Suruhanjaya Tenaga
Energy Commission

COGENERATION

An Energy Efficient Technology

Be Energy Smart

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An Energy Efficient Technology

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Cogeneration in General

Introduction

The purpose of this guide is to provide information on the cost benefit of cogeneration and the platform available to sell the excess energy generated by the cogeneration facilities to the wholesale electricity market operated by the Single Buyer (SB) under the New Enhanced Dispatch Arrangement (NEDA).

Medium Size Cogeneration

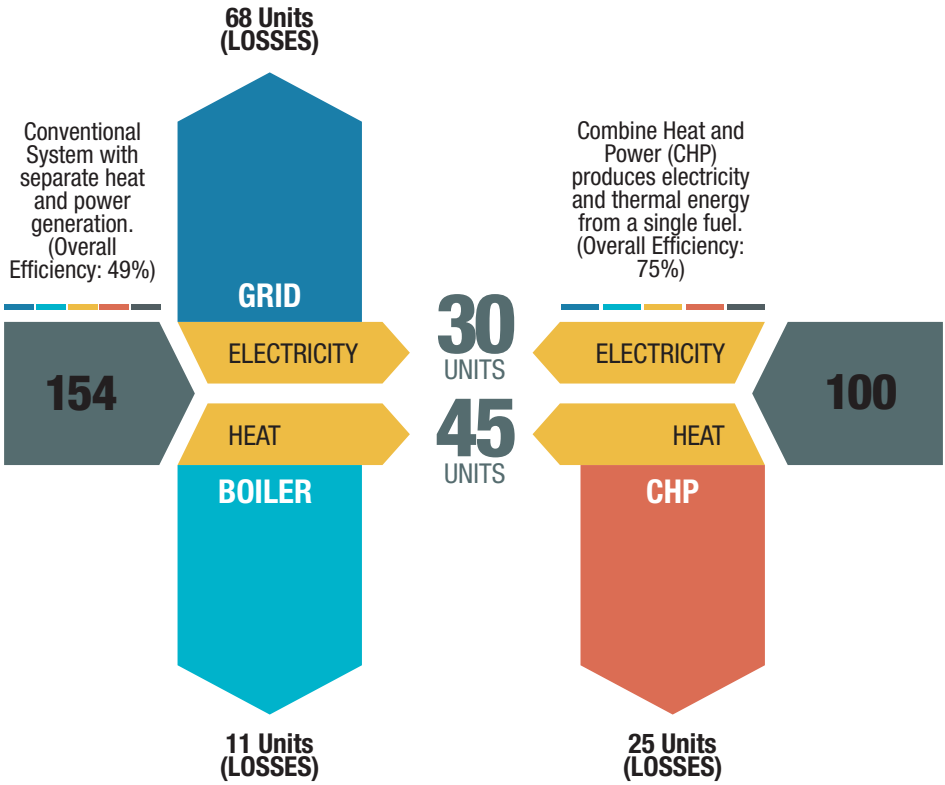
Small Cogeneration

Cogeneration System

Cogeneration is an energy efficient technology which enables the simultaneous production of two (2) different forms of useful energy, typically electricity and thermal energy from a single primary energy source. The electricity generated is normally for onsite use and any excess may be exported to the local utility network. Thermal energy produced may be used for industry processes or to produce steam, hot water or hot air for drying or warming or chilled water for cooling purposes.

The overall efficiency of energy use in a cogeneration system can be up to 75% and more.

Overall Efficiency Comparison between Conventional System and Cogeneration



A cogeneration facility with small gas turbine plant can save more than 40% of the primary energy compared to the electricity generated by a fossil fuel-fired power plant and thermal energy produced by a boiler. In addition to the saving of fossil fuels, cogeneration will reduce carbon dioxide (CO_2) emission since less fuel is used and reduce losses in the transmission and distribution lines as electricity is generated on site or near the loads.

Application of Cogeneration

Petrochemical Industries

Hospital

District Cooling

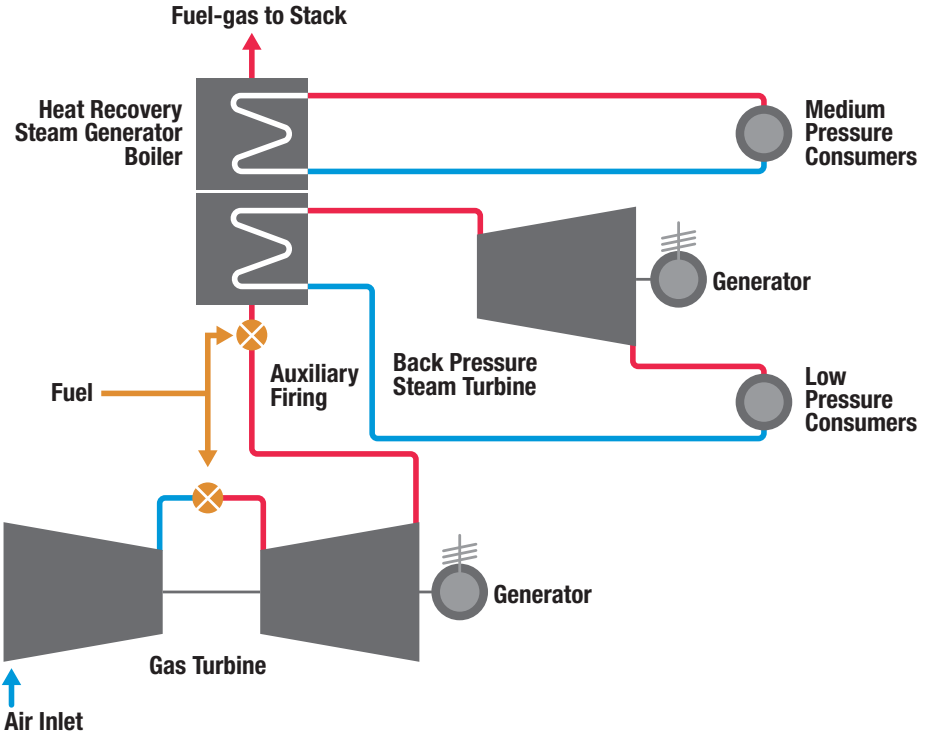
Manufacturing / Heavy Industries

The benefits of cogeneration can be briefly summarised as follows:

- Improve efficiency in the use of energy resources.
- Saving in operation costs with reduced energy costs.
- Improve profitability and competitiveness of the business.
- Reduce peak system demand and operation of less efficient peaking plants.
- Reduce demand and energy losses in transmission and distribution of electricity.

In addition, cogeneration will also encourage private investment in generation using energy efficient technology and use of renewable energy resources. It will generate business opportunities and stimulate growth of the small and medium local enterprises in the manufacturing and supply of equipment and parts, as well as contribute to job creation for the locals, particularly in plant operation and equipment services.

High-Efficient Combined Cycle Cogeneration



The success of a cogeneration facility depends on many factors such as:

- Technology.
- Type of fuel used.
- Size of the plant.
- Optimised use of heat produced and electricity generated.
- Daily and annual load profiles.
- Annual full load operating hours.
- Opportunity for sales of excess energy produced.
- Electricity and fuel prices.
- Electricity top up and standby charges.
- Tax incentives.
- Energy policy of the country.

Criteria for Promotion of Cogeneration

In promoting cogeneration, the emphasis will be on the following areas:

Technical

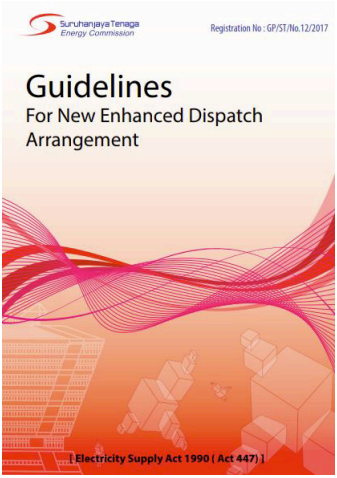
- Known technologies with low risk in implementation and operation.
- Base load energy production.
- Readily available fuel sources.
- No extensive modification or reinforcement to the existing electricity supply networks.

Commercial

- Benefits from an economy-wide perspective, rather than from the energy-sector's perspective only.
- Wider cost and supply benefits of cogeneration for the electricity supply industry; deferral of network capital, relief of network constrains and reduction in network losses by distributed generation.
- Commercial / manufacturing / industry facilities which can provide scale and continuous energy delivery.
- Use of industrial and agriculture wastes and renewable resources.
- Innovation in the use of waste heat, particularly the low-grade heat.

Sale of Excess Energy Under New Enhanced Dispatch Arrangement (NEDA)

In the past, a cogenerator cannot export and sell the excess energy generated in the facility through the electricity supply network unless there is a Power Purchase Agreement (PPA) with the electricity supply company. This is one of the reasons affecting the wider use of cogeneration, particularly in the small and medium-size industry and commercial sectors, as the sale of excess energy may be a factor affecting the consideration in investment in cogeneration.



The New Enhanced Dispatch Arrangement (NEDA) introduced since 2017 has overcome such shortcoming by providing a platform for cogenerators which do not have PPA with the electricity supply company to export and sell energy generated to the SB market. This will enhance financial viability with additional return to the investment on cogeneration.

Under NEDA, depending on the capacity of the cogeneration facility, a cogenerator without a PPA with the electricity supply company can participate in NEDA under one (1) of the following categories:

Large Merchant Generator

A large cogenerator with generation facility of not less than 30 MW which is connected to the Grid System and subject to central dispatch by the Grid System Operator (GSO) can participate as Large Merchant Generator.

Price Taker

A small or medium size cogenerator with generation facility from 100 kW up to below 30 MW (herein after referred to as "SPP-Cogen") which are not subject to central dispatch by the GSO can participate as Price Taker.

Photo courtesy of PETRONAS

For more details of the market arrangement, please refer to the Guidelines for New Enhanced Dispatch Arrangement on the Commission's website.

A large cogenerator with generation facility of not less than 30 MW can participate in the daily bidding system to sell excess energy to the SB market by offering half hourly Price Quantity Pair [(x) RM/kWh for (y) kW] to the SB similar to other Large Merchant Generators. If its offer is lower or equal to the System Marginal Price and is accepted and scheduled by the SB and the energy dispatched by the Grid System, the energy delivered to the Grid System will be paid at the actual System Marginal Price.

As a Price Taker, a SPP-Cogen with generation facility of 100 kW to less than 30 MW can sell excess energy generated to the SB through the electricity supply company without having to participate in the daily bidding process. The energy delivered to electricity supply networks will be paid the actual half hourly System Marginal Price which depends on market fuel prices, system demand and availability of system generation.

Examples of System Marginal Prices (SMP) can be obtained from Single Buyer website through https://www.singlebuyer.com.my/.

Promotion of SPP-Cogen

This section describes the conditions and requirements for a cogenerator to be eligible to participate as an SPP-Cogen under the category of Price Taker in NEDA to export and sell excess energy to the SB Market.

Qualifying Requirements as SPP-Cogen

To qualify as an SPP-Cogen, the cogeneration facility shall meet the following requirements:

Economic Requirements

- The size of the cogeneration facility shall be based on economically justifiable demand of thermal energy required.
- The cost of electricity produced by the cogeneration facility is cheaper than the average generation cost of the electricity supplied by the electricity supply company.

  The example of Cost Benefit analysis of an IMW Cogen facility is as shown in Appendix A.

Efficiency Requirements

- The overall efficiency of the cogeneration facility shall be not less than 70%.

Capacity Requirements

- The cogeneration facility shall be less than 30 MW but not less than 100 kW.

Technical Requirements

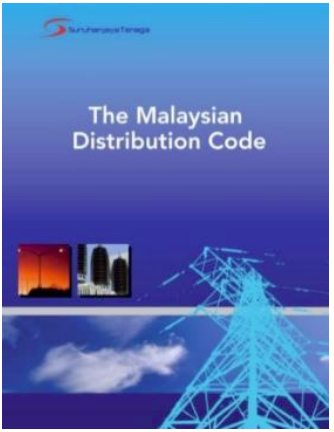
- The primary energy resource must be used to simultaneously produce thermal energy and electricity either by “topping cycle” or “bottoming cycle”.
- The generating facility must comply with the Distribution Code, Guidelines for Single Buyer Market, Guidelines for New Enhanced Dispatch Arrangement and other relevant legal and regulatory requirements, where applicable.

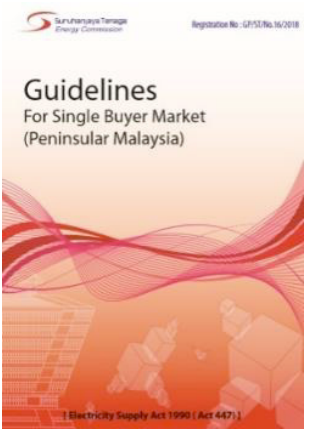
- The connection, protection, control, communication, metering, information exchange and other operational and technical requirements of the cogeneration facility shall comply with the Distribution Code and Grid Code where applicable, unless approved by the Commission otherwise.
- The electricity supply company shall provide connection to the SPP-Cogen for the export and sale of energy on successful completion, testing and commissioning of the cogeneration facility per the licence conditions, the Distribution Code and the Grid Code, where relevant.

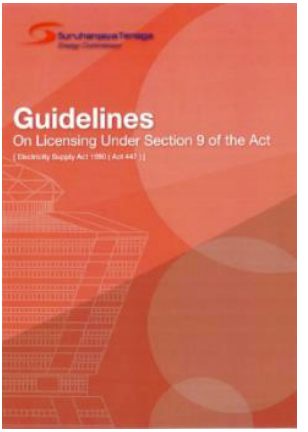
Legal and Regulatory Requirements

The SPP-Cogen shall comply with the following requirements:

- The SPP-Cogen must possess a public licence for generation and supply of electricity issued by the Commission.
- The SPP-Cogen must register with the Commission under the Guidelines for Single Buyer Market as a market participant, and as a NEDA participant under the Guidelines for New Enhanced Dispatch Arrangement.
- The SPP-Cogen shall comply with the legal requirements and the licence conditions and the Grid Code, Distribution Code, Guidelines for Single Buyer Market and Guidelines for New Enhanced Dispatched Arrangement where relevant.
- The SPP-Cogen can only dispatch power to the Distribution Network after all pre-requisite legal and regulatory requirements have been fulfilled.







Operational Matters

- The SPP-Cogen shall provide details of the annual generation plan of the cogeneration facility and declare the annual available energy for export to the SB.
- The SPP-Cogen shall use its best endeavors to deliver not less than 70% of the annual declared available of energy for export as declared by the SPP-Cogen in the annual generation plan unless for reasons not attributed to the SPP-Cogen.
- The SPP-Cogen shall submit day ahead forecast of planned generation of its generation facility to the SB in accordance with format and time schedule in the NEDA Rules.
- The electricity supply company shall accept all energy supplied by the SPP-Cogen unless under such system emergency situations that the importing of such energy will place the safety and security of the electricity supply networks at risk.
- The SPP-Cogen shall take immediate action to comply with any emergency instructions of the control center of the electricity supply company if the security of the electricity supply networks is at risk.
- The minimum export capacity by a SPP-Cogen shall be not less than 100 kW.

Interconnection Voltages

Depending on the top up/standby demand of the cogeneration facility, the interconnection voltages to the electricity supply networks adopted by the electricity supply company are generally as follows:

- Up to 1.0 MW : 415 V or 11 kV
- 1.0 MW to 10.0 MW : 11 kV or 33 kV
- 10.0 MW to 30.0 MW : 33 kV

Top Up and Standby Charge for Power Supply

A SPP-Cogen shall enter into a commercial agreement with the electricity supply company if standby and top up power are required to be provided by the electricity supply company.

The standby and top up power charges of the electricity supply company will be as published and approved by the Government.

To facilitate the electricity supply company in planning and arranging for supply of standby power, the SPP-Cogen shall coordinate with the electricity supply company on the annual maintenance programmes.

The current top up and standby charges are as shown in Appendix B for reference. This will be in accordance to any revision as and when decided by the Government.

Gas Price

The gas price between the cogeneration facility and the shipping licensee will be based on willing buyer willing seller arrangement. The SPP-Cogen must source its own gas supply from shipping licensee with the Third-Party Access (TPA) arrangement as provided for under the Gas Supply Act 1993 [Act 501].

Glossary

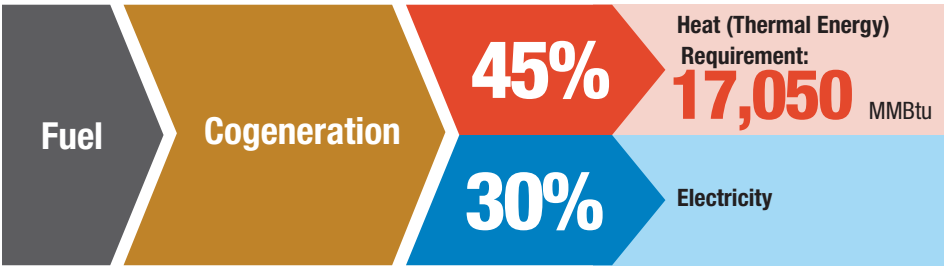
Terms	Meaning
Bottoming Cycle	The energy input to the cogeneration facility is first applied to produce useful thermal energy and the reject heat emerging from the process is then used to produce power.
Cogeneration	A process whereby a single fuel source is used for the simultaneous production of thermal energy and electrical or mechanical energy.
Cogeneration Facility	A facility with one of more cogeneration plant.
Cogenerator	A person who owns or operates a cogeneration facility.
Electricity Supply Company	An entity which is licensed under the Electricity Supply Act to supply and distribute electricity.
Distribution Code	A document issued by the Commission containing rules, principles and procedures to facilitate planning, development, operation and maintenance of and connection to an electricity distribution system in Peninsular Malaysia.
Economically Justifiable Demand	Demand that does not exceed the needs for heating or cooling and which would otherwise be satisfied at market conditions by energy generation processes other than cogeneration.
Generator	A person who is licensed under the Electricity Supply Act 1990 to generate electricity.
Grid Code (or Malaysian Grid Code)	A document issued by the Commission containing rules, principles and procedures to facilitate coordinated planning, design, development, operation and maintenance of the grid system in Peninsular Malaysia.
Grid System	The electricity transmission network as defined in the Electricity Supply (Amendment) Act 2015.
Grid System Operator (GSO)	The person responsible for operational planning, real-time re-scheduling, dispatch and control of the Grid System in compliance with the provisions of the Grid Code and coordinates all parties connected to the Grid System.

Terms	Meaning
Guide	This document, the Guide for Promotion of Cogeneration.
Guidelines for New Enhanced Dispatch Arrangement or New Enhanced Dispatch Arrangement Rules (or NEDA Rules)	The document which sets out the principles, by which the Single Buyer used in scheduling the dispatch of generation, the determination of system marginal prices and the settlement of electricity delivered to and purchased by the Single Buyer in accordance with the New Enhanced Dispatch Arrangement.
Guidelines for Single Buyer Market (or Single Buyer Rules)	A document that sets out the objectives, roles and functions of the Single Buyer and the roles of other Participants in the Single Buyer market.
New Enhanced Dispatch Arrangement (NEDA)	The arrangement used by the Single Buyer in scheduling the dispatch of generation, the determination of prices of electricity purchased etc. in accordance with the NEDA Rules.
Overall Efficiency	The annual sum of electricity and useful heat output divided by the fuel input used for the heat and gross electricity production in a cogeneration process calculated on the net calorific value of the fuel.
Power to Heat Ratio	The ratio of electricity from cogeneration to useful heat when operating in full cogeneration mode using operational data of the specific unit.
Price Quantity Pair	The price (in RM/kWh) for a specific quantity of electricity (in kW or MW).
Price as Bid	The bid price of a specific quantity of electricity for a specific half hourly period offered by a generator to Single Buyer.
Single Buyer	The person authorised by the Commission to be responsible for the management of procurement of electricity and related services, which includes scheduling, procuring and settlement under Single Buyer Guidelines.
SPP-Cogen (or Small Power Producer with Cogeneration Facility)	A Cogenerator with cogeneration facility from 100 kW to less than 30 MW.

Terms	Meaning
Standby Power	The electrical energy or power provided by the electricity supply company to replace the energy ordinarily generated by the cogeneration facility during an outage of the cogeneration facility.
System Marginal Price	The variable price of the most expensive generation plant scheduled to meet the demand.
Topping Cycle	The energy input to the cogeneration facility is first applied to produce power output and the reject heat emerging from the process is then used to produce useful thermal energy.
Top Up Power	The electrical energy and / or power regularly supplied by the electricity supply company and used by the cogeneration facility in addition to the electricity generated by the cogeneration facility itself.
Useful Heat	The heat production in a cogeneration process to satisfy economically justifiable demand for heating or cooling.

Appendix A

COST BENEFIT ANALYSIS OF A 1 MW COGENERATION FACILITY BASED ON HEAT DEMAND



Case 1

Assumption
Average Electrical Load: 1.0 MW
Power to Heat Ratio: 1:1
Annual Operation Hours: 5,000 hours
Annual Thermal Energy Demand: 17,050 MMBtu or 5,000 MWh
(Conversion Factor: 1.0 MWh = 3.41 MMBtu)
Annual Electricity Demand: 5,000 MWh
Efficiency of Boiler: 80%
Efficiency of Gas Turbine Generator: 30%
Efficiency of Heat Production System of Cogeneration Facility: 45%
Electricity Tariff of Electricity Supply Utility: RM0.4/kWh
Gas Price: RM30.00/MMBtu
Average Selling Price of Excess Electricity: RM0.26/kWh (depending on System Marginal Price)

- Business as usual with gas-fired boiler to meet thermal energy demand and electricity purchased from electricity utility company to meet electricity demand.

Annual Electricity Cost	RM0.4 x 5,000,000 kWh = RM2,000,000.00
Annual Fuel Cost for Boiler	$\frac{\text{RM30/MMBtu x 17,050 MMBtu}}{0.8}$ = RM639,375
Total Energy Cost	RM2,000,000 + RM639,375 = RM 2,639,375

- A cogeneration facility with gas turbine generator and heat recovery steam production system.

Annual Fuel Cost	(RM30/MMBtu x 17,050 MMBtu)/0.45 = RM1,136,667
Electricity Produced by Cogen Facility	$\frac{\text{17,050 MMBtu x 0.3}}{\text{0.45 x 3.41}}$ = 3,333 MWh
Top Up Electricity Purchased from Utility	5,000 MWh – 3,333 MWh = 1,667 MWh
Cost of Top Up Electricity Purchased	RM0.4 x 1,667,000 kWh = RM 666,800.00
Total Energy Cost	RM1,136,667.00 + RM666,800.00 = RM1,803,467.00

- Cost benefit with cogen facility compared with business as usual

Annual Saving in Total Energy Cost	RM2,639,375.00 - RM1,803,467.00 = RM835.908.00

Case 2

Assumption
Average Electrical Load: 0.5 MW
Power to Heat Ratio: 0.5:1
Annual Operation Hours: 5,000 hours
Annual Thermal Energy Demand: 17,050 MMBtu or 5,000 MWh (Conversion Factor: 1.0 MWh = 3.41 MMBtu)
Annual Electricity Demand: 2,500 MWh
Efficiency of Boiler: 80%
Efficiency of Gas Turbine Generator: 30%
Efficiency of Heat Production System of Cogeneration Facility: 45%
Electricity Tariff of Electricity Supply Utility: RM0.4/kWh
Gas Price: RM30.00/MMBtu
Average Selling Price of Excess Electricity: RM0.26/kWh (depending on System Marginal Price)

- Business as usual with gas-fired boiler to meet thermal energy demand and electricity purchased from electricity utility company to meet electricity demand.

Annual Electricity Cost	**RM0.4 x 2,500,000 = RM1,000,000.00**
Annual Fuel Cost for Boiler	**RM30 x 17,050 MMBtu ÷ 0.8 = RM639,375.00**
Total Energy Cost	**RM1,000,000.00 + RM639,375.00 = RM1,639,375.00**

- A cogeneration facility with gas turbine generator and heat recovery steam production system.

Annual Fuel Cost	$\frac{\text{RM30/MMBtu x 17,050 MMBtu}}{0.45}$ = RM1,136,667.00
Electricity Produced by Cogen Facility	$\frac{\text{17,050 MMBtu x 0.3}}{\text{0.45 x 3.41}}$ = 3.333 MWh
Excess Electricity Produced	3,333 MWh – 2,500 MWh = 833 MWh
Revenue From Sale of Excess Electricity Produced	RM0.26 x 833,000 kWh = RM216,580.00
Total Annual Energy Cost	RM1,136,667.00 - RM216,580.00 = RM920.087.00

- Cost benefit with cogen facility compared with business as usual.

Annual Saving in Total Energy Cost	RM1,639,375.00 - RM920,087.00 = RM719,288.00

Appendix B

CURRENT TOP UP AND STANDBY CHARGES (2019)

TARIFF CATEGORY	UNIT	CURRENT RATE (1 JAN 2014)	
		TOP UP	STANDBY
TARIFF C1 - MEDIUM VOLTAGE GENERAL INDUSTRIAL TARIFF			
Maximum demand charge per month	RM/kW	30.30	14.00
For all kWh	sen/kWh	36.50	
TARIFF C2 - MEDIUM VOLTAGE PEAK/OFF-PEAK INDUSTRIAL TARIFF			
For each kilowatt of maximum demand per month during the peak period	RM/kW	45.10	14.00
For all kWh during the peak period	sen/kWh	36.50	
For all kWh during the off-peak period	sen/kWh	22.40	
TARIFF E1 - MEDIUM VOLTAGE GENERAL INDUSTRIAL TARIFF			
Maximum demand charge per month	RM/kW	29.60	14.00
For all kWh	sen/kWh	33.70	
TARIFF E2 - MEDIUM VOLTAGE PEAK/OFF-PEAK INDUSTRIAL TARIFF			
For each kilowatt of maximum demand per month during the peak period	RM/kW	37.00	14.00
For all kWh during the peak period	sen/kWh	35.50	
For all kWh during the off-peak period	sen/kWh	21.90	

TARIFF CATEGORY	UNIT	CURRENT RATE (1 JAN 2014)	
		TOP UP	STANDBY
TARIFF E3 - HIGH VOLTAGE PEAK/OFF-PEAK INDUSTRIAL TARIFF			
For each kilowatt of maximum demand per month during the peak period	RM/kW	35.50	14.00
For all kWh during the peak period	sen/kWh	33.70	
For all kWh during the off-peak period	sen/kWh	22.20	
TARIFF F1 - MEDIUM VOLTAGE GENERAL MINING TARIFF			
Maximum demand charge per month	RM/kW	21.10	14.00
For all kWh	sen/kWh	31.30	
TARIFF F2 - MEDIUM VOLTAGE PEAK/OFF-PEAK MINING TARIFF			
For each kilowatt of maximum demand per month during the peak period	RM/kW	29.80	14.00
For all kWh during the peak period	sen/kWh	31.30	
For all kWh during the off-peak period	sen/kWh	17.20	

TARIFF CATEGORY	UNIT	CURRENT RATE (1 JAN 2014)	
		TOP UP	STANDBY
TARIFF H1 - MEDIUM VOLTAGE GENERAL SPECIFIC AGRICULTURE TARIFF			
Maximum demand charge per month	RM/kW	30.30	14.00
For all kWh	sen/kWh	35.10	
TARIFF H2 - MEDIUM VOLTAGE PEAK/OFF-PEAK SPECIFIC AGRICULTURE TARIFF			
For each kilowatt of maximum demand per month during the peak period	RM/kW	40.80	14.00
For all kWh during the peak period	sen/kWh	36.50	
For all kWh during the off-peak period	sen/kWh	22.40	

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