ENVIRONMENTAL-EXTENDED PHYSICAL SUPPLY AND USE TABLES (EE-PSUTs) FOR ENERGY ACCOUNTS IN GHANA

COMPILATION MANUAL

GHANA STATISTICAL SERVICE
OCTOBER 2020

Environmental-Extended Physical Supply and Use Tables (EE-PSUTs) for Energy Accounts in Ghana

2013

Based on the

System of Environmental-Economic Accounting

(SEEA)

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Acronyms

EE- SUT	Environmentally- Extended Supply Use Table
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
GLSS	Ghana Living Standard Survey
IRES	International Recommendations for Energy Statistics
ISIC	International Standard Industry Classification
LPG	Liquefied Petroleum Gas
PEFA	Public Expenditure and Financial Accountability
PSUT	Physical Supply Use Table
SEEA-CF	System of Environmental-Economic Accounting Central Framework
SIEC	Standard International Energy Product Classification
SNA	System of National Accounts
SUT	Supply Use Table

Chapter 1

Introduction

1.1 Background

This manual presents the concept of physical flow accounts and provides some general compilation guidelines. It primarily addresses not only the compilers of System of Environmental-Economic Accounting for Energy (SEEA-Energy) for Ghana but also the users of the documents who are interested in understanding more of the underpinning statistical details. This manual is intended to inform and clarify the methods used in compiling the energy accounts of Ghana in regards to populating the environmental domain flows, balancing of the EE-SUTs on energy and derivation of indicators from the EE-SUT energy.

The concept of SEEA-Energy present data on the physical flows of energy expressed in joules in a way that is fully compatible with the concepts, principles, and data reported under the System of National Accounts (SNA 2008 2008). SEEA-Energy record energy flow data in relation to the economic activities of resident units of national economies. They present the supply and use of natural inputs from the environment, energy products and energy residuals. Economic activities comprise of production, consumption, and accumulation.

The SEEA-Energy manual outlines a general physical flow accounting framework and a set of accounting principles and boundaries within which a consistent recording of all types of physical flows relating to economic activities can be made. The idea of the SEEA-Energy is to align energy information closer to national accounts enabling the integration of energy concerns into macro-economic monitoring, analyses, modelling, and theory building. This account is supposed to complement basic energy statistics and energy balances.

1.2 Ghana 2013 Physical Supply and Use Tables (PSUTs) for Energy

The SEEA-Energy framework follows a similar accounting structure as the System of National Accounts (SNA 2008) with environmental extensions and uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics.

The SEEA-Energy framework seeks to describe the physical flows of energy within the economy and between the environment and the economy. High-quality economic and environmental statistics are important inputs in developing Environmentally-Extended Supply and Use Tables (EE-SUTs).

The System of Environmental-Economic Accounting for Energy (SEEA Energy) is a multipurpose conceptual framework for organizing energy-related statistical information. It supports analysis of both the role of energy within the economy and the relationship between energy-related activities and the environment.

SEEA-Energy is an accounting approach that records the stocks and flows of energy within a country. This accounting approach is based on the System of Environmental-Economic Accounting (SEEA), a conceptual framework that has been developed over the past two decades to integrate the measurement of environmental and economic phenomena. In particular, SEEA-Energy is a subsystem of the System of Environmental-Economic Accounting 2012-Central Framework (SEEA Central Framework), which was adopted by the Statistical Commission in 2012 as the international statistical standard for environmental-economic accounts. More broadly, SEEA-Energy and the SEEA Central Framework are satellite accounts of the System of National Accounts 2008 (2008 SNA).

Energy Accounts have a wide variety of applications: it enable countries to identify their development priorities, baselines, targets and goals; directly support countries in measuring, monitoring, and evaluating Sustainable Development Goals (SDGs), particularly Goals 2, 6, 7, 8, 9, 11, 12, 14, and 15; and are instrumental in evidenced-based planning, policy formulation and decision making.

1.3 Purpose and Objectives

The purpose of the manual is to serve as a guide for subsequent work on EE-SUT on energy and outlines best practice in compiling and developing Energy accounts. It also seeks to find effective solutions and formulate a better strategy for continuing and completing the project successfully in Ghana. The specific objectives of this manual include:

i. Best practices in terms of developing Energy Accounts for the first time in a country;

ii. Practical compilation methodology;

iii. Application and use.

Chapter 2

Fundamentals

2.1 Introduction

In order to compile EE – SUT on energy, there is the need to know the concepts used in the development of EE-SUT and their definitions. These concepts and definitions help to collect the needed information in a uniform manner throughout the country. Moreover, they allow comparisons with other countries in the world. The most important concepts used in Energy accounts are:

2.2 Guiding Framework of SEEA-Energy

The System of National Accounts (2008) and the System of Environmental-Economic Accounts are the two international standards that provide useful guidance on the concepts, definition, classifications, accounting framework and methodology for computing wealth and natural accounting.

The SUT framework is basically a pair of tables which have the same format/structure. Row-wise, the two matrices show the various physical flow types, namely natural inputs, products, and residuals. Column-wise they show the various origins and destinations supplying and using the flow items, namely industries (i.e. production activities), households (i.e. consumption activities), accumulation (changes in stocks of produced assets and product inventories), rest of the world, and environment.

The physical supply table shows which flow items are provided by which supplier (industries, households, accumulation, rest of the world and environment); in other words, it shows the flows by origin. On the other hand, the physical use table shows who using or receiving the respective physical flow. In other words, it shows the flows by its destination. Like this, each flow is recorded twice: first at its origin, secondly at its destination.

The International Standard Industry Classification (ISIC) of industries in the Energy Accounts, includes the following description based on ISIC Rev.4. ISIC includes all of the economic activities relevant to describing the removal or capture of energy from natural inputs, and the transformation and distribution of energy products. These activities are classified mainly within the following sections of ISIC:

i. Section A -Agriculture and Forestry (Crops, Livestock, Forestry & logging, Fisheries);
ii. Section B- Mining and quarrying;
iii. Section C- Manufacturing;
iv. Section D- Electricity, gas, steam and air conditioning supply;
v. Section E - Water Supply, Sewage & Waste Management;
vi. Section F- Construction;
vii. Section for services ((Transportation (ISIC H), Hotels & Restaurant (ISIC I), Public administration (ISIC O), Education (ISIC P), Health (ISIC Q), others). and the added flow items;

Other sections of the supply/use tables include:

i. Households;
ii. Inventories
iii. Imports
iv. Environment

Establishments engaged in extracting mineral and energy resources as a principal activity are included in ISIC B. The mining and quarrying sector include the following:

i. Mining
ii. Extraction of crude petroleum and natural gas;
iii. Mining of metal ores;
iv. Other mining and quarrying;
v. Mining support service activities

The residence principle concept was applied in accordance with the 2008 SNA and the SEEA CF. The residence principle basically assigns flows of energy to the country of residence of the producing or consuming unit.

Chapter 3

Concept of Physical Flow Accounting

3.1 Introduction

The physical supply and use tables are an accounting construct for the compilation and presentation of all those energy flows that enter, are used within and leave a country's national economy for a given period of time. It necessarily expresses energy flows in a common unit (joules) and illustrates the relationship between inputs to and outputs from energy transformation processes. The physical supply and use table for energy aims at comprehensiveness that entails recording all energy flows both within the economy and between the economy and environment. There are three generic types of physical flows: natural inputs, products and residuals.

3.2 Energy from Natural Inputs

The flow of energy from natural inputs encompasses the extraction or capture of energy from the environment by resident economic units. The supplier of these flows is the environment. The flows include energy from natural resource inputs specifically crude oil, natural gas and natural timber resources, inputs from renewable energy sources such as solar, wind and hydro and other natural inputs such as energy inputs to cultivated biomass (Table 1).

Crude oil could be defined as a mineral oil of fossil origin extracted by conventional means from underground reservoirs, and comprising liquid or near-liquid hydrocarbons and associated impurities such as Sulphur and metals. In the case of natural gas, it is a mixture of gaseous hydrocarbons (primarily methane but, generally, also ethane, propane and higher hydrocarbons in much smaller amounts) and some non-combustible gases such as nitrogen and carbon dioxide.

Physical flows from the environment to the economy that are derived principally from stocks of timber are known as natural timber resources. Natural timber resources refer to an energy input from the environment, which are incorporated into energy products such as biofuel or waste. The country has an energy mix where some of the inputs of energy resources come from renewable sources.

Currently, as per the International Recommendations for Energy Statistics (IRES) Ghana's renewable energy sources include solar, wind and hydro.

The data for the quantities of crude oil, natural gas, Natural Timber resources and inputs from renewable sources such as solar, wind and hydro as well as cultivated biomass, extracted from the environment was obtained from the energy balances and basic energy statistics under the production of crude oil, Natural gas, wood and electricity. In the case of cultivated biomass, it is derived from the quantity of charcoal exported which by law it is supposed to be produced from cultivated forest resource. In addition, in the physical supply and use tables, a balancing entry equal to the energy products from cultivated biomass is recorded as a component of energy from natural inputs in both the supply and the use tables.

This is done to ensure a complete balance of energy flows since energy from cultivated biomass, including from cultivated timber resources, is treated as being produced within the economy and hence is first recorded as a flow of an energy product. However, in the energy from natural inputs section of the SUT, the value for energy inputs to cultivated biomass is generally split among several industries, corresponding to end use among them.

Similarly, the industry that extracts mineral and energy resources from the environment as its principal activity is classified under Mining and quarrying. The capture of energy from renewable sources is classified under Agriculture, forestry and fishing or under Electricity, examples include solar, wind and hydro. Table 1 presents details of the supply table.

However, to ensure a complete balance of energy flows in the physical supply and use tables a balancing entry equal to the energy products from energy resources is recorded as a component of energy from natural inputs in both the supply and the use tables. In the energy from natural inputs section of the use table, the value for energy inputs to the various energy resources is generally split among several industries, corresponding to end use among them.

In the case of ISIC A under forestry and logging, the value inputted is the difference between production of wood and other transformation. The production figure for crude oil and natural gas

was recorded under ISIC B, mining and quarrying since it is an end use for the mining and quarrying sector. The transformation of wood and cultivating of biomass is done by the manufacturing sector so it recorded under ISIC C. Consequently, the use of solar and hydro for electricity generation is therefore recorded under Electricity, ISIC D since it is the sector responsible for the use of the energy input. Details of these entries are presented in (Table 2).

Table 1: Supply Table

SUPPLY TABLE																				
	UNIT: Petajoule (10^{15})	Agriculture and Forestry (ISIC A)				Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity (ISIC D)	Water Supply, Sewerage & Waste Management (ISIC E)	Construction (ISIC F)	Services						Households	Inventories	Imports	Environment	Total
		Crops	Livestock	Forestry & Logging	Fisheries						Transport (ISIC H)	Hotels & Restaurant (ISIC I)	Public Administration (ISIC O)	Education (ISIC P)	Health (ISIC Q)	Others [1]					
Energy natural resource inputs	Total																			455.31	455.31
Energy resources	*of which Crude Oil*																			224.87	224.87
	of which Natural Gas																			53.25	53.25
	Natural Timber resources																			147.55	147.55
Inputs of energy from renewable sources	*Solar based renewable*																			0.01	0.01
	Wind based renewable																			0.00	0.00
	Hydro based renewable																			29.64	29.64
Other natural inputs	*Cultivated Biomass*																			0.00	0.00
Energy products	Total	1.24	0.00	64.26	0.00	227.90	64.90	75.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			195.43		630.35
Products	Crude oil					224.87													55.62		280.48
	Kerosene						0.63												0.00		0.63
	Aviation Turbine Kerosene (ATK)						2.58												1.79		4.37
	LPG						1.16												9.22		10.38
	Natural gas					3.03													12.21		15.24
	Gasoline						7.35												44.73		52.08
	Gasoil						4.84												69.98		74.82
	Electrical energy							75.98											0.10		76.07
	Residual Fuel Oil						1.77												1.80		3.57
	Charcoal						46.57												0.00		46.57
	Wood			64.26															0.00		64.26
	Other residues	1.24																	0.00		1.24
	Non-energy [2]																		0.64		0.64
Residuals	Total	0.00	0.07	0.07	2.41	71.35	55.16	33.35	0.74	2.87	106.77	3.09	0.32	4.40	0.95	3.64	131.28				416.47
Residuals	Losses during extraction (Natural Gas)					50.21															50.21
	Losses during distribution (Electricity)							3.93													3.93
	Losses during transmission (Electricity)							2.05													2.05
	Losses during transformation (Crude Oil)						0.67														0.67
	Losses during transformation (Wood)						36.72														36.72
	Energy Residuals from End Use		0.07	0.07	2.41	21.14	16.83	27.37	0.74	2.87	106.77	3.09	0.32	4.40	0.95	3.64	131.28				321.94
	Energy incorporated in Products for Non-Energy Use						0.95														0.95
Total Supply of Energy		1.24	0.07	64.33	2.41	299.25	120.06	109.33	0.74	2.87	106.77	3.09	0.32	4.40	0.95	3.64	131.28	0.00	195.43	455.31	1,502.13

Table 2: Use Table

USE TABLE																				
	UNIT: Petajoule (10^{15})	Agriculture and forestry (ISIC A)				Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity (ISIC D)	Water Supply, Sewerage & Waste Management (ISIC E)	Construction (ISIC F)	Transport (ISIC H)	Hotels & Restaurant (ISIC I)	Public Administration (ISIC O)	Education (ISIC P)	Health (ISIC Q)	Other[1]	Households	Inventories	Exports	Environment	Total
		Crops	Livestock	Forestry & Logging	Fisheries															
Natural inputs	**Total**	**0.00**	**0.00**	**64.26**	**0.00**	**278.11**	**83.29**	**29.65**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**				**455.31**
Energy resources	*of which Crude Oil*					224.87														**224.87**
	of which Natural Gas					53.25														**53.25**
	Natural Timber resources			64.26			83.29													**147.55**
Inputs of energy from renewable sources	*Solar based renewable*							0.01												**0.01**
	Wind based renewable																			**0.00**
	Hydro based renewable							29.64												**29.64**
Other natural inputs	*Cultivated Biomass*						0.00													**0.00**
Energy products	**Total**	**1.23**	**0.07**	**0.07**	**2.41**	**21.14**	**36.76**	**79.68**	**0.74**	**2.87**	**106.77**	**3.09**	**0.32**	**4.40**	**0.95**	**3.64**	**131.28**	**3.23**	**231.09**		**630.38**
Products	Crude oil					2.16	18.69	37.75										1.96	219.92		**280.48**
	Kerosene																0.98	-0.35	0.00		**0.63**
	Aviation Turbine Kerosene (ATK)										0.41							-1.32	5.27		**4.37**
	LPG						0.32				4.36	0.24		0.13	0.01	0.04	6.27	-1.01	0.00		**10.38**
	Natural gas					3.03		11.82										0.39	0.00		**15.25**
	Gasoline	0.57	0.03	0.03	1.12	0.15	0.00			0.05	45.58							2.96	1.58		**52.08**
	Gasoil	0.66	0.04	0.04	1.29	10.30	2.08	0.23		2.82	56.39							-1.22	2.21		**74.82**
	Electrical energy					5.50	5.58	29.88	0.74	0.00	0.01	1.35	0.32	1.52	0.76	3.59	24.91		1.91		**76.08**
	Residual Fuel Oil						1.60											1.82	0.15		**3.57**
	Charcoal						0.15					1.38		1.89	0.18		42.95		0.03		**46.58**
	Wood						8.34					0.12		0.86	0.00		54.92				**64.26**
	Other residues																1.24				**1.24**
	Non-energy						0.64												0.00		**0.64**
Residuals	**Total**																			**416.47**	**416.47**
Residuals	Losses during extraction (Natural Gas)																			50.21	**50.21**
	Losses during distribution (Electricity)																			3.93	**3.93**
	Losses during transmission (Electricity)																			2.05	**2.05**
	Losses during transformation (Crude Oil)																			0.67	**0.67**
	Losses during transformation (Wood)																			36.72	**36.72**
	Energy Residuals from End Use																			321.94	**321.94**
	Energy incorporated in Products for Non-Energy Use																			0.95	**0.95**
Total Use of Energy		**1.23**	**0.07**	**64.33**	**2.41**	**299.25**	**120.06**	**109.33**	**0.74**	**2.87**	**106.77**	**3.09**	**0.32**	**4.40**	**0.95**	**3.64**	**131.28**	**3.23**	**231.09**	**416.47**	**1,502.15**

3.3 Energy products

Energy products are the flow of energy that are used exclusively, or mainly, as a source of energy from natural inputs from the environment within the economy. These flows of energy are recorded in energy units. They include fuels that are produced or generated by an economic unit, electricity that is generated by an economic unit, and sold to third parties by an economic unit. Some energy products may be used for non-energy purposes. Supplies of energy products may arise from imports and through production activity undertaken by resident units.

Energy Products can be classified into primary and secondary energy products. Primary energy products result from the capture of energy from natural inputs from the environment whilst secondary energy products result from transformation of primary or other secondary energy products into other types of energy products (SEEA-Energy, 2019 para 2.105 & 2.106).

The primary energy products in Ghana includes crude oil, natural gas and fuelwood. The secondary energy products include Kerosene, Aviation Turbine Kerosene (ATK), Liquefied Petroleum Gas (LPG), Natural gas, Gas oil, Electrical Energy, Residual Fuel oil and Charcoal which is derived from the transformation of primary energy product (fuelwood).

3.3.1 Supply of Energy Products

In the supply side of the SUT table, statistics are recorded for the amount of energy product that was supplied to the economy by energy-supplying industries and other industries. The energy products are classified based on the Standard International Energy Product Classification (SIEC).

The values inputted for the energy products supplied to the economy were obtained from the production column in the basic energy statistics. The imports values are obtained from the corresponding import values in the energy statistics for each energy product with the exception of the non-energy products. The import statistics for the non-energy product was obtained from the trade statistics from Ghana Statistical Service. It includes the import of Lubricating oils, Bituminous, White Spirit and Paraffin wax. This shown in (Table 3).

Table 3: Supply of Energy products

SUPPLY TABLE																				
	UNIT: Petajoule (10^{15})	Agriculture and Forestry (ISIC A)				Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity (ISIC D)	Water Supply, Sewerage & Waste Management (ISIC E)	Construction (ISIC F)	Services						Households	Inventories	Imports	Environment	Total
		Crops	Livestock	Forestry & Logging	Fisheries						Transport (ISIC H)	Hotels & Restaurant (ISIC I)	Public Administration (ISIC O)	Education (ISIC P)	Health (ISIC Q)	Others [1]					
Energy natural resource inputs	**Total**																			**455.31**	**455.31**
Energy resources	*of which Crude Oil*																			224.87	**224.87**
	of which Natural Gas																			53.25	**53.25**
	Natural Timber resources																			147.55	**147.55**
Inputs of energy from renewable sources	*Solar based renewable*																			0.01	**0.01**
	Wind based renewable																			0.00	**0.00**
	Hydro based renewable																			29.64	**29.64**
Other natural inputs	*Cultivated Biomass*																			0.00	**0.00**
Energy products	**Total**	**1.24**	**0.00**	**64.26**	**0.00**	**227.90**	**64.90**	**75.98**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**			**195.43**		**630.35**
Products	Crude oil					224.87													55.62		280.48
	Kerosene						0.63												0.00		0.63
	Aviation Turbine Kerosene (ATK)						2.58												1.79		4.37
	LPG						1.16												9.22		10.38
	Natural gas					3.03													12.21		15.24
	Gasoline						7.35												44.73		52.08
	Gasoil						4.84												69.98		74.82
	Electrical energy							75.98											0.10		76.07
	Residual Fuel Oil						1.77												1.80		3.57
	Charcoal						46.57												0.00		46.57
	Wood			64.26															0.00		64.26
	Other residues	1.24																	0.00		1.24
	Non-energy [2]																		0.64		0.64

Table 4: Use of Energy products

USE TABLE																				
	UNIT: Petajoule (10^{15})	Agriculture and forestry (ISIC A)				Mining & Quarrying (ISIC B)	Manufacturing (ISIC C)	Electricity (ISIC D)	Water Supply, Sewerage & Waste Management (ISIC E)	Construction (ISIC F)	Transport (ISIC H)	Hotels & Restaurant (ISIC I)	Public Administration (ISIC O)	Education (ISIC P)	Health (ISIC Q)	Other[1]	Households	Inventories	Exports	Environment	Total
		Crops	Livestock	Forestry & Logging	Fisheries															
Natural inputs	**Total**	**0.00**	**0.00**	**64.26**	**0.00**	**278.11**	**83.29**	**29.65**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**				**455.31**
Energy resources	*of which Crude Oil*					224.87														**224.87**
	of which Natural Gas					53.25														**53.25**
	Natural Timber resources			64.26			83.29													**147.55**
Inputs of energy from renewable sources	*Solar based renewable*							0.01												**0.01**
	Wind based renewable																			**0.00**
	Hydro based renewable							29.64												**29.64**
Other natural inputs	*Cultivated Biomass*						0.00													**0.00**
Energy products	**Total**	**1.23**	**0.07**	**0.07**	**2.41**	**21.14**	**36.76**	**79.68**	**0.74**	**2.87**	**106.77**	**3.09**	**0.32**	**4.40**	**0.95**	**3.64**	**131.28**	**3.23**	**231.09**		**630.38**
Products	Crude oil					2.16	18.69	37.75										1.96	219.92		**280.48**
	Kerosene																0.98	-0.35	0.00		**0.63**
	Aviation Turbine Kerosene (ATK)										0.41							-1.32	5.27		**4.37**
	LPG						0.32				4.36	0.24		0.13	0.01	0.04	6.27	-1.01	0.00		**10.38**
	Natural gas					3.03		11.82										0.39	0.00		**15.25**
	Gasoline	0.57	0.03	0.03	1.12	0.15	0.00			0.05	45.58							2.96	1.58		**52.08**
	Gasoil	0.66	0.04	0.04	1.29	10.30	2.08	0.23		2.82	56.39							-1.22	2.21		**74.82**
	Electrical energy					5.50	5.58	29.88	0.74	0.00	0.01	1.35	0.32	1.52	0.76	3.59	24.91		1.91		**76.08**
	Residual Fuel Oil						1.60											1.82	0.15		**3.57**
	Charcoal						0.15					1.38		1.89	0.18		42.95		0.03		**46.58**
	Wood						8.34					0.12		0.86	0.00		54.92				**64.26**
	Other residues																1.24				**1.24**
	Non-energy						0.64												0.00		**0.64**

3.3.2 Use of Energy Products

Energy products used by businesses for intermediate consumption: either for direct use or for input into a transformation process directed towards producing other energy or non-energy products. Energy products, which are also used by households as part of household consumption or by the rest of the world as exports, can be stored in the form of inventories. Inventories of energy products in SEEA-Energy encompass primary energy products that are being accumulated after extraction and before processing (e.g., coal, Crude oil and natural gas) and secondary energy products, which are derived from further processing. (e.g., fuel oil, gasoline and diesel). These are also recorded in the use table and illustrated in Table 4.

It should be noted however, that since the data on transport in the 2013 Energy Balance was not disaggregated based on sectors, allocation of transport energy use within households was not done. This data gap has been flagged to be addressed in the future.

3.4 Supply and Use of Non-Energy Products

Energy products may be used directly for fuels, transformed into other energy products, or exported to the rest of the world. However, in some cases, energy products may be used to produce non-energy products such as plastics or lubricants. These non-energy products are used for non-energy purposes such as asphalt for the construction of road. The non-energy products in the 2013 Ghana Energy Accounts include lubricating oil, bituminous, white spirit and paraffin wax.

The recording is done by making entries in the respective cells of the sectors responsible for the supply or use of these non-energy products. In 2013, most of these non-energy products were imported into the country hence the quantities are recorded under imports in the supply side of the PSUT. The non-energy products imported include; lubricating oil, bituminous, white spirit and paraffin wax.

However, at the use side of the PSUT, the usage of the non-energy products by the respective sectors is recorded. In 2013, these non-energy products were mainly used by the manufacturing industry so the quantity was recorded under the manufacturing industry. Some of the non-energy products such

as lubricating oil, bituminous and paraffin wax were also produced domestically and exported. The quantity exported is also recorded under export in the use table of the PSUT illustrated in (Table 4).

3.5 Supply and Use of Energy Residuals

This section explains flows of solid, liquid and gaseous materials back into the environment by establishments and households through processes of production, consumption or accumulation. It also comprises of energy losses as well as other energy residuals primarily dissipative heat generated through end use of energy products for energy-related purposes, for example, fuel combustion and electricity-powered operation of an appliance.

Losses refer to losses during the transmission, distribution and transport of fuels, heat and electricity. It also includes flaring of manufactured gases and pilferage of fuels or electricity.

3.5.1 Losses during extraction (Natural Gas)

These are losses that occur during the extraction of natural gas prior to any further processing, treatment or transportation of the extracted natural gas and are not included under the production of natural gas. In the case of the Energy account some natural gas that was reinjected into the deposit in order to increase pressure and facilitate further extraction was also added to losses during extraction since it is from the economy to the environment. However, in the energy balance, these flows are not treated as losses since the reinjected gas could be extracted at a later period.

The quantity recorded under losses during the extraction of natural gas is a total of the quantity flared and reinjected. It is recorded under the mining and quarrying sector since it is the sector responsible for the supply of the products. The values can be obtained from the Energy Statistics published by the Energy Commission. These quantities are recorded both as a residual loss on the supply side as well environmental flow going back into the environment due to the double accounting framework.

3.5.2 Losses during Distribution (Electricity)

This type of loss measures the power lost in the distribution of (medium- and low-voltage) electricity from distributors to end-users. The amount of distribution loss is recorded under ISIC D, Electricity.

This is because the electricity industry is responsible for the distribution of (medium- and low-voltage) electricity from distributors to end-users or consumers. These quantities are recorded twice in the PSUT. It is first recorded in the supply table as a residual then a corresponding entry is also entered on the use side as an environmental flow back to the environment.

3.5.3 Losses during Transmission (Electricity)

This type of loss measures the power lost in the transmission of (high-voltage) electricity from power generators to distributors. It is simply the losses during transmission between sources of supply and points of distribution. Similarly, the quantity of transmission loss is reported under ISIC D, Electricity. This is because the electricity industry is responsible for the transmission of (high-voltage) electricity from power generators to distributors. These quantities are recorded twice in the SUT. It is first recorded in the supply table as a residual then a corresponding entry is also entered on the use side as an environmental flow back to the environment.

3.5.4 Losses during Transformation (Crude Oil and Wood)

This loss is attributed to the economic unit that is undertaking the transformation or conversion. The estimate of the intermediate consumption of the energy product that is to be transformed is not affected. Rather, following the general recording principle, the output of the transformed energy products is reduced (and is equal to the amount distributed, assuming no other losses) and a corresponding entry for the supply of energy residuals by the transforming unit is recorded. These quantities are recorded twice in the SUT. It is first recorded in the supply table as a residual then a corresponding entry is also entered on the use side as an environmental flow back to the environment.

3.5.5 Energy Residuals from End use

According to the SEEA-Energy, other energy residuals are most often generated from the end use of energy products. An example is fuel for vehicles and use of fuelwood or LPG by household for cooking or heating. This is because when the end user utilises the energy products, the heat generated from the final use of the energy product enters the environment hence considered as energy residual. The

flow of residual heat is recorded as equal to the energy input in order to satisfy the law of the conservation of energy.

This was done by summing up the quantities of energy products used by end users at the final stage for each ISIC sector. The result obtained was then recorded as energy residual from end use under the corresponding sector or industry. It is important to note that the summation excludes the quantities of energy products that went into transformation. The data for energy residual from end use is reported twice in the SUTs. It is first recorded in the supply table under the respective industries then a corresponding entry is also entered in the use table.

3.5.6 Energy Incorporated in Products for Non-Energy Use

This section accounts for other residual flows which include residual from end use for non-energy purpose. This accounts for the energy embodied in energy products that is used for non-energy purposes in the different sectors; that is not consumed as a fuel or transformed into another fuel. For example, most lubricants and bitumen are used for non-energy purposes.

The quantities of energy products used to produce non-energy products such as white spirit, lubricants and paraffin wax are reported under energy incorporated in products for non-energy use under the residual section. Also, the quantities are placed in the respective sectors (manufacturing) according to the end use of these non-energy products. These quantities are recorded twice in the SUT. It is first recorded in the supply table then a corresponding entry is also entered in the use side.

3.6 Total Supply of Energy

The supply table shows the total inflow of energy to the economy from the environment and the rest of the world. This includes the domestic extraction or production of energy from the environment and production of energy products as well as imports of primary and secondary energy products. All types of energy, energy products, energy for own use and energy losses are included. Ideally, fuel purchases by residents abroad should be included as imports based on the residence principle but due to the absence of data, purchases by residents abroad was not added. Simply put, the total supply

refers to the quantity of domestic production in the country and the imports. For each industry, the column sum shows the amount of primary energy products supplied.

3.7 Total Use of Energy

This section presents a physical use table that displays information on the purpose for which energy was used. Per IRES, the use of energy products can be broadly classified into three groups which include energy purposes, non-energy purposes and transformation. However, according to SEEA-Energy, energy products can be used for energy purposes and non-energy purposes. The total use can be obtained by adding consumption (both intermediate and final consumption), changes in inventories and exports. It is essential to note that other adjustments such as the addition of fuels used by international marine and aviation bunkering to export based on the residence principle of the operator of the transport equipment were also made.

3.8 Balancing the PSUT - Energy

The supply-use identity was used in balancing the PSUT. The technique requires that all energy products which are supplied be recorded as being used in the economy. The energy products are used as intermediate consumption, final consumption, exports and inventories. The equality identity also applies to the natural inputs and the residuals.

While the structure of the energy products section of the supply table is different from that of the use table, care should be taken to ensure that the supply and use identity is maintained. For example, the total supply of the energy product must equal the sum of the total use of the energy product in the transformation of energy products and end use of energy products by SIEC.

Chapter 4

Estimation Procedures

4.1 Introduction

Energy indicators are useful tools for summarizing information and monitoring trends reflecting various aspects of a country's energy situation over time. A number of indicators can be compiled from the energy accounts. The choice of indicators compiled by the country depends on the national priorities, development criteria and objectives, as well as data availability.

4.2 Data sources

Most of the data needed to complete the SEEA-Energy came from the national energy statistics and energy balances developed by the Energy Commission. The basic energy statistics constitute as an established source of energy information. The National accounts, trade statistics and balance of payment statistics obtained from the Ghana Statistical Service also served as a data sources for the Ghana 2013 SEEA-Energy. Table 5 presents details of various data sources and providers.

Table 5 : Sources of data

No.	Sources of Data	Institution/Provider
1.	National Accounts	Statistical Service, Ghana
2.	Trade Statistics	Statistical Service, Ghana
3.	Energy Balance	Energy Commission
4.	Energy Statistics	Energy Commission
5.	Balance of Payment Statistics	Bank of Ghana
6.	Ghana Living Standard Survey (GLSS 6, 2013)	Statistical Service, Ghana

4.3 Indicators Derived the 2013 PSUT-Energy

Energy indicators are essential tools for identifying and quantifying the key drivers for trends and analysis, as well as for prioritizing interventions to control growth of energy consumption. They also help in measuring the benefits of such interventions. Its accuracy strongly depends on the quality and detail of available source data. The selected indicators derived from compiling the PSUT-Energy include the following:

A. Environmentally related;

1. Energy supplied from the environment
2. Extraction of natural energy inputs from the environment
3. Flows of residuals back to the environment

B. Energy and SDG related;

4. Production of energy products across ISIC sectors
5. Intermediate consumption of energy products across ISIC sectors
6. Household consumption of energy products
7. Total energy use
8. Total energy supply
9. Energy use per capita
10. Energy use per unit of GDP
11. Net energy import dependency
12. Renewable consumed share in the total final energy consumption (SDG 7.2.1)
13. Energy intensities per ISIC sectors, value added incl. households (SDG 7.3.1)
14. Indicator 7.3.1: Energy intensity measured in terms of primary energy and GDP

(The indicator can be obtained by dividing total energy supply over GDP).

4.4 Methodology

4.4.1 Production of energy products across ISIC sectors

The production of energy products across ISIC sectors is the summation of the various energy products supplied by the various ISIC sectors in the economy in the supply side of the PSUTs.

4.4.2 Intermediate consumption of energy products across ISIC sectors

This indicator is calculated as the summation of the various energy products used by the various ISIC sectors of the economy in the use side of the PSUTs. In this section, household use of the energy products is not included since households are final consumers of the energy products.

4.4.3 Environmentally related Indicators

4.4.3.1 Energy Supplied from the Environment

Energy Supplied from the Environment

$$= (\text{Total Energy natural resource inputs} + \text{Total Energy products supplied}) - \text{Imports}$$

4.4.3.2 Extraction of natural energy inputs from the environment

Extraction of natural energy inputs from the environment

$$= \text{Total Energy natural resource inputs supplied}$$

4.4.3.3 Flows of residuals back to the environment

Flows of residuals back to the environment

$$= \text{Total Residual that goes back into the environment}$$

4.4.4 Energy and SDG related Indicators

4.4.4.1 Energy Use per Capita

Energy-use per capita is calculated as the total energy consumption divided by total population. This is illustrated mathematically as:

$$\text{Energy use per capita} = \frac{\text{Total Energy Use}}{\text{Total Population}}$$

4.4.4.2 Energy Use per unit of GDP

The energy use per unit of GDP is the total energy consumption of the economy divided by Gross Domestic Products (GDP). This is expressed as:

$$\text{Energy use per unit of GDP} = \frac{\text{Total Energy Use}}{\text{GDP}}$$

This indicator can be calculated for the various economic sectors such as agriculture, industry and services.

4.4.4.3 Net energy import dependency

This indicator measures the import dependency of the country. It can be calculated as:

$$\text{Net import dependency} = \frac{(\text{Imports} - \text{Exports})}{\text{Total Primary Energy Supplied}}$$

4.4.4.4 Renewable energy share of total energy consumed (SDG 7.2.1)

The renewable energy share of the total energy consumed is calculation as the energy consumed from renewable sources divided by the total energy consumed. This is expressed as:

$$\text{Renewable energy share} = \frac{\text{Energy consumed from renewable sources}}{\text{Total final energy consumed}}$$

4.4.4.5 Energy Intensity

Energy intensity is measured in terms of primary energy and GDP. It can be calculated as the total energy supplied divided by GDP. The formula expressed as:

$$\text{Energy Intensity} = \frac{\text{Energy used in the economy}}{\text{Gross Domestic Product (GDP)}}$$

4.4.4.6 Energy intensities of various economic sectors

The Energy intensities of various economic sectors and subsectors: industry, agriculture, services, mining and quarrying and construction, etc. can be computed as the total energy use divided by the valued added.

$$\text{Energy Intensity in ISIC A} = \frac{\text{Energy use in ISIC A}}{\text{Corresponding value added}}$$

Chapter 5

Areas for future improvement

5.1 Introduction

This chapter presents information on the data gaps in the 2013 Ghana SEEA-Energy and areas for future improvement.

5.2 Fuel used by the Embassies Abroad

The residence principle requires that fuel purchases by Ghanaian embassies abroad be accounted for in the Energy Accounts but it was not captured due to the absence of data. Going forward, there is the need come up with strategies to collect these data to fill the data gap and subsequently capture it in the energy accounts for accurate reporting**.**

5.3 Transport data

In the SEEA-Energy, there is conceptual difference between energy balances transport sector and energy accounts ISIC H – Transport. The energy balance records all activities related to transportation within the economy in the transport sector without reference to the industry using these fuels, however, within the energy accounts, consumption of fuel for own-account transportation activities is allocated into the ISIC industry which is actually using these fuels.

The fuel use for private cars, is allocated into household's private consumption. Overall, the sectors within the energy balance are not the same as the economic sectors within Energy Accounts. Due to unavailability of data, the recording of transport had not been disaggregated correctly within the Energy Accounting framework. This means that all activities within the energy balance related to transport sector had been included into ISIC H – Transport in the energy accounts. It is, therefore, essential to make adjustments from all use of energy for transport allocated in the transport sector of energy balances into the split where transport is carried out by all other industries and households in the energy accounts according to the residence principle.

Also, the use of gas fuel use by commercial and private vehicles were difficult to disaggregate according to the various economic sectors and households in the PSUT hence there is the need come up with strategies to collect these data to fill the data gap.

5.4 Non- energy use

Input data sources for non-energy use were not disaggregated across the sectors of the economy as the source data – Trade statistics was in an aggregated form. Going forward, data on non-energy use of fuel for other production has to be clearly disaggregated across these sectors.

Glossary

Concepts and Definitions

Balancing entry	This is an accounting construct obtained by subtracting the total value of the entries on one side of an account (resources or changes in liabilities) from the total value of the entries on the other side (uses or changes in assets).
Economic activity	This comprises of the activities of production, consumption and accumulation.
Economic territory	The area under effective control of a single government. It includes the land area of a country, including islands, airspace, territorial waters and territorial enclaves in the rest of the world. Economic territory excludes territorial enclaves of other countries and international organizations located in the reference country.
Emissions	These are substances released to the environment by establishments and households as a result of production, consumption and accumulation processes.
Extractions	Reductions in stock due to the physical removal or harvest of an environmental asset through a process of production. Estimates of extraction should exclude mining overburden and should include estimates of illegal extraction, either by residents or non-residents.
Households	A group of persons who share the same living accommodation, who pool some, or all, of their income and wealth and who consume certain types of goods and services collectively, mainly housing and food.
Industry	This consists of a group of establishments engaged in the same, or similar, kinds of activities
Input-output identity	It requires that the total flows into the economy (for example, in the form of natural gas extracted from natural deposits) over an accounting period be used in production processes, consumed by final users, accumulated in the economy or returned to the environment
Inputs of energy from renewable sources	They are the non-fuel sources of energy provided by the environment

National economy	Comprises of the set of institutional units that are resident in an economic territory
Natural inputs	Refer to physical flows from the environment into the economy. The EE-SUTs defines natural inputs as all physical inputs that are moved from their location in the environment as a part of economic production processes or are directly used in production (PEFA, 2014)
Products	These are goods and services that result from a process of production in the economy. They are defined consistently with the definition of products in the SNA 2008. Generally, products are evidenced by a transaction of positive monetary value between two economic units (PEFA, 2014).
Residuals	Refers to flows of solid, liquid and gaseous materials, and energy, that are discarded, discharged or emitted to the environment by establishments and households through processes of production, consumption or accumulation but may also flow within the economy (PEFA, 2014).
R**esident of a country**	Refers to an institutional unit with a center of economic interest in the economic territory of that country (under the residence concept or residence principle).

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