ERIA Research Project Report 2022 No. 08

Cambodia Energy Statistics 2000–2019

Prepared by Ministry of Mines and Energy, Cambodia

With Support from
Economic Research Institute for ASEAN and East Asia

Cambodia Energy Statistics 2000–2019

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ERIA Research Project Report FY2022 No. 08

Published in September 2022

Preface

Until March 2020, before the spread of COVID-19, Cambodia had achieved strong GDP growth in the past 2 decades, with a yearly average growth rate of about 7.7%. Thanks to the government's policy reforms that attracted global foreign direct investment into the country. So far, energy has played a critical role in supporting economic activities and growth. However, the COVID-19 pandemic has caused a global recession, and Cambodia is no exception. Its economy contracted by 3.1% in 2020 and recovered very well to grow by about 3% in 2021 and 5.3% in 2022. In 2023, the growth is expected to be around 6.5% (ADB, 2022). Because of the pandemic, the country's energy demand reduced by 5%–10%, and oil and electricity demand decreased largely by about 15%–20% in 2020–2022 compared to 2019.

The COVID-19 impact on energy demand prompted the rethinking of our future energy mix, including the types of fuel to meet the electricity demand and the demand in other sectors. For example, Cambodia revised its Power Development Plan 2020–2030, which foresees a larger share of gas consumption in the power generation mix. Its economic recovery from post-COVID-19 is expected from 2022 onwards. Thus, its energy demand is also expected to bounce back strongly. Liquefied natural gas (LNG) and other clean fuels will play a crucial role in the energy mix, especially in power generation, industrial, transportation, commercial, and residential uses.

Cambodia first published *Cambodia Energy Statistics 2015* with technical and financial support from the Economic Research Institute for ASEAN and East Asia (ERIA). In collaboration with the Ministry of Mines and Energy, Cambodia (MME). ERIA again updated the energy statistics as more data became available in 2019. This energy statistics update will be significantly important for energy policy planners in Cambodia as it will provide more energy data for its planners to prepare appropriate energy policies for the MME. It will also serve more energy stakeholders in Cambodia.

On behalf of the ministry, I am very thankful to Prof Hidetoshi Nishimura, President of ERIA, who always showed kindness and support to ASEAN member states in policy research, including preparing the energy statistics update for Cambodia. Thanks to ERIA and MME staff experts who collected and updated the energy statistics. Lastly, on behalf of the MME, I sincerely thank ERIA for its excellent collaboration on many energy projects, building a solid foundation for energy policy planning in Cambodia.

Suy Sem

Minister of Mines and Energy, Cambodia

Acknowledgements

This statistics publication updates the first Cambodia Energy Statistics published in 2015. The update was developed by a working group comprising the Ministry of Mines and Energy, Cambodia (MME), and the Economic Research Institute for ASEAN and East Asia (ERIA). We want to acknowledge the working group members for their excellent work pulling more data and information into this energy statistics update. We would also like to take this opportunity to express our gratitude to the ministry staff who collected data from various sources, including the petroleum companies in Cambodia and various end-use sector agencies. Thus, I am grateful for their cooperation in this statistics update. Special acknowledgement is also given to Shigeru Kimura, Special Advisor on Energy Affairs to the ERIA President, for his excellent leadership of this project.

Victor Jona

Deputy Secretary of State, Minister of Mines and Energy, Cambodia

September 2022

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List of Abbreviations and Acronyms

AAGR	average annual growth rate
ACE	ASEAN Centre for Energy
ASEAN	Association of Southeast Asian Nations
BAU	business-as-usual scenario/model
CCGT	combined cycle gas turbine
EBT	energy balance table
ERIA	Economic Research Institute for ASEAN and East Asia
GDE	General Department of Energy
GDP	gross domestic product
GDP-MME	General Department of Petroleum, Ministry of Mines and Energy, Cambodia
HFO	heavy fuel oil
IAB	international aviation bunker
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
IFC	International Finance Corporation
IMF	International Monetary Fund
IRENA	The International Renewable Energy Agency
JOGMEC	Japan Oil, Gas and Metals National Corporation
Kt	kilotonne
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MME	Ministry of Mines and Energy, Cambodia
NREL	The National Renewable Energy Laboratory
METI	Ministry of Economy, Trade, and Industry
MTBE	methyl tert-butyl ether
SC	super critical
T&D	transmission and distribution

TFEC	total final energy consumption
TPES	total primary energy supply
UN	United Nations
USC	ultra-supercritical

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Executive Summary

Cambodia National Energy Statistics, containing historical national energy balance tables (EBTs) from 2010 to 2015, was published in 2016 with the strong support of the Economic Research Institute for ASEAN and East Asia (ERIA). It was then updated to 2016–2018 under the collaboration of ERIA and the two departments under the Ministry of Mines and Energy (MME): the General Department of Energy (GDE) and the General Department of Petroleum (GDP-MME). The Cambodia National Energy Statistics respects nationally available energy supply and demand data and applies some estimations to maintain the quality of the data.

The statistics is used to develop the country's energy outlook model based on econometrics. But coverage of the historical period is just 9 years, and it is not enough to estimate energy demand formulas applying the ordinary least squares method. In this regard, the GDE and GDP-MME agreed to extend the historical coverage of the statistics from 2000 to 2019.

The GDE provides nationally available energy data before 2010 on coal, electricity, and biomass. On the other hand, the GDP-MME provides petroleum data, while import data come from the Customs Office. But the energy data before 2010 supplied by the GDE and GDP-MME were limited, so ERIA estimated missing data by paying attention to historical consistency.

The longer historical energy data set reflects the following energy demand–supply analysis. The total final energy consumption (TFEC), indicating its growth rate during 2000–2010, is 6.6% per year, and during 2010–2019, 7.9%, so Cambodia increased its energy demand rapidly after 2010. If biomass is excluded, the rate in 2000–2010 is 9.9% and 11.2% in 2010–2019. Demand for conventional energy, such as oil and electricity, remarkably increased from 2000 to 2019, especially electricity, at 17.9% annually. As a result, the total primary energy supply (TPES) increased by 5.8% annually during 2000–2010 and 8.0% during 2010–2019 showing the same trend as the TFEC. Due to a significant rise in electricity demand, Cambodia rapidly increased hydropower and coal power generation from 2010 to 2019. Liquefied petroleum gas (LPG) also marked a higher ratio in 2000–2019; it is used for cooking in the residential and commercial sectors and by the road transport sector, such as in three-wheel tuk-tuks. But traditional biomass has been phased out from the Cambodian market. As a result, the TPES without biomass increased by 11.1% from 2000 to 2019 and is much higher than the economic growth rate. Thus, Cambodia urges the promotion of energy efficiency and conservation, as contained in the publication *Energy Efficiency and Conservation Master Plan for Cambodia*, prepared with ERIA's support.

The new country's business-as-usual (BAU) energy outlook model has been updated based on the longer historical data set and the latest future macroeconomic assumptions. But the outlook results are moderate compared to the previous results. For example, the TPES growth rate in 2019–2050 is 5.4% per year compared to the previous 5.6% in 2018–2050 due to different gross domestic product (GDP) assumptions, which are 6.7% in this revised case

and 6.4% in the previous one. In addition, the data coverage is extended from 9 to 19 years, so the elasticity between GDP and energy consumption becomes better, from 0.875 in the earlier results to 0.8 in the current results. Thus, a more extended data coverage provides better energy outlook results than shorter data coverage when we apply the econometrics approach.

Chapter 1
Introduction

Cambodia's national energy statistics was prepared in 2018 with the support of the Economic Research Institute for ASEAN and East Asia (ERIA) to the Ministry of Mines and Energy (MME) Cambodia. It analysed historical energy data and forecasted Cambodia's energy demand and supply situation. Previous energy statistical analysis only covered 9 years, from 2010 to 2018. However, this coverage is too short to analyse the historical and future energy demand–supply situation. Therefore, ERIA continuously supported the MME to extend the energy data coverage from 2010–2018 to 2000–2019.

Firstly, ERIA, in collaboration with the MME, checked the availability of primary energy data for 2000–2009, which included coal, petroleum, electricity, and biomass. However, some data were missing. Thus, the missing data were estimated by applying the relationship between energy demand and economic activities. In addition, primary energy data in 2019 were collected. After the estimation, a complete data set of primary energy data for 2000–2019 was finalised. (Please refer to chapters 2 and 3.)

Based on the final primary energy data in 2000–2019, energy balance tables (EBTs) were produced using Excel VBA basis computer software. The EBTs were applied to analyse historical energy data and forecast Cambodia's energy demand–supply situation. (Please refer to chapters 4 and 5.)

This report elaborated on how to extend Cambodia's energy statistics from 2010–2018 to 2000–2019 and the extension of data coverage from 9 to 20 years.

Chapter 2

Final Primary Energy Data in 2000–2019

Fossil fuels, such as coal and petroleum products, are imported, while biomass is produced domestically. Electricity production depends on hydro and coal, with some imports from the Lao People's Democratic Republic (Lao PDR), Thailand, and Viet Nam.

The GDE and the GDP-MME maintain the primary energy data. These departments have a key role in releasing timely, complete, and accurate energy statistics. ERIA has supported the MME in publishing the national energy statistics since 2015.

The previous Cambodia energy statistics only covered the period 2010–2018. To extend the energy statistical analysis, the MME collected primary energy data from 2000 to 2009 and 2019. Most of the consumption data were available post 2003, and others were available after 2007. In this regard, the missing data were being estimated and analysed to check consistency with the existing data.

This chapter shows the final primary energy data from 2000 to 2019. Meanwhile, the methodology to estimate missing data and assess the inconsistent data is elaborated on in chapter 3.

1. Coal

Two types of coal data exist in Cambodia: domestic coal (lignite) and imported coal (sub-bituminous). Domestic coal is only for 2017 and 2018; imported coal started in 2008. Table 2.1. shows the coal balance of Cambodia.

Table 2.1. Coal Balance (in kilotonnes)

Year	Supply			Consumption		
	Production	Import	Total	Industry	Power Plant	Total
2000			-	-	-	-
2001			-	-	-	-
2002			-	-	-	-
2003			-	-	-	-
2004			-	-	-	-
2005			-	-	-	-
2006			-	-	-	-
2007			-	-	-	-
2008		25.5	25.5	-	25.5	25.5
2009		30.6	30.6	-	30.6	30.6
2010		45.2	45.2	10.2	35.0	45.2
2011		52.0	52.0	11.9	40.1	52.0
2012		71.2	71.2	13.0	58.1	71.2
2013		105.3	105.3	13.4	91.9	105.3
2014		582.3	582.3	18.9	563.3	582.3
2015		1,029.5	1,029.5	26.7	1,002.8	1,029.5
2016		1,428.6	1,428.6	34.6	1,394.1	1,428.6
2017	56.0	1,652.9	1,708.9	162.9	1,546.0	1,708.9
2018	34.0	1,772.1	1,806.1	151.6	1,654.5	1,806.1
2019		2,345.5	2,345.5	252.8	2,092.7	2,345.5

Source: GDE-MME in-house data (2021).

2. Oil

2.1. Oil supply

Cambodia does not produce oil and, thus, imports all its petroleum products. The Customs Office prepares the primary data source for oil imports. Table 2.2 shows the imported petroleum data of Cambodia by type from 2000 to 2019.

Table 2.2 Oil Supply (in kilotonnes)

Year	Import							
	Jet A-1	Gasoline	Diesel	Fuel Oil	Lubricant	LPG	Kerosene	Total
2000	17.37	119.76	387.83	95.51	3.64	13.43	29.55	667.09
2001	16.78	120.86	465.65	92.12	3.14	16.66	28.27	743.48
2002	16.83	116.93	389.20	122.46	5.13	18.13	50.41	719.08
2003	16.83	103.80	400.58	118.53	5.65	22.28	83.69	751.36
2004	19.67	96.75	409.62	142.35	6.52	27.54	47.82	750.28
2005	20.03	129.30	346.58	180.03	7.46	28.24	30.34	741.99
2006	27.06	158.98	449.81	248.80	6.94	38.26	24.41	954.27
2007	48.73	238.40	492.53	293.95	11.41	47.34	32.62	1,164.98
2008	44.31	293.22	456.10	310.09	12.83	43.29	30.78	1,190.62
2009	35.19	313.61	677.06	269.94	17.54	56.95	28.95	1,399.24
2010	46.35	384.09	762.08	244.07	16.74	65.11	30.59	1,549.04
2011	54.60	398.52	814.54	228.78	17.64	71.94	12.07	1,598.09
2012	68.99	387.73	897.64	213.74	18.02	84.68	6.26	1,677.06
2013	79.21	392.01	918.44	165.93	18.84	98.69	3.03	1,676.16
2014	91.66	426.83	1,005.48	89.28	11.69	112.12	-	1,737.06
2015	96.95	507.26	1,073.25	35.59	20.39	162.33	-	1,895.77
2016	105.74	513.76	1,240.18	138.53	25.13	193.60	-	2,216.94
2017	152.81	562.04	1,247.63	77.69	12.10	224.37	-	2,276.65
2018	201.52	606.09	1,343.34	84.07	11.83	270.32	-	2,517.17
2019	224.71	725.65	1,661.33	179.92	13.83	340.96	-	3,146.40

* Lubricants include base oil; gasoline includes naphtha and methyl tert-butyl ether (MTBE).
Source: GDP-MME In-house data (2021).

2.2. Oil consumption

Cambodia consumes several types of oil (petroleum products, including additives) for various economic activities (transport, industry, residential, commercial, and others) and electricity generation. However, no data for oil sales is available because the GDP-MME did not collect it from foreign oil companies in Cambodia. Therefore, petroleum consumption by each final sector in 2000–2009 and 2019 was estimated based on the current Cambodia energy statistics of 2010–2018. Table 2.3 shows the petroleum consumption data for each sector by type from 2000 to 2019.

Table 2.3. Oil Consumption by Type (in kilotonnes)

Year	Gasoline	Jet Fuel			Diesel					Fuel Oil			Lubricant*	LPG			Kerosene
	Road	Air	Domestic	International	Power	Road	Agriculture	Industry	Other	Industry	Power	Other	Road	Commercial	Road	Residential	Residential
2000	119.8	17.4	5.3	12.0	71.0	277.4	0.1	31.7	7.6	37.0	53.6	4.9	3.6	11.9	-	1.6	29.6
2001	120.9	16.8	5.2	11.6	77.6	339.7	0.1	38.8	9.4	29.6	58.6	3.9	3.1	14.7	-	1.9	28.3
2002	116.9	16.8	5.2	11.7	84.5	266.8	0.1	30.5	7.3	51.7	63.8	6.9	5.1	16.0	-	2.1	50.4
2003	103.8	16.8	5.2	11.7	94.7	267.9	0.1	30.6	7.4	41.5	71.4	5.5	5.7	19.7	-	2.6	83.7
2004	96.7	19.7	6.0	13.6	108.2	263.9	0.1	30.2	7.3	45.4	90.9	6.1	6.5	24.4	-	3.2	47.8
2005	129.3	20.0	6.2	13.9	134.7	185.5	0.1	21.2	5.1	72.3	98.1	9.6	7.5	25.0	-	3.3	30.3
2006	159.0	27.1	8.3	18.7	172.6	242.7	0.1	27.7	6.7	117.6	115.6	15.7	6.9	22.9	12.3	3.0	24.4
2007	238.4	48.7	15.0	33.8	215.9	242.2	0.1	27.7	6.7	131.8	144.5	17.6	11.4	28.4	15.3	3.7	32.6
2008	293.2	44.3	13.6	30.7	235.2	193.4	0.1	22.1	5.3	134.7	157.4	18.0	12.8	25.9	14.0	3.4	30.8
2009	313.6	35.2	10.8	24.4	192.3	424.5	0.1	48.5	11.7	124.6	128.7	16.6	17.5	34.1	18.4	4.5	28.9
2010	384.1	46.3	14.2	32.1	149.9	536.3	0.2	61.0	14.7	136.3	100.4	7.4	16.7	39.0	21.0	5.1	30.6
2011	398.5	54.6	16.8	37.8	151.6	573.1	0.2	81.5	8.2	120.3	101.5	7.0	17.6	43.1	23.2	5.6	12.1
2012	387.7	69.0	21.2	47.8	142.9	631.1	0.2	89.8	33.7	111.6	95.7	6.5	18.0	50.7	27.3	6.6	6.3
2013	392.0	79.2	24.3	54.9	96.6	644.8	0.2	91.8	85.0	96.2	64.7	5.0	18.8	59.1	31.9	7.7	3.0
2014	426.8	91.7	28.2	63.5	54.5	704.9	0.2	100.5	145.3	50.1	36.5	2.7	11.7	67.2	36.2	8.8	0.0
2015	507.3	96.9	29.8	67.2	27.3	760.0	0.2	107.3	178.4	15.7	18.3	1.6	20.4	97.2	52.4	12.7	0.0
2016	513.8	105.7	32.5	73.2	79.8	852.7	0.3	124.0	183.4	70.3	53.4	14.8	25.1	116.0	62.5	15.2	0.0
2017	562.0	152.8	47.0	105.8	48.3	875.5	0.3	124.8	198.8	42.9	32.3	2.4	12.1	134.4	72.4	17.6	0.0
2018	606.1	201.5	61.9	139.6	49.9	941.3	0.3	134.3	217.5	44.7	33.4	6.0	11.8	161.9	87.2	21.2	0.0
2019	725.7	224.7	69.1	155.7	122.1	1,119.9	0.3	160.0	259.0	86.6	81.7	11.6	13.8	204.2	110.0	26.7	0.0

* Lubricant includes base oil; gasoline includes naphtha and methyl tert-butyl ether (MTBE).

Source: GDE-MME in-house data, (2021).

3. Biomass

Biomass consists of firewood, bagasse, and biogas from animal dung. Firewood and biogas are mainly consumed for cooking by the residential sector in rural areas. Firewood is also used to produce charcoal. Bagasse is consumed to produce electricity. Biomass production is shown in Table 2.4.

Table 2.4. Biomass Production

Year	Production				
	Firewood	Bagasse	Charcoal	Biogas	Total
	kilotonne	kilotonne	kilotonne	kilotonne	kilotonne
2000	3,455		212	0.3	3,667
2001	3,533		216	0.3	3,749
2002	3,606		221	0.3	3,828
2003	3,708		227	0.4	3,935
2004	3,842		235	0.4	4,077
2005	4,031	0	247	0.5	4,279
2006	4,206	2	257	0.5	4,465
2007	4,267	6	261	0.6	4,534
2008	4,454	5	272	1.3	4,733
2009	4,576	8	280	1.4	4,864
2010	4,638	7	283	2.0	4,930
2011	4,842	14	296	2.6	5,154
2012	5,040	14	308	2.3	5,364
2013	5,255	8	321	0.6	5,584
2014	5,500	20	336	0.9	5,857
2015	5,633	49	341	1.7	6,025
2016	5,581	46	342	1.7	5,971
2017	5,439	43	343	2.0	5,827
2018	5,169	39	332	2.2	5,542
2019	5,044	111	321	2.5	5,478

Source: GDE-MME in-house data (2021).

Biomass consumption is shown in Table 2.5.

Table 2.5. Biomass Consumption (in kilotonnes)

Year	Consumption (kilotonnes)						
	Firewood			Biogas	Charcoal	Bagasse	Total
	Residential	Industrial	Charcoal Factory	Residential	Residential	Power Generation	
2000	1,160	443	1,852	0.3	212	-	3,667
2001	1,183	457	1,893	0.3	216	-	3,749
2002	1,204	470	1,932	0.3	221	-	3,828
2003	1,234	488	1,986	0.4	227	-	3,935
2004	1,273	512	2,057	0.4	235	-	4,077
2005	1,328	547	2,157	0.5	247	0	4,279
2006	1,378	578	2,250	0.5	257	2	4,465
2007	1,381	605	2,281	0.6	261	6	4,534
2008	1,441	632	2,381	1.3	272	5	4,733
2009	1,481	649	2,446	1.4	280	8	4,864
2010	1,501	658	2,479	2.0	283	7	4,930
2011	1,567	687	2,588	2.6	296	14	5,154
2012	1,631	715	2,694	2.3	308	14	5,364
2013	1,701	745	2,809	0.6	321	8	5,584
2014	1,780	780	2,940	0.9	336	20	5,857
2015	1,807	842	2,984	1.7	341	49	6,025
2016	1,731	859	2,991	1.7	342	46	5,971
2017	1,658	826	2,955	2.0	343	43	5,827
2018	1,575	734	2,860	2.2	332	39	5,542
2019	1,522	710	2,812	2.5	321	111	5,478

Source: GDE-MME in-house data (2021).

4. Electricity

4.1. Electricity production

Cambodia initially produced electricity only from oil (diesel/heavy fuel oil [HFO]) and hydro. In 2005, bagasse started to be used to generate electricity. Coal entered the country's power production mix in 2008. Since 2017, Cambodia has also been utilising solar energy to generate power. Currently, hydro and coal power are the major power sources. Table 2.6 shows Cambodia's power production mix.

Table 2.6. Electricity Production by Energy Source (in GWh)

Year	Production					
	Hydro	Coal	Oil	Bagasse	Solar	Total
2000	30	-	447	-	-	478
2001	33	-	489	-	-	522
2002	36	-	533	-	-	569
2003	41	-	596	-	-	637
2004	28	-	715	-	-	743
2005	44	-	836	0	-	879
2006	51	-	1,035	2	-	1,087
2007	50	-	1,294	5	-	1,349
2008	46	23	1,410	5	-	1,484
2009	47	28	1,153	6	-	1,235
2010	32	32	899	6	-	968
2011	52	47	909	12	-	1,019
2012	517	37	857	12	-	1,423
2013	1,016	169	579	7	-	1,770
2014	1,852	863	327	17	-	3,058
2015	2,160	2,128	164	38	-	4,489
2016	2,568	2,394	478	42	-	5,483
2017	2,711	3,569	290	59	5	6,634
2018	4,737	3,057	299	64	16	8,172
2019	4,025	3,734	732	91	93	8,675

GWh = gigawatt-hour.
Source: GDE-MME in-house data (2021).

4.2. Electricity supply

Cambodia's total power supply includes imported electricity from neighbouring countries, such as the Lao PDR, Thailand, and Viet Nam. Importing electricity is needed due to seasonal factors because the volume of water for hydropower generation decreases during the dry season. The significant increase in electricity demand due to stable economic growth and insufficient investment in the power sector led Cambodia to keep importing electricity from its neighbouring countries. However, more coal power plants to generate domestic electricity can decrease electricity import. Table 2.7 shows the country's total electricity supply.

Table 2.7. Electricity Supply (in GWh)

Year	Production	Import	Total Supply
2000	478	44	521
2001	522	48	570
2002	569	52	621
2003	637	58	695
2004	743	59	803
2005	879	81	960
2006	1,087	110	1,197
2007	1,349	167	1,517
2008	1,484	374	1,858
2009	1,235	842	2,077
2010	968	1,541	2,509
2011	1,019	1,830	2,848
2012	1,423	2,104	3,527
2013	1,770	2,282	4,052
2014	3,058	1,803	4,861
2015	4,489	1,526	6,015
2016	5,483	1,550	7,033
2017	6,634	1,439	8,073
2018	8,172	1,567	9,739
2019	8,675	3,063	11,738

GWh = gigawatt-hour.
Source: GDE-MME in-house data (2021).

4.3. Electricity consumption

Electricity consumption is based on three final energy consumption sectors: residential, commercial, and industry (factories) (Table 2.8). The commercial sector consumes electricity dominantly (office buildings, hotels, shopping malls, and hospitals). Next, the residential sector (urban and rural areas) and the industry sector, including special economic zones, follow. In 2019, due to the rapid rise of electricity consumption in the industry sector, these three sectors' share in electricity consumption was balanced at around one third.

Table 2.8. Electricity Consumption by Sectors (in GWh)

Year	Consumption (GWh)			
	Residential	Commercial	Industrial	Total
2000	237.10	185.81	26.45	449.36
2001	252.61	204.27	34.73	491.61
2002	268.45	223.49	43.45	535.39
2003	292.17	229.86	76.46	598.49
2004	325.19	270.74	105.93	701.86
2005	365.84	348.03	143.76	857.63
2006	388.83	449.22	215.98	1,054.03
2007	458.25	548.91	338.61	1,345.77
2008	575.40	694.41	389.62	1,659.43
2009	682.03	778.15	388.59	1,848.77
2010	869.08	892.89	489.88	2,251.85
2011	854.16	1,082.45	629.87	2,566.48
2012	1,079.28	1,275.90	900.32	3,255.50
2013	1,186.58	1,539.47	820.04	3,546.09
2014	1,323.08	1,645.19	1,054.35	4,022.62
2015	1,527.15	2,530.31	1,140.70	5,198.16
2016	1,998.00	2,651.45	1,572.60	6,222.05
2017	2,177.00	3,101.98	1,748.00	7,026.98
2018	2,898.65	3,442.68	2,290.34	8,631.67
2019	3,399.57	3,408.23	3,383.29	10,191.09

GWh = gigawatt-hour.
Source: GDE-MME in-house data (2021).

Chapter 3

Treatment of Missing and Inconsistent Energy Data

The GDE and GDP-MME provided the country's 2000–2009 and 2019 primary energy data to update the energy statistics 2010–2018. Table 3.1 shows the primary energy data of coal, electricity (which includes petroleum consumption for power generation), and biomass as provided by the GDE-MME. On the other hand, Table 3.2 shows the import of petroleum products as supplied by the GDP-MME. Some of the data were missing and were estimated. The data were also checked for inconsistency.

The sections below explain the method applied to estimate the missing data and revise the inconsistent data of Cambodia's energy statistics from 2000 to 2019.

1. Coal

1.1 Coal consumption

As described in chapter 2, coal is consumed for power generation and industrial production. Since coal power generation started in 2008, we assume that no coal was consumed to generate power before 2008. As for industrial production, the GDE provided coal consumption data only from 2010 onwards. Considering that the major industrial subsectors of Cambodia are garment and food and beverage, we assume that no coal was consumed for the industry before 2010.

1.2. Coal supply

Coal import data was not available from the GDE before 2014. Since then, the GDE reported coal import data based on the Customs Office's data. However, since data on coal consumption for power generation and the cement industry are available, the coal imports for 2008–2013 were estimated as the sum of coal consumption in the power plants and the cement industry.

2. Petroleum Products (Oil)

2.1. Import data

The GDP-MME provided the data on petroleum products (oil) imports from 2000 to 2019, based on the Customs Office's data (Table 3.2). There were some differences compared to the previous import data of petroleum products in the MME EBT 2010–2018:

- Include import data 2000–2009
- Include kerosene import from 2000 to 2013, which is assumed to be consumed for lighting in the residential sector

Table 3.1. Total Final Energy Consumption by Fuel

	Description	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Coal Consumption	Generation	kt									25.51	30.62	35.04	40.09	58.13	91.89	563.32	1002.82	1394.08			2092.7
	Industry	kt											10.19	11.89	13.02	13.43	18.93	26.67	34.56			252.78
Heavy Fuel Oil (HFO)	Generation	kt	59.28	63.75	68.31	81.12	89.58	124.68	179.53	236.89	258.79	214.34	170.96	183.61	174.91	107.72	61.81	43.03	44.38			200
Diesel		kt	26.42	28.41	30.44	36.15	51.21	39.92	24.28	18.04	18.9	12.68	6.05	6.06	8.95	3.3	2.1	1.46	0.94			8.48
Power Generation	Hydro	GWh	30.42	33.28	36.24	40.51	28.42	43.54	50.61	49.71	46.28	47.43	31.73	51.52	517.37	1,015.54	1,851.60	2,000.38	2619.11			4025.34
	Coal	GWh				-	-	-	-	-	23.36	28.03	32.08	46.5	37.42	168.75	863.02	2,376.49	2551.17			3734.01
	Diesel/HFO	GWh	447.16	489.15	532.66	595.38	714.81	835.71	1,034.82	1,294.36	1,409.94	1,152.65	898.73	908.61	856.56	578.99	326.97	227.62	252.41			731.85
	Wood&Biomass	GWh				-	-	0.12	1.68	5.25	4.53	6.49	5.82	11.91	11.75	6.68	16.79	40.47	43.35			184.05
Electricity	Import	GWh	43.77	47.88	52.14	58.28	59.49	82.25	107.98	167.41	374.25	842.4	1,546.44	1,829.79	2,104.32	2,281.63	1,803.04	1,541.00	1582.85			3062.65
Electricity Consumption	Residential	GWh	237.1	252.61	268.45	292.17	325.19	365.84	388.83	458.25	575.4	682.03	869.08	854.16	1,079.28	1,186.58	1,323.08	1,527.15	2523.49			3399.57
	Commercial	GWh	185.81	204.27	223.49	229.86	270.74	348.03	449.22	548.91	694.41	778.15	892.89	1,082.45	1,275.90	1,539.47	1,639.29	2,530.31	2651.45			3408.23
	Industrial	GWh	26.45	34.73	43.45	76.46	105.93	143.76	215.98	338.61	389.62	388.59	489.88	629.87	900.32	820.04	1,054.35	1,136.84	1992.6			3383.29
	Other	GWh	0.55	0.55	0.55	0.55	0.46	0.72	3.13	3.35	4.96	4.72	2.19	6.26	10.31	6.5	6.84	7.18	7.51			26.5
Biomass Production	Firewood	ton	3,455,084	3,532,727	3,606,432	3,707,993	3,841,962	4,031,521	4,207,773	4,272,869	4,459,457	4,583,360	4,644,997	4,856,076	5,053,881	5,262,683	5,520,148	5,681,802	5,575,106	5,482,156	5,208,000	5,154,509
	Biogas	ton	251	286	325	370	421	480	546	621.57	1,265.29	1,413.93	2,023.60	2,608.41	2,270.61	602.65	881.54	1,661	1,745	1,957	2,195	2,461
Firewood Consumption	Electricity	ton						144	2,017	6,304	5,438	7,783	6,983	14,288	14,096	8,016	20,148	48,562	46,000	43,000	39,000	110,878
	Charcoal	ton	1,851,940	1,893,090	1,932,151	1,985,977	2,056,978	2,157,364	2,249,782	2,280,673	2,380,875	2,445,854	2,479,230	2,588,155	2,693,994	2,808,858	2,940,000	2,984,159	2991286	2,955,000	2,860,000	2,811,835
Charcoal Production		ton	211,650	216,353	220,817	226,968	235,083	246,556	257,118	260,648	272,100	279,526	283,341	295,789	307,885	321,012	336,000	341,047	341,861	343,000	332,000	321,353
Consumption of Firewood	Residential	ton	1,160,462	1,182,968	1,204,332	1,233,771	1,272,603	1,327,508	1,378,053	1,380,816	1,441,482	1,480,823	1,501,030	1,566,978	1,631,058	1,700,601	1,780,000	1,806,735	1,730,852	1,658,156	1,575,000	1,521,796
	Industrial	ton	442,682	456,670	469,948	488,245	512,381	546,505	577,921	605,077	631,661	648,900	657,755	686,653	714,733	745,207	780,000	842,347	806,968	826,000	734,000	710,000
Consumption of Charcoal	Residential	ton	211,650	216,353	220,817	226,968	235,083	246,556	257,118	260,648	272,100	279,526	283,341	295,789	307,885	321,012	336,000	341,047	341,861	343,000	332,000	321,353
Consumption of Biogas	Residential	ton	250.95	285.67	325.19	370.17	421.38	479.68	546.03	621.57	1,265.29	1,413.93	2,023.60	2,608.41	2,270.61	602.65	881.54	1,660.90	1,744.91	1,956.96	2,194.78	2,461.50

Note: Yellow = existing data, white = estimated data, red = revised data.
Source: GDR-MME in-house data (2021).

Table 3.2. Cambodia's Imported Petroleum Products (in tonnes)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jet A-1	17,365	16,781	16,826	16,834	19,671	20,033	27,061	48,733	44,311	35,187	46,349	54,598	68,991	79,211	91,658	96,947	105,736	152,810	201,519	224,711
Gasoline	119,760	120,857	116,931	103,797	96,748	129,298	158,980	238,399	293,220	313,615	384,095	398,516	387,729	392,011	426,830	481,071	490,898	560,046	606,092	711,381
Diesel	387,832	465,648	389,202	400,577	409,624	346,579	449,810	492,527	456,100	677,059	762,077	814,544	897,641	918,437	1,005,484	1,073,248	1,240,184	1,247,632	1,343,339	1,661,325
Kerosene	29,550	28,265	50,406	83,687	47,824	30,336	24,408	32,621	30,785	28,948	30,593	12,072	6,256	3,034	0	0	0	0	0	0
Fuel oil	95,513	92,124	122,456	118,531	142,354	180,034	248,803	293,950	310,085	269,943	244,073	228,784	213,743	165,929	89,280	35,592	138,532	77,694	84,065	179,922
Lubricant	3,637	3,138	5,126	5,651	6,520	7,464	6,943	11,411	12,830	14,248	14,225	14,174	14,769	16,896	11,685	20,385	25,125	12,097	11,834	13,832
LPG	13,434	16,663	18,129	22,283	27,542	28,243	38,264	47,342	43,294	56,946	65,109	71,943	84,678	98,692	112,120	162,332	193,595	224,369	270,320	340,958
Naphtha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18,094	13,504	0	0	0
MTBE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8,096	9,361	1,998	0	14,273
Base Oils	-	-	-	-	-	-	-	-	-	3,292	2,517	3,463	3,251	1,949	-	0	0	0	0	0
Total	667,091	743,476	719,076	751,360	750,283	741,987	954,269	1,164,983	1,190,624	1,399,238	1,549,038	1,598,094	1,677,059	1,676,158	1,737,057	1,895,765	2,216,935	2,276,646	2,517,169	3,146,402

Note: Yellow-coloured cells indicate a revised number; gasoline includes naphtha and methyl tert-butyl ether (MTBE); lubricant includes base oils.
Source: GDE-MME in-house data (2021).

2.2. Breakdown of import data to sectoral demand

The sales structure of the current Cambodia energy statistics 2010–2018 is applied to estimate the international aviation bunkers, stock, and final consumption of motor gasoline, kerosene-type jet fuel, kerosene, diesel oil, fuel oil, LPG, and lubricants. As for additives and bitumen, the reported data from petroleum companies are adopted.

1) Jet fuel

Jet fuel import data is the total consumption of domestic aviation (DA) and international aviation bunker (IAB). However, the current MME energy statistics 2010–2018 already estimated the share of the total consumption for IAB and DA. IAB and DA consumption from 2000 to 2009 was estimated using the shares of IAB and DA in 2010 as follows:

$$IAB_t = IMJF_t * IAB_{2010} / (IAB_{2010}+DA_{2010})$$

$$DA_t = IMJF_t * DA_{2010} / (IAB_{2010}+DA_{2010})$$

Where,

IAB: International aviation bunker

IMJF: Import of jet fuel

DA: Domestic airways

t = year (2000 to 2009)

IAB and DA consumption for 2019 was estimated using a similar method, but with the 2018 shares of IAB and DA as follows:

$$IAB_{2019} = IMJF_{2019} * IAB_{2018} / (IAB_{2018}+DA_{2018})$$

$$DA_{2019} = IMJF_{2019} * DA_{2018} / (IAB_{2018}+DA_{2018})$$

2) LPG

LPG is consumed by the road transport, residential, and commercial sectors. Thus, it is necessary to break down LPG imports from 2000 to 2009 into those three sectors. According to the GDP-MME, LPG is widely used by the three-wheeled tuk-tuks in 2006. Based on this, LPG consumption for vehicles is assumed to have started in 2006. Therefore, the formula to calculate LPG consumption in the road transport, residential, and commercial sectors are as follows:

$$RDt = IMLPt * RD2010 / (RD2010+CM2010+RS2010)$$

$$CMt = IMLPt * CM2010 /(RD2010+CM2010+RS2010)$$

$$RSt = IMLPt * RS2010 / (RD2010+CM2010+RS2010)$$

Where,

IMLP: Import of LPG

RD: LPG consumption in the road transport sector

CM: LPG consumption in the commercial sector

RS: LPG consumption in the residential sector

t = year (2000 to 2009)

3) Diesel

Similar to LPG, it is also necessary to break down diesel oil imports amongst the road transport, industry, commercial, and the other sector for 2000–2009. Diesel is also consumed as input for power generation. Therefore, the total import must first be deducted from the fuel input for power generation, then calculate the sectoral breakdown estimation using the following formula:

*RDt = (IMDOt – PGDOt) * RD2010 / (RD2010+IN2010+CM2010+AG2010+NS2010)*

*INt = (IMDOt – PGDOt) * IN2010 / (RD2010+IN2010+CM2010+AG2010+NS2010)*

*CMt = (IMDOt – PGDOt) * CM2010 /(RD2010+IN2010+CM2010+AG2010+NS2010)*

*AGt = (IMDOt – PGDOt) * AG2010 / (RD2010+IN2010+CM2010+AG2010+NS2010)*

*NSt = (IMDOt – PGDOt) * NS2010 / (RD2010+IN2010+CM2010+AG2010+NS2010)*

Where,

IMDO: Import of diesel oil

PGDO: Diesel consumption for power generation

RD: Diesel consumption in the road transport sector

IN: Diesel consumption in the industry sector

CM: Diesel consumption in the commercial sector

AG: Diesel consumption in the agriculture sector

NS: Diesel consumption in non-specific other sector

t = year (2000 to 2009)

4) Gasoline

Gasoline is consumed only in the road transport sector. The GDP-MME data includes naphtha imports (reformate) and methyl tert-butyl ether (MTBE). Naphtha (reformate) is primarily used as a high-octane blend stock for making gasoline. Another use is as a source of aromatics for the petrochemicals industry. MTBE, on the hand, is an additive for unleaded gasoline as it increases octane and oxygen levels in gasoline and helps achieve complete combustion in gasoline engines. Since both relate to gasoline, the total gasoline consumption of the road transport sector will be:

Gasoline road transport = import of (gasoline + naphtha (reformate) + MTBE)

5) Lubricant

Lubricant is usually used in vehicles and is thus assumed to be all consumed in the road transport sector. Imported base oils are also consumed in the road transport sector. Thus, these other petroleum products are calculated as:

Other Road transport sector = Import of lubricant + import of base oils

6) Kerosene

Previous energy statistics of Cambodia excludes kerosene imports (non-jet-fuel-kerosene type). The GDP-MME's current import data includes kerosene import data from 2000 to 2013. Afterwards, there was no more import of kerosene. The residential sector is assumed to be the user of kerosene. Thus,

Kerosene Residential sector = import of kerosene

3. Biomass

The biomass data maintained by the GDE-MME covers fuelwood, charcoal, and biogas. Charcoal and biogas are consumed only in the residential sector. Fuelwood is used to produce electricity and charcoal; it is also consumed in the industry and residential sectors. Fuelwood consumption for electricity generation is in the form of bagasse; it will be discussed in the following section on fuel input for power generation.

Before 2007, biomass demand and supply data were not available. These data were estimated as described below.

3.1. Fuelwood

In estimating fuelwood demand data before 2007–2016, the demand for fuelwood (firewood) in the residential and industrial sectors are assumed to be related to the gross domestic product (GDP). The demand function of firewood was estimated through the ordinary least squares regression method, using demand and GDP data (constant LCU) from 2007 to 2016. For the residential sector, the estimated regression formula is:

Y = 858,234 + 21.32 GDP (correlation 0.94)

Where,

Y: Firewood consumption in residential sector

GDP: Gross domestic product in constant LCU

For the industry sector, the estimated regression formula is:

Y = 301,259 + 11.77 GDP (correlation 0.97)

Where,

Y: Firewood consumption in the industry sector

The charcoal factory's fuelwood consumption was estimated, assuming the furnace efficiency is 25%. Thus,

Fuelwood consumption = charcoal production/0.25

3.2. Charcoal consumption

Charcoal is assumed to be consumed only by the residential sector. Similar to firewood, charcoal consumption was estimated using the following regression formula:

Y = 148,496 + 4.45 GDP (correlation 0.98)

Where,

Y: charcoal consumption in the residential sector

3.3. Biogas consumption

Biogas is also consumed by the residential sector. Biogas consumption was also estimated using the regression formula. However, the GDP correlation is quite low (0.06). Therefore, the biogas consumption was re-estimated by calculating the average annual growth rate (AAGR) during 2007–2016, as follows:

$$AAGR = (Y2016/Y2007)^{(1/9)} - 1 = 0.12$$

Where, Y: Biogas consumption in the residential sector

4. Electricity

4.1. Fuel input for power generation

Cambodia's primary power generation sources are hydro, oil (fuel oil and diesel), coal, biomass, and solar. Hydro and oil were the only power generation sources from 2000 to 2004. In 2005, Cambodia started to use biomass in the form of bagasse to generate electricity. In 2008, coal was added to the power generation mix, while the solar-powered plant was first generated in 2017.

1) Bagasse

The GDE has provided generation data from bagasse power plants since 2005. However, bagasse consumption for power generation was available only from 2007. Thus, it was necessary to estimate the missing bagasse fuel input data for 2005 and 2006.

In principle, fuel input is estimated as follows:

$$INPUT = OUTPUT / EFFICIENCY$$

The output data unit, which is generated electricity from the bagasse power plant, is in GWh. The fuel input data, the amount of bagasse used for power generation, is in tonnes. Thus, it is necessary to provide the thermal value of bagasse and the thermal conversion factor of electricity.

The thermal efficiency for 2005 and 2006 is assumed to be the same as that of 2007. In this regard, the thermal efficiency for 2007 was calculated using the following formula:

EF2007 = (PG2007*TC1*1000)/(FC2007*1000*TC2/10000000)

Where,

EF2007: Thermal efficiency in 2007

PG2007: Power generation by bagasse in 2007 (GWh)

TC1: Thermal conversion factor of electricity (0.086 toe/MWh)

FC2007: Firewood consumption for power generation in 2007 (tonne)

TC2: Thermal value of firewood (3,820 kcal/kg)

Using EF2007, the bagasse input for power generation in 2005 and 2006 is then estimated as follows:

FCt = (PGt *TC1*1000/EF2007*10000000)/TC2/1000 (tonnes)

Where,

FCt: Firewood consumption for year-t

PGt: Power generation by bagasse in year-t

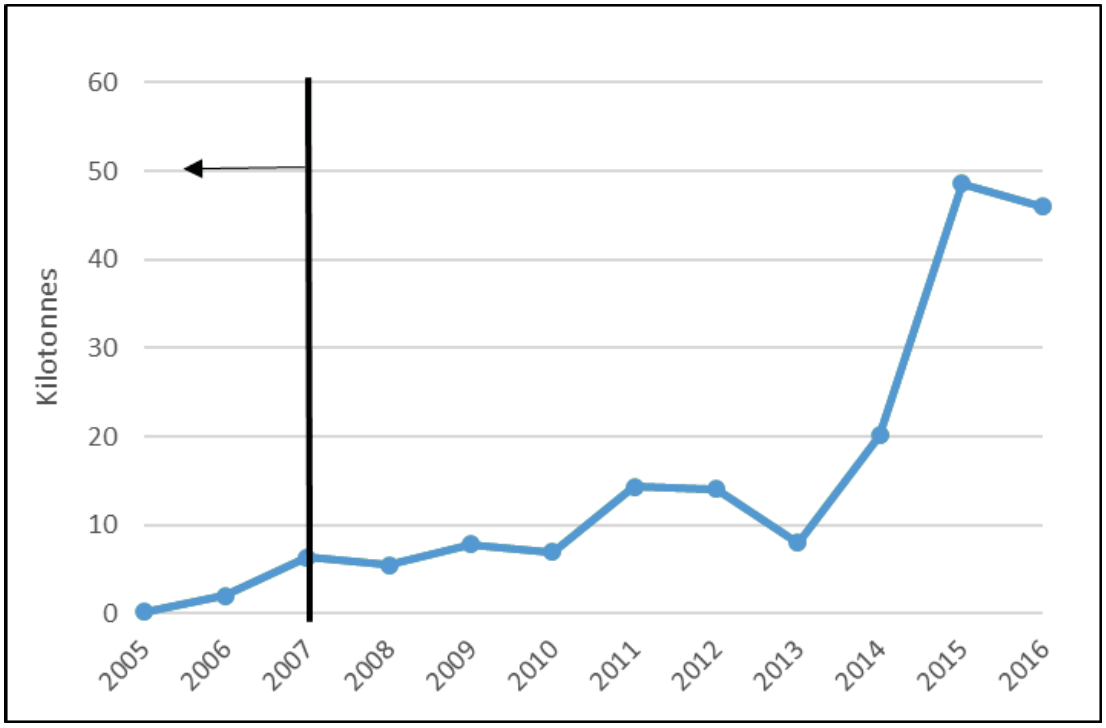
EF2007: Thermal efficiency for 2007

TC1: Thermal conversion factor for electricity (0.086 toe/GWh)

TC2: Thermal value of bagasse (3,820 kcal/kg)

Based on the estimation, the fuel input of bagasse for power generation increased from 0.1 kilotonnes (Kt) in 2000 to almost 112 Kt in 2019 (Figure 3.1)

Figure 3.1. Bagasse Input for Power Generation



Source: GDE-MME in-house data (2021).

2) HFO/diesel consumption

Thermal efficiency in 2003–2009 looks unusual (refer to Figure 3.2). Therefore, it was necessary to re-estimate the oil (HFO/diesel) consumption for power generation using the 2010 thermal efficiency. The thermal efficiency in 2010 (EF2010) is calculated as follows:

EF2010 = (PG2010*TC1*1000)/(HDC2010*1000000*TC2/10000000)

Where,

PG2010: Power generation by firewood in 2010 (GWh)

TC1: Thermal conversion factor of electricity (0.086 toe/MWh)

HDC2010: HFO/diesel consumption for power generation in 2010 (Kt)

TC2: Thermal value of HFO/diesel (10105 kcal/kg)

The approach to estimating the HFO/diesel input for power generation in 2000–2009 will be as follows:

HDCt = (PGt *TC1*1000/EF2010*10000000)/TC2/1000000 (Kt)

HFCt = HDCt * (HFC2010/(HFC2010+DOC2010))

DOCt = HDCt * (DOC2010/(HFC2020+DOC2010))

Where,

HDCt: HFO/diesel input for power generation at year t

HFCt: HFO input for power generation at year t

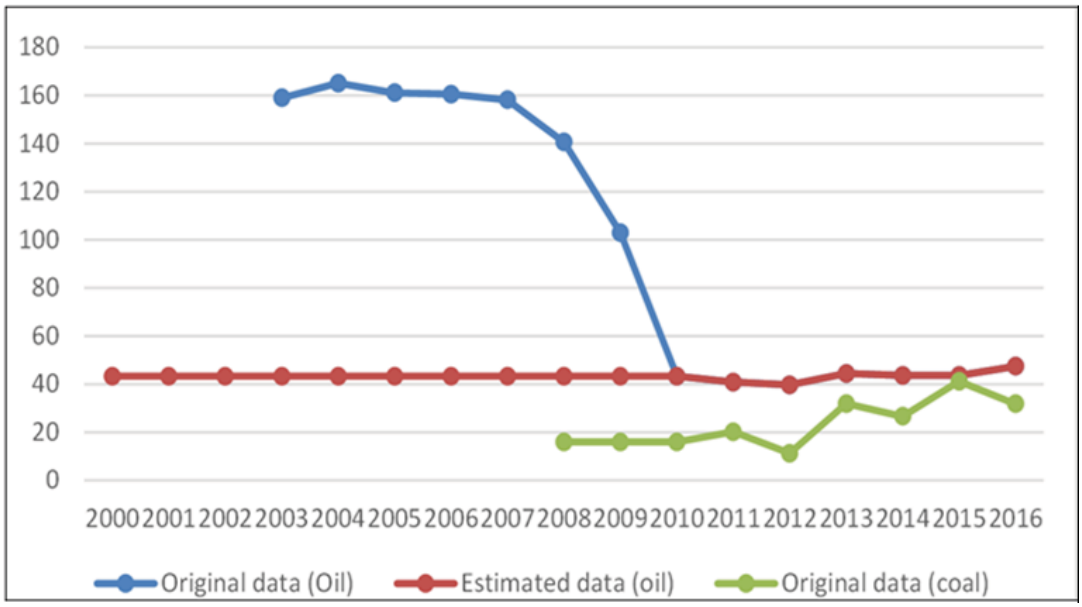
DOCt: Diesel input for power generation at year t

HFC2010: HFO input for power generation at year 2010

DOC2010: Diesel input for power generation at year 2010

The thermal efficiency for 2000–2016 is shown in Figure 3.2.

Figure 3.2. Historical Thermal Efficiency



Source: GDE-MME In-house data (2021).

4.2. Electricity consumption

The primary energy data from the GDE excludes electricity data before 2003. In this case, it is necessary to estimate the missing data on electricity consumption from 2000 to 2002. The method to estimate the missing data is as follows:

1) Residential sector

We estimate the regression formula using the GDP of 2003–2016.

Y = 74.38 * 1.000074^GDP (correlation 0.93) + constant adjustment

Where,

Y: Electricity consumption in the residential sector

GDP: Constant LCU

2) Commercial sector

We estimate the regression formula using the GDP of 2003–2016.

Y = 52.083 * 1.000089 ^ GDP (correlation 0.96)

Where,

Y: Electricity consumption in the commercial sector

GDP: Constant LCU

3) Total final energy consumption (TFEC) sector

We estimate the regression formula using the GDP of 2003–2016.

Y = 134.77 * 1.000087^GDP (correlation 0.93) + constant adjustment

Where,

Y: Electricity consumption in the TFEC sector

GDP: Constant LCU

4) Other sector

Estimation is very difficult; therefore, we treat it as exogenous.

Yt = Y2003 (t=2000-2002)

Where,

Y: Electricity consumption in the other sector

5) Industry sector

Calculation as balance in 2000–2002

Y t= TECt –RSt – CMt – Ott (t=2000-2002)

Where,

Yt: Electricity consumption in the industry sector

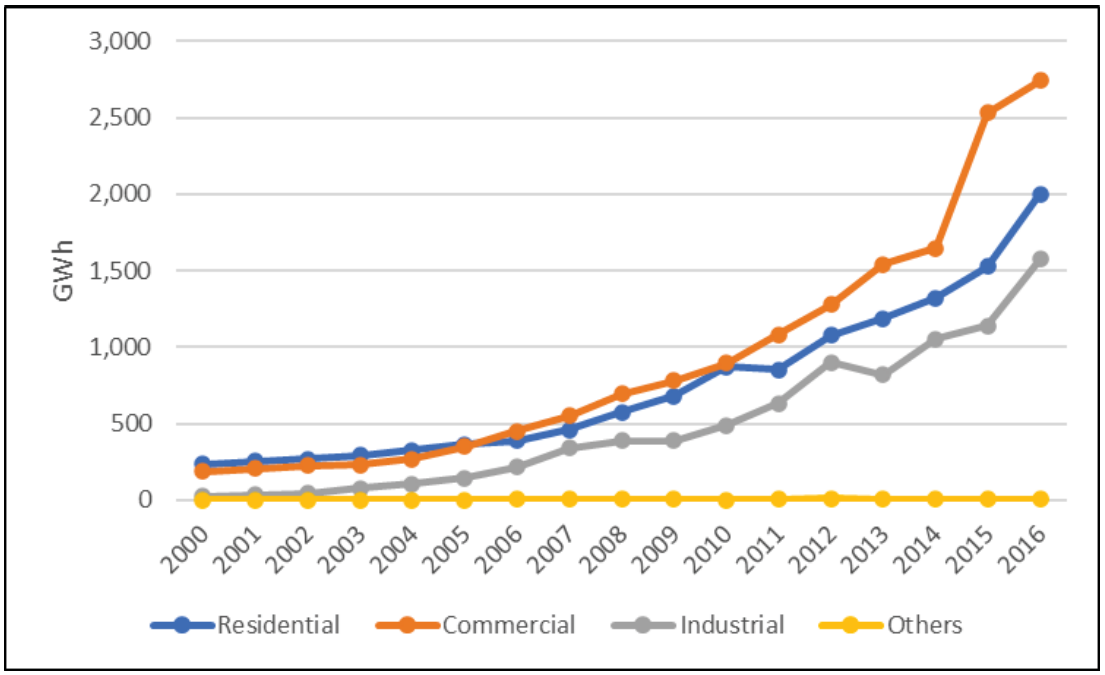
TECt: Total electricity consumption in the final energy consumption sector

RSt: Electricity consumption in the residential sector

CMt: Electricity consumption in the commercial sector

Ott: Electricity consumption in the other sector

Figure 3.3. Electricity Consumption by Sector



Source: GDE-MME In-house data (2021).

4.3. Power balance

Electricity supply is the total amount of domestic and imported electricity. The power generation fuel input consists of coal, oil (fuel oil and diesel), hydropower, and biomass. The total electricity demand will be that of the industry, commercial, residential, and other sectors.

Own use and transmission and distribution (T&D) losses are the difference between electricity supply and demand. The ratio of own use and T&D losses for each year was estimated as follows:

- $B_t = ES_t - ED_t$
- Ratio = B_t / ED_t

Where,

Bt = Power balance of year-t

Est = Electricity supply in year-t

Edt = Electricity demand in year-t

Chapter 4

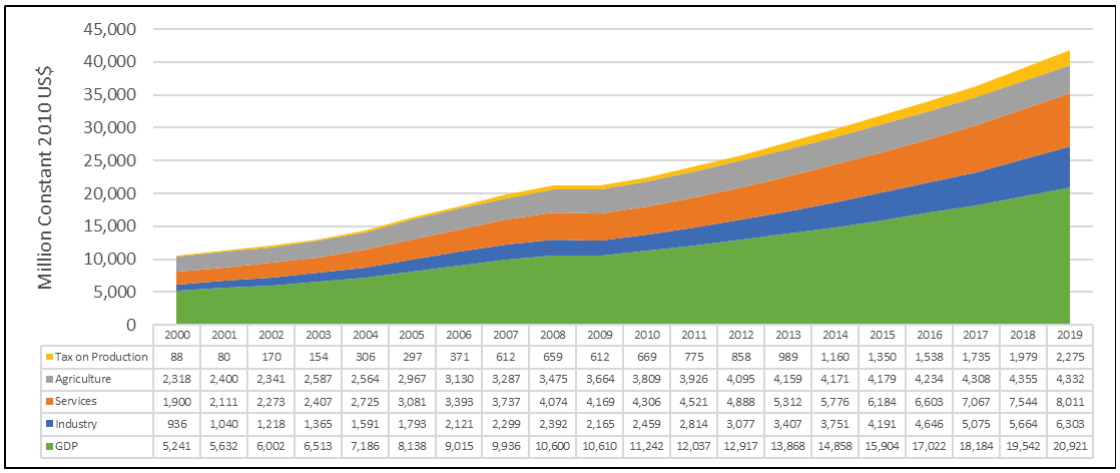
Energy Demand and Supply Analysis in 2000–2019

The final primary energy 2000–2019 data were used to produce Cambodia's energy balance tables (EBTs). The EBT 2000–2019 is the basis for this chapter's energy demand and supply analysis.

1. Socio-economic Situation

Cambodia's GDP average annual growth rate (AAGR) was 7.6% from 2000 to 2019, with a share of around 38% in 2019. The services sector mainly contributed to the economy (Figure 4.1). Although the services sector constantly had the largest share, its AAGR was 8% between 2000 and 2019, lower than the industry sector (11%). This indicated that the industry sector's growth significantly influences its GDP. The agriculture sector's share was around 44% in 2000 and decreased to 21% in 2019, with an AAGR of around 1.7%.

Figure 4.1. GDP in Constant 2010 US$

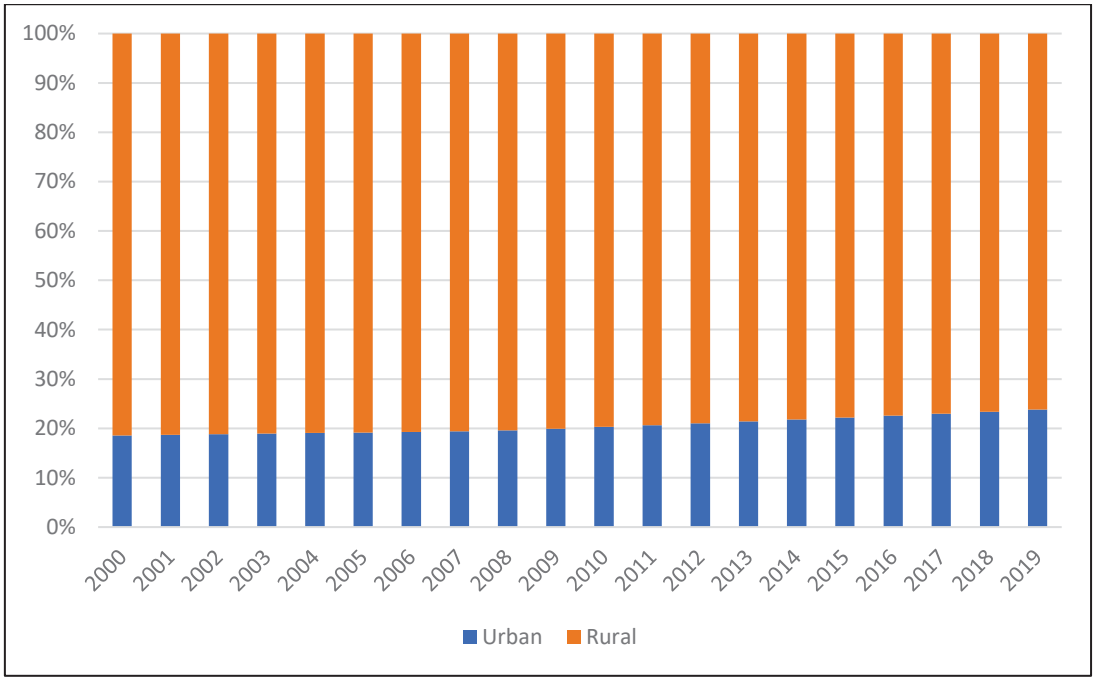


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Tax on Production	88	80	170	154	306	297	371	612	659	612	669	775	858	989	1,160	1,350	1,538	1,735	1,979	2,275
Agriculture	2,318	2,400	2,341	2,587	2,564	2,967	3,130	3,287	3,475	3,664	3,809	3,926	4,095	4,159	4,171	4,179	4,234	4,308	4,355	4,332
Services	1,900	2,111	2,273	2,407	2,725	3,081	3,393	3,737	4,074	4,169	4,306	4,521	4,888	5,312	5,776	6,184	6,603	7,067	7,544	8,011
Industry	936	1,040	1,218	1,365	1,591	1,793	2,121	2,299	2,392	2,165	2,459	2,814	3,077	3,407	3,751	4,191	4,646	5,075	5,664	6,303
GDP	5,241	5,632	6,002	6,513	7,186	8,138	9,015	9,936	10,600	10,610	11,242	12,037	12,917	13,868	14,858	15,904	17,022	18,184	19,542	20,921

Source: World Bank (2021).

Cambodia's population increased steadily with an AAGR of 1.6% from 2000 to 2019. People in the urban areas grew by 3.4% per year, higher than the growth rate in the rural areas. Nevertheless, the share of the population in the rural areas was still bigger than in the urban areas. The share of the population living in rural areas was around 77% in 2019 (Figure 4.2).

Figure 4.2. Population of Cambodia, 2000–2019



Source: World Bank (2021).

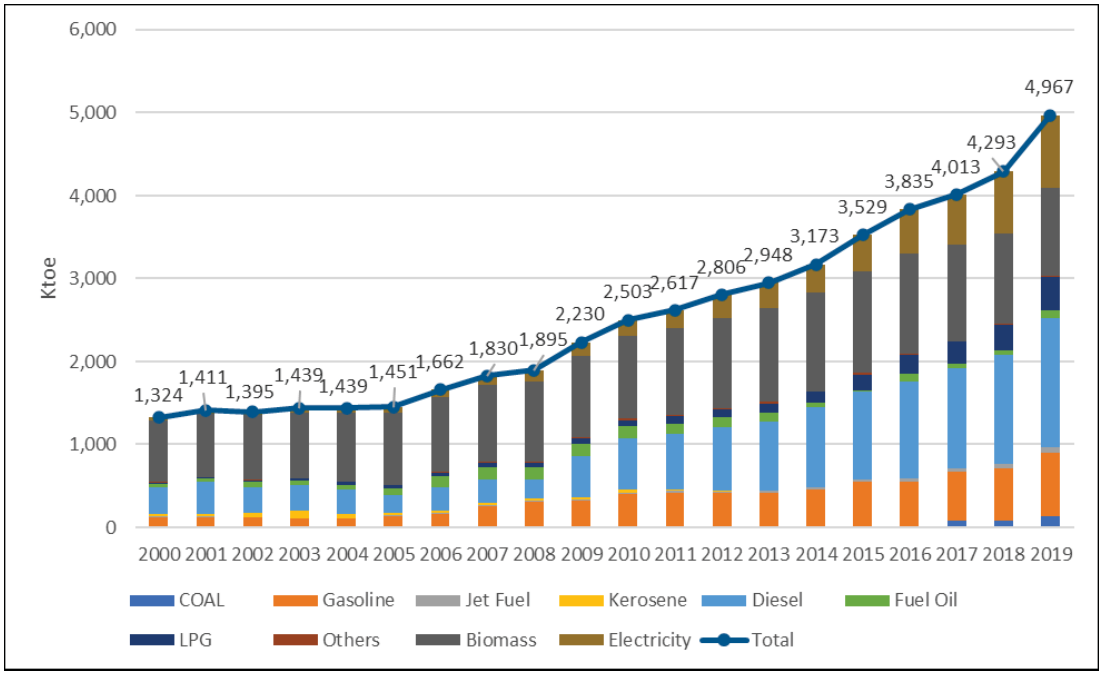
2. Final Energy Consumption

The final energy consumption of Cambodia increased steadily by 7.2% per year from 2000 to 2019 (Figure 4.3). Before 2009, biomass comprised most of the total final energy consumption (TFEC). The share, however, declined from 56% in 2000 to 44% in 2009 and reached 21% by 2019. As a result, biomass is being phased out of the country's energy market.

Oil consumption was also high in Cambodia, but its share was still lower than biomass in 2000–2008. Since 2009, the role of oil in the TFEC became dominant, and the share increased from 49% in 2009 to 58% in 2019. The AAGR of oil consumption was 9% from 2000 to 2019.

Electricity consumption grew the fastest over the 2000–2019 period, at an average annual rate of 18%. Although the fastest, electricity share in the TFEC was only 3% in 2000 and reached 18% in 2019 due to limited power supply capacity.

Figure 4.3. Total Final Energy Consumption by Fuel

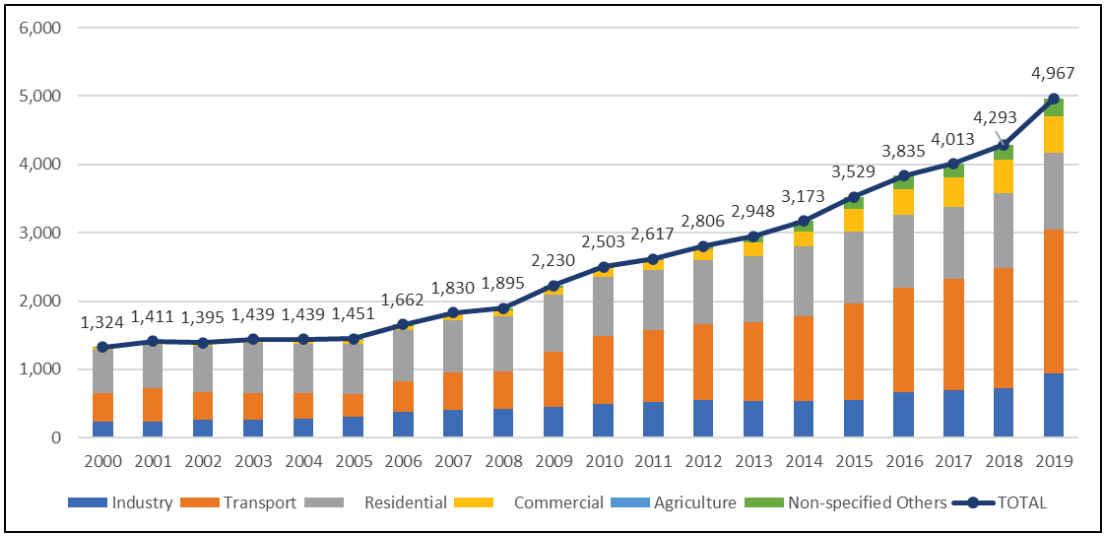


Source: GDE-MME in-house data (2021).

The transport and residential sectors had the largest share in the TFEC (Figure 4.4). Transport is the major oil consumer, while the residential sector mainly consumes biomass. The commercial sector has a smaller share but has high consumption growth rates over the 2000–2019 period, at 16% per year, compared to the transport and residential sectors at 9% and 3% per year, respectively. The industry sector showed an increase of 8% per year, slightly slower than the transport sector.

The high growth of the commercial, transport, and industry sectors was due to significant economic development, as reflected by the remarkable foreign direct investment in the construction of commercial buildings, infrastructure, and economic zones. The country's GDP increased by 7.6% per year in 2000–2019, so the energy elasticity of GDP towards the TFEC (2000–2019) was 0.95. If biomass is excluded from the TFEC, the energy elasticity will be around 1.4, since the TFEC without biomass has been growing at 10.5% faster than the GDP. In this regard, an aggressive energy efficiency and conservation programme must be in place to improve elasticity in the future.

Figure 4.4. Total Final Energy Consumption by Sector

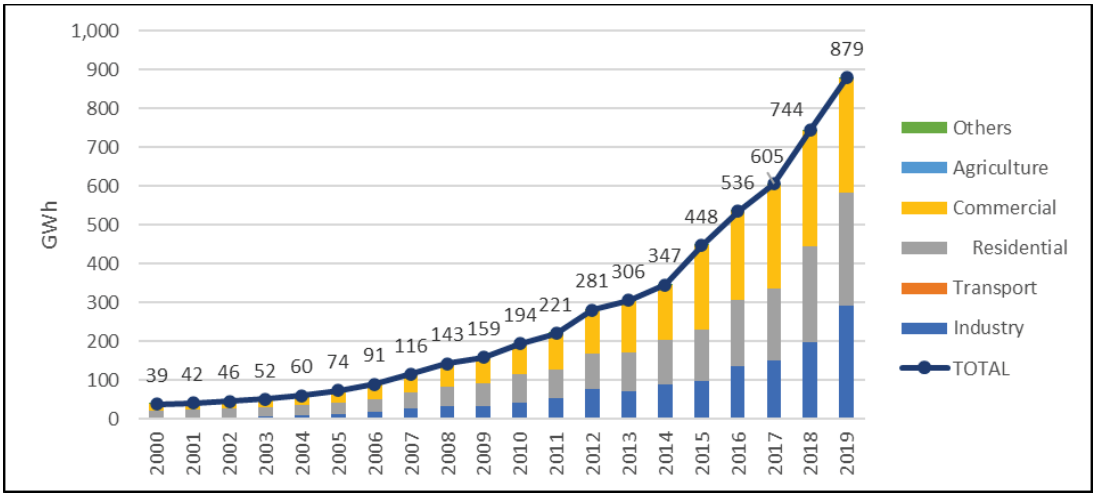


Source: GDE-MME In-house data, (2021).

3. Power Generation

Electricity consumption grew at an AAGR of 18% over the 2000–2019 period (Figure 4.5). By 2019, electricity consumption reached almost 900 GWh. An increase in income and expansion of the electricity distribution network contributed to this significant increase in electricity demand between 2000 and 2019. Although growing slower, the residential and commercial sectors still dominated electricity demand in Cambodia, from 94% in 2000 to 67% in 2019. Although the industry sector had a lower share, it grew the fastest by 29% over the 2000–2019 period. As a result, the share of electricity consumption in industries increased from 6% in 2000 to 33% in 2019. Saving electricity through highly efficient appliances and machines is essential with the strong leadership of the MME.

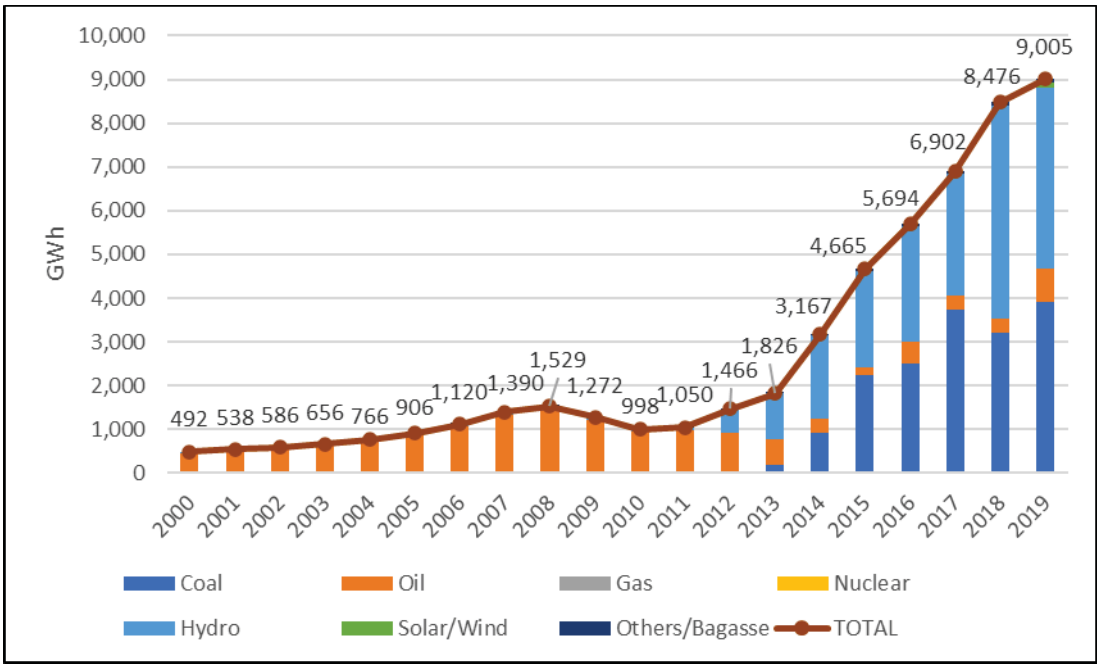
Figure 4.5. Electricity Demand by Sector



Source: GDE-MME in-house data (2021).

The total electricity generation increased from 492 GWh in 2000 to 998 GWh in 2010. Since then, electricity generation has increased significantly ninefold, reaching 9,000 GWh by 2019 at an AAGR of 17% (Figure 4.6). Oil was the primary power source of generation until 2013. However, the share of oil decreased as hydro-based electricity generation started to operate in 2012 and coal in 2015. By 2019, oil share declined to 8%, while coal and hydro increased to 44% and 46%, respectively.

Figure 4.6. Electricity Generation by Fuel



Source: GDE-MME in-house data (2021).

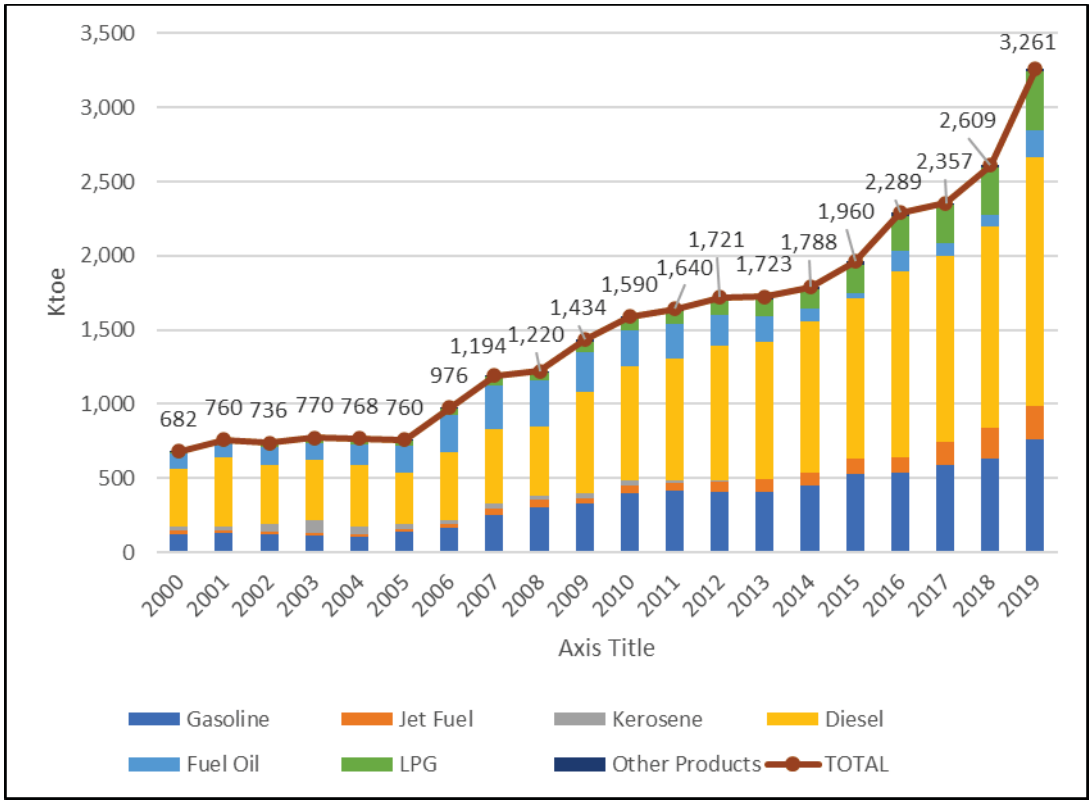
Cambodia imported electricity mainly during the dry season. Electricity imports grew at an AAGR of 25% from 2000 to 2019. The increase in electricity consumption, especially in commercials and industries, including special economic zones, as well as the insufficient power supply system in Cambodia contributed to the rapid growth of electricity imports in the country.

4. Petroleum Products

Cambodia imported 100% of its petroleum products from Singapore, Thailand, and Viet Nam to supply domestic petroleum consumption. The AAGR of imported petroleum products was 9% from 2000 to 2019. The major contributor to the growth of imported petroleum products was LPG (19%), jet fuel (14%), and gasoline (10%). This is in line with the increase in domestic air traffic volume, residential, commercial, and road transport (Figure 4.7). Consumption of jet fuel for international air traffic is larger than domestic air traffic, but the growth in the 2000–2019 period was slower at 9% per year.

Diesel imports grew at an average of 9% per year in 2000–2019. The road transport sector consumed most of the imported diesel (73% in 2019), and consumption has been growing at an average of 9% per year. Other diesel consumers are manufacturing, agriculture, mining, construction, and power generation. Diesel consumption for power generation declined due to the increase of other sources, such as hydro and coal. Diesel consumption for power generation decreased at an average rate of 1% per year over the 2000–2019 period. However, Cambodia needs oil power plants to meet the power supply shortage in the dry season.

Figure 4.7. Import of Petroleum Products

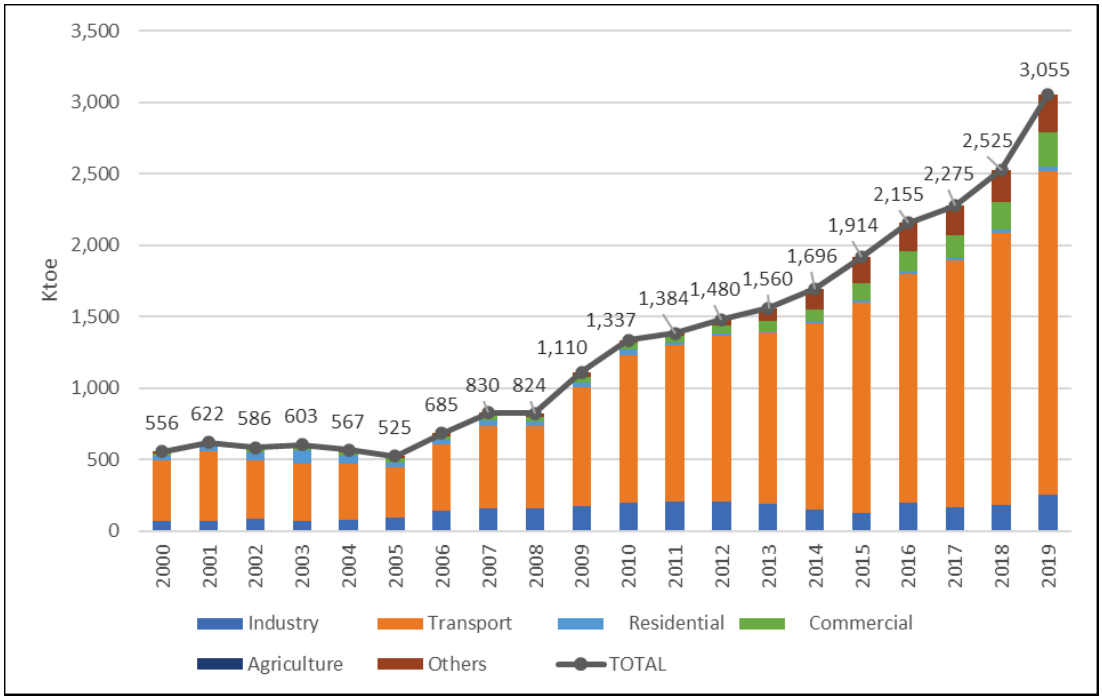


Source: GDE-MME in-house data (2021).

The main consumer of petroleum products in 2019 was the transport sector, at 73% share of total consumption. Other consumers of petroleum products were the industry (9%), residential and commercial sectors (9%), and the agriculture sector with others (9%) (Figure 4.8).

Cambodia's petroleum products demand in the final sector (industry, transport, commercial, residential, and others) increased from around 556 ktoe in 2000 to 3,055 ktoe in 2019, a more-than-fivefold increase over the 2000–2019 period. As mentioned, the AAGR of petroleum products' consumption was 9% (Figure 4.8).

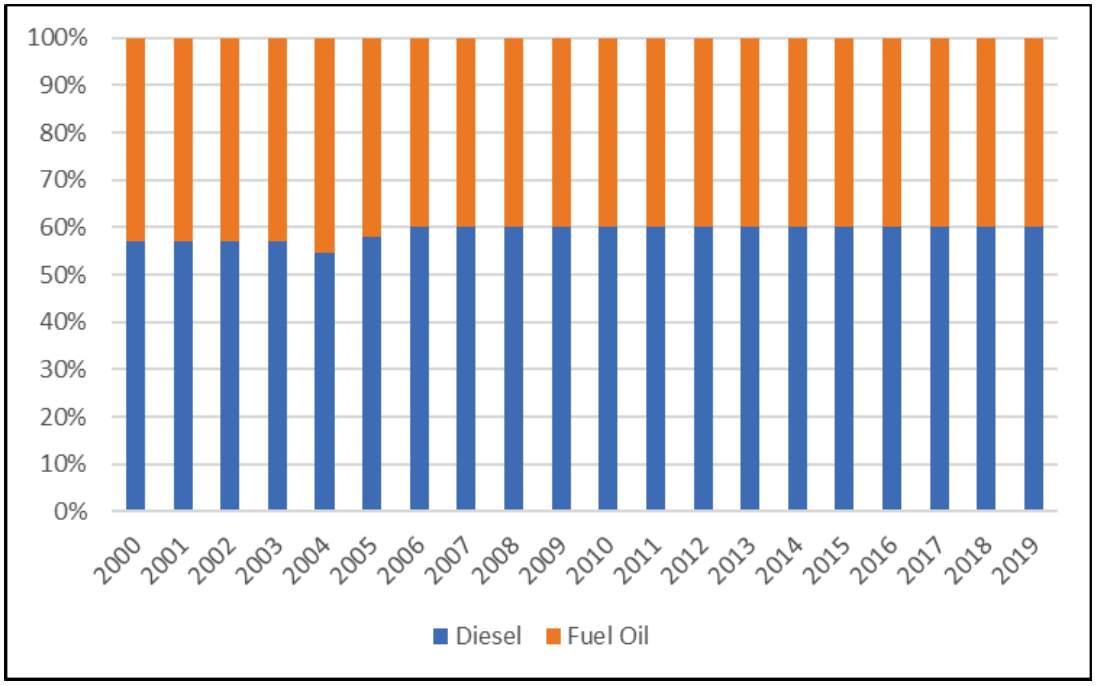
Figure 4.8. Petroleum Demand in the Final Sector



Source: GDE-MME in-house data (2021).

The consumption of petroleum products for power generation consisted of diesel and fuel oil. Total consumption was 126 ktoe in 2000 and increased to 206 ktoe in 2019 at an average rate of 3% per year (Figure 4.9).

Figure 4.9. Petroleum Consumption for Power Generation



Source: GDE-MME in-house data (2021).

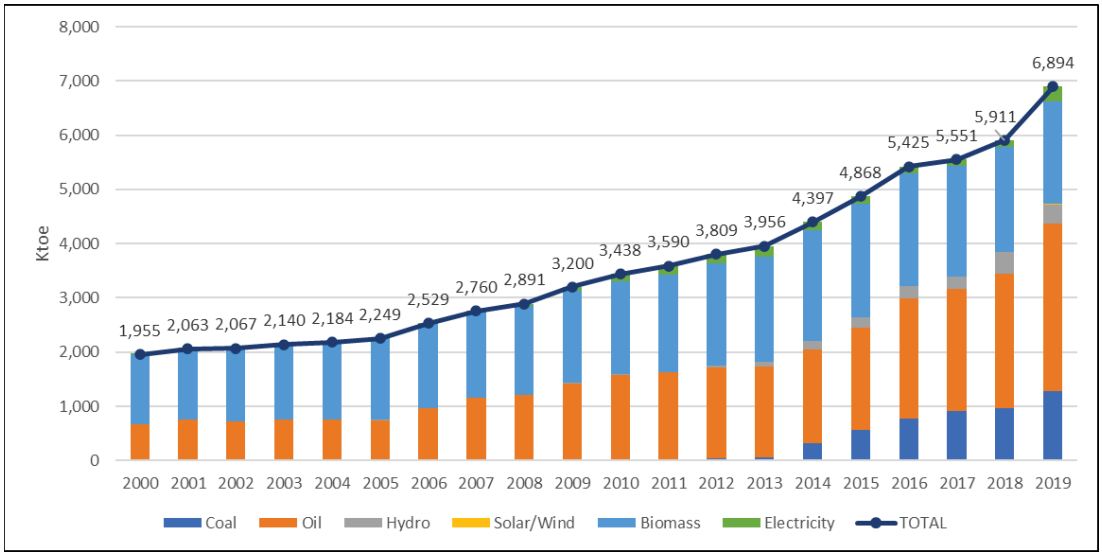
Primary Energy Supply

Primary energy supply is the sum of the transformation and the final energy consumption sectors. Another definition is shown in the equation below:

Primary Energy Supply = indigenous production + (import – export) + stock change (beginning – ending) – international marine and aviation bunkers

Cambodia imported coal, oil (petroleum products), and electricity. Domestic energy comprises hydropower and biomass only. Total primary energy supply (TPES) grew at an AAGR of 7% over the 2000–2019 period (Figure 4.10).

Figure 4.10. Primary Energy Supply



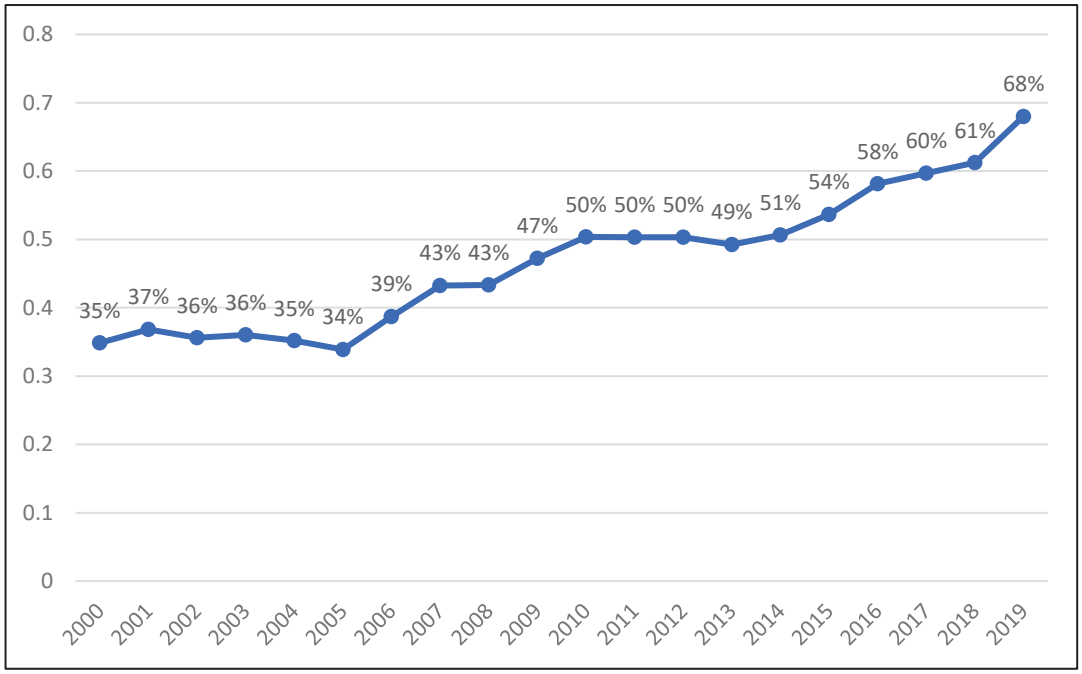
Source: GDE-MME in-house data (2021).

Coal supply grew the fastest at 51% per annum in 2008–2019 due to the rapid increase of its power generation, followed by hydropower supply at 28% yearly from 2000 to 2019, while petroleum products supply increased by 8% per year. On the other hand, traditional biomass supply slightly increased by 2% yearly during 2000–2019 as Cambodia shifted from non-commercial energy to commercial energy (coal, oil, and electricity).

5. Energy Indicator

The import dependency ratio of Cambodia, defined as energy imports divided by the sum of energy production and energy imports, increased from 35% in 2000 to 68% in 2019. This indicates that the country still depended on outside sources for oil supply, making its energy supply security vulnerable. Thus, emergency response and preparedness at the national level, including strategic oil stockpiling, will be needed. (Figure 4.11).

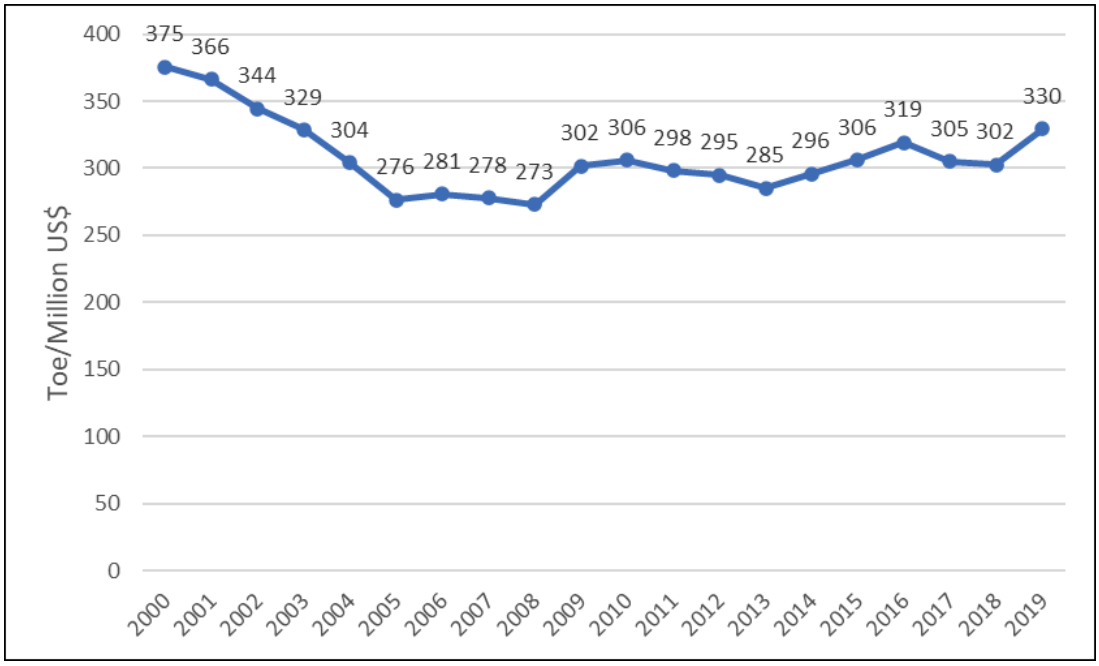
Figure 4.11. Import Dependency Ratio



Source: GDE-MME in-house data (2021).

Energy intensity (Figure 4.12) is defined as the TPES divided by the GDP. Cambodia's energy intensity slightly decreased at an average rate of 1% per year from 2000 to 2019. The growth rate decreased by 6% from 2000 to 2005 due to oil-based electricity generation reduction. However, the energy intensity rose 4% from 2013 to 2016 as coal power plants increased significantly. Overall, 2000–2008 showed its downtrend, but gradually trended upwards after 2009 until 2019. Thus, effective energy efficiency and conservation measures will be needed to change this trend.

Figure 4.12. Energy Intensity

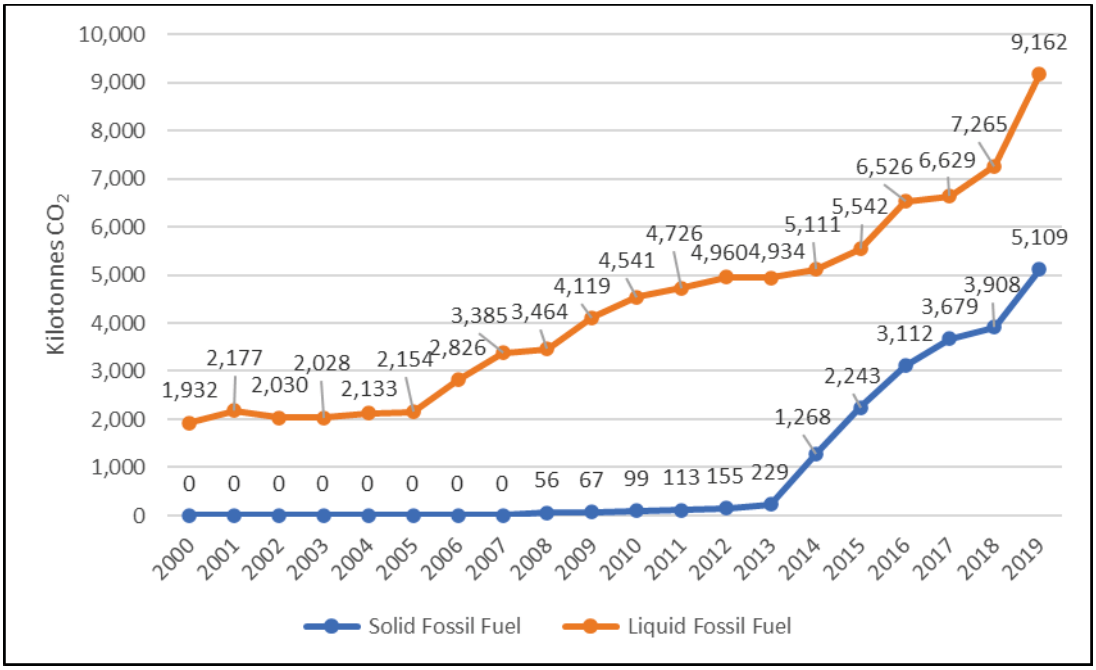


Source: GDE-MME in-house data (2021).

5.1. CO_2 emissions

Cambodia's CO_2 emissions have been increasing at an AAGR of 11% over the 2000–2019 period. CO_2 emissions in 2019 totaled 14,271 Kt-CO_2. CO_2 emissions from liquid fossil fuels grew at an AAGR of 8.5% from 2000 to 2019 because of the rapid increase in petroleum demand for transport activities. CO_2 emissions of solid fossil fuels totaled 56 Kt-CO_2 in 2008 and reached 1,268 Kt-CO_2 in 2014 as the capacity of coal power plants increased significantly (Figure 4.13). CO_2 emissions continued to rise to 5,109 Kt by 2019, increasing at an average rate of 32% between 2014 and 2019 due to the significant electricity demand growth in the same period.

Figure 4.13. CO_2 Emissions in Cambodia



Source: GDE-MME in-house data (2021).

Chapter 5

Analysis of New Energy Outlook of BAU

1. Modelling Assumptions

1.1. GDP and population

In preparing energy demand forecasting for 2050, Cambodia's GDP is assumed to have an AAGR of 6.7%. The population will grow steadily with an AAGR of 1.5%, resulting in an AAGR of GDP per capita of 5.1% (Table 5.1). Compared to ERIA's EAS Energy Outlook 2019–2020, including Cambodia, the GDP assumption was 6.4% in 2017–2050, so this GDP assumption is higher than the previous outlook. On the other hand, the population assumption was the same as 1.5% in 2017–2050.

Table 5.1. Updated Energy Information

Year	2019	2020	2030	2040	2050	AAGR (%) 2019–2050
GDP (2010 US$ billion)	21	22	43	82	154	6.7
Population (million)	16.5	16.7	19.4	22.5	26.2	1.5
GDP/capita (US$/person)	1,300	1,300	2,200	3,600	5,900	5.1

Source: Authors' calculation.

1.2. Electricity generation

Regarding future electricity supply, LNG is expected to dominate Cambodia's fuel mix in 2050, followed by coal. According to the country's Power Development Plan (PDP) 2020–2030, Cambodia will have a total additional installed electricity generation capacity of 24,384 MW. The main contributors will be LNG (9,600 MW); hydro (5,927 MW); and coal (5,140 MW) in 2050 (Table 5.2).

Table 5.2. BAU Install Capacity

Technology	Installed Capacity (MW)						
	2020	2025	2030	2035	2040	2045	2050
HFO_PP_EDC	400	400	400	400	400	400	400
Wind	-	80	180	280	380	480	580
Natural Gas	-	-	3,600	4,800	6,000	7,200	9,600
Solar	75	525	1,725	1,925	2,125	2,325	2,525
Biomass	29	29	29	29	29	29	29
Hydro	2,103	2,103	4,727	4,727	5,927	5,927	5,927
HFO/Diesel	281	183	183	183	183	183	183
Coal-Fired Power Plant	1,000	3,390	5,140	5,140	5,140	5,140	5,140
Total	3,888	6,710	15,984	17,484	20,194	21,684	24,384

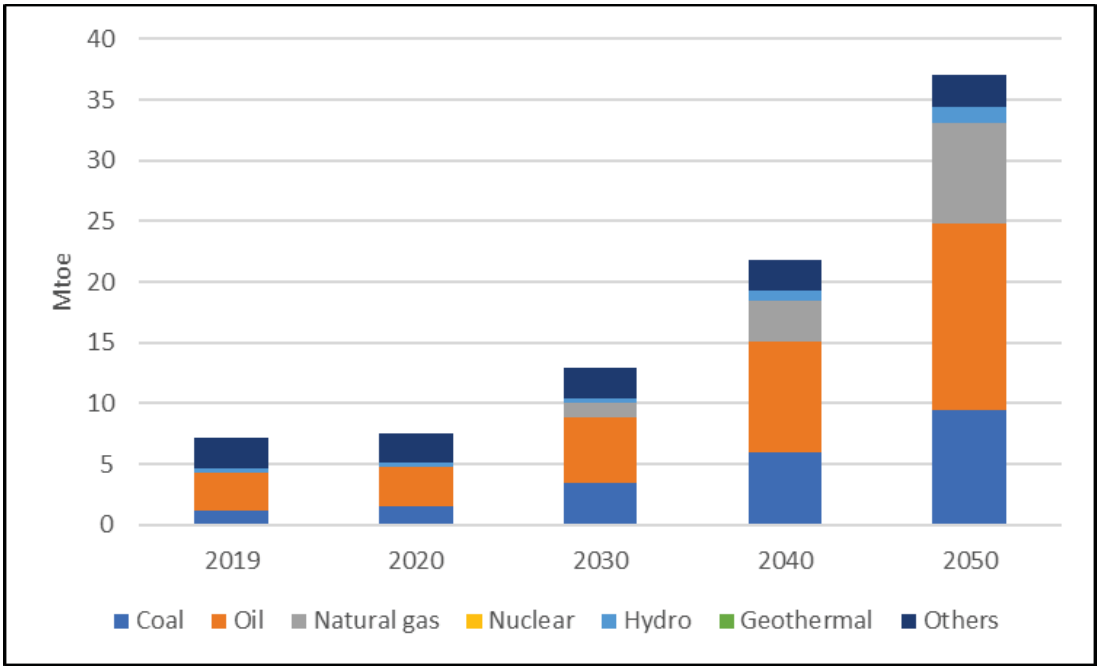
Source: Author's calculation.

2. Outlook Results of Business-as-Usual Scenario

2.1. Primary energy consumption

Cambodia's primary energy consumption, or primary energy supply, grew at an average annual rate of 5.4% from 2019 to 2050. Primary energy consumption will increase from 7.2 Mtoe in 2019 to around 37 Mtoe in 2050, slightly faster than final energy demand, from almost 5 Mtoe in 2019 to 25 Mtoe in 2050 (Figure 5.1).

Figure 5.1. Primary Energy Consumption



Source: Authors' calculation.

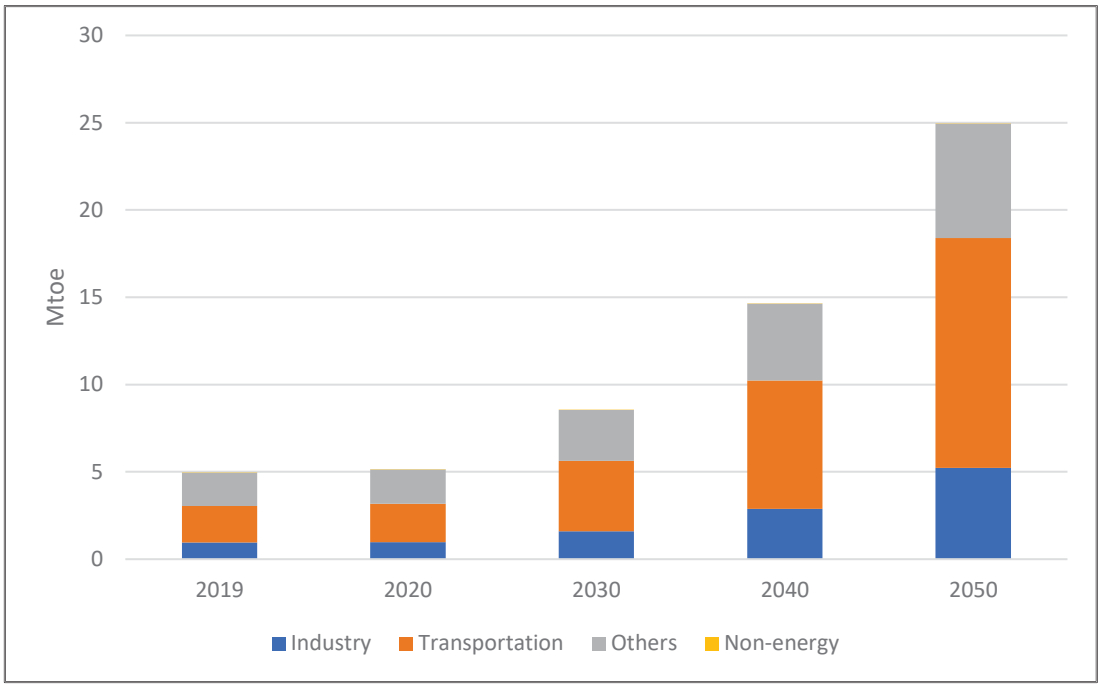
The fastest growth is expected in natural gas, increasing at 16.6% yearly, from 0.24 Mtoe in 2027 to 8.17 Mtoe in 2050. This is followed by solar and wind, growing at an average rate of 12.5% per year between 2019 and 2050, and coal and oil at 6.8% and 5.3% per year, respectively, in the same period.

Oil plays a major role in the country's primary energy mix, with a share reaching 43.4% in 2000. Although still dominant, the share of oil products in the primary energy mix will slightly decrease to almost 42% by 2050. Coal share in the 2050 energy mix will be around 25%, while natural gas will reach 22%. The remaining shares will be those of biomass (6%), hydropower (3.6%), renewable (0.8%), and electricity import (0.6%).

2.2. Final energy demand

Cambodia's final energy demand will grow at an average annual rate of 5.3% from 2019 to 2050. Final energy demand by sector increased from around 5 Mtoe in 2019 to almost 25 Mtoe in 2050, as earlier mentioned (Figure 5.2).

Figure 5.2. Final Energy Demand by Sector

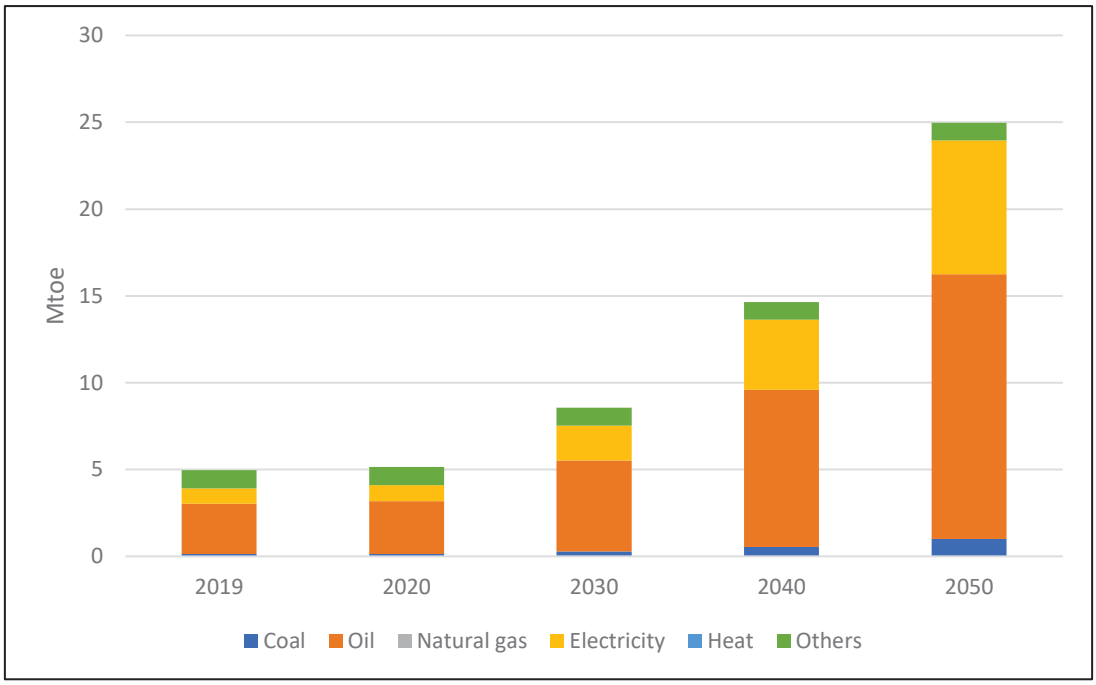


Source: Authors' calculation.

The strongest growth in demand is projected to occur in the industry sector, which will increase at an annual average rate of 6.2% over 2019–2050, or 5.9 times from 0.72 Mtoe in 2019 to 5.04 Mtoe in 2050. In addition, the transport sector is projected to grow at an annual rate of 5.6% or 4.78 times from 1.75 Mtoe in 2019 to 10.12 Mtoe in 2050. This is followed by the other sector at 4.4%, from 1.81 Mtoe in 2019 to 7.15 Mtoe in 2050, respectively (Figure 5.2).

Coal is projected to exhibit the fastest growth in final energy demand, growing at 10.3% per year or 22.06 times from 0.08 Mtoe in 2019 to 1.74 Mtoe in 2050. Electricity is projected to have the second-highest growth rate of 7.6% per year. or 9.35 times from 0.74 Mtoe in 2019 to 7.7 Mtoe in 2050. Oil is projected to have the third-highest growth rate of 5.1% per year. or 3.97 times from 2.38 Mtoe in 2019 to 11.86 Mtoe in 2050. Oil and electricity demand share in 2050 will be significantly large, so the energy saving from both fuels is crucial (Figure 5.3).

Figure 5.3. Final Energy Demand by Fuel



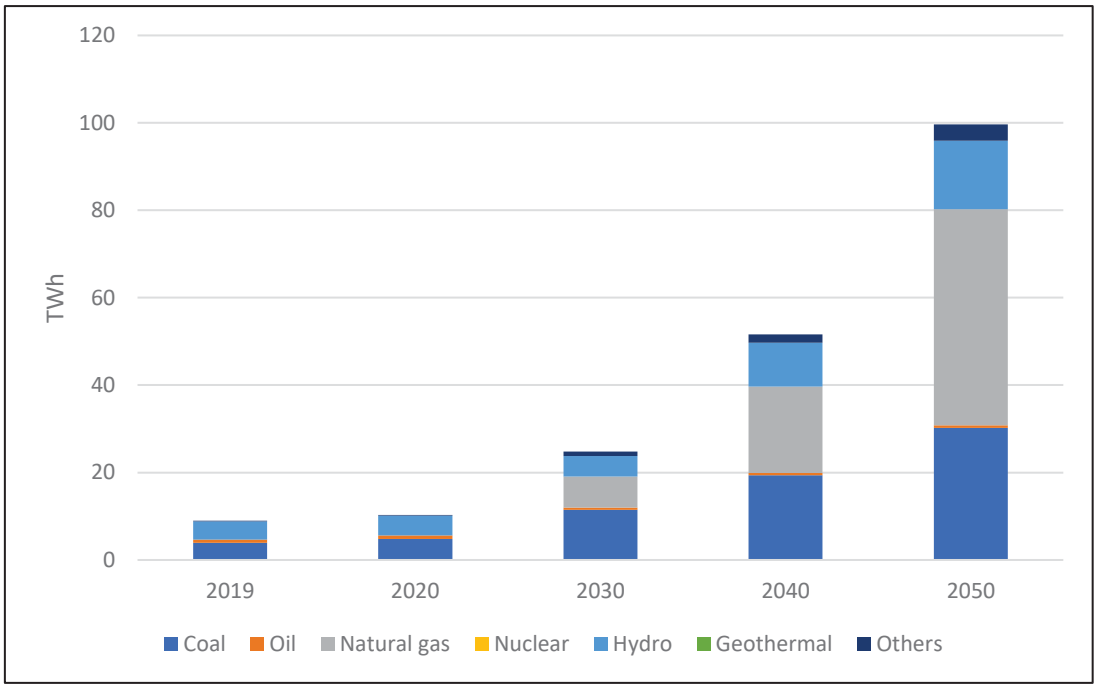
Source: Authors' calculation.

2.3. Electricity generation

Electricity generation will grow by 8.1% per year from 9 TWh in 2019 to almost 100 TWh in 2050 due to the rapid rise in electricity demand. From 2030 to 2050, electricity generation in Cambodia will come from three main sources. These are the LNG power plants having an increasing share from 28% to 50%; coal-fired power plants, from 46% dropping to 30%; and hydro, from 19% dropping to 16%.

Other power generation sources (such as biomass, solar, and wind) will have only a 4% share in 2050. These other sources will experience the fastest growth at 10.2% yearly over 2019–2050. Natural gas power generation will increase at an average annual rate of 16.6% in 2027–2050, while coal-fired and hydropower generation will increase by 6.8% and 4.4%, respectively, in 2019–2050 (Figure 5.4). Due to high fuel costs, generation from oil-fired power plants will decrease by -0.8%.

Figure 5.4. Power Generation by Fuel



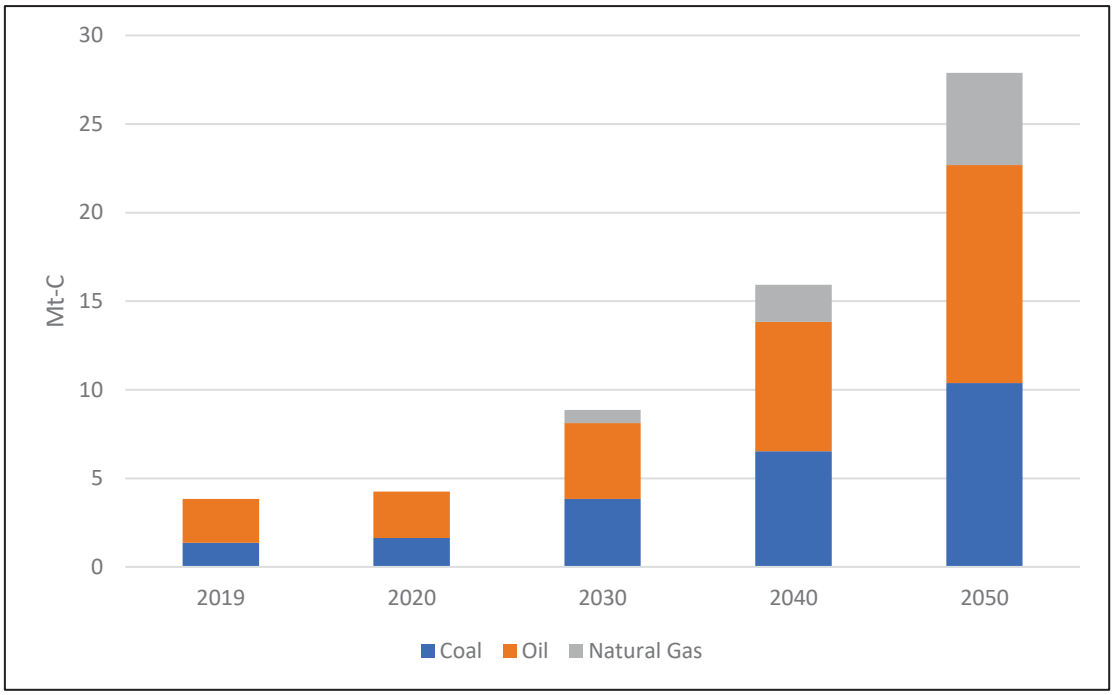
Source: Authors' calculation.

2.4. CO_2 emissions

CO_2 emissions from energy consumption are projected to increase by 6.6% per year from around 4 Mt-C in 2019 to 28 Mt-C in 2050 under BAU. Oil is the largest source of carbon emissions, which will increase faster at an average rate of 5.3% per year from 2.5 Mt-C in 2019 to 12.3 Mt-C in 2050. The second source of carbon emissions will be coal, with an average rate of 6.8% per year from 1.4 Mt-C in 2019 to 10.4 Mt-C in 2050 (Figure 5.5).

The third source of carbon emissions will be natural gas, with the fastest average rate of 10% per year, from 0.7 Mt-C in 2027 to 5.2 Mt-C in 2050. Natural gas shows the highest carbon emission rate; however, the carbon emission amount will be less than half of oil and coal in 2050.

Figure 5.5. CO_2 Emissions from Energy Consumption



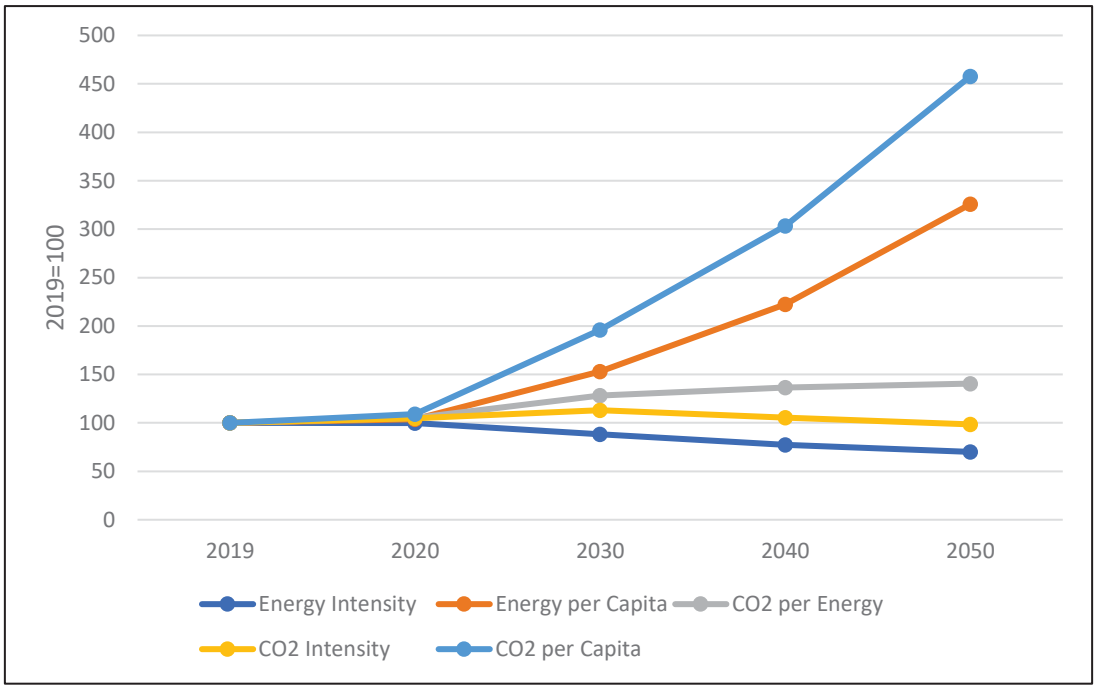
Source: Authors' calculation.

2.5. Energy indicators

Primary energy intensity was 343 toe/million US$ in 2019 and will decrease to 240 toe/million US$ in 2050. This indicates that energy will be used more efficiently in economic development as the country implements natural energy efficiency and conservation programmes. Another reason is biomass because its lower growth rate will press the TPES downward compared to the GDP.

Primary energy per capita will increase from 0.4 toe/person in 2019 to 1.4 toe/person in 2050, indicating that improving people's living standards and shifting to an integrated industry structure will increase energy demand per capita. Figure 5.6 shows various indicators for energy consumption and CO_2 emission.

Figure 5.6. Energy and CO_2 Indicators



Source: Authors' calculation.

On CO_2 emission, the CO_2 per primary energy is projected to increase from 0.5 metric tonnes of carbon per tonne (t-C/toe) in 2019 to 0.8 t-C/toe in 2050, implying faster growth of fossil fuels in the total energy consumption. On the other hand, the CO_2 intensity will slightly decline from 184 t-C/million US$ in 2019 to 181 t-C/million US$ in 2050. This will change the power generation mix in 2019–2050 due to the rapid increase of gas power generation after 2027.

Chapter 6

Conclusion and Recommendations

1. Conclusion

This project produced the EBTs of 2000–2009 based on existing primary energy data to expand the historical coverage of Cambodia's national energy statistics, which contains the EBTs of 2010–2018. But the existing data are historically incomplete. Therefore, the missing data must be estimated by applying extrapolation, referring to correlation with macroeconomic data such as GDP or historical trends.

For biomass consumption in the final sectors, such as industrial and residential, the missing data before 2006 are extrapolated based on the correlation between GDP and biomass or historical trends from post-2006. The firewood consumption for charcoal production is estimated using the charcoal consumption in the final sector estimated above and the conversion ratio defined as charcoal production/firewood consumption in 2007. The firewood consumption for power generation is estimated by biomass power generation data from the Electricité Du Cambodge; its thermal efficiency is calculated by 2007 data. The missing electricity consumption in the final sectors before 2002 is extrapolated based on a correlation between GDP and electricity consumption or historical trends post-2002. Based on the estimated electricity consumption and estimated T&D losses applying its historical trend from post-2002 data, missing electricity generation of hydro- and diesel power is estimated using their shares in 2003. For the fuel input of oil consisting of HFO and diesel oil, their historical data are inconsistent. So, we estimated the fuel input data before 2009 based on power generation data and estimated thermal efficiency referring to post-2010. For oil, as the GDP provided historical petroleum import data from 2000 to 2019, the import data of each petroleum product are distinguished to each final sector, which is industry, transport, commercial, residential, and others, using the historical shares. In addition, the 2019 primary energy data are added to the historical energy data in 2000–2018, which include several estimated data. The energy data in 2000–2019 were revised, if inconsistent. Finally, based on the complete primary energy data, the 2000–2019 EBTs were produced using interface software applying the Excel-VBA.

As a result, the TFEC increased from 1.32 Mtoe in 2000 to 4.97 Mtoe in 2019 at a 7.2% yearly growth rate compared to a 7.9% TFEC growth rate in 2010–2019. So, the longer energy trend in 2000–2019 looks moderate compared to the shorter trend in 2010–2019. The TPES also showed the same trend as the growth rate in 2000–2019, 6.9%. On the other hand, 2010–2019 TPES was 8.0%.

Using the longer historical energy data set, Cambodia's BAU energy outlook model has been updated based on the latest future macroeconomic assumptions. But the outlook results are

different from the previous results. The TPES growth rate in 2019–2050 is 5.4% per year compared to the previous one at 5.6% in 2018–2050 despite different GDP assumptions of 6.7% in the revised case and 6.4% in the previous one. Data coverage is extended from 9 to 19 years so that elasticity between GDP and energy consumption improves from 0.875 of the previous outlook results to 0.8 of this outlook results due to the longer estimation period (9 to 19 years).

2. Policy Recommendations

Through this project, Cambodia's National Energy Statistics, which includes national EBTs, are successfully extended from 2010–2018 to 2000–2019. It can contribute to formulating appropriate energy policies on promoting energy efficiency and conservation and variable renewable energy, such as solar photovoltaic systems, enhancement of petroleum supply security, and challenges of a low-carbon energy transition. Thus, the national EBTs should be updated annually by MME's GDE and GDP based on primary energy data from Cambodia's energy market players. Once the GDE and GDP get primary energy data, they can update the statistics using the primary energy data template and the interface software to produce the EBTs, provided by ERIA.

Diesel oil and LPG are widely consumed across the country's sectors – industry, transport, residential, and commercial. Thus, a detailed diesel oil and LPG energy consumption survey is necessary. Diesel oil is consumed in the industry, transport, commercial, and agriculture sectors. Its uses are heating boilers for thermal demand, auto-generation, and transport fuel of vehicles. On the other hand, LPG is used for cooking and as a transport fuel for vehicles. Therefore, the survey can achieve an appropriate breakdown of diesel oil and LPG across the sectors.

Next, the issues and challenges of each energy source are pointed out as follows. Coal in Cambodia is consumed for industrial activities, such as cement production and power generation. Domestic coal is mainly consumed for industry activities; on the other hand, coal for power generation is mainly imported. Therefore, a data collection system authorised by laws and regulations will be applied to coal mining companies and coal traders by the GDE. Petroleum import data come from Cambodia's Customs Office, so it should be accurate except for smuggling. But the demand side is still issued because there are no petroleum consumption data in the final energy consumption sectors. Thus, the GDP will start collecting petroleum sales data for each final sector from oil companies in Cambodia. Electricity data are robust because the Electricité du Cambodge (EDC) prepares the following data: power generation, fuel inputs, and electricity sales data to end users. However, the thermal efficiency of coal power generation seems inconsistent, so the EDC is suggested to collect more quality fuel input data to be consistent with the power generation data. Biomass will continue to be phased out from the Cambodian energy market. Although biomass will be unimportant, its share was still more than 20% in 2019. Thus, the GDE is suggested to conduct a biomass consumption survey across the sectors every 3 or 5 years.

Establishing appropriate energy policies depends entirely on high-quality energy statistics with a long historical coverage, and producing a meaningful energy outlook also needs reliable energy statistics. Therefore, ERIA would like to continue to support the GDE and GDP-MME to prepare quality national energy statistics.

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Annex A. Cambodia Energy Balance Tables 2000–2019

Annex A-1. Cambodia Energy Balance Table 2000

Unit: ktoe

		1.	3.	4.									6.	9.	10.	12.
					4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
		Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production												3	1,279		1,282
2.	Imports			682	125		17	31	392	96	16	3			4	685
3.	Exports															
4.	International Marine Bunkers															
13.1	International Aviation Bunkers			-12			-12									-12
5.	Stock Changes															
6.	Total Primary Energy Supply			670	125		5	31	392	96	16	3	3	1,279	4	1,955
7.	Transfers															
8.	Total Transformation Sector			-126					-72	-54			-3	-537	42	-623
	8.1 Main Activity Producer			-126					-72	-54			-3		42	-86
	8.8 Charcoal Processing													-537		-537
9.	Loss & Own Use														-7	-7
10.	Discrepancy			0			0		0	0	0				0	0
11.	Total Final Energy Consumption			544	125		5	31	321	42	16	3		742	39	1,324
12.	Industry Sector			69					32	37				164	2	236
13.	Transport Sector			415	125		5		281			3				415
	13.2 Domestic Air Transport			5			5									5
	13.3 Road			409	125				281			3				409
14.	Other Sector			60				31	8	5	16			578	36	674
	14.1 Residential & Commercial			47				31			16			578	36	661
	14.1.1 Commerce and Public Services			14							14				16	30
	14.1.2 Residential			33				31			2			578	20	631
	14.2 Agriculture			0					0							0
	14.4 Non-specified Others			13					8	5					0	13
15.	of which Non-energy Use															
16	Electricity Output in GWh	0		461									31	0		492

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid, MTBE = methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-2. Cambodia Energy Balance Table 2001

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													3	1,308		1,311
2.	Imports				760	126		17	30	471	93	20	3			4	764
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-12			-12									-12
5.	Stock Changes																
6.	Total Primary Energy Supply				748	126		5	30	471	93	20	3	3	1,308	4	2,063
7.	Transfers																
8.	Total Transformation Sector				-138					-79	-59			-3	-549	46	-644
	8.1	Main Activity Producer			-138					-79	-59			-3		46	-94
	8.8	Charcoal Processing													-549		-549
9.	Loss & Own Use															-8	-8
10.	Discrepancy				0			0							0	0	0
11.	Total Final Energy Consumption				610	126		5	30	393	34	20	3		759	42	1,411
12.	Industry Sector				69					39	30				169	3	241
13.	Transport Sector				478	126		5		344			3				478
	13.2	Domestic Air Transport			5			5									5
	13.3	Road			473	126				344			3				473
14.	Other Sector				63				30	10	4	20			590	39	692
	14.1	Residential & Commercial			50				30			20			590	39	678
		14.1.1 Commerce and Public Services			17							17				18	35
		14.1.2 Residential			32				30			2			590	22	644
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			13					9	4					0	13
15.	of which Non-Energy Use																
16	Electricity Output in GWh		0		504									34	0		538

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-3. Cambodia Energy Balance Table 2002

Unit: ktoe

		1.	3.	4.									6.	9.	10.	12.
					4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
		Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production												3	1,335		1,338
2.	Imports			736	122		17	53	394	123	21	5			4	740
3.	Exports															
4.	International Marine Bunkers															
13.1	International Aviation Bunkers			-12			-12									-12
5.	Stock Changes															
6.	Total Primary Energy Supply			724	122		5	53	394	123	21	5	3	1,335	4	2,067
7.	Transfers															
8.	Total Transformation Sector			-150					-86	-64			-3	-561	50	-663
	8.1 Main Activity Producer			-150					-86	-64			-3		50	-103
	8.8 Charcoal Processing													-561		-561
9.	Loss & Own Use														-9	-9
10.	Discrepancy			0			0			0	0			0	0	0
11.	Total Final Energy Consumption			574	122		5	53	308	59	21	5		775	46	1,395
12.	Industry Sector			83					31	52				174	4	261
13.	Transport Sector			402	122		5		270			5				402
	13.2 Domestic Air Transport			5			5									5
	13.3 Road			397	122				270			5				397
14.	Other Sector			89				53	8	7	21			601	42	732
	14.1 Residential & Commercial			75				53			21			601	42	718
	14.1.1 Commerce and Public Services			19							19				19	38
	14.1.2 Residential			56				53			2			601	23	680
	14.2 Agriculture			0					0							0
	14.4 Non-specified Others			14					7	7					0	14
15.	of which Non-energy Use															
16	Electricity Output in GWh	0		549									37	0		586

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

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Annex A-4. Cambodia Energy Balance Table 2003

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													3	1,373		1,376
2.	Imports				770	108		17	89	405	119	26	5			5	775
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-12			-12									-12
5.	Stock Changes																
6.	Total Primary Energy Supply				759	108		5	89	405	119	26	5	3	1,373	5	2,140
7.	Transfers																
8.	Total Transformation Sector				-168					-96	-72			-3	-576	56	-691
	8.1	Main Activity Producer			-168					-96	-72			-3		56	-115
	8.8	Charcoal Processing													-576		-576
9.	Loss & Own Use															-10	-10
10.	Discrepancy				0			0							0	0	0
11.	Total Final Energy Consumption				591	108		5	89	309	47	26	5		797	52	1,439
12.	Industry Sector				73					31	42				181	7	260
13.	Transport Sector				390	108		5		271			5				390
	13.2	Domestic Air Transport			5			5									5
	13.3	Road			385	108				271			5				385
14.	Other Sector				128				89	8	6	26			616	45	789
	14.1	Residential & Commercial			115				89			26			616	45	776
		14.1.1 Commerce and Public Services			23							23				20	43
		14.1.2 Residential			92				89			3			616	25	733
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			13					7	6					0	13
15.	of which Non-energy Use																
16	Electricity Output in GWh		0		614									42	0		656

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-5. Cambodia Energy Balance Table 2004

Unit: ktoe

			1	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													2	1,423		1,425
2.	Imports				768	101		20	51	414	143	32	6			5	773
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-14			-14									-14
5.	Stock Changes																
6.	Total Primary Energy Supply				754	101		6	51	414	143	32	6	2	1,423	5	2,184
7.	Transfers																
8.	Total Transformation Sector				-201					-109	-92			-2	-597	66	-735
	8.1	Main Activity Producer			-201					-109	-92			-2		66	-138
	8.8	Charcoal Processing													-597		-597
9.	Loss & Own Use															-11	-11
10.	Discrepancy				0			0			0	0				0	0
11.	Total Final Energy Consumption				553	101		6	51	305	52	32	6		826	60	1,439
12.	Industry Sector				76					31	46				190	9	275
13.	Transport Sector				380	101		6		267			6				380
	13.2	Domestic Air Transport			6			6									6
	13.3	Road			374	101				267			6				374
14.	Other Sector				97				51	7	6	32			636	51	784
	14.1	Residential & Commercial			83				51			32			636	51	770
		14.1.1 Commerce and Public Services			29							29				23	52
		14.1.2 Residential			54				51			4			636	28	718
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			13					7	6					0	13
15.	of which Non-energy Use																
16	Electricity Output in GWh		0		736									29	0		766

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-6. Cambodia Energy Balance Table 2005

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													4	1,493		1,497
2.	Imports				760	135		20	32	351	181	33	7			7	767
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-14			-14									-14
5.	Stock Changes																
6.	Total Primary Energy Supply				746	135		6	32	351	181	33	7	4	1,493	7	2,249
7.	Transfers																
8.	Total Transformation Sector				-235					-136	-99			-4	-626	78	-787
	8.1	Main Activity Producer			-235					-136	-99			-4	0	78	-161
	8.8	Charcoal Processing													-626		-626
9.	Loss & Own Use															-11	-11
10.	Discrepancy				0			0		0	0	0				0	0
11.	Total Final Energy Consumption				511	135		6	32	214	83	33	7		867	74	1,451
12.	Industry Sector				94					21	73				202	12	309
13.	Transport Sector				336	135		6		188			7				336
	13.2	Domestic Air Transport			6			6									6
	13.3	Road			330	135				188			7				330
14.	Other Sector				80				32	5	10	33			664	61	806
	14.1	Residential & Commercial			65				32			33			664	61	791
		14.1.1 Commerce and Public Services			29							29				30	59
		14.1.2 Residential			36				32			4			664	31	732
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			15					5	10					0	15
15.	of which Non-energy Use																
16	Electricity Output in GWh		0		861									45	0		906

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-7. Cambodia Energy Balance Table 2006

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													4	1,558		1,562
2.	Imports				976	166		27	26	455	251	45	7			9	986
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-19			-19									-19
5.	Stock Changes																
6.	Total Primary Energy Supply				958	166		8	26	455	251	45	7	4	1,558	9	2,529
7.	Transfers																
8.	Total Transformation Sector				-291					-175	-116			-4	-653	96	-853
	8.1	Main Activity Producer			-291					-175	-116			-4	-1	96	-200
	8.8	Charcoal Processing													-653		-653
9.	Loss & Own Use															-15	-15
10.	Discrepancy				0							0			0	0	0
11.	Total Final Energy Consumption				667	166		8	26	280	134	45	7		904	91	1,662
12.	Industry Sector				146					28	118				214	19	379
13.	Transport Sector				441	166		8		246		15	7				441
	13.2	Domestic Air Transport			8			8									8
	13.3	Road			433	166				246		15	7				433
14.	Other Sector				79				26	7	16	31			690	72	842
	14.1	Residential & Commercial			56				26			31			690	72	819
		14.1.1 Commerce and Public Services			27							27				39	66
		14.1.2 Residential			29				26			4			690	33	753
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			23					7	16					0	23
15.	of which Non-energy Use																
16	Electricity Output in GWh		0		1,066									52	2		1,120

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-8. Cambodia Energy Balance Table 2007

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													4	1,582		1,586
2.	Imports				1,194	249		49	35	498	296	56	11			14	1,208
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-34			-34									-34
5.	Stock Changes																
6.	Total Primary Energy Supply				1,160	249		15	35	498	296	56	11	4	1,582	14	2,760
7.	Transfers																
8.	Total Transformation Sector				-364					-218	-146			-4	-664	120	-913
	8.1	Main Activity Producer			-364					-218	-146			-4	-2	120	-251
	8.8	Charcoal Processing													-662		-662
9.	Loss & Own Use															-18	-18
10.	Discrepancy				0			0			0						0
11.	Total Final Energy Consumption				796	249		15	35	280	151	56	11		918	116	1,830
12.	Industry Sector				161					28	133				224	29	414
13.	Transport Sector				538	249		15		245		18	11				538
	13.2	Domestic Air Transport			15			15									15
	13.3	Road			523	249				245		18	11				523
14.	Other Sector				97				35	7	18	38			694	87	878
	14.1	Residential & Commercial			72				35			38			694	87	853
		14.1.1 Commerce and Public Services			33							33				47	81
		14.1.2 Residential			39				35			4			694	39	772
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			24					7	18					0	25
15.	of which Non-energy Use																
16	Electricity Output in GWh		0		1,333									51	5		1,390

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-9. Cambodia Energy Balance Table 2008

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production													4	1,651		1,655
2.	Imports		14		1,220	306		44	33	461	312	51	12			32	1,266
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-31			-31									-31
5.	Stock Changes																
6.	Total Primary Energy Supply		14		1,190	306		14	33	461	312	51	12	4	1,651	32	2,891
7.	Transfers																
8.	Total Transformation Sector		-14		-397					-238	-159			-4	-693	131	-975
	8.1	Main Activity Producer	-14		-397					-238	-159			-4	-2	131	-284
	8.8	Charcoal Processing													-691		-691
9.	Loss & Own Use															-21	-21
10.	Discrepancy															0	0
11.	Total Final Energy Consumption				793	306		14	33	223	154	51	12		959	143	1,895
12.	Industry Sector				158					22	136				234	34	425
13.	Transport Sector				544	306		14		196		16	12				544
	13.2	Domestic Air Transport			14			14									14
	13.3	Road			531	306				196		16	12				531
14.	Other Sector				91				33	5	18	35			725	110	925
	14.1	Residential & Commercial			67				33			35			725	109	901
		14.1.1 Commerce and Public Services			31							31				60	90
		14.1.2 Residential			37				33			4			725	49	811
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			23					5	18					0	24
15.	of which Non-energy Use																
16	Electricity Output in GWh		25		1,452									48	5		1,529

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-10. Cambodia Energy Balance Table 2009

Unit: ktoe

		1.	3.	4.									6.	9.	10.	12.
					4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
		Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production												4	1,697		1,701
2.	Imports	17		1,434	327		35	31	685	272	67	17			72	1,523
3.	Exports															
4.	International Marine Bunkers															
13.1	International Aviation Bunkers			-24			-24									-24
5.	Stock Changes															
6.	Total Primary Energy Supply	17		1,410	327		11	31	685	272	67	17	4	1,697	72	3,200
7.	Transfers															
8.	Total Transformation Sector	-17		-324					-194	-130			-4	-712	109	-948
	8.1 Main Activity Producer	-17		-324					-194	-130			-4	-2	109	-238
	8.8 Charcoal Processing													-710		-710
9.	Loss & Own Use														-22	-22
10.	Discrepancy			0			0		0	0				0		0
11.	Total Final Energy Consumption			1,086	327		11	31	490	142	67	17		985	159	2,230
12.	Industry Sector			175					49	126				240	33	448
13.	Transport Sector			806	327		11		429		22	17				806
	13.2 Domestic Air Transport			11			11									11
	13.3 Road			795	327				429		22	17				795
14.	Other Sector			105				31	12	17	46			745	126	976
	14.1 Residential & Commercial			76				31			46			745	126	947
	14.1.1 Commerce and Public Services			40							40				67	107
	14.1.2 Residential			36				31			5			745	59	839
	14.2 Agriculture			0					0							0
	14.4 Non-specified Others			29					12	17					0	29
15.	of which Non-energy Use															
16	Electricity Output in GWh	29		1,187									49	6		1,272

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-11. Cambodia Energy Balance Table 2010

Unit: ktoe

			1. Coal	3. Crude Oil & NGL	4. Petroleum Products	4.1 Motor Gasoline	4.2 Naphtha	4.3 Jet Fuel	4.4 Kerosene	4.5 Gas/Diesel Oil	4.6 Fuel Oil	4.7 LPG	4.10 Other Petroleum Products	6. Hydro	9. Others	10. Electricity	12. Total
1.	Indigenous Production													3	1,720		1,723
2.	Imports		24		1,590	401		47	32	771	246	77	16			132	1,747
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-32			-32									-32
5.	Stock Changes																
6.	Total Primary Energy Supply		24		1,557	401		14	32	771	246	77	16	3	1,720	132	3,438
7.	Transfers																
8.	Total Transformation Sector		-19		-253					-152	-101			-3	-722	86	-910
	8.1	Main Activity Producer	-19		-253					-152	-101			-3	-2	86	-191
	8.8	Charcoal Processing													-719		-719
9.	Loss & Own Use															-24	-24
10.	Discrepancy				0						0	0			0	0	0
11.	Total Final Energy Consumption		6		1,305	401		14	32	619	145	77	16		999	194	2,503
12.	Industry Sector		6		199					62	137				244	42	490
13.	Transport Sector				999	401		14		543		25	16				999
	13.2	Domestic Air Transport			14			14									14
	13.3	Road			984	401				543		25	16				984
14.	Other Sector				107				32	15	7	52			755	152	1,014
	14.1	Residential & Commercial			84				32			52			755	152	991
		14.1.1 Commerce and Public Services			46							46				77	123
		14.1.2 Residential			38				32			6			755	75	869
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			22					15	7					0	23
15.	of which Non-energy Use																
16	Electricity Output in GWh		34		926									33	6		998

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-12. Cambodia Energy Balance Table 2011

Unit: ktoe

			1. Coal	3. Crude Oil & NGL	4. Petroleum Products	4.1 Motor Gasoline	4.2 Naphtha	4.3 Jet Fuel	4.4 Kerosene	4.5 Gas / Diesel Oil	4.6 Fuel Oil	4.7 LPG	4.10 Other Petroleum Products	6. Hydro	9. Others	10. Electricity	12. Total
1.	Indigenous Production													4	1,798		1,803
2.	Imports		28		1,640	416		55	13	824	230	85	17			157	1,825
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-38			-38									-38
5.	Stock Changes																
6.	Total Primary Energy Supply		28		1,602	416		17	13	824	230	85	17	4	1,798	157	3,590
7.	Transfers																
8.	Total Transformation Sector		-22		-256					-153	-102			-4	-755	90	-947
	8.1	Main Activity Producer	-22		-256					-153	-102			-4	-4	90	-196
	8.8	Charcoal Processing													-751		-751
9.	Loss & Own Use															-26	-26
10.	Discrepancy		0		0							0			0	0	0
11.	Total Final Energy Consumption		6		1,346	416		17	13	671	128	85	17		1,043	221	2,617
12.	Industry Sector		6		204					82	121				254	54	518
13.	Transport Sector				1,057	416		17		580		27	17				1,057
	13.2	Domestic Air Transport			17			17									17
	13.3	Road			1,040	416				580		27	17				1,040
14.	Other Sector				86				13	9	7	57			789	167	1,042
	14.1	Residential & Commercial			70				13			57			789	167	1,026
		14.1.1 Commerce and Public Services			51							51				93	144
		14.1.2 Residential			19				13			7			789	73	882
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			15					8	7					1	16
15.	of which Non-energy Use																
16	Electricity Output in GWh		49		936									53	12		1,050

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-13. Cambodia Energy Balance Table 2012

Unit: ktoe

			1. Coal	3. Crude Oil & NGL	4. Petroleum Products	4.1 Motor Gasoline	4.2 Naphtha	4.3 Jet Fuel	4.4 Kerosene	4.5 Gas / Diesel Oil	4.6 Fuel Oil	4.7 LPG	4.10 Other Petroleum Products	6. Hydro	9. Others	10. Electricity	12. Total
1.	Indigenous Production													44	1,871		1,916
2.	Imports		39		1,721	405		69	7	908	215	100	17			181	1,941
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-48			-48									-48
5.	Stock Changes																
6.	Total Primary Energy Supply		39		1,673	405		21	7	908	215	100	17	44	1,871	181	3,809
7.	Transfers																
8.	Total Transformation Sector		-31		-241					-145	-96			-44	-786	126	-977
	8.1	Main Activity Producer	-31		-241					-145	-96			-44	-4	126	-195
	8.8	Charcoal Processing													-782		-782
9.	Loss & Own Use															-26	-26
10.	Discrepancy		0		0			0		0	0	0			0		0
11.	Total Final Energy Consumption		7		1,432	405		21	7	763	119	100	17		1,085	281	2,806
12.	Industry Sector		7		203					91	112				265	77	552
13.	Transport Sector				1,114	405		21		638		32	17				1,114
	13.2	Domestic Air Transport			21			21									21
	13.3	Road			1,093	405				638		32	17				1,093
14.	Other Sector				115				7	34	7	68			821	203	1,139
	14.1	Residential & Commercial			74				7			68			821	203	1,098
		14.1.1 Commerce and Public Services			60							60				110	170
		14.1.2 Residential			14				7			8			821	93	928
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			41					34	7					1	42
15.	of which Non-energy Use																
16	Electricity Output in GWh		39		882									533	12		1,466

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-14. Cambodia Energy Balance Table 2013

Unit: ktoe

			1. Coal	3. Crude Oil & NGL	4. Petroleum Products	4.1 Motor Gasoline	4.2 Naphtha	4.3 Jet Fuel	4.4 Kerosene	4.5 Gas/ Diesel Oil	4.6 Fuel Oil	4.7 LPG	4.10 Other Petroleum Products	6. Hydro	9. Others	10. Electricity	12. Total
1.	Indigenous Production													87	1,948		2,035
2.	Imports		57		1,723	409		80	3	929	167	116	18			196	1,976
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-55			-55									-55
5.	Stock Changes																
6.	Total Primary Energy Supply		57		1,668	409		24	3	929	167	116	18	87	1,948	196	3,956
7.	Transfers																
8.	Total Transformation Sector		-50		-163					-98	-65			-87	-818	157	-960
	8.1	Main Activity Producer	-50		-163					-98	-65			-87	-2	157	-145
	8.8	Charcoal Processing													-815		-815
9.	Loss & Own Use															-48	-48
10.	Discrepancy				0			0		0	0	0			0		0
11.	Total Final Energy Consumption		7		1,505	409		24	3	831	102	116	18		1,131	306	2,948
12.	Industry Sector		7		190					93	97				276	71	544
13.	Transport Sector				1,142	409		24		652		38	18				1,142
	13.2	Domestic Air Transport			24			24									24
	13.3	Road			1,117	409				652		38	18				1,117
14.	Other Sector				173				3	86	5	79			855	235	1,263
	14.1	Residential & Commercial			82				3			79			855	234	1,171
		14.1.1 Commerce and Public Services			70							70				132	202
		14.1.2 Residential			12				3			9			855	102	969
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			91					86	5					1	92
15.	of which Non-energy Use																
16	Electricity Output in GWh		177		596									1,046	7		1,826

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-15. Cambodia Energy Balance Table 2014

Unit: ktoe

			1. Coal	3. Crude Oil & NGL	4. Petroleum Products	4.1 Motor Gasoline	4.2 Naphtha	4.3 Jet Fuel	4.4 Kerosene	4.5 Gas/ Diesel Oil	4.6 Fuel Oil	4.7 LPG	4.10 Other Petroleum Products	6. Hydro	9. Others	10. Electricity	12. Total
1.	Indigenous Production													159	2,043		2,202
2.	Imports		315		1,788	446		92		1,017	90	132	11			155	2,259
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-64			-64									-64
5.	Stock Changes																
6.	Total Primary Energy Supply		315		1,725	446		28		1,017	90	132	11	159	2,043	155	4,397
7.	Transfers																
8.	Total Transformation Sector		-305		-92					-55	-37			-159	-859	272	-1,143
	8.1	Main Activity Producer	-305		-92					-55	-37			-159	-6	272	-290
	8.8	Charcoal Processing													-853		-853
9.	Loss & Own Use															-81	-81
10.	Discrepancy		0		0			0		0						0	0
11.	Total Final Energy Consumption		10		1,633	446		28		962	53	132	11		1,183	347	3,173
12.	Industry Sector		10		152					102	50				289	91	542
13.	Transport Sector				1,241	446		28		713		43	11				1,241
	13.2	Domestic Air Transport			28			28									28
	13.3	Road			1,213	446				713		43	11				1,213
14.	Other Sector				240					147	3	90			895	256	1,390
	14.1	Residential & Commercial			90							90			895	255	1,240
		14.1.1 Commerce and Public Services			79							79				141	221
		14.1.2 Residential			10							10			895	114	1,019
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			150					147	3					1	150
15.	of which Non-energy Use																
16	Electricity Output in GWh		906		337									1,907	17		3,167

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-16. Cambodia Energy Balance Table 2015

Unit: ktoe

		1. Coal	3. Crude Oil & NGL	4. Petroleum Products	4.1 Motor Gasoline	4.2 Naphtha	4.3 Jet Fuel	4.4 Kerosene	4.5 Gas/ Diesel Oil	4.6 Fuel Oil	4.7 LPG	4.10 Other Petroleum Products	6. Hydro	9. Others	10. Electricity	12. Total
1.	Indigenous Production												186	2,101		2,287
2.	Imports	558		1,960	530		97		1,086	36	192	20			131	2,648
3.	Exports															
4.	International Marine Bunkers															
13.1	International Aviation Bunkers			-67			-67									-67
5.	Stock Changes															
6.	Total Primary Energy Supply	558		1,892	530		30		1,086	36	192	20	186	2,101	131	4,868
7.	Transfers															
8.	Total Transformation Sector	-543		-46					-28	-18			-186	-881	401	-1,254
	8.1 Main Activity Producer	-543		-46					-28	-18			-186	-15	401	-388
	8.8 Charcoal Processing													-866		-866
9.	Loss & Own Use														-85	-85
10.	Discrepancy	0		0			0				0			0	0	0
11.	Total Final Energy Consumption	14		1,846	530		30		1,058	17	192	20		1,221	448	3,529
12.	Industry Sector	14		124					109	16				312	98	549
13.	Transport Sector			1,410	530		30		769		62	20				1,410
	13.2 Domestic Air Transport			30			30									30
	13.3 Road			1,380	530				769		62	20				1,380
14.	Other Sector			312					181	2	130			909	350	1,570
	14.1 Residential & Commercial			130							130			909	349	1,387
	14.1.1 Commerce and Public Services			115							115				218	332
	14.1.2 Residential			15							15			909	131	1,055
	14.2 Agriculture			0					0							0
	14.4 Non-specified Others			182					180	2					1	183
15.	of which Non-energy Use															
16	Electricity Output in GWh	2,234		169									2,224	38		4,665

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE- methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-17. Cambodia Energy Balance Table 2016

Unit: ktoe

		1.	3.	4.									6.	9.	10.	12.
					4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
		Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production												221	2,081		2,302
2.	Imports	774		2,289	536		106		1,255	140	228	24			133	3,196
3.	Exports															
4.	International Marine Bunkers															
13.1	International Aviation Bunkers			-74			-74									-74
5.	Stock Changes															
6.	Total Primary Energy Supply	774		2,216	536		33		1,255	140	228	24	221	2,081	133	5,425
7.	Transfers															
8.	Total Transformation Sector	-755		-135					-81	-54			-221	-882	490	-1,503
	8.1 Main Activity Producer	-755		-135					-81	-54			-221	-14	490	-635
	8.8 Charcoal Processing													-868		-868
9.	Loss & Own Use														-87	-87
10.	Discrepancy	0		0						0	0			0	0	0
11.	Total Final Energy Consumption	19		2,081	536		33		1,174	86	228	24		1,199	536	3,835
12.	Industry Sector	19		196					125	71				318	135	668
13.	Transport Sector			1,529	536		33		863		74	24				1,529
	13.2 Domestic Air Transport			33			33									33
	13.3 Road			1,497	536				863		74	24				1,497
14.	Other Sector			355					186	15	155			881	401	1,637
	14.1 Residential & Commercial			155							155			881	400	1,436
	14.1.1 Commerce and Public Services			137							137				228	365
	14.1.2 Residential			18							18			881	172	1,071
	14.2 Agriculture			0					0							0
	14.4 Non-specified Others			200					186	15					1	201
15.	of which Non-energy Use															
16	Electricity Output in GWh	2,514		493									2,645	42		5,694

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline included naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-18. Cambodia Energy Balance Table 2017

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production		20											233	2,028		2,281
2.	Imports		895		2,357	587		153		1,262	78	265	12			124	3,376
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-106			-106									-106
5.	Stock Changes																
6.	Total Primary Energy Supply		915		2,251	587		47		1,262	78	265	12	233	2,028	124	5,551
7.	Transfers																
8.	Total Transformation Sector		-837		-81					-49	-33			-233	-867	594	-1,425
	8.1	Main Activity Producer	-837		-81					-49	-33			-233	-13	594	-572
	8.8	Charcoal Processing													-854		-854
9.	Loss & Own Use															-112	-112
10.	Discrepancy		0		0			0		0	0	0			0	0	0
11.	Total Final Energy Consumptions		77		2,169	587		47		1,213	46	265	12		1,161	605	4,013
12.	Industry Sector		77		169					126	43				306	150	703
13.	Transport Sector				1,617	587		47		886		85	12				1,617
	13.2	Domestic Air Transport			47			47									47
	13.3	Road			1,570	587				886		85	12				1,570
14.	Other Sector				383					201	2	179			855	455	1,693
	14.1	Residential & Commercial			179							179			855	454	1,489
		14.1.1 Commerce and Public Services			159							159				267	425
		14.1.2 Residential			21							21			855	187	1,063
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			204					201	2					1	205
15.	of which Non-Energy Use																
16	Electricity Output in GWh		3,747		298									2,792	59		6,902

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-19. Cambodia Energy Balance Table 2018

Unit: ktoe

			1.	3.	4.									6.	9.	10.	12.
						4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
			Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production		12											407	1,927		2,347
2.	Imports		960		2,609	633		202		1,359	85	319	11			135	3,704
3.	Exports																
4.	International Marine Bunkers																
13.1	International Aviation Bunkers				-140			-140									-140
5.	Stock Changes																
6.	Total Primary Energy Supply		972		2,469	633		62		1,359	85	319	11	407	1,927	135	5,911
7.	Transfers																
8.	Total Transformation Sector		-896		-84					-51	-34			-407	-838	729	-1,498
	8.1	Main Activity Producer	-896		-84					-51	-34			-407	-12	729	-672
	8.8	Charcoal Processing													-826		-826
9.	Loss & Own Use															-120	-120
10.	Discrepancy		0					0			0				0	0	0
11.	Total Final Energy Consumption		76		2,385	633		62		1,308	51	319	11		1,089	744	4,293
12.	Industry Sector		76		185					136	49				272	197	729
13.	Transport Sector				1,762	633		62		952		103	11				1,762
	13.2	Domestic Air Transport			62			62									62
	13.3	Road			1,699	633				952		103	11				1,699
14.	Other Sector				438					220	2	216			817	547	1,802
	14.1	Residential & Commercial			216							216			817	545	1,578
		14.1.1 Commerce and Public Services			191							191				296	487
		14.1.2 Residential			25							25			817	249	1,091
	14.2	Agriculture			0					0							0
	14.4	Non-specified Others			222					220	2					2	223
15.	of which Non-energy Use																
16	Electricity Output in GWh		3,209		308									4,879	64		8,476

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

Annex A-20. Cambodia Energy Balance Table 2019

Unit: ktoe

		1.	3.	4.									6.	9.	10.	12.
					4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.10				
		Coal	Crude Oil & NGL	Petroleum Products	Motor Gasoline	Naphtha	Jet Fuel	Kerosene	Gas/ Diesel Oil	Fuel Oil	LPG	Other Petroleum Products	Hydro	Others	Electricity	Total
1.	Indigenous Production												346	1,902		2,256
2.	Imports	1,270		3,261	758		226		1,681	181	402	13			263	4,794
3.	Exports															
4.	International Marine Bunkers															
13.1	International Aviation Bunkers			-156			-156									-156
5.	Stock Changes															
6.	Total Primary Energy Supply	1,270		3,104	758		69		1,681	181	402	13	346	1,902	263	6,894
7.	Transfers															
8.	Total Transformation Sector	-1,133		-206					-123	-82			-346	-849	774	-1,768
	8.1 Main Activity Producer	-1,133		-206					-123	-82			-346	-33	774	-952
	8.8 Charcoal Processing													-816		-816
9.	Loss & Own Use														-159	-159
10.	Discrepancy			0			0			0				0		0
11.	Total Final Energy Consumption	137		2,899	758		69		1,557	99	402	13		1,053	879	4,967
12.	Industry Sector	137		257					162	95				263	291	948
13.	Transport Sector			2,103	758		69		1,133		130	13				2,103
	13.2 Domestic Air Transport			69			69									69
	13.3 Road			2,034	758				1,133		130	13				2,034
14.	Other Sector			538					262	3	272			790	588	1,916
	14.1 Residential & Commercial			272							272			790	585	1,648
	14.1.1 Commerce and Public Services			241							241				293	534
	14.1.2 Residential			31							31			790	292	1,114
	14.2 Agriculture			0					0							0
	14.4 Non-specified Others			265					262	3					2	268
15.	of which Non-energy Use															
16	Electricity Output in GWh	3,921		754									4,146	91		9,005

GWh = gigawatt-hour, ktoe = kilotonne of oil equivalent, LPG = liquid petroleum gas, NGL = natural gas liquid. MTBE = methyl tertiary-butyl ether
Gasoline includes naphtha and MTBE; Other petroleum products include lubricant and base oil.

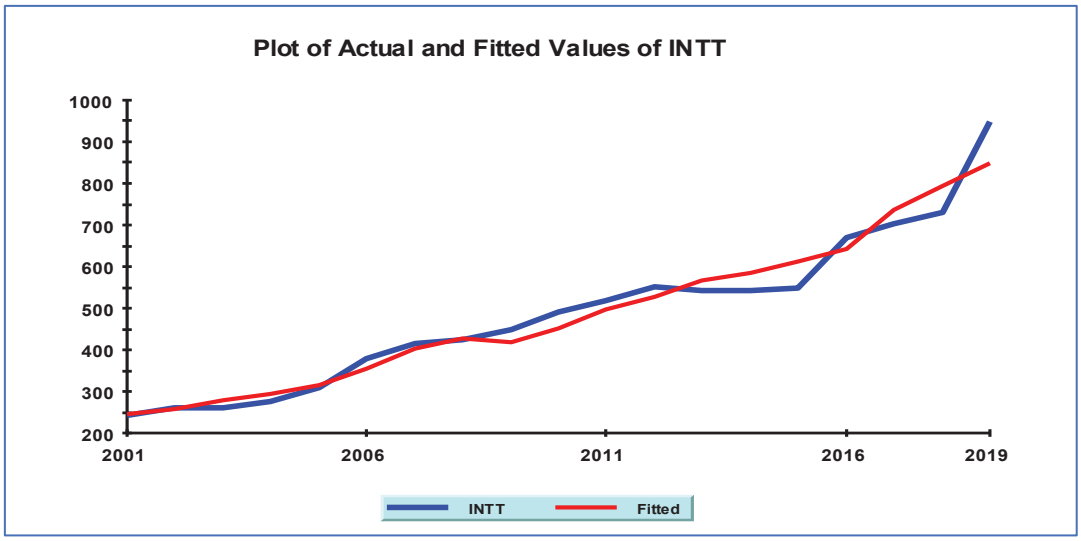
Annex B. Estimation Results of Energy Demand Functions

INDUSTRY

Total (INTT)

INTT = 50.3145*CONS + .6382E-7*INUSD + .54319*INTT(-1)

```
                    Ordinary Least Squares Estimation
*************************************************************
*************
 Dependent variable is INTT
 19 observations used for estimation from 2001 to 2019
*************************************************************
*************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                      50.3145            39.3386
1.2790[.219]
 INUSD                    .6382E-7           .2239E-7
2.8503[.012]
 INTT(-1)                   .54319             .21794
2.4924[.024]
*************************************************************
*************
 R-Squared                    .95687   R-Bar-Squared
.95148
 S.E. of Regression         41.1494   F-Stat.    F(2,16)
177.4884[.000]
 Mean of Dependent Variable  487.1610   S.D. of Dependent Variable
186.8101
 Residual Sum of Squares      27092.3   Equation Log-likelihood
-95.9542
 Akaike Info. Criterion      -98.9542   Schwarz Bayesian Criterion
-100.3709
 DW-statistic                  1.6668   Durbin's h-statistic
2.3252[.020]
*************************************************************
*************
```


Plot of Actual and Fitted Values of INTT
1000
900
800
700
600
500
400
300
200
2001
2006
2011
2016
2019
INTT
Fitted

Diesel (INDO)

INDO = 18.9625*CONS + .1038E-7*INUSD - .0017183*CPOIL + .52913*INDO(-1) - 20.6162*DUM0208

Ordinary Least Squares Estimation

****

Dependent variable is INDO

19 observations used for estimation from 2001 to 2019

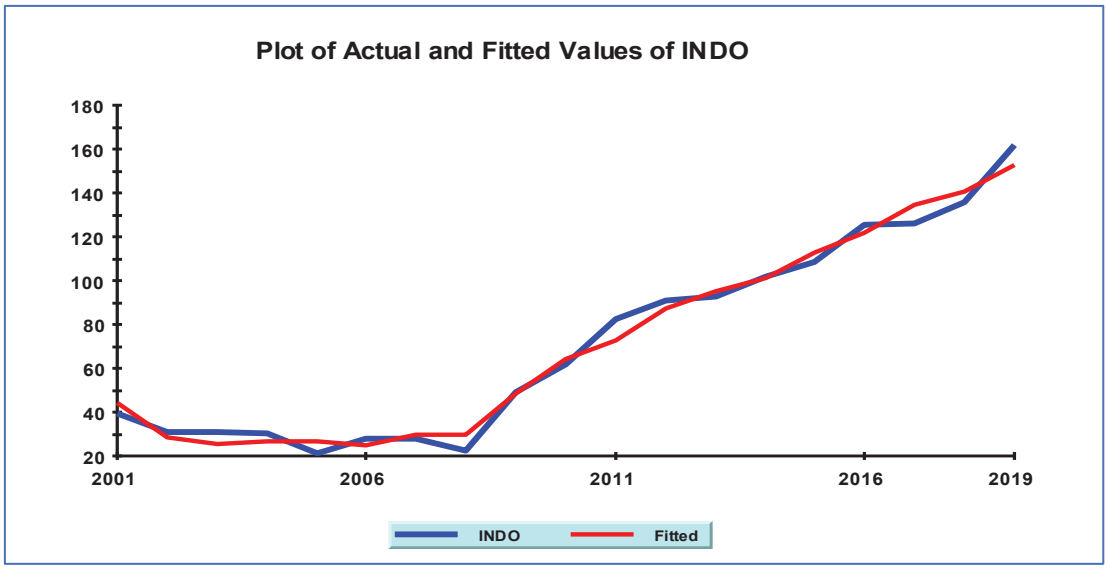
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	18.9625	6.6587	2.8478[.013]
INUSD	.1038E-7	.2880E-8	3.6029[.003]
CPOIL	-.0017183	.0013787	-1.2463[.233]
INDO(-1)	.52913	.12453	4.2489[.001]
DUM0208	-20.6162	3.9510	-5.2179[.000]

****

R-Squared	.98662	R-Bar-Squared	.98280
S.E. of Regression	5.9271	F-Stat. F(4,14)	258.0627[.000]
Mean of Dependent Variable	71.9977	S.D. of Dependent Variable	45.1879
Residual Sum of Squares	491.8225	Equation Log-likelihood	-57.8698
Akaike Info. Criterion	-62.8698	Schwarz Bayesian Criterion	-65.2309
DW-statistic	2.0510	Durbin's h-statistic	-.13237[.895]

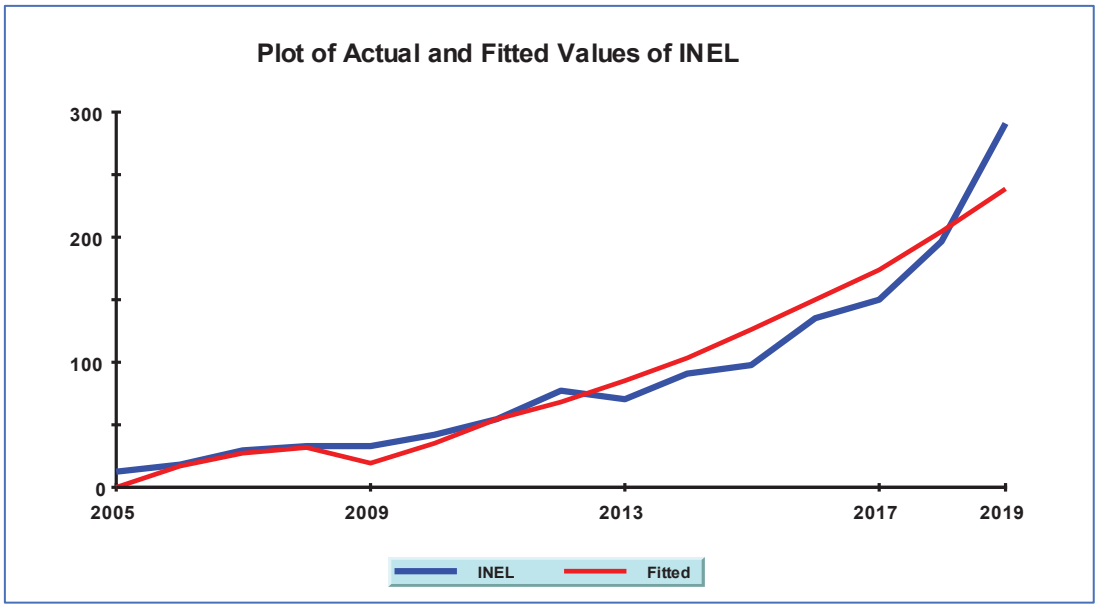
****


Plot of Actual and Fitted Values of INDO
180
160
140
120
100
80
60
40
20
2001
2006
2011
2016
2019
INDO
Fitted

Electricity (INEL)

INEL = -94.7491*CONS + .5285E-7*INUSD

```
                    Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is INEL
 15 observations used for estimation from 2005 to 2019
*******************************************************************************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                     -94.7491            14.2051            -
6.6701[.000]
 INUSD                    .5285E-7           .3806E-8
13.8854[.000]
*******************************************************************************
 R-Squared                    .93683   R-Bar-Squared
.93197
 S.E. of Regression         20.0706   F-Stat.    F(1,13)
192.8051[.000]
 Mean of Dependent Variable 88.9008   S.D. of Dependent Variable
76.9527
 Residual Sum of Squares     5236.8   Equation Log-likelihood
-65.1996
 Akaike Info. Criterion     -67.1996   Schwarz Bayesian Criterion
-67.9077
 DW-statistic                 1.0338
*******************************************************************************
```


Plot of Actual and Fitted Values of INEL
300
200
100
0
2005
2009
2013
2017
2019
INEL
Fitted

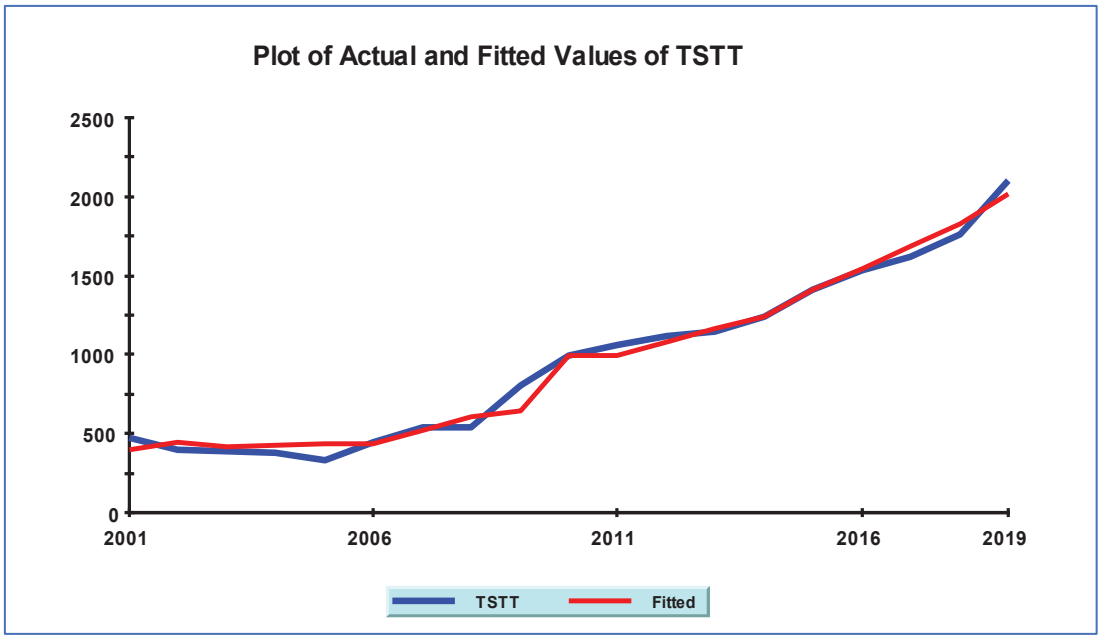
TRANSPORT

Total (TSTT)

TSTT = 69.0120*CONS + .1799E-3*TTVHC - 1.7348*RPOILJ2 + .58721*TSTT(-1) +160.4866*DUM10 + 46.8317*DUM15

Ordinary Least Squares Estimation

```
*******************************************************************************
 Dependent variable is TSTT
 19 observations used for estimation from 2001 to 2019
*******************************************************************************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                      69.0120            74.5323
.92593[.371]
 TTVHC                    .1799E-3           .6251E-4
2.8782[.013]
 RPOILJ2                   -1.7348            68.7814          -
.025222[.980]
 TSTT(-1)                   .58721             .18614
3.1546[.008]
 DUM10                     160.4866            79.6295
2.0154[.065]
 DUM15                      46.8317            81.2558
.57635[.574]
*******************************************************************************
 R-Squared                     .98585   R-Bar-Squared
.98041
 S.E. of Regression           75.8880   F-Stat.    F(5,13)
181.1440[.000]
 Mean of Dependent Variable  962.5685   S.D. of Dependent Variable
542.1610
 Residual Sum of Squares      74866.8   Equation Log-likelihood
-105.6106
 Akaike Info. Criterion     -111.6106   Schwarz Bayesian Criterion
-114.4439
 DW-statistic                  2.0077   Durbin's h-statistic    -
.028873[.977]
*******************************************************************************
```


Plot of Actual and Fitted Values of TSTT
2500
2000
1500
1000
500
0
2001
2006
2011
2016
2019
TSTT
Fitted

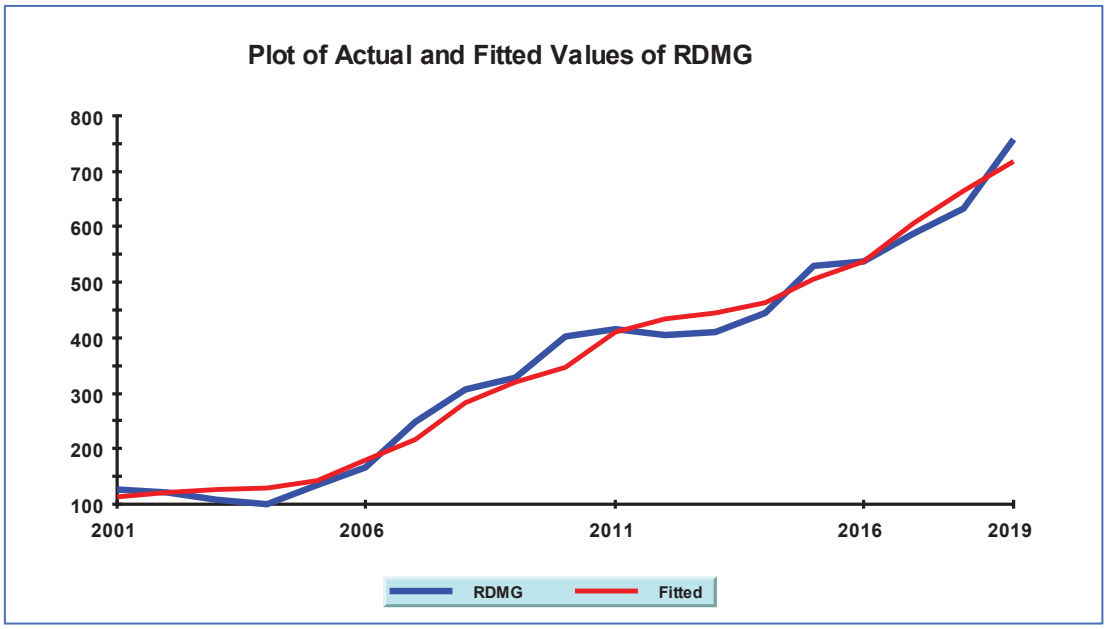
ROAD

Diesel (RDMG)

RDMG = -67.2756*CONS + .6439E-5*MGDPLCU -.3584E-3*RPOILJ + .66744*RDMG(-1)-45.8016*DUM16

Ordinary Least Squares Estimation

```
*******************************************************************************
 Dependent variable is RDMG
 19 observations used for estimation from 2001 to 2019
*******************************************************************************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                     -67.2756            35.0740           -
1.9181[.076]
 MGDPLCU                  .6439E-5           .2212E-5
2.9110[.011]
 RPOILJ                  -.3584E-3            .010955          -
.032713[.974]
 RDMG(-1)                   .66744             .15702
4.2507[.001]
 DUM16                    -45.8016            33.2571           -
1.3772[.190]
*******************************************************************************
 R-Squared                     .98292   R-Bar-Squared
.97803
 S.E. of Regression          29.3632   F-Stat.    F(4,14)
201.3612[.000]
 Mean of Dependent Variable  355.8906   S.D. of Dependent Variable
198.1191
 Residual Sum of Squares      12070.7   Equation Log-likelihood
-88.2738
 Akaike Info. Criterion      -93.2738   Schwarz Bayesian Criterion
-95.6349
 DW-statistic                  1.4572   Durbin's h-statistic
1.6225[.105]
*******************************************************************************
```

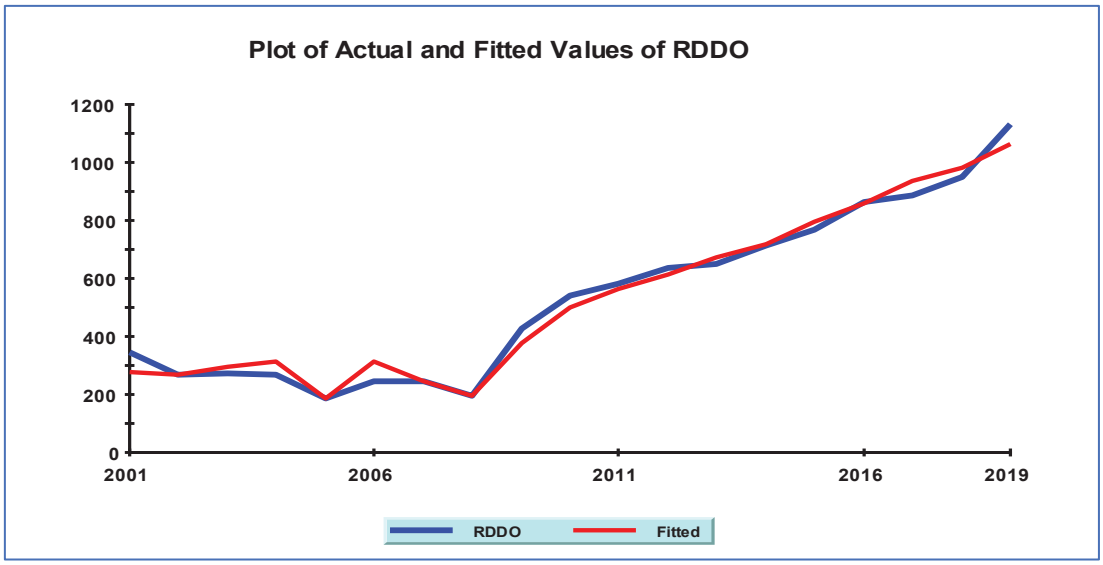

Plot of Actual and Fitted Values of RDMG
800
700
600
500
400
300
200
100
2001
2006
2011
2016
2019
RDMG
Fitted

Diesel (RDDO)

RDDO = -8.5115*CONS + .1149E-4*MGDPLCU - .011686*RPOILJ2 + .46581*RDDO(-1)-46.9912*DUM02 - 139.0378*DUM05 -118.2242*DUM07 -182.6804*DUM08

Ordinary Least Squares Estimation

```
*******************************************************************
*************
 Dependent variable is RDDO
 19 observations used for estimation from 2001 to 2019
*******************************************************************
*************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                      -8.5115            57.6823           -
.14756[.885]
 MGDPLCU                  .1149E-4           .3215E-5
3.5742[.004]
 RPOILJ2                  -.011686            .012888           -
.90669[.384]
 RDDO(-1)                   .46581             .15946
2.9212[.014]
 DUM02                    -46.9912            61.2260           -
.76750[.459]
 DUM05                   -139.0378            53.5493           -
2.5964[.025]
 DUM07                   -118.2242            58.0593           -
2.0363[.067]
 DUM08                   -182.6804            61.4360           -
2.9735[.013]
*******************************************************************
*************
 R-Squared                    .98243   R-Bar-Squared
.97125
 S.E. of Regression         49.5600   F-Stat.    F(7,11)
87.8713[.000]
 Mean of Dependent Variable  535.9193   S.D. of Dependent Variable
292.2919
 Residual Sum of Squares     27018.2   Equation Log-likelihood
-95.9282
 Akaike Info. Criterion     -103.9282   Schwarz Bayesian Criterion
-107.7059
 DW-statistic                 1.3940   Durbin's h-statistic
1.8371[.066]
*******************************************************************
*************
```


Plot of Actual and Fitted Values of RDDO
1200
1000
800
600
400
200
0
2001
2006
2011
2016
2019
RDDO
Fitted

OTHERS

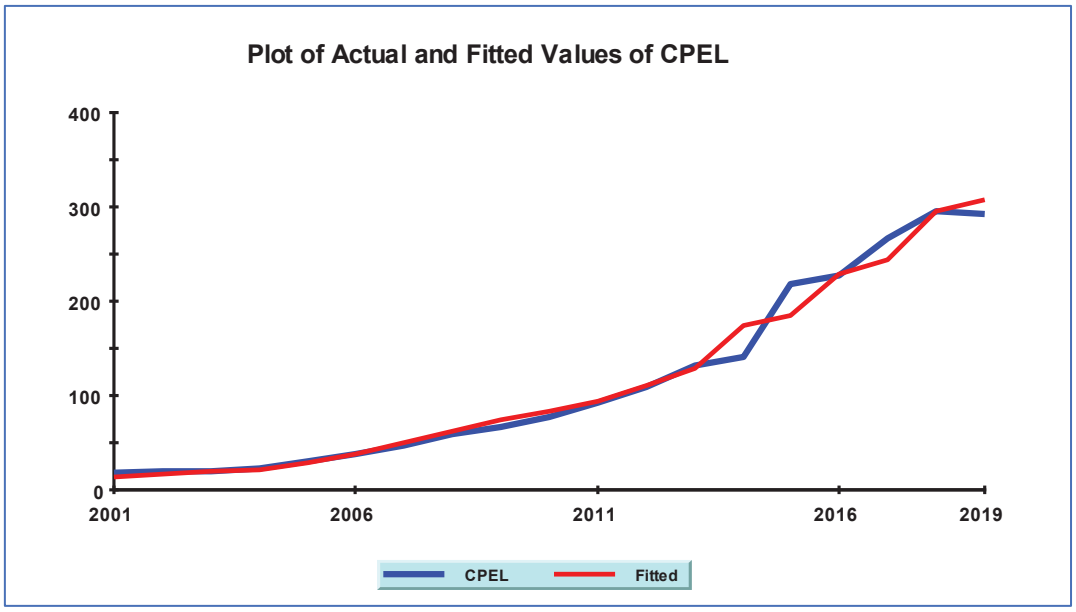
Commercial

Electricity (CPEL)

CPEL = -10.3834*CONS + .4126E-5*MSVLCU - 1.4145*RINELT2 + .79045*CPEL(-1)+ 21.0476*DUM1415 + 17.4953*DUM18

Ordinary Least Squares Estimation

```
*******************************************************************************
 Dependent variable is CPEL
 19 observations used for estimation from 2001 to 2019
*******************************************************************************
 Regressor              Coefficient       Standard Error          T-Ratio[Prob]
 CONS                     -10.3834            57.9706           -.17911[.861]
 MSVLCU                   .4126E-5           .3907E-5            1.0560[.310]
 RINELT2                   -1.4145             3.9221           -.36065[.724]
 CPEL(-1)                   .79045             .17809            4.4386[.001]
 DUM1415                   21.0476            12.8488            1.6381[.125]
 DUM18                     17.4953            18.3908            .95131[.359]
*******************************************************************************
 R-Squared                      .98288   R-Bar-Squared                .97630
 S.E. of Regression           15.0934   F-Stat.    F(5,13)          149.2760[.000]
 Mean of Dependent Variable  114.5956   S.D. of Dependent Variable   98.0349
 Residual Sum of Squares       2961.5   Equation Log-likelihood     -74.9256
 Akaike Info. Criterion      -80.9256   Schwarz Bayesian Criterion  -83.7589
 DW-statistic                  2.6616   Durbin's h-statistic        -2.2872[.022]
*******************************************************************************
```

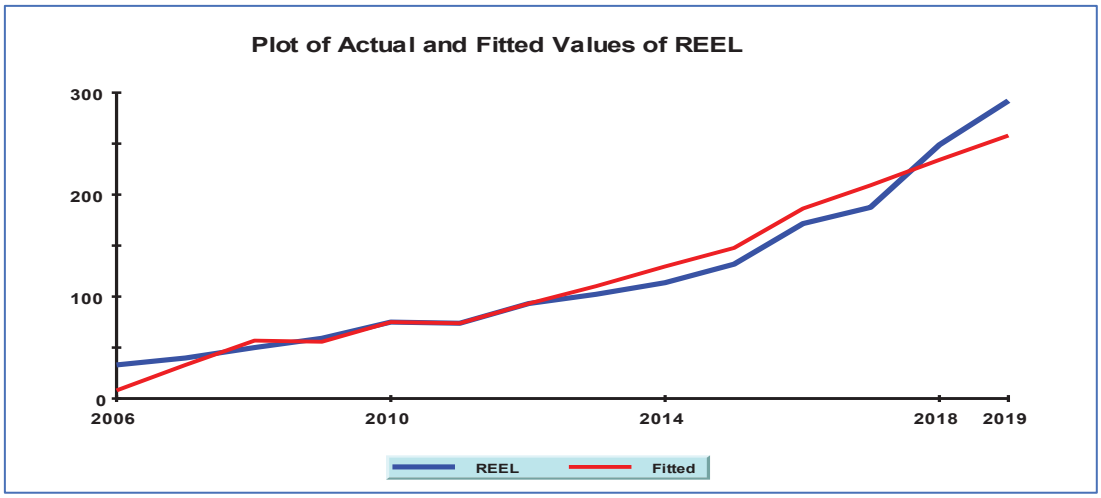

Plot of Actual and Fitted Values of CPEL
400
300
200
100
0
2001
2006
2011
2016
2019
CPEL
Fitted

Residential

Electricity (REEL)

REEL = -102.3253*CONS + .1221E-3*GDPC -
18.8721*RRSELT + 17.7127*DUM10 +   .63237*DUM11

```
                    Ordinary Least Squares Estimation
*******************************************************************
**************
 Dependent variable is REEL
 14 observations used for estimation from 2006 to 2019
*******************************************************************
**************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                    -102.3253           159.4502
-.64174[.537]
 GDPC                     .1221E-3           .3117E-4
3.9173[.004]
 RRSELT                  -18.8721            18.3463
-1.0287[.330]
 DUM10                    17.7127            21.2786
.83242[.427]
 DUM11                     .63237            21.2446
.029766[.977]
*******************************************************************
**************
 R-Squared                      .95701   R-Bar-Squared
.93791
 S.E. of Regression           19.7648   F-Stat.    F(4,9)
50.0908[.000]
 Mean of Dependent Variable  119.2762   S.D. of Dependent
Variable     79.3178
 Residual Sum of Squares       3515.8   Equation Log-likelihood
-58.5469
 Akaike Info. Criterion      -63.5469   Schwarz Bayesian
Criterion    -65.1446
 DW-statistic                   .73842
*******************************************************************
**************
```

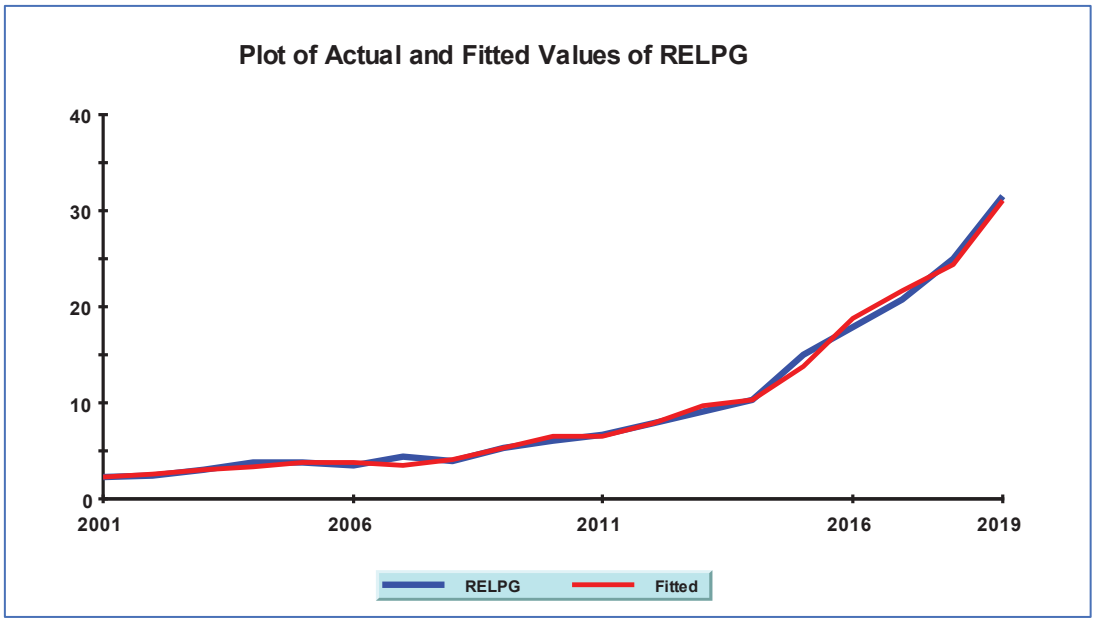

Plot of Actual and Fitted Values of REEL
300
200
100
0
2006
2010
2014
2018
2019
REEL
Fitted

LPG (RELPG)

RELPG = -2.2973*CONS + .3824E-5*GDPC -.0011134*RPOILJ2 + .90287*RELPG(-1)+ .42223*DUM05 -.55384*DUM09 - 2.0490*DUM14 -1.8626*DUM1518

Ordinary Least Squares Estimation

```
*******************************************************************
*************
 Dependent variable is RELPG
 19 observations used for estimation from 2001 to 2019
*******************************************************************
*************
 Regressor              Coefficient       Standard Error         T-
Ratio[Prob]
 CONS                       -2.2973             1.2641            -
1.8173[.096]
 GDPC                              .3824E-5               .1395E-5
2.7410[.019]
 RPOILJ2                  -.0011134           .3390E-3            -
3.2845[.007]
 RELPG(-1)                         .90287                .12443
7.2560[.000]
 DUM05                             .42223                .79520
.53097[.606]
 DUM09                      -.55384             .85360            -
.64882[.530]
 DUM14                      -2.0490             .92752            -
2.2091[.049]
 DUM1518                    -1.8626             .84602            -
2.2016[.050]
*******************************************************************
*************
 R-Squared                                  .99568     R-Bar-Squared
.99293
 S.E. of Regression                .71244     F-Stat.      F(7,11)
362.0022[.000]
 Mean of Dependent Variable    9.6100   S.D. of Dependent Variable
8.4715
 Residual Sum of Squares         5.5833    Equation Log-likelihood
-15.3256
 Akaike Info. Criterion       -23.3256   Schwarz Bayesian Criterion
-27.1034
 DW-statistic                  2.3447   Durbin's h-statistic     -
.89422[.371]
*******************************************************************
*************
```

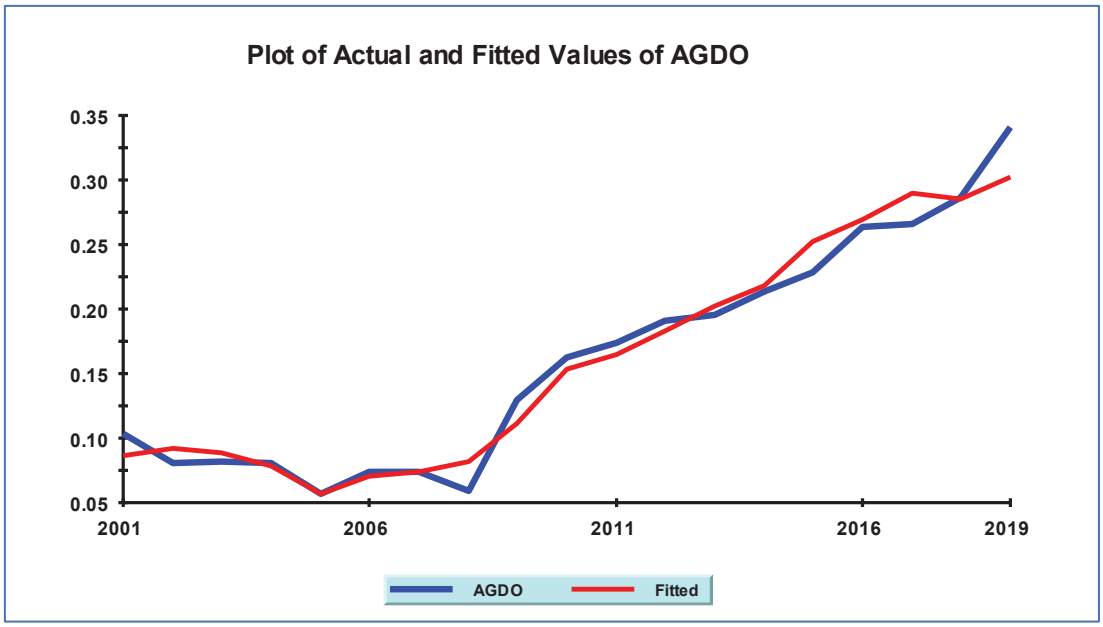

Plot of Actual and Fitted Values of RELPG
40
30
20
10
0
2001
2006
2011
2016
2019
RELPG
Fitted

Agriculture

Diesel (AGDO)

AGDO = -.057142*CONS + .2179E-7*MAGLCU - .061441*RPOILJ2 + .64552*AGDO(-1)-.025450*DUM05 -.0064527*DUM07

```
                    Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is AGDO
 19 observations used for estimation from 2001 to 2019
*******************************************************************************
 Regressor              Coefficient       Standard Error
T-Ratio[Prob]
 CONS                     -.057142            .026905           -
2.1238[.053]
 MAGLCU                   .2179E-7           .6300E-8
3.4596[.004]
 RPOILJ2                  -.061441            .022772           -
2.6981[.018]
 AGDO(-1)                   .64552             .13179
4.8980[.000]
 DUM05                    -.025450            .019243           -
1.3226[.209]
 DUM07                   -.0064527            .019704           -
.32747[.749]
*******************************************************************************
 R-Squared                    .96992   R-Bar-Squared
.95835
 S.E. of Regression          .017954   F-Stat.    F(5,13)
83.8431[.000]
 Mean of Dependent Variable   .16106   S.D. of Dependent Variable
.087979
 Residual Sum of Squares     .0041906   Equation Log-likelihood
53.0240
 Akaike Info. Criterion       47.0240   Schwarz Bayesian Criterion
44.1907
 DW-statistic                  1.5476   Durbin's h-statistic
1.2046[.228]
*******************************************************************************
```


Plot of Actual and Fitted Values of AGDO
0.35
0.30
0.25
0.20
0.15
0.10
0.05
2001
2006
2011
2016
2019
AGDO
Fitted

DEMAND TOTAL

INHEAT = 5.7380*CONS + .2156E-7*INUSD - .0087461*RPOILJ + .76698*INHEAT(-1) + 41.2918*DUM06 -70.7074*DUM15

Ordinary Least Squares Estimation

```
*******************************************************************************
Dependent variable is INHEAT
19 observations used for estimation from 2001 to 2019
*******************************************************************************
Regressor              Coefficient       Standard Error
T-Ratio[Prob]
CONS                      5.7380            28.4148
.20194[.843]
INUSD                    .2156E-7           .1452E-7
1.4854[.161]
RPOILJ                  -.0087461           .020327           -
.43028[.674]
INHEAT(-1)                .76698            .39540
1.9398[.074]
DUM06                    41.2918            36.8592
1.1203[.283]
DUM15                   -70.7074            33.1299           -
2.1342[.052]
*******************************************************************************
R-Squared                    .89287   R-Bar-Squared
.85167
S.E. of Regression         30.7901   F-Stat.    F(5,13)
21.6698[.000]
Mean of Dependent Variable 172.3805   S.D. of Dependent Variable
79.9452
Residual Sum of Squares     12324.4   Equation Log-likelihood
-88.4713
Akaike Info. Criterion     -94.4713   Schwarz Bayesian Criterion
-97.3046
DW-statistic                 1.6835   Durbin's h-statistic
*NONE*
*******************************************************************************
```

Diagnostic Tests

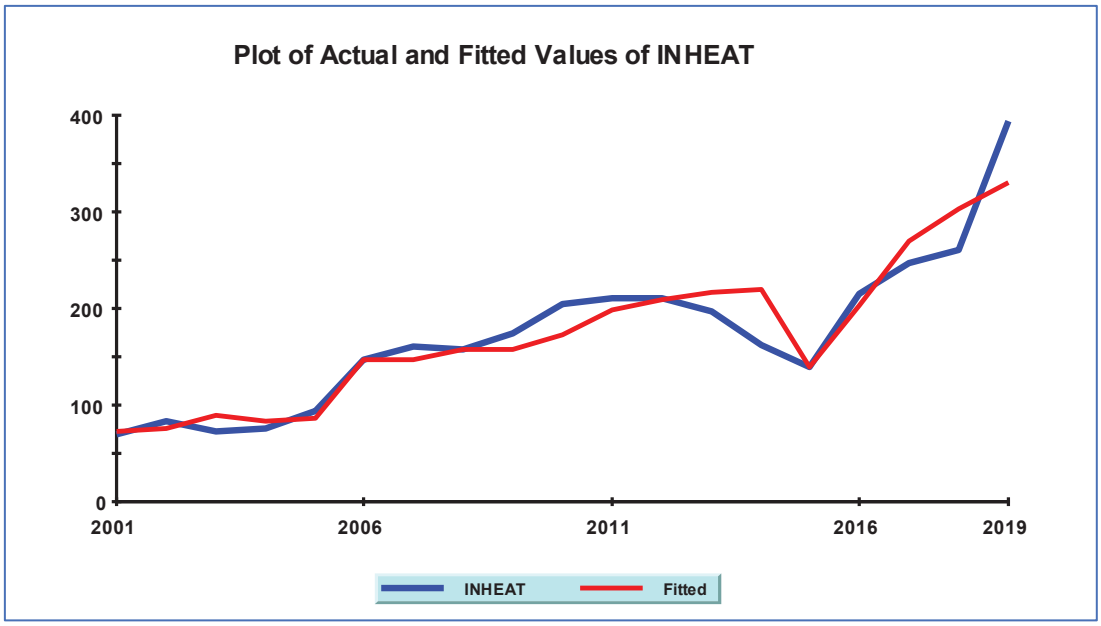
```
*************************************************************************
*************
*    Test Statistics  *        LM Version       *          F
Version          *
*************************************************************************
*************
*                     *                          *
*
* A:Serial Correlation*CHSQ(1)  = .0080882[.928]*F(1,12)      =
.0051105[.944]*
*                     *                          *
*
* B:Functional Form   *CHSQ(1)  =   .85861[.354]*F(1,12)      =
.56795[.466]*
*                     *                          *
*
* C:Normality         *CHSQ(2)  =   .91053[.634]*       Not
applicable        *
*                     *                          *
*
* D:Heteroscedasticity*CHSQ(1)  =  10.2577[.001]*F(1,17)      =
19.9467[.000]*
*************************************************************************
*************
```

A:Lagrange multiplier test of residual serial correlation

B:Ramsey's RESET test using the square of the fitted values

C:Based on a test of skewness and kurtosis of residuals

D:Based on the regression of squared residuals on squared fitted values


Plot of Actual and Fitted Values of INHEAT
400
300
200
100
0
2001
2006
2011
2016
2019
INHEAT
Fitted