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Article

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Development of Consumption and Supplying Energy in Indonesia's Economy

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ABSTRACT

One of the problems faced by Indonesia is the increasing energy consumption and tend to be wasteful, while the fossil energy reserves are depleted and the development of alternative energy is slow, so it is feared Indonesia experiencing energy crisis. The purpose of this article is to analyze the development of consumption and energy supply in Indonesia from 2007 to 2017. Data analysis in this research is by using combination between trend analysis and descriptive analysis. So the conclusion of this article shows that energy consumption in all sectors, namely industrial sector, household sector, transportation sector, commercial sector and other sectors tend to increase from year to year. Meanwhile, overall energy supply tends to increase, but with a smaller increase than the increase in consumption. And to overcome energy problem in Indonesia is needed energy conservation that is by conducting energy saving campaign, determination of energy conservation law, and establishment of energy conservation center. Furthermore, the Indonesian government should have a long-term plan to divert the use of energy from non-renewable sources to renewable energy use, such as the use of water, wind, biomass, biodiesel, biogas and other sustainable energy sources.

Keywords: Energy Conservation, Energy Consumption, Energy Supply, Indonesian Economy
JEL Classifications: D11, O1, Q4

1. INTRODUCTION

Energy is indispensable in carrying out the economic activities of Indonesia, both for consumption needs and for the production activities of various sectors of the economy. As a natural resource, energy should be utilized as much as possible for the welfare of the community and its management should refer to the principle of sustainable development. From the aspect of supply, Indonesia is a country rich with energy resources both energy that is unrenewable resources and that is renewable resources (Dargay et al., 2007). Nevertheless, the exploration of energy resources focused more on fossil energy that is unrenewable resources while renewable energy has not been widely used. This condition causes the availability of fossil energy, especially crude oil, increasingly scarce which causes Indonesia is now a net importer of crude oil and its derivative products (Diputra and Jungho, 2018).

According to the ministry of energy and mineral resources (2017) Indonesia's crude energy reserves can only be produced or will be exhausted within 22.99 years, gas for 58.95 years and coal for 82.01 years. This calculation uses the assumption that no new fields are found as a source of fossil energy. Energy reserves can increase (last long) if new fields are found. From the aspect of consumption shows that Indonesia's energy consumption has increased from year to year. In the period 2007–2017, the final energy consumption experienced an average annual increase of 2.73% from 953,334,957 BOE to 1,058,262,186 BOE. According to sector type, energy consumption in Industrial sector is the highest energy consumption followed by Households, Transportation, Non Energy Utilization, Commercial and Other (Table 1).

With the depletion of fossil energy reserves on one side, while on the other hand energy consumption continues to increase become

Table 1: Final energy consumption by sector

Sector	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*
Industrial	338,665,258	320,302,447	304,791,448	349,040,463	373,947,840	368,119,080	282,175,204	289,801,993	309,184,958	259,123,615	131,601,405
Households	321,992,728	321,936,055	321,569,203	332,203,762	339,153,428	349,084,289	360,016,142	369,893,470	373,786,746	378,046,006	194,789,530
Commercial	27,235,095	28,218,800	29,558,720	30,935,244	34,131,850	37,135,487	39,236,140	40,249,580	42,446,465	41,452,239	22,287,734
Transportation	174,679,830	185,668,882	209,968,398	230,345,870	277,512,762	329,520,051	341,409,711	342,781,960	307,077,749	303,266,139	152,937,164
Other	25,287,155	25,068,604	25,293,606	22,340,493	27,220,338	33,709,215	31,105,254	28,694,657	32,836,385	19,440,220	13,663,753
Non energy utilization	65,474,891	73,847,398	84,096,759	84,146,777	98,284,711	112,565,953	94,531,056	98,745,743	77,443,048	56,933,967	25,765,425
Final energy consumption	953,334,957	955,042,187	975,278,134	1,049,012,609	1,150,250,929	1,230,134,074	1,148,473,507	1,170,167,403	1,142,775,350	1,058,262,186	541,045,011

*Temporary data up to semester I 2017

a threat to the development of the Indonesian economy. Therefore efforts should be made to encourage the efficient utilization of energy use along with the search for new sources of fossil energy intensively and to develop alternative energy that is renewable resources.

The main cause of inefficiency in energy utilization is the policy of cheap energy prices applied by the Government of Indonesia. According to Hakam and Asekomeh (2018), the policy of cheap energy prices by providing large subsidies has a negative impact: First, the high dependence on crude energy sources. Low price signal becomes a disincentive for diversification and conservation (energy saving). Second, fuel subsidies in the state budget threaten the fiscal sustainability of the government. Third, not optimal use of other energy sources, such as natural gas and coal whose reserves are much larger than crude oil as well as new and renewable energy. Fourth, the rampant smuggling of fuel abroad so that the level of demand is higher than the real need. Fifth, the rampant fuel pollution activities that harm the state and general consumers. And sixth, price signals distort the feasibility of investing in the downstream sector of oil and gas.

Utilization of wasteful energy is shown by high energy elasticity. The average energy elasticity value in 2007–2016 period was 2.17. This means that if economic growth (GDP) increases by 1% then the final energy consumption will increase by 2.17%. This figure indicates Indonesia is a wasteful state energy. Energy in Indonesia is still widely used for activities that do not produce (Kim and Yoo, 2016). Elasticity numbers <1 are achieved when available energy has been used productively, as occurs in developed countries ranging from 0.55 to 0.65. In other words, developed countries have a strong, renewable, distributed, and evenly distributed energy retention system optimally and productively (Fotourehchi, 2017).

Another indicator that shows the waste in energy utilization in Indonesia is the energy intensity. Energy intensity is the ratio between the amount of final energy consumption and GDP per capita. The more efficient a country, the less the intensity will be. So far, energy subsidies that have been implemented by the government actually lead to waste of energy, because its use is less than optimal. This is reflected in the relatively high energy intensity of 482 ton-oil-equivalent (TOE) per million US dollar. This means to generate value added (GDP) 1 million US dollars, Indonesia requires energy 482 TOE. In comparison, Malaysia's energy intensity is only 439 TOE/million US dollar, and the average energy intensity of developed countries incorporated in the Organization for Economic Co-operation and Development is only 164 TOE/million US Dollar. This indicates that the potential for energy saving in Indonesia is still considerable (Zambrano et al., 2016).

From the above description shows that the problems faced by Indonesia are increasing energy consumption and tend to be wasteful, while the fossil energy reserves are getting thinning and the development of alternative energy is slow. In more detail the development of energy consumption and supply in Indonesia along with solutions in energy consumption issues will be discussed in this article.

2. METHODS

2.1. Data Sources

The data used in this study is secondary data in the form of time series data from 2007 to 2017. The data collected includes energy consumption data by sector and energy type and data of Indonesian energy supply. The main data sources are Indonesia's energy balance data obtained from the Ministry of Energy and Mineral Resources, as well as data sources from the Central Bureau of Statistics, and other relevant agencies.

2.2. Analysis Method

Data analysis method used is combination between trend analysis and descriptive analysis. Trend analysis shows the pattern or fluctuation of energy supply by type of energy and energy consumption according to the user. Descriptive analysis describes the problems and or advantages of the fluctuations that occur from the results of trend analysis presented.

3. RESULTS AND DISCUSSION

3.1. Energy Consumption in Indonesian Economy

Energy consumption in Indonesia in this study is differentiated by energy user sector which includes: industrial sector, household, transportation, commercial and other sectors. Energy consumed by energy users is the final energy.

3.2. Energy Consumption of Industrial Sector

Along with the development of the industrial sector led to an increase in energy consumption in the production process to produce a product. In the period 2007–2017, industrial energy consumption fluctuated up and down. In 2012, energy consumption in the industry sector is at the highest level of 480,685 BOE, while in 2016 the energy consumption in the industrial sector is at the lowest level of 354,560 BOE. The types of energy consumed by the industrial sector are biomass, coal, briquette, gas, fuel, liquefied petroleum gas (LPG), electricity and other petroleum products. From Table 1 it can be seen that during the period 2007–2017 the highest energy type consumed by the industrial sector was gas and the lowest consumption was briquette (Table 2).

In its development, the type of energy consumption in the industrial sector has increased and decreased. For biomass consumed the highest in 2014 and the lowest in 2016, the highest consumption coal in 2011 and the lowest in 2013. Briquette consumption showed the lowest consumption in the industry sector, and the highest consumption was in 2009 by 220 thousand BOE. Meanwhile, gas is the type most consumed by the industry sector, the highest was in 2013 of 123.8 million BOE. For most types of fuel consumption was in 2007 amounted to 62.667 million BOE. LPG consumption in 2007 amounted to 1.431 million BOE. Furthermore, energy consumed most consumed in 2016 amounted to 41,773 million BOE. While the remaining types of consumption in the energy sector are in other types of petroleum products (the highest in 2012 amounted to 83.418 million BOE).

3.3. Energy Consumption of Household Sector

Energy is needed by household for lighting purposes, cooking, heating/cooling room, and various other household activities. Energy

Table 2: Energy consumption in industrial sector (thousand BOE)

Year	Biomass	Coal	Briquette	Gas	Fuel					other Petroleum product	LPG	Electricity	Total
					Kerosene	ADO	IDO	Fuel oil	Total fuel				
2007	44,047	121,904	105	105,319	3,352	29,761	1,328	28,226	62,667	40,589	1,431	28,077	404,140
2008	44,235	94,035	155	112,001	2,676	30,095	865	27,482	61,118	52,073	1,127	29,405	394,150
2009	44,521	82,587	220	117,535	1,619	32,238	706	24,888	59,451	55,663	588	28,323	388,888
2010	43,317	137,489	123	114,111	964	28,049	612	20,848	50,473	55,765	655	31,254	433,187
2011	43,724	144,502	121	119,649	672	36,886	710	21,820	60,089	69,978	623	33,547	472,233
2012	42,732	123,022	130	123,161	468	49,515	507	20,223	70,713	83,418	621	36,888	480,685
2013	44,399	42,729	130	123,800	427	46,822	438	11,642	59,328	66,161	693	39,466	376,706
2014	45,188	55,064	58	122,699	329	42,330	337	11,112	54,108	70,277	753	40,402	388,548
2015	44,828	70,228	50	122,079	261	51,589	294	9,717	61,859	47,514	788	39,281	386,628
2016	42,434	63,504	107	99,739	200	28,246	209	7,251	35,905	70,277	821	41,773	354,560
2017*	21,217	29,417	50	52,954	101	22,687	38	5,226	28,052	35,139	501	21,216	188,546

*Temporary data up to semester I 2017, LPG: Liquefied petroleum gas

consumed by households includes: biomass, gas, kerosene, LPG and electricity. The types of biomass energy consumed by households are firewood, charcoal, and others used for cooking. In total household consumption increased during the period 2007–2017. During that period household energy consumption increased by 1.87% per year (except in 2008) from 321,993 million BOE (2007) to 378,046 million BOE (2016). Increased consumption in this sector is due to an increase in the number of family members and number of households in Indonesia (Table 3).

The types of energy consumed by households from the highest to the lowest are biomass, electricity, LPG, kerosene and gas. During the period 2007–2017 biomass consumption showed an increase but has a low average growth per year at 1.38%. This indicates that households have started to reduce the use of biomass energy, because there are other alternative energy that is easier and cheaper to use. With the increase of biomass energy consumption in the household sector shows that most households in Indonesia still use firewood for cooking, especially households in rural areas (Aydin, 2015). This happens because the supply of firewood in the countryside is quite large. In addition, the economic price to get firewood is relatively cheap. The results of this study are similar to the results of Jul (2014) study, which states that the type of household consumption in Indonesia is mostly non-commercial energy (fuel wood and charcoal), which is mostly from poor households. Meanwhile, rich households consume commercial energy such as gas, electricity and kerosene.

In addition to biomass energy, electrical energy during the 2007–2017 period showed an increased growth. During the period 2007–2017 the consumption of electric energy showed an average annual increase of 4.2%. Increased electricity consumption by households is due to cheaper electricity prices compared to kerosene and LPG prices. Meanwhile, kerosene consumption by households showed a declining trend, caused by the Indonesian government policy on kerosene conversion to LPG which started in 2008. So from 2008 kerosene consumption decreased significantly. Meanwhile, LPG consumption has increased significantly every year, and the highest consumption of LPG occurred in 2016 amounted to 57,398 million BOE.

3.4. Energy Consumption of Transportation Sector

The means of transportation is necessary in order to mobilize goods and people from one place to another. In relation to energy consumption, the transport sector in question includes means of transportation driven by machinery or motor vehicles. There are three types of energy consumed by the transportation sector, namely fuel, gas and electricity.

From Table 4 it can be seen that transportation sector energy consumption shows an increasing trend during the period 2007–2017 except in 2015. During that period the total energy consumption of the transportation sector increased with an average growth per year of 3.31%. The types of energy consumed by the transportation sector from the largest to the smallest are fuel, gas and electricity, respectively. In its development fuel consumption showed an increasing trend, while gas and electricity consumption fluctuated (Table 5).

The amount of fuel consumption by the transportation sector is due to the increasing number of motor vehicles using fuel, both public and private vehicles. In addition, travel by vehicle is less efficient because of poor road infrastructure so it takes a long travel time. Long travel time will increase fuel consumption.

3.5. Energy Consumption of Commercial Sector

The commercial sector includes residential institutions. The commercial sector also includes waste treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air cooling, lighting, cooling, cooking, and running other equipment. This sector also includes generators that generate electricity and or heat output beneficial to support the activities of the commercial entity mentioned above. The use of energy consumption in this commercial sector can be seen in Table 5.

Based on Table 5 data shows that the type of energy electricity is the type of energy that dominates the use of energy in commercial sector with the highest amount in 2016 amounted to 33.103 million BOE. Meanwhile, the type of energy fuel is in second position with the highest consumption in 2015 of 7,428 million BOE. Biomass is third in energy use in the commercial sector with the highest amount in 2007 of 1,402 million BOE. While LPG is in the fourth position with the highest amount in 2016 amounted to 4.234 million BOE and gas was in the fifth position with the highest amount in 2014 of 1.447 million BOE.

3.6. Other Energy Sector Consumption

Other sectors in this article fall into sectors not mentioned in the previous section, such as trade, hotels and restaurants, and others. The reason for the inclusion of these sectors into other

Table 3: Energy consumption in household sector (thousand BOE)

Year	Biomass	Gas	Kerosene	LPG	Electricity	Total
2007	234,557	132	50,229	8,064	29,010	321,993
2008	237,459	131	40,096	13,487	30,763	321,936
2009	240,736	130	24,255	22,767	33,682	321,569
2010	250,571	135	14,439	30,386	36,673	332,204
2011	253,727	114	10,072	35,326	39,914	339,153
2012	256,594	134	7,015	41,123	44,217	349,084
2013	260,328	122	6,396	45,839	47,330	360,016
2014	263,495	114	4,929	49,810	51,545	369,893
2015	263,275	116	3,903	52,130	54,362	373,787
2016	263,215	137	2,995	54,302	57,398	378,046
2017*	131,607	68	1,514	33,134	28,466	194,790

*Temporary data up to semester I 2017, LPG: Liquefied petroleum gas

Table 4: Energy consumption in transportation sector (thousand BOE)

Year	Gas		Fuel													Electricity	Total
	Avgas	Avtur	RON 88	RON 92	RON 95	RON 90	Solar 51	Solar 53	Kerosene	ADO	IDO	Fuel oil	Bio RON 88	Bio RON 92	Bio solar	Total biofuel	
2007	49	12	14,845	102,784	2,752	921	0	8	0	22	48,643	53	549	326	58	3,604	174,579	52	174,680
2008	124	11	15,526	111,377	1,736	669	0	8	0	18	49,189	35	535	257	95	6,041	185,495	50	185,669
2009	191	9	16,262	121,226	2,682	608	0	13	0	11	52,692	28	484	617	118	14,959	209,709	68	209,968
2010	195	12	20,779	130,486	3,907	663	0	29	0	6	45,845	24	405	0	0	27,939	230,096	54	230,346
2011	181	13	20,983	144,330	3,643	1,717	0	41	0	4	60,289	28	424	0	0	45,804	277,278	54	277,513
2012	154	14	22,967	160,910	3,884	871	0	80	0	3	80,930	20	393	0	0	59,227	329,300	66	329,520
2013	185	16	24,499	166,800	4,956	925	0	150	0	3	76,529	17	226	0	0	67,025	341,146	79	341,410
2014	207	8	24,912	167,960	6,194	903	0	216	0	2	69,187	13	216	0	0	72,868	342,480	95	342,782
2015	246	17	25,546	158,914	16,095	1,624	2,214	250	0	2	84,320	12	189	0	0	19,737	308,921	126	309,292
2016	205	16	27,481	122,992	27,911	1,696	33,832	687	480	1	46,167	8	141	0	0	75,343	336,757	137	337,098
2017*	102	6	14,837	40,350	15,452	733	33,836	801	520	1	37,081	2	102	0	0	42,881	186,601	70	186,773

*Temporary data up to semester I 2017

sectors because these sectors have a small composition in energy consumption. Other sectors consume the type of energy of fuel, gas, biomass and electricity. In Figure 6 it can be seen that the total energy consumption of other sectors tends to increase with an average growth per year of 3.72%. Based on the type of energy, other sectors consume the largest fuel energy followed by gas and kerosene energy. In its development, energy consumption of fuel and gas by other sectors showed an increasing trend, while kerosene consumption showed a declining trend (Table 6).

4. ENERGY SUPPLY IN INDONESIA'S ECONOMY

Energy supply in the future is a problem that is always the concern of all nations because human welfare in modern life is closely related to the amount and quality of energy utilized. For Indonesia which is one of the developing countries, the provision of energy is a very important factor in encouraging development. Along with the increasing development in various sectors, economic growth and population growth, the need for energy will continue to increase (Anastacio, 2017).

In meeting the energy needs, national energy supply is supplied from domestic and imported production. Energy supply from domestic production is highly dependent on technology and energy infrastructure. Energy infrastructure consists of energy conversion infrastructure (in the form of oil refineries, gas and power plants), energy transmission and distribution infrastructure (oil pipelines, gas pipelines, transmission and distribution networks), and physical infrastructure (ports, roads, fire). The fact is that Indonesia has limitations in this regard. Exploration technology and energy infrastructure require large and long-term capital. Therefore, government policy is needed to increase investment in energy sector. With these limitations, to meet domestic energy demand, it can be imported from other countries (Harris, 2017). Oil imports depend on how much energy, world oil prices and the Rupiah exchange rate against the US dollar are.

4.1. Coal Supply

Coal plays an important role in meeting energy demand and ensuring energy availability for industry and power generation. Consumption on the type of coal energy is used by power plant and industry sectors. Table 7 shows that the power plant sector is one of the industries with the highest consumption of coal with the highest consumption in 2016 of 74.4 million tonnes. While the rest is used by industry sector with the type of iron and steel, ceramic and cement, pulp and paper, and briquette. Besides, coal is also used by households as fuel for cooking. The utilization of coal as an energy source is due to the fact that coal reserves are still available and their prices are relatively cheaper than LPG, kerosene and gas (Table 7).

The magnitude of the role of coal as a source of energy other than fuel cannot be separated from the availability of coal that can be consumed by the community as one source of energy. Table 8 shows that coal production tends to increase. During the last 11 years (2007–2017) coal production has increased an average

Table 5: Energy consumption in commercial sector (thousand BOE)

Year	Biomass	Gas	Fuel				LPG	Electricity	Total
			Kerosene	ADO	IDO	Total fuel			
2007	1,402	274	2,774	4,285	7	7,066	1,308	17,185	27,235
2008	1,395	357	2,214	4,333	5	6,552	1,044	18,871	28,219
2009	1,388	730	1,339	4,642	4	5,985	1,029	20,426	29,559
2010	1,381	963	797	4,039	3	4,839	1,026	22,726	30,935
2011	1,374	1,290	556	5,311	4	5,871	1,112	24,485	34,132
2012	1,367	1,625	387	7,130	3	7,520	1,139	25,485	37,135
2013	1,360	1,422	353	6,742	2	7,098	1,269	28,088	39,236
2014	1,353	1,447	272	6,095	2	6,369	1,379	29,701	40,250
2015	1,346	1,435	216	7,428	2	7,645	1,444	30,576	42,446
2016	1,340	1,272	165	4,067	1	4,234	4,234	33,103	41,452
2017	667	636	84	3,267	0	3,351	918	16,717	22,288

*Temporary data up to semester I 2017, LPG: Liquefied petroleum gas

Table 6: Energy consumption in others sector (thousand BOE)

Year	Gas	Kerosene	ADO	IDO	Fuel oil	Total fuel
2007	3,156	2,295	15,098	198	4,539	25,287
2008	3,420	1,832	15,268	129	4,420	25,069
2009	3,722	1,108	16,335	105	4,002	25,294
2010	4,006	660	14,230	91	3,353	22,340
2011	4,432	460	18,713	106	3,509	27,220
2012	4,941	321	25,120	76	3,252	33,709
2013	5,121	292	23,754	65	1,187	31,105
2014	5,157	225	21,475	50	1,767	28,695
2015	4,879	178	26,172	44	1,563	32,836
2016	3,776	137	14,330	31	1,166	19,440
2017*	1,239	69	11,510	6	840	13,664

*Temporary data up to semester I 2017

Table 7: Coal sales (ton)

Year	Total	Iron and steel	Power plant	Ceramic and cement	Pulp and paper	Bri-quette	Others
2007	61,470,000	282,730	32,420,000	6,443,864	1,526,095	25,120	20,772,192
2008	53,473,252	245,949	31,041,000	6,842,403	1,251,000	43,000	14,049,899
2009	56,295,000	256,605	36,570,000	6,900,000	1,170,000	61,463	11,336,932
20102	67,180,051	335,000	34,410,000	6,308,000	1,742,000	34,543	24,350,508
2011	79,557,800	166,034	45,118,519	5,873,144	n.a.	33,939	28,366,165
2012	82,142,862	289,371	52,815,519	6,640,000	2,670,701	36,383	19,690,889
2013	72,070,000	300,000	61,860,000	7,190,000	1,460,000	36,383	1,223,617
2014	76,180,001	298,000	63,054,000	7,187,400	1,458,170	15,623	4,166,808
2015	86,814,099	399,000	70,080,000	7,180,000	4,310,000	13,174	4,831,925
2016	90,550,000	390,000	75,400,000	10,540,000	4,190,000	30,000	0
2017*	46,327,000	123,956	41,500,000	3,349,977	1,331,727	21,340	0

*Temporary data up to semester I 2017

of 14.03% per year. Furthermore, in the period of 2007–2017 (semester 1), total coal production is 3.808 billion tons and total coal exports amounted to 2,958 billion tons, only 9.28% are consumed domestically and 90.72% of the remaining is exported. Thus domestic coal production is more exported than used for domestic purposes (Table 8).

Indonesia's coal export destination countries are countries in Asia such as Japan, China, Taiwan, India, South Korea, Hong Kong, Malaysia, Thailand and the Philippines. Other export destinations are Europe such as Netherlands, Germany and England, as well as countries in America. The largest importers of Indonesian coal are China (22.8%) and India (20.7%). The type of coal exported Indonesia is Steam Coal type.

4.2. Crude Oil

Crude oil as raw material to produce fuel, such as gasoline (premium), diesel, diesel oil, kerosene and lubricants. Thus, crude oil has a role in meeting the energy needs. Crude oil is sourced from non-renewable natural reserves, thereby depleting its reserves in line with the increasing demand for energy. Table 9 shows that Indonesia's crude oil supply tends to decline over the 2007–2017 period from 8.40 Billion barrels in 2007 to 7.53 Billion barrels in 2017.

According to the Indonesian Petroleum and Gas Management Agency, Indonesia's oil production has declined due to the scarcity capacity that can not accommodate domestic and aging oil needs (+30 years), requiring substantial investment to curb the rate of natural decline. While efforts to buffer production through new

Table 8: Coal supply (ton)

Year	Production			Export	Import
	Steam Coal	Antracite	Total		
2007	216,946,699	0	216,946,699	163,000,000	67,534
2008	240,249,968	0	240,249,968	191,430,218	106,931
2009	256,181,000	0	256,181,000	198,366,000	68,804
2010	275,164,196	0	275,164,196	208,000,000	55,230
2011	353,270,937	0	353,270,937	272,671,351	42,449
2012	386,077,357	0	386,077,357	304,051,216	77,786
2013	474,371,369	0	474,371,369	356,357,973	609,875
2014	458,096,707	0	458,096,707	381,972,830	2,442,319
2015	461,566,080	0	461,566,080	365,849,610	3,007,934
2016	456,197,775	0	456,197,775	331,128,438	3,898,932
2017*	230,365,346	0	230,365,346	185,591,205	1,870,722

*Temporary data up to semester I 2017

Table 9: Crude oil reserves (billion barrels)

Year	Proven	Potential	Total
2007	3.99	4.41	8.40
2008	3.75	4.47	8.22
2009	4.30	3.70	8.00
2010	4.23	3.53	7.76
2011	4.04	3.69	7.73
2012	3.74	3.67	7.41
2013	3.69	3.86	7.55
2014	3.62	3.75	7.37
2015	3.60	3.70	7.31
2016	3.31	3.94	7.25
2017	3.17	4.36	7.53

Table 10: Natural gas production (MMSCF)

Year	Associated	Non associated	Total
2007	433,630	2,371,910	2,805,540
2008	472,897	2,412,431	2,885,328
2009	467,570	2,593,326	3,060,897
2010	471,507	2,936,086	3,407,592
2011	472,552	2,783,827	3,256,379
2012	405,465	2,769,175	3,174,639
2013	352,561	2,768,277	3,120,838
2014	304,693	2,871,098	3,175,791
2015	376,669	2,739,473	3,116,142
2016	467,813	2,602,426	3,070,239
2017*	241,785	1,216,720	1,458,505

*Temporary data up to semester I 2017

field production are highly dependent on the performance of contract contractors, because in the petroleum industry requires enormous capital and high technology. The decline in Indonesia's crude oil production will have an impact on increasing domestic fuel needs. Therefore, to meet domestic needs it is necessary to import crude oil. The demand for crude oil imports is expected to continue to increase in line with the increasing population growth and economic growth in Indonesia is expected to improve (Nor and Masron, 2018).

4.3. Natural Gas

From Table 10 shows natural gas production during 2007–2010 increased by an average of 2.3% from 2,805,540 MMSCF (Million Standard Cubic Feet) to 3,407,592 MMSCF. However, during the period 2011-2016 natural gas production tends to decline. During that period natural gas decreased by 0.93% annually from 3,256,379 MMSCF to 3,070,239 MMSCF. This low gas production is due to limited gas production capacity. Gas production plants are old and investments in exploration activities to build new gas and oil wells are lower.

According to Moremadi and Yadollah (2018), the low investment in oil and gas is caused by a number of uncertainties, including security issues, high taxes and uncertainty surrounding the implementation of the new oil and gas law number 22 year 2001, the uncertainty of the government's position in developing wells aged gas, new oil and renewal of contracts at existing oil wells. The implication is that some oil and gas companies suspend their investment plans throughout 2012–2021 (Table 10).

4.4. Electricity

During the period 2007-2017 electricity sales in Indonesia increased by an average of 6.24% per year. The most widely used electricity consumption sector is the household sector with average consumption from 2007-2016 of 69.313 GWh (Giga Watt hour). While the lowest electrical energy consumption in the transportation sector (Table 11).

With the increasing consumption of electrical energy then automatically the supply of electrical energy also increases. The increase in electricity supply is caused by an increase in electricity demand from various sectors due to the improvement of the people's economy. Increased demand for electrical energy encourages the development of the discovery of electrical energy derived from renewable energy, such as hydropower, geothermal energy, micro hydro, biomass, solar and wind.

Table 12 shows the renewable energy that can generate electrical energy. From the table only about 3.32% of renewable energy that can be utilized into electrical energy, the rest cannot be used optimally because of limited technology owned.

5. SOLUTION TO OVERCOMING ENERGY PROBLEMS IN INDONESIA

Solving a problem must be a matter of what is being experienced. As has been pointed out in the previous section that the energy problem that Indonesia is facing today is the problem of energy

Table 11: Electricity sales (GWh)

Year	Electricity sales/tariff segment							Total
	Household	Commercial	Industry	Street lighting	Social	Government	Transportation	
2007	47,325	20,524	45,803	2,586	2,909	2,016	85	121,247
2008	50,184	22,845	47,969	2,761	3,082	2,096	81	129,019
2009	54,945	24,715	46,204	2,888	3,384	2,335	111	134,582
2010	59,825	27,069	50,985	3,000	3,700	2,630	89	147,297
2011	65,112	30,093	54,725	3,068	3,994	2,787	88	159,867
2012	72,133	30,880	60,176	3,141	4,496	3,057	108	173,991
2013	77,211	34,369	64,381	3,251	4,939	3,261	129	187,541
2014	84,086	36,128	65,909	3,394	5,446	3,484	155	198,602
2015	88,682	36,773	64,079	3,448	5,941	3,717	205	202,846
2016	93,635	39,852	68,145	3,498	6,631	4,022	223	216,004
2017*	46,437	20,145	34,609	1,751	3,398	1,977	114	108,431

*Temporary data up to semester I 2017

Table 12: Potential of renewable energy for power generation

Renewable energy	Potency	Installed generator capacity
Water power	75.67 GW	4200.00 MW
Geothermal	27.00 GW	800.00 MW
Mini/micro hydro	458.75 MW	84.00 MW
Biomass	49.81 GW	302.40 MW
Sun	4.80 KWh/m^2/day	8.00 MW
Wind	9.29 GW	0.50 MW

Source: Blue print national energy management 2006–2025

waste (Liddle and Lung, 2013). On the other hand, increased energy consumption is not balanced with the supply of sufficient energy, so that Indonesia has an energy deficit. Thus, it is necessary to find solutions to these problems, among others, by converting (saving) energy and applying appropriate economic policies.

5.1. Energy Conservation

As has been stated earlier that based on the value of elasticity and intensity of energy utilization Indonesia is one of the countries with the utilization of energy wasted in the world. Therefore, intensive efforts are needed in order to improve the efficiency of energy utilization. According to Dudin et al. (2016) several strategic steps that need to be taken to streamline the energy conservation movement: First, energy-saving campaigns, conducting energy audits (free), disseminating energy conservation techniques, providing incentives for energy efficiency utilization. Second, prepare the Energy Conservation Act. And third, establish National Energy Conservation Center, as did Japan and Thailand.

Strategic steps put forward by Dudin et al. (2016) is based on the idea that letting the energy-consuming pattern of consumption be wasteful will be very detrimental, both in terms of economy, environment and efforts to maintain the benefits of the energy resources themselves. Since the "disease" caused as a result of ignoring these energy conservation efforts is already severe enough, the conservation of energy as a necessity should not be postponed again in Indonesia.

Conservation (saving) energy will bring many benefits. By conserving energy as if finding new energy sources. If Indonesia can save fuel consumption by about 10%, it means "finding" a new oil field that can produce about 150,000 barrels per day, which in reality costs considerable expenses for exploration and production. The cost that can be saved by doing conservation is huge.

In addition, energy conservation is also set forth in the Presidential Instruction issued in 1982 (INPRES No. 9/1982) which is then refined by Presidential Decree No. 43 in 1991. In the community emerged Non-Governmental Organizations (Energy Efficient Society) who pay attention to energy conservation. An ESCO was established by the government which then made it a state-owned energy company (PT KONEBA). PLN (National Electric Company) undertook several demand side management projects to reduce electricity consumption on the usage side. The Department of Energy undertook a number of energy conservation demonstration projects, for example in government office buildings (something similar was done at college campus buildings). The government even issued a document of RIKEN (Master Plan for Conservation of Energy) which was not followed by a clear action plan.

5.2. Economic Policy

The formulation of the right economic policy can overcome the national energy consumption and supply. In addressing the issue of energy availability that cannot meet domestic energy needs, it is necessary to enact policies in the short term, medium term and long term. In the short term, efforts are needed to improve efficiency and productivity of energy utilization, among others, by the conversion of fuel to gas for households, and the elimination of fuel subsidies (Lee and Chang, 2008). A low interest rate policy and stable exchange rate are also needed to counter the negative impact of rising world oil prices that could lead to declining consumption and energy supply (Sari and Soytas, 2007).

In the medium term, efforts are needed to increase investment from aspects of fossil energy production, processing and distribution, and efforts to convert fuel-based energy use by the industrial sector to other types of energy (Devereux and Lane, 2003). Along with that, efforts need to increase the number and capacity of oil and gas refineries to reduce the level of dependence on the final energy sourced from imports (Apostolakis, 1990). Efforts to increase the number and capacity of power plants also need to be done to eliminate electricity deficits, focused on the use of energy other

than fuel, such as power plants using coal and gas energy. In the long run, efforts to shift energy use from unrenewable resources to renewable energy use, such as water, wind, biomass, biodiesel, biogas and other sustainable energy sources. In other words, a green energy strategy is needed.

6. CONCLUSION

The trend of energy consumption of various sectors shows that in the period 2007–2017, industrial energy consumption fluctuated up and down. In 2012, energy consumption in the industry sector was at the highest level of 480,685 BOE, while in 2016 energy consumption in the industry sector was at the lowest level of 354,560 BOE. In total household consumption increased during the period 2007–2017. During that period household energy consumption increased by 1.87% per year (except in 2008) from 321,993 million BOE (2007) to 378,046 million BOE (2016). Transportation energy consumption shows an increasing trend during the period 2007–2017 except in 2015. During that period the total energy consumption of the transportation sector increased with an average growth per year of 3.31%. Type of energy electricity is the type of energy that dominates the use of energy in commercial sector with the highest amount in 2016 amounted to 33.103 million BOE. Total energy consumption of other sectors tends to increase with an average growth per year of 3.72%.

The trend of energy supply by type of energy shows that during the last 11 years (2007–2017) coal production has increased by an average of 14.03% per year. If further noted, in the period 2007–2017 (semester 1) total coal production of 3.808 billion tons. Indonesia's crude oil supply tended to decline during the 2007–2017 period from 8.40 Billion barrels in 2007 to 7.53 Billion Bars in 2017. Natural gas production during 2007–2010 increased by an average of 2.3% from 2,805,540 MMSCF (Million Standard Cubic Feet) to 3,407,592 MMSCF. And electricity sales in Indonesia increased by an average of 6.24% per year. The most widely used electricity consumption sector is the household sector with average consumption from 2007–2016 of 69.313 GWh (Giga Watt hour).

In order to overcome energy problems in Indonesia, energy conservation is needed in various layers, both from the management aspect of energy management and from among the community. In addition, there is also a need for low interest rate economic policies and stable exchange rates to encourage energy investment in order to increase crude oil production and counteract the negative impacts of rising world oil prices that lead to a decline in energy supply. In the long run, efforts should be made to shift energy use from unrenewable resources to renewable energy use, such as water, wind, biomass, biodiesel, biogas and other sustainable energy sources.

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