Suruhanjaya Tenaga

Seminar To Enhance Energy Efficiency Initiative In Malaysia Through Legislation & Policy

Initiatives Towards Greener Malaysia

TNBES
(424407-M)

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TNB Energy Services Sdn Bhd
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ENERGY EFFICIENCY

Contents

- **Introduction**
- **Energy Audit & Energy Savings Measures**
- **TNB Initiatives & Case Studies**

TNBES

COMPANY BACKGROUND – TNB Energy Services Sdn Bhd

Nature of Business

- Main focus is services related to Green Energy - Renewable Energy (RE) and Energy Efficiency (EE)
- Support TNB and Government in implementation of rural electrification program
- Support TNB in implementation of Green Initiatives

PROJECTS (EPC, PMC)	OPERATION & MAINTENANCE	ENGINEERING & CONSULTANCY
SOLAR HYDBID SYSTEM (OFF-GRID)	SOLAR HYDBID SYSTEM (SHS)	ENERGY EFFICIENCY (EE)
SOLAR SYSTEM (GRID-CONNECT)	MINI HYDRO STATION (MHS)	POWER QUALITY (PQ)
NEW MINI HYDRO STATION (MHS) / REHAB PROJECTS	OTHER RE PLANTS (BIOMASS / BIOGAS)	POWER SYSTEM STUDY (PSS)
OTHER RE PROJECTS (BIOMASS/BIOGAS/ WIND)		RE INTERCONNECTION PROJECT & CONSULTANCY

WHY ARE THERE ENERGY SAVINGS

- Initial design
- Improper system commissioning
- Changes in operations
- Lack of Maintenance

How to uncover such savings → Through a systematic approach called ENERGY AUDITS

TNBES

ENERGY AUDIT

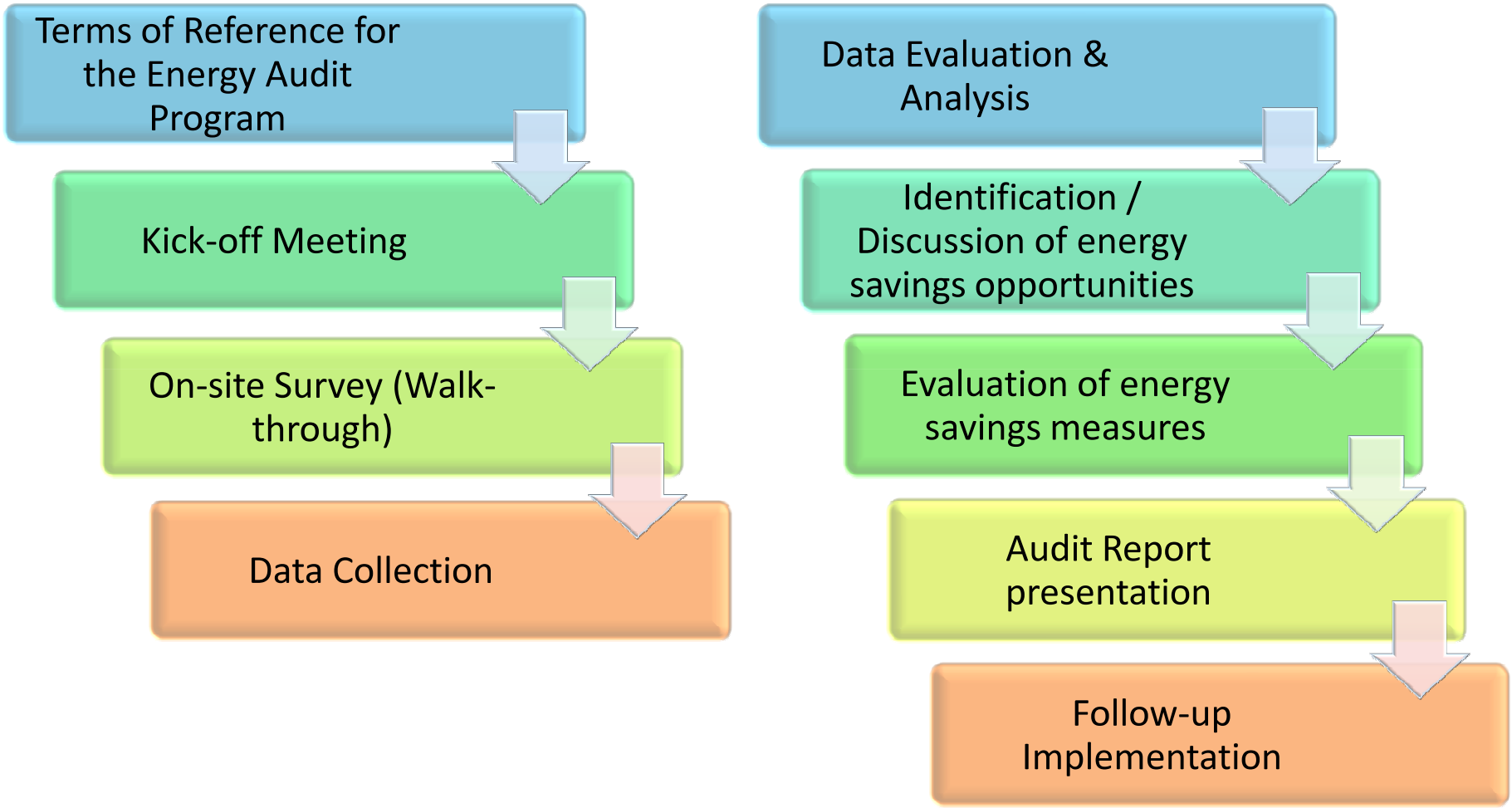
ENERGY AUDIT APPROACH

Study on how a building or facility uses energy

Identification of savings / improvement measures

Recommendations & reporting of findings

ENERGY AUDIT PROCESS



ENERGY SAVINGS MEASURES

ENERGY SAVINGS MEASURES

No Cost or Low Cost

- Fine-tuning of building services
- User awareness
- Repair leaks
- Reschedule load/usage
- Understand & review tariff structure, MD, pf
- Saving potential 3-10%

Medium Cost

- Cooling system improvement
- Energy efficient equipment & technology
- Building envelope
- Monitoring & Targeting (Utilize BAS)
- Housekeeping / Proper Maintenance
- Saving potential 6-15%

High Cost

- Equipment technology change (e.g. high efficiency motor)
- System change
- Cogeneration
- BAS
- Saving potential >10%

TNBES

Understanding Your Electricity Bills

Electricity Tariff Structure

- Customer categories
  - Residential, Commercial, Industrial
- Voltage Levels
  - Low (<1kV) , Medium (6.6kV to 66kV), High (132kV and above)
- Time of Use of Energy
  - Peak & Off-Peak for selected tariffs

Electricity Tariff Components:

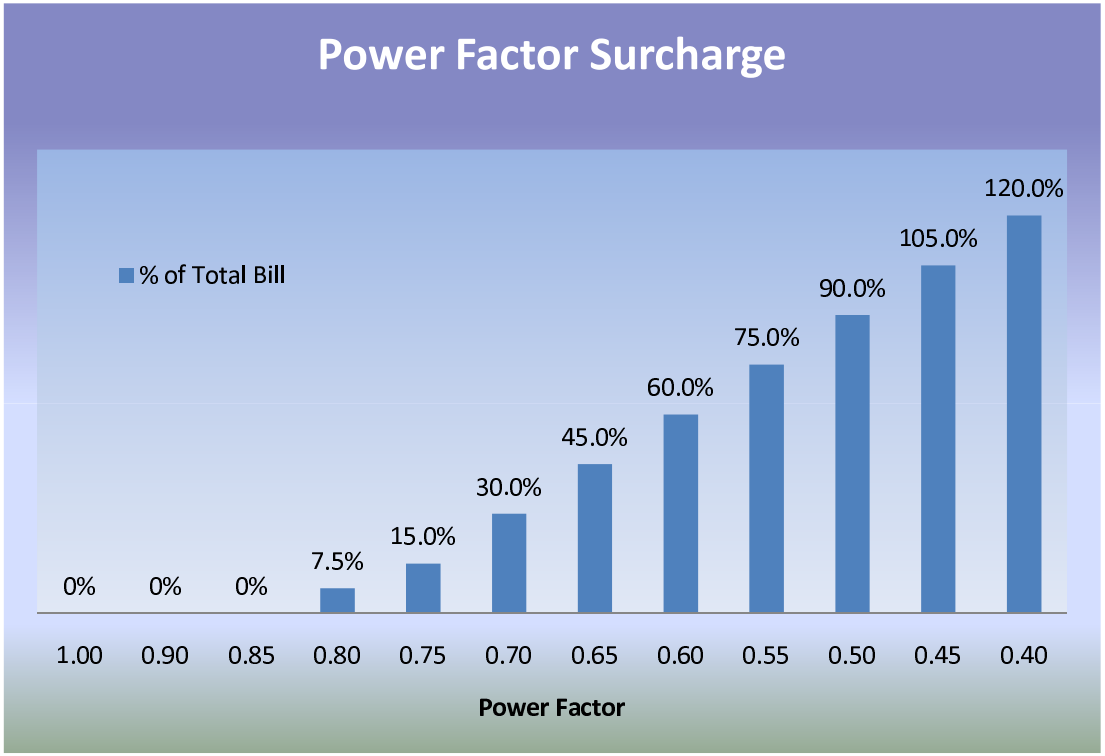
- Energy (kWh) consumed during billing period
  - Different rates for peak and off-peak periods
  - Peak period : 10.00pm to 8.00am
- Maximum Demand (kW) registered in a month
  - For medium and high voltage customers only
  - Applicable during peak period only
- Power Factor Surcharges
  - For lower pf < 0.85 or < 0.9 (for high voltage customers)
- Others
  - Guaranteed maximum demand charge

TNB Electricity Tariff

Tariff Category	Unit	Old Rates (1 June 2011)	New Rates (1 January 2014)
2. Tariff B - Low Voltage Commercial Tariff			
For overall monthly consumption between 0-200 kWh per month:			
For all kWh	sen/kWh	39.30	
The Minimum Monthly Charge is	*RM*	*7.20*	
For overall monthly consumption more than 200 kWh per month:			
For all kWh (from 1kWh and above)	sen/kWh	43.00	
The Minimum Monthly Charge is	*RM*	*7.20*	
New Structure			
For the first 200 kWh (1 -200 kWh) per month	sen/kWh		43.50
For the next kWh (201 kWh onwards) per month	sen/kWh		50.90
The Minimum Monthly Charge is	*RM*		*7.20*
3. Tariff C1 - Medium Voltage General Commercial Tariff			
For each kilowatt of maximum demand per month	RM/kW	25.90	30.30
For all kWh	sen/kWh	31.20	36.50
The Minimum Monthly Charge is	*RM*	*600.00*	*600.00*

Power Factor Surcharges

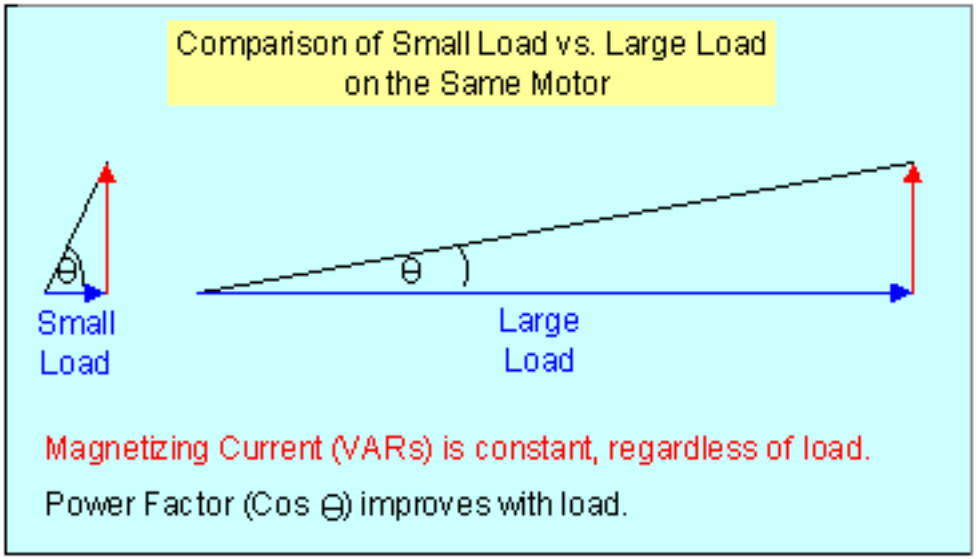
	Voltage < 132kV	Voltage => 132kV
PF	Surcharge (% of total bill)	Surcharge (% of total bill)
1.00	0%	0%
0.90	0%	0%
0.85	0%	7.5%
0.80	7.5%	15%
0.75	15%	30%
0.70	30%	45%
0.65	45%	60%
0.60	60%	75%
0.55	75%	90%
0.50	90%	105%
0.45	105%	120%
0.40	120%	135%

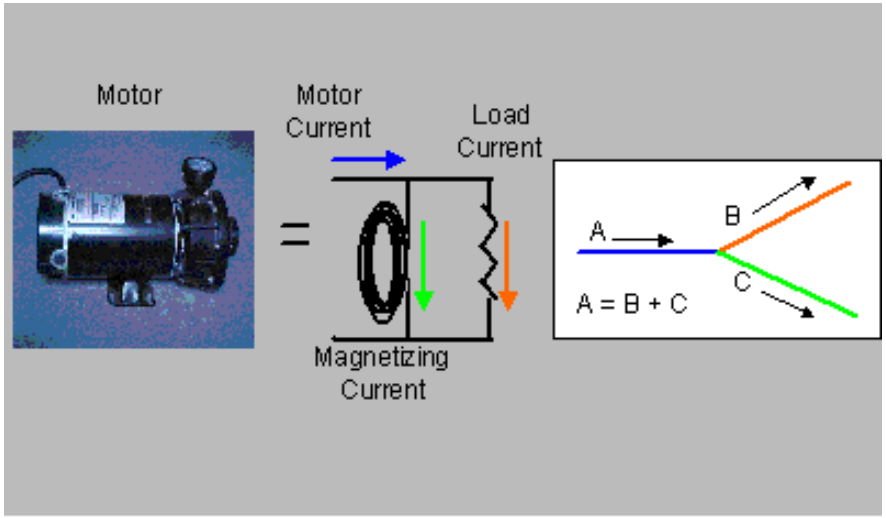


Why TNB Impose Low PF surcharges

- For the same active energy required, an electricity with supply system with low PF requires a higher current to be generated and supplied through the transmission and distribution system

- This will lead to an increase in equipment and cable costs and will result in higher energy loss in the power supply system





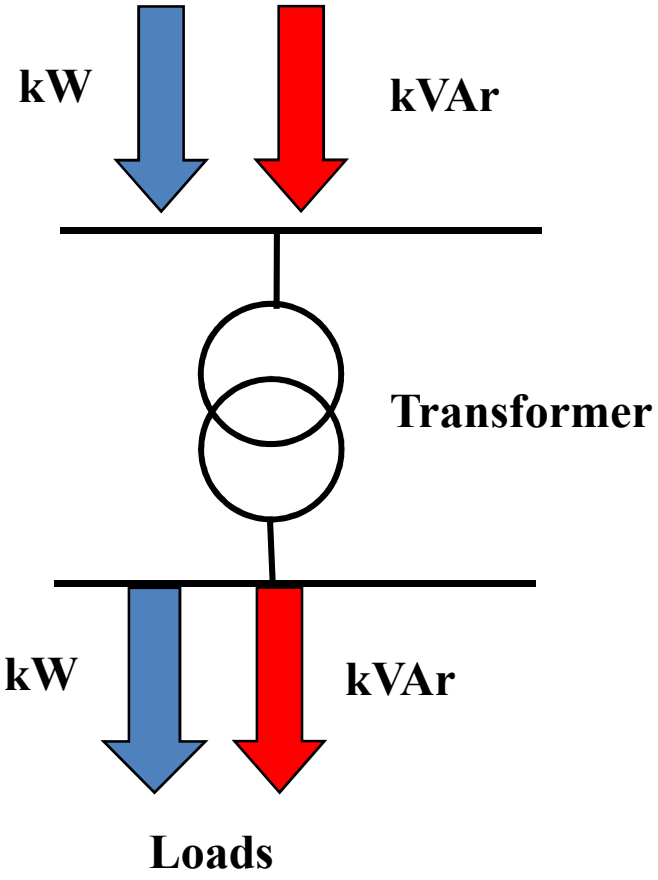
Power Factor

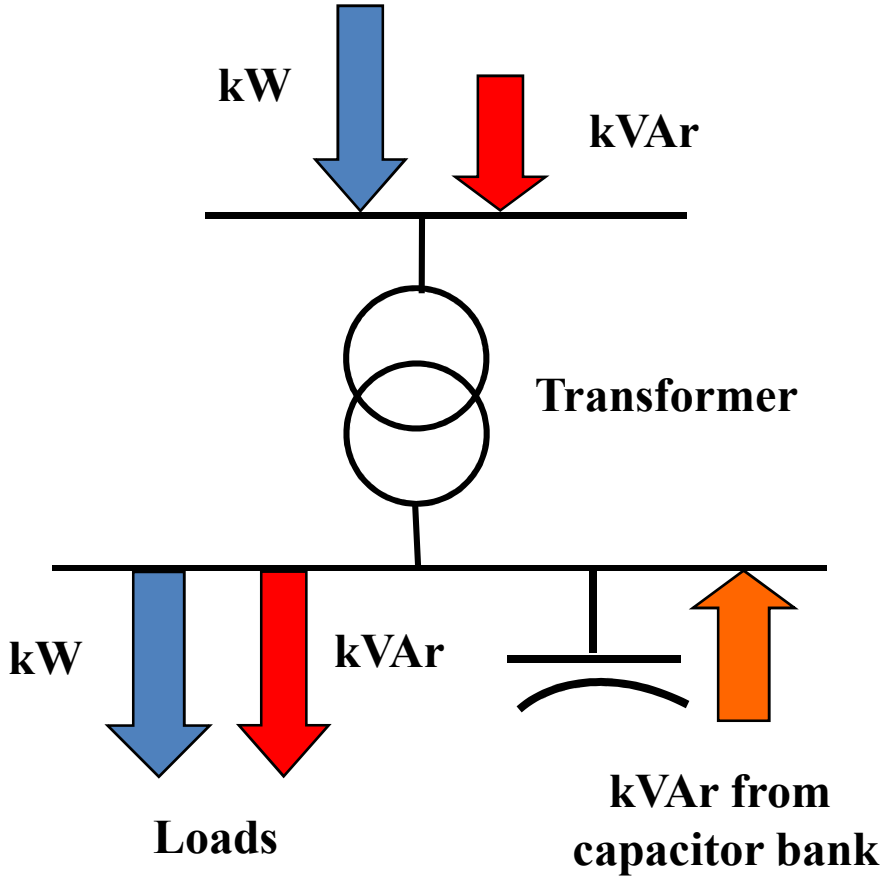
Equipment and appliances		cos φ	tan φ
■ Common induction motor loaded at	0%	0.17	5.80
	25%	0.55	1.52
	50%	0.73	0.94
	75%	0.80	0.75
	100%	0.85	0.62
■ Incandescent lamps		1.0	0
■ Fluorescent lamps (uncompensated)		0.5	1.73
■ Fluorescent lamps (compensated)		0.93	0.39
■ Discharge lamps		0.4 to 0.6	2.29 to 1.33
■ Ovens using resistance elements		1.0	0
■ Induction heating ovens (compensated)		0.85	0.62
■ Dielectric type heating ovens		0.85	0.62
■ Resistance-type soldering machines		0.8 to 0.9	0.75 to 0.48
■ Fixed 1-phase arc-welding set		0.5	1.73
■ Arc-welding motor-generating set		0.7 to 0.9	1.02 to 0.48
■ Arc-welding transformer-rectifier set		0.7 to 0.8	1.02 to 0.75
■ Arc furnace		0.8	0.75

***Fig. L6** : Values of cos φ and tan φ for commonly-used equipment*

How to Improve PF

- Installing Capacitor Bank
- Capacitor bank provides the reactive power (kVAr) needed by the loads



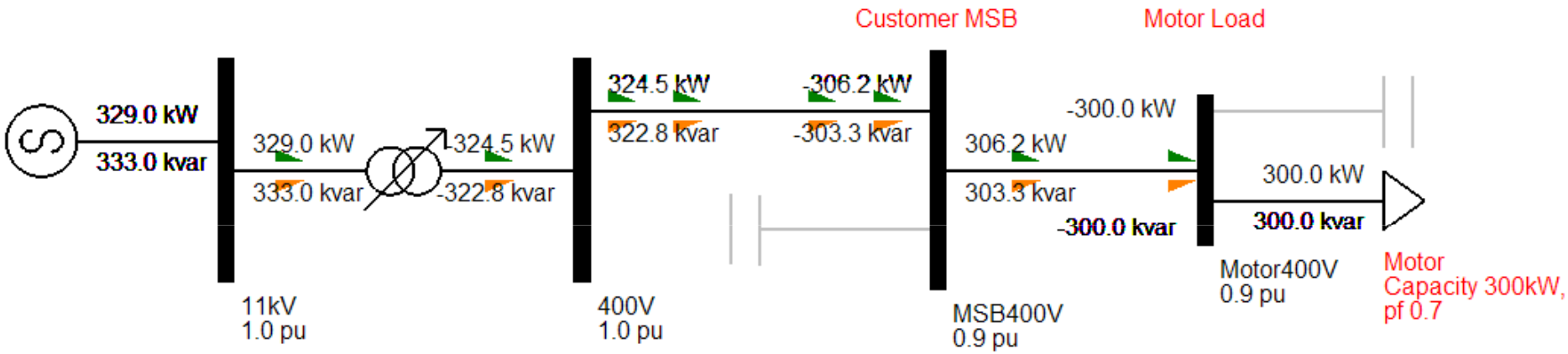


Capacitor Bank Locations

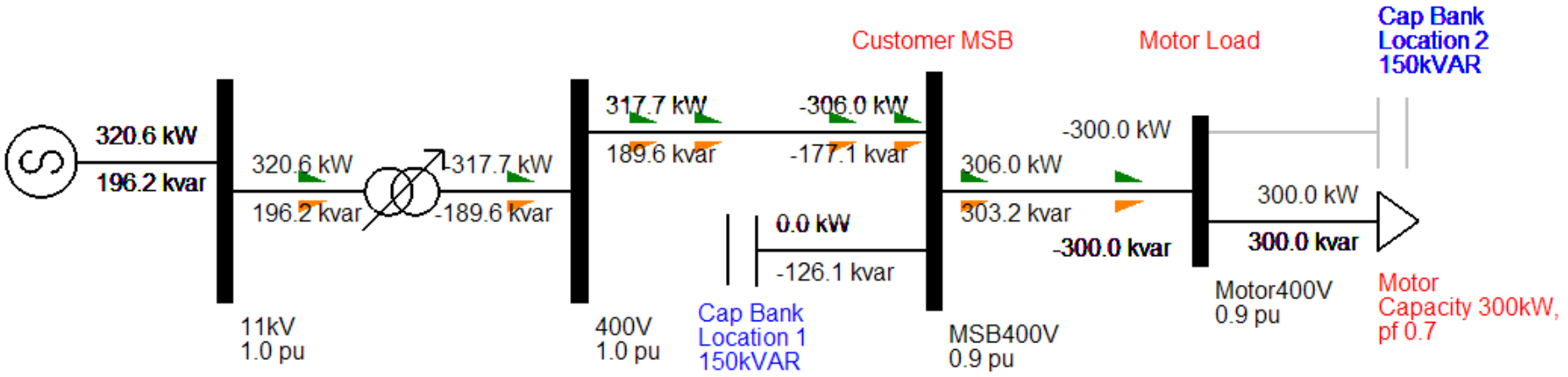
- Central/Group Compensation Scheme
  - After the energy meter
  - Minimize / eliminate PF surcharge

- Individual Compensation Scheme
  - Near to the load
  - Minimize line losses and line loading
  - Minimize / eliminate PF surcharge

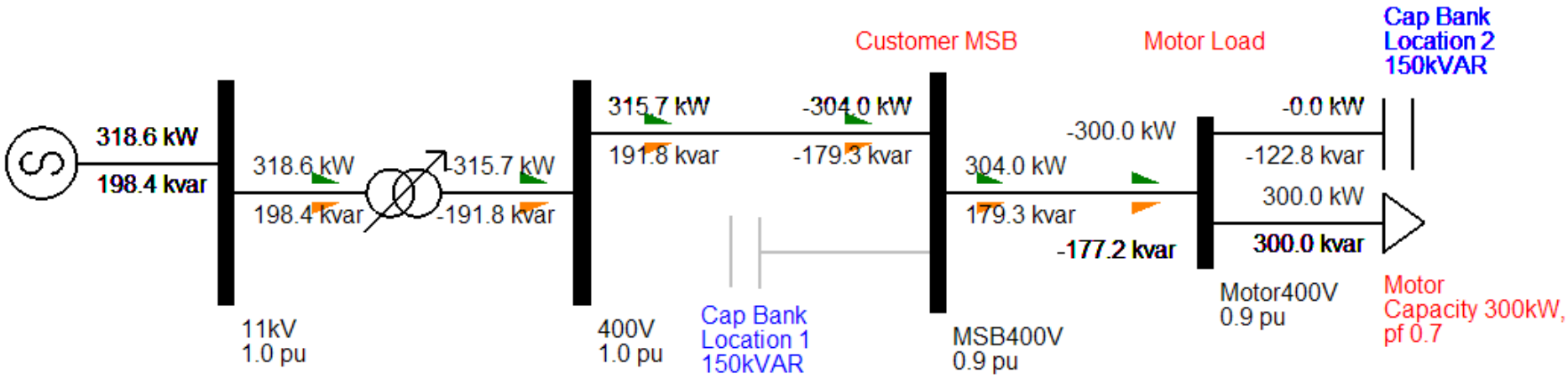
Why TNB Impose PF Surcharge - Simulated Results



- TNB Meter is located at Customer MSB
- Without Capacitor bank,
  - Customer MSB recorded 306kW, 303kVAR, pf = 0.71
  - Total generation 329kW, 333kVAr, pf = 0.70
  - Total losses 29kW



- Option 1 - Capacitor bank installed at Customer MSB,
  - Customer MSB recorded 306kW, 177kVAr, pf = 0.87
  - Total generation 320kW, 196kVAr, pf = 0.85
  - Total losses = 21kW



- Option 2 - Capacitor bank installed at Motor DB,
  - Customer MSB recorded 304kW, 179kVAr, pf = 0.86
  - Total generation 318kW, 198kVAr, pf = 0.85
  - Total losses = 19kW

kVA and Low PF

PF	kW	kVAr	kVA	Amps @ 415V
1.00	100 kW	0	100	139.1 A
0.90		48	111	154.4 A
0.80		75	125	173.9 A
0.70		102	142	197.6 A
0.60		133	167	232.2 A

$$VA = \sqrt{(W^2 + VAr^2)}$$

$$\text{Power Factor (PF)} = W / VA$$

Potential Area of Savings - Lighting

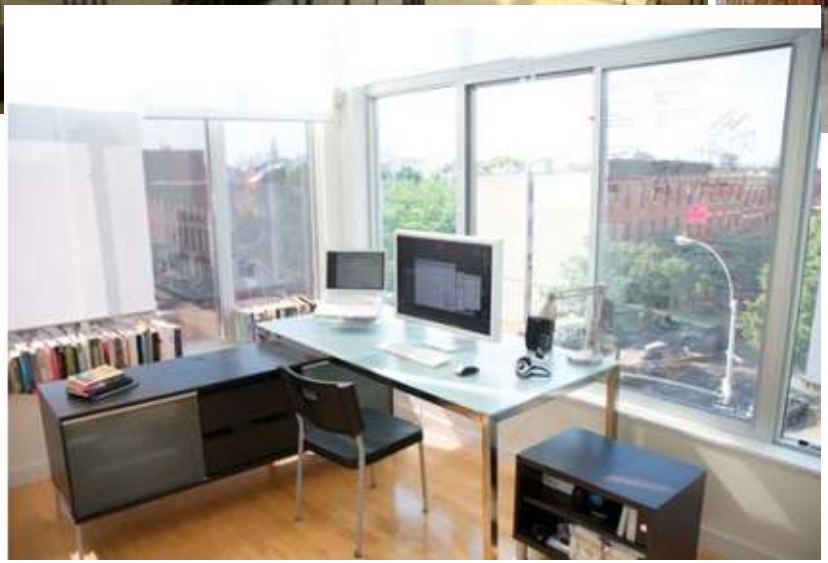
(Min baseline: MS1525:2007)

- Efficient Lighting Level
  - Based on activities (MS 1525:2007)
  - Task lighting
- Harvesting Daylight
  - Windows
  - Sky lights
  - Light shelves
- Select more efficient lamp & accessories
  - T5 fluorescent
  - LED tube
- Efficient operation of lighting system
  - Lighting zoning
  - Auto sensor
  - Other innovation

Lighting

Parameters	T8 FL (1200mm)	T5 FL (1200mm)	LED Tube (1200mm)
Bulb Wattage (W)	36W	28W	19W
Ballast (Type & Wattage)	Electromagnetic 9W	Electronic 2W	None
Mercury Content	4-6mg	3-4mg	None
Total luminaries wattage	45W	30W	19 – 20W
Expected running hours	10,000 hours	10,000 to 20,000 hours	40,000 to 50,000 hours (lumens output deteriorates)
Warranty	None	Ballast only (for certain manufacturer)	2 to 3 years

Day lighting



SUSTAINABLE ENERGY MANAGEMENT

ENERGY EFFICIENCY BENEFITS

- Energy efficiency has demonstrated, time and again, that
  - ✓ It saves industrial firms money
  - ✓ It increase reliability of operations
  - ✓ It has a positive effect on productivity and competitiveness
  - ✓ It can offer attractive financial and economic returns
  - ✓ Reduces exposure to rising energy prices
  - ✓ Increases security of supply
  - ✓ ….

then

Why it is not happening?

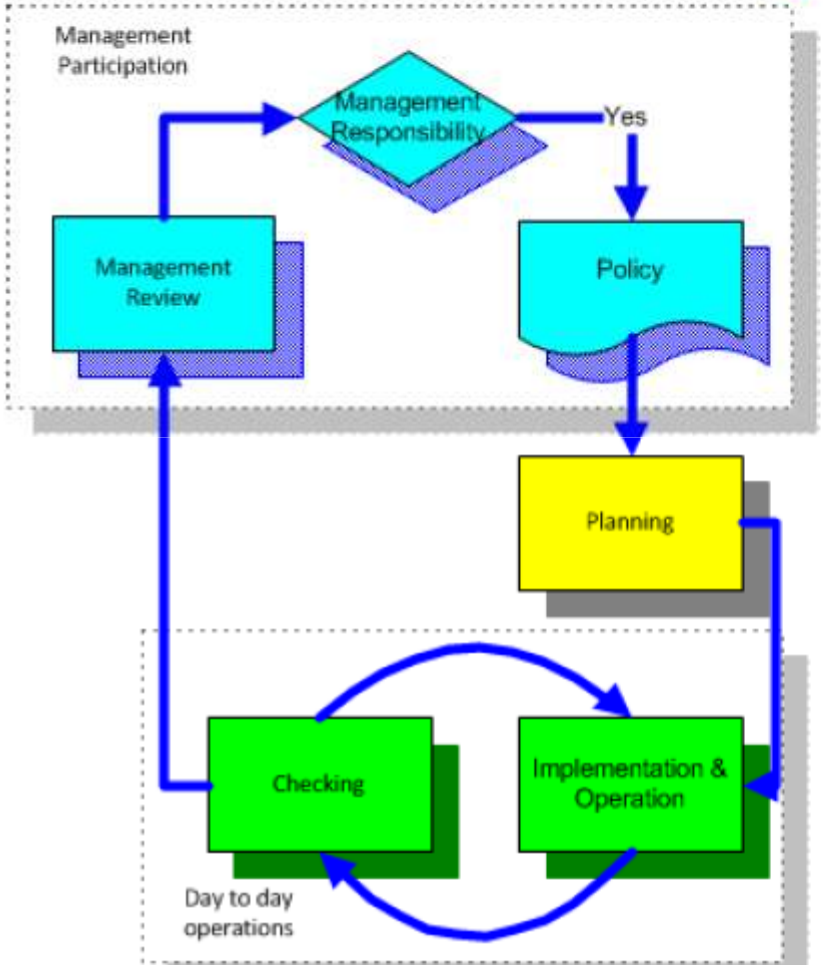
CHALLENGES TO ENERGY EFFICIENCY

- Management focus is on production and not on energy efficiency
- Lack of information and understanding of financial and qualitative benefits
- Lack of adequate technical skills for developing and implementing EE measures and projects
- Poor monitoring systems and data
- First costs more important than recurring costs → disconnection between capital and operating budgets
- When EE knowledge exists it very often resides with individuals rather than with the company/ organization → sustainability risk
- Defensiveness – "I'm already doing a good job!"

Establishment of EMEER 2008 and implementation of Sustainable Energy Management System will certainly overcome the challenges

SUSTAINABLE ENERGY MANAGEMENT SYSTEM

Six Key Concepts

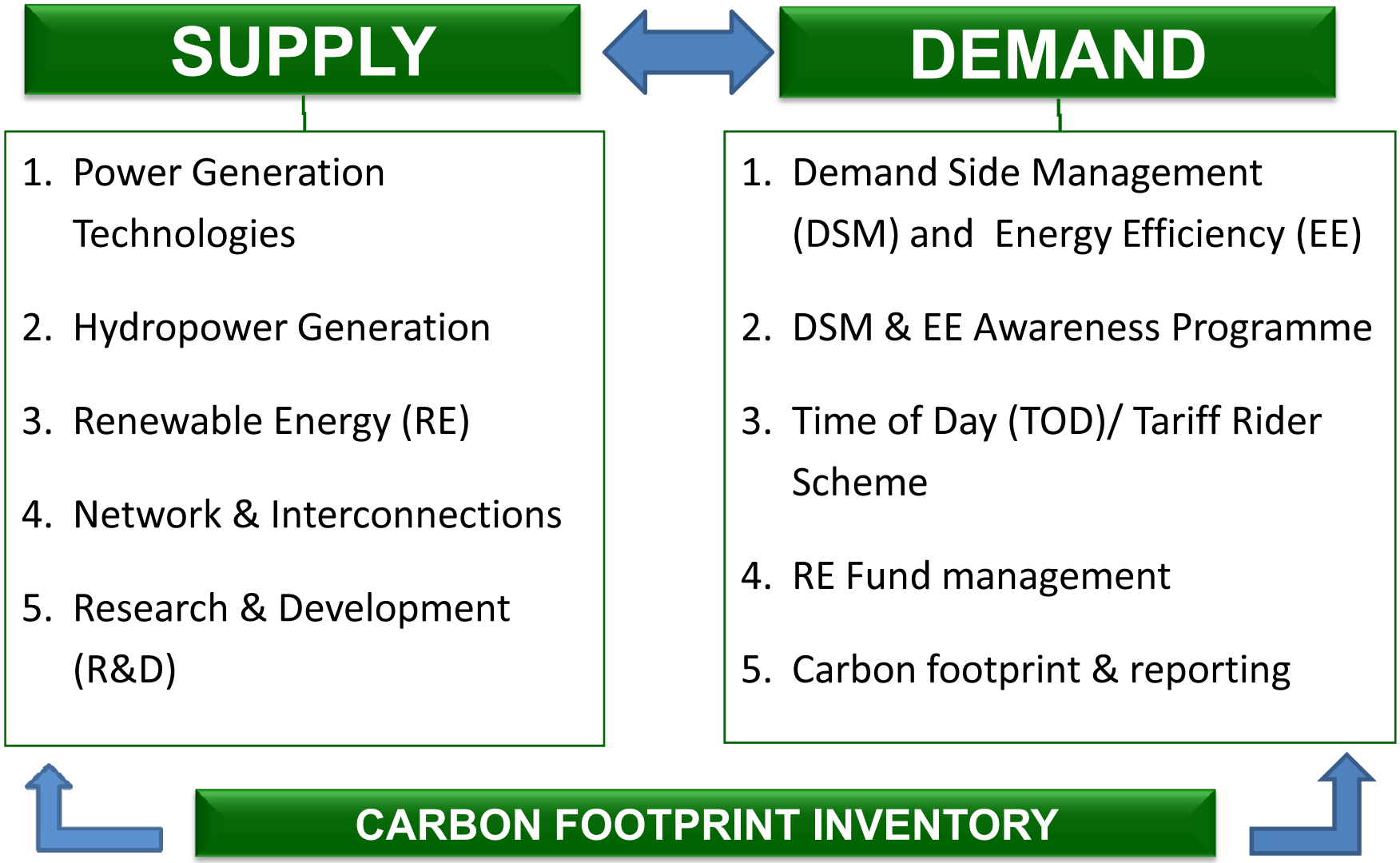


1. Commitment
   - Roles and Responsibilities
2. Significant Energy Users (SEUs)
3. Energy Performance Indicators (EnPIs)
4. Opportunities List
5. Operational Control
6. Review

TENAGA NASIONAL BERHAD

TNBs' INITIATIVES

TNB GREEN ENERGY STRATEGY AREAS



DEMAND SIDE MANAGEMENT AND ENERGY EFFICIENCY

Demand Side Management

1. District Cooling System
2. Study and analysis on Demand-side management which include study on potential customers for voluntary load reduction/ shedding during peak times by offering incentives, interruptible tariff etc.
3. Study on the impacts of DSM in terms of CAPEX, OPEX, Risks hardware advancement i.e. Smart grids/meters

Energy Efficiency

1. Circular/guideline enhancing EE practices in offices circulated in September 2011
2. EE studies and implementation to be conducted by Divisions.
3. 20 TNB Offices have been selected for Energy Efficiency enhancement project till 2015
4. Courses and training program for energy managers' development program

ANALYSIS ON DSM INCENTIVES IN ELECTRICITY TARIFF STRUCTURE

This is a pricing signal to encourage Demand Side Management (DSM). It is a method of load control to reduce energy consumption at peak period (normally occurs 1200 hr – 1700hr) and increase energy consumption during an off-peak period, thus levelise the load distribution profile.

- **Time of Day (TOD) tariff scheme** - (peak/ off peak) to encourage consumers (LPC) to shift their operations towards off peak periods.
- **Thermal Energy Storage (TES) incentive scheme** - discounts are given to these installations to operate at off peak times and promote load leveling
- **Sunday Tariff Rider and Off Peak Tariff Rider** - provide incentive for consumers (LPC) to increase their operations during Sundays and off peak periods

EFFORTS IN RAISING GREEN AWARENESS

TNB supports Government's National Green Technology (GT) Plan in raising Green Awareness aspects:

- **Public Awareness** – National Energy Awareness Campaign (e.g. SWITCH campaign with FOMCA, SAVE program with Malaysian Government), EE awareness during CLOP and Advertorial on Energy Efficiency (LAT Cartoon) in major newsprint
- **TNB Staff Awareness** – EE practices in offices, GREENER Portal, awareness training programme, green articles in Tenagawan magazines

TENAGA NASIONAL BERHAD

New STRAITS TIMES

DATE	31/12/2013	PAGE	9
DAY	TUESDAY	SECTION	STRETS YOUR SPORTS

BRIGHT WAYS TO SAVE ENERGY

TIP 1

Besides turning your main switches off, try unplugging unused appliances to save even more energy.

TIP 2

Washing machines consume a lot of energy. Full loads will save energy by reducing the amount of times you'll have to do your laundry.

TIP 3

Keeping your air conditioner filter clean keeps it running efficiently by allowing more cool air to flow out.

TIP 4

Closing your windows and doors while your air conditioner is on, cools your room faster.

TIP 5

Energy saving light bulbs consume less energy and last longer.

For more details at www.tnb.com.my

TENAGA NASIONAL Better Brighter

BRIGHT WAYS TO SAVE ENERGY

TIP 1
A full load of laundry saves energy. And time.
Washing machines consume a lot of energy. Full loads will save energy by reducing the amount of times you'll have to do your laundry.

TIP 2
Clean your air con filter to save more. And sweat less.
Keeping your air conditioner filter clean keeps it running efficiently by allowing more cool air to flow out.

TIP 3
Close windows to save energy. And keep cool.
Closing your windows and doors while your air conditioner is on, cools your room faster.

TIP 4
Save smart with energy-saving light bulbs.
Energy-saving light bulbs consume less energy and last longer.

TIP 5
Iron in bigger amounts to bring down your energy usage.
Ironing bigger loads of laundry at once reduces the amount of times you'll have to iron your clothes.

TIP 6
Fill your kettle to the max level to maximise your energy savings.
Make the most out of every boil with a full kettle. And to save even more, store your boiled water in a flask to keep it warm for longer.

TIP 7
5-star appliances give you 5-star savings.
5-star rated appliances are designed to run more efficiently, reducing your consumption.

TIP 8
Give your fridge some space to breathe more. And consume less.
Keep your refrigerator at least 10cm from the wall, and away from warm areas such as the stove. Proper positioning of your refrigerator can help it run more efficiently.

TIP 9
Switch off your computer to switch on the savings.
Computers and laptops still consume energy while on standby. Switch them off completely to save even more energy.

TIP 10
Use outdoor light timers to prevent excessive energy usage.
Instead of leaving your outdoor lights on all night, install a timer to keep them on only when they need to be.

TIP 11
Brighten up for less with T5 fluorescent lights.
Slimmer fluorescent lights such as the T5 variants provide ample brightness to light up your home while consuming less energy.

TIP 12
Set your air con at 24°C for optimum coolness with higher savings.
Air conditioners consume a lot of energy. Setting the temperature between 24-26°C provides sufficient cooling while keeping your energy consumption down.

TIP 13
Setting a timer on your air con is a smart way to manage and save energy.
You do not need the air con running all night to stay cool. Try setting it to switch off a few hours after you've fallen asleep to be more energy efficient.

TIP 14
Use spotlights with motion sensors to brighten your savings.
Installing motion sensors can help save energy by turning on your spotlights only when they need to be.

TIP 15
Use energy saving water pumps to pump up your energy savings.
The water pumps that keep your ponds, aquariums and pools running use up a fair bit of electricity. That's why it is important to get ones with energy efficient motors.

TIP 16
An organised fridge makes room for energy savings.
An uncluttered fridge allows cool air to circulate more efficiently.

TIP 17
Keep your kettle clean to enjoy more savings.
Limescale on your kettle's heater element slows down the heating process. Clean it regularly to keep it running more efficiently.

TIP 18
Switch to instant water heaters to save more energy.
Unlike tank water heaters, instant water heaters save more by heating up only when in use.

TIP 19
Save smart with a cold wash.
Hot water makes your washing machine work a little harder. Getting your washing machine to a cold wash whenever possible will help save electricity.

TIP 20
Your air con size matters when it comes to energy savings.
When choosing an air conditioner for your home, remember to buy one that's appropriate for the size of the room.

TIP 21
Choose fans over air con to save energy.
Using fans instead of your air conditioners is a simple but very effective way to cut down your energy consumption.

TIP 22
Open up to natural light to save energy.
Draw your curtains and blinds to let in as much natural light as possible to help save on internal lighting costs.

TIP 23
Dress right for cool savings.
Dressing appropriately for the weather can help reduce your energy consumption. Choose thinner and breathable clothing to keep cool.

TIP 24
A higher energy rating means higher energy savings.
When buying electrical appliances, be sure to look out for the energy rating label. Choose 5-star rated appliances which are designed to save energy.

TIP 25
Shade up your home to bring down your bill.
Installing shades, drapes and tinting can minimise the entry of external heat into your home, making it easier not to turn on the air conditioner.

TIP 26
Choose the clothes line over the dryer.
The heavy electricity consumption of clothes dryers is why the trusted clothes line still across us till today. Using our sunny weather to dry your clothes will help you save more.

TIP 27
Manage your water pump to manage your savings.
Pool or pond pumps consume a lot of energy as they need to be on for longer periods of time. Turning them off when not in use will not down your electricity usage.

More details at www.tnb.com.my

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Lighting Up Lives

TENAGA NASIONAL BERHAD (200866-W)

CUSTOMER SATISFACTION PROPELS TNB ASPIRATIONS FORWARD

Ir. Kamaliah binti Abdul Kadir
Senior General Manager (Customer Service) Distribution Division TNB

Powering the nation and serving up to eight million customers nationwide, Tenaga Nasional Berhad (TNB) is entrusted with the responsibility and social obligation to provide the basic right to electricity for every Malaysian household and industry.

Placing you, our esteemed customers, at the forefront of our business has enabled TNB to greatly strenghten our operations; enhance the quality of our services; bring forth greater efficiency innovation and productivity; and at the same time propelled us to becoming a world class utility company.

In the course of the next six months, this column intends to share valuable insights as well as knowledge on how you, our customers, can better benefit from savings on your electricity bill and the extensive suite of services offered by TNB. More importantly, each and everyone of you have the power to make a valuable contribution towards the global initiative of conserving energy.

In terms of primary concerns voiced by customers, the highest number of feedback received by TNB relates to the cost of energy usage.

customers is that the less you use the better. Being prudent with the use of energy translates into direct and significant savings on one's electricity bills. As a responsible and caring utility company, our biggest challenge at TNB is in trying to make consumers understand the benefits of energy conservation which is underlined by the two focal areas of energy efficiency and the pursuit of renewable energy resources. This is in support of a concerted global effort to reduce the consumption of energy and emissions of greenhouse gases.

Today, appliance manufacturers offer a wide range of energy efficient products from air-conditioning units, chillers and refrigerators, to even the use of energy efficient fluorescent lights to replace traditional incandescent light bulbs which uses more energy to provide the same degree of illumination. Switching off electrical appliances, not leaving appliances on stand-by mode or the simple act of switching off the room lights or fan when you leave all contribute to the lesser use of electricity.

As demand for electricity increases exponentially it places higher expectations on sufficient and uninterrupted supply.

Join us in the coming weeks as we discuss a variety of matters from safety at home and in the work place, electricity tariff structure, and consumption by electrical appliances to combatting the threat of vandalism and power theft. We also welcome feedback and invite you to share with us your views via our TNB Careline email at tnbcareline@tnb.com.my.

You, are an important partner and with your understanding and co-operation, together, we can embrace this greater global objective of

TNB EE PROJECTS

i. EE Initiatives for 6 TNB buildings (EA6)
ii. Energy Audit for 15 TNB buildings (EA15)
iii. EEC Services by TNBES

EE Initiatives for 6 TNB Buildings (EA 6)

- Background
  - Buildings audited: TNB HQ, Wisma TNB Jln Timur, TNB Shah Alam, TNB Kepong, TNB Seremban and TNB Cheras Jaya
  - Dec 2009 – May 2010

- Energy Savings Measures
  - PF Improvement
  - Energy Monitoring System
  - EE Lighting
  - EE ACMV

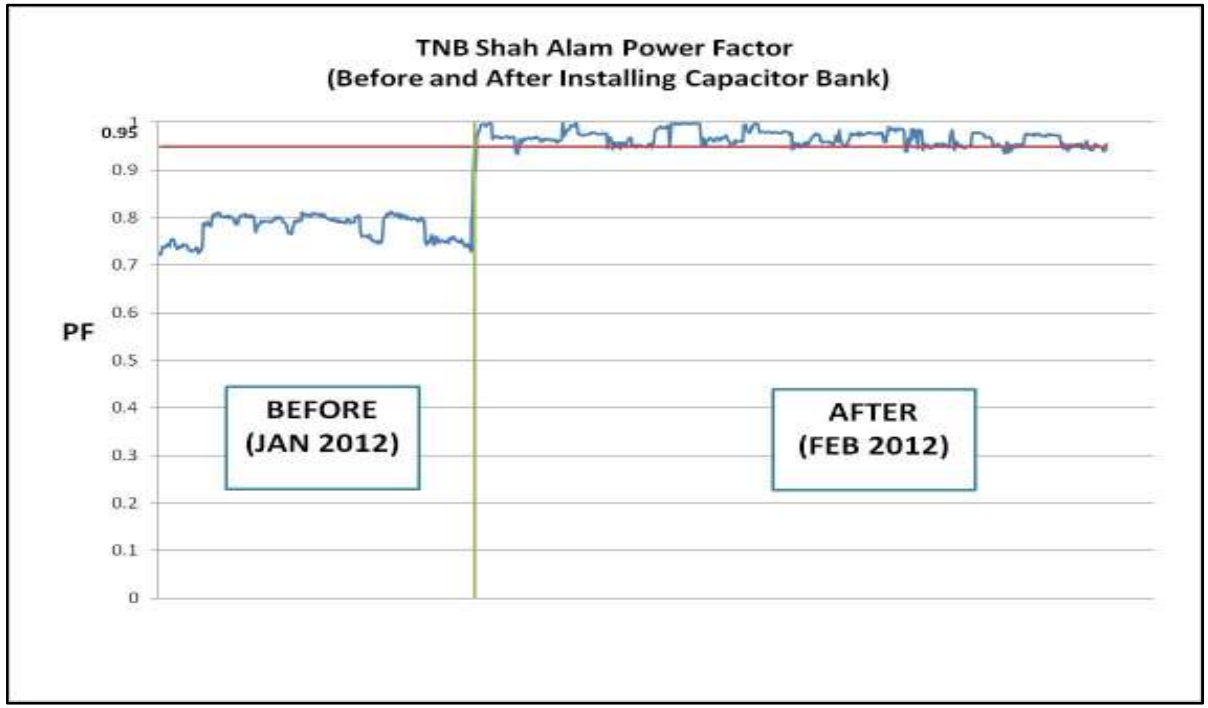
PF Improvement

- TNB Shah Alam
  - Installed & commissioned in Feb 2012
  - PF setting: 0.95 (from 0.75)
  - Savings: RM36k/year (13%)

- TNB Kepong
  - Installed & commissioned in July 2013
  - PF setting: 0.95 (from 0.71)
  - Savings: RM300k/year (25%)

PF Improvement

- TNB Shah Alam
  - Installed & commissioned in Feb 2012
  - PF setting: 0.95

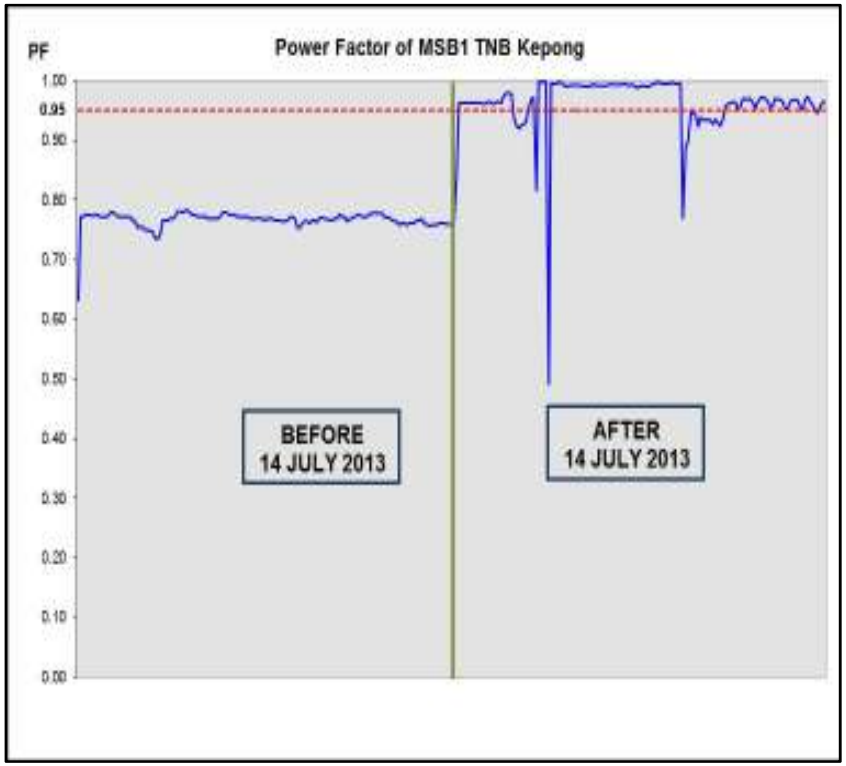


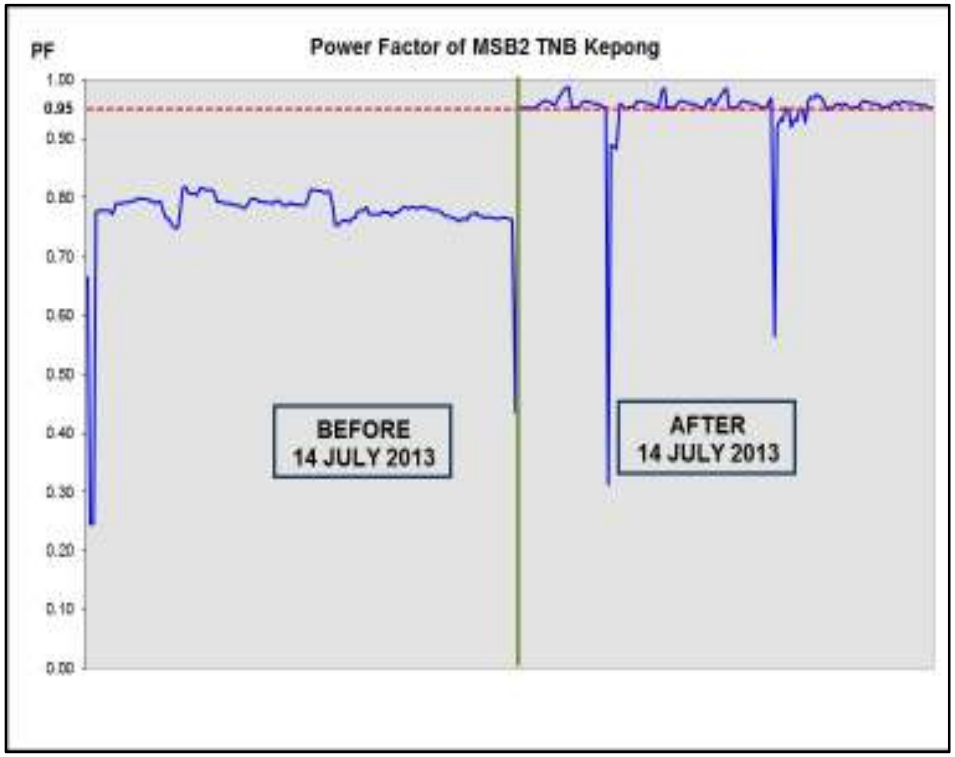
PF Improvement

- TNB Kepong
  - 2 units of Cap Bank: Installed & commissioned in July 2013
  - PF setting: 0.95

PF Improvement

- TNB Kepong (cont'd)

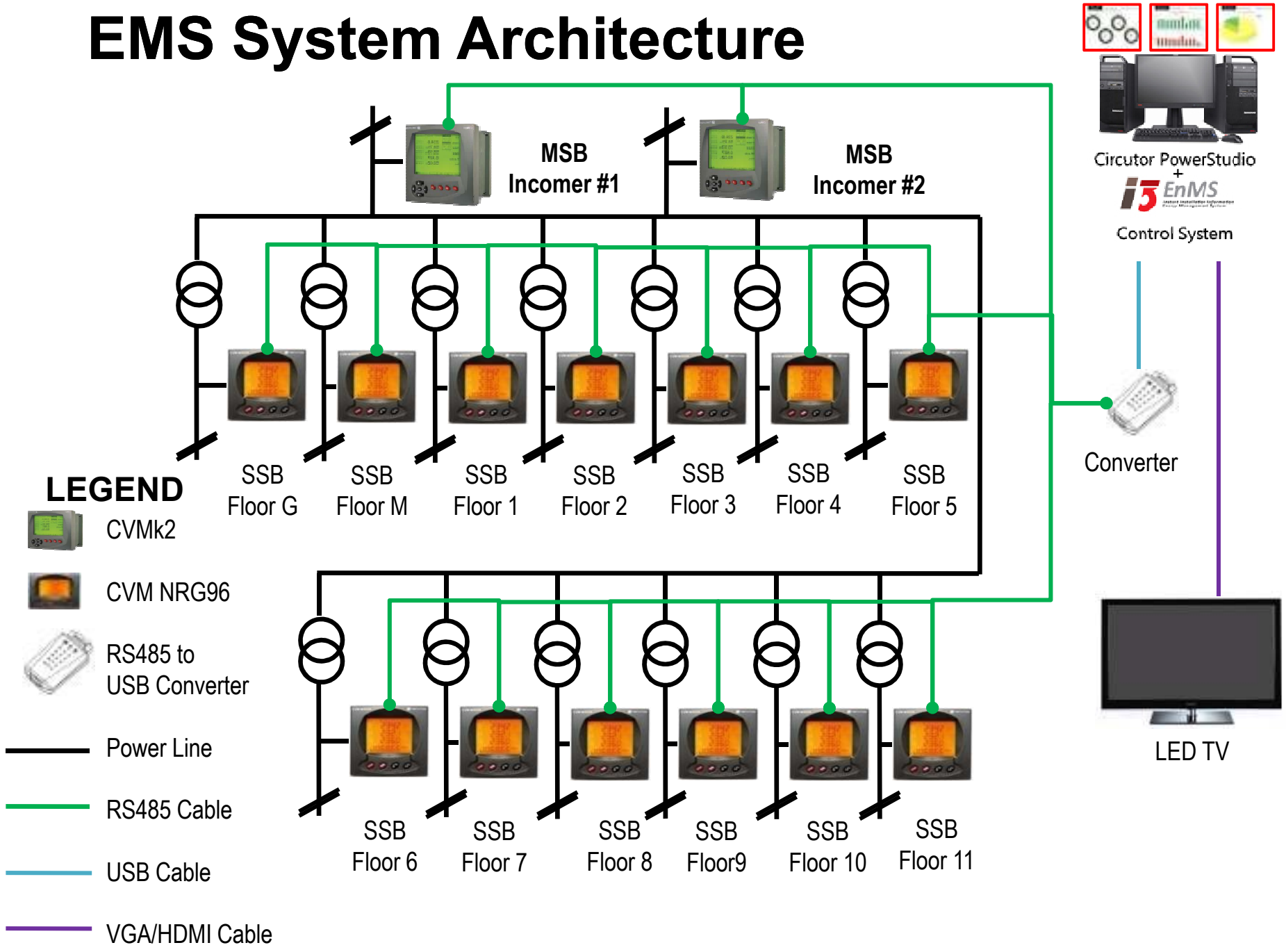




Energy Monitoring System (EMS)

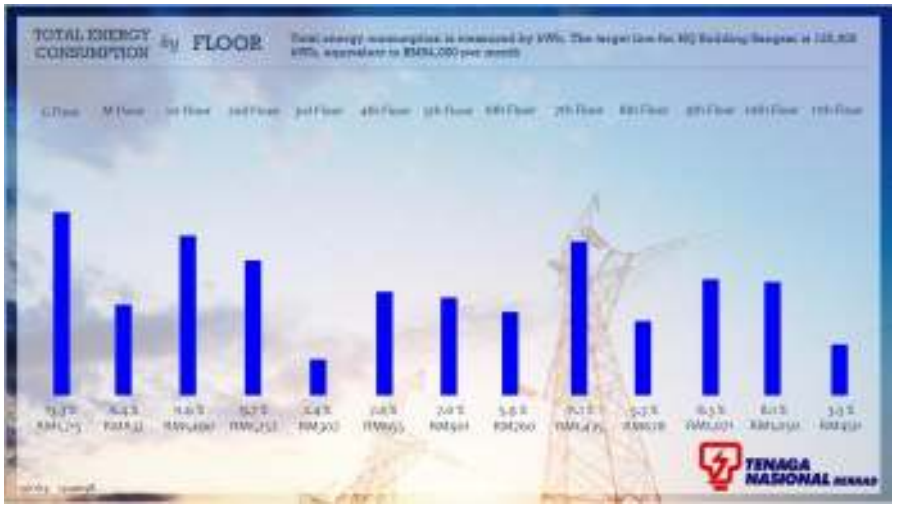
- TNB HQ Bangsar
  - Installed & commissioned in Aug 2013
  - Monitor and display electricity consumption for each floor in the building
  - Hourly/daily trending and monthly report
  - Create awareness to the tenants
  - Part of energy management system – benchmarking, setting target, further improvement

EMS System Architecture



Energy Monitoring System

- TNB HQ Bangsar (cont'd)



Energy Audit for 15 TNB buildings (EA15)

2012-2013

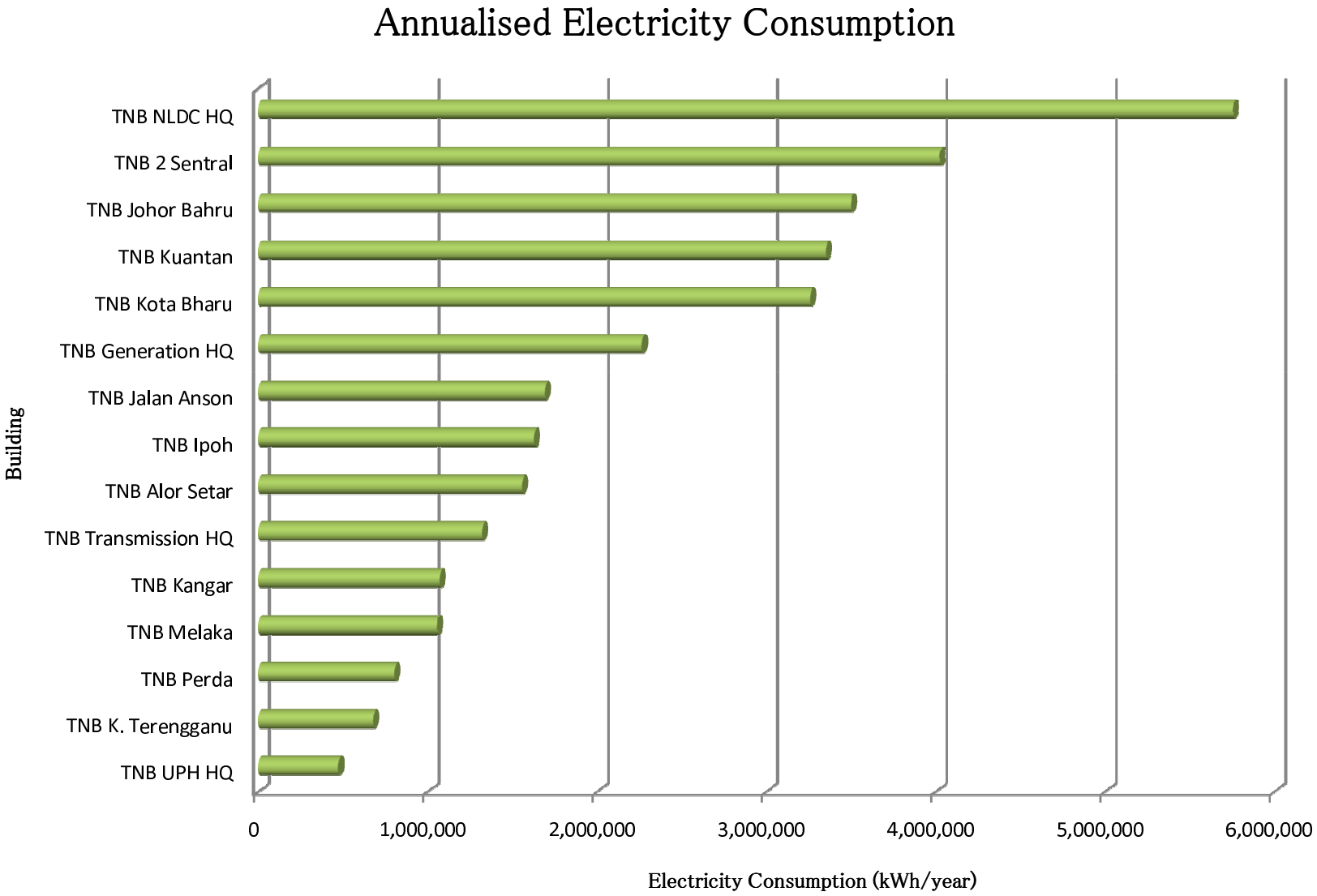
i. General Info
ii. Key findings
iii. Energy Saving Measure

Energy Audit for 15 TNB buildings - General Info

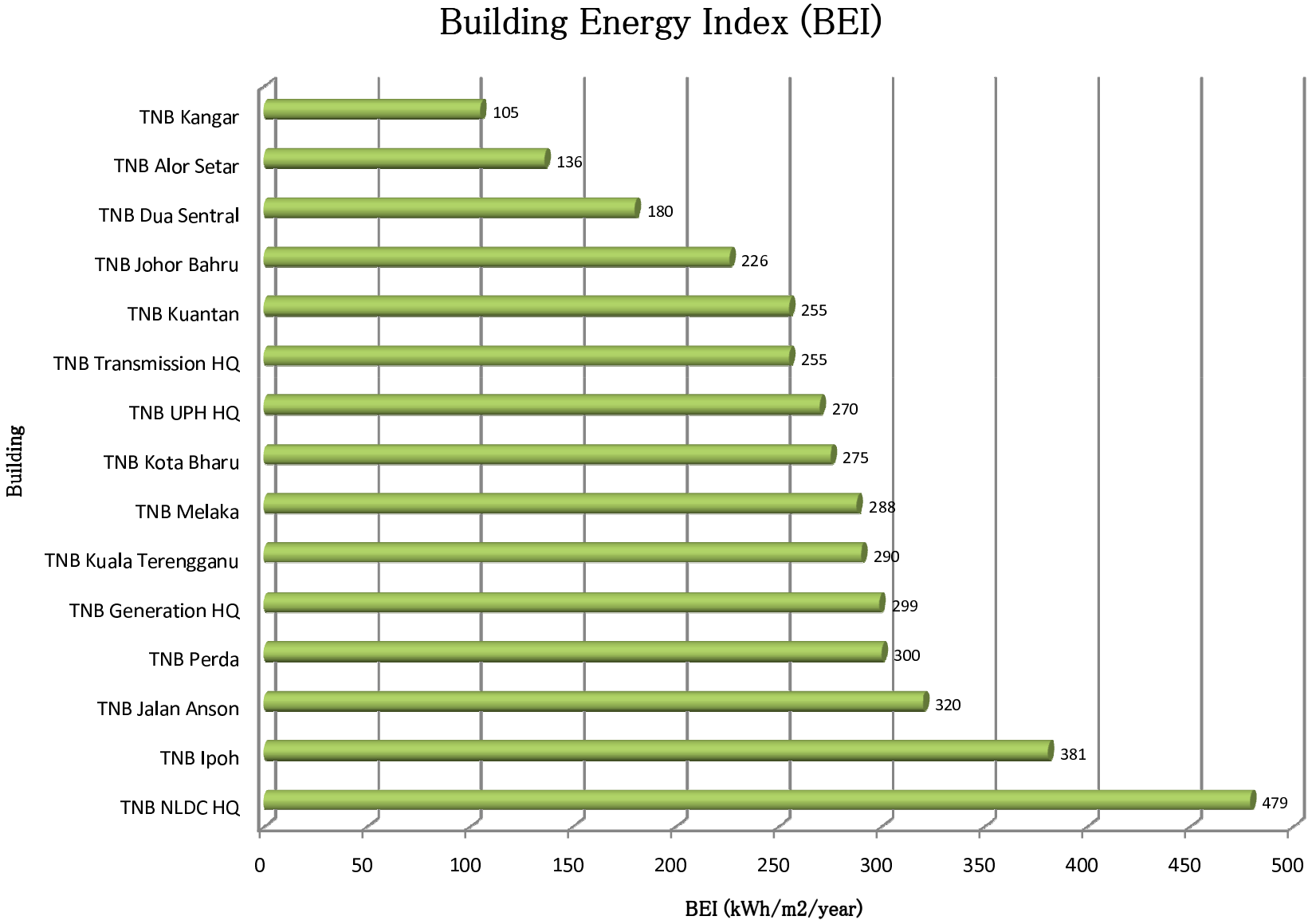
List of buildings:

No	Building	GFA (m2)	Aircond area (m2)
1	TNB 2 Sentral	37,318	22,391
2	TNB Johor Bahru	23,663	15,378
3	TNB Generation HQ	20,179	7,587
4	TNB Alor Setar	18,677	11,403
5	TNB NLDC HQ	15,065	12,069
6	TNB Kuantan	14,334	7,310
7	TNB Kota Bharu	12,606	8,572
8	TNB Kangar	10,906	10,238
9	TNB Transmission HQ	5,436	5,134
10	TNB Jalan Anson	5,272	3,269
11	TNB Ipoh	4,348	4,200
12	TNB Melaka	4,080	3,484
13	TNB K. Terengganu	3,011	1,686
14	TNB Perda	2,721	1,796
15	TNB UPH HQ	1,838	1,746

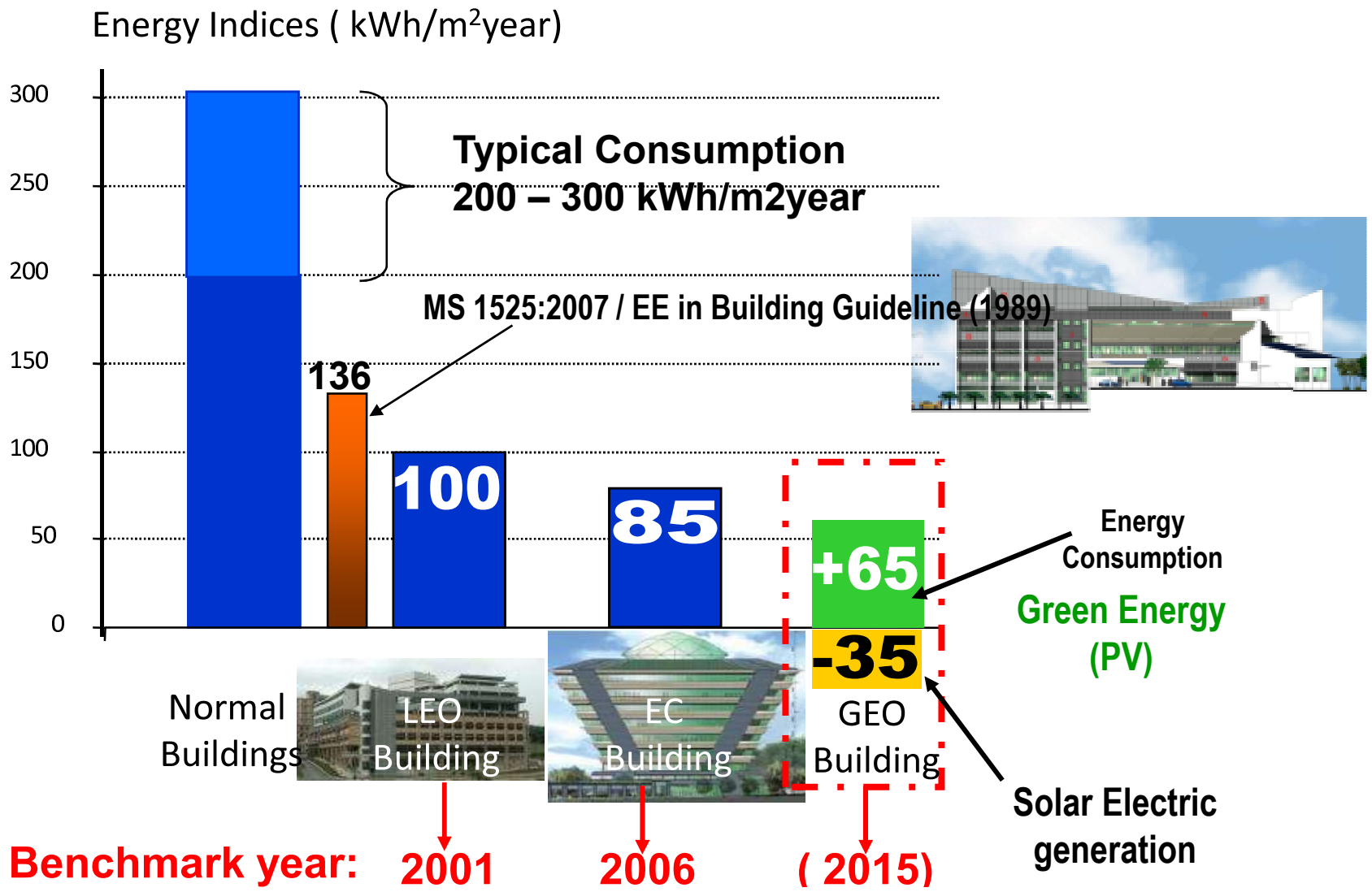
Energy Audit for 15 TNB buildings - Key findings & Observation



Energy Audit for 15 TNB buildings - Key findings & Observation



Energy Efficiency buildings in Malaysia – [Building Energy Index (BEI)]



MS 1525:2007 – Code of Practise Use of EE & RE for Non-residential buildings

Energy Audit for 15 TNB buildings - Key findings & Observation

Types of Loads & Apportioning

Type	Range (%)
ACMV	51 - 79
Lighting	10 - 21
Lift	1 - 2
Other	8 - 37

Energy Audit for 15 TNB buildings
- Key findings & Observation

Prior Energy Saving initiatives/projects:

- EEC campaign and promotion:
  - Appointment of energy managers – NLDC buildings
  - Auto sleep mode for computers – NLDC (Level 5)
  - Energy savings stickers and poster
  - Display of room temperature using Digital Thermohygrometer – UPH building
  - Utilization of energy savings electrical appliances (i.e. 5 Star ratings refrigerator)
- Electronic ballast & LED lighting – Generation & UPH building
- VSD for Chilled water pump motor – Generation building

Energy Audit for 15 TNB buildings - Energy Saving Measure

- Sustainable Energy Management System (SEMS)
- Power Factor Improvement
- EE Lighting
- ACMV

Energy Audit for 15 TNB buildings - Energy Saving Measures

Sustainable Energy Management System (SEMS) :

- In general, awareness on EEC are low
- Setup committee/workforce for EEC for each building (management policy, program, target etc.)
- Proposed activity/program:
  - Continuous awareness (talk, competition etc.)
  - Monitoring of energy usage – e.g. monthly bills, online monitoring or energy monitoring system
  - Energy Audit & implement EEC projects
- Potential savings (annual):
  - 1% is achievable = 320,000kWh or RM99,840
- Certification - Energy Management Gold Standard by AEMAS

Energy Audit for 15 TNB buildings - Energy Saving Measures

ACMV System :

- Improve maintenance (i.e. AHU room must be clean and clear at all times, air filter and fin coils must be clean)
- Chiller management – turn off 1 chiller ½ hour earlier (also save water – e.g. TNB Kuantan), temp setting 24 deg Celcius
- Replace inefficient motor (measured/calculated efficiency 40 to 60%) for CW pump
- Install VSD for CW pumps & CT Fan
- Replace with new energy efficient chiller (i.e. EEI = 0.5kW/RT)

Energy Audit for 15 TNB buildings - Energy Saving Measures

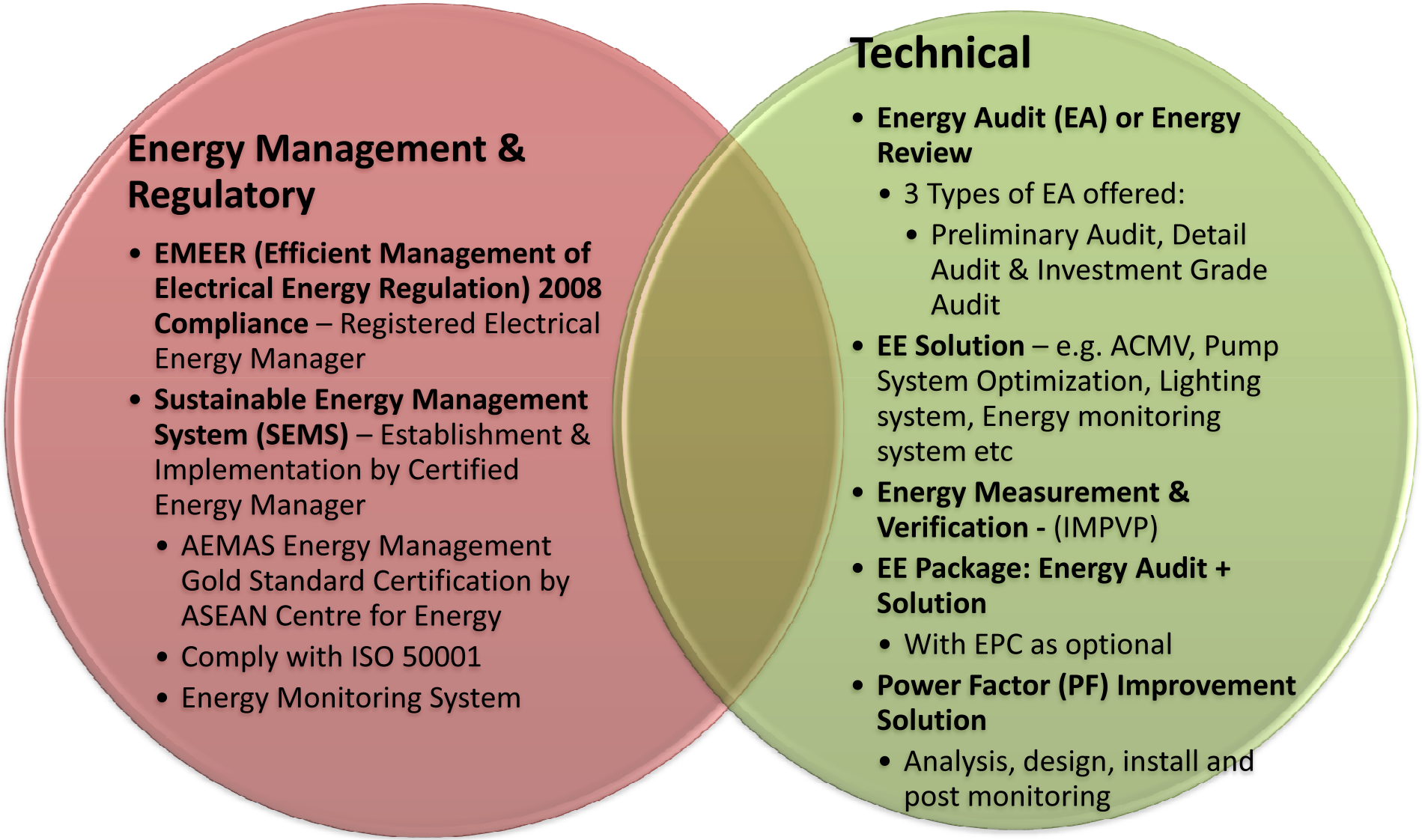
- EE Lighting
  - T5 FL
    - 10,000 to 20,000 hours
    - ROI = 3 to 4 years
  - LED tube
    - 40,000 to 50,000 hours
    - ROI = 5 to 7 years

- Voltage Optimization Device

TNBES EE PROJECTS TRACK RECORDS

Making It Happen, Getting It Done

OFFERED EE SERVICES BY TNBES



DETAILED TECHNICAL SERVICES (AUDIT & SOLUTION)

1. PERFORM ENERGY AUDIT/REVIEW
-**Detail Audit**
or
-**Investment Grade Audit (specific equipment/area)**

2. IMPLEMENTATION OF EE SOLUTION
-**Project development**
or
-**Energy Performance Contract (EPC)**

Potential EE area:

- **HVAC System**
- **Lighting System**
- **Pump System Optimization**
- **Automation System**
- **Power Factor (PF) Improvement**
- **Voltage Optimization**
- **Energy Monitoring System**

CASE STUDIES

NO COST/ LOW COST INVESTMENT

EEC Services/Projects by TNBES

- PF Improvement for OPC (less than 100A 3-phase)
  - Installation of Capacitor Bank LV Panel
  - Offer to TNB OPC
  - Ratings: 20kVAR to 45 kVAR
  - Payback 3 – 12 months

Power Factor for OPC – Case Study of Completed Project

Customer A (Sunway)

- Commercial
- Average Monthly bill: RM6,800.00
- Average PF surcharge: RM1,400.00
- Savings: 21%
- Payback: 3 months

Customer B (Petaling Jaya)

- Workshop
- Average Monthly bill: RM2,000.00
- Average Monthly PF Surcharge: RM900.00
- Savings: 45%
- Payback: 5 months

Customer C (Subang)

- Apartment (Common Area)
- Average Monthly bill: RM3,900.00
- Average Monthly PF Surcharge: RM2,050.00
- Savings: 53%
- Payback : 2 months

LPC - 2012 - Office Building (11 Storey) – Kepong

Month	kWh	kVarh	Power Factor	Total PF surcharge	Monthly Electricity Bill
Nov-11	362,898	343,606	0.73	MYR 26,465.82	152,493.51
Dec-11	344,871	321,548	0.73	MYR 25,335.34	145,979.82
Jan-12	346,190	329,916	0.72	MYR 29,074.56	150,218.56
Feb-12	298,171	284,528	0.72	MYR 26,473.39	136,779.16
Mar-12	325,614	302,688	0.73	MYR 24,246.06	139,703.47
Apr-12	303,021	277,779	0.74	MYR 19,628.34	128,674.69
May-12	317,274	292,175	0.74	MYR 22,219.04	145,658.12
Jun-12	302,320	284,464	0.73	MYR 24,719.42	142,430.96
Jul-12	301,126	285,537	0.73	MYR 24,706.46	142,356.27
Aug-12	275,342	265,431	0.72	MYR 26,292.82	135,846.22
Sep-12	292,060	277,296	0.73	MYR 24,395.28	140,563.30
Oct-12	310,523	299,335	0.72	MYR 29,194.46	150,838.03
Nov-12	296,686	176,960	0.87	-	118,155.23
Dec-12	291,538	180,377	0.96	-	115,668.46
Jan-13	309,304	91,793	0.96	-	122,376.95
Feb-13	276,059	79,279	0.96	-	111,538.31
Mar-13	361,534	104,143	0.96	-	127,788.56
Apr-13	368,193	123,891	0.95	-	129,395.26
May-13	356,669	189,803	0.88	-	125,262.73
Jun-13	337,572	271,633	0.78	-	131,359.51
Jul-13	333,806	185,432	0.87	-	118,391.03
Aug-13	334,005	116,877	0.94	-	117,108.26
Sep-13	334,530	118,999	0.94	-	116,756.93
Oct-13	363,139	131,456	0.94	-	137,023.77
				MYR 302,750.98	

Savings = RM300k/year (20%)
Payback = 6 months

LPC - 2011 - Office Building (5 Storey) – Shah Alam

Month	kWh	kVarh	Power Factor	Total surcharge	Monthly Electricity Bill
Mar-11	113,728	89,286	0.79	MYR 3,604.71	MYR 43,657.02
Apr-11	109,405	83,523	0.79	MYR 4,179.69	MYR 50,620.65
May-11	118,002	93,747	0.78	MYR 4,374.94	MYR 46,041.05
Jun-11	109,427	88,965	0.78	MYR 4,839.28	MYR 50,927.62
Jul-11	109,302	87,718	0.78	MYR 4,089.24	MYR 43,034.38
Aug-11	134,322	109,500	0.78	MYR 4,805.64	MYR 50,573.66
Sep-11	100,270	82,087	0.77	MYR 4,338.30	MYR 40,490.78
Oct-11	112,038	95,165	0.76	MYR 5,351.05	MYR 44,988.43
Nov-11	118,626	102,517	0.76	MYR 5,523.19	MYR 46,435.74
Dec-11	95,934	77,662	0.78	MYR 3,604.59	MYR 37,933.98
Jan-12	117,121	100,692	0.76	MYR 5,519.60	MYR 46,405.52
Feb-12	84,651	51,235	0.86	MYR -	MYR 31,606.35
Mar-12	101,000	32,665	0.95	MYR -	MYR 35,931.98
Apr-12	110,744	31,604	0.96	MYR -	MYR 39,312.57
May-12	106,806	32,070	0.96	MYR -	MYR 37,723.76
Jun-12	115,915	34,288	0.96	MYR -	MYR 40,514.66
Jul-12	121,876	39,783	0.95	MYR -	MYR 42,638.24
Aug-12	107,986	34,989	0.95	MYR -	MYR 38,494.34
Sep-12	97,711	28,158	0.96	MYR -	MYR 35,606.93
Oct-12	117,483	37,256	0.95	MYR -	MYR 41,038.03
Nov-12	117,250	36,225	0.96	MYR -	MYR 40,899.14
Dec-12	115,704	37,369	0.95	MYR -	MYR 40,406.03
Jan-13	122,256	39,743	0.95	MYR -	MYR 42,747.68
				MYR 50,230.22	

Savings = RM50k/year (10%)
Payback = 6 months

EEC Services/Projects by TNBES

- Registered Electrical Energy Manager (REEM) Services
  - Law & Regulation – Efficient Management of Electrical Energy Regulation 2008 (EMEER 2008) under Electricity Supply Act 1990 by Energy Commission
  - Provisions of the regulation – electrical energy intensive consumers and producers (>3,000,000kWh for 6 consecutive months) are required to engage a Registered Electrical Energy Manager (REEM)
  - TNBES has 3 REEM by EC & 6 CEM by AEMAS and 1 certified with IPMVP

Commercial Facilities (KL)
Electricity Consumption & MD

Month	kWh			kW		
	2012	2013	2014	2012	2013	2014
Jan	1,212,876.00	1,190,845.00	1,198,347.00	2,355.00	2,453.00	2,248.00
Feb	1,076,601.00	1,052,423.00	1,002,790.00	2,250.00	2,259.00	2,164.00
Mar	1,196,175.00	1,155,036.00	1,043,418.00	2,499.00	2,262.00	2,033.00
Apr	1,176,547.00	1,168,741.00	1,103,338.00	2,596.00	2,458.00	2,439.00
May	1,113,206.00	1,211,379.00	0.00	2,208.00	2,468.00	0.00
Jun	1,062,817.00	1,162,671.00	0.00	2,220.00	2,379.00	0.00
Jul	1,130,240.00	1,232,153.00	0.00	2,233.00	2,386.00	0.00
Aug	1,125,995.00	1,233,924.00	0.00	2,320.00	2,329.00	0.00
Sept	1,098,675.00	1,209,393.00	0.00	2,223.00	2,339.00	0.00
Oct	1,183,926.00	1,219,492.00	0.00	2,300.00	2,373.00	0.00
Nov	1,156,093.00	1,166,204.00	0.00	2,428.00	2,301.00	0.00
Dec	1,203,844.00	1,177,442.00	0.00	2,370.00	2,216.00	0.00
Average:	**1,144,749.58**	**1,181,641.92**	**1,086,973.25**	**2,333.50**	**2,351.92**	**2,221.00**

1.0 Change Tariff

- Based on load profiling findings:
  - Peak hours consumption: 70%
  - Off-peak hours consumption: 30%
- Convert 11kV tariff from C1 to C2
- Estimated savings = ~RM12k per month

			Tariff C1 (new)					Tariff C2 (new)				
			kWh	MD		Distribution		kWh-peak	kWh-off	MD		
Month	kWh	kW	0.365	30.30	Bill (RM)	Peak	Off-peak	0.365	0.224	45.10	Bill (RM)	Difference
Jan-14	1,198,347.00	2,248.00	437,396.66	68,114.40	505,511.06	0.7	0.3	306,177.66	80,528.92	101384.8	488,091.38	17,419.68
Feb-14	1,002,790.00	2,164.00	366,018.35	65,569.20	431,587.55	0.7	0.3	256,212.85	67,387.49	97596.4	421,196.73	10,390.82
Mar-14	1,043,418.00	2,033.00	380,847.57	61,599.90	442,447.47	0.7	0.3	266,593.30	70,117.69	91688.3	428,399.29	14,048.18
Apr-14	1,103,338.00	2,439.00	402,718.37	73,901.70	476,620.07	0.7	0.3	281,902.86	74,144.31	109998.9	466,046.07	10,574.00

2.0 Voltage Regulation

- Average supply voltage to equipment = 430V (Line voltage) or 248V (Phase voltage)
- Regulating (or reducing) supply voltage at optimum value (e.g. 220V to 230V) will :
  - Reduce energy consumption
  - Prolong lifespan of equipment
- Method to regulate (or reduce) supply voltage:
  - Option A (No Cost): Reduce tapping of transformer
  - Option B (Medium/High Cost): Install Voltage Regulator Device (also known as Energy Saving Device)
- Estimated energy savings: 10% to 20% (Reduction from 430V to 400V)
- Caution: Too low of supply voltage leads to malfunction of electrical equipment – proper engineering design is required (functionality, end of line supply, savings from other EE equipment etc.)

Summary of Identified ESM/EE Projects

Identified Projects	Annual Energy Savings (RM) per year	Estimated Cost (RM)	Simple Payback
Change Tariff from C1 to C2	RM140,000	No Cost	NA
Establish Energy Management System	RM50,000	RM50,000	1 year
Voltage Optimization: Option A: Reduce tapping transformer Option B: Install VO device	RM91,000 to RM182,000	Option A: No cost Option B (e.g.): RM250,000	Option B: 1.5 to 3 years
EE Lighting: Option A: Replace T8 to T5 Retrofit Option B: Replace T8 to LED Tube	Option A: RM409,635 Option B: RM1,024,000	Option A: RM1,964,740 Option B: RM3,940,000	Option A: 4.8 years Option B: 3.8 years

Commercial Data Centre (Cyberjaya)
Change Tariff from C1 to C2

Main Peak KWH	Main Peak KW	Peak 8am-10pm 62% - Load Profile	Off Peak 10pm-8am 38% - Load Profile	Total RM Tariff C1 (Now)	Total RM Tariff C2	Total C2-C1
1,033,418.73	1,945.04	640,719.61	392,699.12	RM 344,169	RM 323,278	RM (20,891)
1,009,835.35	2,040.04	626,097.92	383,737.43	RM 339,651	RM 320,863	RM (18,788)
1,053,285.44	2,040.04	653,036.97	400,248.47	RM 352,164	RM 331,544	RM (20,620)
1,013,085.36	2,033.37	628,112.92	384,972.44	RM 340,427	RM 321,425	RM (19,003)
1,021,080.21	2,041.74	633,069.73	388,010.48	RM 342,930	RM 323,688	RM (19,242)
2,157,954.32	1,973.37	1,337,931.68	820,022.64	RM 668,714	RM 600,720	RM (67,993)
1,062,668.79	2,021.71	658,854.65	403,814.14	RM 354,428	RM 333,198	RM (21,230)
1,083,968.83	2,025.04	672,060.67	411,908.16	RM 360,642	RM 338,553	RM (22,090)
355,681.00	2,003.00	220,522.22	135,158.78	RM 150,368	RM 158,740	RM 8,372
1,086,272.00	1,960.00	673,488.64	412,783.36	RM 359,749	RM 336,803	RM (22,946)
1,105,320.00	2,103.00	685,298.40	420,021.60	RM 368,657	RM 346,577	RM (22,080)
1,034,561.00	2,027.00	641,427.82	393,133.18	RM 346,460	RM 326,477	RM (19,983)
1,100,637.00	2,082.00	682,394.94	418,242.06	RM 366,806	RM 344,678	RM (22,128)
1,121,203.00	2,148.00	695,145.86	426,057.14	RM 374,308	RM 352,083	RM (22,225)
1,153,873.00	2,049.00	715,401.26	438,471.74	RM 381,348	RM 356,589	RM (24,759)
1,105,971.00	2,045.00	685,702.02	420,268.98	RM 367,456	RM 344,672	RM (22,785)
1,160,767.00	1,991.00	719,675.54	441,091.46	RM 381,946	RM 356,219	RM (25,726)
1,171,802.00	1,968.00	726,517.24	445,284.76	RM 384,573	RM 358,113	RM (26,460)
1,121,325.00	1,969.00	695,221.50	426,103.50	RM 370,060	RM 345,741	RM (24,319)
1,192,842.00	2,065.00	739,562.04	453,279.96	RM 392,954	RM 366,738	RM (26,216)
1,188,005.00	2,080.00	736,563.10	451,441.90	RM 391,920	RM 366,083	RM (25,836)
1,192,024.00	2,069.00	739,054.88	452,969.12	RM 392,814	RM 366,680	RM (26,134)
1,184,618.00	2,054.00	734,463.16	450,154.84	RM 390,322	RM 364,325	RM (25,997)
1,109,756.00	2,146.00	688,048.72	421,707.28	RM 370,964	RM 349,198	RM (21,766)
26,819,954.03				RM 8,893,830	RM 8,332,986	RM (560,844)
			Average Price RM/kWh:	0.332	0.311	

Commercial Building (Cyberjaya)

Change Tariff from B (low voltage) to C2 (Medium Voltage)

		Peak 8am-10pm	Off Peak 10pm-8am	Tariff B (now)	Total RM Tariff C2	Total C2-B
Main Peak KWH	Main Peak KW	61% - Load Profile	39% - Load Profile	0.397		
194,189.00	289	118,455.29	75,733.71	RM 77,093	RM 57,808	RM (19,285)
206,615.00	297	126,035.15	80,579.85	RM 82,026	RM 61,134	RM (20,892)
192,623.00	296	117,500.03	75,122.97	RM 76,471	RM 57,674	RM (18,797)
186,649.00	276	113,855.89	72,793.11	RM 74,100	RM 55,500	RM (18,599)
226,219.00	286	137,993.59	88,225.41	RM 89,809	RM 65,540	RM (24,269)
225,077.00	340	137,296.97	87,780.03	RM 89,356	RM 67,183	RM (22,173)
208,992.00	442	127,485.12	81,506.88	RM 82,970	RM 66,878	RM (16,092)
178,248.00	223	108,731.28	69,516.72	RM 70,764	RM 51,558	RM (19,207)
172,140.00	222	105,005.40	67,134.60	RM 68,340	RM 50,028	RM (18,312)
234,253.00	201	142,894.33	91,358.67	RM 92,998	RM 64,480	RM (28,519)
146,633.00	229	89,446.13	57,186.87	RM 58,213	RM 44,035	RM (14,178)
171,947.00	213	104,887.67	67,059.33	RM 68,263	RM 49,660	RM (18,603)
201,391.00	208	122,848.51	78,542.49	RM 79,952	RM 56,687	RM (23,265)
188,916.00	188	115,238.76	73,677.24	RM 75,000	RM 52,922	RM (22,077)
202,143.00	238	123,307.23	78,835.77	RM 80,251	RM 57,939	RM (22,312)
191,581.00	198.5	116,864.41	74,716.59	RM 76,058	RM 53,948	RM (22,109)
206,456.00	334.8	125,938.16	80,517.84	RM 81,963	RM 62,441	RM (19,522)
171,503.00	271.9	104,616.83	66,886.17	RM 68,087	RM 51,648	RM (16,439)
216,903.00	198.8	132,310.83	84,592.17	RM 86,110	RM 60,156	RM (25,955)
204,404.00	211.2	124,686.44	79,717.56	RM 81,148	RM 57,538	RM (23,610)
194,154.00	219	118,433.94	75,720.06	RM 77,079	RM 55,308	RM (21,771)
174,151.00	207.6	106,232.11	67,918.89	RM 69,138	RM 50,007	RM (19,131)
183,829.00	200.7	112,135.69	71,693.31	RM 72,980	RM 52,130	RM (20,850)
251,979.00	210.7	153,707.19	98,271.81	RM 100,036	RM 69,163	RM (30,873)
4,730,995.00				RM 1,878,205	RM 1,371,365	RM (506,841)
			Average Price RM/kWh:	0.397	0.290	

EE Lighting Project
for
TNB Kepong, TNB Jalan Timur, & TNB Seremban

TNB Energy Services Sdn Bhd

September 2014

Objectives

- To improve energy efficiency for lighting loads in the building

- To reduce energy consumption for lighting loads hence overall energy consumption of the buildings

- To provide awareness for building occupants on EE (reading of existing indoor temperature & humidity)

- To support TNB GREENER policy

Scope of Work

- Dismantling of existing T8 FL and its fitting (if any) and checking of wiring system

- Installation of new fitting (if any) for new efficient lighting

- Installation and commissioning of new efficient lighting complete with accessories (if any)

- Assessment on the performance of the new efficient lighting through inspection and energy consumption before and after installation

- Project management

Lamp Replacement Work

Rewiring work to bypass the ballast and starter

Replacement Work

Brightness of Fluorescent T5 Retrofit (28W for 1200mm) tube after replacement

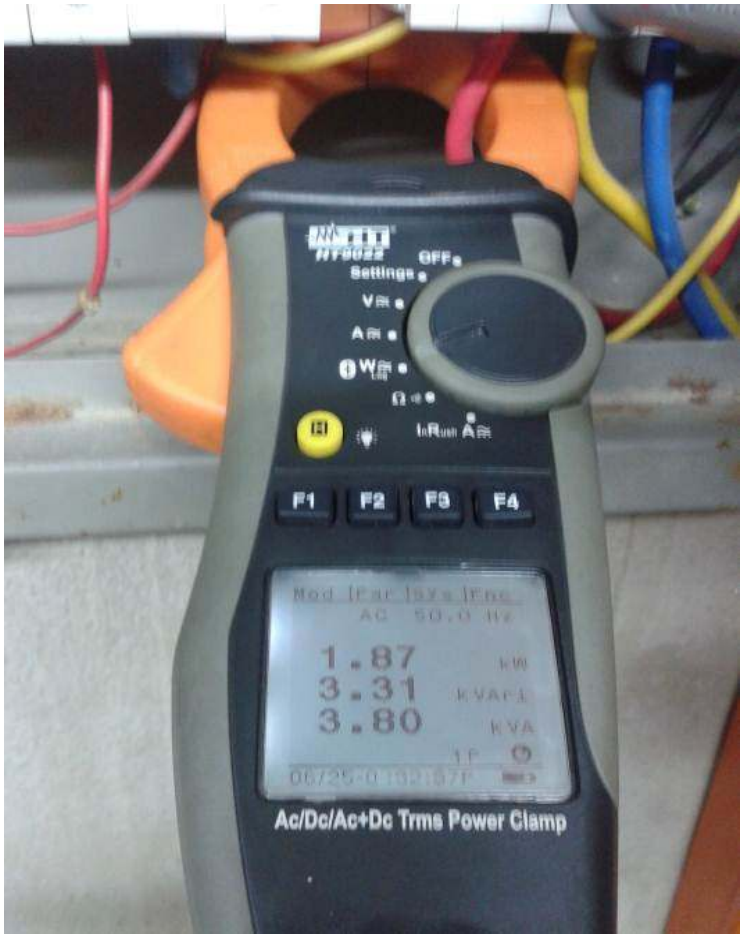
Lamp Measurement

Lux level was measured to compare the brightness of old and new lamps

Lamp Measurement

Measurement of energy consumption on the lighting

Lamp Measurement



Measurement of energy consumption on the lighting

Comparison of Load Consumption

Comparison of load consumption before and after EE lighting replacement at TNB Jalan Timur

TNB Jalan Timur	Parking FL (1200mm)	Office Area		Total Saving
		FL (1200mm)	FL (600mm)	
Quantity	545	4404	519	
Average Load per Lamp				
- Existing 36w T8 FL 1200mm (W/unit)	40.24	44.12		
- Existing 18w T8 FL 600mm (W/unit)			31.82	
- New 28w T5 FL Retrofit 1200mm (W/unit)		30.61		
- New 14w T5 FL Retrofit 600mm (W/unit)			24.09	
- New 16w LED Tube 1200mm (W/unit)	16.17			
Saving (%)	60%	31%	24%	35%
Operating Hours per day	24	12	12	
Saving (kWh/year) with 365days/year	114,921.17	260,669.19	17,565.79	393,156.15
Saving (RM/year)	41,946.23	95,144.25	6,411.51	143,502.00

Saving

Based on the Energy Saving Measurement & Verification (M&V), energy saving obtained from EE lighting work for the three buildings are as follows:

Building	Saving	Percentage of Saving (Based on Lighting Load only)	Percentage of Saving (Based on Total Load)	Payback Period (Year)
TNB Kepong	181,716.41 kWh/year (RM 66,326/year)	41%	6%	2.7
TNB Jalan Timur	393,156.15 kWh/year (RM143,502/year)	35%	5%	3.6
TNB Seremban	88,691.18 kWh/year (RM32,372/year)	42%	6%	3.8

TNB ENERGY SERVICES SDN. BHD.

ENERGY EFFICIENT AND CONSERVATION (EEC) SERVICES OFFERED

Why EEC?

- Improve bottom line/profit
- Key in Long term competitiveness
- Reduce capital requirements for new energy production facilities
- Reduce environmental pollution
- Potential savings on energy consumption: 5 to 40% (depends on type of system)

EEC Package (For Building & Industry):

1. PERFORM ENERGY AUDIT/REVIEW
Detail Audit
or
Investment Grade Audit
(specific equipment/area)

▶

2. IMPLEMENTATION OF EEC SOLUTION
Project development
or
Energy Performance Contract (EPC)

OUR EXPERIENCES

TENAGA NASIONAL BERHAD

SATU LAGI PRODUK DAHULUKAN RAKYAT

TNB ENERGY SERVICES SDN. BHD.

POWER QUALITY (PQ) SERVICES

Why PQ Services?

- To overcome PQ incidence or to minimize impact during PQ incidence
- Avoid hefty losses

PQ Packages:

- PQ Monitoring System
- PQ Load Consultancy (Testing & Mitigation strategy)
- PQ Mitigation project
- PQ Training

GEARING FOR BUSINESS EXPANSION

TNBES to build a profitable and sustainable Green Energy business within Malaysia, and to capitalise on Asian and **Middle East business opportunities**

OUR EXPERIENCES

TENAGA NASIONAL BERHAD

SATU LAGI PRODUK DAHULUKAN RAKYAT

CONCLUSION

- Conserve energy & efficient usage – understand parameters that affect specific equipments energy usage, be knowledgeable, be innovative
- Be 1st Class Maintenance mentality
- Reuse, Reduce, Recycle

- TNB is fully committed towards RE & Green Energy, aims to become a primary driver of Green Energy in Malaysia by 2015
  - Embarked on a numerous RE, DSM and EE projects
  - Embarked on public awareness and knowledge dissemination
  - Training and Capacity Building (ILSAS, Uniten/IEPRE, TNBR)


TNBES
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Making It Happen, Getting It Done