Annex 1

Definition of Petroleum Products Sales Questionnaire

Definition of Fuels

1. Liquefied petroleum gas (LPG)

LPG refers to liquefied propane (C_3H_8) and butane (C_4H_{10}) or mixtures of both. Commercial grades are usually mixtures of the gases with small amounts of propylene, butylene, isobutene, and isobutylene stored under pressure in containers.

2. Naphtha

Naphtha refers to light or medium oils distilling between 30°C and 210°C which do not meet the specification for motor gasoline. The main uses for naphtha are as feedstock for high octane gasolines and the manufacture of olefins in the petrochemical industry.

3. Motor gasoline

Motor gasoline is a mixture of some aromatics (e.g. benzene and toluene) and aliphatic hydrocarbons in the C5–C12 range. The distillations range is 25°C–220°C. Motor gasoline may also contain biogasoline products.

4. Kerosene type jet fuel

This is a blend of kerosene suited to flight conditions with particular specifications, such as freezing point. The specifications are set down by a small number of national standards committees, most notably the American Society for Testing Material (ASTM), United States; the Ministry of Defence (MOD), United Kingdom; and the GOST (GOsudarstvennyy STandart) Russia.

5. Other kerosene

Kerosene which is used for heating, cooking, lighting, solvents, and internal combustion engines. Other names of this product are burning oil, vaporising oil, power kerosene, and illuminating oil.

6. Diesel oil

Diesel oils are middle distillates, predominantly of carbon number range C11–C25 and with a distillation range of 160°C–420°C. This product comprises road diesel and heating or other gas oil.

7. Fuel oil

This comprises residual fuel oil and heavy fuel oil which is usually a blended product based on the residues from various refinery, distillation, and cracking processes. Residual fuel oils A-5 has a distillation range of 350°C–650°C and a kinematic viscosity in the range 6–55 centistokes (cSt) at 100°C. Their flash point is always above 60°C and their specific gravity is above 0.95.

8. Lubricants

Lubricants are oils produced from crude oil, for which the principal use is to reduce friction between sliding surfaces and during metal cutting operations.

9. Bitumen

Bitumen is a solid, semi-solid, or viscous hydrocarbon with a colloidal structure, being brown to black in colour. It is obtained as a residue in the distillation of crude oil and by vacuum distillation of oil residues from atmospheric distillation. It should not be confused with the nonconventional primary extra heavy oils which may also be referred to as bitumen.

10. Other products

Other products comprise white spirits and special boiling points industry spirits, paraffin wax, petroleum coke, and other products.

Definition of Flows

1. Import

Data should reflect amounts having crossed the national territorial boundaries, whether customs clearance has taken place or not. Quantities of crude oil and products imported or exported under processing agreements (i.e. refining on account) should be included.

2. Blending

Petroleum companies blends several petroleum products and create a petroleum product, so there are + (create) and – (blended), and the total should be zero.

3. Own use

Own use by petroleum import companies.

4. Stock (at the end of the year)

All stocks on national territory, including stocks held by governments, by major consumers or by stockholding organisations, stocks held on board incoming ocean vessels, stocks held in bonded areas, and stocks held for others, whether under bilateral government agreement or not.

5. Total sales
= 1 ± 2 – 3

6. Sell to power producers
= 6 + 7

7. Electricité du Cambodge (EDC)
Sales of diesel or fuel oil to EDC

8. Independent power producer (IPP), off-grid factory (OGF), etc.
Sales of diesel oil and fuel oil to other power producers

9. Sell to large-scale industrial users (13 subsectors)
= 10 + 11 + 12 + 13 + 14 + 15 + 16 + 17 + 18 + 19 + 20 + 21+ 22

10. Iron and steel
International Standard Industrial Classification of All Economic Activities (ISIC) Group 241 and Class 2431 (Statistical Classification of Economic Activities in the European Community (NACE) Groups 24.1, 24.2, and 24.3; and Classes 24.51 and 24.52). To avoid double counting, oil used in blast furnaces should be reported in the energy or transformation sector.

11.Chemical (incl. petrochemical)
ISIC Division 20 and 21 (NACE Division 20 and 21)
Note: This heading includes petroleum products used as fuel and as feedstock (non-energy use). However, consumption should be net, after deduction of backflows. The breakdown of net consumption by product should be calculated applying the same proportion of product split for gross deliveries.

12.Non-ferrous metals
ISIC Group 242 and Class 2432 (NACE Group 24.4 and Classes 24.53, 24.54)

13.Transportation equipment
ISIC Divisions 29 and 30 (NACE Divisions 29 and 30)

14.Machinery
ISIC Divisions 25, 26, 27, and 28 (NACE Divisions 25, 26, 27, and 28). Report fabricated metal products, machinery, and equipment other than transport equipment.

15. Mining and quarrying
ISIC Divisions 07, 08, and Group 099 (NACE Divisions 07, 08, and Group 09.9)

16. Food, beverages, and tobacco
ISIC Divisions 10, 11, and 12 (NACE Divisions 10, 11, and 12)

17. Pulp, paper, and printing
ISIC Divisions 17 and 18 (NACE Divisions 17 and 18). This category includes reproduction of recorded media.

18. Wood and wood products
ISIC Division 16 (NACE Division 16)

19. Construction
ISIC Division 41, 42, and 43 (NACE Division 41, 42, and 43)

20. Textiles and leather
ISIC Divisions 13, 14, and 15 (NACE Divisions 13, 14, and 15)

21. Not elsewhere specified (industry)
If your economy's industrial classification of oil consumption does not correspond to the above ISIC (or NACE) codes, please estimate the breakdown by industry and only include in not elsewhere specified the consumption in sectors which are not covered above. This industry is classified as ISIC Division 22, 31, and 32 (NACE Divisions 22, 31, and 32).

22. Sell to large-scale transport user
= 23 + 24 + 25 + 26 + 27

23. Taxi, bus, road freight, etc.
Report oil for use in road vehicles. Include fuel used by agricultural vehicles on highways and lubricants for use in road vehicles. Exclude motor gasoline and diesel used in stationary engines (see not elsewhere specified – other sectors), diesel oil for non–highway use in tractors (see agriculture/forestry – other sectors), military use (see not elsewhere specified – other sectors), and gas oil used in engines at construction sites (see construction – industry sector).

24. International civil aviation
Report quantities of aviation fuels delivered to aircraft for international aviation bunkers (also known as 'international aviation bunkers'). The domestic/international split should be determined on the basis of departure and

landing locations and not by the nationality of the airline. Exclude fuels used by airlines for their road vehicles (see not elsewhere specified – transport sector) and military use of aviation fuels (see not elsewhere specified – other sectors).

25. Domestic air transport
Report quantities of aviation fuels delivered to aircraft for domestic aviation – commercial, private, agricultural, etc. Include fuel used for purposes other than flying, e.g. bench testing of engines. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. Note that this may include journeys of considerable length between two airports in an economy (e.g. San Francisco to Honolulu). Exclude fuels used by airlines for their road vehicles (see not elsewhere specified – transport sector) and military use of aviation fuels (see not elsewhere specified – other sectors).

26. Inland waterways
Report fuels delivered to vessels of all flags not engaged in international navigation (see 'international marine bunkers'). The domestic/international split should be determined on the basis of port of departure and port of arrival and not by the flag or nationality of the ship. Note that this may include journeys of considerable length between two ports in an economy (e.g. San Francisco to Honolulu).

27. International marine bunkers
Bunkers cover the quantities of fuels delivered to sea-going ships of all flags. Consumption of warships should be included in final consumption under other sector, not elsewhere specified. Consumption by ships engaged in fishing and in transport in inland and coastal waters is not included.

28. Sell to other large-scale users
= 29 + 30 + 31 + 32 + 33 + 34

29. Commercial services such as mall, hotel, school, hospital, office building
ISIC Divisions and NACE Divisions 33, 36, 37, 38, 39, 45, 46, 47, 52, 53, 55, 56, 58, 59, 60, 61, 62, 63, 64, 65, 66, 68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 79, 80, 81, 82, 84 (exclude Class 8422), 85, 86, 87, 88, 90, 91, 92, 93, 94, 95, 96, and 99. Oil consumed by businesses and offices in the public and private sectors. Note that oil use at railway, bus stations, shipping piers, and airports should be reported in this category and not shown in the transport sector.

30. Public services such as central and local governments
Sales of petroleum products to central and local governments

31. Residential
Report fuels consumed by all households including ‘households with employed persons’ (ISIC and NACE Divisions 97 and 98).

32. Agriculture
ISIC Divisions 01 and 02 (NACE Divisions 01 and 02). Report oil consumption by users classified as agriculture, hunting, and forestry.

33. Fishing
Report fuels used for inland, coastal, and deep-sea fishing. Fishing should cover fuels delivered to ships of all flags that have refuelled in the economy (include international fishing). Also include energy used in the fishing industry as specified in ISIC Division 03 and NACE Division 03.

34. Petroleum wholesaler
Sales of petroleum products to petroleum wholesaler

35. Sell to gas station
= 36 + 37

36. Company-owned stations
Delivery of petroleum products to owned service stations

37. Company franchises
Delivery of petroleum products to franchised service stations

Table A1.1 Revised Questionnaire for Sales Data from Petroleum Companies

Petroleum Product Sales Questionnaire

Corporation/Company: Contact Person: Tel:

Year: Email:

Quantity Descriptions	LPG	Naphtha	Motor Gasoline	Kerosene Type Jet Fuel	Other Kerosene	Diesel Oil	Fuel Oil	Lubricants	Bitumen	Other Products (specify)
	Ton	KL	KL	KL	KL	KL	KL	KL	Specify	Specify
Import										
Blending										
Own Use										
Stock (in the end of the year)										
Total Sales										
Sell to Power producers										
EDC										
IPP, Rural, etc										
Sell to Large Scale Industrial Users										
Iron and Steel										
Chemical (incl. Petro-Chemical)										
Non Ferrous Metals										
Transportation Equipment										
Machinery										
Mining and Quarrying										
Food, Beverages and Tobacco										
Pulp, Paper and Printing										
Wood and Wood Products										
Construction										
Textiles and Leather										
Not Elsewhere Specified (Industry)										
Sell to Large Scale Transport Users										
Taxi, Bus, Road Freight, etc										
International Civil Aviation										
Domestic Air Transport										
Inland Waterways										
International marine Bunker										
Sell to Other Large Scale Users										
Commercial Services such as Mall, Hotel, School, Hospital, Office Building										
Public Services such as Central and Local Governments										
Residential										
Agriculture										
Fishing										
Petroleum Wholesaler										
Sell to Gas Station										
Company Owned Stations										
Company Franchises										

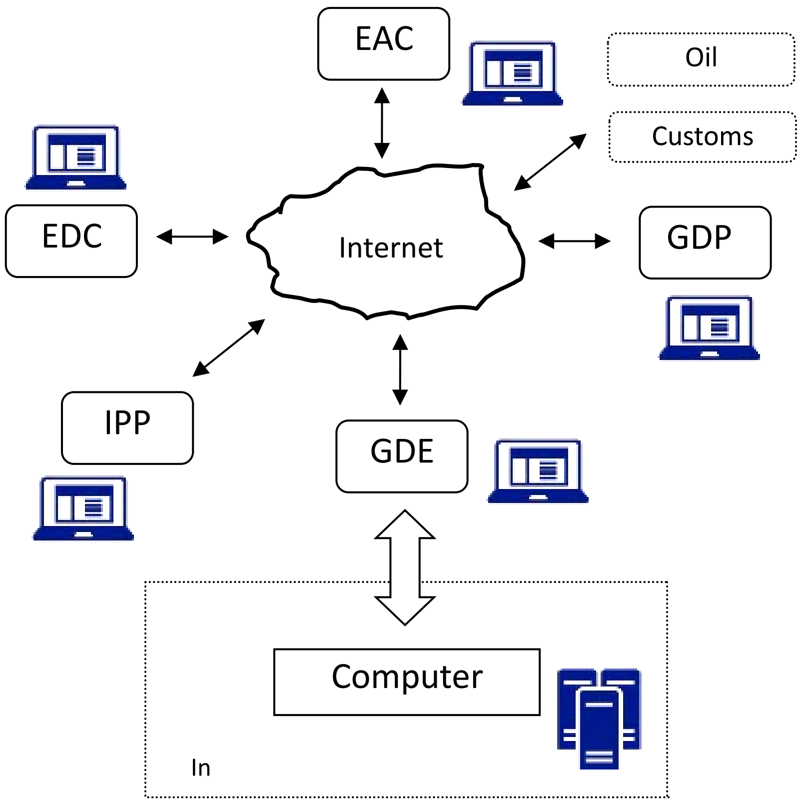
Annex 2

Data Collection Flow of Existing Data

1. Stakeholders of Energy Data

Since energy data are maintained by public facilities and private companies, it is necessary to set up an energy data collection system. The scatter situation of existing energy data is as follows:

Figure A2.1 Scatter Situation of Energy Data Holders



EAC = Electricity Authority of Cambodia, EDC = Electricité du Cambodge, GDE = General Department of Energy, GDE = General Department of Petroleum, IPP = independent power producer.

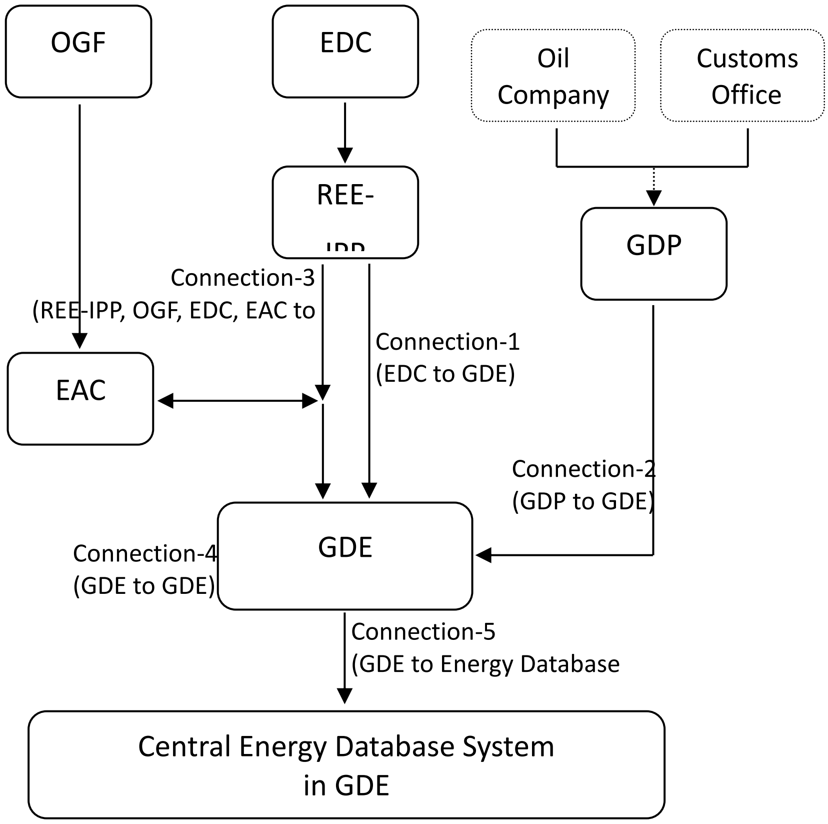
2. Energy Data Collection Flow

Each facility shall be equipped with a Windows PC and an Internet connection. It is recommended that the computer centre be installed in the General Department of Energy (GDE) office.

Energy data via the Internet from each facility will be sent to the management system after changing to the required format.

The data stream can be classified into five significant flows. The main information flow of energy data is shown below:

Figure A2.2 Energy Data Collection Flow



EAC = Electricity Authority of Cambodia, EDC = Electricité du Cambodge, GDE = General Department of Energy, GDP = General Department of Petroleum, IPP = independent power producer, OGF = off-grid factory, REE = rural electricity enterprise.

3. Specification of Each Connection

The five categories are connection-1, connection-2, connection-3, connection-4, and connection-5.

<Connection-1>

Flow between the relevant organisations

_EDC -> EAC -> GDE

Associated data

Coal by transformation input to power plant

Petroleum products by transformation input to own plant

Flow between the relevant organisations

_EDC -> GDE

Associated data

Electricity by own use

Electricity by loss

Electricity by industry consumption

Electricity by service consumption

<Connection-2>

Flow between the relevant organisations

_GDP (Customs office) -> GDE

Associated data

Petroleum products by import

Flow between the relevant organisations

_GDP (Oil company) -> GDE

Associated data

Petroleum products by consumption

<Connection-3>

Flow between the relevant organisations

_OGF -> EDC -> EAC -> GDE

Associated data

Electricity by import

Electricity by transformation output

Electricity by residence consumption

Flow between the relevant organisations

_EDC (REE-IPP) -> EAC -> GDE

Associated data

Hydropower by production

Hydropower by transformation input to power plants

<Connection-4>

Flow between the relevant organisations

_GDE (Data collection department) -> GDE

Associated data

Biomass firewood by production

Biomass firewood by transformation input to power plant

Biomass firewood by transformation input with charcoal

Biomass firewood by industry consumption

Biomass firewood by residence consumption

Biomass biogas by production

Biomass biogas by residence consumption

Biomass charcoal by transformation output

Biomass charcoal by residence consumption

Other necessary data

<Connection-5>

Flow from the data centre to the database registration

_GDE-> Energy database system

Associated data

All of energy data by sect

Annex 3

Energy Efficiency in the Industry Sector

1. Energy Efficiency

Energy efficiency is defined as 'using less energy to provide the same level of service on a per unit basis'.[1] It is generally achieved by adopting a more efficient technology or production process or by applying commonly accepted methods to reduce energy losses.

Using less energy to perform the same function will reduce energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy-efficient technology. Reducing energy use will be important in shaping patterns of energy use and in opening opportunities to increase exports or to decrease imports, which will eventually result in higher domestic (and global) energy security. It will enable the strengthening of research, development, and demonstration (RD&D) activities and creating jobs.[2]

Energy efficiency will also be important for reducing CO_2 emissions because the amount of energy use will be lower. Strategies to implement energy efficiency, if coupled with strategies to develop renewable energy, can raise clean energy supplies, making deep cuts of fossil fuel use. Thus, a sustainable energy economy requires strong commitment to both efficiency and renewables.

Significant improvements in final energy intensity worldwide played a key role in limiting global increases of energy use and CO_2 emissions. The reductions in energy intensity were largest in non–Organisation for Economic Co-operation and Development (OECD) countries, due to a combination of structural changes and efficiency improvements.[3] Developing countries have set energy saving targets and formulated policies and programmes to achieve these targets.

Large potential for further improvements in energy efficiency still remains, particularly in the industry sector and the power generation sector. Strong policy actions from government policies, including stringent norms and standards, will be necessary to accelerate energy efficiency improvements.

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[1] http://dictionary.sensagent.com/Efficient%20energy%20use/en-en/ (accessed 14 June 2016).
[2] Mieke Reece (2010), 'Energy Efficiency Indicators', paper presented at the APEC/ASEAN Joint Workshop on Energy Statistics, Bangkok, 8–12 November 2010.
[3] International Energy Agency (IEA) (2008), *Worldwide Trends in Energy Use and Efficiency: Key Insights from IEA Indicator Analysis*. Paris.

2. Measuring Energy Efficiency

Energy use and efficiency trends are usually analysed using indicators based on detailed statistics. These indicators examine the impacts of economic activity and structure, income, prices, policies, etc. relating to energy use in the different sectors and subsectors of the economy.

The energy intensity of a country is often used as an energy efficiency indicator (EEI) for that country. It is the ratio of the total primary energy supply (TPES) or total final energy consumption (TFEC) divided by the gross domestic product (GDP) of the country. Energy intensity is easy to calculate because the TPES or TFEC and GDP figures are readily available. TPES and TFEC data are available in the energy balance table of the country. GDP is a country's total value of production reflecting the country's economy and, therefore, the number is easily obtained from the national statistics.

Energy intensity is only an aggregate indicator for a country and can be used as a comparative measure between countries. However, a given country with a low energy intensity does not necessarily have high efficiency. For instance, a small service-based country with a mild climate would certainly have a much lower intensity than a large industry-based country in a very cold climate, even if energy is more efficiently consumed in this country than in the former. Other elements beside efficiency need to be considered such as the structure of the economy (presence of large energy-consuming industries, for instance), the size of the country (higher demand from the transport sector), the climate (higher demand for heating or cooling), and the exchange rate.[4]

Overall energy indicators provide an explanation on the basic energy consumption patterns and are usually not suitable for designing or monitoring the effects of policies that operate at lower aggregation levels. The energy intensity of a subsector or specific production process will need energy consumption data at the end-use level and corresponding activity data. Having reliable end-use energy statistics will be crucial in monitoring and evaluating the energy saving targets and action plans and in conducting a robust analysis of the energy saving potential.

A country's energy balance table is usually too aggregated and provides no breakdown of data at the end-use level.[5] In the case of developing countries, the breakdown is sometimes only at the sector level. At this level of disaggregation, the energy data do not provide significant information to monitor energy efficiency trends.

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[4] IEA (2014), *Energy Efficiency Indicators: Fundamentals on Statistics*. Paris.

[5] Roberta Quadrelli (2014), 'The IEA Work on Data and Methodologies for Energy Efficiency Indicators', paper presented at the 9th Meeting of the Oslo Group on Energy Statistics, Hilton Grand Capital, Abu Dhabi, United Arab Emirates, 5–8 May 2014.

Nevertheless, this type of energy balance can still be useful to assess the largest consuming sectors within a country where the energy saving potential will have more impact.

Collecting more detailed data, such as residential or services end-use data, transport vehicle types, or segment data, can provide a better understanding of which subsectors or end users drive energy consumption within each sector. In this regard, the International Energy Agency (IEA) has already designed a template to collect data for the EEIs. The template provides a starting point for data collection and helps in identifying the data gaps and issues. [6] The IEA published a corresponding manual[7] to provide guidance on how to collect the data needed for the EEIs. The IEA also published a guideline for policymakers to develop and interpret EEIs.[8]

3. Energy Efficiency in the Industry Sector

The industry sector covers the manufacturing sector (the manufacture of finished goods and products), construction, and mining and quarrying of raw materials. It does not include transport-related energy consumption and refineries. Industries consume energy to power a diverse range of manufacturing and resource extraction processes. In addition, some industries generate fuel from waste products that can be used to provide additional energy.

As a boiler fuel, energy is used to generate steam or hot water. In process heating, energy is used to raise the temperature of products in the manufacturing process. Besides fuel, energy is also used by some industries as feedstock to make products or for other non-energy purposes.

Considering the diversity of industrial processes, there is a multitude of possible opportunities for energy efficiency in industries. Many depend on the specific technologies and processes in use at each industrial facility.

Installing combined heat and power (co-generation) plants in industries that use both steam and electricity within their facilities will be more efficient compared to just installing conventional power plants. In a co-generation plant, the heat produced as a byproduct of electricity generation can be captured and used as process steam. Consequently, a co-generation plant can convert up to 90 percent of the fuel into usable energy, whereas a conventional power plant is only about 30 percent efficient.

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[6] Taejin Park (2014), 'Energy Efficiency Indicators Data Collection', paper presented at the Energy Statistics Training, Paris, 24 March 2014.
[7] IEA (2014), *Energy Efficiency Indicators: Fundamentals on Statistics*. Paris.
[8] IEA (2014), *Energy Efficiency Indicators: Essentials for Policy Making*. Paris.

Another area for energy efficiency is replacing conventional boilers and furnaces with advanced types that can operate at higher temperatures while burning less fuel. Another option would be reducing the fuel used to produce steam by insulating steam and condensate return lines, stopping steam leakage, and maintaining steam traps.[9]

Electric motors usually run at a constant speed, but a variable speed drive allows the motor's energy output to match the required load. This achieves energy savings ranging from 3 to 60 percent, depending on how the motor is used. Motor coils made of superconducting materials can also reduce energy losses. Motors may also benefit from voltage optimisation.[8]

Although many industries already implement energy efficiency practices, achieving energy efficiency in this sector remains challenging due to the variety of activities within the sector, the variety of relevant actors, and the importance of industry for national economies. The Rocky Mountain Institute points out that in industrial settings, 'there are abundant opportunities to save 70–90 percent of the energy and cost for lighting, fan, and pump systems; 50 percent for electric motors; and 60 percent in areas such as heating, cooling, office equipment, and appliances.' In general, up to 75 percent of the electricity used in the United States today could be saved with efficiency measures that cost less than the electricity itself.[10]

3.1 Energy Efficiency Indicator (EEI) for Industry

In principle, the EEI is the ratio of energy consumption per activity; in other words, it is the amount of energy required to conduct an activity. In the industry sector, activity is the process of producing an output. Thus, it can be measured in quantity produced or its value.

According to the IEA manual on Energy Efficiency Indicators,[11] the indicator for commodities production is the energy intensity calculated as the ratio of production divided by energy use. This relates to the physical production of major manufacturing sectors (energy-intensive industries) covering:

- ISIC 21. Paper and paper products
- ISIC 24. Chemicals and chemical products
- ISIC 26. Other non-metallic mineral products
- ISIC 27. Basic metals

The manual differentiates the aggregate indicators and the disaggregate indicators. The aggregate indicators are sufficient to provide a high-level picture of

[9] Wikipedia. Efficient Energy Use. https://en.wikipedia.org/wiki/Efficient_energy_use (accessed 12 June 2016).
[10] http://dictionary.sensagent.com/Efficient%20energy%20use/en-en/ (accessed 14 June 2016).
[11] IEA (2014), *Energy Efficiency Indicators: Fundamentals on Statistics*. Paris.

the sectoral consumption and allow a first comparison across countries, as well as a preliminary assessment of the importance of the various subsectors and energy sources. These indicators are:

- Total industry energy consumption (absolute or as a share of TFEC)
- Share of each energy source in the total industry energy consumption mix

Another indicator at the aggregate level referring to intensity is the total industry energy consumption divided by total industry value added. This indicator provides a first assessment of the overall intensity of the sector and its trends. The total output of the sector at the overall industry level is represented by the sector's value added because the physical output across the subsectors is not homogenous. The value added should be in constant currency to avoid bias induced by fluctuations in the monetary market.

At the subsector level, the indicators describing the energy use and energy efficiency trend are:

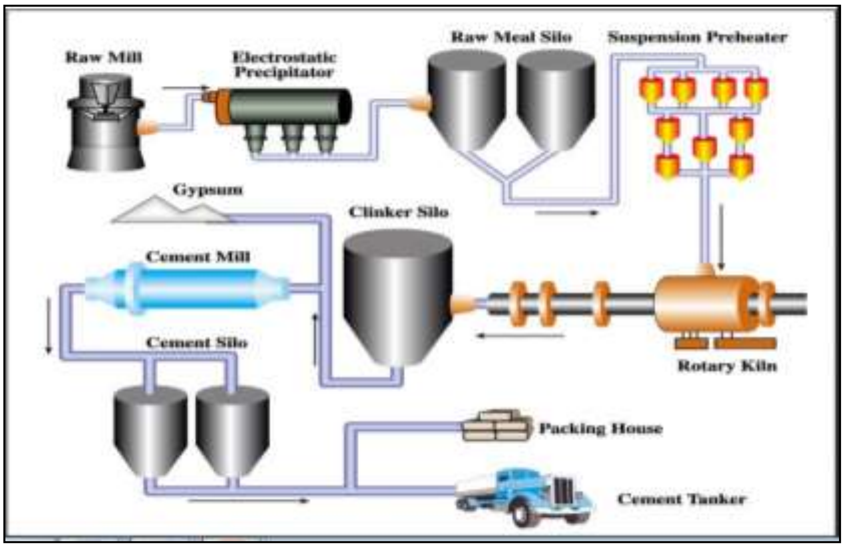
- Total subsectoral energy consumption (absolute or as a share of industry consumption)
- Share of each energy source in total subsectoral energy consumption mix
- Subsectoral energy consumption per unit of subsectoral physical output
- Subsectoral energy consumption per subsectoral value added
- Energy consumption per unit of physical output for each process/product type
- Energy consumption per value added for each process/product type

3.2 An Example of the Use of EEI: Cement Industry

The cement industry is classified under the non-metallic minerals subsector which refers to ISIC Division 23. The production of cement accounts for 83 percent of total energy use in the production of non-metallic minerals and 94 percent of CO_2 emissions. Energy represents 20–40 percent of the total cost of cement production. The production of cement clinker from limestone and chalk by heating limestone to temperatures above 950°C is the main energy consuming process. Mixing additives to clinker to form cement is less energy intensive. Portland cement, the most widely used cement type, contains 95 percent cement clinker. Large amounts of electricity are necessary to grind the raw materials and finished cement. Figure A3.1 shows the cement production process.

Depending on the water content of the raw feedstock, the process of clinker production can be either 'wet' or 'dry' – the first being much more energy intensive than the latter because it avoids the need for water evaporation. The dry process has a lower energy intensity (around 3.0 gigajoules [GJ] per ton of clinker) compared with 4.2 GJ per ton of clinker for efficient plants. The other major difference is between vertical shaft kilns and rotary kilns, their more efficient counterparts.

Figure A3.1 Cement Production Process



Source: Lootahgroup, cited in ClimateTechWiki. Energy Efficiency and Saving in the Cement Industry. http://www.climatetechwiki.org/technology/energy-saving-cement (accessed 30 June 2016).

Considering that cement production is a relatively simple process with well-defined system boundaries and a uniform product, the IEA developed disaggregate indicators to track the progress of energy efficiency over time and also to calculate the technical potential for energy reductions that could be achieved by moving to best available technology (BAT) or best practical technology (BPT).

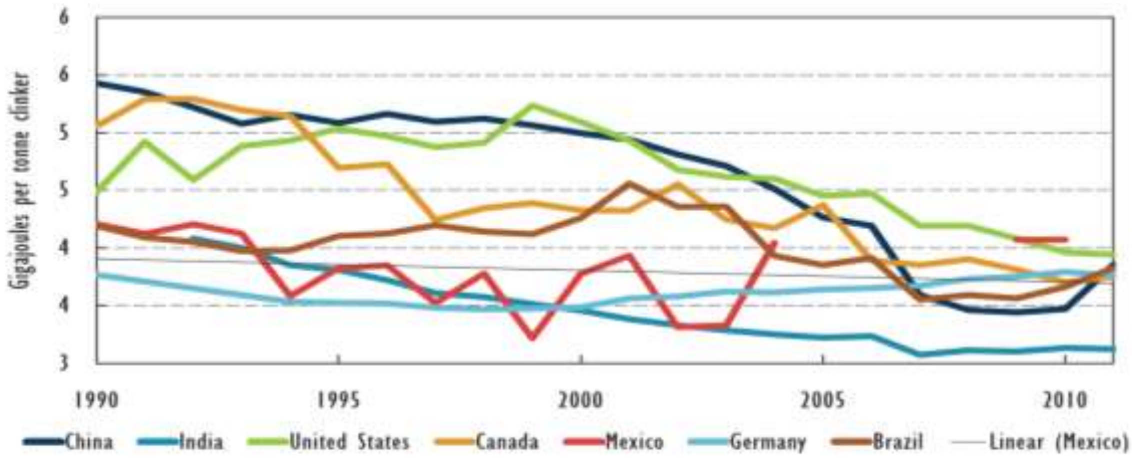
A number of indicators can easily be calculated for clinker (the partially fused product of a kiln, which is then ground for use in cement) and cement production to track developments over time. These include:

- Energy consumption, including alternative fuels, per ton of clinker
- Electricity consumption per ton of cement
- Total primary energy equivalent per ton of cement
- Total CO_2 emissions (process and energy-related) per ton of cement
- Alternative fuel use in clinker production
- Clinker-to-cement ratio
- Waste heat recovered per ton of clinker

- CO_2 emissions from energy consumption (including electricity) per ton of cement

From an energy efficiency view, the most important indicator is the average energy consumption per ton of clinker produced. For most countries, the indicator shows a downward trend in the energy intensity of clinker production between 1990 and 2011 (Figure A3.2). The reason for this downward trend has largely been due to the shift from wet-process to dry-process cement kilns, coupled with the replacement of older dry kilns by the latest technology using pre-heaters and pre-calciners. Using consistent definitions and boundaries across all countries, it can be seen that the average energy consumption per ton of clinker in China is currently about 3.45 GJ per ton whereas the European Union, Canada, and the United States all use around 3.8–4.0 GJ per ton of clinker.

Figure A3.2 Energy Consumption per Ton of Clinker by Country



Source: IEA (2014), Energy Efficiency Indicators: Essentials for Policy Making. Paris.

Cement companies are investing in low-consumption technologies to be more competitive as they can reduce energy consumption and thus lower the production cost. Moreover, legislation in terms of greenhouse gas (GHG) emissions as well as local pollution often pushes industry to be cleaner and more energy-concerned. Today's state-of-the-art dry rotary kilns are fairly fuel efficient, using around 2.9–3.0 GJ per ton of clinker.

Annex 4

Energy Efficiency in Buildings

1. Introduction

In 2015, about 40 percent of total energy consumption in the United States was in residential and commercial buildings.[1] In the ASEAN region, energy consumption in buildings accounts for about 32 percent of energy demand.[2] For countries with a hot and humid climate such as Cambodia, the energy demand for air-conditioning systems in buildings accounts for the largest proportion of energy use in the operation of buildings. Therefore, it makes sense to channel efforts to devising both appropriate policy strategies and technical measures to achieve energy efficiency in the design, operation, and maintenance of new and existing buildings.

Substantial energy will be saved through the adoption of energy efficiency measures and practices. If one takes into account a building's life span, the operational energy savings can be huge, and such savings can be translated into reduction in the country's CO_2 emissions, in addition to energy cost savings.

2. Benchmarking of Energy Efficiency for Buildings

Before embarking on strategies to achieve energy efficiency, it is important to set a parameter that can determine or indicate the extent of energy efficiency in the operation of buildings. It is recognised that daily energy consumption in a building fluctuates by hour, day, and month because the main energy use for air-conditioning cooling loads changes and peaks at different hours during the day as a result of solar heat gained mainly through daily solar radiation. Building occupancy and seasonal changes will also influence the energy consumption in buildings.

Taking the above into account, it is recommended to use building energy intensity (BEI) as an energy efficiency indicator or index to gauge and compare building energy performance, which is based on a building's annual energy consumption and gross floor area. The following formula is used to calculate BEI:

$$\text{BEI} = \frac{Annual\ Energy\ Consumption\ (kWh/yr)}{Gross\ Floor\ Area\ (m^2)}$$

It should be noted that the annual energy consumption shall include all energy usage by the owner and tenants, including installations that consume energy

[1] US Energy Information Administration (2016), Frequently Asked Questions, http://www.eia.gov/tools/faqs (accessed April 2016).
[2] International Energy Agency (IEA) and Economic Research Institute for ASEAN and East Asia (ERIA) (2013), *Southeast Asia Energy Outlook*. Paris: OECD/IEA.

and serve the whole building except car parks and data centre equipment because their inclusion would distort the BEI. The gross floor area shall be the gross area of occupied space excluding car park areas and the data centre room, which corresponds with the exclusion of energy consumption for these areas. It should also be noted that this BEI method is not applicable to buildings without much air-conditioning in building floor spaces, such as for residential buildings. For the purpose of this study, it is suggested to set the minimum air-conditioned space to be at least 50 percent of the gross floor area for a meaningful comparison of BEI in buildings.

Another aspect that will influence the BEI values is building categories and operational hours. For example, BEI for office buildings will differ from that of shopping malls, which again will differ from that of hotels and hospitals. In the absence of proper surveyed data in Cambodia and for the purpose of having some values for discussion purposes, the table below provides typical values, which are based on the green building benchmark values in Malaysia. It is not suggested that Cambodia should adopt the benchmarking values listed below. The intention of listing these values is to illustrate that BEI values can be determined if there are sufficient quality data on buildings. From the energy consumption survey data obtained for the building sector in Cambodia in the recent exercise, it was not possible to establish similar BEI benchmarking values.

Table A4.1 Typical Minimum Building Energy Intensity Benchmarking Values for Green Buildings

Building Category	Typical Operational Hours	BEI (minimum values to be considered energy efficient) (kWh/m^2/yr)	
Office	52 hours/week	150	
Retail and Mall	84 hours/week	200	350 (incl. high energy intensity outlets)
Hotel	24 hours / 7 days week	200 (3-star & below)	290 (4-star & above)
Hospital	24 hours / 7 days week	200	290 (incl. major clinical services)

Source: Green Building Index (GBI), GBI Tools, Malaysia.

3. Strategies to Achieve Energy Efficiency

The common approach to achieve energy efficiency in buildings is to improve efficiency in lighting and air-conditioning systems. However, for a hot and humid climate like in Cambodia, it is important to firstly adopt a ***passive design strategy*** before considering an ***active design strategy*** in order to attain a holistic approach to energy efficiency in buildings.

3.1 Passive Design Strategy

For a hot and humid climate, all buildings have the primary function of providing an internal environment with thermal comfort, which is desirable for the purpose of occupancy in buildings. Therefore, understanding weather conditions will offer opportunities to minimise solar heat gains, which will lead to saving capital costs due to the reduction in the capacity of air-conditioning equipment and ultimately saving energy costs in the operation of buildings.

The primary objective in a passive design strategy is to minimise solar thermal heat gains and some examples of the key elements to be considered in this strategy are as follows:

a) ***Building orientation*** with the longer building axis facing North–South so that the narrow ends of the building face East–West.
b) ***Building facades*** that provide shading for windows.
c) ***Fenestrations (windows)*** that provide low thermal transmittance and an effective shading coefficient of glazing used in the fenestration system.
d) ***Building and insulating materials*** that provide low thermal transmittance of the opaque walls and roofs.
e) ***Strategic landscaping*** that provides shading from the sun, shielding from heat reflection in the surrounding spaces, and the creation of a cooler microclimate around the building.
f) ***Daylighting*** design that captures the natural daylight to reduce the need for artificial lighting.
g) ***Natural ventilation*** that makes use of the natural forces of wind and buoyancy to deliver sufficient fresh air and air change to ventilate enclosed spaces without the need to rely on air conditioning.
h) ***Measures to prevent air leakage*** as uncontrolled mixing of outside air with air-conditioned space requires more energy to remove moisture and heat gain contributed by air leakage.

3.2 Active Design Strategy

Having minimised solar heat gain and having maximised the capture of daylight and natural ventilation, an active design strategy will play a key role to complete the achievement of energy efficiency in buildings.

The extent of energy efficiency in active systems often depends on budget allocations. If budget permits, sophisticated energy management and lighting control systems may be considered. The minimum approach in an active design strategy is to cover systems that consume higher shares of energy, i.e. air-conditioning systems and lighting.

a) Air-conditioning system

The design of energy-efficient air-conditioning system requires a clear understanding of the building's functional requirements and consideration of many aspects. This may begin with accurate estimates of cooling load requirements, correct sizing, configuration and selection of chillers or air-conditioning equipment, pumps, fans, motors, variable speed drives, etc. Other considerations are appropriate zoning, effective air distribution and type of control, energy loss minimisation in ducting and piping systems, air leakage minimisation, and energy recovery system. Setting the temperature for the air-conditioned space during building occupancy will have a significant influence on the energy consumption of a building. The lower the temperature setting, the higher the energy consumption will be.

b) Lighting

Lighting must provide a suitable level of illuminance for the performance of a range of tasks and provision of a desired appearance. In general, lighting for infrequently used areas should be designed with lower illuminance (e.g. 100 lux[3] for corridors, car parks, etc.); lighting for working interiors should be designed with higher illuminance (e.g. 300–400 lux for general offices, reading and writing areas, 500 lux for proof reading, etc.). In addition, there should be guidelines for the design of lighting load, which should not exceed the maximum allowable power (e.g. 15 watts per square meter (W/m^2) for restaurants, offices, and hotel rooms; 20 W/m^2 for lobbies and concourses; 25 W/m^2 for supermarkets, departmental stores, etc.).[4] It should be noted that these are typical maximum values. For higher energy efficiency, these values should be set lower. It is possible to achieve such design objectives by using high efficiency lamps with high efficacy (e.g. > 80 lumens/watt light fittings).

[3] Department of Standards Malaysia (2014), *MS1525:2014: Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-residential Buildings*. Cyberjaya.
[4] Ibid.

Further savings in lighting can be achieved by employing methods to capture daylight to reduce artificial lighting, provision of lighting zones control for energy saving, use of task lights, and also use of lighting controls with timers as well as motion and photoelectric sensors.

4. Conclusion

It can be concluded from the above that building energy performance can be assessed by means of determining the BEI. Based on the BEI method, national average benchmarking values can be established to evaluate building energy performance and estimate building energy consumption when building floor areas are known.

Effective energy efficiency in buildings can be achieved through a holistic approach by adopting passive and active design strategies. As illustrated in the above, there are various design measures and values to be considered and incorporated in order to achieve energy efficiency in buildings. As a way forward towards energy efficiency in buildings, national energy-efficient building guidelines are recommended to be developed and established for the effective implementation and achievement of energy efficiency in buildings in a consistent way, which can be translated into energy cost savings, CO_2 emissions reductions, and improved building energy performance. Such guidelines for energy efficiency in buildings will require the support of a national building code for enforcement purposes.

Annex 5

Enabling Policy and Institutional Support for Functioning Cambodia Energy Statistics

1. Introduction

The Ministry of Mines and Energy (MME) has been working to improve energy policies towards realising the power sector strategy, energy efficiency and conservation (EE&C) goals, and other policies to ensure that a stable and affordable supply of primary energy – such as coal, oil, gas, and electricity – can be achieved for the sustainable economic development of Cambodia. As Cambodia has been moving up in terms of gross domestic product per capita thanks to stable economic growth, energy consumption is also expected to continue to grow which will increase the pressure to find appropriate and effective energy policies for the present and the future.

The MME also recognised that the current situation of Cambodia's energy data and statistics remains delicate and requires strengthening in terms of procedure, analytical tools, and systematic data collection from concerned agencies and ministries. The ministry also believed that improving the country's energy data and statistics would not only serve Cambodia's policy purposes but also enhance regional energy cooperation with other member states of the Association of Southeast Asian Nations (ASEAN), and other regional and international bodies such as the ASEAN Centre for Energy and International Energy Agency (IEA) that require data for policy and analyses from time to time.

Given the above-mentioned needs, the MME's General Department of Energy (GDE), together with the General Department of Petroleum, approached the Economic Research Institute for ASEAN and East Asia (ERIA) for support and preparation of the Cambodia Energy Statistics, including the construction of energy balance tables. The ministry had also received support from ERIA in past projects such as the preparation of Cambodia Petroleum Products Demand and Outlook Modelling and the Study on Preparation of Accurate Petroleum Statistics in Cambodia. The past projects and this current project on Cambodia Energy Statistics provide a good baseline and preparation towards appropriate energy policy planning.

The MME hopes to see the Cambodia Energy Data and Statistics (CEDS) function and continue even after ERIA's support for the above-mentioned projects comes to an end. Towards that, it will be necessary to clearly elaborate the goal, objective, structure, and policy support of a functioning energy statistics unit.

In this respect, the CEDS unit may play a forward-looking role:

- Having a lead role in developing and maintaining comprehensive national and sectoral statistics for energy production, transformation, and end use
- Producing data for advising policymakers and informing investment decisions
- Sharing data as a vital input to meeting regional and international reporting obligations
- The core function of CEDS may include the collecting, processing, and publishing energy statistics to support policy analysis; conducting statistical and economic analyses of energy services sectors and sustainable energy options; and contributing to the development and promulgation of appropriate sustainability indicators. Timely and reliable statistics are essential to monitor the energy situation.

2. Review of the Legal Framework for Supporting Energy Data and Statistics

Cambodia's Statistics Law consists of 29 articles and provides a legal framework for all matters relating to collection, processing, compilation, analysis, publication, and dissemination of statistical data pertaining to the whole country.

According to the Statistics Law, Article 17 states the National Institute of Statistics (NIS) of the Ministry of Planning as the official national statistical institution of the Royal Government, with the responsibility for establishing, leading, and coordinating an integrated national statistical system which covers all designated official statistics and statistical units within ministries and government institutions. In addition to the NIS, Article 18 states that each ministry and other government institution shall have a statistics unit responsible for producing statistics. Article 12 states that ministries and government institutions shall collect sectoral data either independently or in cooperation with the NIS by conducting surveys and/or collecting statistical data on administrative records.

Article 2 states that the technical terms used in this law shall have the following meaning:

- **Statistics** are data obtained by collecting, processing, compiling, analysing, publishing, and disseminating results gathered from respondents through statistical collection or from administrative data sources.
- The **National Statistics System** is made up of integrated statistics data at the national and local levels, including all official statistical data and national statistical programmes, statistical organisations and statistical

units within the ministries and government institutions, as well as their statistical staff and other infrastructure.

- **Basic statistics** are official economic, environmental, and socio-demographic national and subnational statistics that are cross-sectoral in nature and that are required by the government for policy and programme formulation and evaluation, as well as for use by the wider Cambodian and international communities.
- **Sectoral statistics** are statistics collected by the ministries or government institutions for their internal needs and reporting purposes.

Article 13 states that the NIS under the Ministry of Planning shall be responsible for making official statistical policies in establishing an integrated National Statistical System, encompassing all designated official statistics and statistical organisational units within the ministries and institutions. The Royal Government shall issue a sub-decree on the operation of the National Statistical System and designated official statistics.

Under the Statistics Law, there are two sub-decrees that define the work for the National Statistical System: Sub-Decree on Organization and Functioning of the National Statistical System and Sub-Decree on Designated Official Statistics.

The Sub-Decree on Designated Official Statistics defines which surveys the statistical units shall be responsible for and what data obligations the NIS and the statistical units have to collect, compile, analyse, publish, and disseminate to the public. The system consists of NIS and 27 line ministries, government institutions, and the National Bank of Cambodia, who are all producers of designated official statistics. In the sub-decree, the defined role of the Ministry of Industry, Mines and Energy for the above task is to have '[e]nergy statistics, annually, mineral resources statistics, annually, clean water statistics annually, and Industrial property registration statistics, annually'.

3. Proposed Actions and Collaboration for Data Collection and Acquisition

Asia-Pacific Economic Cooperation (APEC) economies have experience performing energy data collection, analyses, and dissemination that is worth exploring. Some APEC economies such as Japan, Indonesia, Thailand, and the United States collect their energy data through their energy ministry, whereas others such as Canada, China, and Russia use their national statistical office to collect the energy data.

The Statistics Law of Cambodia and the Sub-Decree on Designated Official Statistics provide a legal framework for the MME to have a fully functioning sectoral statistical unit to collect, compile, analyse, publish, and disseminate data and information such as energy statistics and mineral resources statistics to the public.

However, the current statistical unit within the MME needs support to make it fully functional in the near future. The envisaged coordination, policy, and institutional support include the following:

- **Institutional and Data Collection Coordination**
  - Work with NIS to issue a sub-decree with regard to regular energy data consumption surveys, household/residential surveys, transportation surveys, industrial surveys, and commercial/building surveys.
  - Collaborate with NIS as it has a well-established structure of administrative data collection from line agencies. The first step is to set up an official meeting with NIS to see how energy data statistics can be collected from line agencies. It is very important to define clear and simple energy data as well as the types of energy data to be collected. The next step is to have a well-designed energy data collection format for the discussion with NIS and relevant agencies.
  - The GDP has designated staff for the petroleum statistics. Thus, it may explore the Statistics Law to get the petroleum imports companies to comply with the data acquisition.

- **Technical Capacity Building and Budgets**
  - There are capacity constraints to process, analyse, and publish the data after these have been collected. Therefore, capacity building is necessary to have trained staff to handle the energy data and statistics.
  - The GDP and GDE may continue to request ERIA's support to further strengthen the design of the petroleum product specifications and the legal framework, regulation, policy, and procedures further down the line.
  - The GDE may continue to seek ERIA's technical advice and lead a regular technical and high-level working group on the energy statistics.
  - Have clear financial support and budget for the Energy Statistical Unit for its daily core functions (including surveys, data collection and coordination, and capacity building).
  - Maintain staff and update knowledge and analytical skills. The Energy Statistical Unit may aim for a series of publications (monthly, quarterly, yearly statistics). Furthermore, it may aim to produce a Cambodia Energy Outlook and other energy-specific papers to support the policy formulation.

- **Energy Data Centre**
    - The GDE may act as the energy data centre by linking to all concerned stakeholders for data sharing as well as data collection and updating.
    - Both hardware and software (computer, software, staff) have to be equipped with GDE as the energy data centre.

Annex 6

Definition of Cambodia's Energy Products and Flows

1. Energy Products

Energy Products	Definition
1. Coal	Includes all coal, i.e. solid fossil fuel consisting of carbonised vegetal matter, such as hard coal (coking coal, other bituminous coal, sub-bituminous coal), anthracite, lignite, and peat.
3. Crude Oil and Natural Gas Liquids	Comprise crude oil, natural gas liquids (NGLs), refinery feedstock, additives, and other hydrocarbons (including emulsified oils, synthetic crude oil, mineral oils extracted from bituminous minerals such as oil shale, bituminous sand, etc., and oils from coal liquefaction).
4. Petroleum Products	Comprise motor gasoline, aviation gasoline, naphtha, jet fuel, kerosene, gas/diesel oil, fuel oil, liquefied petroleum gas (LPG), refinery gas, ethane, white spirit, lubricants, bitumen, paraffin waxes, petroleum coke, and other petroleum products.
4.1 Motor Gasoline	A mixture of some aromatics (e.g. benzene and toluene) and aliphatic hydrocarbons in the C5–C12 range. The distillation range is 25°C–220°C. Motor gasoline may also contain biogasoline products.
4.2 Naphtha	Refers to light or medium oils distilling between 30°C and 210°C which do not meet the specification for motor gasoline. The main uses for naphtha are as feedstock for high octane gasoline and the manufacture of olefins in the petrochemical industry.
4.3 Jet Fuel	A blend of kerosene suited to flight conditions with particular specifications, such as freezing point. The specifications are set down by a small number of national standards committees, most notably ASTM (United States), MOD (United Kingdom), and GOST (Russia).
4.4 Kerosene	Used for heating, cooking, lighting, solvents, and internal combustion engines. Other names of this product are burning oil, vaporising oil, power kerosene, and illuminating oil.
4.5 Gas/Diesel Oil	Diesel oils are middle distillates, predominantly of carbon number range C11–C25 and with a distillation range of 160°C–420°C. This product comprises road diesel and heating or other gas oil.
4.6 Fuel Oil	Comprises residual fuel oil and heavy fuel oil which are usually a blended product based on the residues from various refinery, distillation, and cracking processes. Residual fuel oil A-5 has a distillation range of 350°C–650°C and a kinematic viscosity in the range 6–55 centistokes (cSt) at 100°C with a flash point always above 60°C and a specific gravity above 0.95.
4.7 Liquefied Petroleum Gas (LPG)	Refers to liquefied propane (C_3H_8) and butane (C4Hl0) or mixtures of both. Commercial grades are usually mixtures of the gases with small amounts of propylene, butylene, isobutene, and isobutylene stored under pressure in containers.
4.10 Other Petroleum Products	Comprise lubricant, bitumen, white spirits and special boiling points industry spirits, paraffin wax, petroleum coke, and other products.

Energy Products	Definition
6. Hydro	The energy content of the electricity produced in hydropower plants. Hydro output excludes output from pumped storage plants.
9. Other (Combustible Renewables and Waste)	Comprise solid biomass, liquid biomass, biogas, industrial waste, and municipal waste. Biomass is defined as any plant matter used directly as fuel or converted into fuels (e.g. charcoal) or electricity and/or heat. Included here are fuelwood and wood waste, bagasse, charcoal, other biomass, and biogas. Municipal waste comprises wastes produced by the residential, commercial, and public service sectors that are collected by local authorities for disposal in a central location to produce heat and/or power. Hospital waste is included in this category.
10. Electricity	Showing final consumption and trade in electricity, which is accounted at the same heat value as electricity in final consumption (i.e. 1 MWh = 0. 086 toe).
12. Total	Defined as 1 + 3 + 4 + 6 + 9 + 10

2. Energy Flow

Energy Flows	Definition
1. Indigenous Production	The production of primary energy, i.e. hard coal, lignite/brown coal, peat, crude oil, NGL, natural gas, combustible renewables and waste, nuclear, hydro, geothermal, solar, and the heat from heat pumps that is extracted from the ambient environment. Indigenous production is calculated after removal of impurities (e.g. sulphur from natural gas).
2. Imports **and** **3. Exports**	Comprise amounts having crossed the national territorial boundaries of the country, whether or not customs clearance has taken place. • For coal: Imports and exports comprise the amount of fuels obtained from or supplied to other countries, whether or not there is an economic or customs union between the relevant countries. Coal in transit should not be included. • For oil and gas: Quantities of crude oil and oil products imported or exported under processing agreements (i.e. refining on account) are included. Quantities of oil in transit are excluded. Crude oil, NGL, and natural gas are reported as coming from the country of origin; refinery feedstock and oil products are reported as coming from the country of last consignment. Re-exports of oil imported for processing within bonded areas are shown as exports of product from the processing country to the final destination. • For electricity: Amounts are considered as imported or exported when they have crossed the national territorial boundaries of the country. If electricity is 'wheeled' or transited through a country, the amount is shown as both import and export.
4. International Marine Bunkers	The quantities delivered to ships of all flags that are engaged in international navigation, which may take place at sea, on inland lakes and waterways, and in coastal waters. Consumption by ships engaged in domestic navigation is excluded. The domestic/international split is determined based on the port of departure and port of arrival, and not by the flag or nationality of the ship. Consumption by fishing vessels and by military forces is also excluded.
5. International Aviation Bunkers	Including deliveries of aviation fuels to aircraft for international aviation. Fuels used by airlines for their road vehicles are excluded. The domestic/international split should be determined based on the departure and landing locations and not by the nationality of the airline. For many countries, this incorrectly excludes fuel used by domestically owned carriers for their international departures.
6. Stock Changes	Reflecting the difference between opening stock levels on the first day of the year and closing levels on the last day of the year of stocks on national territory held by producers, importers, energy transformation industries, and large consumers. A stock build is shown as a negative number, and a stock draw as a positive number.
7. Total Primary Energy Supply (TPES)	Equals Indigenous Production + Imports − Exports − International Marine Bunkers − International Aviation Bunkers ± Stock Changes
8. Transfers	Include interproduct transfers, products transferred, and recycled products (e.g. used lubricants which are reprocessed).
9. Total Transformation Sector	Transformation is the process where part or all of the energy content of a product entering a process moves to one or more different products leaving the process (e.g. coking coal to coke, crude oil to petroleum products, and heavy fuel oil to electricity). The total is the sum of transformation input (negative number) and

Energy Flows	Definition
	transformation output (positive number) of various energy industries.
9.1 Main Activity Producers	Generating electricity and/or heat for sale to third parties is their primary activity. They may be privately or publicly owned. Note that the sale need not take place through the public grid. Columns 1–9 show the use of primary and secondary fuels for the production of electricity and/or heat as negative entries. Gross electricity and/or heat produced (including power stations' own consumption) appears as a positive quantity in the electricity and heat column. Transformation losses appear in the total column as a negative number.
9.8 Charcoal Processing	Recording the transformation of fuelwood or other vegetal matter to produce charcoal. The quantity of fuelwood or other vegetal matter input is recorded as a negative number, whereas the output of charcoal is recorded as a positive number.
10. Loss and Own Use	Losses include distribution and transmission losses in gas distribution, electricity transmission, and coal transport. Own use contains the primary and secondary energy consumed by transformation industries for heating, pumping, traction, and lighting purposes (ISIC4 Divisions 10-12, 23, and 40). These quantities are shown as negative figures. Included here are, for example, own use of energy in coal mines, own consumption in power plants (which includes net electricity consumed for pumped storage), and energy used for oil and gas extraction.
11. Discrepancy	Includes the sum of the unexplained statistical differences for individual fuels as they appear in the basic energy statistics. It also includes the statistical differences that arise because of the variety of conversion factors in the coal and oil columns.
12. Total Final Energy Consumption (TFC)	The sum of consumption by the different end-use sectors. Backflows from the petrochemical industry are not included in final consumption.
13. Industry Sector	Specified in the following subsectors (energy used for transport by industry is not included here but is reported under transport): • Iron and steel industry (ISIC Group 271 and Class 2731); • Chemical (incl. petrochemical) industry (ISIC Division 24) excluding petrochemical feedstock; • Non-ferrous metals basic industries (ISIC Group 272 and Class 2732); • Non-metallic minerals such as glass, ceramic, cement, etc. (ISIC Division 26); • Transport equipment (ISIC Divisions 34 and 35); • Machinery comprising fabricated metal products, machinery and equipment other than transport equipment (ISIC Divisions 28 to 32); • Mining (excluding fuels) and quarrying (ISIC Divisions 13 and 14); • Food, beverages, and tobacco (ISIC Divisions 15 and 16); • Paper, pulp, and printing (ISIC Divisions 21 and 22); • Wood and wood products (other than pulp and paper) (ISIC Division 20); • Construction (ISIC Division 45); • Textile and leather (ISIC Divisions 17–19); • Other industry (any manufacturing industry not included above) (ISIC Divisions 25, 33, 36, and 37). Note: The other industry row is also used when there is difficulty breaking down industrial subsectors. This number should be treated with caution.
14. Transport Sector	Includes all fuels used for transport (ISIC Divisions 60–62) except international marine bunkers and international aviation bunkers. It includes transport in the industry sector and covers domestic aviation, road, rail, pipeline transport, domestic navigation, and non-specified transport. Domestic aviation includes deliveries of

Energy Flows	Definition
	aviation fuels to aircraft for domestic aviation (commercial, private, agriculture, etc.). It includes use for purposes other than flying, e.g. bench testing of engines, but not airline use of fuel for road transport. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. Fuel used for ocean, coastal and inland fishing (included under fishing), and military consumption (included in other sectors not specified) are excluded from the transport sector.
14.1 Domestic Air Transport	Quantities of aviation fuels delivered to aircraft for domestic aviation (commercial, private, agricultural, etc.). Includes fuel used for purposes other than flying, e.g. bench testing of engines. The domestic/international split should be determined on the basis of departure and landing locations and not by the nationality of the airline. Note that this may include journeys of considerable length between two airports in an economy (e.g. San Francisco to Honolulu). Excludes fuels used by airlines for their road vehicles (see not elsewhere specified – transport sector) and military use of aviation fuels (see not elsewhere specified – other sectors).
14.2 Road	Oil for use in road vehicles. Includes fuel used by agricultural vehicles on highways and lubricants for use in road vehicles. Excludes motor gasoline and diesel used in stationary engines (see not elsewhere specified – other sectors), diesel oil for non–highway use in tractors (see agriculture/forestry – other sectors), military use (see not elsewhere specified – other sectors), and gas oil used in engines at construction sites (see construction – industry sector).
15. Other sector	Covers residential, commercial, and public services (ISIC Divisions 41, 50–52, 55, 63–67, 70–75, 80, 85, 90–93, 95, and 99); agriculture (ISIC Divisions 01 and 02); fishing (ISIC Division 05); and others. Others include military fuel use for all mobile and stationary consumption (e.g. ships, aircraft, road, and energy used in living quarters) regardless of whether the fuel delivered is for the military of that country or for the military of another country.
15.1 Residential and Commercial	Defined as 15.1.1 + 15.1.2
15.1.1 Commercial and Public Services	ISIC Divisions and NACE Divisions 33, 36, 37, 38, 39, 45, 46, 47, 52, 53, 55, 56, 58, 59, 60, 61, 62, 63, 64, 65, 66, 68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 79, 80, 81, 82, 84 (excl. Class 8422), 85, 86, 87, 88, 90, 91, 92, 93, 94, 95, 96, and 99. Oil consumed by businesses and offices in the public and private sectors. Note that oil use at railway stations, bus stations, shipping piers, and airports should be reported in this category and not shown in the transport sector.
15.1.2 Residential	Fuels consumed by all households including households with employed persons (ISIC and NACE Divisions 97 and 98).
15.2 Agriculture	Oil consumption by users classified as agriculture, hunting, and forestry. ISIC Divisions 01 and 02 (NACE Divisions 01 and 02).
15.3 Others	Activities not included elsewhere, please specify. This category includes military use.
16. Non-energy Use	Covers those fuels that are used as raw materials in the different sectors and not consumed as a fuel or transformed into another fuel. Non-energy use is shown separately in final consumption under the heading non-energy use.

Annex 7

Cambodia's Energy Demand Outlook

Cambodia's energy needs have been forecasted until 2035. The forecast was made as part of the Study on Petroleum Demand Projection Modelling in Cambodia. The study was conducted in 2015 by the Economic Research Institute for ASEAN and East Asia (ERIA) in collaboration with the Institute of Energy Economics, Japan (IEEJ) and the General Department of Petroleum, Ministry of Mines and Energy (MME), Cambodia. The following are the major results of the projection:

Table A7.1 Final Energy Consumption by Sector

	Historical			Projection				Average Annual Growth Rates, %			
	1995	2005	2012	2015	2025	2030	2035	1995-2012	2012-2025	2025-2035	2012-2035
Industry	438	693	884	895	1,138	1,474	2,140	4.2	2.0	6.5	3.9
Transport	382	441	1,223	1,489	2,457	3,135	3,976	7.1	5.5	4.9	5.3
Other Sector	1,716	1,653	2,904	3,073	3,819	4,312	4,889	3.1	2.1	2.5	2.3
Commercial	3	20	72	91	192	262	343	21.2	7.8	6.0	7.0
Residential	1,712	1,629	2,822	2,971	3,601	4,014	4,498	3.0	1.9	2.2	2.0
Others	1	4	9	12	25	36	48	14.5	7.9	6.5	7.3
Non-energy	8	10	14	17	25	30	36	3.7	4.2	3.8	4.0
Total	**2,543**	**2,798**	**5,025**	**5,473**	**7,438**	**8,951**	**11,041**	**4.1**	**3.1**	**4.0**	**3.5**

Figure A7.1 Evolution of Final Energy Consumption by Sector

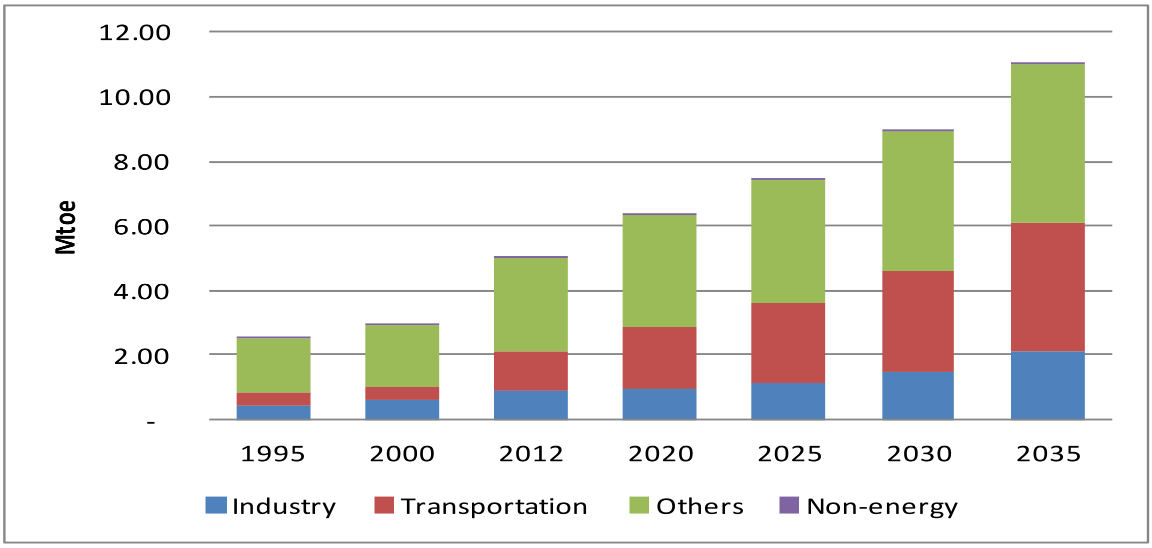


Table A7.2 Final Energy Consumption by Fuel

	Historical			Projection				Average Annual Growth Rates, %			
	1995	2005	2012	2015	2025	2030	2035	1995-2012	2012-2025	2025-2035	2012-2035
Biomass	1,854	1,834	2,725	2,763	2,868	2,913	2,956	2.3	0.4	0.3	0.4
Charcoal	239	335	598	616	667	690	711	5.6	0.8	0.6	0.8
Gasoline	138	132	393	499	724	854	1,002	6.4	4.8	3.3	4.1
Diesel	247	317	843	1,014	1,747	2,284	2,960	7.5	5.8	5.4	5.6
Fuel Oil	4	26	70	45	63	75	90	18.3	(0.8)	3.5	1.1
LPG	2	35	100	166	388	520	655	24.6	11.0	5.4	8.5
Jet Kerosene	12	21	33	44	73	80	87	6.0	6.2	1.9	4.3
Kerosene	39	31	6	6	3	1	-	-10.1	-6.1	-	-
Lubricants	8	10	14	17	25	30	36	3.7	4.2	3.8	4.0
Electricity	10	74	260	345	946	1,576	2,622	20.9	10.4	10.7	10.6
Total	**2,554**	**2,815**	**5,044**	**5,512**	**7,503**	**9,023**	**11,118**	**4.1**	**3.1**	**4.0**	**3.5**
Oil	*451*	*572*	*1,460*	*1,789*	*3,022*	*3,845*	*4,829*	*7.2*	*5.8*	*4.8*	*5.3*

Figure A7.2 Evolution of Final Energy Consumption by Fuel

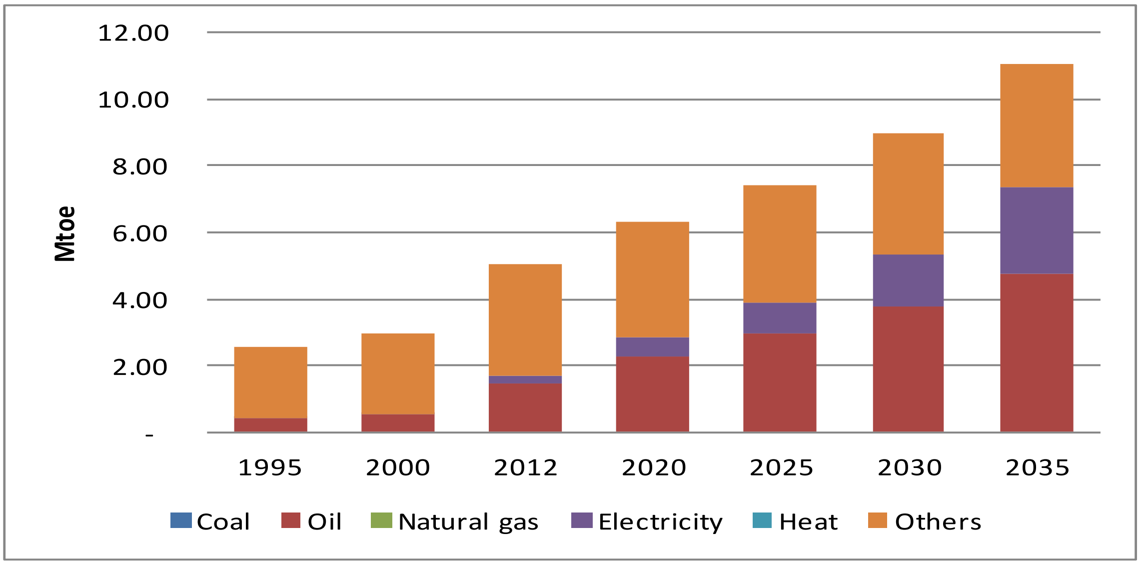


Table A7.3 Primary Energy Supply

	Historical			Projection				Compounded Annual Growth Rates, %			
	1995	2005	2012	2015	2025	2030	2035	1995-2012	2012-2025	2025-2035	2012-2035
Coal	0.0	0.0	8.1	564.2	1,624.9	1,568.8	1,555.7	-	50.4	-0.2	25.7
Oil	511.3	761.7	1,550.0	1,759.5	3,274.5	4,073.4	5,051.8	6.7	5.9	2.3	5.3
Crude Oil	0.0	0.0	0.0	0.0	5,305.1	5,305.1	5,305.1	-	-	-	-
Oil Products	511.3	761.7	1,550.0	1,759.5	-2,030.6	-1,231.8	-253.4	6.7	-202.1	-10.4	-192.4
Hydropower	0.0	3.8	2.2	219.6	542.4	1,261.5	2,421.4	-	52.5	8.2	35.5
Others	2,325.4	2,494.5	3,735.6	3,941.5	4,146.3	4,234.1	4,319.1	2.8	0.8	0.2	0.6
Renewables	0.0	0.1	0.3	0.3	0.3	0.3	0.3	-	-0.1	0.0	0.0
Biomass	2,325.4	2,491.9	3,618.6	3,963.8	4,168.6	4,256.5	4,341.4	2.6	1.1	0.2	0.8
Electricity	0.0	2.5	116.7	-22.6	-22.6	-22.6	-22.6	-	-188.1	0.0	-193.1
Total	2,836.7	3,259.9	5,295.9	6,484.8	9,588.1	11,137.8	13,347.9	3.7	4.7	1.8	4.1

Figure A7.3 Evolution of Primary Energy Supply

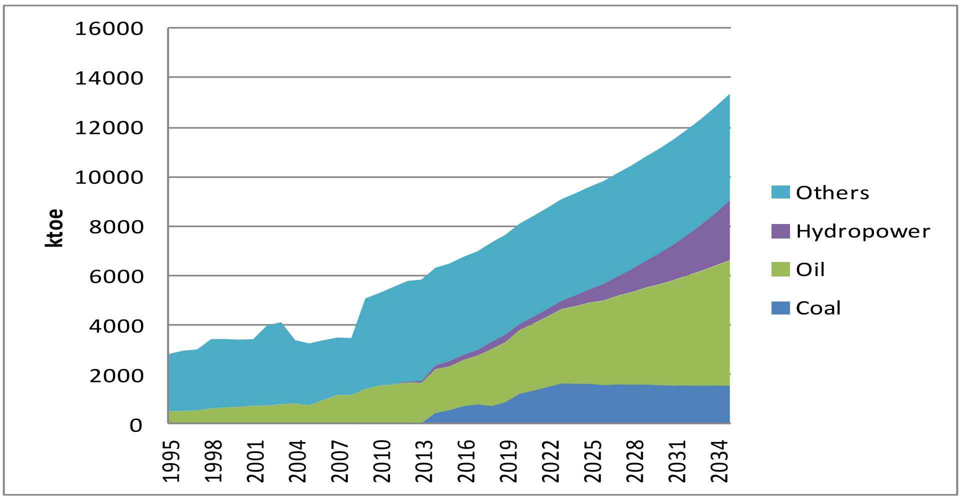


Table A7.4 Energy Balance Table of Cambodia in 2035

Energy Balance for Cambodia
Scenario: BAU, Year: 2035, Units: Thousand Tonnes of Oil Equivalent

	Solid Fuels	Crude Oil	Hydropower	Renewables	Biomass	Electricity	Oil Products	Total
Production	-	-	2,421.4	0.3	4,341.4	-	-	6,763.1
Imports	1,555.7	5,305.1	-	-	-	-	1,227.6	8,088.5
Exports	-	-	-	-	-	(22.6)	(1,481.0)	(1,503.6)
Total Primary Supply	1,555.7	5,305.1	2,421.4	0.3	4,341.4	(22.6)	(253.4)	13,347.9
Charcoal Production	-	-	-	-	(667.2)	-	-	(667.2)
Oil Refining	-	(5,305.1)	-	-	-	-	5,004.8	(300.4)
Electricity Generation	(1,555.7)	-	(2,421.4)	(0.3)	(7.4)	2,918.5	-	(1,066.3)
Transmission and Distribution	-	-	-	-	-	(273.4)	-	(273.4)
Total Transformation	(1,555.7)	(5,305.1)	(2,421.4)	(0.3)	(674.6)	2,645.1	5,004.8	(2,307.2)
Industry	-	-	-	-	570.6	1,373.5	196.1	2,140.2
Transport	-	-	-	-	-	-	3,976.1	3,976.1
Other Sectors	-	-	-	-	3,096.2	1,249.0	543.4	4,888.6
Non Energy	-	-	-	-	-	-	35.8	35.8
Total Demand	-	-	-	-	3,666.8	2,622.5	4,751.4	11,040.7