GUIDELINES ON ENERGY AUDIT REPORT

[GP/ST/No.49/2024]

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ENERGY EFFICIENCY AND CONSERVATION ACT 2024
[*Act 861*]

GUIDELINES ON ENERGY AUDIT REPORT

GP/ST/No.49/2024

IN exercise of the power conferred by subsections 9(1) and14(1) and section 67 of the Energy Efficiency and Conservation Act 2024 [*Act 861*], the Commission issues the following guidelines:

Citation and commencement

1. These Guidelines may be cited as the Guidelines on Energy Audit Report.

2. These Guidelines shall come into operation on 1 January 2025.

Purpose

3. The purpose of these Guidelines are—

(a) to set the requirements for an energy audit report that shall be prepared by a Registered Energy Auditor on the findings of the energy audit conducted; and

(b) to establish a structured framework for organizing and presenting the findings and recommendations resulting from energy audit activities.

Dated: 30 December 2024

DATO' IR. TS. ABDUL RAZIB BIN DAWOOD
Chief Executive Officer
Energy Commission

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1. SCOPE

These Guidelines shall apply to any registered energy auditor who is required to prepare an energy audit report pursuant to subsections 9(1) and 14(1) of the Energy Efficiency and Conservation Act 2024 [*Act 861*].

2. INTERPRETATION

In these Guidelines, the following terms shall bear the following meanings:

"Act"	means the Energy Efficiency and Conservation Act 2024 [*Act 861*];
"Commission"	has the same meaning assigned to it in the Act;
"ESM"	means Energy Saving Measure which refers to range of actions, strategies, and practices implemented to reduce energy consumption and improve energy efficiency in various systems, processes, and operations;
"GFA"	means the Gross Floor Area which refers to the total area of floor space within a building, as measured between the external sides of wall or, in the case of party walls, between the centres of such walls but it excludes the following areas: *(a)* parking spaces and circulation areas, including any mechanical or electrical spaces within the parking area of the building; *(b)* open or covered parking area outside the building; *(c)* staircases and lift shafts on floors other than the ground floor or lobby; *(d)* waiting area for commercial vehicles unloading goods;

(e) gardens or recreational facilities for residents provided on the rooftop or podium in open or semi-open spaces;

(f) pedestrian pathway connected to the building or transit station, including any supporting activities; and

(g) pedestrian pathways within building functioning as public walkways.

"POE" means the Percentage Of Energy which refers to the fraction of energy used from the total energy consumption of each month to produce each product for that month in percentage;

"REA" means a Registered Energy Auditor who has the same meaning assigned to it in the Act;

"SEC" means Specific Energy Consumption which refers to the amount of energy consumed per unit of output or activity in a specific process, system, or sector; and

"SEU" means Significant Energy Use which refers to any system, proses, or equipment within an organization that consumes a substantial amount of energy.

"UOM" means Unit of Measurement.

3. INTRODUCTION

3.1 An energy audit is defined as a systematic and objective assessment of energy needs, consumption and efficiency.

3.2 The energy audit shall be conducted in compliance with the provisions related to safety under the Electricity Supply Act 1990 [*Act 447*], the Gas Supply Act 1993 [*Act 501*] and any other law related to safety.

4. ENERGY AUDIT REPORT

4.1 The energy audit report shall be prepared by the REA and shall include the following details:

(a) cover page;
(b) declaration;
(c) executive summary;
(d) introduction;
(e) energy audit methodology;
(f) details of operation of the facility;
(g) description of the equipment or system audited;
(h) description of baseline;
(i) observation and findings;
(j) analysis and identification of ESM;
(k) ESM improvement plan; and
(l) appendices.

A. COVER PAGE

4.1.1 The cover page of the energy audit report shall contain the following details:

(a) the title of the energy audit report based on the format below:
"ENERGY AUDIT REPORT FOR …….(INSERT FACILITY NAME)……."
(b) the name and full address of the facility; and
(c) the name and the certificate of registration number of the REA.

4.1.2 An example of cover page of energy audit report is shown in Figure 1:

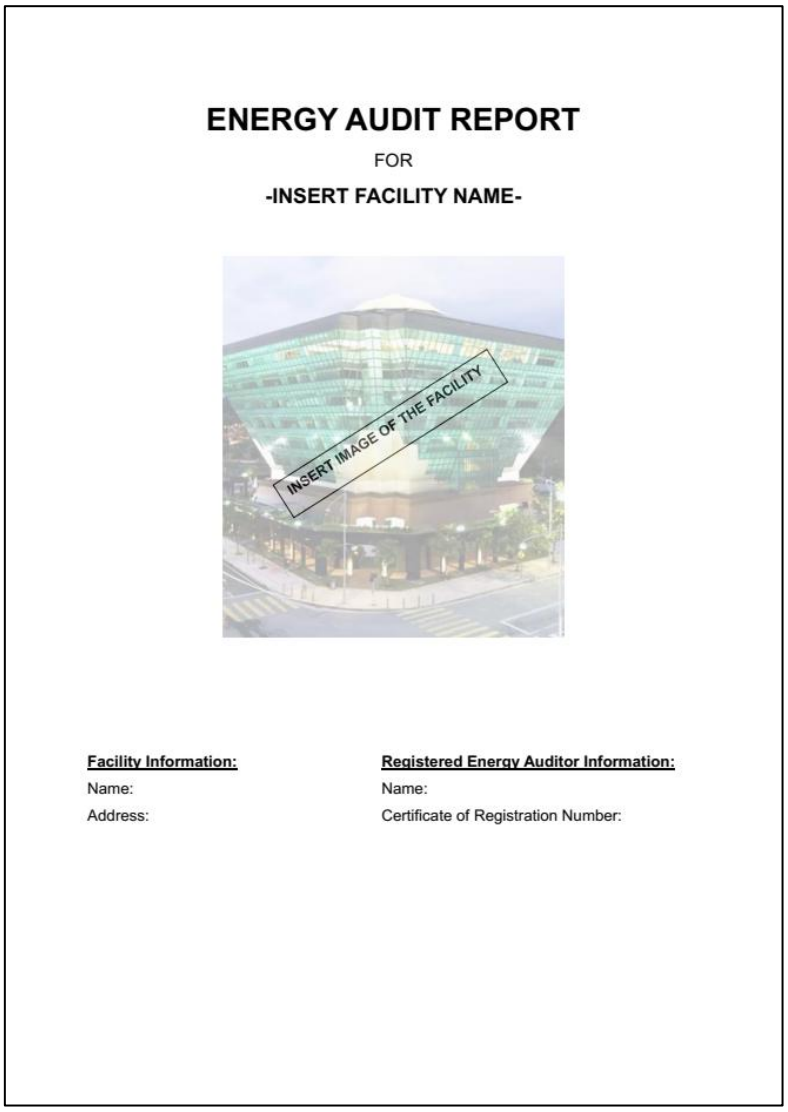


Figure 1: Example of Cover Page for Energy Audit Report

B. DECLARATION

4.1.3 The declaration page shall include the following:

(a) an assertion by the REA that the energy audit has been conducted and the information presented in the energy audit report prepared by the REA is accurate, complete and verified to the best of his knowledge and expertise;

(b) a statement confirming that the energy audit report has been prepared in accordance with these Guidelines;

(c) a statement emphasizing the obligation of REA to maintain confidentiality of the information obtained from the energy audit activity and any information contained in the energy audit report;

(d) an acknowledgment by the energy consumer or person in charge of a building that they have received the energy audit report, reviewed the contents of the report, and have accepted responsibility for taking appropriate actions based on the energy audit findings and recommendations;

(e) the signatures of the REA, energy consumer or person in charge of a building with the date; and

(f) a copy of the REA's certificate of registration and practicing certificates.

Sample of Declaration Page by REA

Declaration by Registered Energy Auditor

I, [*Name of REA*], hereby declare that –

(a) I have conducted the energy audit;

(b) I have ensured the accuracy and completeness of the energy audit report to the best of my knowledge and expertise;

(c) I have prepared the energy audit report in accordance with the Guidelines on Energy Audit Report issued by the Commission; and

(d) I shall be responsible for the preservation of confidentiality, integrity and availability of the information obtained when conducting the energy audit and when preparing the energy audit report.

Signature: _____ Date: _____

[Name of REA]

[REA Certificate of Registration number]

Acknowledgment by Facility Representative

I, [*Name of Facility Representative], hereby acknowledges receipt of the energy audit report prepared by the REA [Name of REA], confirms that I have reviewed the contents of the energy audit report and accepts responsibility to take appropriate actions and measures based on the energy audit findings and recommendations in the energy audit report.

Signature: _____ Date: _____

[Name of Facility Representative]

[Position/Title]

Note:

*Facility Representative refers to the energy consumer or the person in charge of a building who is responsible for overseeing the implementation of energy-saving initiatives of the facility.

C. EXECUTIVE SUMMARY

4.1.4 The executive summary of the energy audit report shall include but not limited to the following:

(a) the objectives of the energy audit;

(b) the scope of the energy audit;

(c) a summary information on the systems or equipment audited;

(d) a summary information on the following for the baseline period:

(i) the energy or energy resources consumption of the energy consumer or building;

(ii) for the industry sector, the production data and its SEC; and

(iii) for the commercial sector, the GFA or any variables in determining the energy intensity performance.

For example, the energy intensity performance for an office building shall be "BEI office building" as defined in the Guidelines in Ascertaining a Building and The Energy Intensity Performance of a Building issued by the Commission;

(e) load apportioning; and

(f) a brief summarized description of the ESM recommendations.

4.1.5 The summary information for the baseline period as mentioned in subparagraph 4.1.4*(d)* shall be presented in table format as shown in Table 1 and Table 2.

***Baseline period**				**(mm/yyyy – mm/yyyy)**	
Energy or Energy Resources					
Type	**Account**	**Energy**		****Energy [GJ]**	
Energy or Energy Resources Type (example "Electricity", if more than one, add new row below)	*Supplier of energy account number associated with the energy or energy resources*	*Amount*	*UOM (example kWh)*	*Amount in GJ*	
			Total Energy [GJ]	*Amount*	
Products and Specific Energy Consumption					
Product Type	**Product Name**	**Production**		**POE [%]**	**SEC**
Products Type (example "Cement", if more than one, add new row below)	*Products name (example "White Cement")*	*Amount*	*UOM (example MT)*	*Amount*	*Amount*	*UOM (example GJ/MT)*
*****Variables**					
Name				**Variables**	
Variable Name, if any (example "Down Time", if more than one, add new row below)				*Amount*	*UOM (example hour)*

Table 1: Summary information for the baseline period for Industry sector.

***Baseline period**				**(mm/yyyy – mm/yyyy)**
Energy or Energy Resources				
Type	**Account**	**Energy**		****Energy [GJ]**
Energy or Energy Resources name (example "Electricity", if more than one, add new row below)	*Supplier of energy account number associated with the energy or energy resources*	*Amount*	*UOM (example kWh)*	*Amount in GJ*
			Total Energy [GJ]	
*****Variables**				
Name			**Variables**	
Variable Name (example "Gross Floor Area", if more than one, add new row below)			*Amount*	*UOM (example m^2)*
Energy Intensity Performance				
Amount				*UOM (example GJ/ m^2)*

Table 2: Summary information for the baseline period for Commercial sector

Note:

*the baseline period shall be in month and year as specified in the tables above.

**for conversion to GJ, please refer to the Appendix F: Conversion Coefficients and Equivalence

***examples of variable data may be referred to in the Guidelines on Energy Management System issued by the Commission.

(a) for additional information, the energy consumer or person in charge of a building may report the equivalent CO_2 emission from energy consumption.

(b) for carbon emission conversion, it can be referred to the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.

4.1.6 The summary description of ESM recommendations as mentioned in subparagraph 4.1.4*(f)* shall be presented in table format as shown in Table 3:

No Cost or Low-Cost Measures						
***Category**	***Type**	**Description**	**Estimated Yearly Savings (GJ)**	**Estimated Yearly Savings Cost (MYR)**	**Estimated Investment Cost (MYR)**	**Estimated Simple Payback Period (Years)**
Total						

Medium-Cost Measures						
***Category**	***Type**	**Description**	**Estimated Yearly Savings (GJ)**	**Estimated Yearly Savings Cost (MYR)**	**Estimated Investment Cost (MYR)**	**Estimated Simple Payback Period (Years)**
Total						

High-Cost Measures						
***Category**	***Type**	**Description**	**Estimated Yearly Savings (GJ)**	**Estimated Yearly Savings Cost (MYR)**	**Estimated Investment Cost (MYR)**	**Estimated Simple Payback Period (Years)**
Total						

Table 3: Summary of the ESM recommendations

Note:

*for “Category” and “Type”, reference shall be made to the Guidelines on Energy Efficiency and Conservation Report issued by the Commission.

D. INTRODUCTION

4.1.7 The introduction for the energy audit report shall include the following:

(a) the details on audited facility

(i) the basic information about the location, business activities, number of employees of organization, sector, and subsector of the facility. The selection of “Sector” and “Subsector” can be referred to Appendix B of the Guidelines on Energy Efficiency and Conservation Report issued by the Commission;

(ii) the energy management system review of the audited facility, for example the energy matrix;

(iii) the summary from previous energy audit report, if any, as listed below:

A. the date of the last energy audit report;
B. the list of the ESM; and
C. potential energy saving value in GJ per year, RM per year, and annual percentage of saving;

(iv) the status of implementation of the ESM from the previous energy audit, if any;

(v) for industry sector, the following information shall be reported:

A. the type of product, which may be referred to in Appendix B of the Guidelines on Energy Efficiency and Conservation Report issued by the Commission;
B. the name of the product;
C. the UOM; and
D. the historical production trend, which is the value of products produced during the baseline period; and

(vi) for commercial sector, the following information shall be reported:

A. the GFA [m^2];
B. the air-conditioned area [m^2];

C. the data centre area [m²];
D. the enclosed parking area [m²];
E. the external corridor area [m²]; and
F. the historical of applicable variables trend for the baseline period;

(b) a brief description of all energy or energy resources consumed at the facility;

(c) the constraints faced while conducting the energy audit; and

(d) the justification on the scope of the energy audit conducted by the REA.

E. ENERGY AUDIT METHODOLOGY

4.1.8 The energy audit report shall include the following:

(a) a chronology and brief description of the methods taken by the REA in conducting the energy audit, which includes but not limited to:

(i) initial discussions with the owner of the facility;
(ii) the date and period of data collection;
(iii) data collection analysis;
(iv) identification of recommendation of ESM; and
(v) report writing; and

(b) a list of the measurement tools used by the REA to conduct the energy audit, which includes but not limited to:

(i) energy data logger;
(ii) flow data logger; and
(iii) meter.

The measuring tools used for the purpose to conduct the energy audit shall be calibrated once every two years and the calibration record shall be included in the energy audit report as part of its appendices.

F. DETAILS OF OPERATION OF THE FACILITY

This section shall provide detailed description of the function and operation of the facility that may include the detail of production process, operation hours, type of machinery used, and significant energy consumption machinery or equipment.

G. DESCRIPTION OF THE EQUIPMENT OR SYSTEM AUDITED

4.1.9 The energy audit report shall include the description of the electrical equipment or system audited which consist of the following:

(a) the description of the main incoming electricity supply.
the report shall provide information about the electrical distribution system of the facility and a single line diagram which includes but not limited to –
(i) the incoming voltage level;
(ii) the rating and number of transformers installed; and
(iii) the electricity tariff used.

(b) the plot of main incoming electrical load profile (kW) with analysis for a minimum of seven days and covering the full operation cycle of the facility. Examples of the plot of main incoming electrical load profile are shown in Figure 2 and Figure 3, respectively.

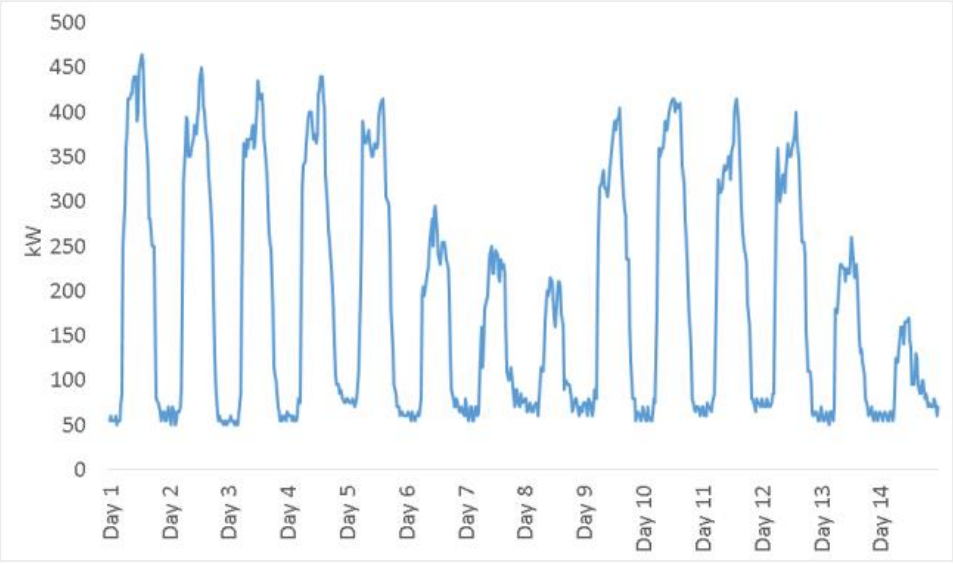


Figure 2: Example plot of main incoming electrical load profile over 14 days.

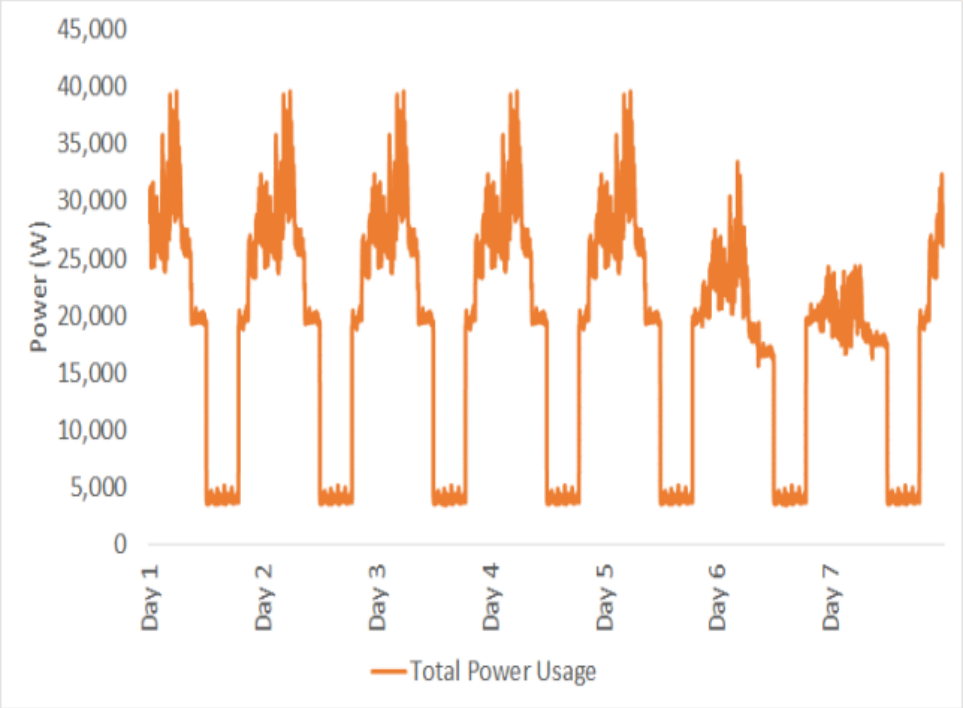


Figure 3: Example plot of main incoming electrical load profile over 7 days.

(c) the identification of the SEU for electrical energy which shall include the following:

(i) the methodology used to identify the SEU;

(ii) the technical description and plot of the electrical load profile of the identified SEU which includes but not limited to –

A. lighting system;

B. air conditioning system including –

i. chiller;

ii. cooling tower;

iii. Air Handling Unit; or

iv. split unit air conditioning system;

C. motor system;

D. pump system;

E. air compressor system;

F. industrial furnace system;

G. oven system;

H. lift system; or

I. escalator.

4.1.10 The energy audit report shall include the description of the thermal equipment or system audited which consist of the following:

(a) the description on the main thermal energy supply.

the report shall provide information about the thermal energy supply collection, distribution or storages systems and a thermal energy flow diagram as shown in Figure 4 below:

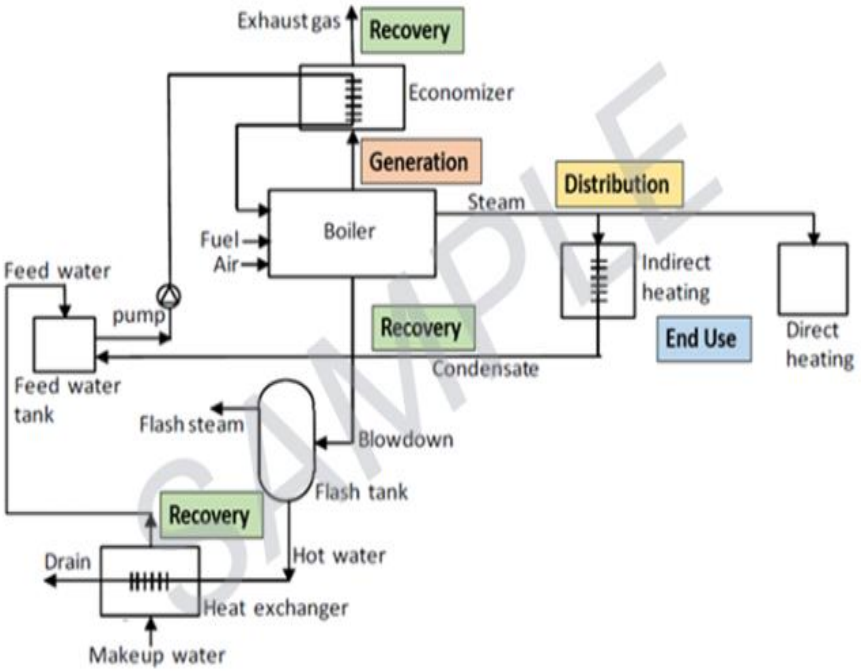


Figure 4: Sample of thermal energy flow diagram

(b) the technical description on the thermal energy of the facility which includes but not limited to –

(i) heat generation and distribution;

(ii) heat-use processes;

(iii) waste heat utilization; or

(iv) co-generation.

(c) the identification of SEU for thermal energy which shall include the following:

(i) the methodology used to identify the SEU;

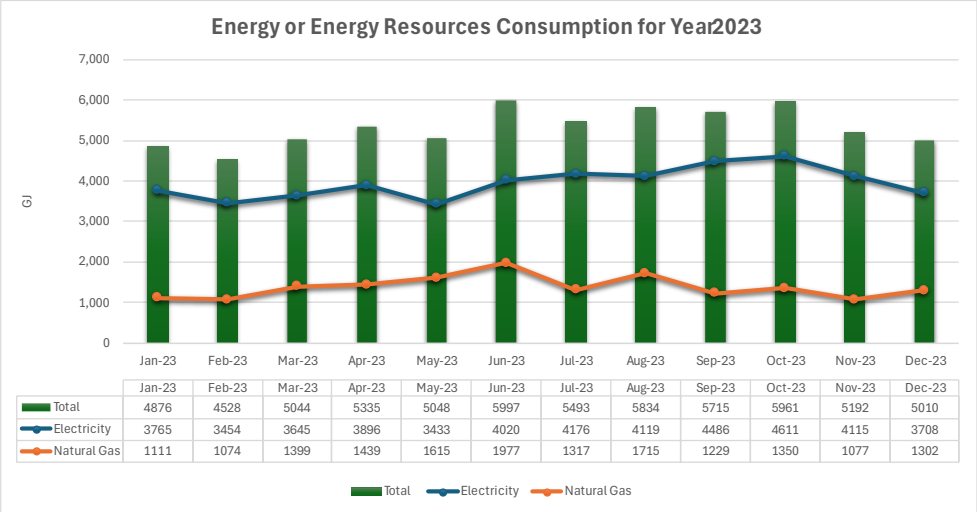
(ii) the technical description and plot of the thermal load profile of the identified SEU which includes but not limited to –

A. reactor;
B. boiler system;
C. dryer system;
D. industrial furnace system such as kiln or oven;
E. heat exchanger;
F. preheater;
G. chiller;
H. absorption chiller system;
I. co-generation system;
J. steam system;
K. thermal oil heater system; or
L. heat pump system.

H. DESCRIPTION OF BASELINE

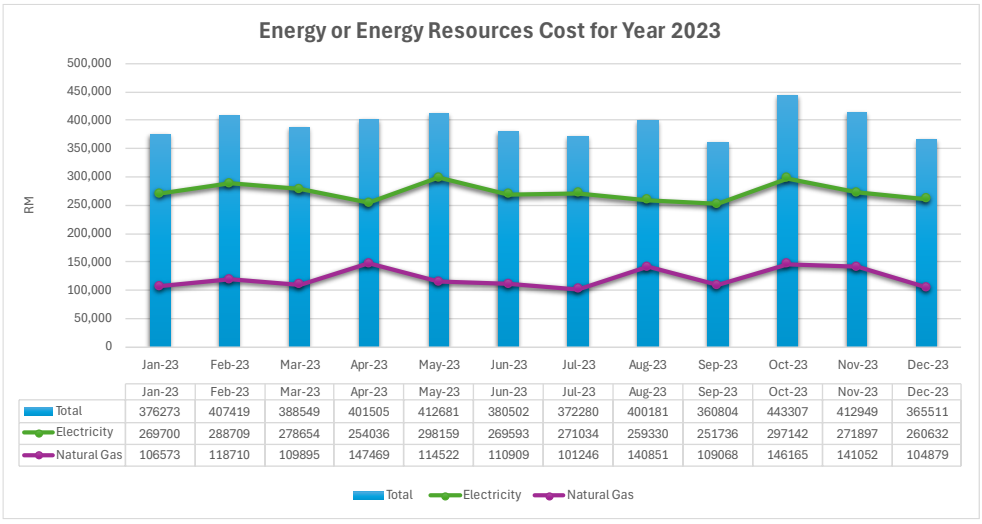
4.1.11 The energy audit report shall include the description of the establishment of energy baseline for a minimum of 12 months which includes:

(a) the historical energy or energy resources consumption trend with cost and type of energy or energy resources breakdown, as shown in the example in Figure 5 and Figure 6;
(b) the historical production data;
(c) historical variables data;



	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Total	4876	4528	5044	5335	5048	5997	5493	5834	5715	5961	5192	5010
Electricity	3765	3454	3645	3896	3433	4020	4176	4119	4486	4611	4115	3708
Natural Gas	1111	1074	1399	1439	1615	1977	1317	1715	1229	1350	1077	1302

Figure 5: Example of plot of historical energy or energy resources consumption trend



	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Total	376273	407419	388549	401505	412681	380502	372280	400181	360804	443307	412949	365511
Electricity	269700	288709	278654	254036	298159	269593	271034	259330	251736	297142	271897	260632
Natural Gas	106573	118710	109895	147469	114522	110909	101246	140851	109068	146165	141052	104879

Figure 6: Example of plot of historical energy or energy resources cost trend

4.1.12 The baseline regression analysis for the relationship between energy or energy resources consumption and relevant variables such as the operating hours, production output, etc.;

4.1.13 The SEC for industrial sector or the energy intensity performance for commercial sector.

I. OBSERVATION AND FINDINGS

4.1.14 The energy audit report shall provide the findings on the electrical equipment or system which consist of the following:

(a) load apportioning;

the findings shall provide the distribution of the total electrical energy consumption among the electrical SEU, based on the load data collected, as shown in the examples in Figure 7 and Figure 8 below:

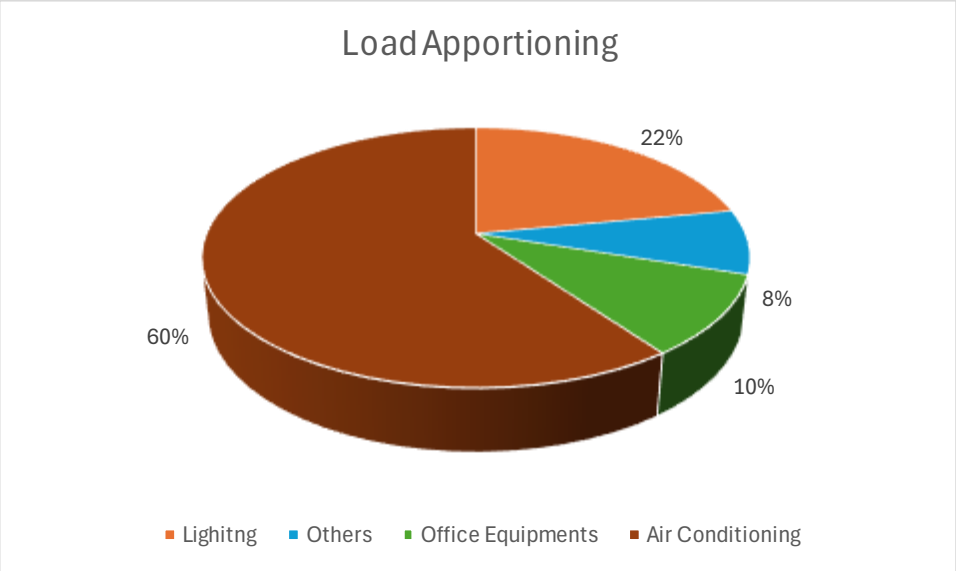


Figure 7: Example of load apportioning for commercial sector

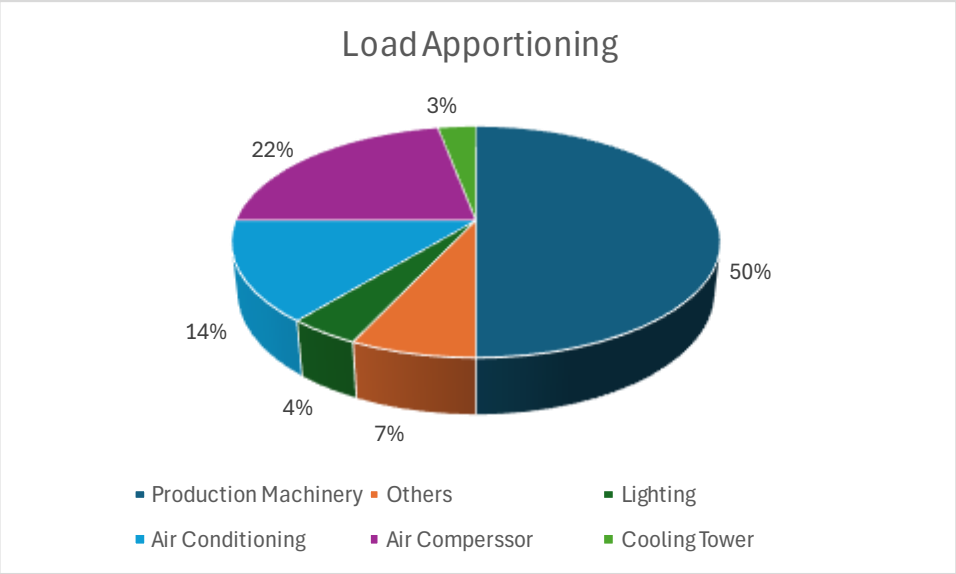


Figure 8: Example of load apportioning for industrial sector

(b) energy supply and consumption analysis which includes but not limited to load factor, maximum demand, type of tariff and power factor value; and

(c) where applicable, the data and specific findings on identified SEU, focusing on details that includes but not limited to as follows:

(i) for lighting system –

A. the lux level;
B. the operation hours;
C. the lighting control system;
D. the maintenance and lighting application; or
E. the human behavior.

The sample for the data collection form for lighting system can be referred to in Appendix A of these Guidelines.

(ii) for air conditioning system, the related measurements such as the temperature setting, operation hours, control system, schedule arrangement, maintenance, indoor air quality, human behavior, etc.

for air conditioning equipped with chiller system, the data includes the heat balance, thermistor accuracy and flow accuracy.

for air conditioning equipped with air handling unit (AHU), the measurements includes –

A. the air handling pressure drop;
B. the airflow and duct pressure loss;
C. the AHU supply and return air parameters such as the flow rate, dry bulb, wet bulb and dew point;
D. the fresh air intake parameters such as the flow, temperature, dew point or the relative humidity;
E. the room conditions such as its relative humidity and temperature for selected areas;
F. the AHU efficiency;

G. the state of operation of the AHU, which refers to whether the AHU operation is at overcapacity or under capacity;
H. the control valve operations; and
I. the thermal comfort.

The sample of the data collection form for air conditioning, chiller system and AHU can be referred to in Appendix B of these Guidelines.

(iii) for motor system, the related measurements such as the corresponding load characteristics;

(iv) for pump system, the measurements such as –
A. the pump head;
B. the flow and differential head;
C. any issues related to over-pumping; and
D. cavitation.;

(v) for air compressor system, the related measurements such as –
A. the output capacity at the main header;
B. the operating and idling time of compressors;
C. the pressure drop profile;
D. the result of any leakage test and controls;
E. the user side demand check; and
F. the pipe sizing and design.;

(vi) for industrial furnace system, the related measurements such as –
A. the electricity consumption;
B. the fuel and air use;
C. the air-fuel ratio;
D. the temperature of heating zone;
E. the furnace walls and outlet;
F. the heat loss through infiltration and walls;
G. the potential heat recovery; and
H. the basis or method used in any calculative analysis.

(vii) for oven system, the related information or data such as –

A. the type of oven;

B. the operational temperature;

C. the output temperature;

D. the product quality;

E. the comparison between the efficiency of the oven system with the original design condition or best available technology of the oven system; and

F. the potential heat loss through infiltration and walls.

(viii) any related output parameter data for other electrical equipment or system.

4.1.15 The energy audit report shall provide the findings on the thermal equipment or system which consist of the following:

(a) the description of the thermal flow as follows:

A. stream list. A stream list is an organized representation of different streams of thermal energy inputs and outputs in a system.

The stream list description includes the types of stream, its temperature, flow rate, energy content and other related input and output of the description of the thermal energy. The stream list shall be presented in table form as shown in Table 4.

Stream Description	Temperature (°C)	Flow Rate (kg/h)
Hot Water Inlet	80	500
Hot Water Outlet	40	500
Steam Inlet	150	200
Condensate Outlet	90	200
Cooling Water Inlet	25	800
Cooling Water Outlet	35	800

Table 4: Sample of stream list

B. an energy balance diagram which shall be presented in the form of a Sankey diagram.

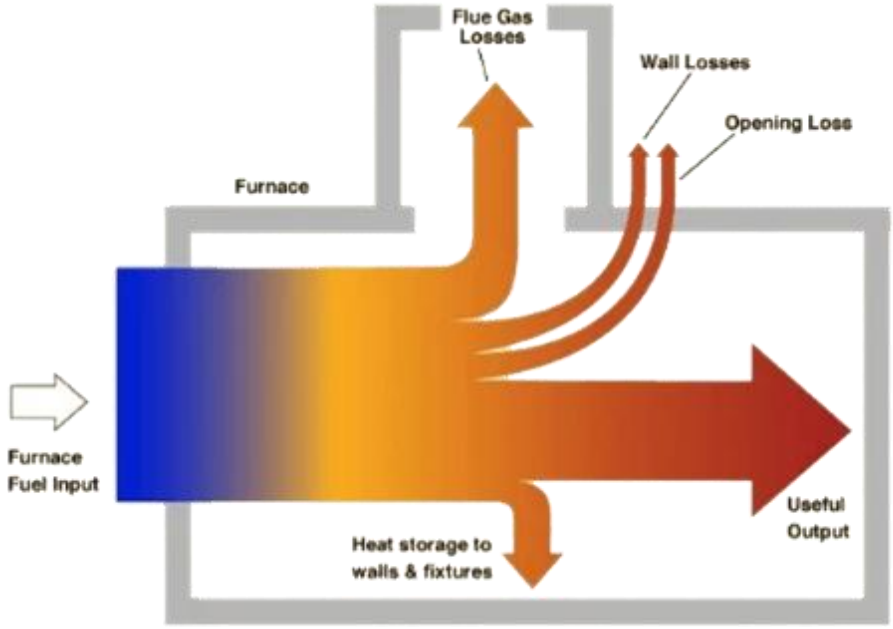


Figure 9: Sample of a Sankey diagram

(b) where applicable, the data and specific findings on identified SEU, emphasizing on details that includes but not limited to as follows:

(i) for boiler –

A. the pressure;
B. the temperature;
C. the steam capacity;
D. the flow rate;
E. the blowdown;
F. flue gas analysis; and
G. efficiency of the boiler.

The sample for the data collection form for boiler can be referred to in Appendix C of these Guidelines.;

(ii) for thermal oil heater –

A. the pressure;
B. the inlet and outline temperatures;
C. the production capacity;
D. the ambient air condition;
E. the flue gas analysis; and
F. efficiency of the thermal oil heater.

The sample for the data collection form for thermal oil heater can be referred to in Appendix D of these Guidelines; and

(iii) for furnace –

A. operating temperature;

B. production capacity;

C. flue gas analysis; and

D. efficiency of the furnace.

The sample for the data collection form for furnace can be referred to in Appendix E of these Guidelines; and

(iv) Any related output parameter data for other thermal equipment or system.

The related information or basic measurable data that is related to energy consumption and conservation as well as the efficiency of the equipment or system.

J. ANALYSIS AND IDENTIFICATION OF ESM

4.1.16 The summary of the findings and the ESM shall be provided in table format as shown in Table 5 of these Guidelines.

No Cost or Low-Cost Measures						
***Category**	***Type**	**Description**	**Estimated Yearly Savings (GJ)**	**Estimated Yearly Savings Cost (MYR)**	**Estimated Investment Cost (MYR)**	**Estimated Simple Payback Period (Years)**
		Total				

Medium-Cost Measures						
***Category**	***Type**	**Description**	**Estimated Yearly Savings (GJ)**	**Estimated Yearly Savings Cost (MYR)**	**Estimated Investment Cost (MYR)**	**Estimated Simple Payback Period (Years)**
		Total				

High-Cost Measures						
***Category**	***Type**	**Description**	**Estimated Yearly Savings (GJ)**	**Estimated Yearly Savings Cost (MYR)**	**Estimated Investment Cost (MYR)**	**Estimated Simple Payback Period (Years)**
		Total				

Table 5: Summary of the ESM recommendations

Note:

*for “Category” and “Type”, reference shall be made to the Guidelines on Energy Efficiency and Conservation Report issued by the Commission.

4.1.17 The explanation of the calculation for each ESM shall include but not limited to the following:

(a) the methods used in estimating the savings;

(b) assumptions made;

(c) energy saving potentials;

(d) the estimated budget or investment cost for implementing the recommended ESM;

(e) cost savings and potential returns from the costs to implement ESM for example simple payback period, return on investment or internal rate of return; and

(f) equivalent carbon emission reduction. For carbon emission conversion, reference may be made to the IPCC Guidelines for National Greenhouse Gas Inventories.

K. ESM IMPROVEMENT PLAN

4.1.18 The REA may provide some recommendations of priorities and strategies on the improvement plan for the ESM which may include:

(a) the recommendation for immediate implementation of the improvement plan for a facility under the “no cost or low-cost measures” category”;

(b) the strategies to implement the proposed ESM improvement plan, for example ESM prioritization based on the return on investment;

(c) the proposed action plan and estimated time required to implement each ESM improvement plan;

(d) the proposed timeline of each ESM improvement plan within appropriate implementation period; and

(e) the financing options or government incentives available for the purpose of implementing the ESM improvement plan.

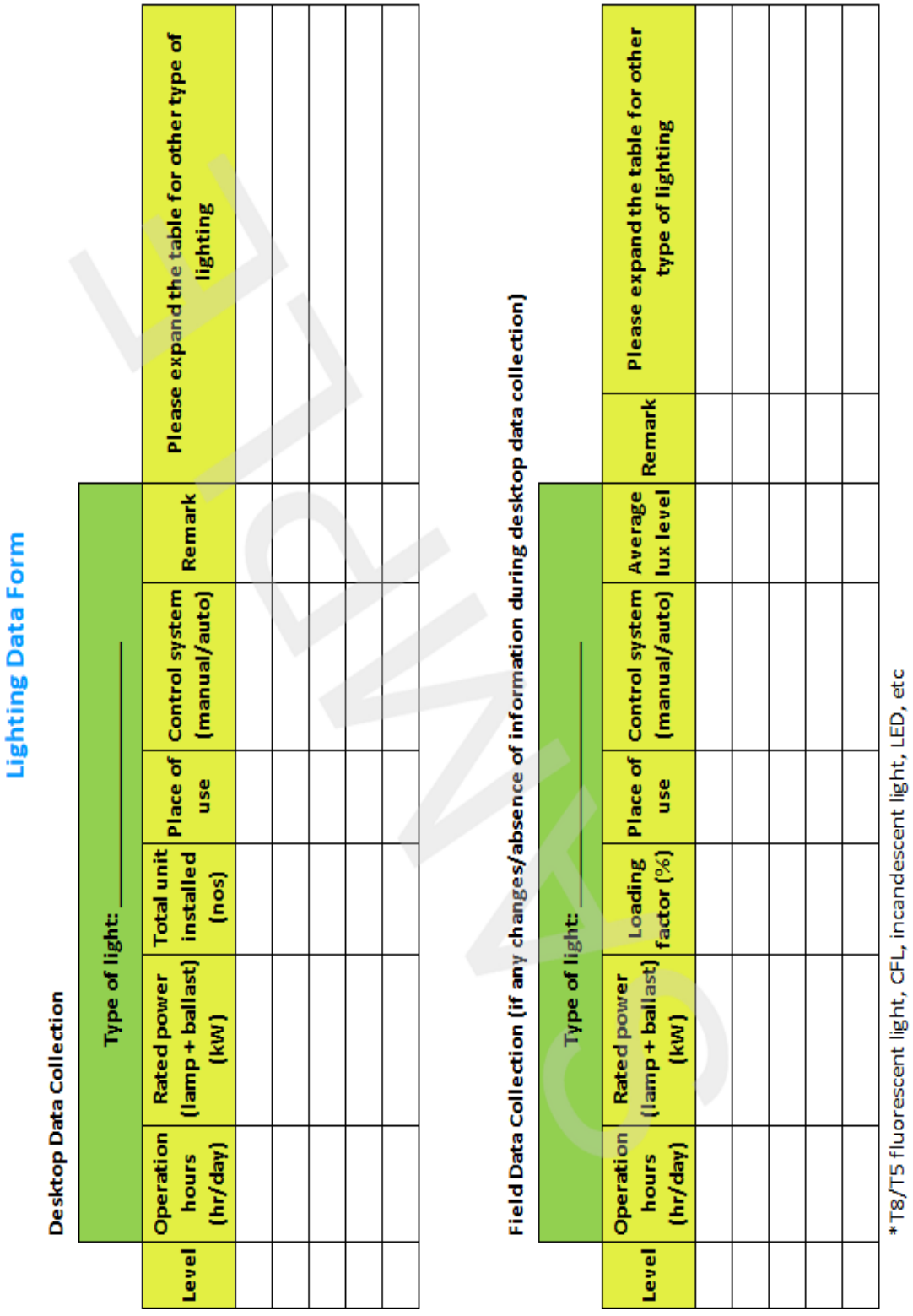
5. SUBMISSION OF REPORT

5.1 The energy audit report shall be prepared by REA and shall be agreed upon and verified by the energy consumer or person in charge of building.

5.2 The verified copy of the energy audit report shall be submitted to the Commission through its online system.

6. APPENDIXES

APPENDIX A: SAMPLE DATA COLLECTION FORM FOR LIGHTING SYSTEM



Lighting Data Form

Desktop Data Collection

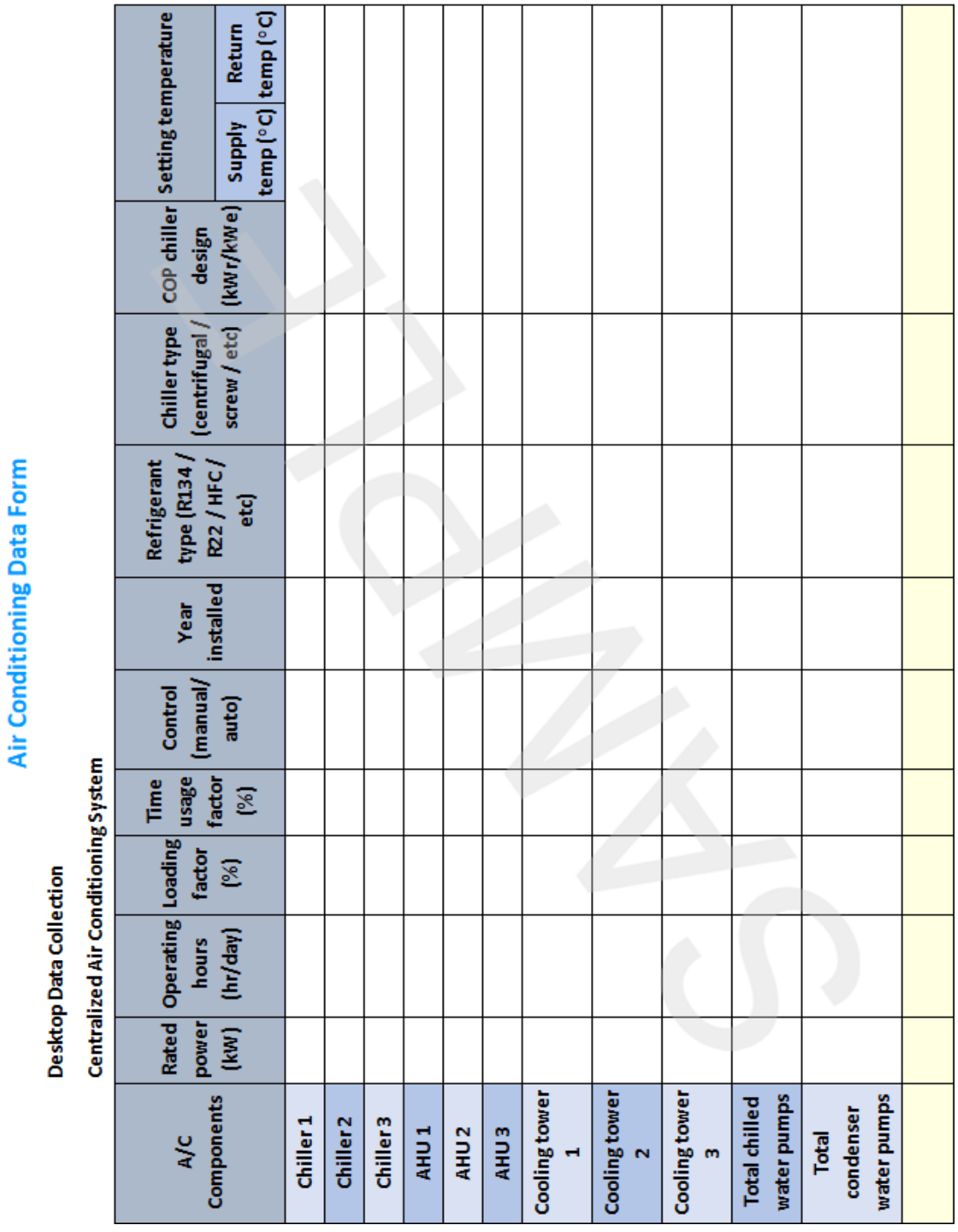
Level	Type of light: _____							Please expand the table for other type of lighting
	Operation hours (hr/day)	Rated power (lamp + ballast) (kW)	Total unit installed (nos)	Place of use	Control system (manual/auto)	Remark		

Field Data Collection (if any changes/absence of information during desktop data collection)

Level	Type of light: _____							Please expand the table for other type of lighting
	Operation hours (hr/day)	Rated power (lamp + ballast) (kW)	Loading factor (%)	Place of use	Control system (manual/auto)	Average lux level	Remark	

*T8/T5 fluorescent light, CFL, incandescent light, LED, etc

APPENDIX B: SAMPLE DATA COLLECTION FORM FOR AIR CONDITIONING SYSTEM



Air Conditioning Data Form

Desktop Data Collection

Centralized Air Conditioning System

A/C Components	Rated power (kW)	Operating hours (hr/day)	Loading factor (%)	Time usage factor (%)	Control (manual/ auto)	Year installed	Refrigerant type (R134 / R22 / HFC / etc)	Chiller type (centrifugal / screw / etc)	COP chiller design (kWr/kWe)	Setting temperature	
										Supply temp (°C)	Return temp (°C)
Chiller 1											
Chiller 2											
Chiller 3											
AHU 1											
AHU 2											
AHU 3											
Cooling tower 1											
Cooling tower 2											
Cooling tower 3											
Total chilled water pumps											
Total condenser water pumps											

Air Conditioning Data Form

Split Unit Air Conditioning System

Split Unit No.	Level	Room No / Description	Rated Power (kW)	Operating hours (hr/day)	Control (manual/ auto)	Remarks
Split Unit 1						
Split Unit 2						

Field Data Collection (if any changes/absence of information during desktop data collection)

Chiller No.	Loading factor (%)	Time usage factor (%)	Flow rate (l/s)	Operating hours (hr/day)	Chilled water temperature measured		Total power measured			
					Supply temp (°C)	Return temp (°C)	Chiller (kW)	Chilled water pump (kW)	Condenser water pumps (kW)	Cooling tower (kW)
Chiller 1										
Chiller 2										
Chiller 3										

Air Handling Unit (AHU)

AHU No.	Level	Outside air intake				Return air				AHU air intake				Control (manual/ auto)	Measured Power (kW)	Loading factor (%)	Operating hours (hr/day)	Remarks
		Temp (°C)	RH (%)	Vel (m/s)	Area (m^2)	Temp (°C)	RH (%)	Vel (m/s)	Area (m^2)	Temp (°C)	RH (%)	Vel (m/s)	Area (m^2)					
AHU 1																		
AHU 2																		
AHU 3																		

Split Unit No.	Level	Room No / Description	Measured Power (kW)	Loading factor (%)	Operating hours (hr/day)	Control (manual/auto)	Remarks
Split Unit 1							
Split Unit 2							

Field Data Collection

Indoor Air Quality

	Indoor Air Quality						
Level	Place of use	Temperature (°C)	Humidity (%)	CO_2 (ppm)	CO (ppm)	Remarks

Note:

RH - Relative Humidity (%)

Vel - Velocity (m/s)

Temp - Temperature (°C)

APPENDIX C: SAMPLE OF THE DATA COLLECTION TEMPLATE FOR BOILER

	Unit	Boiler #1	Boiler # 2	Boiler #3
Design Parameters				
Type of boiler	-			
Pressure	barg			
Temperature	°C			
Steaming Capacity	ton/hr			
Operating Parameters				
Feedwater pressure	barg			
Feedwater inlet temperature	°C			
% blowdown	%			
Steam pressure	barg			
Steam temperature	°C			
Steam production	ton/hr			
Type of fuel	-			
GCV of fuel	MJ/ton or MJ/Nm^3			
Fuel consumption	ton or Nm^3			
Flue gas temperature	°C			
Ambient temperature	°C			
O_2 in flue gas	%			
CO in flue gas	ppm			

APPENDIX D: SAMPLE OF THE DATA COLLECTION TEMPLATE FOR THERMAL OIL HEATER

	Unit	Thermal Oil Heater #1	Thermal Oil Heater # 2	Thermal Oil Heater #3
Design Parameters				
Production Capacity	ton/hr			
Operating Parameters				
Thermal oil pressure	barg			
Thermal oil inlet temp	°C			
Thermal oil outlet temp	°C			
Thermal oil production	ton/hr			
Type of fuel	-			
GCV of fuel	MJ/ton or MJ/Nm^3 or MJ/lit			
Fuel consumption	ton or Nm^3 or litre			
Flue gas temperature	°C			
Ambient temperature	°C			
Humidity in air	$kg/kg_{dry\ air}$			
O_2 in flue gas	%			
CO in flue gas	ppm			

APPENDIX E: SAMPLE OF THE DATA COLLECTION TEMPLATE FOR INDUSTRIAL FURNACE

Operation Status					
Amount of steel heated					
Temperature of discharged steel (surface)					
Amount of burning loss					
Temperature of charging steel					
Amount of crude oil used; caloric value					
Temperature of crude oil used					
Temperature of combustion air					
Temperature of flue gas at furnace outlet					
Temperature for each zone (°C)					
Measurement Results					
Flue gas temperature (°C) and composition (%)	Temp.	CO_2	O_2	CO	N2
*Flue gas at furnace outlet					
*Flue gas before recuperator					
*Flue gas after recuperator					
Internal pressure					
Temp. and amount of skid rail cooling water					
Temperature of furnace walls					

APPENDIX F: CONVERSION COEFFICIENTS AND EQUIVALENCE

Energy Resources

Energy Resources	Conversion Coefficients/Equivalence
Hard coal	29.3076 GJ/tonne
Coke/oven coke	26.3768 GJ/tonne
Gas coke	26.3768 GJ/tonne
Brown coal coke	19.6361 GJ/tonne
Pattern fuel briquettes	29.3076 GJ/tonne
Lignite/brown coal	11.2834 GJ/tonne
Peat	9.5250 GJ/tonne
Lignite briquettes	19.6361 GJ/tonne
Liquefied Natural Gas (LNG)	45.1923 GJ/tonne
Butane	50.393 GJ/tonne
Propane	49.473 GJ/tonne
Liquefied Petroleum Gas (LPG) (Mixture of Butane and Propane)	0.045544 GJ/kg
	0.13640 GJ/m^3
Natural Gas	1000 GJ/MMscf
	1.055 GJ/MMBtu
	0.02898 GJ/m^3
Ethane	1,067.82 GJ/MMscf
	47.8 GJ/tonne
Methane	1,131.31 GJ/MMscf
Solar Photovoltaic	0.0036 GJ/kWh
Solar Thermal	0.0036 GJ/kWh
Biogas	50.4 GJ/tonne
Biodiesel	27.0 GJ/tonne
Charcoal	29.5 GJ/tonne
Empty Fruit Bunch (EFB)	18.8 GJ/tonne
Fuelwood	15.6 GJ/tonne
Mesocarp Fibre	18.8 GJ/tonne
Palm Kernel Shell (PKS)	20.1 GJ/tonne

Energy

Energy	Conversion Coefficients/Equivalence
Electricity	0.0036 GJ/kWh
Chilled water	0.01266 GJ/RTH
	0.0036 GJ/kWrh
Steam (saturated condition)	
(a) at 10 bar steam pressure	2.7771 GJ/tonne
(b) at 8 bar steam pressure	2.7683 GJ/tonne
(c) at 6 bar steam pressure	2.7561 GJ/tonne
Hot water (saturated condition)	
(a) at 80^{o}C hot water temperature	0.3350 GJ/tonne
(b) at 90^{o}C hot water temperature	0.3770 GJ/tonne

Note: For steam and hot water at temperatures or pressures other than those listed, please refer to the Steam Tables.