RMK-12 ENERGY AUDIT CONDITIONAL GRANT (EACG)

ENERGY AUDIT GUIDE

(FOR INDUSTRIAL SECTOR)

BY

SUSTAINABLE ENERGY DEVELOPMENT AUTHORITY

(SEDA MALAYSIA)

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1.0 ENERGY AUDIT

Energy audit is an important tool in establishing the energy supply and consumption pattern and the measures that need to be taken to optimize energy usage in buildings. Energy audit is an important effort to facilitate the building owners / ESCO to identify the energy saving potentials and to promote efficient use of energy.

The reference in this document stipulate the objectives, scope of work, deliverables, and other requirements of energy audit to be conducted at selected industrial buildings that consume high electrical energy.

Thus, the building owners and ESCOs must comply with the terms of reference provided in order to conduct and produce a good, systematic and quality audit exercise, as well as uniform and comprehensive reports.

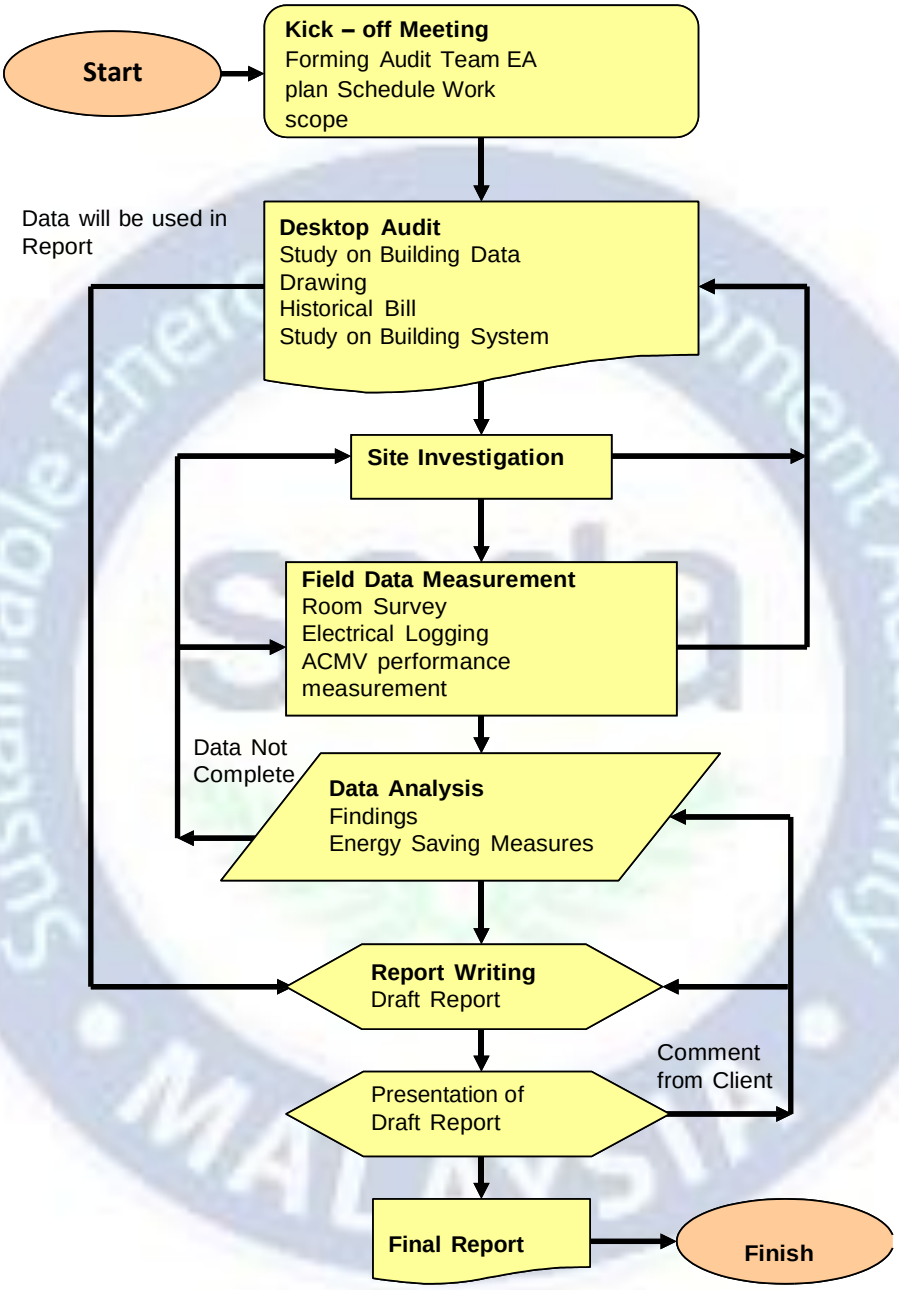
The objectives of the Energy Audits are;

- **To identify the energy supply information and status;**
- **To identify the current energy management program, setup, policy, implementation, and effectiveness.**
- **To identify present and historical energy usage pattern;**
- **To identify where the wastage occurs and measures to be taken to optimize consumption and reduce wastage; and**
- **The findings of this audit will be used to assist the building owner to formulate energy management plan and implement the relevant energy saving measures (ESMs) recommended in the energy audit report.**
- **Providing detail technical solutions and estimated cost in the energy audit report.**

2.0 METHODOLOGY OF ENERGY AUDIT

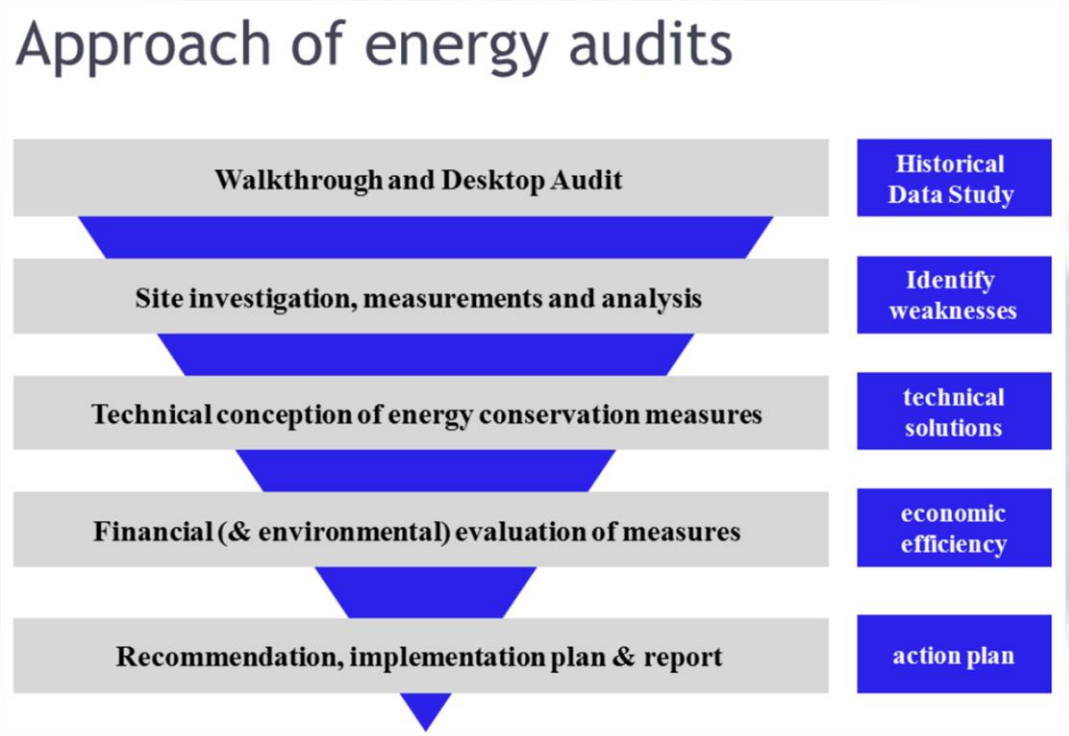
The energy audit consists of several main activities such as the following:

- √ Kick-off meeting
- √ Walk through
- √ Site investigation and measurement
- √ Data analysis
- √ Data verification
- √ Report Writing
- √ Presentation of result
- √ Feedback from all parties
- √ Submission of final report



The energy audit approach and process normally involve;

i. Obtain and study the historical data of the building in order to establish baseline;
ii. Identify the current weakness or energy wastages;
iii. Propose the technical solutions to minimise the wastages;
iv. Evaluate and perform economic efficiency or life cycle costing analysis; and
v. Develop recommendation and action plan.



3.0 SCOPE OF WORK ENERGY AUDIT

The main component of the audit shall cover the following:

3.1 Energy management of the installation;

- To review Operation and Maintenance Contract including budget required;
- To review existing Energy Efficiency Policy/Energy Management System;
- To review documents and data pertaining to energy usage;

- To review Organizational Structure and Resource Allocation for Energy Management;
- To obtain installation information; and
- Energy Management Matrix.

3.2 Energy supply information;

- Tariff structure;
- Maximum demand value and charges;
- Voltage level;
- Historical supply information (preferably 5 years-subject to age of installation); and
- Power factor.

3.3 Energy usage information;

- To conduct overall power distribution profile of the premise including the main electrical powered equipment (if available), monitoring and analysis for audited system at least for a period of 14 days;
- To conduct electrical energy load loss survey and site evaluation for the audited system (refer to energy audit proposal and scope submitted and approved by the government / Energy Audit Conditional Grant Committee);
- To study on the energy usage for all/selected equipment and systems;
- To establish electricity consumption distribution based on equipment/systems e.g. heating and cooling system, lighting, chiller, boiler, compressor and etc. in kWh or equivalent, and percentage;
- To identify and study operating schedule or parameters that affecting the energy consumption; and
- To establish Specific Energy Consumption (SEC) for each installation
- To identify control system being used (automatic/manual);
- To conduct power measurement and analysis;
- To carry out necessary measurement for relevant parameters;
- To conduct pump system efficiency (depend to site condition);
- To calculate overall System Coefficient of Performance;

- Fans and Blowers (if relevant)
  - To describe the system(s) briefly;
  - To study the system schedule and operation hours; and
  - To describe observations and findings.

- Lighting System (if relevant)
  - To prepare a list of types of lamps used and its rated power at internal and external areas (fluorescent, CFL, LED etc);
  - To study lighting operating schedule;
  - To conduct measurement and analysis of lighting fitting layout and lux level;
  - To conduct power measurement and analysis; and
  - To conduct lighting control systems and zoning analysis.

- Air Compressor System (if relevant)
  - To provide air compressor system diagram;
  - To identify the number of air compressor used in the system;
  - To study the air compressor operating schedule; and
  - To provide and explain load profile for each compressor.

- Electrical Motor, Pumps and Production Machine (if relevant)
  - To show the list of machine/equipment types and quantity;
  - To describe the system and operations for each type of machine/equipment;
  - To provide and explain load profile for each machine/equipment; and
  - To describe observations and findings for each machine/equipment.

- Ventilation System / Indoor Air Quality & Infiltration (if relevant)
  - To identify control system being used (automatic/manual);
  - To study ventilation system operating schedule;
  - To conduct air flow measurement and analysis;
  - To conduct energy and power measurement for selected fan;

- To conduct CO and CO_2 level measurement and analysis; and
- Analysis on zoning and air change measurement.

- Building Automation System (BAS) (if relevant)
  - To confirm the function of the BAS facilities and parameters being controlled;
  - To perform measurement variation study between actual and the reading in the system; and
  - To study the characteristic of BAS in term of monitoring, control and reporting.

- Process Equipment (if relevant)
  - To survey and identify the types of process equipment in each room and area with its power consumption (rated capacity, performance rating etc).

- Steam Generation by Biogas/Diesel/others and Distribution System (if relevant)
  - To explain the generation and distribution system; and
  - To explain the energy consumption and load profile for each generator and distributor system.

- Any processes that proposed to be audited.

3.4 Energy saving potential and measures (ESMs)

ESMs (action plan and estimated time required to implement the measure recommended, amount of saving and cost of implementation). The ESMs shall address the energy management and energy efficiency. Renewable energy can be included but it is not part of the Energy Audit Conditional Grant scope.

- Energy Saving Measures and Recommendations
  - Text
    - Describe the proposed energy savings measures
    - A list of equipment potential credible suppliers
  - Chart
    - Graphical illustration
    - Existing and proposed system (if applicable)
  - Photo
    - Existing situation
    - Proposed equipment sketches or sample photo from manufacturer catalogue

- To list opportunities for electrical energy saving measures identified (saving to systems / equipment / control / monitoring / management) in tables
  - Each measure should have tables consisting:
    - The assumptions used in estimating the energy savings.
    - The methods used in estimating the savings
    - Technical calculation
    - The conditions to achieve the savings

- To identify detailed methods to achieve savings/electrical energy reduction according to;
  - No cost/ min cost – changes of time and operation methods, minor repair / improvements
  - Low and high cost or Medium cost - based on percentage
  - High cost measure

- To estimate total potential electrical energy saving in kWh
- To propose an action plan and the estimated time required to implement each saving measure if the management decides to implement it.
- To propose methods of measurement and calculation to quantify energy savings based on identified saving potentials.

3.5 Financial analysis

Normally involved basic life cost cycle analysis for the proposed energy saving measures (SPP, ROI)

- Measures and costs
- Each measure and potential saving
- Expected return of investments from financial evaluation tools (e.g. SPP, ROI etc.) in years or months.

3.6 Financial and Energy Savings Measures Implementation Planning for Owner to Implement (3 Years)

- 1ST Year, estimated implementation cost and savings.
- 2ND Year, estimated implementation cost and savings.
- 3rd Year, estimated implementation cost and savings.

* The ESMs implementation planning shall address the energy management and energy efficiency. Renewable energy can be included but it is not part of the Energy Audit Conditional Grant scope. The total cost and savings from renewable energy are not counted as implementation and savings achieved under this EACG scheme.

4.0 MANDATORY REQUIREMENT

Energy audit report must be according to the Energy Audit Report Template as in **Appendix A**.

Prepared and updated by,
SEDA Malaysia

Mobile : +603 8870 5849 / +603 8870 5814 for any enquiry

Factory picture/s

ENERGY AUDIT CONDITIONAL GRANT REPORT FOR Factory Name

Prepared By

Company logo

Auditor Name and Address

Client logo

Client Name and Address

Under

SUSTAINABLE ENERGY DEVELOPMENT AUTHORITY MALAYSIA

Appendix A

CONFIDENTIALITY

This document contains information for the sole perusal of ……

DISCLAIMER

XXXXX. has no personal or financial interest in supplying or installing equipment for this document.

Appendix A

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1 EXECUTIVE SUMMARY

Objectives, scope and type of audit.

Key systems and equipment audited.

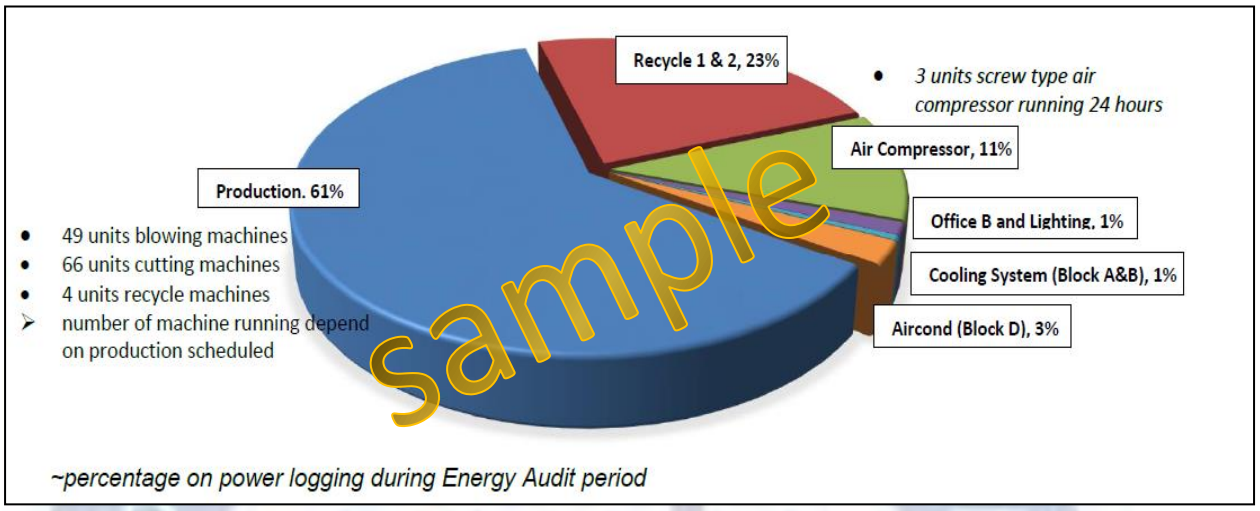
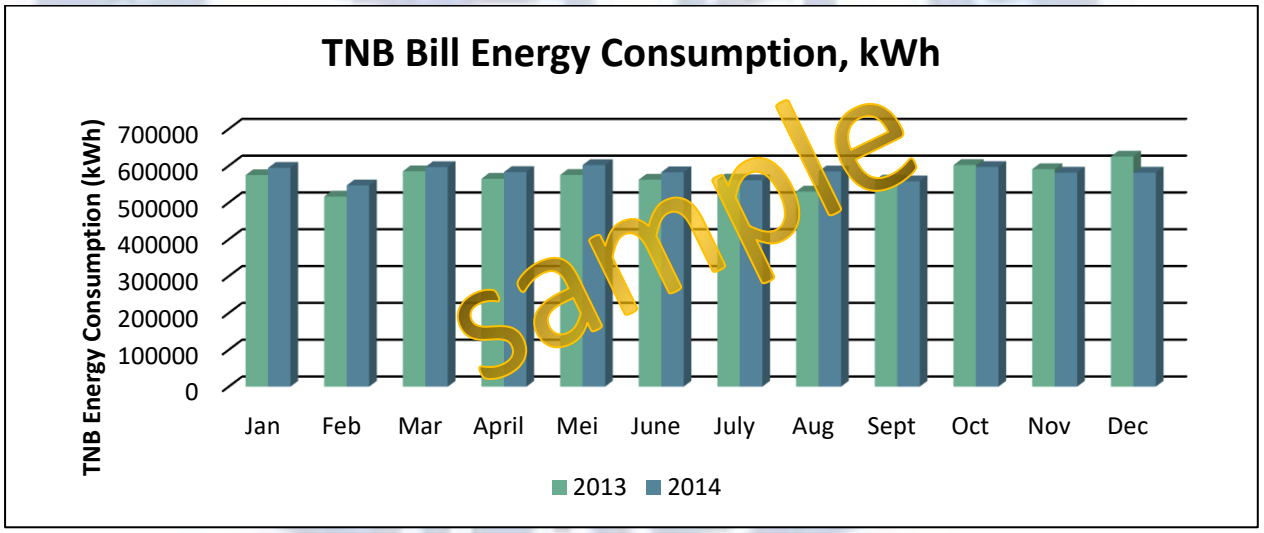


Chart description.



Graft description.

Appendix A

No.	ESM	Estimated Savings		Estimated Investment(RM)	Simple Payback Period (yrs)	Estimated Carbon Reduction
		Energy (kWh)	Cost (RM)			kgCO2/kWh
No Cost						
1	Decommissioning all non critical ACSU units when chiller plant has been retrofitted	577587.64	306[illegible].45	0	Immediate	
Low/Medium Cost						
2	Replace all Incandescent decorative lamps with LED strips/LED lamps	[illegible]539.22	15,[illegible]25.78	1,000.00	0.07	21,147.56
3	Switch off outdoor corridor lights during the daytime	[illegible]5442.85	29,384.71	80000	2.7	41,083.15
4	Repairing compressed air leakage	4[illegible]00.00	2597.00	15000	5.8	3,630.9
High Cost						
5	Retrofit chillers, chilled water pumps, condenser water pumps, cooling tower and upgrade pipeworks	380112.00	201459.36	1190000	5.9	281,662.9
6	Retrofit AHUs and ducting to improve efficacy	669384.00	354773.52	359000	1.0	496,013.54
7	Replace all existing fluorescent and CFL lamps with LED lamps	567599.96	300,827.98	482,640.00	1.60	420,591.57

Brief summarized description of energy saving recommendations and their cost-effectiveness.

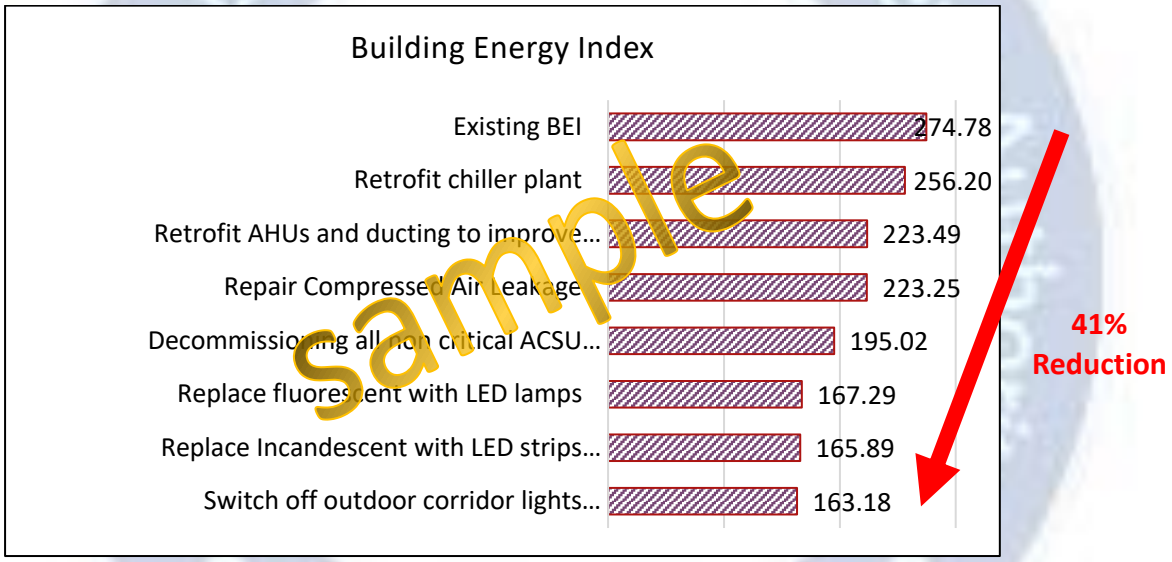


Chart description.

Appendix A

Level of achievement (% of CO_2e reduction)	Assessment Scheme for Existing Buildings
100% Carbon Neutral	💎💎💎💎💎💎
≥ 70 to < 100	💎💎💎💎💎
≥ 50 to < 70	💎💎💎💎
≥ 30 to < 50	💎💎💎
≥ 10 to < 30	💎💎
≥ 1 to < 10	💎

Based on the CIDB 2012 GreenPASS assessment scheme above, the level of achievement in % carbon reduction is eligible for x diamond certification.

2 INTRODUCTION

Brief explanation on functions, operation hours, occupancy rate, etc.

Factory Description

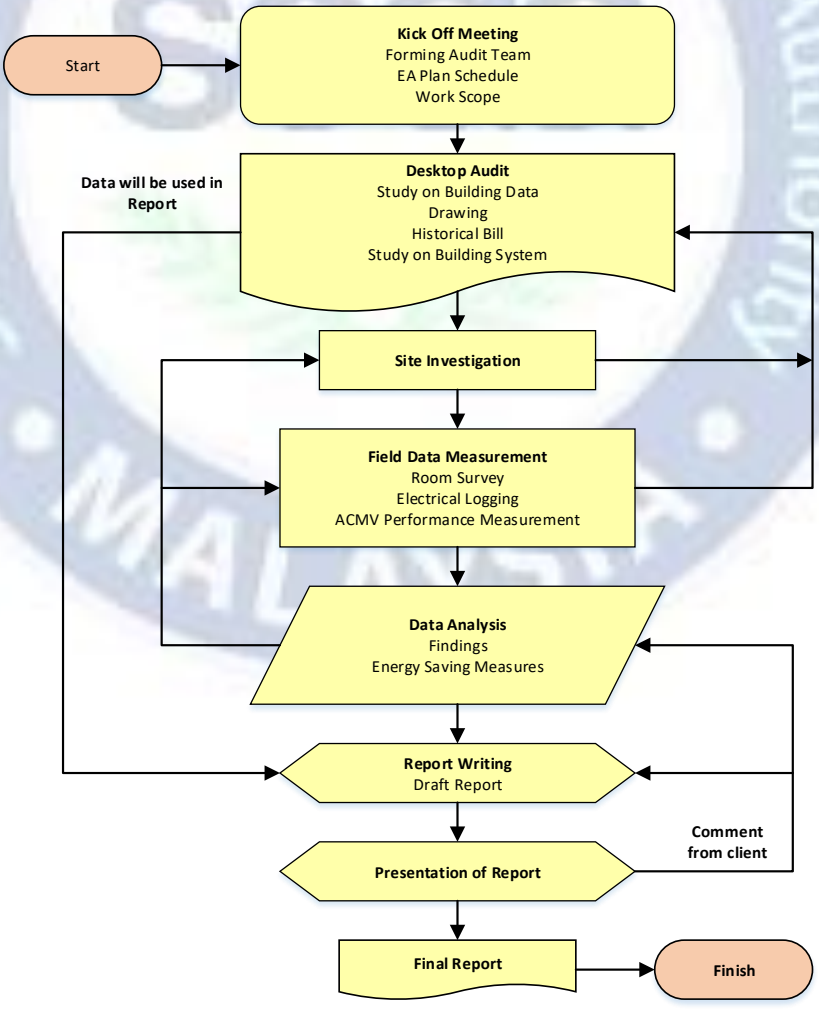
Factory Name:	**Client name**
Address:	**Client address**
Factory Use:	**Production and Office**
In operation since:	**2001**

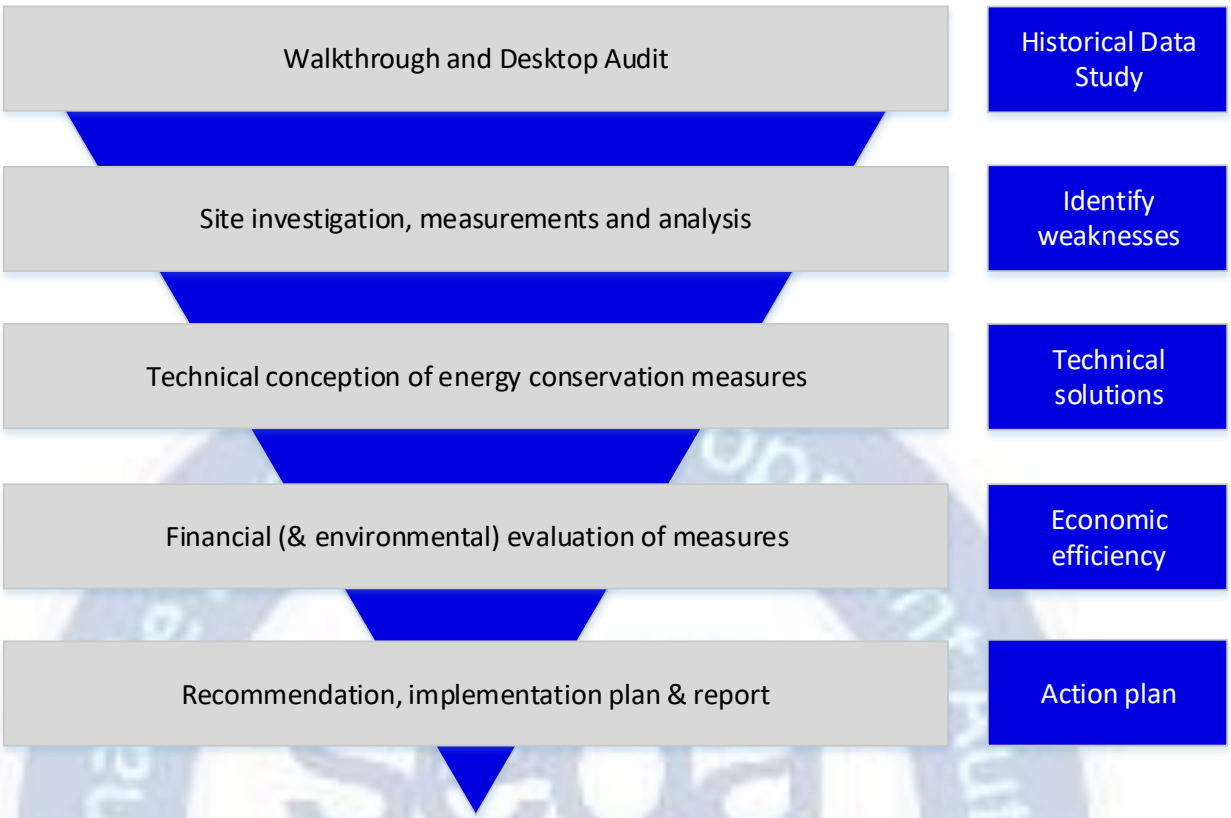
2.1 Objective

Brief explanation.

2.2 Methodology

Brief explanation.





2.3 Type of Energy Audit and Process

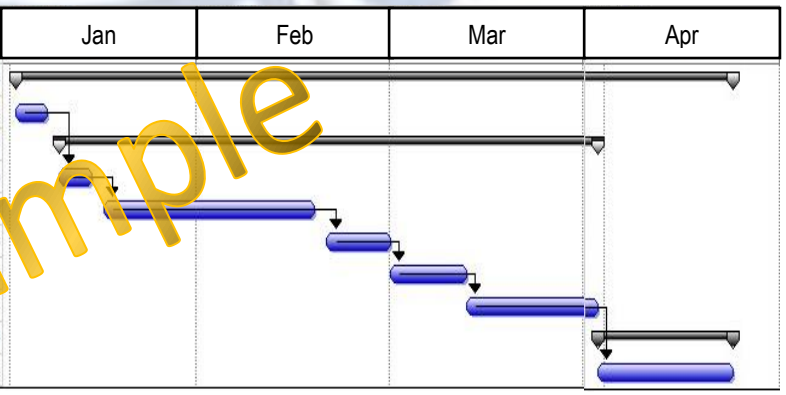
Brief explanation.

2.4 Scope of work

Brief explanation.

2.5 Time Schedule and Audit Framework

	Indicators	Task Name	Duration	Work
1		**Energy Audit Proposal for 3G3**	**81 days**	**0 hrs**
2		Preliminary Walkthrough	5 days	0 hrs
3		**Detailed Energy Audit**	**61 days**	**0 hrs**
4		Desktop Data	5 days	0 hrs
5		Field Measurement & Observation	25 days	0 hrs
6		Data Analysis	8 days	0 hrs
7		Load Demand	8 days	0 hrs
8		Energy Saving Measures	15 days	0 hrs
9		**Report**	**15 days**	**0 hrs**
10		1st Draftc& Presentation	15 days	0 hrs



2.6 Energy Audit Equipment

List of equipment.

3 ENERGY MANAGEMENT SYSTEM REVIEW

3.1 Policy and targets

Policy declaration and brief description of action plans, targets, timeframe, roles and responsibilities.

3.2 Energy data, documentation and monitoring

Describe the level of documentation available in the organization, policies, records, regulations, guides, training in relation to energy management.

Describe monitoring of energy use procedures, energy performance indicators, effectiveness of action plans in achieving objectives and targets, evaluation of actual vs expected energy consumption – results from monitoring and measurement should be recorded.

3.3 Compliance towards regulations

Describe evaluation procedures in complying with legal requirements in relation to energy use and consumption, records.

3.4 Energy management team

List names, position and role.

3.5 Energy audit team

List names, position and role.

3.6 Energy Management Matrix

EM matrix may be used to determine level of energy management practiced and can be used as a guide for improvement.

	Policy and Systems	**Organization**	**Motivation**	**Information System.**	**Training and awareness**	**Investment**
4	Formal energy /environmental policy and management system, action plan and regular review with commitment of senior management or part of corporate strategy	Energy / environmental management fully integrated into management structure. Clear delegation of responsibility for energy use	Formal and informal channels of communication regularly exploited by energy / environmental manager and staff at all levels	Comprehensive system sets targets, monitors materials and energy consumption and wastes and emissions, identifies faults, quantifies costs and savings and provides budget tracking	Marketing the value of material and energy efficiency and the performance of energy / environmental management both within the organization and outside it	Positive discrimination in favour of energy / environmental saving schemes with detailed investment appraisal of all new build and plant improvement opportunities

Appendix A

	Policy and Systems	Organization	Motivation	Information System.	Training and awareness	Investment
3	Formal energy / environmental policy but no formal management system and with no active commitment from top management	Energy / environmental manager accountable to energy committee, chaired by a member of the management board	Energy / environmental committee used as main channel together with direct contact with major users	Monitoring and targeting reports for individual premises based on sub-metering / monitoring but savings not reported effectively to users	Programme of staff training, awareness and regular publicity campaigns	Same pay back criteria as for all other investments. Cursory appraisal of new build and plant improvement opportunities
2	Unadopted / informal energy / environmental policy set by energy / environmental manager or senior departmental manager	Energy / environmental manager in post, reporting to ad-hoc committee but line management and authority unclear	Contact with major users through ad-hoc committee chaired by senior departmental manager	Monitoring and targeting reports based on supply meter / measurement data and invoice. Env / energy staff have ad-hoc involvement in budget setting	Some ad-hoc staff awareness and training	Investment using short term pay back criteria mostly
1	An unwritten set of guidelines	Energy or environmental management the part-time responsibility of someone with only limited influence or authority	Informal contacts between engineer and a few users	Cost reporting based on invoice data. Engineer compiles reports for internal use within technical department	Informal contacts used to promote energy efficiency and resource conservation	Only low cost measures taken
0	No explicit policy	No energy environmental manager or any formal delegation of responsibility for env/energy use	No contact with users	No information system. No accounting for materials and energy consumption and waste	No awareness raising of energy efficiency and resource conservation	No investments in increasing environmental performance or energy efficiency in premises

3.7 Operation and Maintenance System Review

List scope of works involved for energy management.

4 INDUSTRIAL OPERATIONAL AND TECHNOLOGICAL DESCRIPTION

4.1 General Description and Operation Hours

Describe factory function, occupancy and general services provided.

4.2 Installation orientation and footprint

Picture/s of factory – side, front, top views

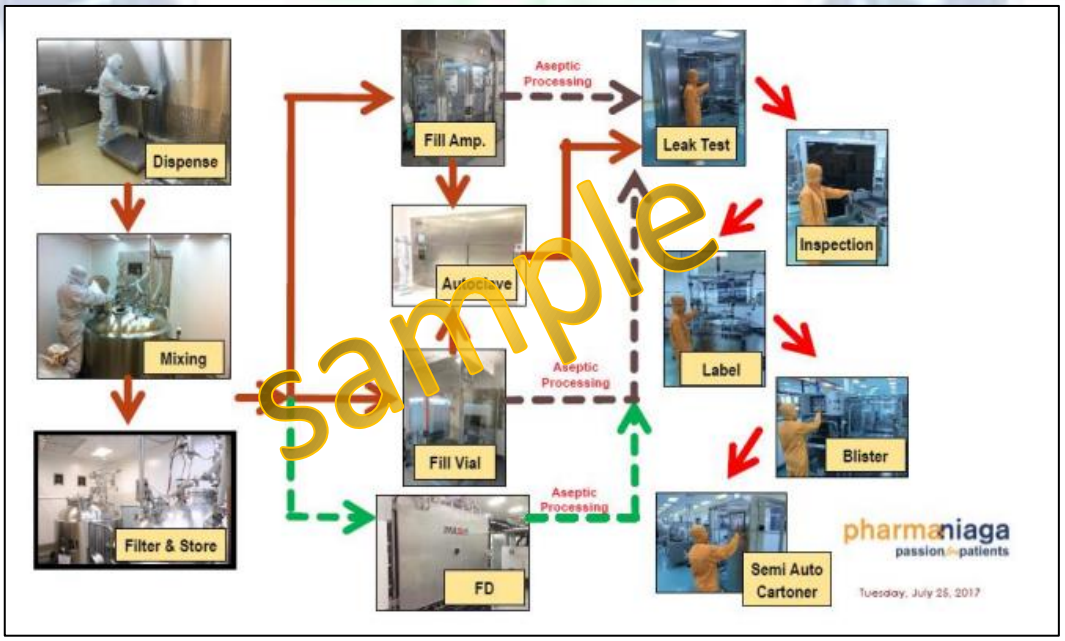
Description	Gross Floor Area	Air-Conditioned Area	Height (m)
Installation name	83,000	45,900	35 (6 floors)

4.3 Production Type

Explain briefly the products manufactured by factory including sample picture of products starting from first year operation until current year.

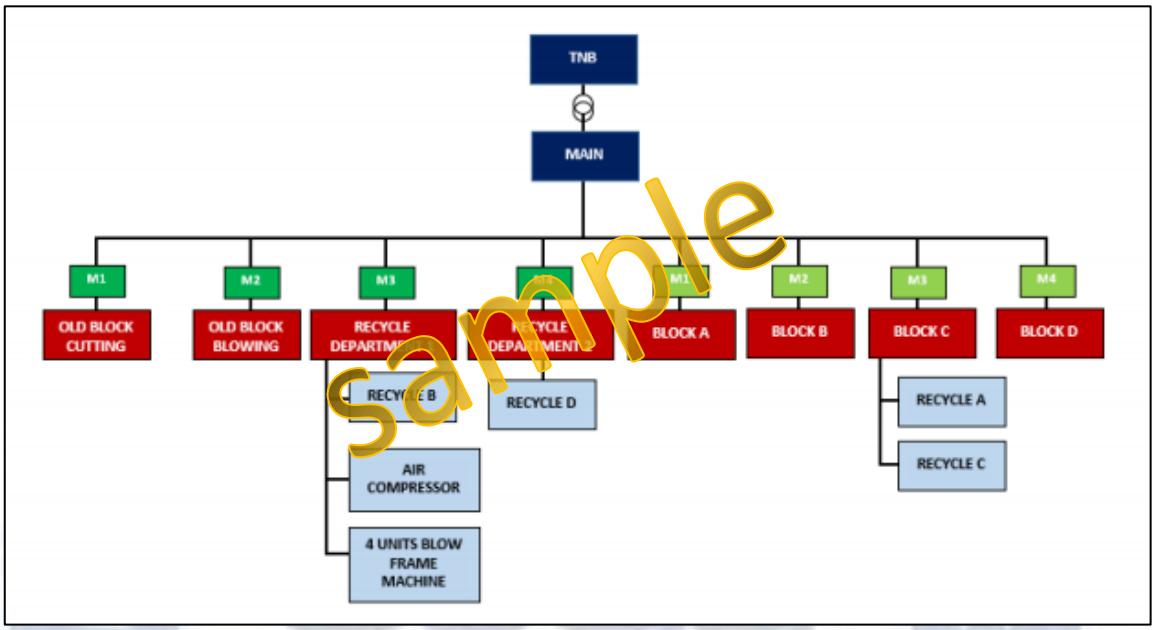
4.4 Process Flow

Briefly explain the process flow of production including graphical figure to show the steps of the process.



4.5 Overview Active System

General explanation of each active systems that involved during energy audit. Please include the photos/diagram/schematic of the overall view of the electrical distribution and reflecting the energy balance in the premise. This is to make people who read the report can understand the power / load capacity and energy flows, how and where it been used (incoming and outgoing/consumed).

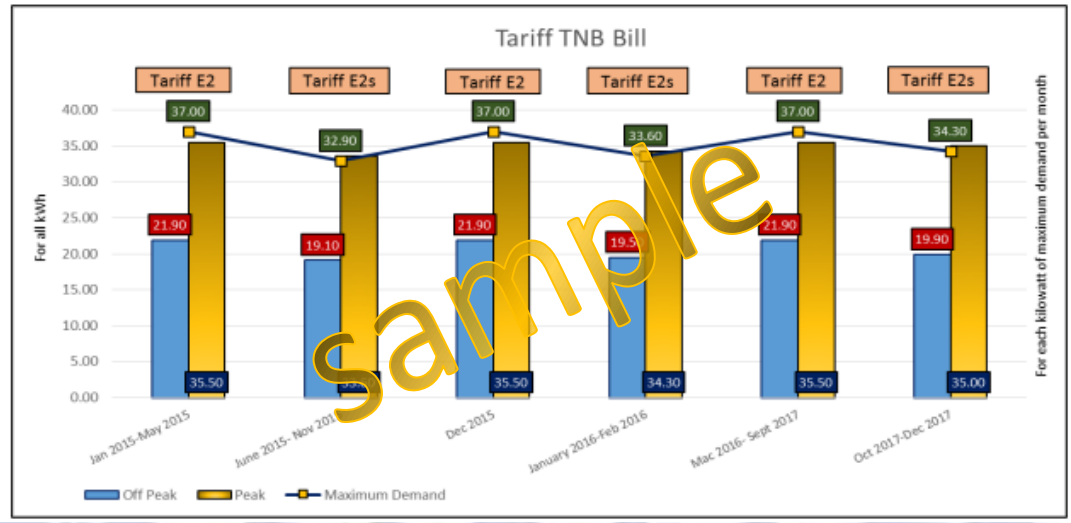


5 ELECTRICAL SUPPLY AND DEMAND INFORMATION

5.1 Historical bill and production

5.1.1 Tariff

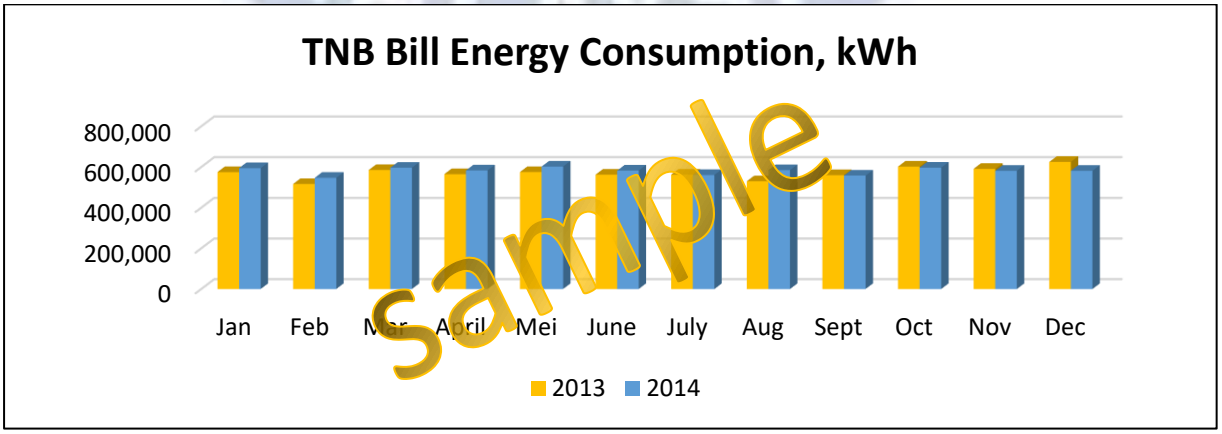
Describe tariff system used and include the diagram/graph/table.



Month	Tariff	Peak	Off Peak	Unit	Maximum Demand	Unit
Jan 2015-May 2015	E2	35.50	21.90	cent/kWh	37.00	RM/kW
June 2015- Nov 2015	E2s	33.60	19.10	cent/kWh	32.90	RM/kW
Dec 2015	E2	35.50	21.90	cent/kWh	37.00	RM/kW
January 2016-Feb 2016	E2s	34.30	19.50	cent/kWh	33.60	RM/kW
Mac 2016- Sept 2017	E2	35.50	21.90	cent/kWh	37.00	RM/kW
Oct 2017-Dec 2017	E2s	35.00	19.90	cent/kWh	34.30	RM/kW

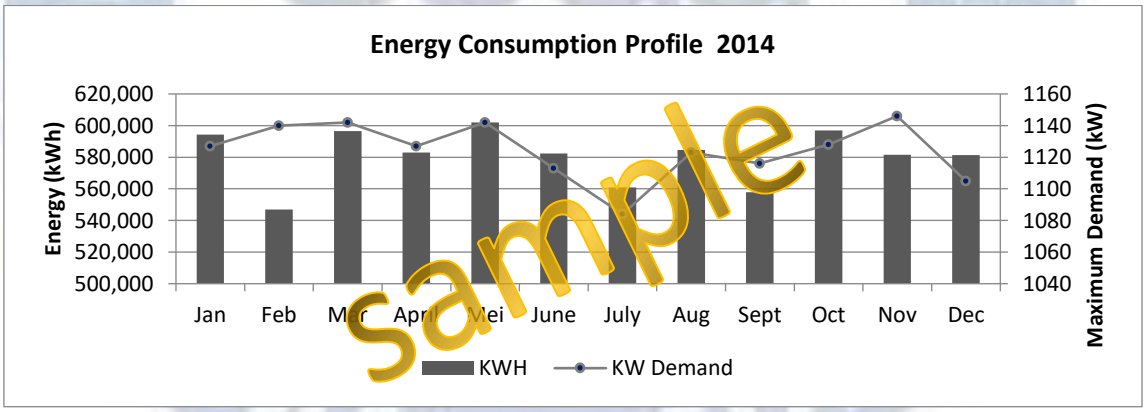
5.1.2 Historical Energy Consumption

Describe energy consumption and cost for historical bill.



Month	kWh (Peak)	kWh (Off Peak)	kWh (Total)	kWh rate (RM Peak)	kWh rate (RM Off Peak)	Rebate ICPT (RM0.015 2/kWh)	Cost (RM)	MD (RM)	Total Cost (RM)	"Penggenapan" (RM)	Electricity Bill (RM)	Production Output Cutting Departing (kg)	Raw Material Input (kg)	SEC (Production) kwh/kg	SEC (Raw Material Input) kWh/kg
Jan-17	320,088	215,919	536,007	113,631	47,286	8,147	152,770	40,885	193,655.19	0.02	**205,274.53**	515,137	546,045	1.04	0.98
Feb-17	381,891	248,117	630,008	135,571	54,338	9,576	180,333	43,475	223,807.81	-0.01	**237,236.26**	750,541	795,573	0.84	0.79
Mar-17	476,153	319,341	795,494	169,034	69,936	12,092	226,878	47,619	274,497.49	0.02	**290,967.36**	743,443	956,850	1.07	0.83
Apr-17	379,546	255,739	635,285	134,739	56,007	9,656	181,089	42,735	223,824.34	[illegible]	**237,253.82**	710,970	753,628	0.89	0.84
May-17	411,766	268,559	680,325	146,177	58,814	10,341	194,650	42,846	237,496.4[illegible]	[illegible]2	**251,746.22**	729,945	902,756	0.93	0.75
Jun-17	372,198	246,294	618,492	132,130	53,938	9,401	176,668	[illegible]4,030	220,6[illegible]60	0.01	**233,939.46**	655,851	695,202	0.94	0.89
Jul-17	432,121	283,843	715,964	153,403	62,162	10,883	[illegible],682	44,[illegible]22	[illegible],303.92	0.01	**264,262.16**	758,556	944,696	0.94	0.76
Aug-17	438,746	294,245	732,991	155,755	64,[illegible]40	11,141	20[illegible],053	45,658	254,711.02	-0.01	**269,993.67**	692,384	862,062	1.06	0.85
Sep-17	413,383	267,953	681,336	146,751	5[illegible]	1[illegible]	195,076	49,506	244,582.36	0.02	**259,257.33**	710,748	907,119	0.96	0.75
Oct-17	452,832	301,214	754,046	158,491	59,9[illegible]	11,461	206,971	42,601	249,571.89	0.02	**264,546.22**	808,719	857,242	0.93	0.88
Nov-17	441,649	294,694	736,343	154,577	58,644	11,192	202,029	41,194	243,223.14	0.02	**257,816.55**	722,300	889,913	1.02	0.83
Dec-17	452,096	305,622	757,718	158,234	60,819	11,517	207,535	43,664	251,198.96	-0.02	**266,270.88**	801,129	849,197	0.95	0.89
TOTAL	**4,972,469**	**3,301,540**	**8,274,009**	**1,758,494**	**705,007**	**125,765**	**2,337,735**	**528,835**	**2,866,570.13**	**0.12**	**3,038,564.47**	**8,599,723**	**9,960,285**	**0.96**	**0.84**
AVG-17	**414,372**	**275,128**	**689,501**	**146,541**	**58,751**	**10,480**	**194,811**	**44,070**	**238,880.84**	**0.01**	**253,213.71**	**716,644**	**830,024**		

Describe the energy consumption trend, maximum demand and costs

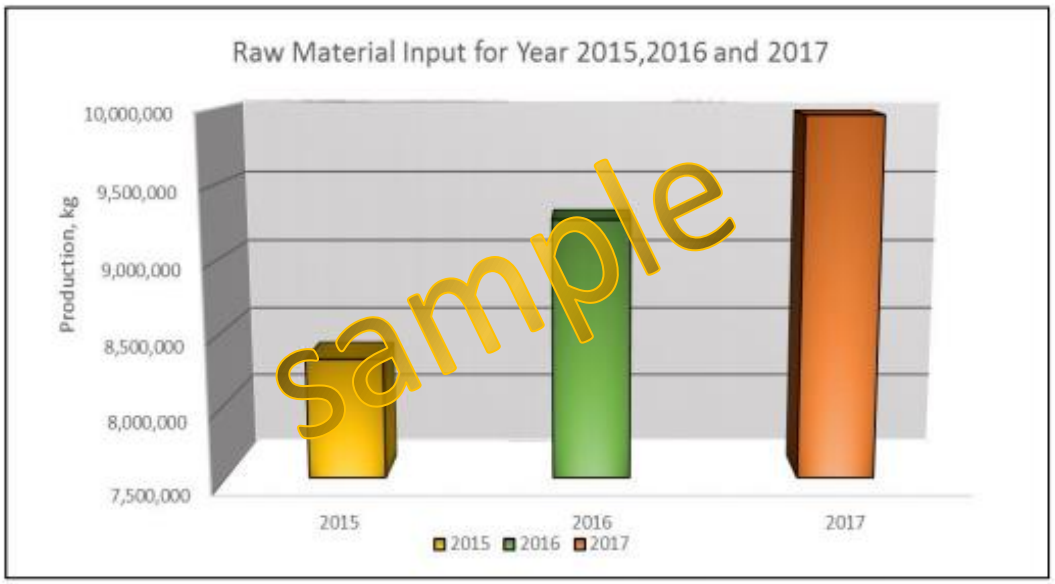


5.1.3 Raw Material Input

Describe raw material as a feedstock yearly (3 consecutive years) whereby is a basic material that is used to produce…….

Describe raw material input, total, average, maximum and minimum.

Appendix A



Month	*Raw Material Input by Year (kg)*		
	2015	*2016*	*2017*
Jan			
Feb			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
TOTAL			
AVERAGE			
MAXIMUM			
MINIMUM			

5.1.4 Production

Describe the total production in 3 consecutive years in terms of total, average, maximum, minimum and etc..

Month	Production Output by Year (kg)		
	2015	2016	2017
January	449,708	671,465	515,137
February	450,814	611,791	750,541
March	515,536	694,937	743,443
April	555,281	716,995	710,970
May	532,214	637,426	729,945
June	555,663	692,429	655,851
July	572,638	578,157	758,556
August	587,158	685,821	692,384
September	586,634	651,494	710,748
October	651,088	714,166	808,719
November	732,426	732,710	722,300
December	658,679	627,942	801,129
Total	**6,847,838**	**8,015,333**	**8,599,723**
Average	**570,653**	**667,944**	**716,644**
Maximum	**732,426**	**732,710**	**808,719**
Minimum	**449,708**	**578,157**	**515,137**

Explain the comparison of production every year

	2015 (kg)	2016 (kg)	Difference (%)
Total	6,847,838	8,015,333	17%
Average	570,653	667,944	17%
Maximum	732,426	732,710	0.04%
Minimum	449,708	578,157	29%

Table 4.6: Comparison of production output for year 2015 and 2016

	2016 (kg)	2017 (kg)	Difference (%)
Total	8,015,333	8,599,723	7%
Average	667,944	716,644	7%
Maximum	732,710	808,719	10%
Minimum	578,157	515,137	-11%

Table 4.7: Comparison of production output for year 2016 and 2017

5.2 Energy Baseline (Regression Analysis)

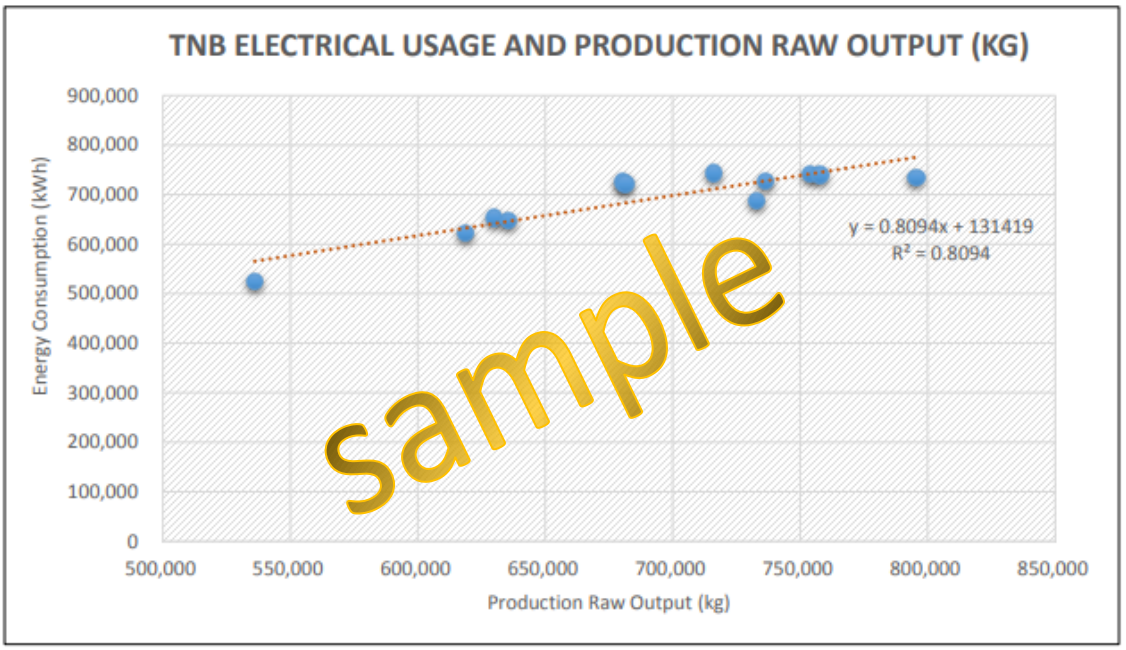
Describe how Regression Analysis influences the energy usage according to the related factor.

Month	Production Output (m^3)	Raw Material Input (kg)	Rejected or Recycled Product (kg)	TNB Bill Energy (kWh)
Jan-17	1,308,608	546,045	61,722	536,007
Feb-17	1,707,992	795,573	127,746	630,008
Mar-17	1,966,993	956,850	170,596	795,494
Apr-17	1,690,148	753,628	111,107	635,285
May-17	1,932,877	902,756	124,041	680,325
Jun-17	1,611,648	695,202	103,782	618,492
Jul-17	1,990,614	944,696	130,975	715,964
Aug-17	1,815,750	862,062	113,878	732,991
Sep-17	1,922,112	907,119	129,054	681,336
Oct-17	1,982,895	857,242	141,401	754,046
Nov-17	1,935,091	889,913	140,237	736,343
Dec-17	1,973,896	849,197	132,910	757,718

Appendix A

Show the Regression analysis calculation in order to obtain R^2

Regression Statistics	
Multiple R	0.899667
R Square	0.8094
Adjusted R Square	0.767045
Standard Error	35667.85
Observations	12



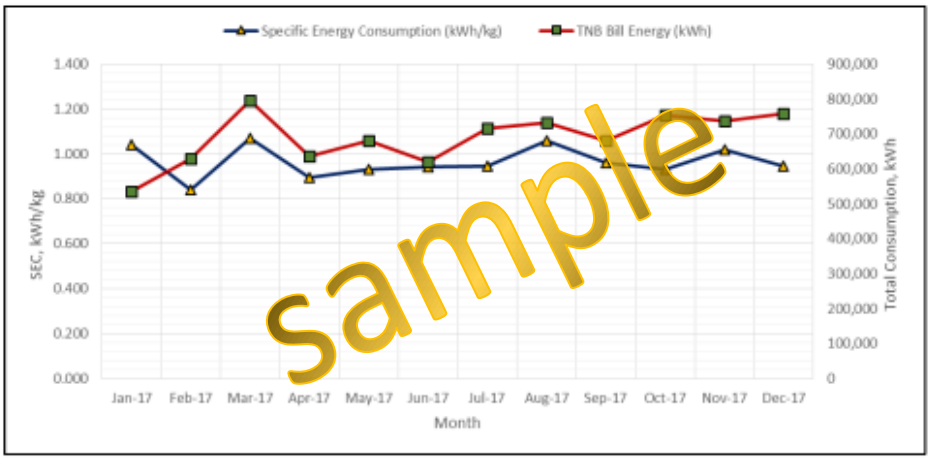
5.3 Specific Energy Consumption

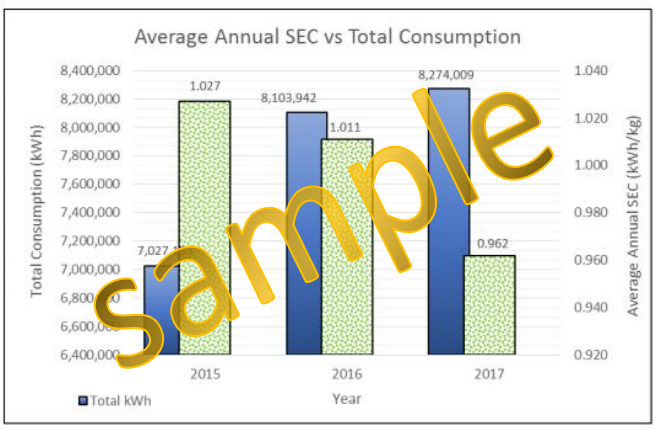
5.3.1 Specific energy consumption based on production output

Briefly describe the influence of variable production output to the pattern of energy consumption.

Month	TNB Bill Energy (kWh)	Production Output (kg)	Specific Energy Consumption (kWh/kg)
Jan-17	536,007	515,137	1.041
Feb-17	630,008	750,541	0.839
Mar-17	795,494	743,443	1.070
Apr-17	635,285	710,970	0.894
May-17	680,325	7[illegible]	0.932
Jun-17	618,492	6[illegible]	0.943
Jul-17	715,964	7[illegible]	0.944
Aug-17	732,991	6[illegible]	1.059
Sep-17	681,[illegible]36	710,748	0.959
Oct-17	7[illegible]54,04[illegible]	808,719	0.932
Nov-17	[illegible]	722300	1.019
Dec-17	757,[illegible]18	801129	0.946
Total	8,274,009	8,599,723	0.962
Average	689,501	716,644	
Maximum	795,494	808,719	1.070
Minimum	536,007	515,137	0.839

Table 4.10: Specific Energy Consumption (SEC) for year 2017

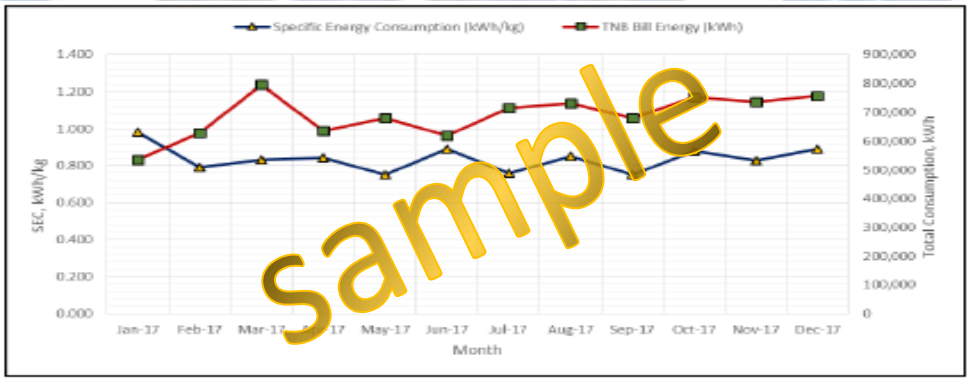


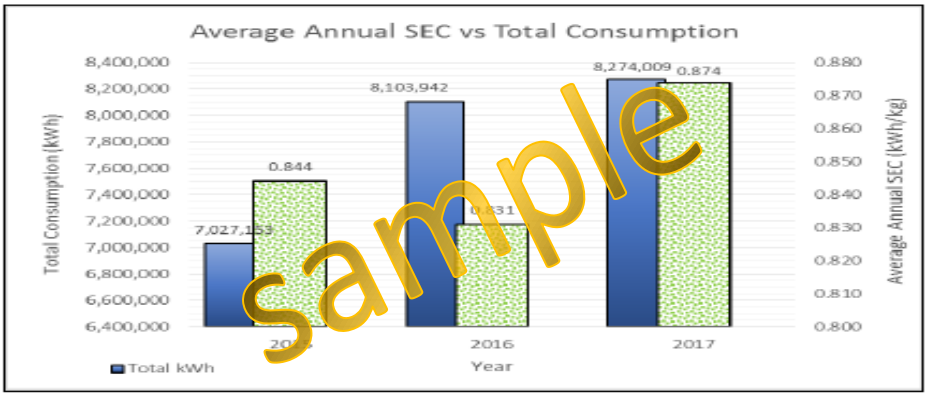


5.3.2 Specific energy consumption based on raw material input

Describe the pattern that influences the energy consumption according to the raw material input.

Month	TNB Bill Energy (kWh)	Raw Material Input (kg)	Specific Energy Consumption (kWh/kg)
Jan-17	536,007	546,045	0.982
Feb-17	630,008	795,573	0.792
Mar-17	795,494	956,850	0.831
Apr-17	635,285	753,628	0.843
May-17	680,325	902,756	0.754
Jun-17	618,492	695,202	0.890
Jul-17	715,964	944,696	0.758
Aug-17	732,9[illegible]	862,062	0.850
Sep-17	681,336	907,119	0.751
Oct-17	754,046	857,242	0.880
Nov-17	730,343	889,913	0.827
Dec-17	757,718	849,196	0.892
Total	**8,274,009**	**9,960,286**	**0.831**
Average	**689,501**	**830,024**	
Maximum	**795,494**	**956,850**	**0.982**
Minimum	**536,007**	**546,045**	**0.751**



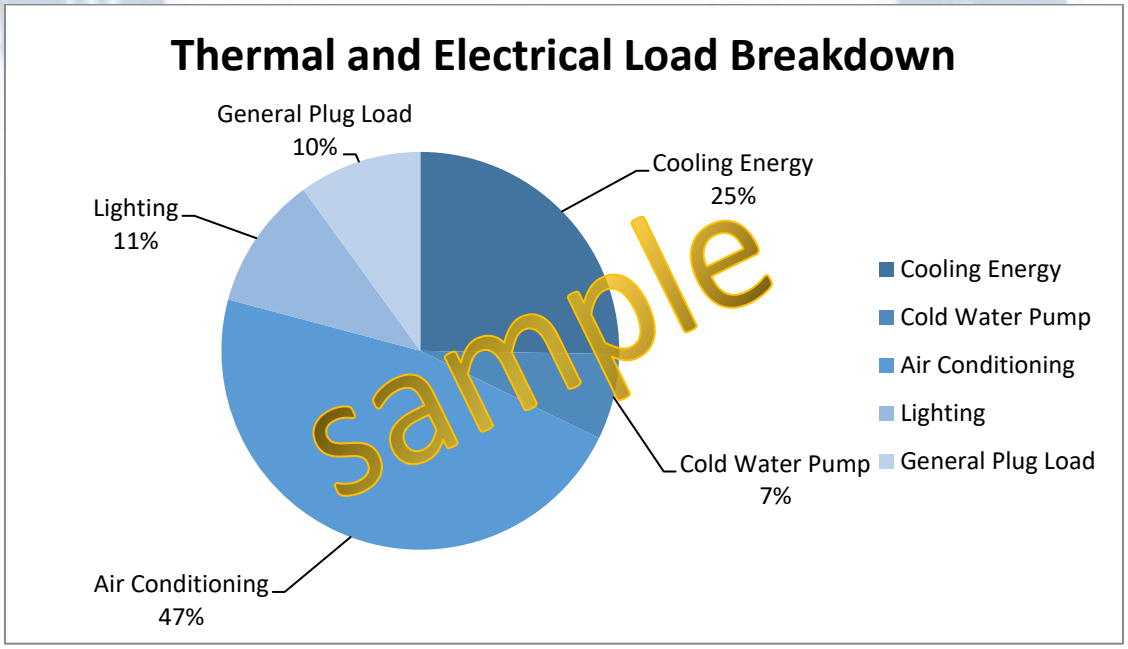


5.4 Load apportioning and Energy Efficiency Indices (EEI)

Describe table and charts.

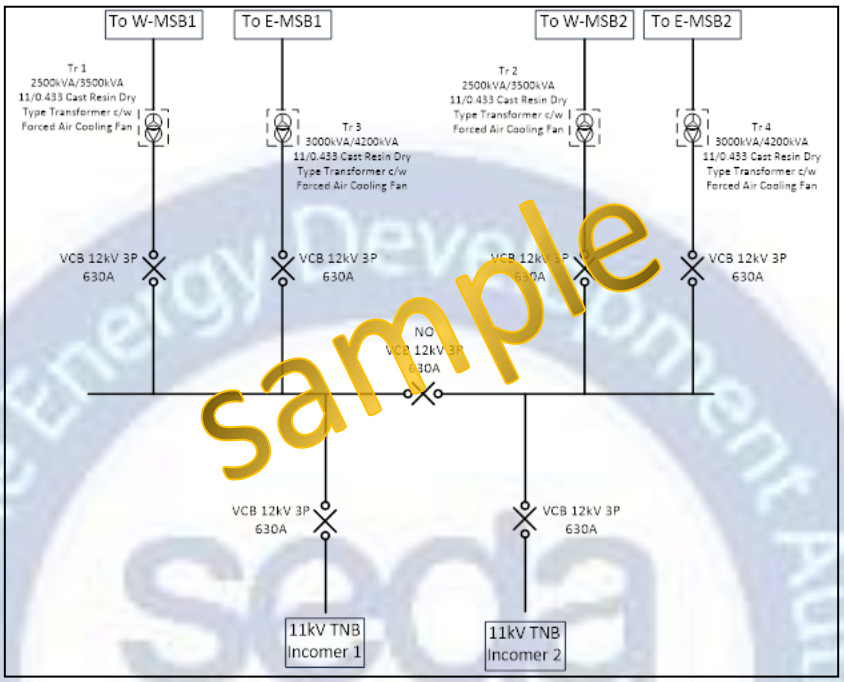
Building Energy Intensity Index (BEII)		kWh/m2
Lighting Energy Intensity Index (LEII)		kWh/m2
Air Conditioning Energy Intensity Index (ACEII)		kWh/m2
Building Power Baseload		kW

Lighting Power Density		W/m2
Air Conditioning Power Density		W/m2
Equipment Power Density		W/m2
Baseload Power Index		W/m2



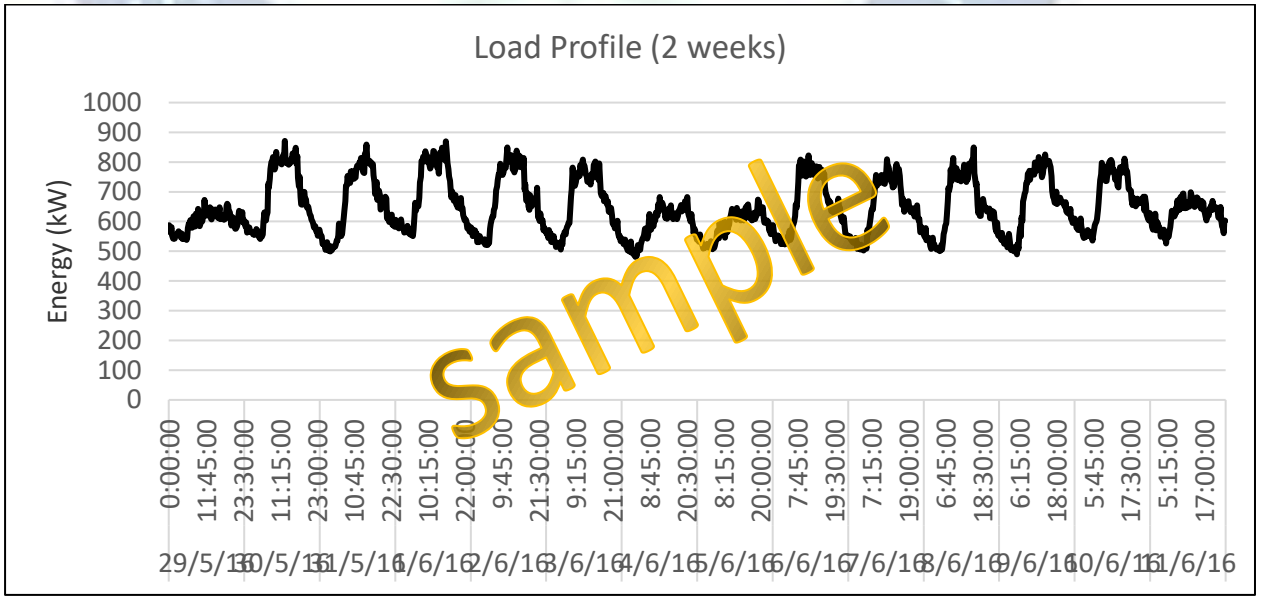
6 ENERGY CONSUMPTION INFORMATION AND ANALYSIS – System description, load profile, observations, and findings

Describe system electrical schematic diagram.



Describe load profile and observations.

Highlight baseload readings.

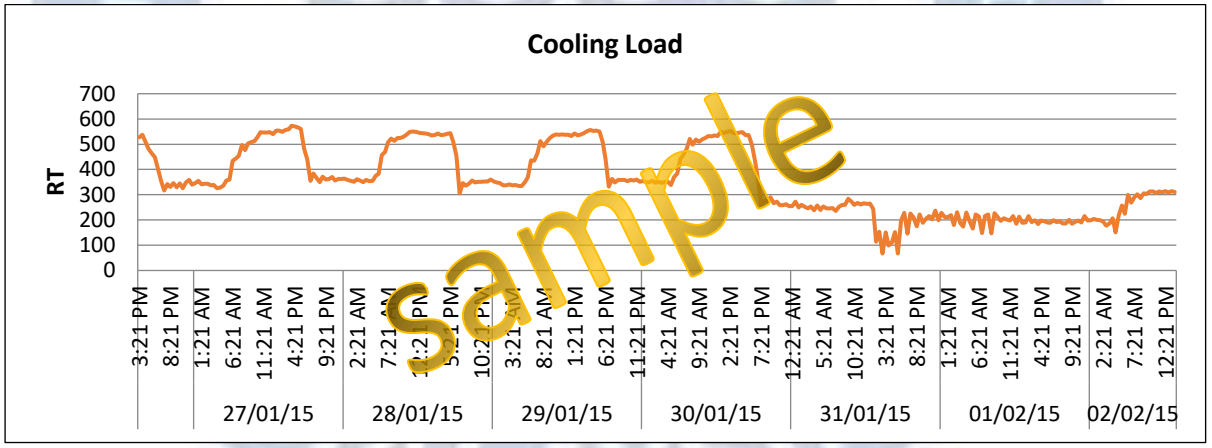


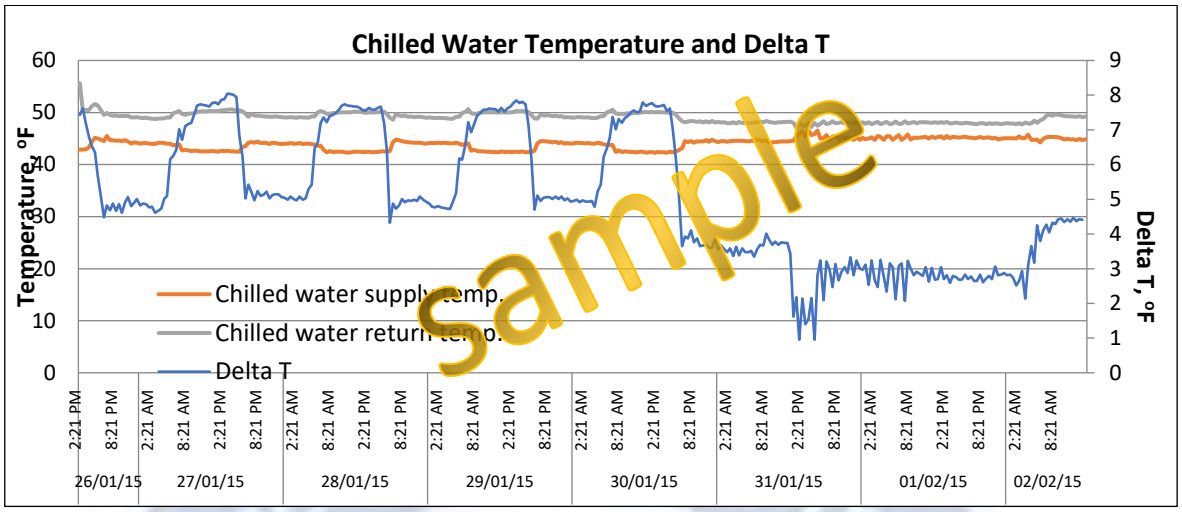
Describe load loss evaluation for transformers and UPS (if any).

Description	Tx 1	Tx 2	Tx 3	Tx 4
Average Efficiency (%)	94.37%	94.63%	94.52%	94.85%
Current Capacity (kVA)	321.65	156.86	221.30	551.88
	12.87%	6.27%	7.65%	13.14%
Available Capacity (%)	87.13	93.73%	92.35%	86.86%
Problems Detected		Dip, swell, interruption and impulse	Interruption	Interruption and impulse

6.1 Air conditioning and mechanical ventilation including pump and chilled water system

Describe load profile and observations of thermal/chilled water

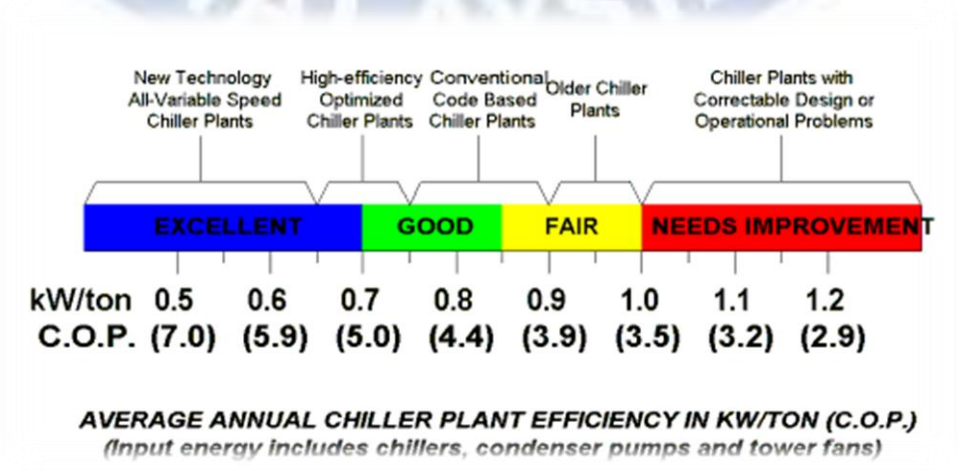




Describe chilled water system and operation.

Day	Average Load factor	Average COP
01	77%	3.7
02	82%	4.0
03	88%	4.5
04	89%	4.3
05	94%	4.8
06	95%	4.9
07	94%	5.1
Overall	**88%**	**4.5**

Evaluate chiller COP and System COP.



Describe ACMV System.

No	Description	Qty	Total Installed Power (kW)
	Main Building		
1	Chilled Water Pumps	4	220kW
2	Air Handling Units	4	632.2kW
3	Fan Coil Unit	30	188kW
4	Variable Refrigerant Volume (VRV) Unit	29	100.37kW
5	Ventilation Fans	90	337.6kW
6	Cooling Tower Fan	4	200kW
7	Condenser Water Pumps	4	130kW

Time schedule of operations.

No	Description	Quantity	Operation Hours	
			Start	Stop
	Main Building			
1	Chilled Water Pumps (Duty)	2	6:00am	6:00pm
	Chilled Water Pumps (Standby)	2	6:00pm	6:00am
2	Rooftop Chiller (Duty)	1	6:00pm	6:00am
	Rooftop Chiller (Standby)	1	6:00am	6:00pm
3	Air Handling Units (24hrs)	25	6:00am	6:00am
4	Air Handling Units	21	6:30am	6:00pm
5	Fan Coil Unit (24hrs)	16	6:00am	6:00am
6	Fan Coil Unit	14	7:00am	6:00pm
7	Variable Refrigerant Volume (VRV) Unit	28	6:00am	6:00am
8	Ventilation Fans (toilets)	86	Manual	
9	Ventilation Fans (Fresh air)	4	6.00 a.m	6.00 p.m

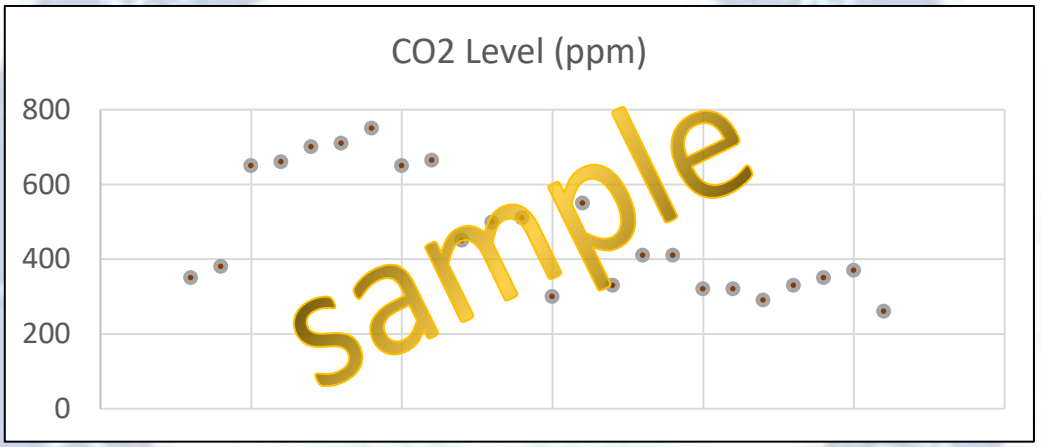
Describe findings of fan specific power.

No	AHU	Air Flow Rate, m^3/hr		Fan Power, W	Fan Efficiency, W/m^3hr
		Design	Running		
1	AHU-L1-MO1.4	28,237	17,193	8,668	0.50
2	AHU-L1-MO1.8	34,503	33,361	9,833	0.29
3	AHU-L1-MO1.9	24,451	9,539	7,439	0.78
4	AHU-L2-MO1.1	37,392	25,554	9,768	0.38
5	AHU-L2-MO1.2	36,621	10,602	8,345	0.79
6	AHU-L2-MO1.5	36,358	30,991	15,202	0.49

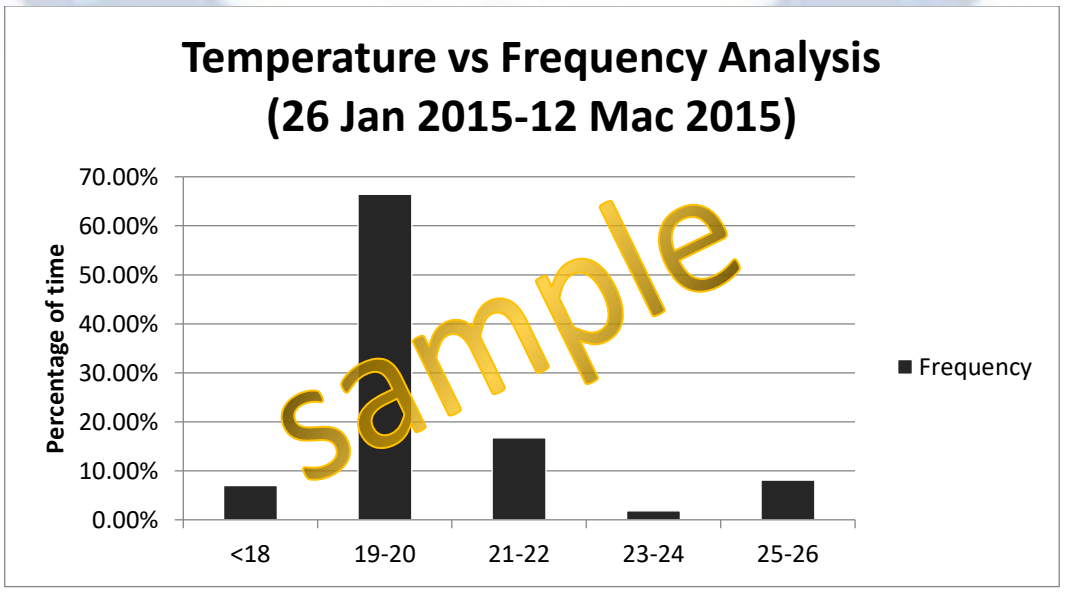
Describe findings of air change rate (ACR) and AHU capacity analysis.

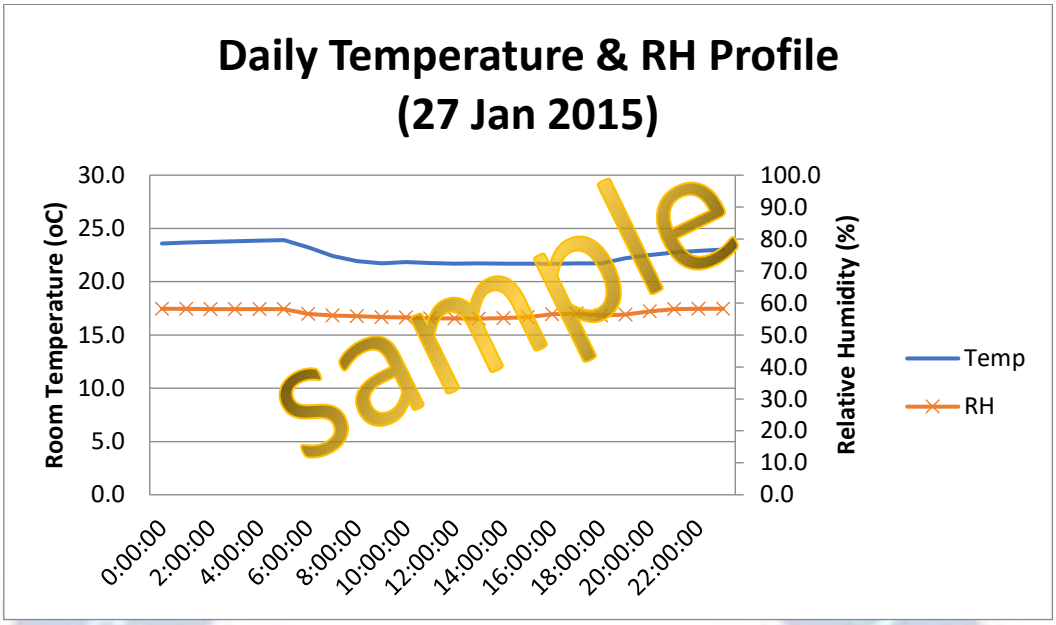
No	AHU	Capacity, Btu/hr	Air Flow Rate, m³/hr		Served Area, m²	Air Change Per Hour (ACH)		Capacity Intensity, Btu/hr ft²
			Design	Running		Design	Running	
1	AHU-L1-M01.9	593,688	25,269	9,539	969.2	8.5	3.2	56.9
2	AHU-L1-M01.8	812,056	34,503	33,361	1,600.9	7.0	6.8	47.1
3	AHU-L1-M01.4	665,340	28,252	17,192	1,077.5	8.6	5.2	57.4
4	AHU-ANX-L1A.3	535,684	22,824	5,853	925.2	8.1	2.1	53.8
5	AHU-L2-M01.1	880,296	37,392	25,554	1,720.3	12.8	4.9	47.5
6	AHU-L2-M01.2	863,236	36,621	10,603	1,448.8	8.3	2.4	55.4

Describe about indoor air quality.



Describe about air conditioning room conditions.





Describe observations and findings.

6.2 Fans and blowers

Describe system/s.

No	Description	Qty	Total Installed Power (kW)
			Main Building
1	Chilled Water Pumps	4	220kW
2	Cooling Tower Fan	4	200kW
3	Condenser Water Pumps	4	130kW

Time schedule of operations.

No	Description	Quantity	Operation Hours	
			Start	Stop
				Main Building
1	Air Handling Units (24hrs)	25	6:00am	6:00am
2	Air Handling Units	21	6:30am	6:00pm
3	Fan Coil Unit (24hrs)	16	6:00am	6:00am
4	Fan Coil Unit	14	7:00am	6:00pm

Describe observations and findings.

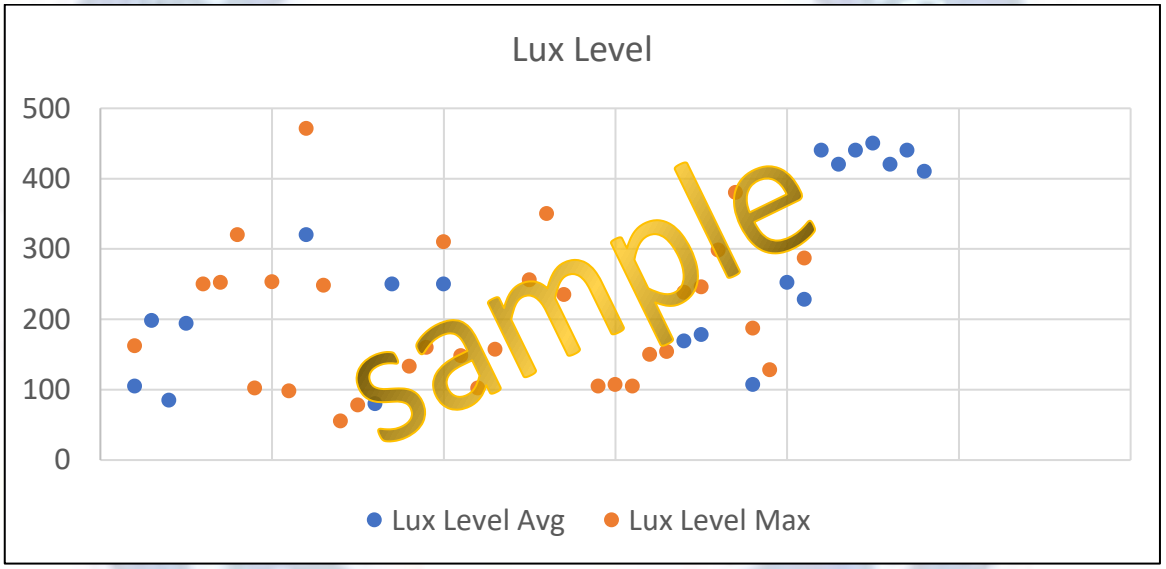
6.3 Lighting system

Show list of lighting types and quantity.

Describe lighting system and operation.

No	**Description**	**Operation Hours**	
		Start	**Stop**
		Main Building	
1	Lobby, Walkways	6:00am	6:00am
2	Offices	6:30am	6:00pm
3	Outdoor Lighting	7:00pm	7:00am
4	Decorative Lighting	6:00am	6:00am
5	Car Park (24hrs)	6:00am	6:00am

Describe findings about the lighting conditions.



Describe observations and findings from the lighting system.

6.4 Air compressor system

Show the list of compressors and the specifications and briefly explain the system.

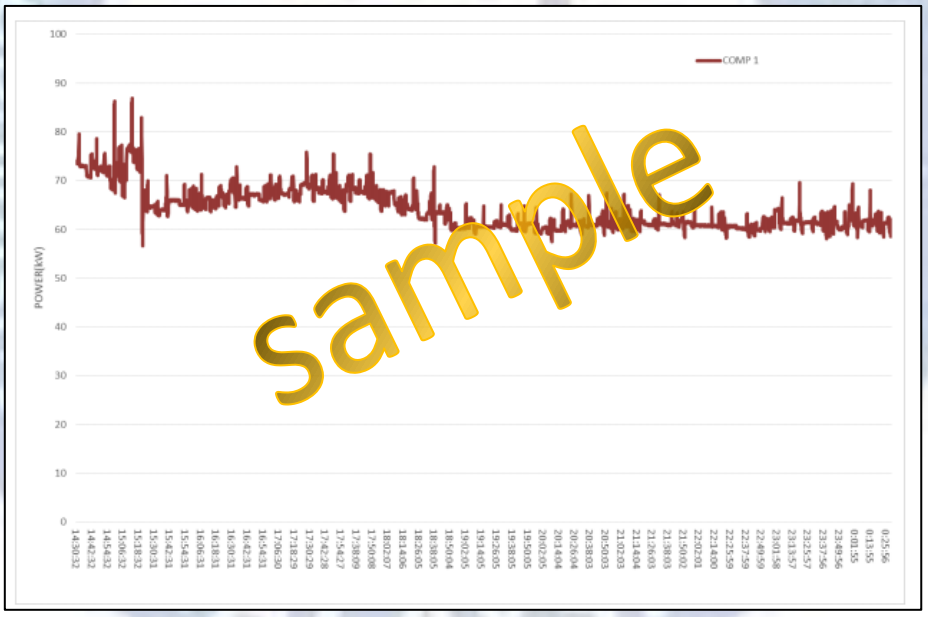
Date		12-04-18 (Peak)	19-07-18 (Peak)	20-07-18 (Off-Peak)
Brand		ELGi	ELGi	ELGi
Model		EG75-10.5V	EG75-10.5V	EG75-10.5V
Compressor Capacity (rated)	m^3/min	12.74	12.74	12.74
Targeted Pressure	bar	7.0	7.0	7.0
Average Power (measured)	kW	95	84.96	50.34
Rated Power	kW	75	75	75
Speed	%	92.00	83.25	50.88
Flow (Calculation – Affinity Law)	m^3/min	11.72	10.61	6.48
Specific Power (measured)	kW/m^3/min	8.11	8.01	7.77

Table 5.23: Specific power of air compressor (Support Block B & C)

**Refer Figure 5.43 for load profile of air compressor at 12/4/2018*

**Refer Figure 5.46 for load profile of air compressor at 19/7/2018 – 20/7/2018*

Explain the load profile for each compressor.



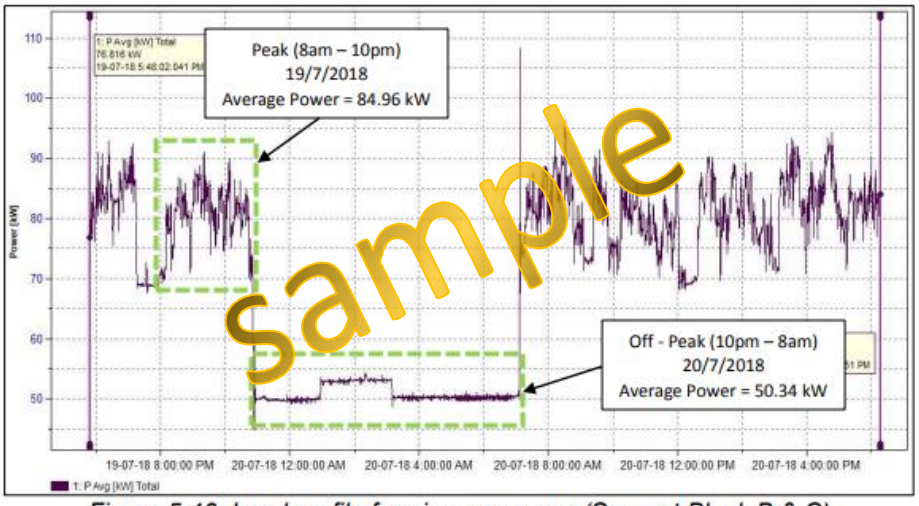


Figure 5.46: Load profile for air compressor (Support Block B & C) (19/7/2018 – 20/7/2018)

Describe observations and findings for each compressor.

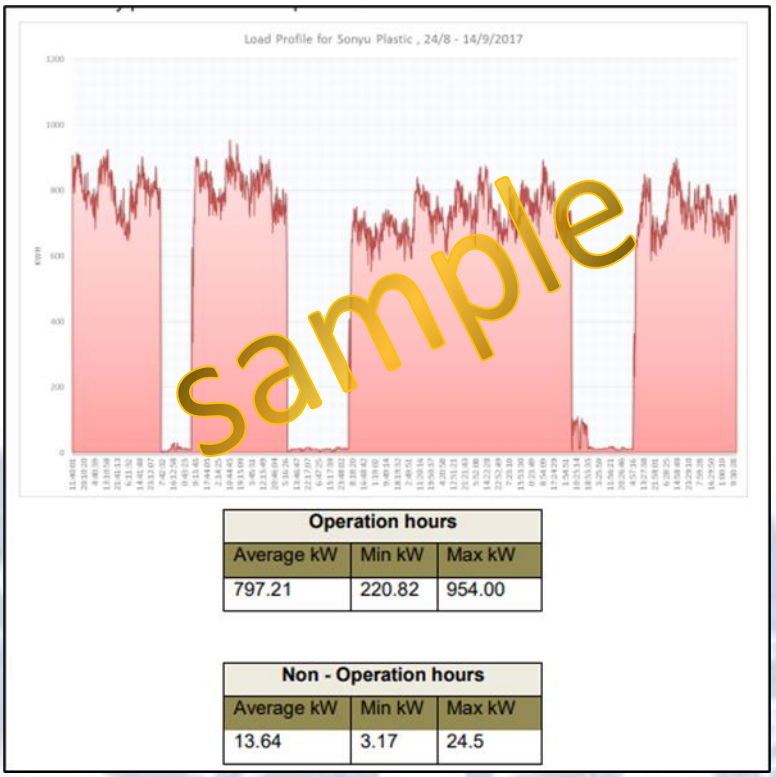
6.5 Electric motor, pumps and production equipment

Show the list of machine/equipment types and quantity.

Describe the system and operation for each type of machine/equipment.

Explain the load profile for each machine/equipment.

Describe observations and findings (the condition) from the machine/equipment.



Operation hours		
Average kW	Min kW	Max kW
797.21	220.82	954.00

Non - Operation hours		
Average kW	Min kW	Max kW
13.64	3.17	24.5

6.6 Steam generation by biogas/diesel/others and distribution system

Briefly explain the generation and distribution system.

Explain the energy consumption and load profile for each generator and distributor system.

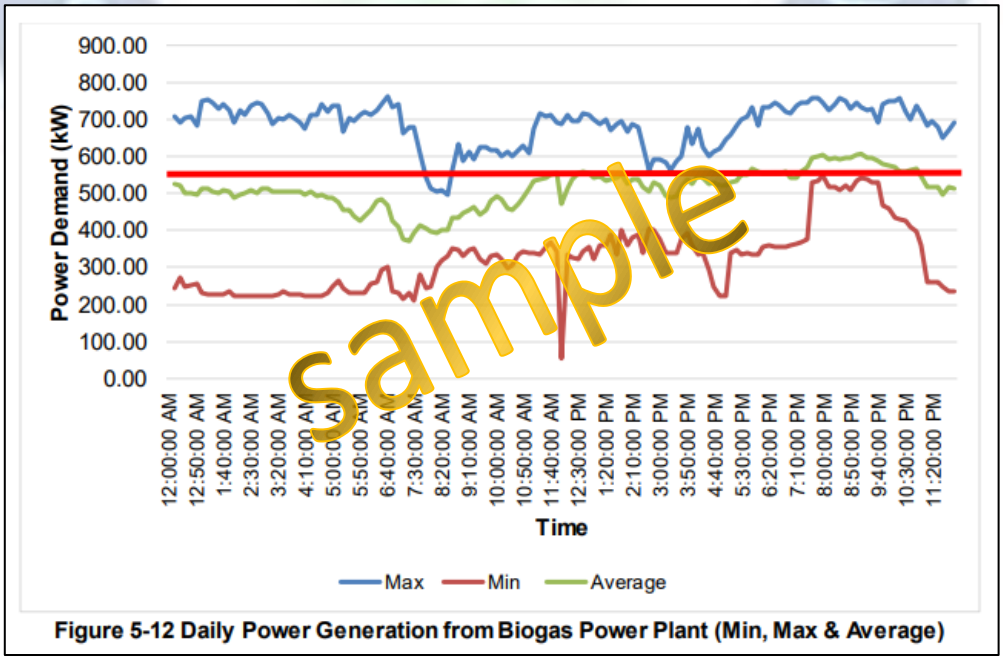


Figure 5-12 Daily Power Generation from Biogas Power Plant (Min, Max & Average)

Table 5-1 Summary of Energy Consumption

Type	kWh/week
Boiler Steam Turbine	336,652.57
Diesel Generator Set	16,180.93
Biogas Power Plant	86,056.81
Total	**438,890.31**
Estimate Monthly	1,755,561.24
Actual Average Power Generation 2016	1,850,244.17
Deviation Percentage	5.12%

6.7 Others

Show the list of types and quantity.

Provide the diagram, graph, picture for the explanation.

Describe the system and operation for each type of system.

Explain the energy consumption and load profile.

Describe observations and findings (the condition) from the system.

7 ENERGY SAVING MEASURES

Explain each ESM in detail showing basis of calculations and assumptions made.

No cost measures

Findings.

Energy Saving Recommendation/Measure.

Potential Annual Cost and Savings.

Estimated Investment Cost.

ROI/SPP.

Low / Medium cost measure

Findings.

Energy Saving Recommendation/Measure.

Potential Annual Cost and Savings.

Estimated Investment Cost.

ROI/SPP.

High cost measure

Findings.

Energy Saving Recommendation/Measure.

Potential Annual Cost and Savings.

Estimated Investment Cost.

ROI/SPP.

* The ESMs shall address the energy management and energy efficiency. Renewable energy can be included but it is not part of the Energy Audit Conditional Grant scope.

Appendix A

Summary ESM table.

No.	ESM	Estimated Savings		Estimated Investment(RM)	Simple Payback Period (yrs)	Estimated Carbon Reduction
		Energy (kWh)	Cost (RM)			kgCO2/kWh
No Cost						
1	Decommissioning all non critical ACSU units when chiller plant has been retrofitted	577587.64	306121.45	0	Immediate	
Low/Medium Cost						
2	Replace all Incandescent decorative lamps with LED strips/LED lamps	28539.22	15,126.78	1,000.00	0.07	21,147.56
3	Switch off outdoor corridor lights during the daytime	55,449.85	29,388.71	80000	2.7	41,083.15
4	Repairing compressed air leakage	4,900.00	2597.00	15000	5.8	3,630.9
High Cost						
5	Retrofit chillers, chilled water pumps, condenser water pumps, cooling tower and upgrade pipeworks	380112.00	201459.36	1190000	5.9	281,662.9
6	Retrofit AHUs and ducting to improve efficacy	669384.00	354773.52	359000	1.0	496,013.54
7	Replace all existing fluorescent and CFL lamps with LED lamps	567599.96	300,827.98	482,640.00	1.60	420,591.57

'TO BE COMPLETED BY BUILDING OWNER'

- Financing options/Government Incentives available.
- Guides on how to implement proposed energy saving measures.
- Proposed action plan and estimated time required to implement each measure.

8 ENERGY SAVING MEASUREMENT AND VERIFICATION

'TO BE COMPLETED BY BUILDING OWNER'

Types of baseline data:

- Past year bills.
- Measurements.

Measurement and Calculation methods.

Measurement & Verification methods.

9 FINANCIAL AND ENERGY SAVINGS MEASURES IMPLEMENTATION PLANNING FOR OWNER TO IMPLEMENT (3 YEARS)

'TO BE COMPLETED BY ENERGY AUDITORS AND BUILDING OWNER'

- 1ST Year, estimated implementation cost and savings.
- 2ND Year, estimated implementation cost and savings.
- 3rd Year, estimated implementation cost and savings.

Describe how to manage the financial at top management in order to execute the plan for the recommended ESMs.

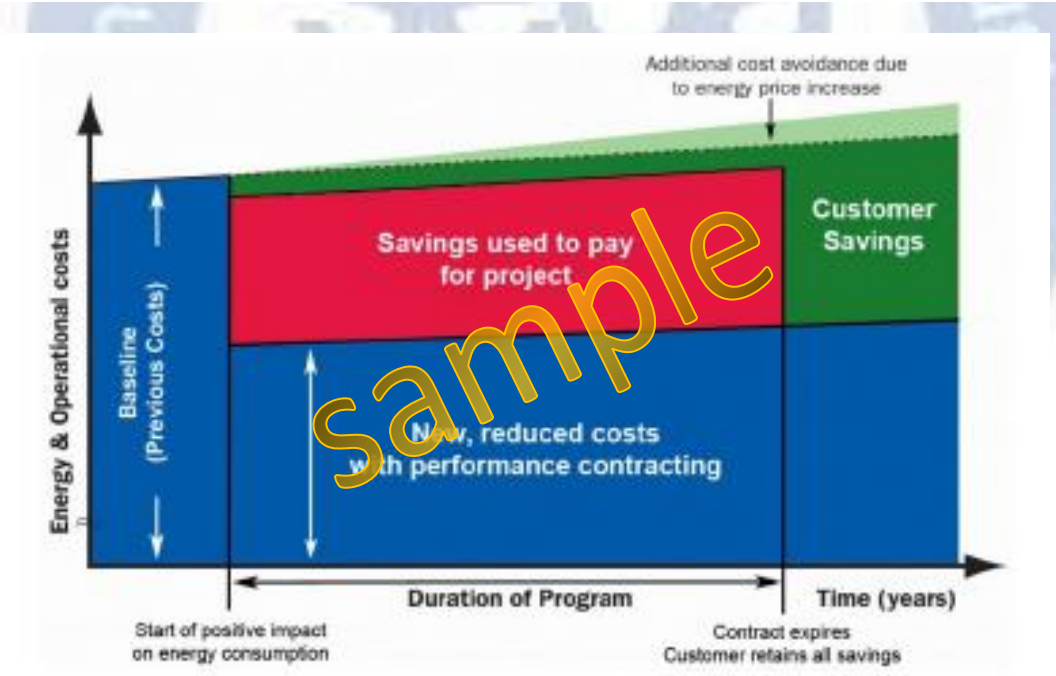
Include the planning of ESMs implementation every year for 3 years.

* The ESMs implementation planning shall address the energy management and energy efficiency.

Renewable energy can be included but it is not part of the Energy Audit Conditional Grant scope.

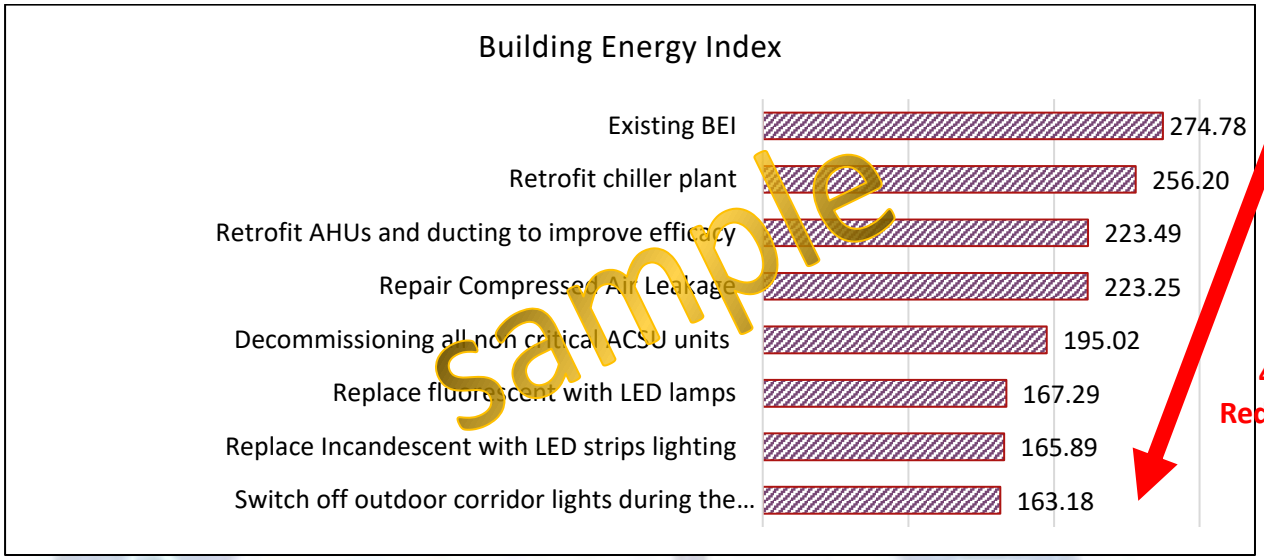
No	Proposed of Energy Saving measures	Priority of Implementation	Year of Implementation	Financial Plan
ESM 01	INSTALL ELECTRICAL SUB-METER MONITORING SYSTEM	1	2019	Self-funding
ESM 06	CONTROL MAXIMUM DEMAND BY RESCHEDULLING RECYCLE PRODUCTION	2	2019	Self-funding
ESM 03	MAINTENANCE IMPROVEMENET TO AVOID AIR COMPRESSOR RUNNING MORE THAN RATED POWER	3	2019	Self-funding
ESM 02	REDUCE AIR COMPRESSOR OPERATION PRESSURE AND LEAKAGE	4	2020	Self-funding
ESM 04	REPLACE AGING AIR COMPRESSOR FOR RECYCLE MACHINE WITH NEW VARIABLE SPEED DRIVE AIR COMPRESSOR	4	2019	Self-funding
ESM 05	INCREASE CONDITIONED SPACE ROOM TEMPERATURE AT BLOCK D PRODUCTION BLOWING JAPAN LINE	5	2020	Self-funding
ESM 07	REPLACE NEW SCREW AND BARREL FOR PRODUCTION BLOWING MACHINE TO IMPROVE SEC	6	2021	Self-funding
ESM 08	CENTRALIZE AIR COMPRESSOR SYSTEM FOR BLOCK A, B, C AND D	7	2022	Self-funding
ESM 09	MAINTENANCE IMPROVEMENT TO INCREASE EFFICIENCY OF PUMP	8	2023	Self-funding
ESM 10	INSTALL SOLAR PANEL	9	2023	Self-funding

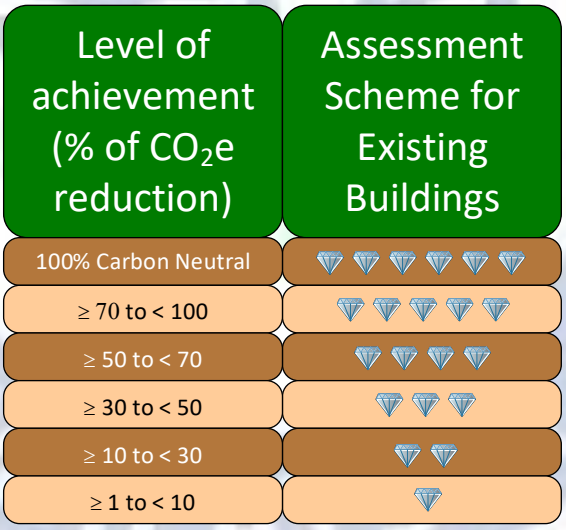
Table 9.1: Energy Efficiency Project Implementation Priority and Financial Plan



10 CONCLUSION

Conclusion.





Construction Industry Standard 2012 CIS20:2012 GreenPASS assessment scheme

11 VERIFICATION

This Energy Audit Report is		
prepared by:	checked by:	received by SEDA Malaysia
Name: **Position:** **Date:**	Name: Position: Date:	Name: Position: Date: