0.244	0.408
10	0.577	0.244	0.822	0.178	0.836	0.502	**1.338**	-0.338	0.164
11	0.452	0.358	0.810	0.190	0.505	0.515	1.020	-0.020	0.495
12	0.287	0.108	0.395	0.605	0.820	0.018	0.838	0.162	0.180
13	0.409	0.125	0.534	0.466	0.550	0.000	0.550	0.450	0.450
14	0.492	0.271	0.763	0.237	0.125	0.000	0.125	0.875	0.875
15	0.512	0.192	0.705	0.295	0.512	0.032	0.544	0.456	0.488
16	0.565	0.129	0.694	0.306	0.160	0.021	0.181	0.819	0.840
17	0.439	0.118	0.557	0.443	0.708	0.060	0.768	0.232	0.292
18	0.399	0.094	0.493	0.507	0.435	0.034	0.469	0.531	0.565

Source: Author calculated from Vietnam input – output table

Below table 2 summarize the elasticity of labor and capital of Vietnam economy of 18 sectors with capital driven intensively.They areNo. 1, No. 6, No. 9, No. 13, No. 14 and No. 17. The elasticity of the labor and the capital of aformentioned electricity sectors

have a very higher surplus than the rest of the industries.as they are monopoly industry.

Table 2. Share of labor and capital of Vietnam economy

Unit: Times

Industry Code	Share of labor	Share of capital
1	0.956	0.044
2	0.667	0.333
3	0.738	0.262
4	0.718	0.282
5	0.862	0.138
6	0.964	**0.036**
7	0.686	0.314
8	0.868	0.132
9	0.921	**0.079**
10	0.695	0.305
11	0.709	0.291
12	0.370	0.630
13	0.915	**0.085**
14	0.922	**0.078**
15	0.806	0.194
16	0.843	0.157
17	0.960	**0.040**
18	0.729	0.271
Tổng số	**0.773**	**0.227**

Source: Author calculated from Vietnam input – output table

Below the table 3presentas a unit of the final demand induces to the output that is higher than other industries.Industries with higher spillover coefficients are sectors no. 04 (livestock), no. 05 (aquaculture), no. 07 (processing industry for agricultural, forestry and fishery products), no. 10 (Production of petroleum, chemicals, rubber and plastic products), no. 15 (transportation & preservation), no. 16 (Food service activities drink & stay).However, the spillover of the final demand to the value added is really more important, as it spreads strongly to the output, but they does not spread to the value added as much as these sectors . No. 05, no. 07, no. 10 and no. 15.

On the other hand, a few industries have a low power of dispersion coefficient to the output, but they have higher spillover to the added value i.e. no. 01 (Products for planting and taking care of forests), no.03 (cultivation), 12 (electricity), no. 13 (Water supply; drainage, waste management and treatment activities), no. 17 (Professional, scientific & technical activities) and no. 18 (other services).

With regard to environmental impact, Most of the processing, manufacturing and the construction industries release huge amounts of green house gase to the environment. They are industry no. 12 (electricity) and no. 13 (water supply; drainage, waste management and treatment activities) that with green house gas emissions many times higher than the overall level of the economy. The electricity and water supply sector have a high level of spillover to the value added as they are monopolistic or semi-marketable. Which means that every increase in electricity price increases the value added of these sectorsincome increasing from the production and the operating surplus? One reason why the electricity industry emits a lot of greenhouse gases is that thermal power accounts for more than 60% of the total electricity production.The total capacity of the thermal power plants (i.e. coal, gas) will reach about 64.5% of the total installed capacity by 2020 in accordance with master plan of Vietnam Govrnment, producing about 70.8% of the electricity output.The total capacity of the power plants thermal power accounts for 63.4% of the

total installed capacity by 2030, producing thermal is about 71.2% of electricity output.As a result, the level of air pollution in Vietnam is not reducing but increasing.

The results of the empirical study sugguests that planting trees are very important reducing green house gas emission. If one wishes to develop afast and sustainiable economic development, planting trees shall be the main priority rather than deforestation.

Table 3. The Induced impacts of a unit increase of final demand to supply side and GHG emissions (times)

Industry Code	Output requirements	Power of dispersion on output	Induced to value added	Power of dispersion on value added	Induced to GHG (thousand tons / million Vietnam dong)	Power of dispersion on GHG
1	1.783	0.883	0.852	1.375	-0.00048	-8.901
2	1.515	0.750	0.560	0.903	-0.00006	-1.146
3	1.944	0.962	0.691	1.114	0.00010	1.835
4	2.908	1.439	0.636	1.025	0.00009	1.631
5	2.484	1.230	0.600	0.968	0.00003	0.489
6	1.782	0.882	0.600	0.968	0.00006	1.159
7	2.809	1.390	0.610	0.984	0.00005	0.934
8	1.968	0.974	0.517	0.834	0.00002	0.303
9	2.007	0.993	0.487	0.786	-0.00004	-0.778
10	2.145	1.062	0.506	0.816	0.00004	0.653
11	1.847	0.914	0.401	0.647	0.00001	0.205
12	1.521	0.753	0.772	1.244	0.00024	4.426
13	1.778	0.880	0.709	1.144	0.00066	12.338
14	1.968	0.974	0.489	0.789	0.00008	1.479
15	2.043	1.011	0.581	0.937	0.00007	1.270
16	2.289	1.133	0.658	1.061	0.00008	1.395
17	1.825	0.903	0.726	1.171	0.00003	0.467
18	1.749	0.866	0.765	1.234	0.00001	0.240

Source: Author's calculations from Vietnam input - output table

Table 4 presents how the factors of the domestic final demands (i.e.final consumption, investment and exports) induces the impacts into the production value, the value added and the greenhouse gas emissions. Production value: The table 4 shows the Investment induced to production value is the lowest, one unit of investment induced to the production value USD 2,008 of production value, lower than the spillover of final consumption and exports induces to the output about 4%.

Value added: Investment not only spreads to the low production value, but it also has the lowest spillover to value added, followed by export of goods. The final consumption and service exports spillover to production value is not the highest, but the spillover to the value added is very large. When it comes to demand stimulus, it is implied that the stimulus on the demand side increases the supply side. Research shows that the stimulus to consumption and export of services spreads best to the value added of the economy

Impact on the Environment: Export of goods is not only spreads to the low value added but it also releases the highest greenhouse gas emissions in the production process, accounting for nearly 39% of total emissions. Goods Export is the basic by the foreign direct investment sector, the sector's exports account for more than 70% of merchandise exports. However, the irony is that the main culprit of air pollution seems to be innocent; exporting goods is also seen as an achievement and enjoys many policy incentives such as taxes, land...

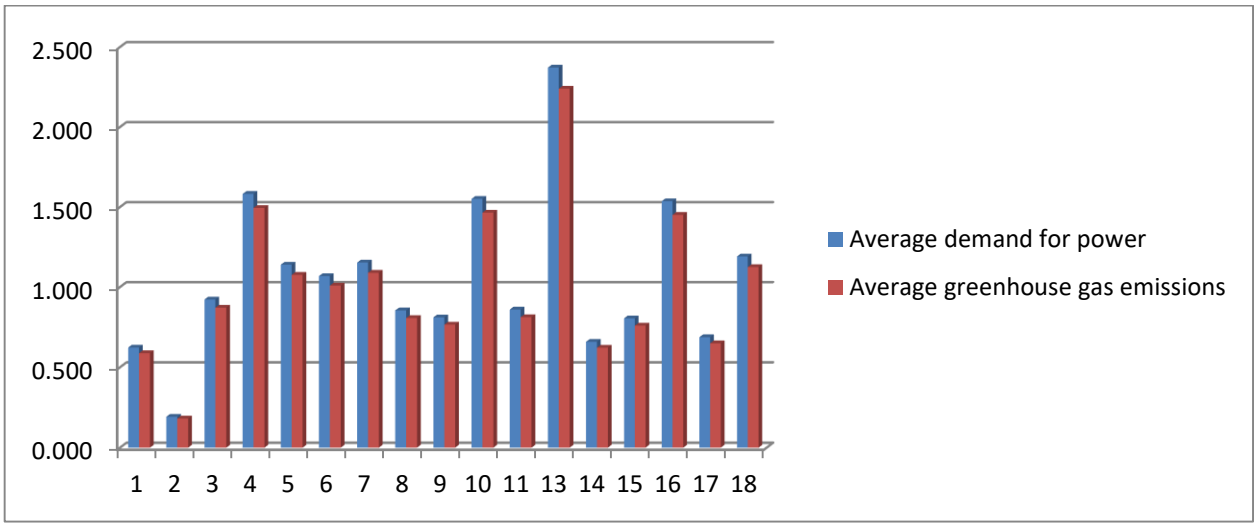
Table 4. Induced impacts from final demand factors to output, value added and greenhouse gas (GHG) emissions

	Final cónumption	Gross capital formation	Export of goods	Export of sẻvices
Output (times)	2.093	2.008	2.082	2.096
Value added (times)	0.66	0.49	0.54	0.55
GHG (%)	34.60	20.39	38.89	6.12

Source: Author's calculations from Vietnam input - output table

Below Figure 1 presents how the final products spillover to the power output? Calculation results show that the final products of industries (i.e. no. 04, no. 10, no. 13 and no. 16) induced to the very high power outputs. These industries are also the industry sectors that release the highest greenhouse gas emissions through electricity consumption,

Figure 1. Average electricity requirements and average greenhouse gas emissions (times)



Source: Author's calculations from Vietnam input - output table, 2016

CONCLUSIONS

The research results sugguest that the most of the manufacturing and processing industries have a relatively higher spillover into the production value, but it has a low spillover to the added value, which partly sugguests that the almost all activities of these industries group are outsourcing. However, this group of industries is the group that releases the largest greenhouse gas. The manufacturing and processing industries need to increase the spread to the added value by introducing the outsourcing process quickly and shall be paying a higher environmental protection tax.

The cropping, livestock and aquaculture have a good level of spillover to added value, but it also generates greenhouse gases higher than the average level of the economy. In order to develop quickly with sustainable development, these industry groups need to be invested in techology and to improve production processes reducing greenhouse gas emissions.

In short, the research recommends that the priority of the industry structure shall be changed from 1) industry, 2) service, 3) agriculture to 1) service, 2) agriculture3) industry for the rapid with sustainable development. In particular, the forestry activities, especially planting, tending and protecting forests should be given a top priority. .

The research results also found that Vietnam has not yet focus on the environment impact, but rather cofocsing onnon-sustainable econcomic growth in the short term. It is necessary to replace the structure in the total electricity output with other power production methods that have less impact on the environment in order to grow the economic in sustainableway.

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Appendix 1. Sectors in the model

Products for planting and taking care of forests	**1**
Logging and other forest products	**2**
Crop	**3**
livestock	**4**
Aquaculture	**5**
Mining and quarrying	**6**
processing industry for agricultural, forestry and fishery products	**7**
Manufacture of textiles, clothing, footwear and leather goods	**8**
Manufacture of wood, paper and related products; Printing	**9**
Production of petroleum, chemicals, rubber and plastic products	**10**
Manufacture of metal products, machinery and equipment	**11**

ELECTRICITY	**12**
Water supply; drainage, waste management and treatment operations	**13**
Construct	**14**
Transport & Storage	**15**
Catering & accommodation service activities	**16**
Professional, scientific & technical activities	**17**
Other services	**18**

Appendix 2. Layout of electrical groups in the input - output

		Intermediate input					Final demand	Gross output
		Thermal	Hydroelectricity	Other power production	Power distribution	Other sector		
Intermediate cónumption	Thermal	0	0	0	X1	0	0	**X1**
	Hydroelectricity	0	0	0	X2	0	0	**X2**
	Other power production	0	0	0	X3	0	0	**X3**
	Phân phối điện	0	0	0		T4	Y4	**X4**
	Other sector	Z1	Z2	Z3	Z4	Z5	Y5	**X5**
	Valuue added	V1	V2	V3	V4	V5		
	Gross input	**X1**	**X2**	**X3**	**X4**	**X5**		

Note: Z1 + V1 = X1; Z2 + V2 = X2; Z3 + V3 = X3; T4 + Y4 = X4 = X1+ X2 + X3 + Z4 + V4;