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Name of author
Zanial Fahmi Firdaus

Organization
BPS – Statistics Indonesia

Contact address
Jl. dr. Sutomo no. 6 – 8, Jakarta, Indonesia

Contact phone
+62 8563862206

Email
zanialf@gmail.com

Title of Paper

Integrating Asset Accounts and Flow Accounts: A Combined Presentation of Energy Accounts in Indonesia

Abstract

Energy accounts provide various information on energy resources and their relationship with economic activities. BPS–Statistics Indonesia has compiled both energy asset accounts and energy flow accounts based on SEEA Central Framework 2012. Energy asset accounts present information about the stock of energy reserves at the start and the end of the year as well as the changes between them, which is mainly caused by the extraction of energy. However, energy asset accounts do not provide the detail information about how the extracted energy was used in the economy. Meanwhile, the energy flow accounts record the flow of extracted energy from the environment into the economy, the flow of energy products in the economy, and the flow of energy residuals which return to the environment, but these accounts do not present the information of the energy stock remaining in the country to monitor the sustainability of energy use. Therefore, this paper aims to integrate the energy asset accounts and energy flow accounts into a combined presentation in order to obtain a whole picture of energy resources in Indonesia including their use in various economic activities. The compilation of energy asset accounts and energy flow accounts used many kinds of data from various institutions. Integration of energy asset accounts and energy flow accounts could derive many indicators related to Goal 7 SDGs, such as renewable energy mix, energy intensity by industry, reserves-to-production ratio, efficiency of energy transformation, and net energy import dependency. Furthermore, decoupling analysis was also conducted to analyze the linkages between economic development and environmental pressure related to energy resources in recent years.

Keywords: asset accounts, energy, environmental-economic accounting, flow accounts, national capital accounting

I. Contents

II. Introduction

Indonesia is a country with the largest consumption of energy in Southeast Asia.[1] As a country with large population number, the demand of energy in Indonesia would increase along with the growth of population. The number of population in Indonesia was projected to increase from 238,5 million in 2010 to 305,6 million in 2035.[2] Hence, there will be an increase of population by 28 percent in 25 years.

The demand of energy not only comes from household side. All economic activities also need energy to carry out their production processes. During 2014-2018, the growth of Gross Domestic Products (GDP) in Indonesia had never been below 4 percent.[3] The high growth of GDP was predicted to stimulate the demand of energy in the future.

Between 1990 and 2013, Indonesia final energy consumption had increased at an average annual rate of 3,1 percent. It was projected that the average annual rate would be faster between 2013 and 2040.[4] Therefore, the increasing demand of energy should be balanced with the increasing supply of energy.

Government of Indonesia has made a regulation in order to ensure the energy security and energy independence in Indonesia. The regulation was written in form of National Energy General Plan. The National Energy General Plan is a guidance to direct the national energy management in order to achieve energy independence and energy security to support the sustainable development in Indonesia.[5] The National Energy General Plan highlighted some current issues on energy in Indonesia, including the dependency on fuel import, the low utilization of renewable energy resources, and the inefficiency of energy use.

BPS-Statistics Indonesia has compiled energy asset accounts since 1990s, which has been published in the Integrated System of Environmental and Economic Accounts (Sisnerling). The energy asset accounts describe the condition of energy resources in Indonesia. The information provided in the energy asset accounts comprised stock of reserves, extraction, and other changes in reserves stock by commodity.[6]

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[1] Agency for the Assessment and Application of Technology, *Indonesia Energy Outlook 2018* (Jakarta: BPPT, 2018), p. 2.

[2] BPS, *Indonesia Population Projection 2010-2035* (Jakarta: BPS, 2013), p. 23.

[3] BPS, *Indonesia Quarterly Gross Domestic Product 2014-2018* (Jakarta: BPS, 2018), p. 38.

[4] Cecilya Laksmiwati Malik, 'Indonesia Country Report' in Kimura, S. and P. Han (eds.) in *Energy Outlook and Energy Saving Potential in East Asia 2016*, ERIA Research Project Report 2015-5 (Jakarta: ERIA, 2016), pp. 137-161.

[5] President of Indonesia Regulation No. 22 Year 2017 about National Energy General Plan, p. 4-18.

[6] BPS, *Indonesia Integrated System of Environmental and Economic Accounts 2013-2017* (Jakarta: BPS, 2018), p. 85-101.

However, the information on energy asset accounts was limited only about stock and changes in stock of energy reserves, which was primarily caused by the extraction of energy. The energy asset accounts did not provide the detailed information about how the extracted energy was used by various economic sectors in the economy. Therefore, since late 2017, BPS has tried to compile physical energy flow accounts that could describe the flows of energy from environment into the economy until it returned to the environment after being used as energy product in the economy.

The information on energy asset accounts and energy flow accounts are complemented each other. The energy flow accounts provide more detail information about the extracted energy which energy asset accounts did not provide. On the other hand, energy asset accounts record the remaining stock of energy reserves which energy flow accounts did not record. Therefore, this paper aims to integrate the energy asset accounts and energy flow accounts into a combined presentation in order to obtain a whole picture of energy resources in Indonesia including their use in various economic activities.

III. Indonesia Energy Accounts

A. Energy Asset Accounts

1. Data and Methodology

Energy asset accounts present information on the stock of energy resources at the start and the end of the year. It could be presented both in physical terms and monetary terms.[7] These accounts also provide information about the changes of stock occurred during the year which was mainly caused by the extraction of energy for economic activities. However, the change of stock might also be caused by new discoveries, reclassification, reappraisal, or other changes, such as the effect of natural disaster.

The compilation of energy asset accounts in Indonesia started with the compilation of physical energy asset accounts. It comprised four different kind of resources, such as coal, crude oil, natural gas, and geothermal. Each resources has its own unit, depending on the data source obtained from the ministries.

Meanwhile, the monetary energy asset accounts were compiled based on the result of physical energy asset accounts using Net Present Value Method (NPV). All kind of resources would have the same unit, that was Indonesia rupiah (IDR).

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[7] United Nations, *System of Environmental-Economic Accounting 2012 – Central Framework* (New York: United Nations, 2014), p. 160-172.

NPV is a method to calculate the value of resources using the price of resources as the future value, subtracted by exploitation cost. The NPV formula used in this research is as follows:

$$PV = \sum_{t=1}^{T} \frac{FV_t}{(1+r)^t} = \sum_{t=1}^{T} \frac{N_t Q_t}{(1+r)^t} \qquad (1)$$

where:

PV = present value of the natural resource;

FV_t = future value of the natural resource in year t;

N_t = value of the natural resource subtracted by exploitation cost in year t;

Q_t = volume of the natural resource exploited in year t;

t = year;

T = asset life; and

r = discount rate.

The main data source for energy asset accounts was from Ministry of Energy and Mineral Resources (MEMR). MEMR provided data on energy reserves by type of natural resources and data on volume of production by commodity.[8] These data were used to compile physical energy asset accounts.

The compilation of monetary asset energy accounts needed additional data as indicated in the NPV formula. The price data by commodity was obtained from BPS – Statistics Indonesia. The discount rate used in the NPV formula was government bond rate which was obtained from Ministry of Finance.

2. Empirical Results

a) Physical Energy Asset Accounts

The result of the compilation of physical energy asset accounts is presented in the table 1 below.

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[8] Ministry of Energy and Mineral Resources Republic of Indonesia, *Handbook of Energy & Economic Statistics of Indonesia* (Jakarta: MEMR, 2018), p. 62-106.

Table 1. Indonesia Physical Energy Asset Accounts, 2017**)

Description	Type of Resources			
	Crude Oil (million barrel)	**Natural Gas (million Mscf)**	**Coal (million ton)**	**Geothermal (million ton)**
(1)	(2)	(3)	(4)	(5)
Opening stock	7.250	144.060	28.457	870
Extraction	292	2.784	461	92
Other changes in stock	572	1.444	-3.756	89
Closing stock	7.530	142.720	24.240	867

Source: Indonesia Integrated System of Environmental and Economic Accounts 2013-2017

**) very preliminary figures

b) Monetary Energy Asset Accounts

By using NPV method, the monetary energy asset accounts were compiled from physical energy asset accounts. The compilation result is as follows.

Table 2. Indonesia Monetary Energy Asset Accounts (in billion IDR), 2017**)

Description	Type of Resources			
	Crude Oil	**Natural Gas**	**Coal**	**Geothermal**
(1)	(2)	(3)	(4)	(5)
Opening stock	1.038.448	2.466.900	2.839.578	23.592
Extraction	52.498	47.504	77.951	2.698
Other changes in stock	102.773	24.637	-634.777	2.595
Revaluation	263.317	-8.472	1.969.697	1.914
Closing stock	1.352.040	2.435.560	4.096.547	25.403

Source: Indonesia Integrated System of Environmental and Economic Accounts 2013-2017

**) very preliminary figures

From table 2 above, it was estimated that the value of energy resources at the end of 2017 in Indonesia was about 7.910 trillion IDR. Coal resources had the highest value among all resources. The value of coal resources increased significantly at the end of 2017 due to revaluation because the coal price also increased 39 percent in 2017.

3. Decoupling Analysis

An analysis could also be made to assess the linkages between economic development and the environmental pressure, namely decoupling analysis.[9] This analysis compared the growth rate of environmental pressure and economic driving force. Decoupling occurred when the growth rate of environmental pressure was less than the growth rate of economic driving force over a given period of time.

In terms of energy resources, the selected variable for economic driving force was the gross value added of mining of coal and lignite industry and extraction of crude petroleum and natural gas industry as both industries were the industries that extracted energy from the environment. Meanwhile, the selected variable for environmental pressure was the depletion of energy resources resulted from the compilation of monetary energy asset accounts.

Figure 1 presented the growth rate of gross value added in the mining industry, especially for coal, crude oil, and natural gas mining, and the growth rate of depletion for coal, oil, and natural gas resources during 2013-2017. From the figure, it could be concluded that there were no decoupling occurred during the period as the growth rate of environmental pressure in 2017, relative to 2013, is greater than the growth rate of gross value added that seemed to decrease over time.

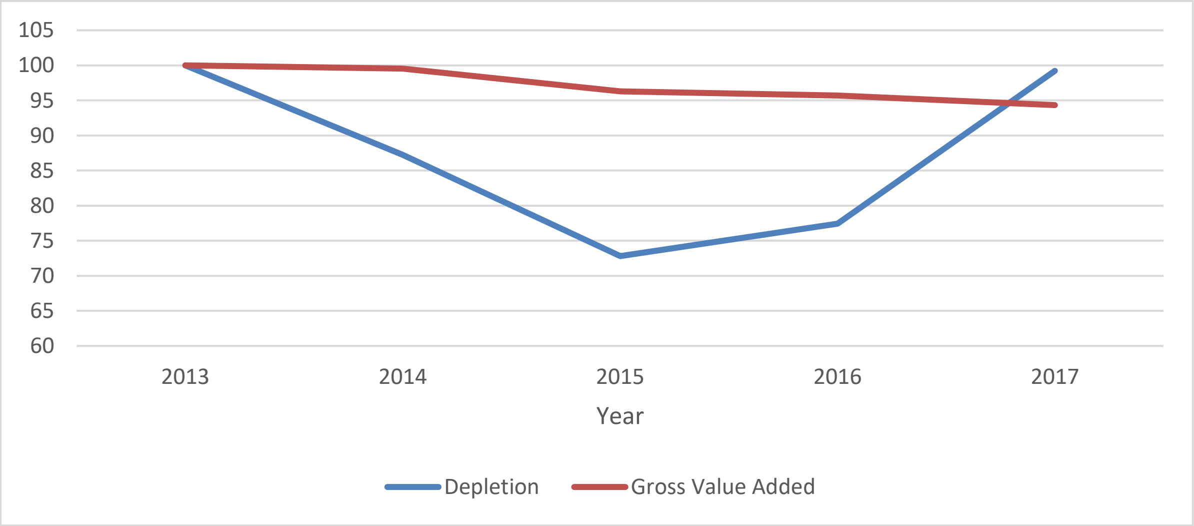

Figure 1. Decoupling Indicator for Energy Resources (2013=100), 2013-2017

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[9] United Nations, *System of Environmental-Economic Accounting 2012 – Applications and Extensions* (New York: United Nations, 2017), p. 14-15.

B. Energy Flow Accounts

1. Data and Methodology

Energy flow accounts present the information of flows of energy extracted from the environment into the economy, flows of energy within the economy in form of energy products, and the flows of energy from the economy to the environment as energy residual. The flows of energy was recorded in physical term using the international standard unit for energy, which was Joule.[10]

Physical energy flow accounts (PEFA) are presented in form of physical supply and use tables (PSUT). Each row in the Energy PSUT represents each type of energy flows which moves from the environment to various economic actors before returning back to the environment. All rows in the Energy PSUT could be divided into three parts, which are natural energy inputs, energy products, and energy residuals.[11] The classification of energy products complies with The Standard International Energy Product Classification (SIEC). For each row, both in the supply table and use table, should meet the equation

$$\text{Supply} = \text{Use} \tag{2}$$

Each column in Energy PSUT describes all sectors who produce or consume energy. These sectors comprise industries, households, accumulation, rest of the worlds, and environment. Industry classification used in Energy PSUT refers to International Standard Industrial Classification of All Economic Activities (ISIC) Rev 4. This classification is also in line with the classification used in the compilation of Indonesia Gross Domestic Products (GDP). Therefore, the comparison could be made between gross value added and energy use for each industry. For each column of industries, both in the supply table and use table, should meet the equation

$$\text{Output} = \text{Input} \tag{3}$$

The main data source for compiling PEFA is Energy Balance. This paper used Energy Balance produced by BPS-Statistics Indonesia.[12] The compilation of PEFA also used the information from Supply and Use Table (SUT) to disaggregate the use of energy products by industry.

However, there were difference of principle used in PEFA and Energy Balance. PEFA uses the residence principle in classifying the activities in national boundary, which is in line with 2008 System of National Accounts (SNA). Meanwhile, Energy Balance uses territory principle.[13] Therefore,

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[10] United Nations, *System of Environmental-Economic Accounting 2012 – Central Framework* (New York: United Nations, 2014), p. 59-69.

[11] Eurostat, *Physical Energy Flow Accounts (PEFA) Manual 2014.*

[12] BPS, *Indonesia Energy Balance* (Jakarta: BPS, 2018), p. 38-41.

[13] United Nations. *System of Environmental-Economic Accounting for Energy* (New York: UN, 2019), p. 65-66.

additional data is needed to adjust the territory principle used in Energy Balance into the residence principle used in PEFA. This research used the information from annual report of air transportation companies that operated international transportation services to adjust those principles.

There were several indicators that could be derived from PEFA. Some of them were also indicators for Goal 7 SDGs. Goal 7 SDGs is to ensure access to affordable, reliable, sustainable and modern energy for all.[14] There are several indicators for each target of SDGs. For Goal 7 SDGs, the indicators are presented in table 3 below.

Table 3. Indicators for Goal 7 SDGs

Targets	Indicators
7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1 Proportion of population with access to electricity 7.1.2 Proportion of population with primary reliance on clean fuels and technology
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	7.2.1 Renewable energy share in the total final energy consumption
7.3 By 2030, double the global rate of improvement in energy efficiency	7.3.1 Energy intensity measured in terms of primary energy and GDP
7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	7.a.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems
7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support	7.b.1 Investments in energy efficiency as a proportion of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services

From some indicators listed in the table 3 above, two indicators could be derived directly from PEFA. The first indicator is renewable energy mix as the indicator for target 7.2 SDGs. The second indicator is energy intensity, which is the indicator for target 7.3 SDGs.

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[14] United Nations, Transforming Our World: The 2030 Agenda for Sustainable Development.

Renewable energy mix presents information about the proportion of energy final consumption which come from renewable energy, such as hydro, geothermal, biomass, wind, and solar. This indicator could be used to observe the progress of sustainable development in increasing substantially the share of renewable energy in the global energy mix by 2030.

Energy intensity is an indicator to monitor the energy use of economic sectors in order to perform their production activities. This indicator reflects the amount of energy needed to produce one unit of output or value added. The smaller value of energy intensity indicates the more efficient energy use in the production activities. The value of energy intensity by industry could be obtained by dividing the amount of energy use with gross value added as shown in the formula below.

$$Energy\ intensity = \frac{End\ use\ of\ energy}{Gross\ value\ added} \tag{4}$$

Other indicators which could be derived from PEFA were efficiency of energy transformation and net energy import dependency.[15] Efficiency of energy transformation measures how efficient the energy transformation process conducted by coal plants, petroleum refineries, gas refineries, and electric power plants in transforming primary energy products into secondary energy products. The formula used to calculate the efficiency of energy transformation was

$$Energy\ Transformation\ Efficiency = \frac{Energy\ Output}{Energy\ Input} \tag{5}$$

Net energy import dependency is an indicator for energy security. It shows the proportion of primary energy supply imported from the rest of the world. The formula is as follows

$$Net\ energy\ import\ dependency = \frac{Energy\ imports}{Total\ primary\ energy\ supply} \tag{6}$$

2. Empirical Results

a) Physical Energy Flow Accounts

The compilation of PEFA was started with the adjustment of territory principle used in Energy Balance into residence principle used in PEFA as recommended by SEEA Central Framework 2012. Therefore, a bridge table was made to show the conceptual differences between Energy Balance and PEFA. The bridge table was presented below.

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[15] United Nations. *System of Environmental-Economic Accounting for Energy* (New York: UN, 2019), p. 116-118.

Table 4. Bridge Table of Indonesia Energy Balance and Indonesia PEFA (in TJ), 2017

Total energy use by resident units (domestic energy use) – residence principle		**5.050.857**
(-)	**Energy use by resident units abroad**	**11.073**
	National fishing vessels operating abroad	0
	Land transport operated by resident units abroad	n.a.
	International water transport undertaken by resident units	0
	International air transport operated by resident units	11.073
(+)	**Energy use by non-residents on the territory**	**0**
	Land transport operated by non-residents on the territory	n.a.
	Water transport operated by non-residents on the territory	0
	Air transport operated by non-residents on the territory	n.a.
(+/-)	**Other adjustments and statistical discrepancies**	**53.899**
(=)	**Gross inland energy consumption – territory principle**	**4.985.885**

The information on Energy Balance then was reorganized into the framework of PEFA. Disaggregation of energy use by ISIC was conducted using the data on Indonesia Supply and Use Table (SUT). The result of Indonesia PEFA compilation was presented below.

Table 5. Physical Supply Table for Energy (in Petajoules), 2017

		Agriculture, Forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Households	Accumulation	Statistical Differe-nces	Import	Environment	Total Supply
		ISIC A	ISIC B	ISIC C	ISIC D	ISIC H							
	ENERGY FROM NATURAL INPUTS											**17.462**	**17.462**
N01	Fossil											16.799	16.799
N011	Oil resources											1.941	1.941
N012	Natural gas resources											2.496	2.496
N013	Coal resources											12.362	12.362
N02	Hydro											76	76
N03	Wind											0	0
N04	Solar											0	0
N05	Geothermal											32	32
N06	Biomass											555	555
N07	Others											0	0
	ENERGY PRODUCTS	**555**	**16.380**	**1.984**	**1.039**	**0**	**0**				**2.361**		**22.319**
P08	Coal	0	12.362	53	0	0	0				133		12.548
P09	Natural Gas	0	2.078	0	0	0	0				0		2.078
P10	Oil	0	1.940	1.671	0	0	0				2.228		5.839
P11	Electricity	0	0	0	931	0	0				0		931
P12	Biofuels	555	0	260	0	0	0				0		815

		Agriculture, Forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Households	Accumulation	Statistical Differences	Import	Environment	Total Supply
		ISIC A	ISIC B	ISIC C	ISIC D	ISIC H							
P13	Renewables	0	0	0	108	0	0				0		108
	ENERGY RESIDUALS	**19**	**515**	**2.194**	**2.222**	**1.455**	**595**	**1.399**	**206**		**0**		**8.604**
R14	Renewable waste								0		0		0
R15	Non-renewable waste								0		0		0
R16	Energy losses of all kinds	0	232	0	89	0	0	0	0				321
R17	Energy residual in form of dissipative heat from end use	19	95	2.130	2.133	1.455	595	1.399	206	-1			8.030
R19	Energy incorporated in products for non-energy use	0	188	64	0	0	0	0	0				253
	TOTAL SUPPLY	**574**	**16.895**	**4.178**	**3.261**	**1.455**	**595**	**1.399**	**206**	**-1**	**2.361**	**17.462**	**48.385**

Table 6. Physical Use Table for Energy (in Petajoules), 2017

		Agriculture, Forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Households	Accumulation	Statistical Differences	Export	Environment	Total Use
		ISIC A	ISIC B	ISIC C	ISIC D	ISIC H							
	ENERGY FROM NATURAL INPUTS	**555**	**16.799**	**0**	**108**	**0**	**0**						**17.462**
N01	Fossil	0	16.799	0	0	0	0						16.799
N011	Oil resources	0	1.941	0	0	0	0						1.941
N012	Natural gas resources	0	2.496	0	0	0	0						2.496
N013	Coal resources	0	12.362	0	0	0	0						12.362
N02	Hydro	0	0	0	76	0	0						76
N03	Wind	0	0	0	0	0	0						0
N04	Solar	0	0	0	0	0	0						0
N05	Geothermal	0	0	0	32	0	0						32
N06	Biomass	555	0	0	0	0	0						555
N07	Others	0	0	0	0	0	0						0
	ENERGY PRODUCTS	**19**	**95**	**4.178**	**3.154**	**1.455**	**595**	**1.399**	**-47**	**-1**	**11.472**		**22.319**
P08	Coal	0	7	393	2.191	0	1	0	10	56	9.889		12.548
P09	Natural Gas	0	45	642	590	3	13	2	0	1	782		2.078
P10	Oil	17	36	2.383	224	1.451	188	981	-57	-120	737		5.839
P11	Electricity	2	7	308	41	1	229	343	0	0	0		931
P12	Biofuels	0	0	452	0	0	164	73	0	62	64		815
P13	Renewables	0	0	0	108	0	0	0	0	0	0		108

		Agriculture, Forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Households	Accumulation	Statistical Differences	Export	Environment	Total Use
		ISIC A	ISIC B	ISIC C	ISIC D	ISIC H							
	ENERGY RESIDUALS	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**253**		**0**	**8.351**	**8.604**
R14	Renewable waste	0	0	0	0	0	0	0	0	0	0		0
R15	Non-renewable waste	0	0	0	0	0	0	0	0	0	0		0
R16	Energy losses of all kinds											321	321
R17	Energy residual in form of dissipative heat from end use											8.030	8.030
R19	Energy incorporated in products for non-energy use								253				253
	TOTAL USE	**574**	**16.895**	**4.178**	**3.261**	**1.455**	**595**	**1.399**	**206**	**-1**	**11.472**	**8.351**	**48.385**

PSUT Energy presented more detailed information about the flow of energy after being extracted from the environment. The framework ensure that the supply of each energy products is equal to its use.

b) Indicators Derived from Energy Flow Accounts

- **Renewable Energy Mix**

According to Table 3, total final energy consumption in Indonesia was 5.051 PJ. This energy, which was consumed by both industries and households, was obtained from fossil non-renewable energy natural resources as well as from renewable energy natural resources.

In the table 5, all renewable energy captured from the environment was used to produce electricity, except energy obtained from biomass based renewable energy natural resources. Most energy from biomass, which consisted of fuel wood and charcoal, was used for final consumption. However, some part of them also transformed into briquettes. Therefore, the proportion of renewables in the total final energy consumption consisted of all renewable energy transformed into electricity, end use of fuel wood, end use of charcoal, and some part of end use of briquette resulted from the transformation of biomass.

Table 7. Total Final Energy Consumption by Source of Energy, 2017

		End Use (Terajoules)	Percentage (percent)
Final Energy Consumption		5.050.857	100,00
Source of energy:			
1.	Fossil non-renewable energy natural resources	4.522.361	89,54
2.	Hydro based renewable energy natural resources	76.161	1,51
3.	Geothermal based renewable energy natural resources	31.616	0,62
4.	Biomass based renewable energy natural resources	420.719	8,33
5.	Other renewable energy natural resources	0	0,00

From table 7 above, the renewable energy mix in Indonesia in 2017 was 10,46 percent. Most of renewable energy in Indonesia was sourced from biomass based renewable energy natural resources.

- **Energy Intensity by Industry**

One of the advantages of compilation of PEFA is the derivation of energy intensity indicator by industry, which only could be calculated if there were information about energy use by industry as well as the information about gross value added.

Information of gross value added by industry could be obtained from National Accounts as the data was compiled quarterly by BPS. The energy use by industry could be obtained from the use table of PSUT for Energy.

However, the use of energy which was used to calculate the energy intensity was the end use of energy. In other words, the energy that was used by industry to be transformed into other forms of energy products was excluded.

Table 8. Energy Intensity by Industry, 2017

Description	Agriculture, Forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Total industries
	ISIC A	ISIC B	ISIC C	ISIC D	ISIC H		
Gross value added (billion IDR)	1.257.875,5	779.678,4	2.103.466,1	101.551,3	406.679,4	4.881.641,4	9.530.892,1
End use of energy products (Terajoules)	18.639	94.842	1.341.039	146.998	1.454.842	595.585	3.651.945
Energy intensity	**0,015**	**0,122**	**0,638**	**1,448**	**3,577**	**0,122**	**0,383**

Energy intensity indicator indicated how much TJ of energy needed to produce 1 billion IDR gross value added (GVA). From table 8, in average, industries in Indonesia needed 0,383 TJ of energy products to produce 1 billion IDR GVA.

By comparing each industry, it could be observed that the transportation industry was the most energy intensive industry as it had the biggest number of energy intensity. This industry required 3,577 TJ of energy to produce gross value added 1 billion IDR.

Comparison could also be made across time to examine whether the economic activities in Indonesia become more efficient in using energy. If the energy intensity is lower than before, it means that the industry needed smaller amount of energy to produce the same amount of gross value added. In other words, the industry becomes more energy efficient.

- **Energy Transformation Efficiency**

The transformation process of energy products into other energy products is called as energy transformation. In energy transformation process, not all energy input could be processed entirely into energy output. There would be some energy which lost during the transformation process. These energy recorded as energy losses which return to the environment.

The comparison between the energy produced with the energy needed in the energy transformation process derives a value of energy transformation efficiency. Manufacturing industry and electricity and gas supply industry are the industries that execute the energy transformation process in Indonesia. Both industries change the form of energy from an energy product, both primary energy product and secondary energy product, into another energy product in different form. Table 9 below shows the transformation efficiency for each industry.

Table 9. Energy Transformation Efficiency by Industry, 2017

Description	Manufacturing	Electricity and Gas Supply
	ISIC C	ISIC D
Energy Input (TJ)	2.837.467	3.006.774
Energy Output (TJ)	1.984.216	1.039.311
Transformation Efficiency (percent)	**69,93**	**34,56**

Table 9 shows that the efficiency of energy transformation in the manufacturing industry was better than in the electricity and gas supply industry. It means that the energy losses in transformation of electricity was much bigger than the transformation of energy into other forms as only a third of energy input that could be transformed into electricity.

- **Net Energy Import Dependency**

  Information in the supply table of Energy PSUT could be used to analyze the dependency of a country in terms of energy supply. The analysis was useful to describe the energy security and energy independence in Indonesia as both are the main focus of National Energy General Plan.

  In 2017, there were 17.462 PJ of energy extracted from the environment. At the same time, 2.361 PJ of energy products also imported from the rest of the world. By dividing the amount of energy import with total primary energy supply plus import, net energy import dependency indicator could be derived.

  From 19.823 PJ energy supplied into the economy in Indonesia, only 12 percent that was imported from the rest of the world. In other words, most of energy used in Indonesia was supplied by the resident. It indicated that the energy dependency of Indonesia to the rest of the world was relatively small. It was a good sign in term of energy security as the energy consumption in Indonesia was one of the biggest in the world.

C. Combined Presentation

The purpose of combining energy asset accounts and energy flow accounts into one framework was to obtain full coverage of information about energy in a country or region, including the stock of energy asset and the flow of energy products.

The main idea was to add the information of reserve stock into the Energy PSUT. As the Energy PSUT used ‘joule’ as a unit, then the information of reserve stock in the energy asset accounts needed to be converted into joule before it could be combined with energy flow accounts.

Both energy asset accounts and energy flow accounts had information on energy extracted from the environment. The difference was only in the unit. Information of energy extraction in energy asset accounts was presented in mass unit, whereas the same information in energy flow accounts was presented in energy unit. Hence, both information could be used to obtain the conversion factor to convert the data of reserve stock in energy asset accounts, which was still presented in the mass unit, into the energy unit.

The combined presentation is as follows.

Table 10. Combined Presentation of Energy Accounts (in Petajoules), 2017

		PRODUCTION									**ROW**			**RESERVES**		
		Agriculture, forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Households	Accumulation	Statistical Differences	Import	Extraction	Total Supply	Opening Stock	Other changes in stock	Closing Stock
		ISIC A	ISIC B	ISIC C	ISIC D	ISIC H										
	ENERGY FROM NATURAL INPUTS											**17.462**	**17.462**	**940.761**	**-95.593**	**828.338**
N01	Fossil											16.799	16.799	940.462	-95.623	828.040
N011	Oil resources											1.941	1.941	48.190	3.802	50.051
N012	Natural gas resources											2.496	2.496	129.177	1.295	127.975
N013	Coal resources											12.362	12.362	763.096	-100.720	650.014
N02	Hydro											76	76			
N03	Wind											0	0			
N04	Solar											0	0			
N05	Geothermal											32	32	299	31	298
N06	Biomass											555	555			
N07	Others											0	0			
	ENERGY PRODUCTS	**555**	**16.380**	**1.984**	**1.039**	**0**	**0**				**2.361**		**22.319**			
P08	Coal	0	12.362	53	0	0	0				133		12.548			
P09	Natural Gas	0	2.078	0	0	0	0				0		2.078			
P10	Oil	0	1.940	1.671	0	0	0				2.228		5.839			

		PRODUCTION									**ROW**			**RESERVES**		
		Agriculture, forestry, and Fishing	Mining and Quarrying	Manufacturing	Electricity and Gas Supply	Transportation	Other industries	Households	Accumulation	Statistical Differences	Import	Extraction	Total Supply	Opening Stock	Other changes in stock	Closing Stock
		ISIC A	ISIC B	ISIC C	ISIC D	ISIC H										
P11	Electricity	0	0	0	931	0	0				0		931			
P12	Biofuels	555	0	260	0	0	0				0		815			
P13	Renewables	0	0	0	108	0	0				0		108			
	ENERGY RESIDUALS	**19**	**515**	**2.194**	**2.222**	**1.455**	**595**	**1.399**	**206**		**0**		**8.604**			
R14	Renewable waste								0		0		0			
R15	Non-renewable waste								0		0		0			
R16	Energy losses of all kinds	0	232	0	89	0	0	0	0				321			
R17	Energy residual in form of dissipative heat from end use	19	95	2.130	2.133	1.455	595	1.399	206	-1			8.030			
R19	Energy incorporated in products for non-energy use	0	188	64	0	0	0	0	0				253			
	TOTAL SUPPLY	**574**	**16.895**	**4.178**	**3.261**	**1.455**	**595**	**1.399**	**206**	**-1**	**2.361**	**17.462**	**48.385**			

Information in combined presentation of energy accounts could be used to estimate the remaining asset life. It is calculated by dividing closing stock of reserve with the amount of energy extraction, with the assumption that the amount of extraction in the next years is the same as the latest year.

Table 11. Reserves-to-Production Ratio by Resources, 2017

Description	**Type of Resources**			
	Oil	**Natural Gas**	**Coal**	**Geothermal**
(1)	(2)	(3)	(4)	(5)
Extraction (Petajoules)	1.941	2.496	12.362	32
Closing stock (Petajoules)	50.051	127.975	650.014	298
Estimated Asset Life (years)	25,79	51,27	52,58	9,31

Table 11 shows the result of estimated asset life by resources. Estimated asset life of oil resources was 25,79 years. It means that if the amount of extraction would not change and there would not be addition to stock, then the exploitation of oil resources in Indonesia could only be undertaken until 25,79 years later.

Natural gas resources and coal resources had estimated asset life more than 50 years whereas the geothermal resources only lasted until 9 more years.

IV. Conclusion

The compilation of energy accounts could be used to provide information, especially for the government, on energy resources in Indonesia. Several indicators could be derived to give policy-makers sufficient data to solve some issues in the National Energy General Plan, including the issue of energy dependency on import by using net energy import indicator, the issue of the low utilization of renewable energy resources by deriving renewable energy mix indicator, and the issue of inefficiency of energy use by calculating energy intensity indicator.

Combined presentation of energy accounts was compiled by combining physical energy asset accounts and physical energy flow accounts into one framework with the same unit for all type of resources. The integration of energy asset accounts and energy flow accounts provides information about stock of energy reserves at the start and the end of the year as well as the changes in stock during the period. In addition, it also presents more detailed information on the flow of extracted energy from the environment. From the combined presentation, the asset life of energy resources could be estimated.

For the next research, it is suggested to analyze the indicators derived from energy accounts in time series. By doing that, the progress of sustainable development across the year could be analyzed more deeply.

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