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VIET NAM ENERGY-FOCUSED SOCIAL ACCOUNTING MATRIX (ESAM)

2019 Energy Accounts an Emissions Accounts for Viet Nam

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2019 ENERGY ACCOUNTS AND EMISSIONS ACCOUNTS FOR VIET NAM

Technical Report

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LIST OF ABBREVIATIONS AND TERMS

Abbreviations/ Terms	Definition
CO_2e	CO_2-equivalent
Decision No. 2626/QĐ-BTNMT	Decision No. 2626/QĐ-BTNMT dated 10 October 2022 of the Ministry of Natural Resources and Environment on publishing list of emission factors serving greenhouse gas (GHG) inventory development
Emission Factor Matrix Table	The matrix table that describes the emission factors (for CO_2, N_2O, and CH_4) from combustion for energy products by accounts The rows of this table describe the energy products used, while the columns illustrate the accounts that use energy products. The emission factors are collected from the emission factors for fuel combustion activities in Appendix 1 of Decision No. 2626/QĐ-BTNMT; IPCC (2006).
Emission Matrix Table	The matrix table that describes the volume of greenhouse gas emissions (for CO_2, N_2O, and CH_4) from fuel combustion for each energy product in each account. The rows of this table represent the energy products used, while the columns show greenhouse gas emissions from fuel combustion by accounts.
Energy Supply Table	The matrix table that describes the volume of energy products supplied by accounts in the economy. The rows of the table describe the energy products supplied; the columns describe accounts supplying the energy products.
Energy Use Table	The matrix table that describes the volume of energy products used by every account. The rows of this table represent the energy products used, while the columns illustrate the accounts consuming energy products.
E-SAM	Energy-focused Social Accounting Matrix
EST	Energy Supply Table
EUT	Energy Use Table
GHG	Greenhouse gas
GWP	Global Warning Potential Index
HH	Household
IPCC (2006)	The Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories (2006)
KTOE	Kilo Tone of Oil Equivalent
NSO	National Statistics Office
Official dispatch No. 116/BĐKH-TTBVTOD	Official dispatch No. 116/BĐKH-TTBVTOD dated 26 February 2021 of the Department of Climate Change - Ministry of Natural Resources and Environment on the emission factor for the Vietnam electricity grid in 2019
PSUT	Physical Supply – Use Table
SDG	Sustainable Development Goals
SEEA-Energy	System of Environmental – Economic Accounting for Energy
TJ	Terajoule

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INTRODUCTION

Within the framework of the E-SAM Project, Vietnam's 2019 Physical Supply and Use Table for Energy (PSUT 2019) was compiled by the NSO. These tables record the supply and use of 20 types of energy products[1] across different accounts, including: Economic sectors (46 sectors), Households, Changes in inventories and Exports. Based on PSUT 2019, the Institute of Policy and Strategy Studies (IPSS) has constructed GHG emission matrix tables from fuel combustion (comprising CH_4, N_2O, CO_2 and CO_2e). The 2019 statistics aim to connect with E-SAM 2019[2], which was developed using the latest updates of Supply and Use Tables for Vietnam in 2019. The connection between the PSUT and E-SAM enables a more detailed analysis of the mechanisms affecting the use of energy products within the economy, thereby informing appropriate regulatory policies. Linking energy use with emissions and the E-SAM enhances the capacity to model, analyze and evaluate the socio-economic impacts of policies further, thereby promoting the green transition in Vietnam.

This report provides an overview of actual energy supply – use and related GHG emissions for Vietnam in 2019. This is a part of ongoing efforts to support the development of energy transition policies with an orientation to achieve net-zero emissions by 2050 - a vital strategic direction that has been clearly identified by Vietnam's policymakers.

The data and information used to compile the PSUT 2019 were collected from multiple sources using standard statistical methods, with the aim of providing reference information on energy use trends and characteristics in Vietnam. The GHG emission matrix was developed by combining information from the 2019 EUT with the emission factors stipulated in Decision No. 2626/QĐ-BTNMT, focusing on GHG emissions factors from fuel combustion[3].

Apart from the introduction and conclusion, the report is structured into four sections as follows:

(i) Section 1 provides an overview of the structure of the PSUT 2019 and the methodology for constructing the GHG emission matrix table from fuel combustion;

(ii**)** Section 2 presents an overview of energy production and consumption based on the PSUT 2019, including: overview of energy production and consumption in Vietnam in 2019; an analysis of energy consumption intensity by sectors; and the share of renewable energy in total final energy consumption (SDG Indicator 7.2.1);

(iii) Section 3 outlines the situation of GHG emissions from fuel combustion in Vietnam in 2019, including GHG emissions by accounts and by energy products;

(iv) Section 4 presents selected results of a E**-**SAM multiplier analysis, based on the integration of energy account data with E-SAM 2019. The aim is to demonstrate the potential of combining these two datasets to provide more detailed and policy-relevant analyses.

[1] Measured in KTOE or TJ.

[2] For further information, see a descriptive report on ESAM 2019.

[3] In the energy sector, GHG emissions arise from: (i) fuel combustion and (ii) dispersion.

CHAPTER 1. Overview of the Energy Account and Methodology for Developing the Emission Matrix Table from the Energy Use Table

1.1. Structure of Energy Account

Vietnam's 2019 Physical Supply and Use Table for Energy, compiled by the NSO, consists of the Energy Use Table (EUT) and the Energy Supply Table (EST). The tables were constructed based on maximum compliance to the characteristics and statistical principles of the SEEA-Energy System. The structure, content and level of disaggregation for energy products and economic accounts are fully consistent across two tables. These tables describe the volume of physical energy flows across different accounts of the economy. The size of these tables is a matrix of 62 rows and 61 columns (62x61), in which ***for rows***, from 1 to 8 recording energy inflows from nature; from 9 to 52 recording energy product flows; and from 53 to 61 showing energy residuals; while row 62 records total energy use (for EUT) or total energy supply (for EST). ***The columns*** represent accounts using or supplying energy products; specifically, from 1 to 54 is industries; from 55 to 57 is households; 58 is Change in inventory; 59 is export (for EUT) or import (for EST); column 60 is the natural environment; and column 61 is the total energy inflows from nature, energy products, and energy residuals.

The two tables have complementary statistical perspectives on each energy flow. Specifically, for energy inputs from nature, the EST records the natural energy products supplied to domestic energy production, whereas the EUT describes the natural energy products used by extraction and mining sectors (including industries and households). For energy product flows, the EST captures the volume of energy products supplied by domestic industries and imported to satisfy the energy demand of the economy. In contrast, the EUT records the volume of energy products used by four accounts. Although the statistical perspectives of the two tables differ, for each energy product the total energy supply (the total row) equals the total energy use.

Table 1. Full structure of Energy Use Table

		Accounts of the economy					Total use of inputs, energy products, and energy residues (61)
		Industries (1-54)	**HH** (55-57)	**Change in inventory** (58)	**Export** (59)	**Environment** (60)	
Energy flows	**Natural energy inputs** (1-8)	X	X	X			X
	Energy products (9-52)	X	X	X	X		X
	Energy residuals (53-61)	X	X	X	X	X	X
Total energy use (62)		X	X	X	X	X	X

Table 2. Full structure of Energy Supply Table

		Accounts of the economy					Total use of inputs, energy products, and energy residues (61)
		Industries (1-54)	**HH** (55-57)	**Change in inventory** (58)	**Import** (59)	**Environment** (60)	
Energy flows	**Natural energy inputs** (1-8)					**X**	**X**
	Energy products (9-52)	**X**			**X**		**X**
	Energy residuals (53-61)	**X**	**X**	**X**	**X**	**X**	**X**
Total energy supply (62)		**X**	**X**	**X**	**X**	**X**	**X**

Note: The numbers in parentheses () indicate the rows and columns in the EST or EUT; the volume of energy supply/use is measured in KTOE/TJ; The (X) indicates cells containing volume; the remaining are left blank in accordance with the statistical principles of the SEEA-Energy System.

The specific content for the rows and columns of the EST or EUT is as follows:

The rows of the Table: The rows describe different physical energy flows and are classified into 3 main flows including: (i) energy inflows from the natural environment (symbol N00); (ii) energy product flows (symbol P00) and (iii) energy residuals (symbol R00). Energy inflows from the natural environment are as flows of energy from the natural environment into the economy; energy residuals are the flows of energy from the economy into the natural environment, while energy product flows circulate within the economy to meet the energy use demand or to reflect the energy supply capacity of different accounts of the economy.

Within each of these physical energy flows, statistics are further detailed for different types of energy inputs and energy products. Specifically, *Energy inflows from the natural environment* include 7 different energy inputs[4], denoted N01 to N07; *Energy product flows* include 20 types of energy products[5] used/supplied by different accounts, denoted P01 to P20, in which some energy products are disaggregated in more detail; including natural gas, motor gasoline, diesel oil, fuel oil, lubricant, bitumen, non-specified oil products, electricity; *Energy residuals* include 4 types[6], denoted from R01 to R04, in which energy losses are presented in more detail with 4 subcategories[7].

[4] Including: ***(N01)*** Fossil non-renewable natural energy inputs; ***(N02)*** Nuclear non-renewable natural energy inputs; ***(N03)*** Hydro based renewable natural energy inputs; ***(N04)*** Wind based renewable natural energy inputs; ***(N05)*** Solar based renewable natural energy inputs; ***(N06)*** Biomass based renewable natural energy inputs; ***(N07)*** Other renewable natural energy inputs

[5] Including: ***(P01)*** Hard coal; ***(P02)*** Brown coal; ***(P03)*** Coal coke; ***(P04)*** Natural gas; ***(P05)*** Conventional crude oil; ***(P06)*** Liquefied Petroleum Gases; ***(P07)*** Motor gasoline; ***(P08)*** Jet fuel; ***(P09)*** Kerosene; ***(P10)*** DO; ***(P11)*** FO; ***(P12)*** Lubricant; ***(P13)*** Bitumen; ***(P14)*** Non-specified oil products; ***(P15)*** Solid biofuels (Wood, wood waste and other solid biomass, charcoal); ***(P16)*** Liquid biofuels; ***(P17)*** Biogases; ***(P18)*** Waste; ***(P19)*** Electrical energy; ***(P20)*** Heat.

[6] Including: ***(R01)*** Renewable waste; ***(R02)*** Non-renewable waste; ***(R03)*** Energy losses all kinds of (during extraction, distribution, storage and transformation, and dissipative heat from end use); ***(R04)*** Energy incorporated in products for non-energy use

[7] Including: Energy losses during extraction; Energy losses during transformation; Energy losses during distribution and storage; Energy losses from end use.

The columns of the Table: The columns describe 5 main accounts of the economy that use or supply energy, including: (i) industries; (ii) household; (iii) change in inventory; (iv) export (for EUT) or the import sector (for EST); (v) the natural environment. *The industries* are mostly classified according to the level-one industries in the Vietnam Standard Industrial Classification, with some level-one sectors which are further disaggregated into level-two sectors. However, there are also some groups of level-one sectors combined into a large sector group[8]. Specifically, the columns of the EUT or EST record 16 level one sector groups[9], in which 5 out of 16 level-one sector groups are further detailed into several level-two sector groups[10].

The remaining sectors include households which are divided into two main groups, namely households using energy for transport activities and households using energy for other activities. The EUT (or EST) also records the energy demand (or energy supply) of inventory changes and export (or import) for energy products. Furthermore, the natural environment is also recorded for energy products to reflect the volume of energy losses to the environment for each type of energy product.

1.2. Greenhouse Gas Emissions Account from Fuel Combustion

1.2.1. Data sources

The GHG Emission Matrix Table from fuel combustion consists of four tables corresponding to three types of greenhouse gases - CH_4, N_2O, CO_2 and CO_2e. The development of these emission tables is based on the following data sources: (i) the EUT; (ii) Emission Factor Matrix Tables; and (iii) GWP.

For EUT, since the study focuses on GHG emissions from fuel combustion, only data related to the flow of energy products is used, while data related to natural energy input flows and residual energy are excluded. This means that data from rows 1 to 8; rows 53 to 62; columns 60 and 61 are excluded.

Table 3. The structure of shorten EUT to construct Emission Matrix Table

	Accounts of the economy			
	Industries (1-54)	**HH** (55-57)	**Change in Inventory** (58)	**Export** (59)
Energy product (9-52)				

Note: The numbers in () indicate the row and column numbers in the full EUT; the quantity of energy use is measured in KTOE/TJ.

The GHG Emission Factor Matrix Table is developed based on combination of emission factors from Appendix 1 of Decision No. 2626/QĐ-BTNMT (for fuel combustion), Official dispatch No. 116/BĐKH-TTBVTOD and IPCC (2006). The use of these GHG emission factors from Decision No. 2626/QĐ-BTNMT and Official dispatch No. 116/BĐKH-TTBVTOD helps to better capture the

[8] For example, the sectors Real Estate Activities; Professional, Scientific and Technical Activities; and Administrative and Support Service Activities are grouped together and denoted as **L,M,N**

[9] Including: ***(A)*** Agriculture, forestry, and fisheries; ***(B)*** Mining and quarrying; (***C)*** Manufacturing; ***(D)*** Electricity production, transmission, and distribution; ***(E+D*)*** Gas production and distribution through pipelines; steam, hot water, air conditioning, and ice production and distribution; water supply, waste, and wastewater management; ***(F)*** Construction***; (G)*** Wholesale and retail trade; repair of motor vehicles and motorcycles; ***(H)*** Transportation and storage; ***(I)*** Accommodation and food service activities; ***(J)*** Information and communication; ***(K)*** Financial, banking, and insurance activities excluding social insurance; ***(L,M,N)*** Real estate activities; professional, scientific and technical activities; administrative and support service activities; ***(O)*** Activities of the Communist Party, socio-political organizations, state administration, national defense, foreign affairs, and compulsory social security; social insurance; ***(P)*** Education and training; ***(Q)*** Health and social work activities; ***(Other)*** Other services.

[10] Including: ***(A)*** Agriculture, forestry, and fisheries; (***B)*** Mining and quarrying; ***(C)*** Manufacturing; ***(D)*** Electricity production, transmission, and distribution; ***(H)*** Transportation and storage**.**

specific features of Vietnam's development process.

GHG emission factors are specified for each CH_4, N_2O, and CO_2 in Decision No. 2626/QĐ-BTNMT; therefore, three corresponding GHG Emission Factor Matrices are constructed. Due to differences in the classification of energy products[11] and the energy-consuming accounts in the economy[12] between the EUT and Decision No. 2626/QĐ-BTNMT, the GHG Emission Factor Matrix needs to be refined following several steps (*details of the GHG Emission Factor Matrices for CH_4, N_2O, and CO_2 are presented in Table 4*).

i) Regarding the differences in the number of energy products: The list of energy products is divided into two groups: Group 1 includes energy products listed in Decision No. 2626/QĐ-BTNMT, for which the GHG emission factors specified in the Decision are applied. In cases where certain energy products are used by different accounts but are not specified in Decision No. 2626/QĐ-BTNMT, emission factors from the IPCC (2006) are applied. Group 2 includes energy products that are recorded in the EUT but are not specified in Decision No. 2626/QĐ-BTNMT. For this group, **(i)** For electricity, the 2019 emission factor for Vietnam's electricity grid was applied, at 0.8458 tCO_2/MWh (equivalent to 234,944 $kgCO_2$/TJ)[13]; **(ii)** For the energy products, including coal coke, lubricant , bitumen, waste, the default emission factors of the IPCC (2006) are used; **(iii)** For the energy products, including heat[14] and non-specified oil products, the energy use are assumed to produce the non-energy products. Therefore, the emission factors are zero.

ii) Regarding the differences in accounts that use energy: Since Decision No. 2626/QĐ-BTNMT does not specify emission factors for fuel combustion in the change in inventory and export, the emission factors for CH_4, N_2O, and CO_2 are referenced from the IPCC (2006)[15].

It can be observed that while these matrices differ in the emission factor values for each GHG, they share the same structural format. Specifically, ***the columns*** of the matrix represent different accounts using energy, including: (i) industries[16]; (ii) HH; (iii) change in inventory; and (iv) the export. ***The rows*** of the matrix describe the list of energy products used. Since the electricity used produces only CO_2 emissions, the Emission Factor Matrix Table for CO_2 consists of 13 columns and 20 rows, while the tables for CH_4 and N_2O contain 13 columns and 19 rows.

[11] The number of energy products recorded in the Energy Use Table is 20, while Decision No. 2626/QĐ-BTNMT refers to only 14 types of energy products.

[12] The number of energy-consuming accounts in the economy presented in the EUT is four, whereas Decision No. 2626/QĐ-BTNMT mentions only 2 accounts; additionally, the two tables also differ in the level of detail industries.

[13] Official dispatch No. 116/BĐKH-TTBVTOD dated 26 February 2021 of the Department of Climate Change - Ministry of Natural Resources and Environment announced emission factor for the Vietnam electricity grid in 2019.

[14] For Heat, according to Vietnam's 2019 EUT, the total quantity used is zero. Therefore, the assumption of a zero GHG emission factor for the combustion of this energy product has no impact on the final emission estimates.

[15] As shown in Table 2.2 on page 16. (*Table 2.2. Default emission factors for stationary combustion in the energy industries*)

[16] Fully inheriting the industrial classification defined in Decision No. 2626/QĐ-BTNMT, there are 8 groups of industries as follows: ***(1)*** Agriculture, forestry, and fisheries; ***(2)*** Energy industry; ***(3)*** Manufacturing and construction; ***(4)*** Road transport; ***(5)*** Rail transport; ***(6)*** Inland waterway and domestic maritime transport; ***(7)*** Domestic air transport; ***(8)*** Trade and services.

Table 4. Emission Factor Matrix Tables

For CH_4 emission factors (Unit: $KgCH_4/TJ$)

Group	Energy Products	Industries *(under Decision 2626/QĐ-BTNMT)*								HH	Change in inventory	Export
		Agriculture, forestry, fishing	Energy industry	Manufacturing and construction	Road transport	Railway transport	Inland waterway and inland maritime transport	Domestic air transport	Services			
1	Diesel oil	10	3	3	4	4	7	3	10	3	3	3
	Kerosene	3	3	3	3	3	3	3	3	10	3	3
	Fuel oil	3	3	3	3	3	7	3	3	3	3	3
	Conventional crude oil	3	3	3	3	3	3	3	3	3	3	3
	Liquefied Petroleum Gases	1	1	1	62	1	1	1	5	5	1	1
	Natural gas	1	1	1	92	1	1	1	1	1	1	1
	Biomass	300	30	30	3	3	3	3	3	300	3	3
	All fuels	3	3	3	3	3	3	1	3	3	3	3
	Anthracite coal	10	1	10	10	10	10	10	10	300	10	10
	Firewood	200	200	200	200	200	200	200	200	200	200	200
	Sub-bitumen coal	10	1	10	10	10	10	10	10	10	10	10
	Motor gasoline	10	3	3	33	3	3	3	3	3	3	3
2	Lubricant	3	3	3	3	3	3	3	3	3	3	3
	Bitumen	3	3	3	3	3	3	3	3	3	3	3
	Non-specified oil products	0	0	0	0	0	0	0	0	0	0	0
	Waste	30	30	30	30	30	30	30	30	30	30	30
	Coal coke	10	10	10	10	10	10	10	10	10	10	10
	Electricity	0	0	0	0	0	0	0	0	0	0	0
	Heat	0	0	0	0	0	0	0	0	0	0	0

Note: GHG emission factors in Decision No. 2626/QĐ-BTNMT is shaded in green; GHG emission factors according to the IPCC (2006).

N_2O emission factors (Unit: KgN_2O/TJ)

Group	Energy Products	Industries *(under Decision 2626/QĐ-BTNMT)*								HH	Change in inventory	Export
		Agriculture, forestry, fishing	Energy industry	Manufacturing and construction	Road transport	Railway transport	Inland waterway and inland maritime transport	Domestic air transport	Services			
1	Diesel oil	0.6	0.6	0.6	3.9	28.6	2.0	0.6	0.6	0.6	0.6	0.6
	Kerosene	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Fuel oil	0.6	0.6	0.6	0.6	0.6	2.0	0.6	0.6	0.6	0.6	0.6
	Conventional crude oil	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Liquefied Petroleum Gases	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Natural gas	0.1	0.1	0.1	3.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Biomass	4.0	4.0	4.0	0.6	0.6	0.6	0.6	0.6	4.0	0.6	0.6
	All fuels	0.6	0.6	0.6	0.6	0.6	0.6	2.0	0.6	0.6	0.6	0.6
	Anthracite coal	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Firewood	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1.0	1.0	4.0	4.0
	Sub-bitumen coal	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Motor gasoline	0.6	0.6	0.6	3.2	0.6	0.6	0.6	0.6	0.6	0.6	0.6
2	Lubricant	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Bitumen	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Non-specified oil products	0	0	0	0	0	0	0	0	0	0	0
	Waste	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	Coal coke	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Electricity	0	0	0	0	0	0	0	0	0	0	0
	Heat	0	0	0	0	0	0	0	0	0	0	0

Note: GHG emission factors in Decision No. 2626/QĐ-BTNMT is shaded in green; GHG emission factors according to the IPCC (2006).

CO_2 emission factors (Unit: $KgCO_2/TJ$)

Group	Energy Products	Industries (under Decision 2626/QĐ-BTNMT)								HH	Change in inventory	Export
		Agriculture, forestry, fishing	Energy industry	Manufacturing and construction	Road transport	Railway transport	Inland waterway and inland maritime transport	Domestic air transport	Services			
1	Diesel oil	74,100	74,100	74,100	74,100	74,100	74,100	74,100	74,100	74,100	74,100	74,100
	Kerosene	71,900	71,900	71,900	71,900	71,900	71,900	71,900	71,900	71,900	71,900	71,900
	Fuel oil	77,400	77,400	77,400	77,400	77,400	77,400	77,400	77,400	77,400	77,400	77,400
	Conventional crude oil	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300
	Liquefied Petroleum Gases	63,100	63,100	63,100	63,100	63,100	63,100	63,100	63,100	63,100	63,100	63,100
	Natural gas	56,100	56,100	56,100	56,100	56,100	56,100	56,100	56,100	56,100	56,100	56,100
	Jet Kerosene	71,500	71,500	71,500	71,500	71,500	71,500	71,500	71,500	71,500	71,500	71,500
	Biomass	70,800	100,000	70,800	70,800	70,800	70,800	70,800	70,800	100,000	70,800	70,800
	Anthracite coal	98,300	98,300	98,300	98,300	98,300	98,300	98,300	98,300	98,300	98,300	98,300
	Firewood	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000
	Sub-bitumen coal	96,100	96,100	96,100	96,100	96,100	96,100	96,100	96,100	96,100	96,100	96,100
	Aviation Gasoline	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000
	Motor gasoline	69,300	69,300	69,300	69,300	69,300	69,300	69,300	69,300	69,300	69,300	69,300
2	Lubricant	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300
	Bitumen	80,700	80,700	80,700	80,700	80,700	80,700	80,700	80,700	80,700	80,700	80,700
	Non-specified oil products	0	0	0	0	0	0	0	0	0	0	0
	Waste	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300	73,300
	Coal coke	107,000	107,000	107,000	107,000	107,000	107,000	107,000	107,000	107,000	107,000	107,000
	Electricity	234,944	234,944	234,944	234,944	234,944	234,944	234,944	234,944	234,944	234,944	234,944
	Heat	0	0	0	0	0	0	0	0	0	0	0

Source: GHG emission factors in Decision No. 2626/QĐ-BTNMT is shaded in green; GHG emission factors according to the IPCC (2006). For electricity, the CO_2 emission factor is based on Official dispatch No. 116/BĐKH-TTBVTOD.

1.2.2. Methodology

The calculation of the GHG Emission Matrix Table is carried out in two main steps: (i) Matching the energy products and accounts using energy between the EUT and the GHG Emission Factor Matrix Tables; (ii) Calculating the emission quantities for CH_4, N_2O, CO_2 and CO_2e. Details follow below.

Step 1. Matching between the EUT and the GHG Emission Factor Matrix

There are existing differences between the list of energy products and the energy-using accounts in the economy between the EUT and the GHG Emission Factor Matrix. Therefore, it is necessary to match the discrepancies between these two tables in a way that aligns the information from the GHG Emission Factor Matrix with the content and structure of the EUT. This ensures that the structure of the GHG Emission Factor Matrix is consistent with that of the EUT. For the GHG emission factor matrix, some energy products are used across industries but are not specified in Decision No. 2626/QĐ-BTNMT; therefore, they are supplemented with emission factors from the IPCC (2006). Accordingly, the matching of energy products is based on three references: EUT, Decision No. 2626/QĐ-BTNMT and the IPCC (2006).

Details of the matching for the energy products and the energy-consuming accounts in the economy is shown in Tables 5 and 6.

Table 5. Matching Energy Products

Code	Energy products in the EUT	Energy products in Decision No. 2626/QĐ-BTNMT	Energy products in IPCC (2006)
P01	Hard coal	Anthracite coal	Anthracite
P02	Lignite	Sub-bituminous coal	Sub-bituminous coal
P03	Coke, semi-coke, and coal tar	N/A	Coking Coal
P04	Natural gas	Natural gas	Natural gas
P04a	Natural gas – energy use	Natural gas	Natural gas
P04b	Natural gas – non-energy use	Natural gas	Natural gas
P05	Conventional crude oil	Crude oil	Crude oil
P06	Liquefied petroleum gas	Liquefied Petroleum Gases	Liquefied Petroleum Gases
P07	Motor gasoline	Motor Gasoline	Motor Gasoline
P07a	Motor gasoline – energy use	Motor Gasoline	Motor Gasoline
P07b	Motor gasoline – non-energy use	Motor Gasoline	Motor Gasoline
P08	Jet fuel	Jet Kerosene	Jet Kerosene
P09	Kerosene	Kerosene	Other Kerosene
P10	Diesel oil	Diesel oil	Gas/Diesel Oil
P10a	Diesel oil – energy use	Diesel oil	Gas/Diesel Oil
P10b	Diesel oil – non-energy use	Diesel oil	Gas/Diesel Oil
P11	Fuel oil	Fuel oil	Residual Fuel Oil
P11a	Fuel oil – energy use	Fuel oil	Residual Fuel Oil
P11b	Fuel oil – non-energy use	Fuel oil	Residual Fuel Oil
P12	Lubricants	Lubricants	Lubricants
P12a	Lubricants – energy use	Lubricants	Lubricants
P12b	Lubricants – non-energy use	Lubricants	Lubricants

Code	Energy products in the EUT	Energy products in Decision No. 2626/QĐ-BTNMT	Energy products in IPCC (2006)
P13	Bitumen	Asphalt	Bitumen
P13a	Bitumen – energy use	Asphalt	Bitumen
P13b	Bitumen – non-energy use	Asphalt	Bitumen
P14	Non-specified oil products	Other oils	N/A
P14a	Non-specified oil products – energy use	Other oils	N/A
P14b	Non-specified oil products – non-energy use	Other oils	N/A
P15	Solid biofuels	Biomass	Wood / Wood Waste
P16	Liquid biofuels	Biomass	Other Liquid Biofuels
P17	Biogas	Biomass	Bio-gasoline
P18	Waste	Waste	Waste Oils
P19	Electrical energy	N/A	N/A
P1901	Solar power	N/A	N/A
P1902	Wind power	N/A	N/A
P1903	Hydropower	N/A	N/A
P1904	Biomass power	N/A	N/A
P1905	Electricity from waste	N/A	N/A
P1906	Coal thermal power	N/A	N/A
P1907	Gas thermal power	N/A	N/A
P1908	Oil thermal power	N/A	N/A
P1909	Other electricity	N/A	N/A
P20	Heat	N/A	N/A

Note: N/A = *Not Available*

Source: Research team.

Table 6. Matching accounts between the EUT and the GHG emission factor matrix

Code	Accounts in the EUT	Accounts in the GHG Emission Factor Matrix
A	Agriculture, Forestry and Fishing	
A1	Growing	Agriculture, Forestry and Fishing
A2	Animal productions	Agriculture, Forestry and Fishing
A3	Forestry	Agriculture, Forestry and Fishing
A4	Fishing and aquaculture	Agriculture, Forestry and Fishing
B	Mining	
B1	Mining of coal and lignite	Energy industry
B2	Extraction of crude petroleum	Energy industry
B3	Extraction of natural gas	Energy industry
B4	Other mining and quarrying	Energy industry
C	Manufacturing	

Code	Accounts in the EUT	Accounts in the GHG Emission Factor Matrix
C1	Processing meat and fish	Manufacturing and Construction
C2	Processing other food products	Manufacturing and Construction
C3	Manufacture of grain mill products, starches and starch products	Manufacturing and Construction
C4	Manufacture of textiles, apparel, leather and related products	Manufacturing and Construction
C5	Manufacture of wood and product of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Manufacturing and Construction
C6	Manufacture off paper and paper products; Printing and reproduction of record media	Manufacturing and Construction
C7	Manufacture of coke and refined petroleum products	Manufacturing and Construction
C8	Manufacture of chemicals; manufacture of pharmaceuticals, medicinal chemical and botanical products; manufacture of rubber and plastics products	Manufacturing and Construction
C9	Manufacture of other non-metallic mineral products	Manufacturing and Construction
C10	Manufacture of cement	Manufacturing and Construction
C11	Manufacture of basic metal and other metal products	Manufacturing and Construction
C12	Manufacture of computer, electronic and optical products; electrical equipment	Manufacturing and Construction
C13	Manufacture of machinery and equipment n.e.c	Manufacturing and Construction
C14	Manufacture of motor vehicles and other transport equipment	Manufacturing and Construction
C15	Other manufacturing	Manufacturing and Construction
D	Electric power generation, transmission and distribution	
D1	Solar power	Energy industry
D2	Wind power	Energy industry
D3	Hydropower	Energy industry
D4	Biomass power	Energy industry
D5	Coal thermal power	Energy industry
D6	Gas thermal power	Energy industry
D7	Oil thermal power	Energy industry
D8	Other electricity generation	Energy industry
D9	Electricity transmission and distribution	Energy industry
E+D*	Gas production and distribution through pipelines; production and distribution of steam, hot water, air conditioning, and ice; Water supply; sewerage, waste management and remediation activities	Manufacturing and Construction
F	Construction	Manufacturing and Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	Trade and services

Code	Accounts in the EUT	Accounts in the GHG Emission Factor Matrix
H	Transportation and storage	
H1	Passenger land transport	Land transportation
H2	Freight land transport	Land transportation
H3	Water transport	Inland water transport and inland freight water transport
H4	Air transport	Domestic air transport
H5	Warehousing and support activities for transportation	Trade and services
I	Accommodation and food service activities	Trade and services
J	Information and communication	Trade and services
K	Financial, banking and insurance activities	Trade and services
L,M,N	Real estate activities; Professional, scientific and technical activities; Administrative and support service activities	Trade and services
O	Communist party, socio-political organizations activities; public administration and defence; compulsory social security	Trade and services
P	Education	Trade and services
Q	Human health and social work activities	Trade and services
Other	Other service activities	Trade and services
HH	Total consumption of household	
HH_TR	Household consumption for transportation	Domestic
HH_OTH	Household consumption for other activities	Domestic
ACC	Change in Inventory	Change in Inventory
ROW	Rest of the world/ Export	Export

Source: research team.

Step 2. Calculating Greenhouse Gas Emissions

After the structure of the GHG Emission Factor Matrix has been adjusted to ensure consistency with the structure of the EUT through the matching process, the calculation of GHG emission aimed at constructing the Emission Matrix Table is carried out using the following formula.:

$$EA_{s,j} = EU_{s,p} * EF_{s,p,j}$$

In which, $EA_{s,j}$ is the emission quantity of gas j from fuel combustion by account s; $EU_{s,p}$ is the quantity of energy product p used by sector s; $EF_{s,p,j}$ is the emission factor of gas j from the combustion of energy product p in sector s. The greenhouse gases j are CH_4, N_2O and CO_2.

In addition**,** the CO_2e is also calculated to convert all GHG into a single common unit, thereby providing an assessment of total emissions. The formula for calculating CO_2e is as follows:

$$EA_{CO2e} = EA_{CO2} * 1 + EA_{CH4} * 25 + EA_{N2O} * 298$$

In which, $EA_{CO2}, EA_{CH4}, EA_{N2O}$ represent the emission quantity of CO_2, CH_4 and N_2O, respectively. The coefficients 1, 25 and 298 are referenced from the Global Warming Potential (GWP) values published in the IPCC Sixth Assessment Report (AR6), 2021–2022**.**

CHAPTER 2. Energy Supply and Consumption in Viet Nam in 2019

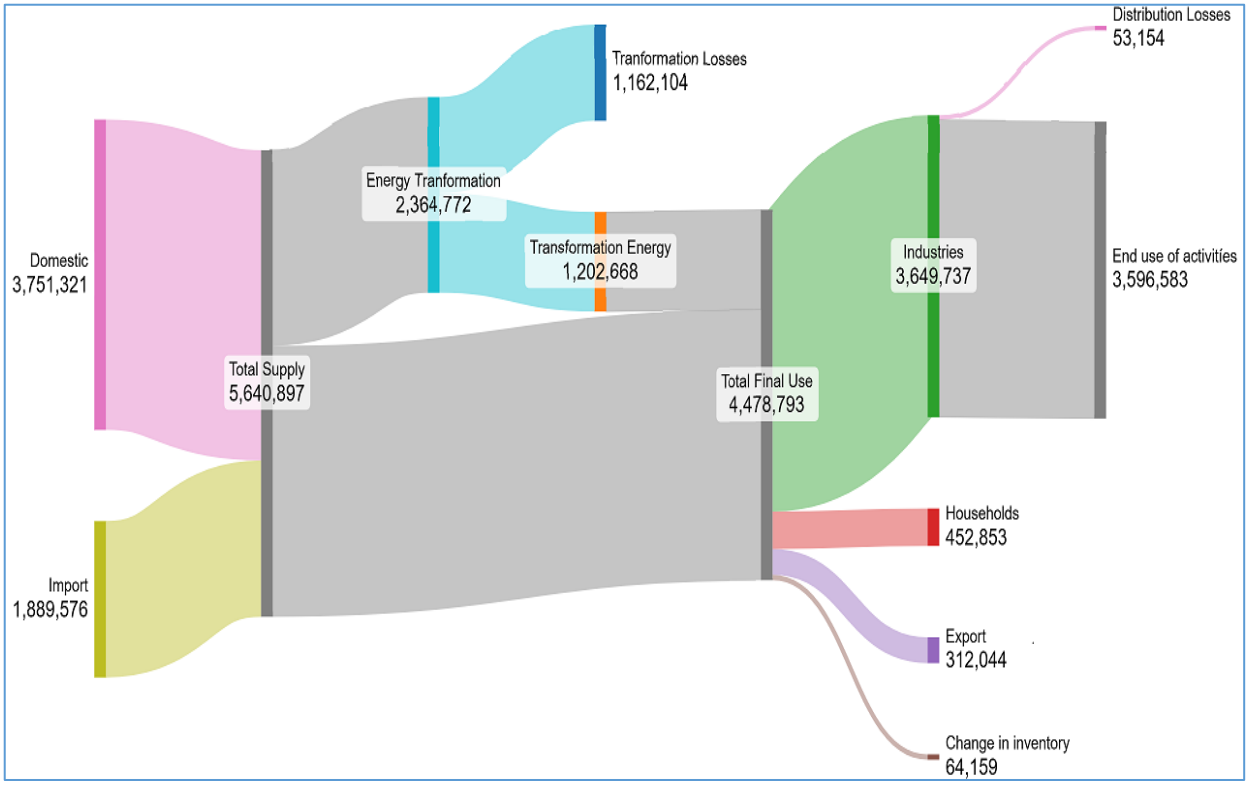
2.1. Overview of Energy Production and Consumption in Vietnam for 2019

The Sankey diagram in Figure 1 provides an overview of energy flows in Vietnam in 2019, including data on domestic production, imports, energy transformation, losses, and final consumption. Below is a more detailed analysis.

The total energy supply in 2019 reached 5,640,897 TJ. Of which, domestic energy production accounted for 3,751,321 TJ, making up 66.5%, while imported energy amounted to 1,889,576 TJ, representing 33.5%.

Figure 1. Sankey Diagram of Energy Flows in Vietnam in 2019

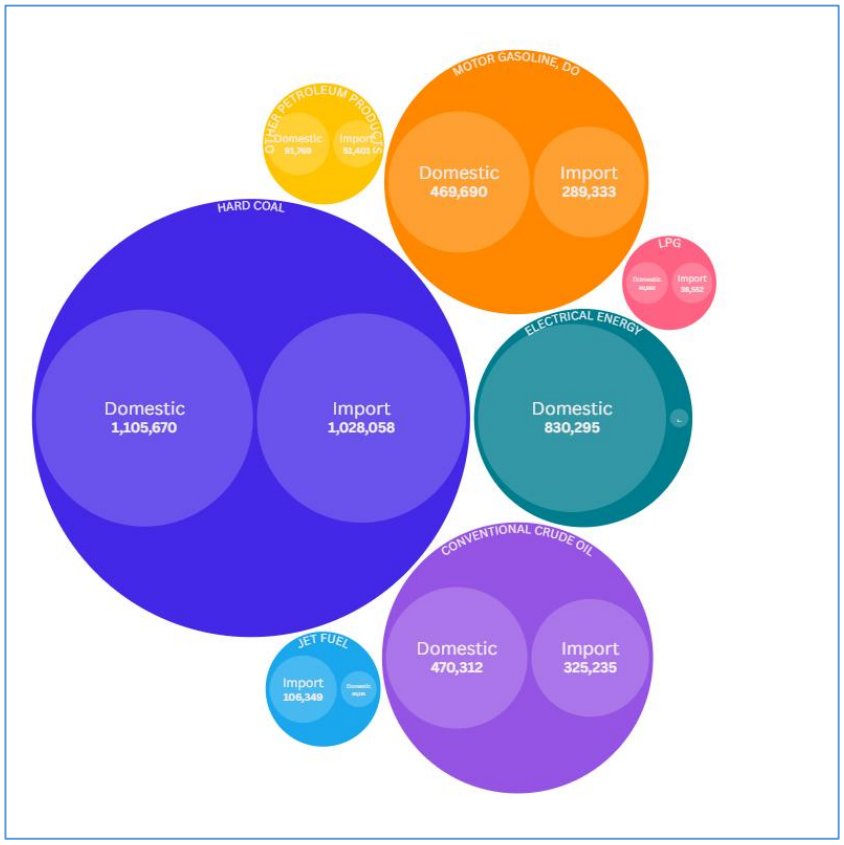
Unit: Terajoule



Vietnam has a relatively high level of energy self-sufficiency; however, it still depends on imports for about one-third of its total energy supply. Coal, crude oil, liquefied petroleum gas (LPG), and petroleum products have a significant share of imports. Figure 2 below shows the production and import of major energy types in Vietnam for the year 2019.

Figure 2. Production and import of energy types of Vietnam in 2019

Unit: Terajoule



In 2019, Vietnam still had to import a large amount of coal to meet domestic consumption demands, with the proportion of import accounting for over 48% of the total coal supply. Additionally, crude oil also had a relatively high import share, at nearly 41%.

For petroleum refinery products, Vietnam still relies heavily on imports. Jet fuel has a very high import share, nearly 78%. The import shares for gasoline used in cars and motorcycles[17], as well as other petroleum products[18], are 38% and 36%, respectively. Meanwhile, the import share of liquefied petroleum gas (LPG) is nearly equal to domestic production, at around 49%.

On the other hand, domestically produced electricity almost fully meets domestic demand, accounting for 99%, with only 1% coming from imports. However, it should be noted that a portion of domestically generated electricity currently relies on imported fuels, particularly imported coal for thermal power plants.

The Sankey diagram in Figure 1 also illustrates that a significant portion of the total energy supply is used for energy transformation processes. Specifically, the total input of primary energy in transformation processes is 2,364,772 TJ, accounting for 42% of the total energy supply, while the remaining energy is 3,276,125 TJ, making up for 58%, counted directly to final consumption.

The energy transformation process mainly takes place at power plants and refineries, where primary energy sources (such as coal, crude oil, and natural gas) are converted into other forms of energy (such as electricity or refined petroleum products).

The amount of energy lost during the transformation process is 1,162,104 TJ, accounting for over

[17] gasoline used in cars and motorcycles including Motor gasoline and Diesel oil (DO)

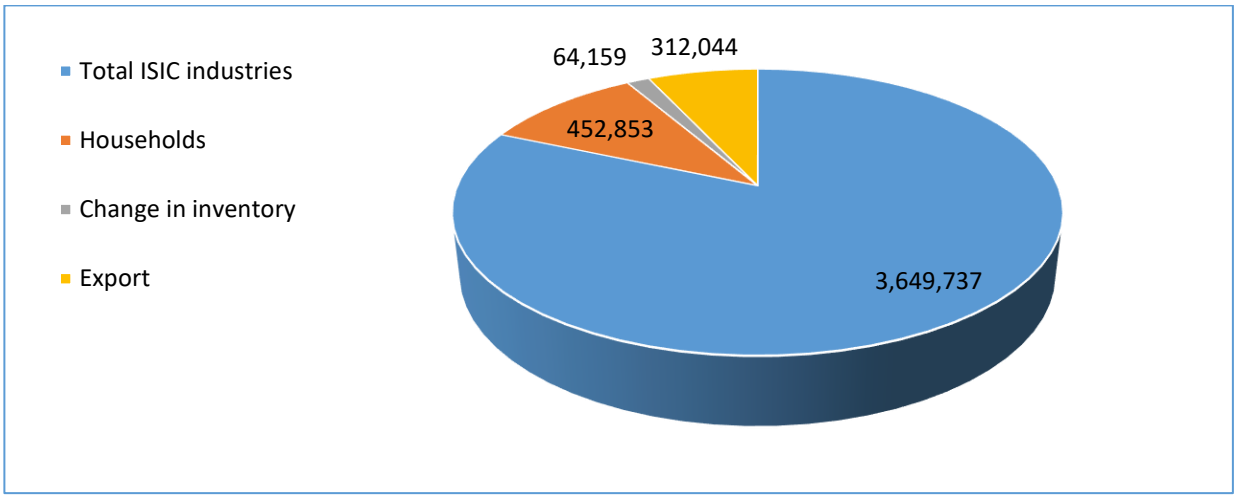
[18] other petroleum products including Kerosene, Fuel oil (FO), Lubricant and Non-specified oil products for energy use

49% of the total input of energy transformation process, indicating a significant energy loss rate. The remaining transformed energy (secondary energy), 1,202,668 TJ, continues to final consumption, representing around 51% of the total input of energy for the transformation process.

After production, import, and transformation, energy is used for various sectors. The total final energy consumption is 4,478,793 TJ, with three main user groups: economic activities, households, and exports. Additionally, a small portion of the energy supply is recorded as changes in inventory. Figure 3 shows the final energy consumption for Vietnam in 2019.

Figure 3. Final Energy Consumption for Vietnam in 2019

Unit: Terajoule



Most of the final energy consumption, up to 3,649,737 TJ, is attributed to economic activities. This means that 81.5% of total final energy consumption is concentrated in production and business activities, making this group become a major driver of the country's overall energy consumption.

Besides economic activities, households are also a significant energy-consuming group, with a consumption of 452,853 TJ, accounting for 10.1% of total final energy consumption. In households, electricity is the primary source of energy consumption, totalling 206,517 TJ and accounting for approximately 45.6% of total household energy use. It is commonly used for electrical appliances such as air conditioners, refrigerators, and washing machines. Next, around 18.5% of energy is used for transportation purposes, primarily through motor gasoline (44,767 TJ) and diesel oil (39,157 TJ). Solid biofuels (including firewood, wood, and charcoal) remain important, making up about 15.3% of household energy use. Hard coal ranks fourth with 60,256 TJ, representing approximately 13.3%. LPG, a cooking fuel, accounts for 7.1% with 32,285 TJ. Kerosene (346 TJ) and fuel oil (50 TJ) are now rarely used in households.

A portion of the energy is not consumed domestically but is exported to serve international markets, totalling 312,044 TJ, which accounts for approximately 7% of the total final energy consumption of Vietnam.

In addition to the main consumption groups, a small portion of energy is recorded as changes in inventory, totalling 64,159 TJ, accounting for 1.4% of total final energy consumption.

2.2. Energy Consumption Intensity by Economic Activities for Vietnam in 2019

In 2019, economic activities consumed a total of 4,811,841 TJ, of which 2,364,772 TJ was used for energy conversion purposes. The manufacturing industry (C) and the electricity generation, transmission, and distribution industry (D) had the highest energy consumption, playing a crucial role in the structure of the economy's energy utilization. These are also the two economic activities that use energy for energy conversion purposes. Figure 4 below illustrates energy consumption by

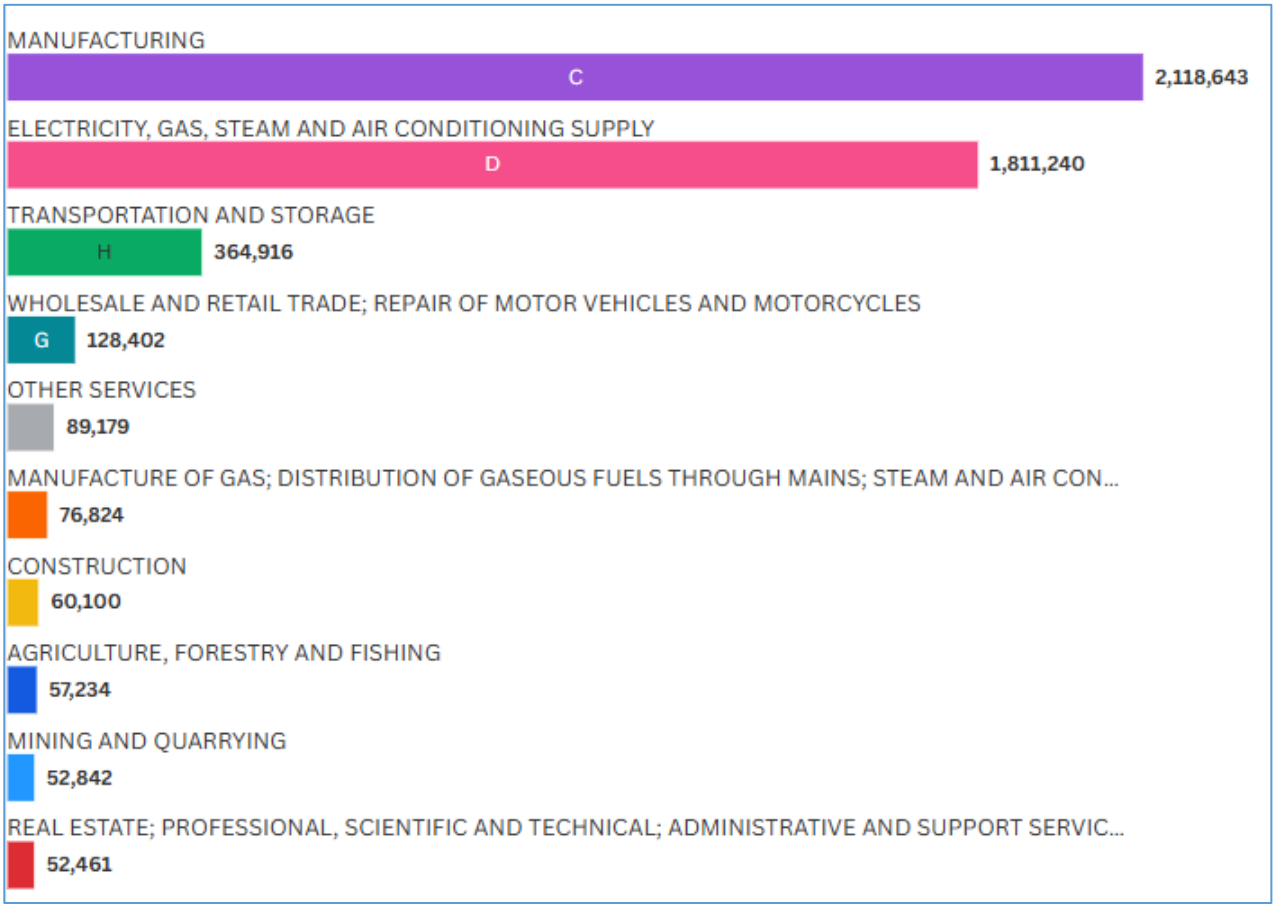
economic activities in Vietnam in 2019.

The manufacturing industry (C) was the largest energy-consuming industry, using 2,118,643 TJ, accounting for approximately 44% of the total energy consumption of economic industries. Of which 639,130 TJ was used in the transformation process to create some products such as Motor gasoline, Diesel, LPG, Jet Fuel, and others, representing about 30.2% of the total energy consumption of manufacturing industry.

Ranked second was the electricity generation, transmission, and distribution activity (D), with a total energy consumption of 1,811,240 TJ, equivalent to 37.6% of the total energy consumption of economic activities. However, most of this energy, approximately 1,725,642 TJ (95.3%), was used for conversion processes, while only 85,598 TJ (4.7%) was used for final consumption. This reflects the crucial role of the industry in terms of producing and supplying energy to other industries. It is important to note that the amount of 85,598 TJ used for final consumption included 53,154 TJ lost during the distribution process.

Figure 4. Energy Consumption by Economic Activities in Vietnam in 2019

Unit: Terajoule



Additionally, the transportation and storage activity (H) also had a considerable energy consumption of 364,916 TJ, accounting for nearly 7.6% of the total energy consumption of economic activities. All of which was used for final consumption, highlighting the substantial energy demand in this activity.

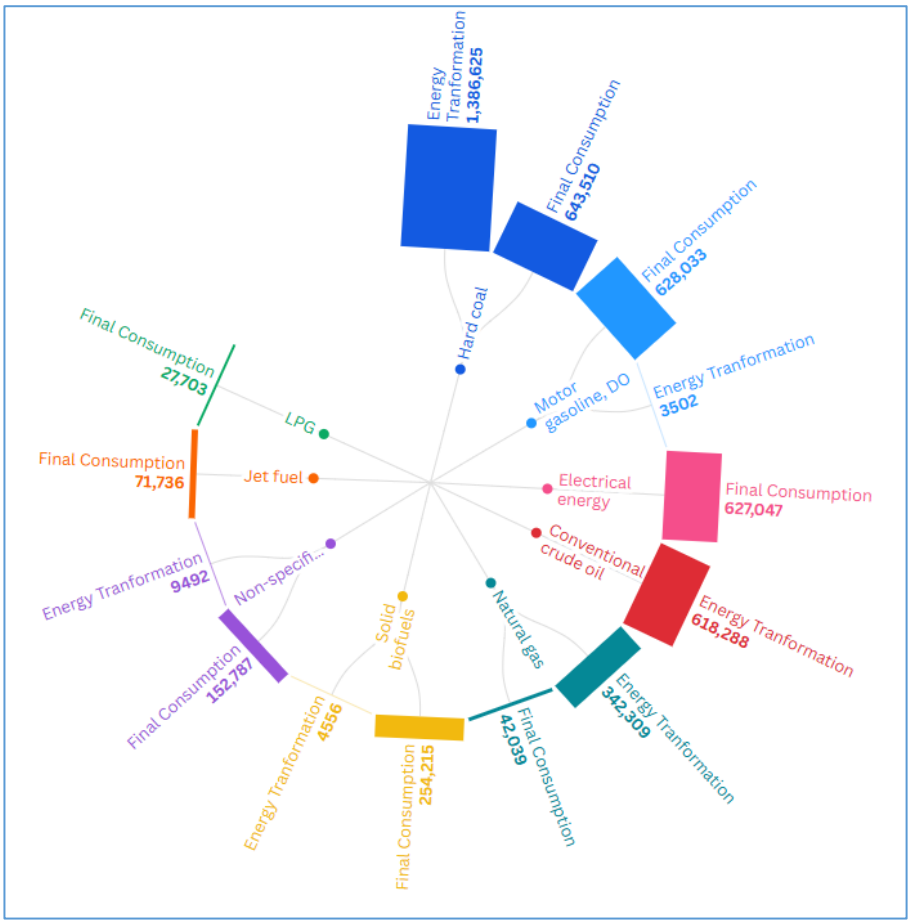
The wholesale, retail trade, and motor vehicle repair activity (G) consumed 128,402 TJ (2.7% of the total energy consumption of economic activities), while the Manufacture of gas; distribution of gaseous fuels through mains; Steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities consumed 76,824 TJ (1.6%). Activities with lower energy

consumption included construction (F) with 60,100 TJ (1.2%), agriculture, forestry, and fisheries activity (A) with 57,234 TJ (1.2%); the mining activity (B) consumed 52,842 TJ; real estate and professional services activities (L, M, N) with 52,461 TJ (1.1%). The other service activities[19] had low consumption.

The 2019 energy account data also indicated that Vietnam remains heavily dependent on fossil fuels for both final consumption and energy conversion. Solid biofuels had a significant consumption level, but the conversion rate into other forms of energy remains low. The data from Figure 5 on energy consumption by economic sectors in 2019, broken down by energy type, further clarifies the above observation.

Figure 5. Energy consumption by economic activities in Vietnam in 2019 by energy products

Unit: Terajoule



Hard coal plays an important role in the energy system, with over 2 million TJ consumed. However, only 31.7% of hard coal is used for final consumption, while 68.3% is utilized for electricity generation. This indicates that Vietnam still heavily relies on coal-fired power, an energy source with significant environmental impacts.

Motor vehicle gasoline and diesel[20] are the second-largest energy products after hard coal, with 628,033 TJ, which is primarily used for transportation (99.4%), while only 0.6% is used for electricity conversion.

[19] other services including Wholesale and retail trade; repair of motor vehicles and motorcycles; Information and communication; Financial and insurance activities; Public administration and defense; compulsory social security; Pension funding; Education; Human health and social work activities; Other services

[20] gasoline used in cars and motorcycles including Motor gasoline and Diesel oil (DO)

Electricity is the next important energy source with 627,047 TJ of which all of it is used for final consumption.

The fourth most used energy type by economic sectors is crude oil, with 618,288 TJ consumed as input for petrochemical refineries to be converted into other energy products such as gasoline, diesel and LPG.

Out of a total of 384,348 TJ used, only 10.9% of natural gas is directly consumed, and 89.1% is converted into electricity or other forms of energy; solid biofuels, including firewood, charcoal, and agricultural residues, are primarily used for final consumption at 98.2%, while only 1.8% is used for electricity generation.

The energy consumption intensity indicator measures the amount of energy consumed per unit of GDP, reflecting the efficiency of energy use in generating economic value.

$$Energy\ Consumption\ Intensity\ = \frac{Total\ Energy\ Consumption}{GDP}$$

At the economic industry level, the energy consumption intensity by industry indicator is typically calculated as the amount of energy consumed per unit of the industry's value-added.

$$Energy\ Consumption\ Intensity\ n = \frac{Total\ Energy\ Consumption\ of\ Activity\ n}{VA\ of\ Activity\ n}$$

In this report, Energy consumption intensity by industry is determined by the ratio of energy consumption (MJ) to value added (VA). This indicator reflects the level of energy use in generating economic value - the higher the index, the more energy-intensive the industry is relative to the economic value it creates. Therefore, comparing this index between the industries helps assess energy efficiency levels and identify industries with the potential to improve used energy performance.

The energy consumption intensity of the whole economy in Vietnam is 681.7 MJ/1 million VND, indicating that, on average, the economy needs to consume 681.7 MJ of energy to generate 1 million VND of value added.

The electricity generation, transmission, and distribution industry (D) has the highest energy consumption intensity, reaching 7,960.8 MJ/1 million VND. This means that to generate 1 million VND of value added, the industry consumes 7,960.8 MJ of energy. This reflects the specific nature of the electricity industry, where energy is primarily consumed for power production to supply the economy. In addition, the high energy intensity in the electricity sector is also attributed to the low efficiency of electricity conversion, with average conversion losses reaching nearly 67%.

Table 7. Energy consumption intensity by industries in Vietnam in 2019

Activities	Activity Code	VA (Million VND)	Energy Consumption (TJ)	Energy Consumption Intensity (MJ/Million)
Total ISIC industries	**ISIC**	7.058.597.720	**4.811.841**	**681,7**
Agriculture, forestry and fishing	A	856.178.168	57.234	66,8
Mining and quarrying	B	225.010.953	52.842	234,8
Manufacturing	C	1.946.525.791	2.118.643	1.088,4
Electricity, gas, steam and air conditioning supply	D	227.518.480	1.811.240	7.960,8
Manufacture of gas; distribution of gaseous fuels through mains; Steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities	E+D*	49.727.865	76.824	1.544,9
Construction	F	453.464.014	60.100	132,5
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	718.523.700	128.402	178,7
Transportation and storage	H	387.689.279	364.916	941,3
accommodation and food service activities	I	216.953.560	19.636	90,5
Information and communication	J	287.992.951	33.559	116,5
Financial and insurance activities except Pension funding	K	329.871.793	821	2,5
Real estate; Professional, scientific and technical; administrative and support service activities	L,M,N	582.712.759	52.461	90,0
Public administration and defence; compulsory social security;Pension funding	O	166.430.044	5.359	32,2
education	P	277.360.137	5.969	21,5
Human health and social work activities	Q	170.509.683	9.408	55,2
Other services	Other	162.128.540	14.428	89,0

Other industries with high energy consumption intensity include the gas production, steam, water supply, and wastewater treatment industry (E+D)*, which has an energy consumption intensity of 1,545 MJ/1 million VND, making it the second highest after the electricity industry. Following this is the manufacturing and processing industry (C), with an energy consumption intensity of 1,088.4 MJ/1 million VND, indicating the significant energy demand required to sustain production. The transportation and storage industry (H) also has a high energy consumption intensity, reaching 941.3 MJ/million dong.

Industries with moderate energy intensity include the mining activity (B), with an energy intensity of 234.8 MJ per VND 1 million. The wholesale and retail trade activity (G) has an energy intensity of 178.7 MJ per VND 1 million, primarily driven by store operations and logistics. The construction activity (F) and the services activity, including information and communication (J), have energy intensities of 132.5 MJ per VND 1 million and 116.5 MJ per VND 1 million, respectively.

Activities with low energy intensity—below 100 MJ per VND 1 million—are primarily service industries such as real estate, scientific and technical services (L, M, N); other service activities; education (P) and health care (Q); as well as finance and insurance (K), due to their focus on service provision rather than industrial production. The agriculture activity is also in the low energy intensity group, with 66.8 MJ per VND 1 million.

2.3. Renewable energy share in the total final energy consumption

The share of renewable energy in total final energy consumption is one of the indicators under the United Nations Sustainable Development Goals (SDGs, Indicator 7.2.1). It serves as a key measure to monitor the shift toward renewable energy in national energy consumption, reduce

greenhouse gas emissions, and promote green energy transition and sustainable development.

According to the guidelines of the United Nations Statistics Division, the indicator of the share of renewable energy in total final energy consumption is calculated using the following formula:

$$TFEC_{RES} = \frac{TFEC_{RES} + \left(TFEC_{ELE} \times \frac{ELE_{RES}}{ELE_{TOTAL}}\right) + \left(TFEC_{HEAT} \times \frac{HEAT_{RES}}{HEAT_{TOTAL}}\right)}{TFEC_{TOTAL}}$$

In which:

TFEC: Total final energy consumption (also equivalent to the total final consumption minus the non-energy use).

ELE: Gross electricity production

HEAT: Gross heat production

RES: Renewable energy sources.

Reference: https://unstats.un.org/sdgs/metadata/files/Metadata-07-02-01.pdf

From the results of the energy balance, the SDG 7.2.1 indicator in 2019 reached 13.65%. This means that 13.65% of the total final energy consumption came from renewable energy sources such as hydropower, wind power, solar power, and biomass. In which Total Final Energy Consumption (TFEC_Total) excludes energy used for non-energy purposes. TFEC_RES refers to the final consumption of biomass energy. Other indicators are detailed in the table below.

Table 8. Renewable energy share in the total final energy consumption for Vietnam in 2019

TFEC_TOTAL (1)	**4,339,376 TJ**
TFEC_RES (2)	**328,245 TJ**
TFEC_ELE (3)	**838,284 TJ**
ELE_TOTAL (4)	**830,295 TJ**
ELE_RES (5)	**261,555 TJ**
Solar power plant	17,827 TJ
Wind power plant	2,603 TJ
Hydro power plant	239,648 TJ
Biomass electricity	1,476 TJ
Waste electricity	
Other electricity	
TFEC_RES_RATIO = (2+5/4*3)/1	**13.65%**

CHAPTER 3. Emissions from Energy Use of Vietnam in 2019

3.1. Overview of Greenhouse gas Emissions from Energy End Use

To calculate GHG emissions from fuel combustion for energy-end use in Vietnam, the quantity of energy-end use needs to exclude the following activities when calculating GHG emissions, specifically:

i. Energy used for energy transformation, rather than for energy end use;

ii. Energy used in the Change in inventory does not generate GHG emissions, as it has not yet actually been used;

iii. Energy used for export generates GHG emissions that fall outside Vietnam's territorial boundary;

iv. Energy-end use for non-energy purposes does not generate GHG emissions.

In the industrial sector, energy is used for two purposes: energy transformation and energy-end use. Energy transformation accounts for 2,364,772 TJ (49.1%) of total energy used in the industrial sector. Energy-end use reached 2,447,069 TJ, of which 139,417 TJ (5.7%) was for non-energy purposes. In the household sector, energy is used entirely for energy-end use, reaching 452,853 TJ.

Thus, the quantity of energy-end use generating GHG emissions from fuel combustion in 2019 reached 2,760,505 TJ[21], of which the industrial sector accounted for 83.6% and the household accounted for 16.4% (*detailed in Table 9*). Electricity is the energy product most used for energy-end use, reaching 833,564 TJ, accounting for 30.2% of total energy-end use, significantly higher than the share of hard coal (25.5%). This indicates a strong trend of electrification within the industrial sector for energy-end use.

Table 1. Quantity of Energy-end use in 2019 (Unit: TJ)

Energy Products	Total energy use (including industrial + HH sectors)					
	In which:	Energy transform	Energy-end use			
			In which:	Industries		HH
				Energy	Non-energy	
Hard coal	2,090,391	1,386,625	703,766	643,510	0	60,256
Brown coal	0	0	0	0	0	0
Coal coke	0	0	0	0	0	0
Natural gas	384,348	342,309	42,039	42,039	0	0
Conventional crude oil	618,288	618,288	0	0	0	0
Liquefied Petroleum Gases	59,988	0	59,988	27,703	0	32,285
Motor gasoline	300,982	0	300,982	255,995	220	44,767
Jet fuel	71,736	0	71,736	71,736	0	0
Kerosene	1,355	0	1,355	1,009	0	346
Diesel oil	414,477	3,502	410,976	371,625	194	39,157
Fuel oil	22,623	9,492	13,131	12,776	306	50
Lubricant	5,428	0	5,428	0	5,428	0
Bitumen	42,113	0	42,113	0	42,113	0

[21] This figure does not account for distribution losses. If distribution losses are accounted for, the quantity of energy-end use = 2,760,505 – 53,154 = 2,707,351 (TJ).

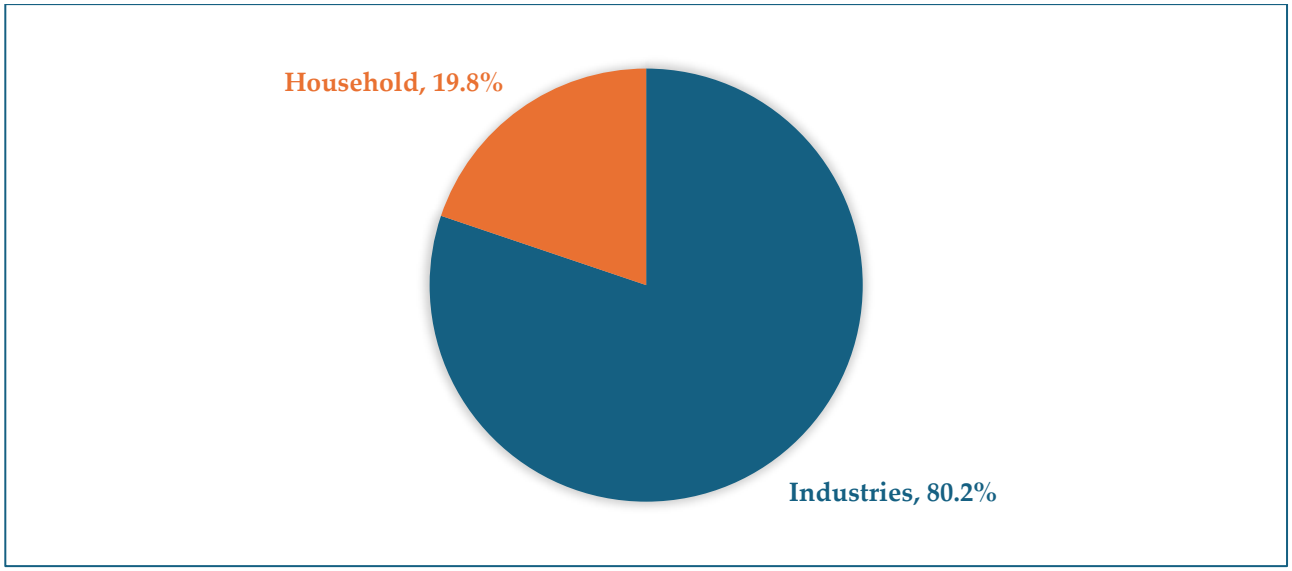
Energy Products	Total energy use (including industrial + HH sectors)					
	In which:	Energy transform	Energy-end use			
			In which:	Industries		HH
				Energy	Non-energy	
Non-specified oil products	91,157	0	91,157	0	91,157	0
Solid biofuels (Wood, wood waste and other solid biomass, charcoal)	328,245	4,556	323,689	254,215	0	69,475
Liquid biofuels	0	0	0	0	0	0
Biogases	0	0	0	0	0	0
Waste	0	0	0	0	0	0
Electrical energy	833,564	0	833,564	627,047	0	206,517
Heat	0	0	0	0	0	0
TOTAL	**5,264,694**	**2,364,772**	**2,899,922**	**2,307,652**	**139,417**	**452,853**

Source: Calculated from EUT 2019.

In 2019, the total CO2e emissions from fuel combustion for energy-end use reached 356.18 million tons22, of which the industrial sector contributed 80.2% of the total emissions, equivalent to 285.61 million tons of CO2e; followed by the HH sector with a share of 19.8%, reaching 70.57 million tons of CO2e (Figure 6).

For energy used for transformation, the quantity of emissions generated from fuel combustion reached 203.12 million tons of CO2e, mainly from the electricity production, transmission and distribution sector (77.2%) and the processing and manufacturing industry (22.8%). The main energy products used for energy transformation include hard coal (accounting for 58.6% of the total energy used for transformation); conventional crude oil (26.1%) and natural gas (14.5%).

Figure 6. Share of CO_2e Emission from fuel combustion for energy-end use by sectors



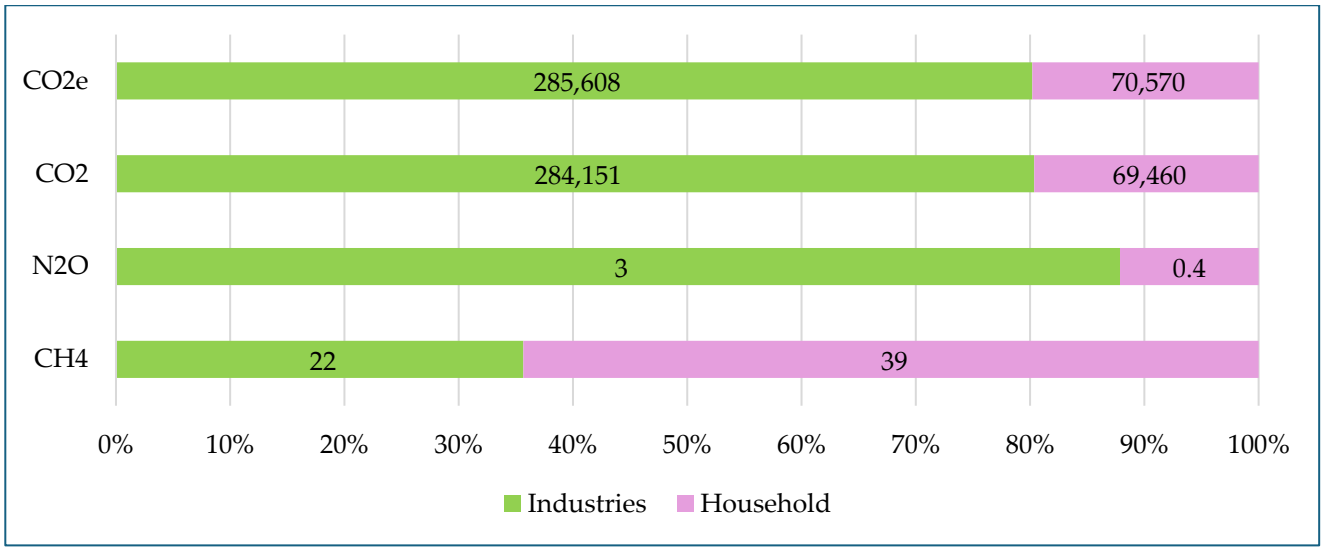
Source: Calculated by IPSS based on the GHG emission matrix 2019.

For each type of GHG emissions, the main sources of emissions come from the industrial sector.

[22] This is the quantity of emissions calculated for the energy-end use of 2,760,505 TJ (which does not account for distribution losses). If accounting for distribution losses, the quantity of energy-end use is only 2,707,351 TJ, which generates 343.69 million tons of CO_2e.

Specifically, emissions of CO_2 and N_2O originate primarily from energy-end use in industrial sector, accounting for 80.4% and 87.9% of total emissions respectively. However, the pattern is reversed for CH_4, where households is the largest source, contributing 64.3% of total CH_4 emissions.

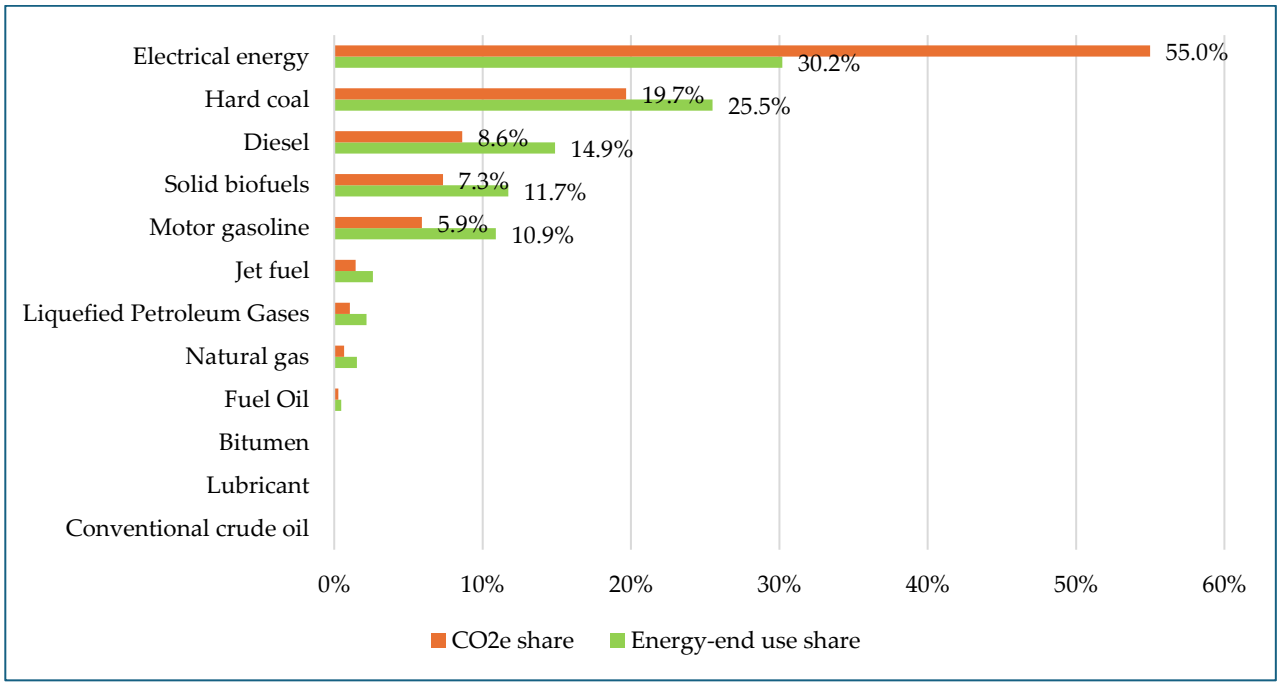
Figure 7. Structure of Greenhouse Gas Emissions by EEU Sector (Unit: 1.000 tonnes of CO2e)



Source: Calculated from the 2019 greenhouse gas emission matrix table.

In 2019, electricity was the largest source of emissions from energy-end use, accounting for 55% of total CO2e emissions, followed by hard coal at 19.7%. The next largest sources of emissions came from the energy-end use of solid biofuels (7.3%) and diesel oil (8.6%). In contrast, energy products accounting for a small share of CO2e emissions from energy-end use included kerosene (accounting 0.03% of total CO2e emissions), fuel oil (0.3%) and liquefied petroleum gas (1.1%).

Figure 8. Quantity of CO_2e emissions by Energy Product (Unit: %)



Source: Calculated from the 2019 greenhouse gas emission matrix table.

3.2. Greenhouse Gas Emission by Economic sectors in Vietnam

In 2019, total GHG emissions from energy-end use by industrial sector reached 285.6 million tonnes of CO_2e, in which emissions are primarily generated by the Manufacturing (60.3%), Transportation and

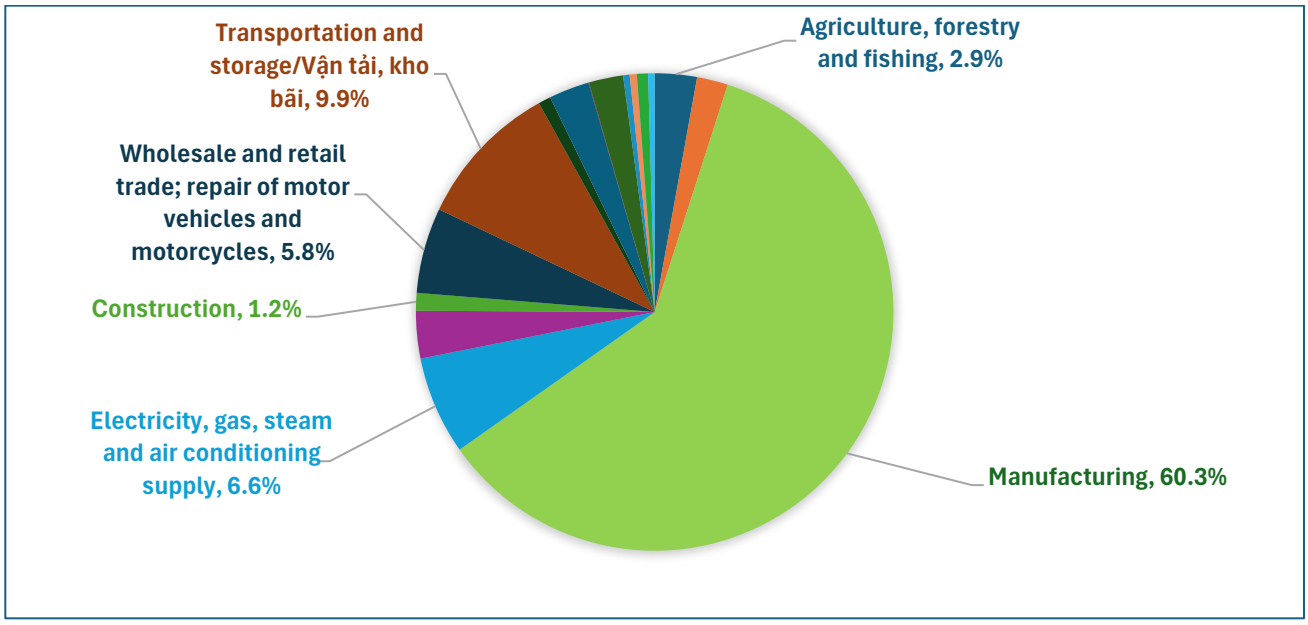
storage (9.9%) and Electricity, gas, steam and air conditioning supply (6.6%), while the other industrial sectors together accounted for only about 23.2%.

The manufacturing industry generated the total emissions of 172.1 million tonnes of CO_2e, in which the manufacture of other non-metallic mineral products except cement is the largest source, contributing 22.0% of the sector's emissions; followed by the manufacture of paper and paper products; printing and reproduction of recorded media (8.2%) and the manufacture of textiles, wearing apparel and leather products (13.3%). In contrast, sectors with negligible emissions include meat & fish processing (2.6%), manufacture of machinery and equipment (only 0.6%) and Processed grain products (2.3%).

The transportation and storage with the volume of emissions reaches 28.2 million tonnes of CO_2e, accounting for 9.9% of total emissions from all industrial sector, in which most emissions came from land transport, which contributed 56.4% of the sector's total emissions. This reflects the reality that in 2019 most land transport vehicles in Vietnam still relied on motor gasoline (34.46%) and diesel oil (63.6%) as primary fuels for energy-end use, meanwhile electricity accounted for only 0.8%.

Electricity, gas, steam and air conditioning supply (sector D) generated 19.0 million tonnes of CO_2e, accounting for 6.6% total emissions from energy-end use in the industrial sector. The GHG emissions from electricity generation accounted for 29.4% of the sector's total CO2e emissions (equivalent to 5.6 million tonnes of CO2e); the remaining CO2e emissions of the sector came from the electricity transmission and distribution activities.

Figure 9. Share of CO2e emissions in the industrial sector in Vietnam in 2019 (Unit: %)



Source: Calculated from the 2019 greenhouse gas emission matrix table.

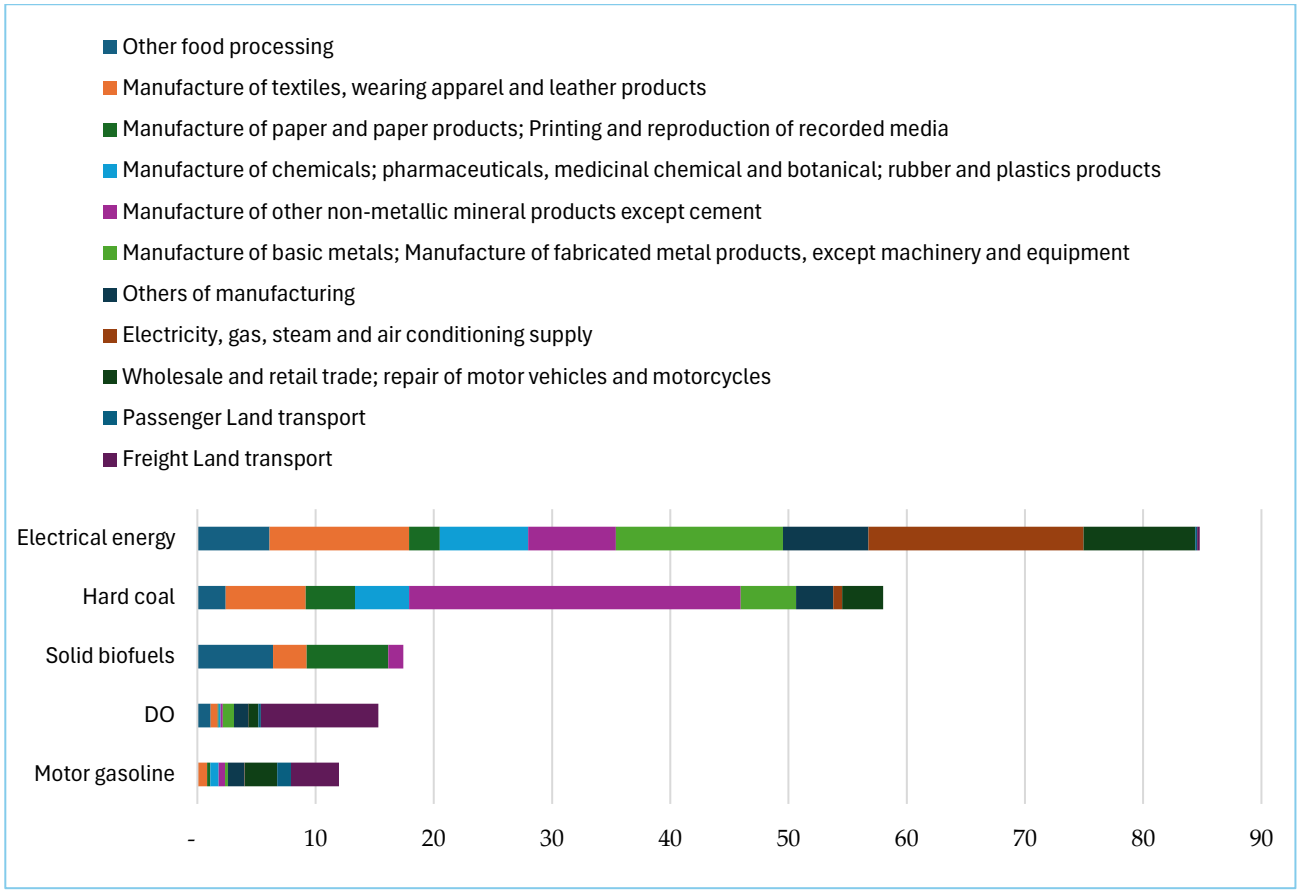
Hard coal has remained the primary energy product for energy-end use in the industrial sector, although its share is not significantly greater than that of electric power. This reflects the increasing trend of electrification across industrial sectors23. In 2019, the shares of coal and electricity used for energy-end use in the industrial sector accounted for 27.9% and 27.2% respectively. The emissions generated from these energy products reached 63.7 and 147.3 million tonnes of CO_2e respectively (accounting for 22.3% and 51.6% of total CO2e in the industrial sector).

[23] Electricity is used for energy-end use primarily by the manufacturing (accounting for 56.0% of total electricity used for energy-end use in the industrial sector), followed by the electricity, gas, steam and air conditioning supply (12.3%); the wholesale and retail trade; repair of motor vehicles and motorcycles (6.4%); and the information and communication industry (5.3%).

The use of solid biofuels (wood, wood waste, and related biomass residues) in the industrial sector generated the second-largest source of GHG emissions, reached 18,6 million tonnes of CO_2e, accounting for 6.5% of total emissions from the industrial sector. The main source of emissions comes from other food processing (accounting for 34.5% of emissions, equivalent to 6,4 million tonnes of CO_2e); manufacture of paper and paper products; printing and reproduction of recorded media (accounting for 37.3% of emissions, equivalent to 6,9 million tonnes of CO_2e); and manufacture of other non-metallic mineral products (accounting for 6.8%, equivalent to 1,3 million tonnes of CO_2e).

The third-largest source of GHG emissions came from the energy-end use of diesel oil, which reached 27,8 million tonnes of CO_2e, accounting for 9.7% total CO2e in the industrial sector. These CO2e emissions were concentrated in the transportation and storage sector, which accounted for 53.0% of diesel-related emissions, as diesel is the primary fuel for energy-end use in road transport (representing 63.6% of the sector's total energy-end use) and water transport (77.1%). In addition, diesel serves as an important input fuel in manufacture of basic metals; manufacture of fabricated metal products, except machinery and equipment (10.3% of the sector's total energy-end use); manufacture of motor vehicles, trailers and semi-trailers; other transport equipment (44.8%); and manufacture of computer, electronic and optical products; electrical equipment (15.3%).

Figure 10. CO_2e Emission by Industries and energy product for energy-end use in industrial sector (Unit: Tonne CO2e)



Source: Calculated from the 2019 greenhouse gas emission matrix table.

CHAPTER 4. Multiplier Analysis for Energy Use in the economy

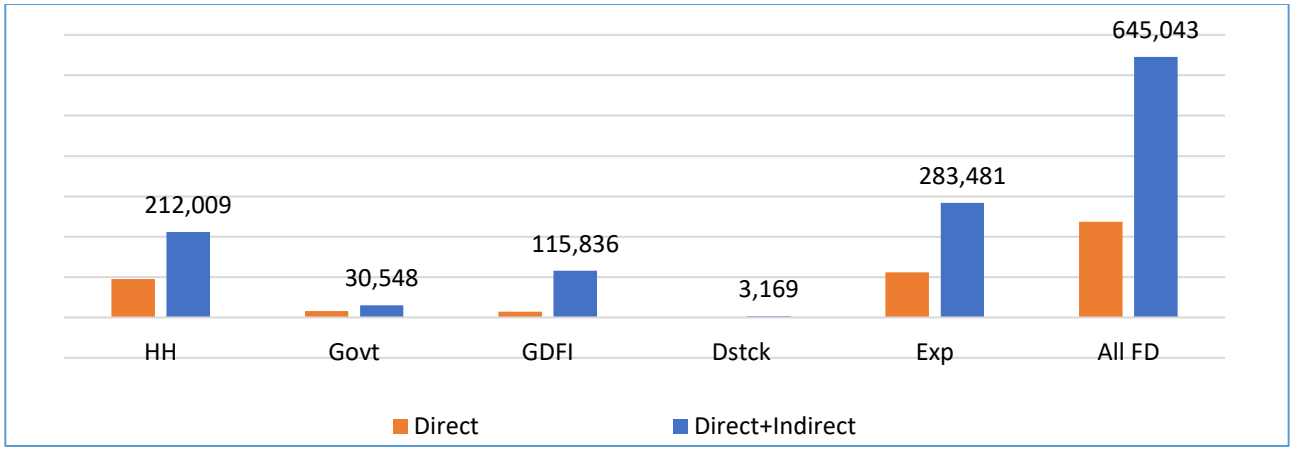
4.1. Energy use from the aggregate final demand

Section 2 provided an analysis of the status of the quantity of energy supply and use across accounts of the economy. However, the analyses presented above are relatively independent and have not yet established linkages between economic sectors/activities and have not addressed the question of how shocks or changes in the aggregate demand affect the level of energy consumption in various industrial sectors. Clearly, any change in the aggregate demand will lead to a change in the scale of production, thereby altering energy demand within industrial sectors.

Linking the E-SAM with the EUT provides a quantitative tool to address this question. Specifically, using energy intensity coefficients by industrial sectors, analyzing the scale of energy use derived from the components of the aggregate demand helps answer the question of which component in the aggregate final demand is the primary driver of changes in the level of energy use within the economic sector. This analysis can be applied to each specific energy product used across the entire sector, or to individual industries.

The example below illustrates the direct and indirect coefficients driving electricity use within the industrial sector, broken down by each component of electricity use within final aggregate demand (Figure 11). Accordingly, electricity use in export activities drives the largest increase in electricity use across the entire economic sector, reaching 283.48 thousand TJ per trillion VND; followed by household consumption. The smallest impact comes from government use, in which the direct impact is nearly negligible. It can be observed that the indirect impacts are consistently much larger than the direct ones across all components of the final aggregate demand. This can be explained by the strong interlinkages among economic sectors that use electricity in the economy.

Figure 11. Coefficient to increase the electricity use in industrial sectors by components of final aggregate demand (Unit: TJ/ trillion VND)

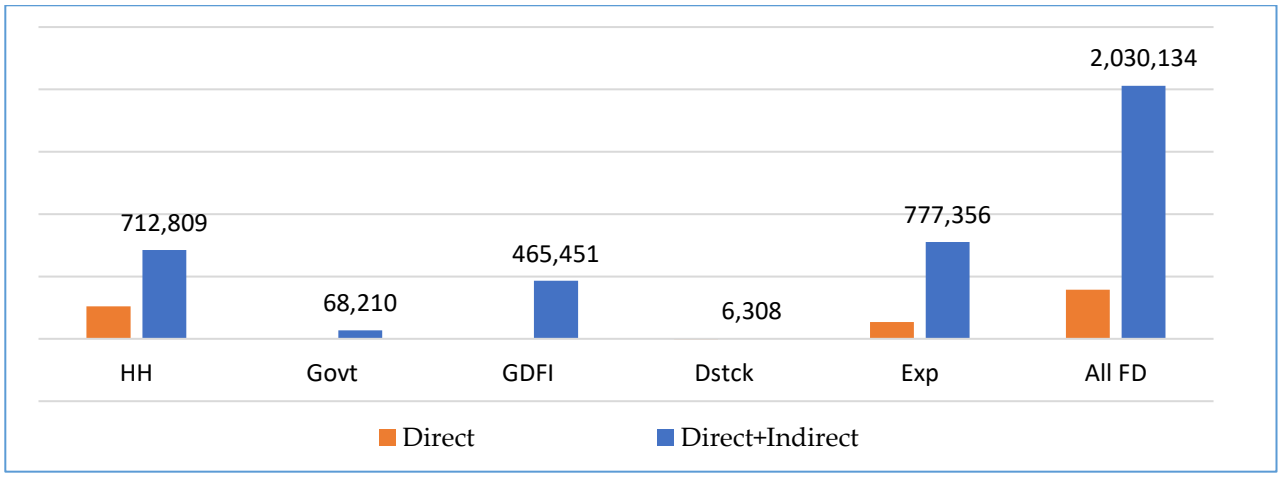


Source: Calculated by the research team.

The following example illustrates the coefficients driving coal use within the economic sector, by component of coal use within final aggregate demand. The aggregate final demand for coal increases the coal consumption across the entire industrial sector by 2,030.1 thousand TJ per trillion VND, of which coal use for exports drives the largest increase in coal use across the economic sector, reaching 777.36 thousand TJ per trillion VND; followed by the household (712.8 thousand TJ per trillion VND). The driving coefficient for coal is significantly higher than the corresponding coefficient for electricity, mainly because coal is a critical input energy product for the energy transformation of the electricity generation, accounting for 80.4% of total energy used for

transformation within the industry.

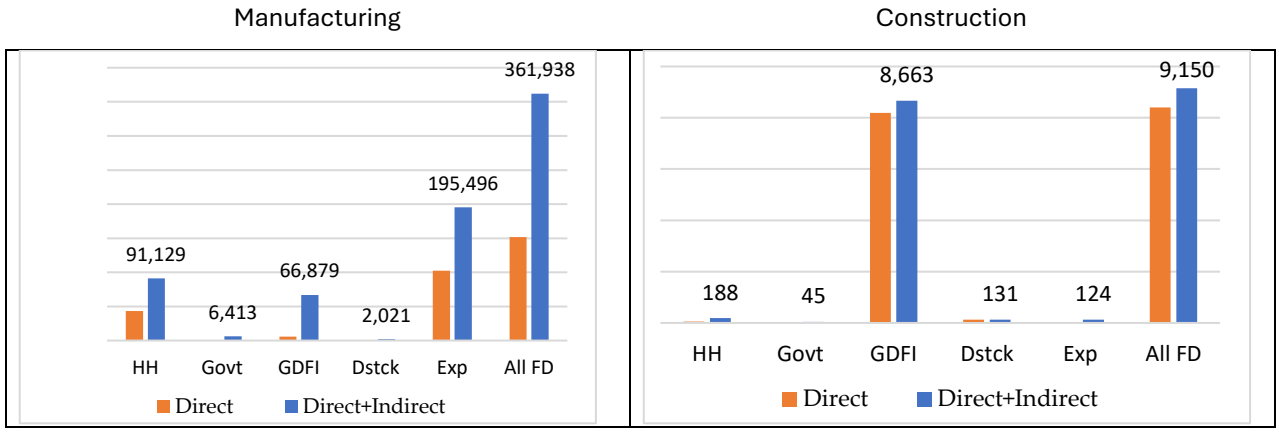
Figure 12. Coefficient to increase the coal use in industrial sectors by components of final aggregate demand (Unit: TJ/ trillion VND)



Source: Calculated by the research team.

The above analysis can be applied to individual economic sectors to examine their direct and indirect final energy use. For example, focusing on Manufacturing and Construction for a deeper dive, in which the share of electricity used in the manufacturing reaches 16.6% of total energy used in this industry; for the construction industry, this ratio reaches 15.2%.

Figure 13. Coefficient to increase the electricity use in manufacturing and construction by components of final aggregate demand (Unit: TJ/ trillion VND)



Source: Calculated by the research team.

There is a significant difference in the electricity use impact on final electricity consumption between the two sectors. In terms of impact scale, the Manufacturing has the much greater total impact (including both direct and indirect coefficient) than that of Construction. Regarding the sources of influence, electricity uses from households, exports, and gross fixed capital formation all have substantial effects on final electricity use by the manufacturing sector. Meanwhile, the impact coefficients of the construction sector mostly come from gross fixed capital formation. Moreover, regarding the Manufacturing, the indirect impact is considerably larger than the direct one, reflecting the industry's extensive linkages with other sectors of the economy. However, in the case of the construction, the direct and indirect components are roughly equal in magnitude, indicating that indirect effects are relatively insignificant.

4.2. Analysis of energy use through intersectoral linkages

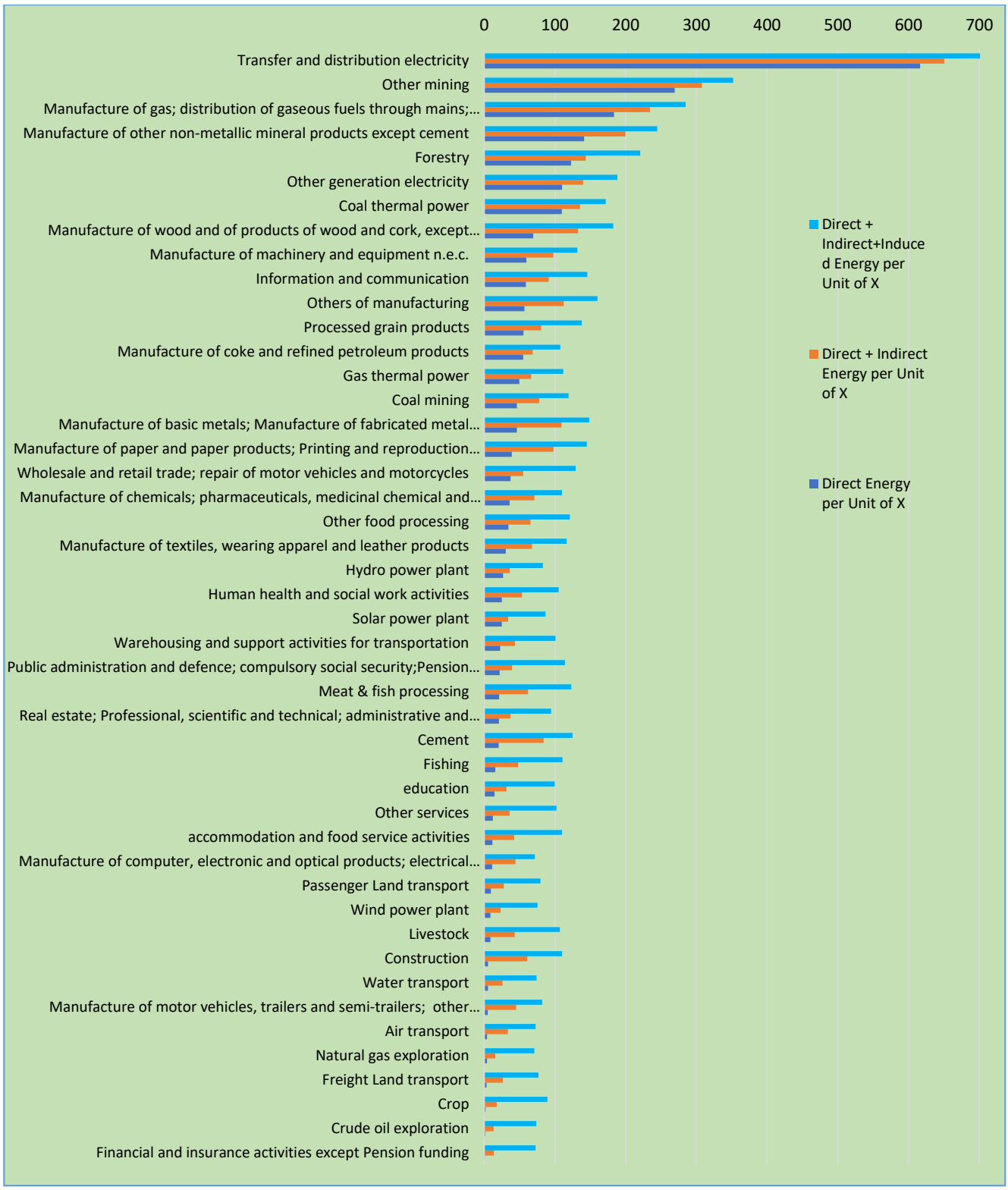
The current state of energy use intensity across economic sectors in Section 2 can be used to develop energy use multipliers which show the multiplier impact of a unit increase in activity production on energy use. However, this assessment may be incomplete, as it does not yet comprehensively account for the degree of backward/forward linkages between economic sectors, nor even the distributional effects arising from household consumption.

Specifically, when an industry A uses additional energy to meet its additional own production activities (***direct effect***), this stimulates production and business activities in other sectors that supply intermediate inputs to sector A. Furthermore, because industry A provides intermediate inputs to several other industries, the production demand of industry A increases, leading to increased energy consumption (***indirect effect***). Moreover, the expansion of production across industries raises household income through labour demand and capital. This additional income leads households to increase their consumption of goods produced by sector A, prompting the sector A to further expand production and to consume further energy (***induced effect***). Therefore, when calculating the additional energy intensity resulting from a one-unit increase in output of an industry, it is necessary to fully account for the indirect, direct and induced effects. Figure 14 below illustrates this relationship.

As an example for in-depth analysis, considering the coefficient of additional electricity use when economic sectors increase their own output by one unit. In 2019, the Electricity transmission and distribution had the highest direct, indirect and induced effects of electricity use per unit of output, reaching 650,9 TJ per trillion VND. The direct electricity use intensity was 616,5 TJ per trillion VND, meaning that the electricity consumption of the electricity transmission and distribution sector will increase by an additional 616.5 TJ when the sector increases its output value by one trillion VND. The indirect electricity use intensity accounted for about 5.6% of the direct intensity. Meanwhile, the induced effect contributed an additional 7.7% to both direct and indirect effects of electricity use in this sector.

On the other hand, the direct electricity use intensity of some industrials is minimal or even negligible such as the Freight Road transport. However, through indirect effects as well as induced effects, this sector still exhibits a relatively notable electricity use intensity, amounting to 77 TJ per trillion VND of additional output. In which, indirect effects accounted for 30%, and induced effects made up as much as 65.6%, while direct effects represented about 4.3%.

Figure 14. Multiplier of increased electricity use per unit of additional sectoral output (Unit: TJ per 1,000 billion VND)



Source: Calculated by the research team.

Comparing the above results with the analyses presented in Section 2 highlights the benefits of combining the E-SAM with the EUT to examine energy use in economic sectors. Clearly, shocks to aggregate output or demand impact on economic sectors, thereby altering the level of energy use of these sectors as well as the volume of GHG emissions generated.

In the context of Vietnam striving to achieve a "double-digit" growth target while ensuring sustainability, it is necessary to have a comprehensive analysis and quantification of energy use intensity across economic sectors. This provides a critical foundation for accurately estimating total

GHG emissions and serves as an important basis for designing effective policies to mitigate the negative environmental impacts of economic development, thus supporting climate change adaptation and mitigation efforts.

CONCLUSION

The aim of this report was to provide a comprehensive overview of Vietnam's energy supply and use in 2019. In combination with the emission factors published by the Ministry of Natural Resources and Environment (currently Ministry of Agriculture and Environment), the IPCC (2006) and Official dispatch No. 116/BĐKH-TTBVTOD[24], an emission matrix table was developed to reflect the volume of emissions generated from the energy-end use. These are important quantitative tools that help integrate many policy aspects including socio-economic development, energy consumption and environmental statistics into a unified analytical framework, thereby supporting in-depth socio-economic analyses aligned with sustainable development goals and emission reduction commitments of Vietnam.

First, the report clarifies the status of Vietnam's energy supply and consumption in 2019. The total energy supply reached over 5.6 million TJ, of which domestic production accounted for about two-thirds, while imports made up one-third, indicating a significant dependence on imported energy. Hard coal, conventional crude oil remained the dominant primary energy sources, particularly for electricity generation and transportation. The consumption structure shows that economic sectors accounted 81.5% of total energy-end use, of which manufacturing and electricity production and distribution play a leading role. Households consumed around 10.1% of total energy-end use, mainly from electricity, motor gasoline and solid biofuels (Wood, wood waste and other solid biomass, charcoal).

Besides, the study reveals significant disparities in energy use intensity across economic sectors. The electricity production, transmission, and distribution exhibit the highest energy consumption intensity, reflecting low conversion efficiency, whereas many service sectors show low intensity due to their relatively limited reliance on energy inputs. The overall energy use intensity of the economy stands at 681.7 MJ per million VND of value added, indicating that, on average, the economy needs to consume 681.7 MJ of energy to generate 1 million VND of value added, substantially higher than that of developed countries, indicating considerable potential for improving energy efficiency and conservation in Vietnam. In addition, the share of renewable energy in total energy-end use (SDG indicator 7.2.1) reached 13.65%, demonstrating the important contribution of renewables, particularly from hydropower and biomass. However, this proportion remains modest compared with the requirements of the green energy transformation in the coming period. This underscores the need to accelerate the development of clean energy sources such as wind, solar, and biomass power, as well as to enhance electricity power storage, transmission and distribution infrastructure to support the transition process.

The analysis found that total GHG emissions from fuel combustion for energy-end use within Vietnam in 2019 reached 356.18 million tonnes of CO_2e[25]. The main source of emissions came from the industrial sector (80.2%), in which the manufacturing accounted for the largest share (60.3%), followed by the electricity generation and distribution industry (6.6%) and the transportation and storage (9.9%). By energy product, electricity was the largest source of emissions from energy-end use, accounting for 55% of total CO_2e emissions, followed by hard coal (19.7%). The next largest sources of emissions came from the energy-end use of solid biofuels (7.3%) and diesel oil (8.6%).

By linking the EUT with the E-SAM, this research demonstrates the potential of applying a multiplier model to quantify the direct, indirect, and induced effects of aggregate demand shocks on energy consumption across industrial sectors. A detailed analysis of electricity consumption,

[24] Official dispatch No. 116/BĐKH-TTBVTOD dated 26 February 2021 of the Department of Climate Change - Ministry of Natural Resources and Environment on the emission factor for the Vietnam electricity grid in 2019.

[25] If we account for the losses from electricity distribution, the emissions from energy-end use is 343.69 million CO2e.

for instance, showed that demand from exports and household are the strongest drivers of electricity use intensity amongst industrial sectors of Vietnam

It would be inaccurate and incomplete to assess the increase in a sector's energy consumption solely based on the direct impact of a one-unit increase in its output on its own energy use intensity. Instead, both indirect and induced effects must also be considered. The use of a multiplier model, derived from linking the E-SAM and the EUT, enables such an in-depth analysis. This provides a solid foundation for accurately estimating the total GHG emissions generated from increases in sectoral output.

REFERENCE

Decision No. 2626/QĐ-BTNMT dated 10 October 2022 of the Ministry of Natural Resources and Environment on publishing list of emission factors serving greenhouse gas (GHG) inventory development

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APPENDIX

Appendix 1 - GHG emissions from energy-end use by energy products in 2019 (Unit: Million Tonne)

Energy products used for energy-end use	CH_4	NO_2	CO_2	CO_2e
Hard coal	0.02	0.00	69.18	70.10
Brown coal	-	-	-	-
Coal coke	-	-	-	-
Natural gas	0.00	0.00	2.36	2.37
Conventional crude oil	-	-	-	-
Liquefied Petroleum Gases	0.00	0.00	3.79	3.79
Motor gasoline	0.00	0.00	20.84	21.03
Jet fuel	-	-	5.13	5.13
Kerosene	0.00	0.00	0.10	0.10
DO	0.00	0.00	30.44	30.71
FO	0.00	0.00	0.99	1.00
Lubricant	-	-	-	-
Bitumen	-	-	-	-
Non-specified oil products	-	-	-	-
Solid biofuels (Wood, wood waste and other solid biomass, charcoal)	0.03	0.00	24.95	26.10
Liquid biofuels	-	-	-	-
Biogases	-	-	-	-
Waste	-	-	-	-
Electrical energy	-	-	195.84	195.84
Heat	-	-	-	-
TOTAL	**0.06**	**0.00**	**353.61**	**356.18**

Source: Calculated from the greenhouse gas emission matrix 2019

Appendix 2. GHG emissions from energy transformation by energy products in 2019 (Unit: Million Tonne)

Energy products used for energy transformation	CH_4	N_2O	CO_2	CO_2e
Hard coal	0.001	0.002	136.305	136.960
Brown coal	-	-	-	-
Coal coke	-	-	-	-
Natural gas	0.000	0.000	19.204	19.222
Conventional crude oil	0.002	0.000	45.321	45.477
Liquefied Petroleum Gases	-	-	-	-
Motor gasoline	-	-	-	-
Jet fuel	-	-	-	-
Kerosene	-	-	-	-
DO	0.000	0.000	0.259	0.260
FO	0.000	0.000	0.735	0.737
Lubricant	-	-	-	-
Bitumen	-	-	-	-
Non-specified oil products	-	-	-	-
Solid biofuels (Wood, wood waste and other solid biomass, charcoal)	0.000	0.000	0.456	0.464
Liquid biofuels	-	-	-	-
Biogases	-	-	-	-
Waste	-	-	-	-
Electrical energy	-	-	-	-
Heat	-	-	-	-
TOTAL	**0.004**	**0.003**	**202.279**	**203.121**

Source: Calculated from the greenhouse gas emission matrix 2019.