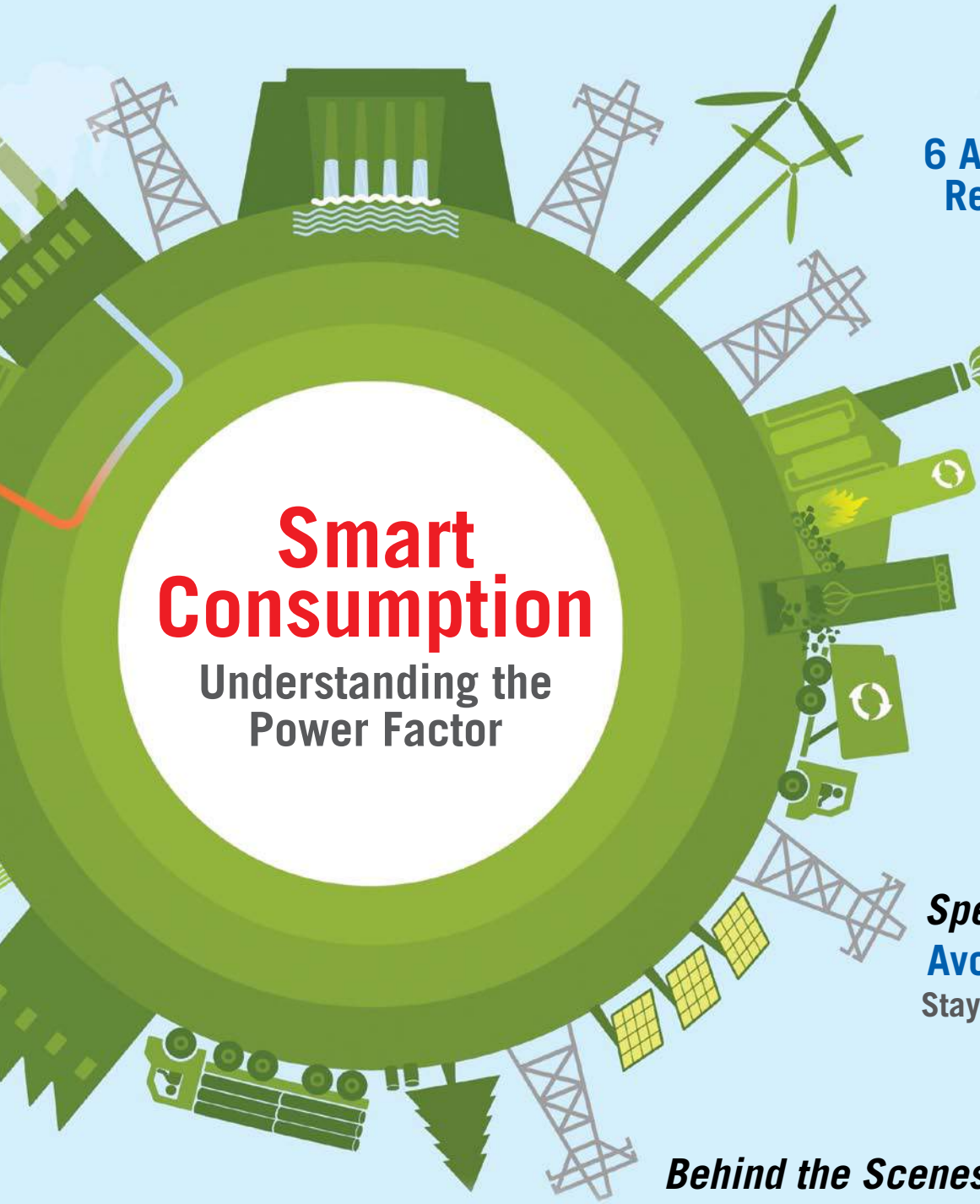
COMMUNICATING TO LARGE POWER CUSTOMERS

TENAGALINK

KDN : PP8515/01/2013(031995)



Smart Consumption

Understanding the Power Factor

6 After-Flood Reminders

Expert Talk:

The Importance of Power Quality

Microalgae for Power Plants

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Staying Safe at Work

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A Practical Guide to Energy Efficiency

Volume 1 | 2015

The firefly is symbolic of TNB's commitment to our customers and the country. TNB supports the conservation of the *Lampyridae* firefly colony found along riverbanks of Kampung Kuantan, Kuala Selangor. The area turns magical as the sun sets and the sky is enveloped in darkness. The fireflies will then flash their lights in unison, creating a spectacular light show only nature could provide.

TENAGA NASIONAL BERHAD (200866-W)

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" Not only has the company proceeded to strengthen its foothold in the growing number of countries where we operate worldwide, but we have also reaffirmed our commitment to providing the highest standards of service to our clients and Large Power Customers (LPCs). "

I am both pleased and proud to look back on 2014 as a year of new highs for Tenaga Nasional Berhad (TNB).

TNB is eager to continue raising the bar, in terms of contributing towards the creation of a globally relevant energy sector in Malaysia. We pursue initiatives that showcase our efforts to enhance the electricity supply and use of power, on the part of both customers and industry practitioners, as well as through groundbreaking research and development.

Primarily, we are providing our clientele with timely and effective advice and guidance on power-related issues – especially those relevant to industrial customers that use sensitive equipment, and are thus more greatly affected by changes in the quality of service. These matters include power factor correction, as well as those relating to energy efficiency, power quality and safety standards.

Apart from that, various internal efforts are underway to elevate the operation and management of electrical installations throughout the country – encompassing those used by TNB as well as its customers. Additionally, we have made strides in the pursuit of alternative and sustainable resources and practices, as exemplified by our participation in 2014's *International Greentech & Eco Products Exhibition & Conference Malaysia (IGEM)*, as well as the pioneering studies on microalgae being undertaken by TNB Research (TNBR).

As the primary power utility in Peninsular Malaysia, TNB always remains mindful of the important role it plays in leading the advancement of energy industry standards. At the same time, we acknowledge the contributions of customers and power sector practitioners, and are committed to partnering all quarters in improving the effectiveness and capability of the industry.

Datuk Ir. Baharin Din
Vice President (Distribution)
Tenaga Nasional Berhad

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Majority of TNB poles are made from **concrete** and have **overhead cables**

Step 2

Locate

Let us know the location and **pole number*** if available

Step 3

Report

Call 15454 or
SMS <SL> to15454
Providing the pole number can expedite the response time

** Old TNB poles may not carry the TNB logo and pole number.*

TENAGA NASIONAL BERHAD (200866-W)

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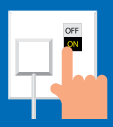
IMPORTANT NOTES

ELECTRICITY DOs AND DON'Ts
AFTER A FLOOD

IMPORTANT: Get an electrician registered with the Energy Commission (www.st.gov.my) to test all electrical items and inspect your premises.



Do not attempt to switch on electrical appliances affected by the flood.

Take affected electrical appliances for cleaning, inspection and repairs (if needed) to a qualified electrician.

Never attempt to move or hold an exposed wire.

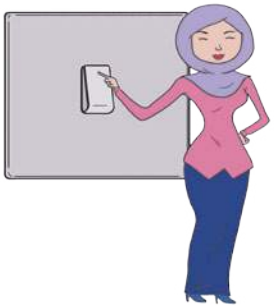
Do not allow children to approach fallen electrical poles or exposed electrical cables.

Call TNB Careline at 15454 or visit any TNB office for advice and assistance.

BRIGHT WAYS TO SAVE ENERGY

Use the stairs to save energy. And burn calories.

The lifts consume a lot of electricity. Wherever possible, get a little exercise by taking the stairs.



Turn off unused lights to save more.

Remember to turn off the lights when not in use, or when you're leaving the office.

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.

Fill your kettle to the max level for maximum 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.

Set the air con to 24°C to cool down for less.

Air conditioners use a lot of energy as it is. Setting the temperature between 24-26°C provides sufficient cooling, while keeping your energy consumption down.

Better. Brighter.

TENAGA NASIONAL

EMPHASIS ON EXPERIENCE

In April 2014, TNB CareLine registered as an associate member of the Contact Centre Association of Singapore (CCAS), a non-profit organisation focusing on technologies, operational approaches and business issues for contact centres. TNB then submitted an entry for the annual *CCAS International Contact Centre Awards 2014*, for which judges provide participants with a feedback report, allowing them to identify opportunities for improvement.

TNB CareLine competed under the *Special Category – Best Customer Experience Delivered*, which also saw entries from organisations such as Barclays Capital Services, Direct Asia Insurance (Singapore) and Singapore's Economic Development Board.

At the awards ceremony, which was held on 19 September 2014 at the Grand Copthorne Waterfront Hotel Singapore, TNB was declared as the Silver Award recipient, while Standard Chartered Bank and DBS Bank were the Gold and Bronze winners respectively. The award was accepted by Dato' Mohandass Nair, then General Manager (Customer Relations), Customer Service Department, Distribution Division, TNB.

Below: *Members of TNB CareLine celebrate their victory after receiving the* Special Category – Best Customer Experience Delivered *award, silver category.*

For a contact centre which was formed just three years ago, this acknowledgement is a very proud achievement for TNB in its continuing quest for excellence to meet international standards.

TNB CareLine Assistant General Manager Ir S Parameswaran (centre) poses with staff from TNB Careline, dressed in accordance with the retro-themed ACE Awards & Gala Dinner Night 2014.

HIGHLIGHTING CUSTOMER CARE

As a member of the Association of Customer Experience (ACE) of Malaysia (formally known as the Contact Centre Association of Malaysia – CCAM), TNB CareLine competed for an award in a newly introduced category this year – the *Open Category for Best Contact Centre – Utilities*, and was shortlisted for the finals.

On 24 September 2014, a panel of three judges from Australia, Hong Kong and Singapore conducted on-site judging, interviewing members of the staff and the management. Among the criteria the judges looked at were the workforce profile, Key Performance Indices, achievements, key objectives, core competencies, contact centre customer service strategy, integration with the rest of the organisation within TNB, and adherence to the overall objectives of the organisation.

During the ACE Awards & Gala Dinner Night 2014, held at the Grand Mahkota Ballroom, Istana Hotel in Kuala Lumpur on 8 November 2014, TNB CareLine was revealed as the winner of the third prize for the *Best Contact Centre 2014 – Utilities*. Due to stringent judgement criteria, no company qualified for the first or second place except TNB, ensuring its win in this category. The award was received by Ir Kamaliah Abdul Kadir, Senior General Manager of Customer Service, Distribution Division, accompanied by Ir S Parameswaran, Assistant General Manager (TNB CareLine) Customer Service Department, Distribution Division and TNB CareLine staff from across Peninsular Malaysia.

Tenaga Nasional Berhad received the certificate of achievement and trophy for third place in the Best Contact Centre 2014 – Utilities *category.*

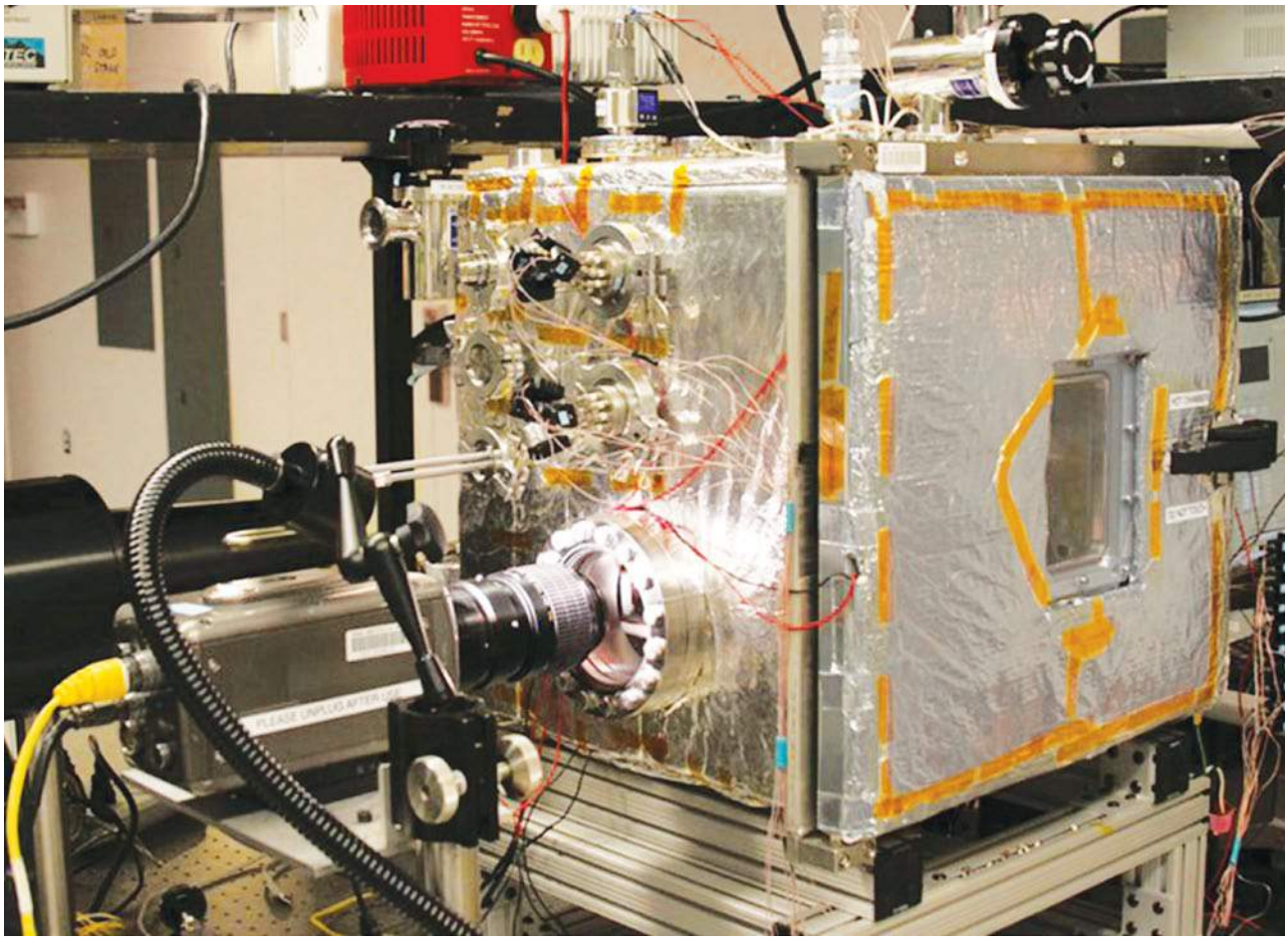
CONDENSED POWER

Utilising hydrophobic (water-repelling) and hydrophilic (water-attracting) surfaces, researchers at the Massachusetts Institute of Technology (MIT) have been able to generate electricity from water droplets. To achieve this, the scientists bounced the globules between two conductive shells; one water-repelling copper oxide plate and another water-attracting copper layer. As the droplets bounce off the repellent surface, they generate charges which become electricity with the continuous movement of the droplets across the boards.

Led by Nenad Miljkovic, the researchers noted that the difference between the surrounding environmental temperature and the device – which allows condensation to form – plays a crucial role in determining its success. They however point out that any surface area where dew forms is sufficient to generate electricity.

In testing, the team was able to generate 15 picowatts per square centimetre of metal plate but could easily enhance this to achieve at least one microwatt per square centimetre. This translates to a generator about the size of a camping cooler completely charging your mobile phone in about 12 hours. Since the plates can be made out of any conductive material, the device can be manufactured easily and cheaply, and can be used in rural areas and developing countries as a power source.

The device – which has the potential to provide renewable energy in inaccessible and remote areas – was developed by Massachusetts Institute of Technology's Nenad Miljkovic, using the principles of attracting and repelling water to generate electricity from condensation.



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PROMOTING GREEN TECHNOLOGY

TNB Participates in the IGEM 2014

From 16 to 19 October 2014, Tenaga Nasional Berhad (TNB) was the Utility Partner for the 5th International Greentech & Eco Products Exhibition & Conference Malaysia (IGEM), organised by the Ministry of Energy, Green Technology and Water (KeTTHA). Engaging in this event was a part of TNB's continued efforts to enhance the well-being of the people, by educating them on the benefits of Green technology and eco-friendly products.

TNB's booth at the 5th International Greentech & Eco Products Exhibition & Conference Malaysia (IGEM) placed emphasis on being environmentally friendly while maintaining modern comforts.

Themed *Creating Green Wealth*, this year's IGEM was a platform for industry players to showcase their latest innovations, services, products and initiatives. The annual event pushes for the rapid adoption of Green technology, which not only promotes sustainable economic growth, but helps the environment and the populace in the long-term.

AN INFORMATIVE MEET

The conference brought together a global network of professionals, experts, IT managers and other industry leaders, who shared in-depth information in a full-day plenary session, with three tracks for delegates to discuss relevant problems and solutions on Green technology.

Deputy Prime Minister Tan Sri Dato' Muhyiddin Yassin gave the keynote address, highlighting the environmental challenges that have dramatically impacted the lives of many, and how governments worldwide are working towards mitigating the effects of climate change.

In addition to the IGEM Conference, there was also the Green Insight series of seminars and workshops, designed to educate and update delegates and other

Left: *Deputy Prime Minister Tan Sri Dato' Muhyiddin Yassin delivered the keynote address during the IGEM Conference.*

Below: *The IGEM exhibition featured plenty of interesting concepts and models that promote Green and eco-friendly ideas, such as electric cars.*

participants on Green technology and ongoing initiatives to implement it. Topics ranged from developing an integrated and sustainable waste management system, to energy-demand management.

TNB also participated in this session, leading discussions on topics such as the *Development of Innovative Slope Protection Systems Using Recycled Or Environmentally Friendly Materials, Photovoltaic Energy Forecasting – Towards Reliable Utilisation of Photovoltaic Power Plants* and *Future Energy Generation Using Green Technologies*.

INSIGHTFUL EXHIBITIONS

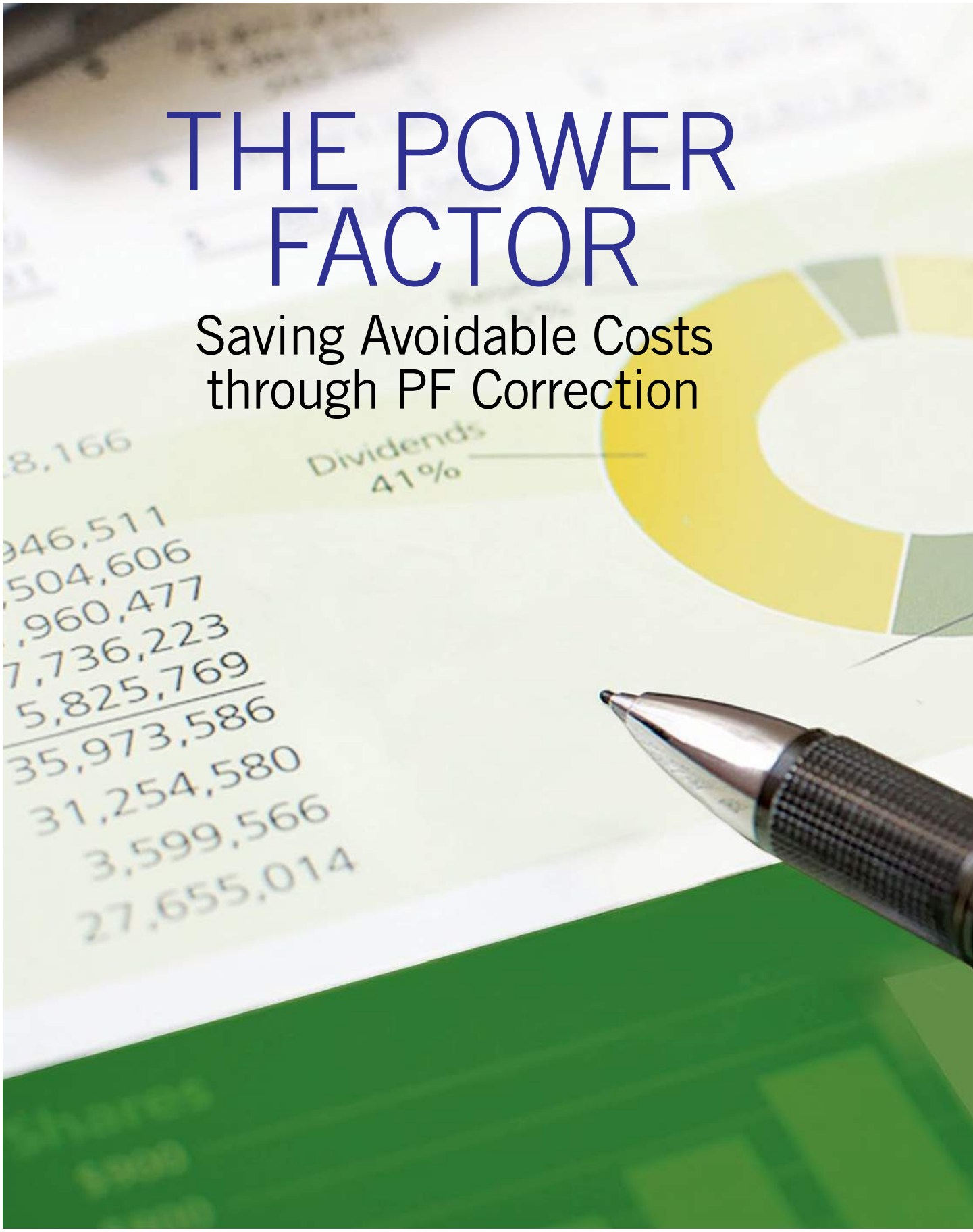
This year's instalment of IGEM served as a platform to showcase Green technology, eco-products and services – enabling delegates to forge partnerships and explore opportunities for trade, investment and collaboration. There were exhibitors from various industries, including logistics, transportation, agriculture, construction, waste management and energy.

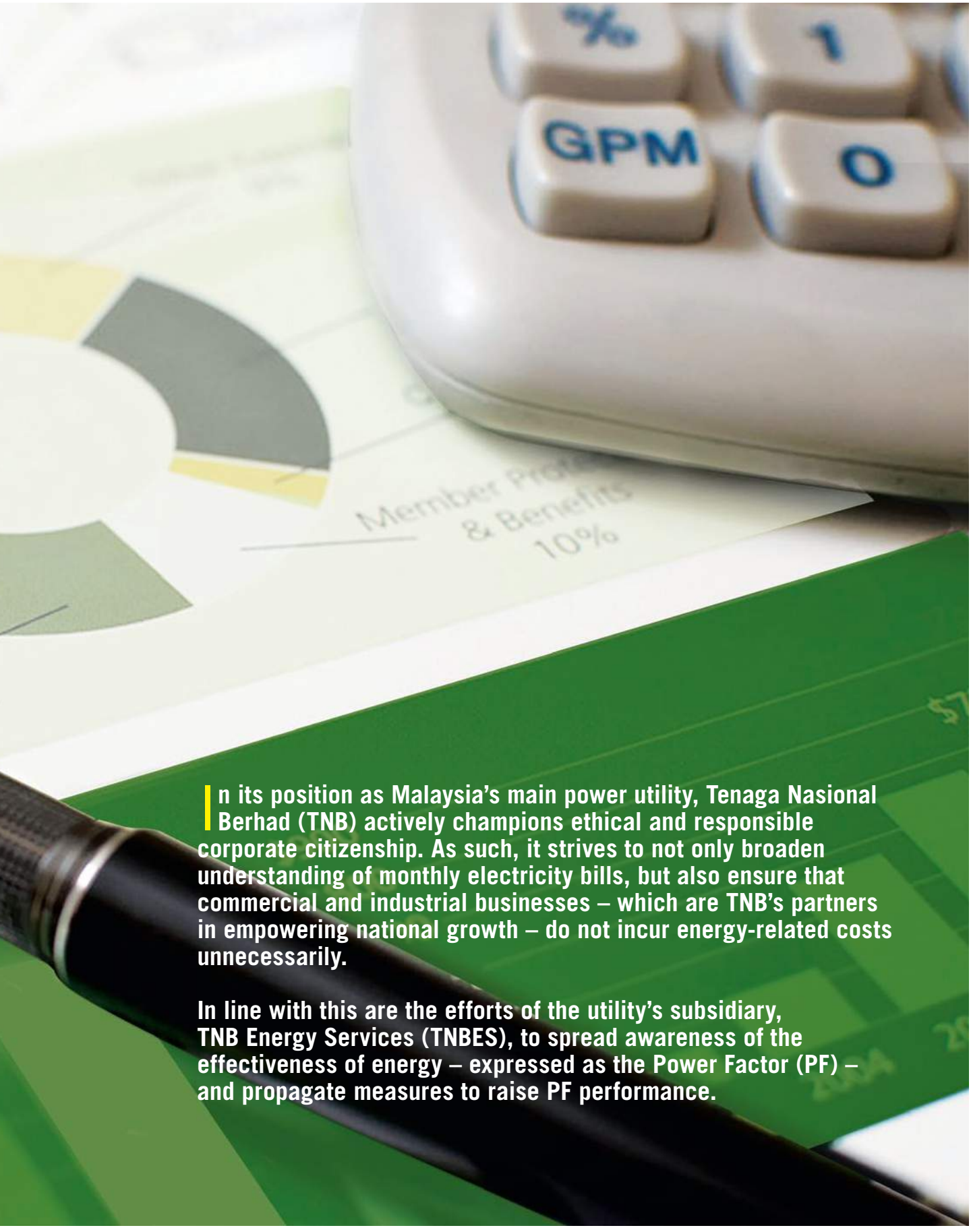
The event also featured a large spectrum of exhibits, which ranged from dedicated products such as Toyota's hybrid cars, to concepts such as Panasonic's EcoHome. There were also pavilions dedicated to countries such as Germany, Taiwan and Korea. Meanwhile, TNB's booth focused on electric transportation and other systems inspired by the concept of smart living, with an electric car featured as one of the highlights at the booth.

Other attractions at IGEM included business matching, business consultation and networking sessions, as well as the KeTTHA Industry Awards dinner, where outstanding Malaysia-based energy, Green technology and water industries were honoured. With the support of partners such as TNB, IGEM 2014 was a successful venture, generating over RM1 billion worth of business deals, and helping to drive the growth of the Green technology sector in Malaysia and the world.

THE POWER FACTOR

Saving Avoidable Costs through PF Correction

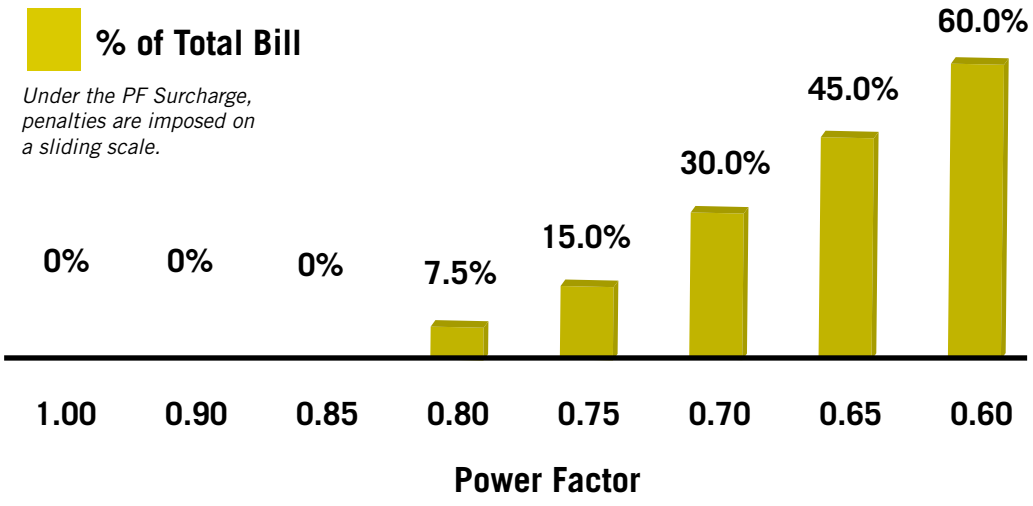




In its position as Malaysia's main power utility, Tenaga Nasional Berhad (TNB) actively champions ethical and responsible corporate citizenship. As such, it strives to not only broaden understanding of monthly electricity bills, but also ensure that commercial and industrial businesses – which are TNB's partners in empowering national growth – do not incur energy-related costs unnecessarily.

In line with this are the efforts of the utility's subsidiary, TNB Energy Services (TNBES), to spread awareness of the effectiveness of energy – expressed as the Power Factor (PF) – and propagate measures to raise PF performance.

LOW POWER FACTOR'S IMPACT ON BILL



STRIKING A BALANCE

To adequately explain the concept of PF, it is essential to first understand that electrical devices – such as motors, air conditioners and refrigerators – inherently require both active or 'real' power (which is measured in kW on monthly electricity bills), and reactive power (which is measured in kVAr).

As explained by TNBES Head of Engineering & Consultancy Services Ir Hamdan Ali, the reactive power requirement of each piece of equipment – especially that used in an industrial setting – is clearly indicated on its faceplate. "By paying closer attention to the reactive power needs of all machinery, company technicians can generally determine the PF at each facility," he states, adding, "Of course, they can also refer to their TNB bill to know the exact PF for the preceding month."

This is an important consideration for both the power utility as well as its commercial and industrial customers, because large and unmitigated reactive power demands place an additional and unnecessary strain on electrical transmission and distribution systems at all levels. Not only does this degrade the efficiency and reliability of power supply, it can also potentially result in increased operational and overall energy costs.

Below: *Induction motors can be found in many household appliances, including fans, air conditioners, refrigerators, vacuum cleaners and even computers. This equipment requires reactive power in order to operate – and this energy is supplied by TNB along the national grid, alongside active power.*

SEIZING THE CHALLENGE

As a necessary core component of power, it is essential that the reactive power requirements of devices and facilities are met. The reactive power is supplied by TNB, along with active power through national transmission and distribution networks. However, this has consequently led to a number of complications and difficulties with significant and wide-ranging impact.

"Primarily, the transmission of reactive power occupies vital network capacity that might otherwise be utilised to supply customers with active power," notes Ir Hamdan. The most common method to overcome this is by generating additional power to compensate for the compromise in capacity.

Even so, this strategy has its own shortcomings, requiring the establishment of additional generation facilities and the essential supporting infrastructure, as well as increasing the overall volume of power that is supplied through the national grid. As a result of these issues, not only is it necessary to consume greater amounts of energy resources, but the cost of grid maintenance is raised as well. When viewed together, it is clear that these increases in component costs may also give rise to higher overall energy costs in the long term.

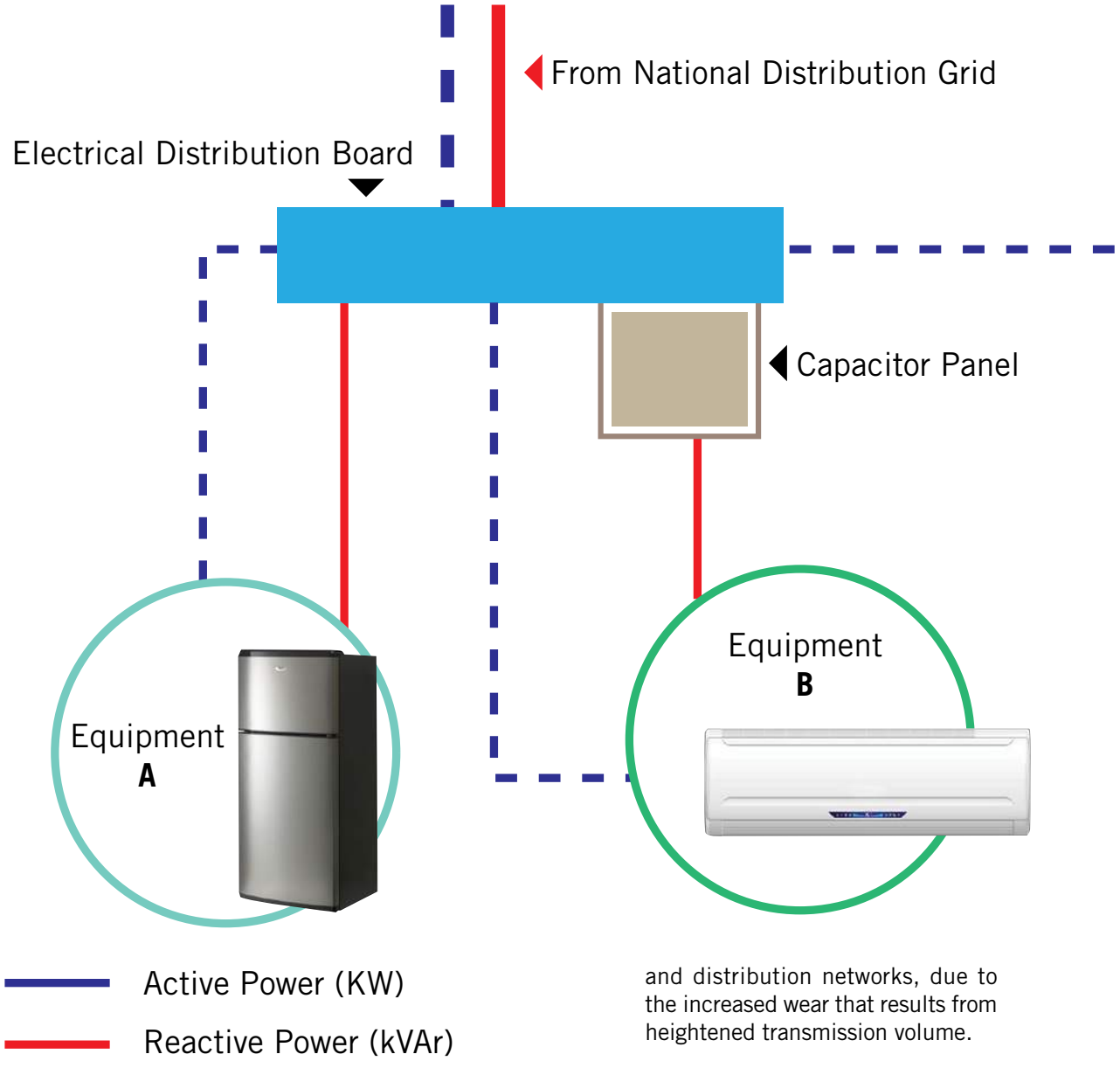
SHARING RESPONSIBILITY

The National Electricity Board (NEB), or Lembaga Lektrik Negara (LLN), introduced the PF Surcharge when the installation of kVAr meters in commercial and industrial facilities enabled the measurement of reactive power consumption. In general terms, PF is measured on a scale ranging from 0 to 1, and the PF Surcharge is a form of penalty that imposes additional costs on customers that have a PF of below 0.85 (or 0.9 for High Voltage Customers), through their monthly electricity bills.

"Aside from improving PF performance, those of our clients that have undertaken modifications to their equipment, have also reported better voltage stability – which can be crucial in companies with highly sensitive equipment."

– TNBES Head of Engineering & Consultancy Services Ir Hamdan Ali

HOW POWER FACTOR CORRECTION WORKS

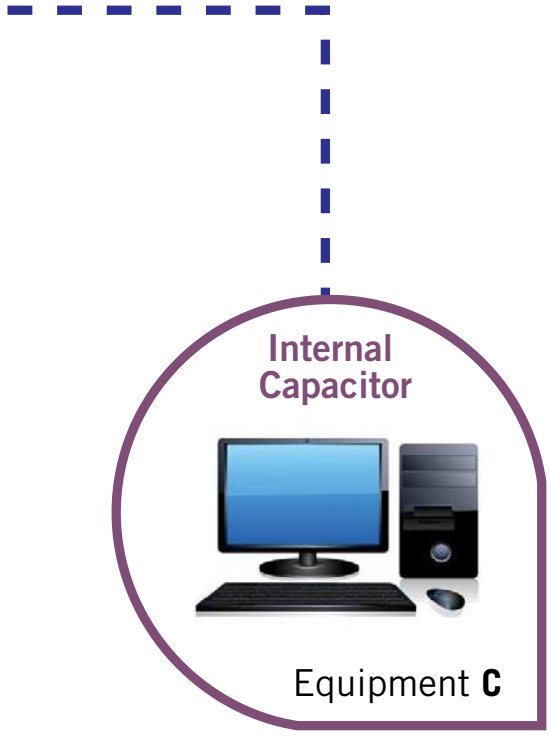


Depending on the variance in PF at each facility, business operators may face significant but avoidable costs due to this mechanism. As a result of the PF Surcharge, companies may be facing monthly energy surcharge costs that could potentially amount to as much as 120% of their monthly bill.

These penalties have been essential to recovering power loss in the networks, and also the cost of additional investment that is made to meet the reactive power needs of energy consumers with a low PF, such as additional generation capacity and the installation of capacitor banks at strategic locations throughout the national grid. Aside from this, the funds raised through the surcharge have also helped offset the cost of repairs, maintenance and replacements that are carried out on the national transmission and distribution networks, due to the increased wear that results from heightened transmission volume.

OPTIMISING PERFORMANCE

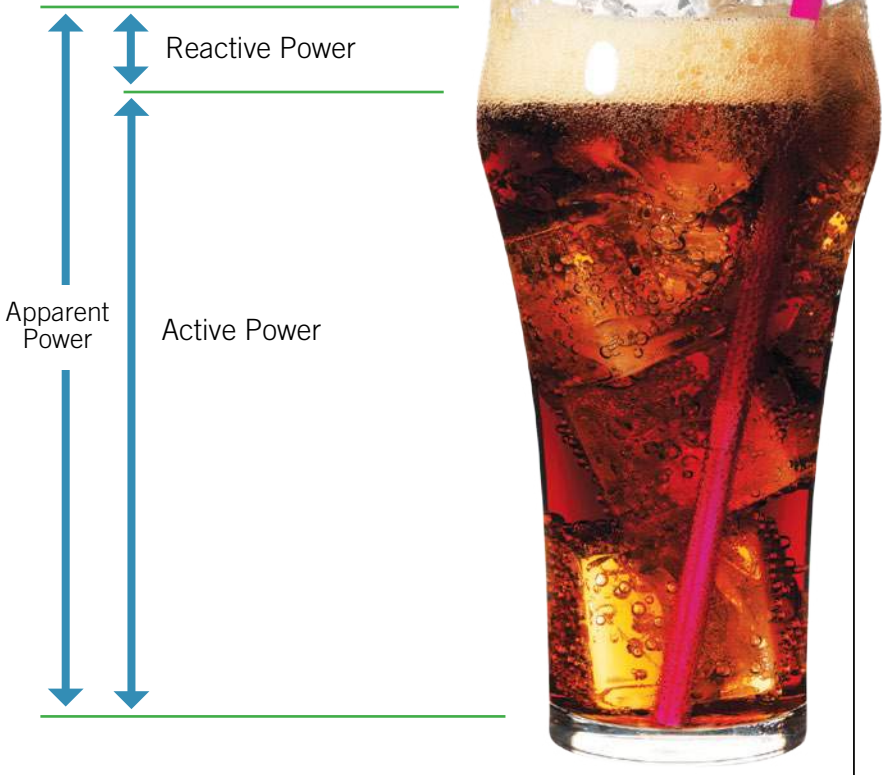
Raising PF performance not only eliminates the need for energy customers to incur unnecessary additional costs due to the PF Surcharge, but also results in important benefits for TNB and the nation – improving asset utilisation and enhancing energy efficiency (EE) at the national grid level by reducing generation wastage. As such, TNBES has developed the capability to provide consultation



Left: *This graphical illustration shows three methods to supply equipment with the reactive power necessary. Equipment A utilises the conventional approach, where all reactive power needs are supplied by the national grid. Equipment B demonstrates the use of a capacitor panel, which produces all the reactive power required locally. Equipment C has been fitted with internal capacitors, meaning that it only needs to draw active power – thus improving the efficiency of facility-level electrical distribution.*

Below: *Like the layer of froth in a glass of soda, reactive power is an essential and unavoidable element of overall power flow. Similarly, high demand for reactive power can occupy network capacity that is better spent on the transmission of active power.*

UNDERSTANDING REACTIVE POWER



and suggest solutions suited to facilities of varying sizes and complexity.

The subsidiary offers to conduct in-depth studies of customer facilities and recommend the installation of a tailored capacitor panel which produces the necessary reactive power locally. Following a site survey, a load profile and an analysis of the resulting data, the ideal capacitor panel is designed and a cost-benefit analysis is also carried out for the project.

After the equipment is installed and commissioned at a customer's premises, it is continuously

Power Factor Correction at a Glance

Capacitor Panel

Power factor correction is a voluntary procedure that the operators of commercial and industrial facilities should consider undertaking, in order to reduce unnecessary potential energy costs while also improving the efficiency of their internal electrical distribution system. At present, TNB has taken the initiative to supply all reactive power needs, through the establishment of capacitor banks at strategic locations throughout the national distribution grid.

However, installing and maintaining these additional instruments has increased operational costs for the energy provider, prompting it to impose a Power Factor Surcharge, in order to encourage consumers to improve the power factor at their facility. This can be achieved through the installation of tailored capacitor panels at the premises of energy users, or through the modification of equipment to integrate capacitors internally. These expert services are readily available from the utility's subsidiary TNB Energy Services (TNBES).

In addition to enabling facility operators to avoid unnecessary energy costs associated with the Power Factor Surcharge, these measures also have the potential to significantly improve the efficiency and effectiveness of premise-level electrical systems, by removing the need to distribute reactive power.

monitored to measure the improvement in PF performance. Aside from that, the panels supplied also carry a one-year warranty, during which TNBES staff will repair or maintain the device in the event of any malfunction, at no additional cost to the customer.

TNBES can also comprehensively analyse all customers' machinery that operates with a low PF, in order to conduct targeted modifications that integrate capacitors within the machine itself. This approach has the added benefit of preventing the facility's transmission capacity from being taken up by reactive power. As a result, customers may be able to realise additional savings through the utilisation of more optimal electrical cables and switchgear, as well as reduced repair, maintenance and replacement of existing equipment.

As Malaysia proceeds along its path of rapid development, demand for the supply of energy continues to expand as well. In addition to ensuring the availability and security of energy resources, measures such as Power Factor optimisation demonstrate significant and achievable benefits, in terms of guaranteeing the efficiency and effectiveness of national transmission and distribution systems, as well as the affordability of the energy provided, for companies in all sectors of the economy.

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Cable Jointer Level 1	Cable Jointer Level 2	Cable Jointer Level 3	Shielded Metal Arc Welding (SMAW-3G)
9 - 24 Apr	18 - 19 May	3 - 14 Aug	9 - 13 Mar
Shielded Metal Arc Welding (1 F Position)	International Combustion Engine (ICE) Driver Grade 1	International Combustion Engine (ICE) Driver Grade 2	Steam Driver Grade 1
13 - 17 Apr	9 - 12 Mar 13 - 16 Oct 3 - 6 Nov 1 - 4 Dec	12 - 15 Jan 16 - 19 Mar 3 - 6 Aug 24 - 27 Nov	9 - 12 Mar 29 Sept - 2 Oct 27 - 30 Oct 24 - 27 Nov
Steam Driver Grade 2	Building Maintenance Management	Building Defects & Maintenance Planning	General Building Maintenance Planning (Lighting & Air Condition)
6 - 9 Apr 11 - 14 May 8 - 11 Sept 10 - 13 Nov	2 - 3 Mar	12 - 15 Jan	8 - 11 Jun
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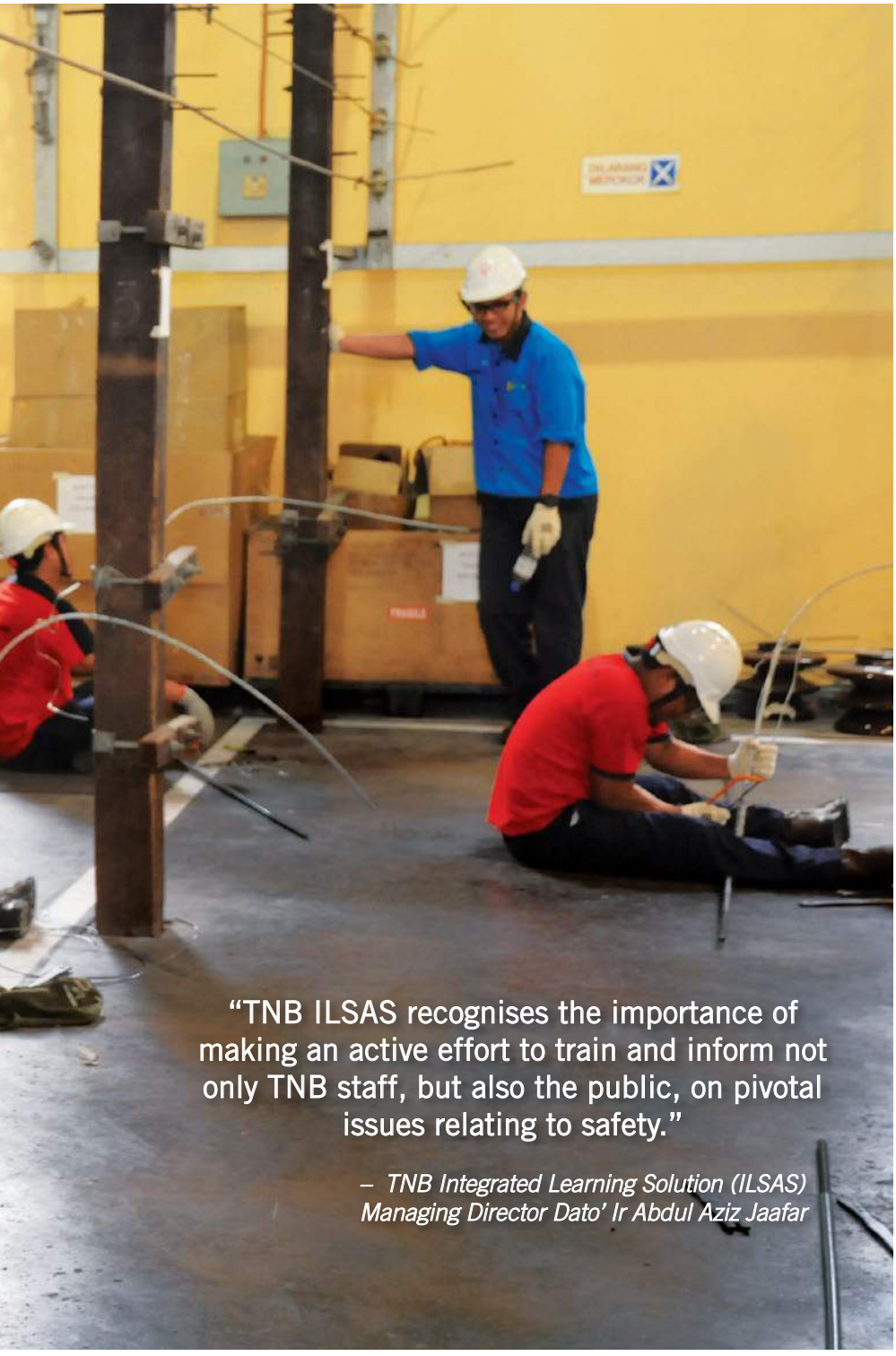


Not only has Tenaga Nasional Berhad (TNB) established its dominance as the main power utility in Malaysia with an estimated 8.5 million customers, but the company's technical reach has also extended beyond national borders to include countries such as Indonesia, India, Pakistan, Saudi Arabia and Kuwait. In light of this, it is no surprise that TNB places huge emphasis on ensuring that its workforce of over 35,000 individuals remains equipped with the latest and most up-to-date expertise and competence.

To meet this objective, the utility's wholly-owned subsidiary TNB Integrated Learning Solution (ILSAS) was created to provide expert and professional training, and relevant services that are tailored to the needs of the utility as well as the industry as a whole.

CENTRE OF EXCELLENCE

As explained by its Managing Director, Dato' Ir Abdul Aziz Jaafar, TNB ILSAS was first established in 1978 as a training centre for the utility. "Through this facility, TNB has been able to effectively improve not only the knowledge but also the technical, management and leadership competencies of its employees," he notes, adding, "Of course, this is paramount because of the important safety precautions that must be maintained, in order to ensure the safety of not just our staff, but also the millions of TNB customers."

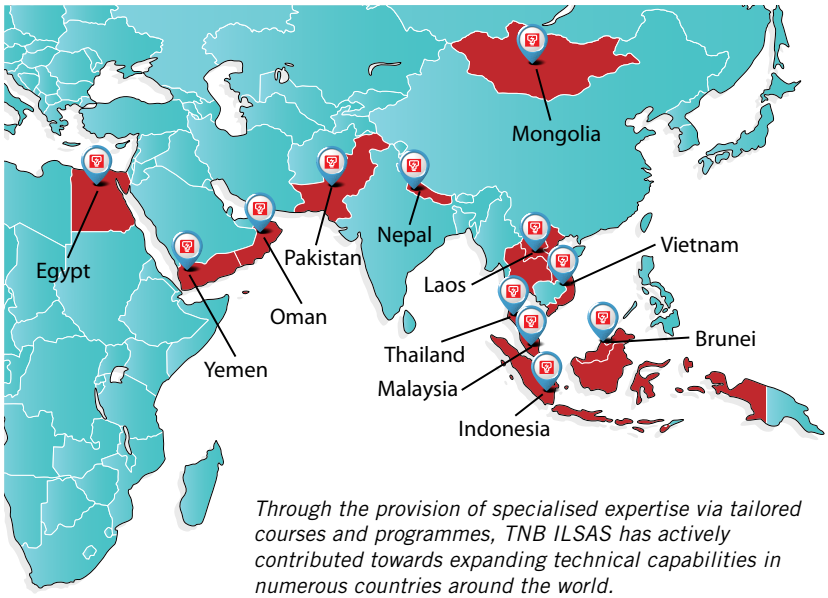
TNB ILSAS has over 250 members, with more than half that number comprising full-time teaching staff who possess between 10 to 20 years of practical experience.

Initially, the core programmes offered at TNB ILSAS related to the technical aspects that are involved in the distribution, transmission and generation of electricity. Following this, a number of additional programmes that are relevant to a range of other industries were also offered. These programmes are open to the public, encompassing courses for chargemen and cable jointers.

At present, a total of over 600 specialised courses are conducted at TNB ILSAS each year. While the majority of these programmes are tailored towards the technical competencies required by TNB's internal staff, there are also approximately 100 courses that are oriented towards character building, management, leadership and supervisory skills, which have a far wider application as well.

RAISING THE GAME

Aside from expanding the scope of training programmes available, courses and facilities at TNB ILSAS are also constantly modified and enhanced, in order to stay current with the latest technological and regulatory developments. "Our modules are continuously revised to maintain relevance with the requirements of TNB staff as well as the latest global industry standards. This helps us to continuously ensure that participants are knowledgeable,



Through the provision of specialised expertise via tailored courses and programmes, TNB ILSAS has actively contributed towards expanding technical capabilities in numerous countries around the world.

technically competent and capable of carrying out their functions efficiently and effectively," reveals the Managing Director.

Recently, the centre has also become the first in Malaysia that provides courses on condition-based maintenance – an emerging standard that is in use by TNB and now being adopted by an increasing number of utility operators around the world. "In contrast with conventional practices such as preventive and quality maintenance, condition-based maintenance allows operators to accurately predict when various elements of the electrical system are expected to fail, enabling them to effectively plan and conduct maintenance and repair work in advance of such incidents, thus reducing breakdowns and other avoidable occurrences," explains Dato' Ir Abdul Aziz.

INTERNATIONAL RELEVANCE

In addition, TNB ILSAS has also been active on the world stage, having provided training to industry professionals from a total of 24 countries since its establishment. To facilitate these efforts, the centre has contributed to a number of relevant multi-lateral cooperative forums as well.

"Every factory, shopping complex, or similar facility requires a dedicated sub-station and Malaysia alone has more than 60,000 of them, meaning that there is a clear imperative to inculcate essential competencies and capabilities through effective and accessible training programmes."

– TNB Integrated Learning Solution (ILSAS) Managing Director Dato' Ir Abdul Aziz Jaafar

Pursuing Greater Heights

One chargeman candidate currently acquiring qualification at TNB ILSAS is Mohd Ehfaruzi Mohd Rashid, a 10-year veteran in the field. In spite of his experience, he has found that technical and professional improvement is crucial to ensuring continued career advancement in the industry.

"I believe that opportunities to develop yourself professionally do not come along often, and so I resigned from my previous job to pursue the B0 chargeman course offered at TNB ILSAS," explains Mohd Ehfaruzi, adding, "For qualified personnel, job opportunities are readily available in the market. The only obstacle is acquiring the right technical capabilities and qualifications to be employable – which ILSAS provides."

Supplying Skills

Considering the prevalence of electrical installations in modern society, it is clear that there is a widespread need for individuals who are equipped with the relevant and essential competencies and capabilities needed to effectively operate and manage such systems. In Malaysia, these requirements have also been set out in the *Electricity Supply Act 1990* and regulations such as the *Electricity Regulations 1994*.

"To meet these needs, TNB Integrated Learning Solution (ILSAS) has been certified as a training provider in Malaysia, for all chargeman courses under the A0, A1, A4, B0, B1 and B4 categories and all cable jointer courses under the PK1, PK2 and PK3 categories – all of which relate to low and high voltage works," reveals Managing Director Dato' Ir Abdul Aziz Jaafar. The six programmes are available exclusively at TNB ILSAS due to the strict regulatory requirements involved.

Specifically, chargemen are responsible for the operation of electricity supply, as well as all activities relating to the inspection, testing and maintenance of all components and connections in the local electrical system. Meanwhile, cable jointers have expertise that enables them to establish facility-level networks and connect them to the nationwide distribution system, making them valuable not only to TNB, but also to companies in the manufacturing and oil and gas sectors.

In accordance with regulations issued by the Energy Commission of Malaysia, candidates for each chargeman and cable jointer course must first have at least three years of experience working in the electrical installation environment, as well as the relevant certification for the level completed before that. Admissions at TNB ILSAS take place yearly during October and November, with training being conducted in March the following year.

Meeting the Need

Category of Customer	Number of Customers	Estimated Number of Competent Persons Required	
			Number
132kV and above	79	x3	237
6.6kV - 66kV	6,449	x2	12,898
LV (Large Power Customers)	85,758	x1	85,758
LV (Domestic & Commercial)	8,347,000	250 @ 1	33,380
Utility and Service Sector			15,000
Total			147,270
Number of Competency Certificates Issued			101,240
Shortfall			**(46,033)**

Source: The Energy Commission of Malaysia

In light of Malaysia's strict regulations regarding the certification of electricians, it is evident that TNB ILSAS plays a pivotal and crucial role not just for the utility, but for the industrial and commercial sectors as well.

Under the centre's B1 chargeman programme, participants are taught to carry out stay-splicing, as part of the process of installing high voltage overhead lines.

One such example is the Malaysian Technical Cooperation Programme (MTCP) operated by the Ministry of Foreign Affairs, through which TNB ILSAS recently provided training to 23 participants from 15 countries, including those in ASEAN, the Middle East, Africa and the Pacific. Apart from this, the centre also recently trained personnel from Vietnam Electricity (EVN) – which is Vietnam's largest energy utility – as well as oil and gas operators in Brunei, through the Heads of ASEAN Power Utilities and Authorities (HAPUA) Council.

Apart from these institutional collaborations, the centre also recently conducted training for engineers from the Muscat Electrical Distribution Company (MEDC) in Oman, to enable them to manage a Supervisory Control and Data Acquisition (SCADA) industrial control system which remotely monitors and operates facilities and other infrastructure.

Meanwhile, courses on the safe and reliable application of electricity also continue to prove attractive among international policymakers and domestic industry operators alike.

With the rapid technological advancements around the world, global demand for highly qualified individuals with specialised expertise required to work in an electrical installation environment continues to grow. Through its concerted efforts in training and development, not only is TNB ILSAS ensuring that its parent utility continues to be staffed by the most competent personnel available, but also that the superior skill and competency training offered remains accessible to its industrial customers across the globe.

MICROALGAE, MACRO IMPACT

TNB Research uses microalgae to provide solutions to CO_2 emissions in power plants

For anyone who has ever owned a fishpond, algae ranks as a constant source of irritation. These fast-growing, simple plants turn crystal clear waters into a murky green in very short order and, aside from ruining the appearance of the pond, they deoxygenise the water resulting in the death of the fish. However, algae – in particular microalgae – also hold much promise as a source of food and fuel, and presently, a number of research organisations are carrying out experiments on how to best harvest these properties.

Among them is TNB Research (TNBR) – the R&D arm of Tenaga Nasional Berhad (TNB) – which has placed the study and utilisation of microalgae under its Emission and Waste Management Technology Group. TENAGALINK spoke to Muhammad Nazry Chik – the group's principal researcher – to find out more about how microalgae may hold the key to solving the problem of CO_2 production during the generation of electricity.

A TEAM WITH A MISSION

Identified as a major cause of the greenhouse effect, which results in the rising of temperatures in the atmosphere thus leading to global warming, CO_2 reduction has become a major mission for many, and TNB is no different.

According to Nazry, research into microalgae (or phycology, as it is properly known) has been ongoing in several Malaysian universities, owing to the versatility of the plant. At TNBR, the focus is on utilising microalgae to reduce CO_2 emission levels, which is in line with TNB's long-term mission to enhance sustainability in the generation, transmission and distribution of electricity.

Elaborating on the project, he explained, "This is a biological alternative to current Carbon Capture and Storage (CCS) technologies. Our inspiration is the natural process of photosynthesis, where plants absorb CO_2 and convert it into carbohydrate and oxygen compounds."

Of course, before any research work could be carried out, a team had to be formed. Those selected were Nazry (himself a mechanical engineer), biotech engineer Liyana Yahya, chemical engineer Irina Harun and technician Mohd Asyraf. According to the group's principal researcher, the talent and experience that each individual member brings to the table is of extreme importance.

This is because the study and utilisation of microalgae require a mix of knowledge that touches upon the fields of biology and chemistry, in the first instance, and the creation of the right apparatus with which to process it. This is where mechanical engineering – the expertise of Nazry and Asyraf comes in.

REACHING MILESTONES

Having started in 2011, the initial period was spent collecting samples of various types of local algae and establishing which one had the best carbon fixation property. This is in order to find the type of algae which will provide the best value for the least amount of source material. Working around the area of the TNB Janamanjung power plant, which is where the pilot bioreactor is to be located, the team shortlisted several species of algae – namely *Tetraselmis sp, Nannochloropsis sp* and *Isochrysis sp*.

Further studies were carried out to determine the CO_2 fixation rate of these different species, with *Isochrysis* showing the most promising results at 1.47 g/day, through its initial project. In other words, 1 gram of this particular microalga will absorb 1.47 grams of CO_2 per day. Other endeavours have been planned to further improve this rate, which among others, will look into areas like culture parameters, nutritent improvement and gas transfer rate.

For Nazry, the successful identification of an ideal species is one of the key milestones of the project. It was also extremely fortuitous that, given the almost hundreds of thousands of different species of microalgae around, this one is readily found near the Janamanjung power plant, thus making it an ideal feedstock for the pilot bioreactor.

Before the pilot bioreactor – which is expected to be operational in December 2014 this year – could be built, the team had to first create a similar mechanism, on a smaller scale. A lab-scale photo bioreactor was set up and is currently in operation at the TNBR headquarters in Bangi. This fully-functional apparatus is used by the research team to carry out experiments which can then be scaled up in the future.

A comprehensive research programme has been devised by the team, until the year 2020, targeting some pertinent issues and areas in this field to be resolved and improved. To this, strategic collaboration and co-operation between government and its agencies, as well as local universities have been identified and welcomed.

GOING BEYOND POWER

The importance of successful large-scale trials of the photo

Right: *Muhammad Nazry Chik – principal researcher of TNB Research's Emission and Waste Management Technology Group – in front of the pilot bioreactor where algae is used to remove CO_2 from water.*

bioreactor in Janamanjung cannot be overestimated, as the emission of CO_2 during the process of generating electricity is one of the major concerns for operators of power plants that use fossil fuel such as coal.

In the case of the coal-fired Janamanjung plant, it already uses clean coal technology, which significantly reduces CO_2 emissions. Paired with the microalgae bioreactor, it promises to eliminate further carbon pollutants into the air, through an alternative biological approach. If the project is successful, TNB shall possess competitive knowledge and expertise in this biological approach, apart from other CCS technologies like gasification and amine-absorption, which are equally and simultaneously pursued at TNBR.

The study however is still new and it will take some time before conclusive results will be reached. But it is definitely a step in the right direction, and a timely one too. This is because the setting up of the photo bioreactor at Janamanjung is done in anticipation of changes to current government policy.

Presently, CO_2 emissions are not considered pollutants according to Malaysian law. In view of current international trends though, Malaysia may soon fall in line with many other developing and developed countries, and thus CCS technology such as this will be a must-have.

Aside from this aspect, the spin-off from this photosynthesis process can offer other beneficial and valuable bio-products, to the likes of biodiesel, animal feed for animals, and even pharmaceutical products. These provide opportunity for TNB to champion and practice a branch of sustainable development initiative, through a peculiar waste management strategy, called Industrial Ecology, where one industry's waste becomes a commodity to others.

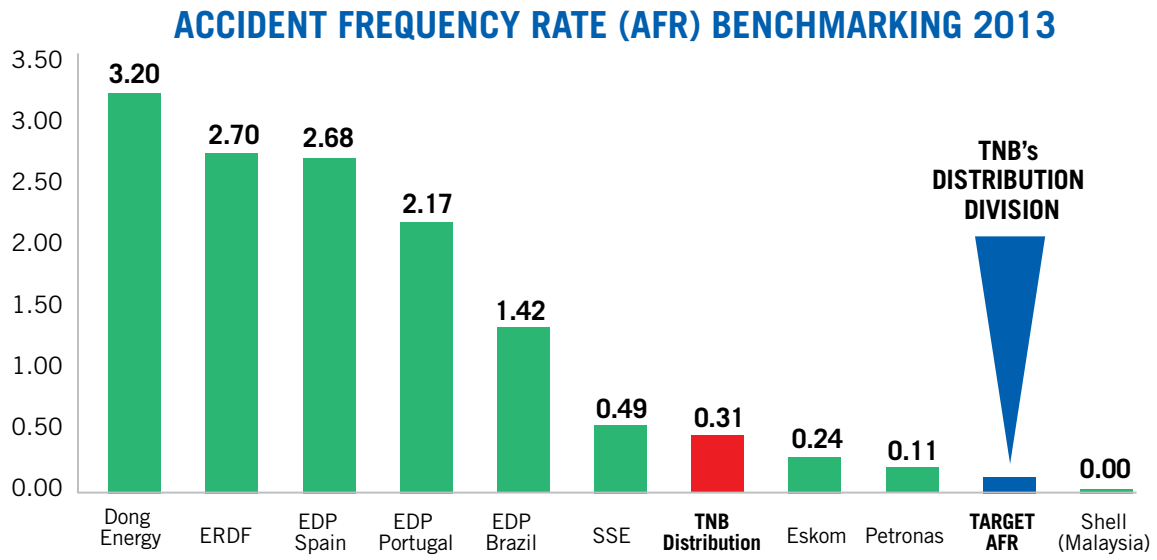
Above: *Members of the Emission and Waste Management Technology Group collecting algae for their research.*

Through TNBR, TNB has committed approximately RM3 million to conduct R&D on microalgae. This is minuscule compared to the huge advantages that are in store, which are manifested in the form of lesser pollution in the atmosphere, through a more natural and sustainable means.

ENSURING SAFETY

The Quest to Raise Safety Standards

Aside from enabling the consistency and reliability of electrical supply, guaranteeing the safety and security of operations is paramount to Tenaga Nasional Berhad (TNB), as it minimises avoidable accidents that can be detrimental to TNB staff and contractors, as well as the customers served by the utility. In this special feature, TENAGALINK explores the role played by TNB's Occupational Safety, Health and Environment (OSHE) Unit, in creating exemplary standards that can be emulated by industry players at all levels.



First created in 1995, the OSHE Unit – which is a part of TNB's Asset Management Department and is placed under the direct supervision of the utility's Vice President of Distribution – has undergone a number of evolutions since its formation. The Unit completed its latest transformation in 2012, acquiring its current name and expanding in function to encompass environmental considerations.

This was in addition to its existing responsibilities of ensuring proper job performance among TNB staff and the contractors employed by the utility, as well as the responsible management and disposal of scheduled waste products resulting from regular operations. Among these are potentially hazardous waste items, including used transformer oil and retired electricity meters, as well as spent street-light lanterns and light bulbs.

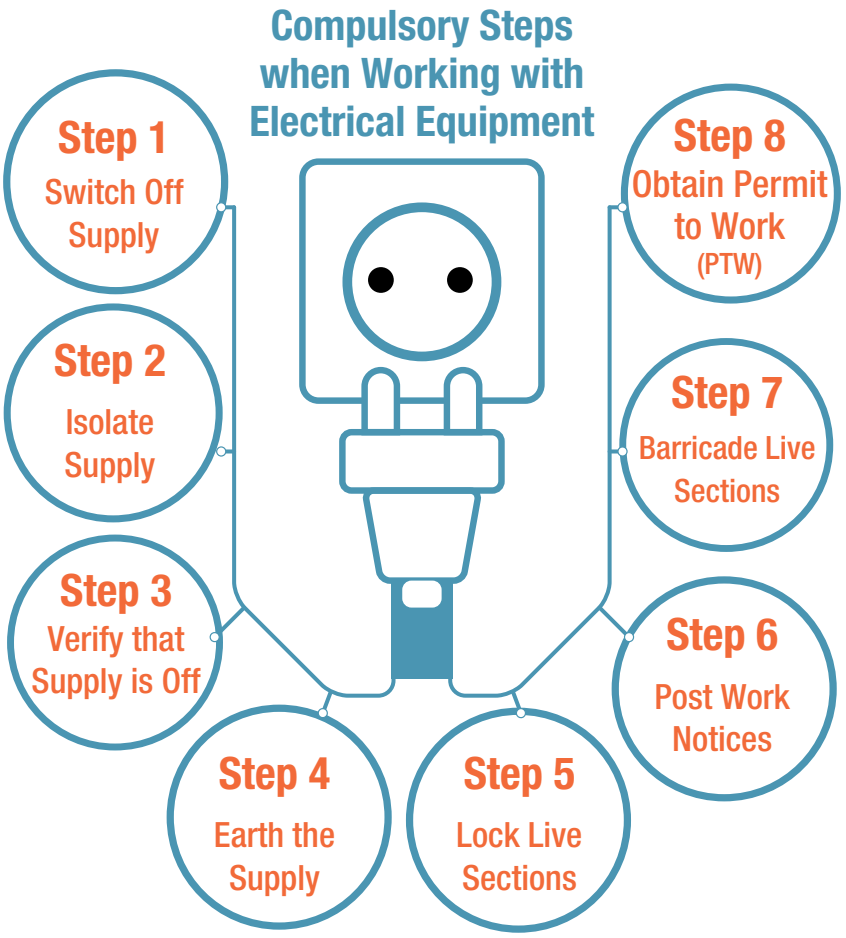
Additionally, the OSHE Unit has recently developed circulars relating to the handling of scheduled waste items and the

relevant Enterprise Resource Planning (ERP) measures that should be taken. This reflects TNB's increasing emphasis on compliance with safety standards as it expands globally – which is pivotal for the utility to secure investor interest – through the demonstration of improved safety performance and a reduced accident rate.

INSTITUTING IMPROVEMENT

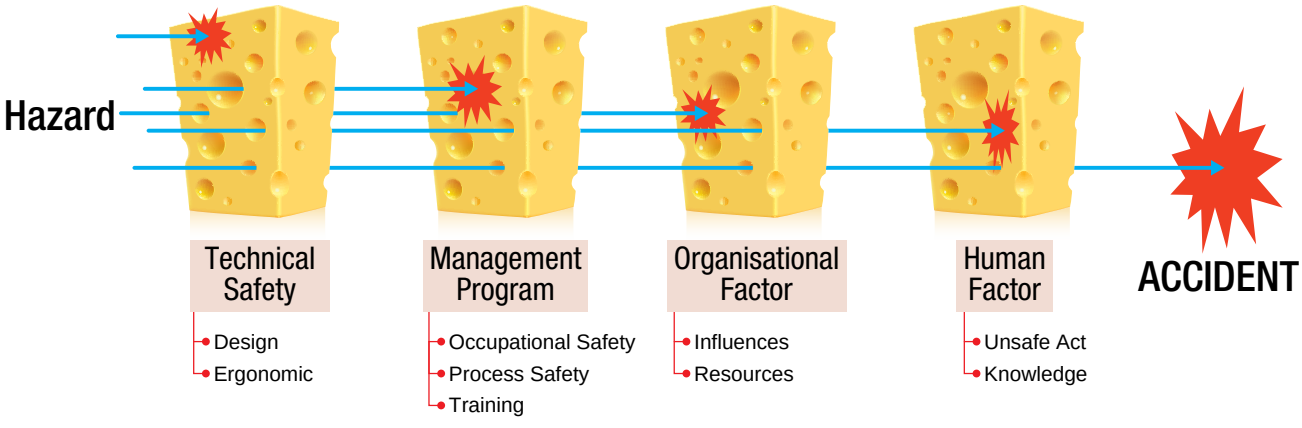
Considering that an estimated 85% of accidents occur due to behavioural factors, the OSHE Unit has also spearheaded TNB's efforts to develop its own Safety Quality Audit (SQA) system. This sets the requirement for Safety & Health Officers at the local level of TNB management – who are certified by the Department of Occupational Safety and Health (DOSH) – to undertake regular Safety Compliance Audits (SCAs) at the utility's facilities nationwide.

Most recently, the Unit has also developed and instituted the country's first programme to enforce protocols that relate to operational safety. Introduced in December 2013 as a pilot project in the state of Perak, the programme calls for the issuance of warnings when hazards uncovered during SCAs remain unresolved. Following the first warning, the proficiency certificate of the electrical practitioner responsible



Safety Cheese Model

Making a workplace safer requires taking into account many different factors, illustrated here as a series of "Swiss cheese" barriers. The cheese holes represent weaknesses in the system, which fails when all the holes in each slice align and allow a hazard to go through.

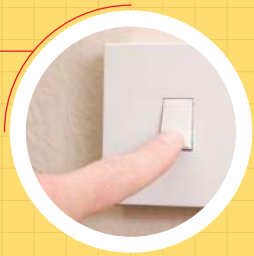


Practicing Electrical Safety

At the Office

- **Damaged** and **exposed wiring** can **cause accidents**
- **Wiring extensions** must be carried out by an **authorised practitioner**
- **Never** attempt to **connect two power outlets**

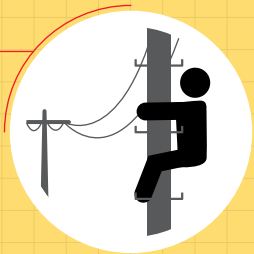
- **Never** attempt to **handle damaged** or **frayed wiring** without first **disconnecting** the **power source**
- **Never** attempt to **connect wiring** to a **two-way** lighting switch
- Always **ensure** that **lighting** is **switched off before changing light bulbs**



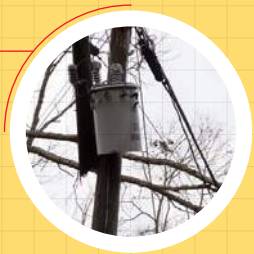
- **Never** place or attempt to **operate electrical** appliances **near water**

In Industrial Areas

- **Never install** appliances or equipment **beneath electrical lines**
- Always **consult TNB** for guidance relating to **underground cables** before undertaking **excavations**
- **Never** undertake **excavations** near electrical **towers**



- **Never** attempt to **climb electrical poles** for any reason
- Practice additional **precautions** when working **near electrical connections**
- **Notify TNB** when **tree branches** come into contact with **electrical lines**



- **Avoid parking** vehicles beneath **electrical lines**
- **Never touch** anything near fallen **electrical lines** and contact the nearest TNB office immediately
- **Never** attempt to **retrieve** objects that are **hanging** on **electrical lines** and contact the nearest TNB office immediately

is suspended when a subsequent infringement is recorded.

After the third incident, the culpable parties are issued a summons to appear before the disciplinary committee at TNB headquarters in Kuala Lumpur. Aside from this, in the event that investigations into accidents reveal the cause to be a breach of safety protocols, a disciplinary summons is immediately issued. While warnings have been issued since the initial stage of its introduction, the programme entered its second phase in the middle of 2014, signalling that summonses would begin to be issued as well.

The enforcement programme instituted by the OSHE Unit is set to be applied throughout the scope of works carried out by TNB's Distribution Division. Not only does this pave the way for significant improvements to the performance of electrical practitioners and their compliance with essential safety procedures, it also sets a clear example that can be adopted by LPCs, for the benefit of energy consumers at all levels and national development as a whole.

UNDERSTANDING ELECTRICITY

Energy Efficiency and Energy Saving Devices

Contributed by Ir Dr Mohamed Fuad Faisal, Power Quality & Energy Efficiency Specialist, Asset Management Department, Distribution Division of TNB

Before electricity became available in Malaysia over 65 years ago, houses were lit with kerosene lamps, food was cooked by wood-burning or coal-burning stoves and clothes were manually washed. There was no electrical lighting, rice cookers or washing machines. Now, many use electricity to make their personal lives more comfortable, from lighting, heating and cooling our homes, to powering our televisions and computers. Today, a number of cars are designed to work on electricity. Despite its great importance, few stop to think what life would be like without electricity. Like air and water, we tend to take electricity for granted.

Electricity is the flow of electrical power or charge and is a secondary energy source, also referred to as an energy carrier. This means that we get electricity from the conversion of other sources of energy – such as coal, nuclear, or solar energy – called primary sources. The energy sources we use to make electricity can be renewable or non-renewable, but electricity itself is neither renewable nor non-renewable.

Electric power is generated (partially) – from hydro, gas, coal and petroleum – transmitted and distributed to customers by Tenaga Nasional Berhad (TNB) – which constructs power plants, transmission networks, underground cables, overhead lines and substations.

THE COST OF ENERGY

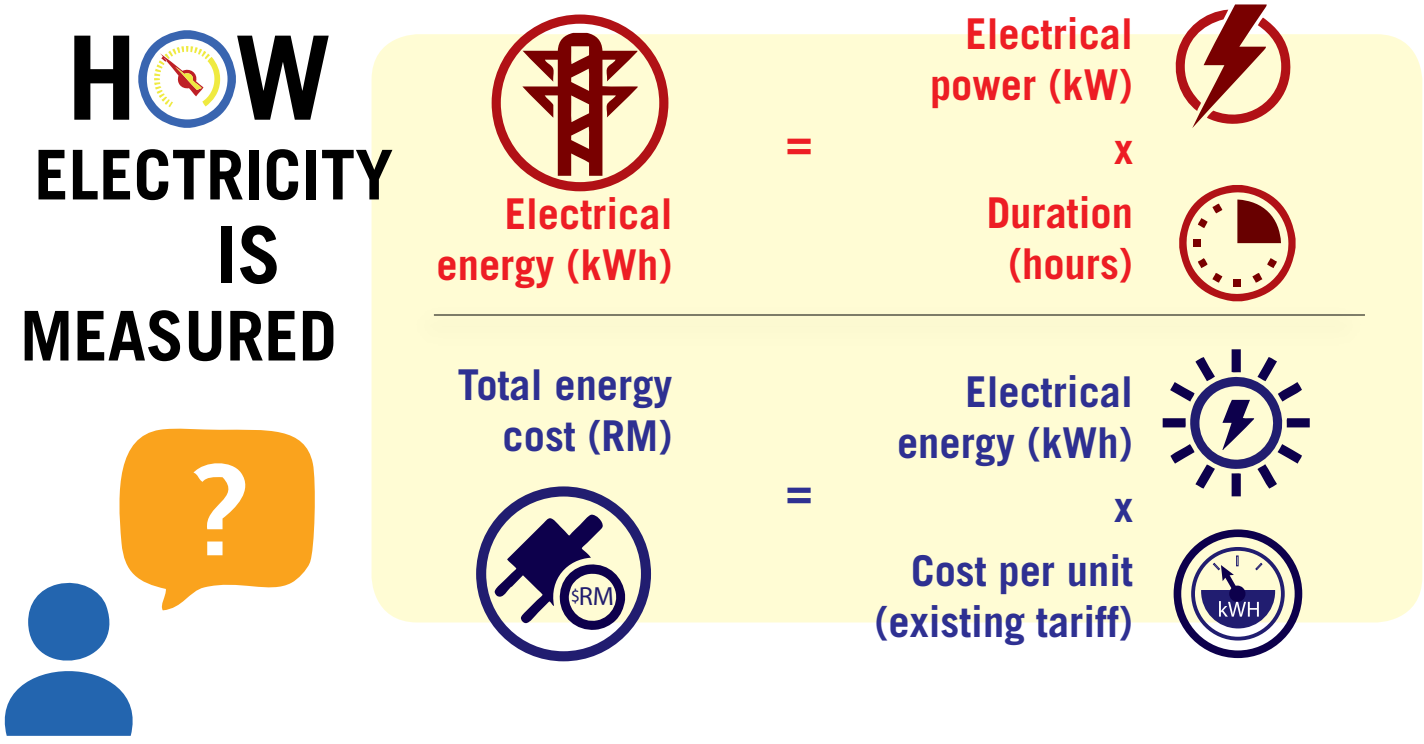
At the end of every month, the amount of electricity consumed by the customer is recorded by an electric meter – a device that measures the amount of electricity consumed by a residence, business, industry or an electrically powered device – calibrated in billing units, the most common one being the kilowatt hour (kWh).

Periodic readings of electric meters establish billing cycles and the energy consumed during a cycle. The term kWh refers to the energy consumed by customers, from which the cost of energy consumption is determined based on the existing electric tariff. This cost is also termed as the energy cost – applicable for all categories of customers. It is also important to note that this definition of energy based only on kWh is only applicable in Malaysia and some parts of the world. Other countries define energy based on total apparent energy or kVAh.

ENERGY EFFICIENCY EXPLAINED

Efficient energy use, sometimes simply called energy efficiency, is the goal of efforts to reduce the amount of energy required to provide the same products and services. For example, installing fluorescent lights or natural skylights reduces the amount of energy required to attain the same level of illumination compared to using traditional incandescent light bulbs. Compact fluorescent lights use less energy than incandescent lights.

There are various motivations to improve energy efficiency. Reducing energy use reduces energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy-efficient technology. Reducing energy use is also seen as a key solution to the global aim of reducing emissions. According to a study by the International Energy Agency (IEA)in 2006, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases.



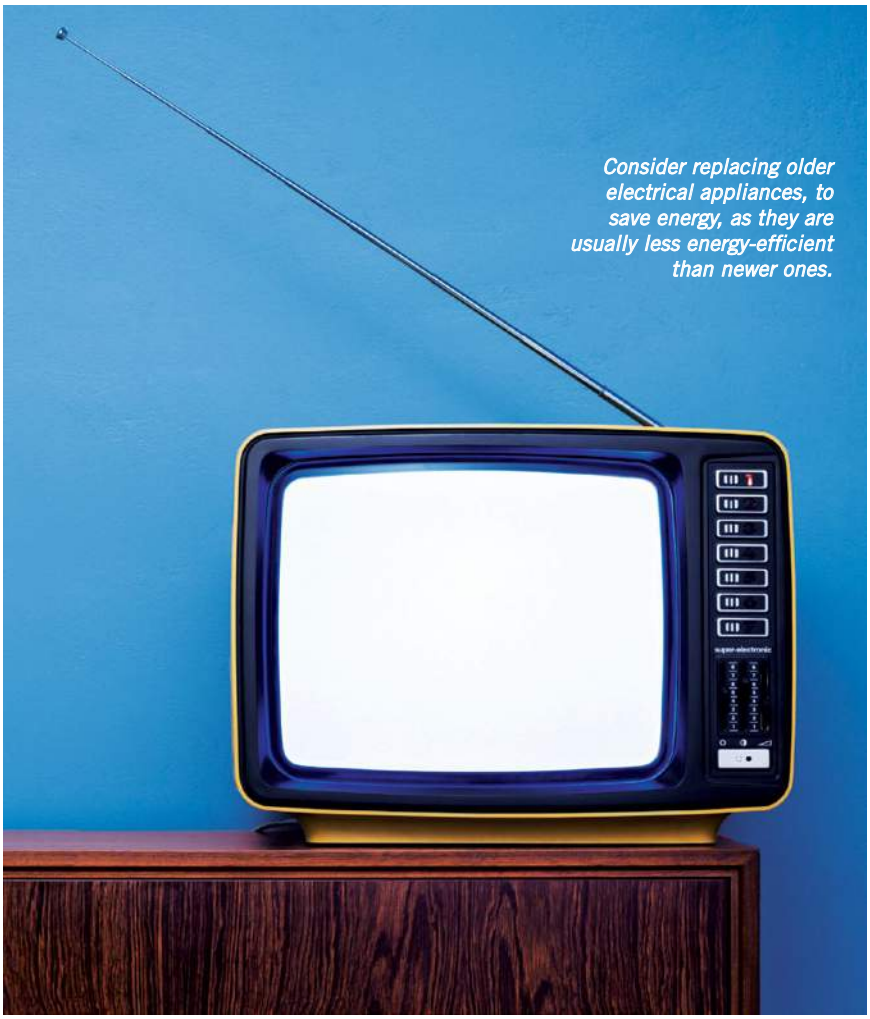
Choosing energy-efficient products is one of the smartest ways consumers can reduce energy use and help prevent greenhouse gas emissions. A household that buys energy-efficient equipment instead of standard new equipment can substantially reduce carbon dioxide emissions over the lifetime of the products.

Energy-efficient products also save money. When we receive our monthly electricity bill from TNB, many of us think there is little we can do to reduce monthly costs besides adjusting our air conditioners, but this is not true! The products you select can significantly affect that monthly bill. You can reduce your electricity bill by about 10 to 20% when you purchase energy-efficient products.

A PRACTICAL GUIDE

Recently, there have been many products defined as Energy Saving Devices (ESD) or Black Boxes being made available for homeowners and marketed under various names. They are simple to use; just insert the device in the power socket and the devices will then reduce your monthly electricity bill. But do these devices really reduce your electricity bills? Testing performed on these ESDs has revealed that they do not promote energy (kWh) savings.

Conceptually, the principles behind these devices make sense, but the reality of a controlled test environment has proven they are generally not worth the investment. Some ESDs with a simple voltage reduction technique can save partial energy but have limited application since there is usually a reduction in output and performance, such as lower lighting levels or less shaft horsepower. These devices typically cut the voltage sine wave to achieve a voltage reduction. Other devices only reduce reactive power but not watts. Since customers pay for watts or kilowatt-hours, there may be little or no financial savings. Reducing reactive power also helps to improve the power factor but does not reduce kWh and therefore does not minimise your energy cost.



Consider replacing older electrical appliances, to save energy, as they are usually less energy-efficient than newer ones.

There are a few good guidelines on implementing practical energy efficiency programmes. Commercial and industrial customers can refer to the *Code of Practice for Energy Efficiency of Electrical Installations* developed in Hong Kong. This guideline sets out the minimum requirements on energy efficiency of electrical installations and forms a part of a set of comprehensive Building Energy Codes that address energy efficiency requirements for building services installations, which designers are encouraged to proactively adopt, to exceed these minimum requirements.

The most simple action plan to achieve energy efficiency and energy saving is by switching off electrical appliances whenever they are not in use. However, major improvements in energy efficiency are most often achieved by increasing the awareness of users, improving maintenance procedures and adopting a more efficient technology.

DEPENDABLE CONNECTIONS

The Importance of Power Quality, Communication and Satisfaction

Contributed by Ir Dr Mohamed Fuad Faisal, Power Quality & Energy Efficiency Specialist, Asset Management Department, Distribution Division, TNB

Concerns about electrical power quality (PQ) in Peninsular Malaysia have become of increasing interest, as PQ problems have a negative influence on both the technical and economic aspects of Malaysian industries. But what is the difference between poor PQ and power supply interruptions, and how can customers differentiate between them?

Right: *In addition to conducting discussions and providing consultancy services for its Large Power Customers, TNB also holds talks and public awareness programmes on short and continuous power quality dips.*

DEFINING PQ

When a momentary or sustained power interruption occurs in a semiconductor plant, the effects can be costly, due to equipment breakdown and product damage – sometimes amounting to more than RM100,000. These power interruptions can be caused by a number of factors, including natural events, third party encroachment and equipment failure.

However, PQ is a generic term applied to a wide variety of electromagnetic phenomena in alternating current (AC) electrical power systems. Quite often, this term is associated with specific problems with equipment or systems, for example equipment damage, data problems or loss, equipment malfunction or complete system failure.

The main problem in using the term PQ arises when trying to determine the actual problems and causes of equipment misoperation. While PQ is a convenient term for many, it is the quality of the voltage – rather than power or electric current – that is actually described by the term. Power is simply the flow of energy and the current demanded by a load is largely uncontrollable. Monetary losses due to PQ problems can be as high as those caused by power reliability problems.

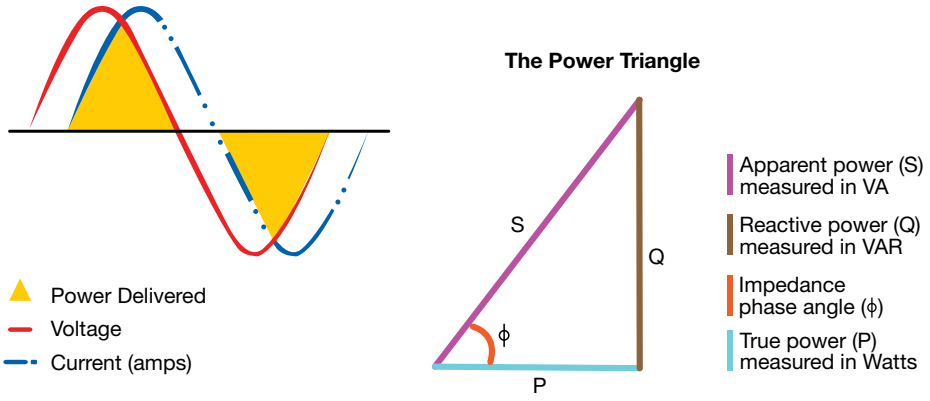
The Institute of Electrical and Electronics Engineers (IEEE) is a global society of electrical and electronic engineers that defines PQ in the *IEEE Std.1100-1999: IEEE Recommended Practice for Powering and Grounding, and IEEE Std.1159-2009: IEEE Recommended Practice for Monitoring Electric Power Quality*, as "the concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the premise wiring system and other connected equipment." It also discusses problems with equipment and systems and offers solutions to these problems.

Above: *With a Power Quality Monitoring System (PQMS), TNB observes and records power flow, sharing this data with customers via SMS when requested, in the event of voltage sags or other power quality incidents.*

The International Electrotechnical Commission's (IEC) standards, particularly IEC 61000-2-1, *Electromagnetic Compatibility (EMC) – Part 2: Environment – Section 1: Description of the Environment – Electromagnetic Environment for Low-Frequency Conducted Disturbances and Signaling in Public Power Supply Systems* – defines PQ as conducted electromagnetic disturbances present in AC electrical supply networks in the frequency range from 0 to 9 kHz, with an extension up to 148.5 kHz. PQ disturbances can be further categorised as short duration – such as voltage sags and transients – or continuous and steady state – including Harmonics, Notches, Flickers and Unbalance.

MANAGING QUALITY

For events related to voltage sags, the line voltage momentarily decreases due to the rush of current drawn by short circuits or the starting of heavy loads. For cases involving system faults, TNB protection system will operate and isolate the faults. The whole process of fault occurrence and clearing gives rise to voltage sags in the power system. Older electro-mechanical equipment could typically handle these types of changes in voltage with little or no effect on operation. The worst case might be a machine tripping. However, modern solid-state controls are more sensitive to these



The total power delivered to a device is a product of voltage and current received. However, these factors may not be delivered simultaneously, leading to wastage caused by the reactive power and increasing the apparent power required. A higher reactive power results in a higher power factor, which can be calculated through the impedance phase angle.

voltage variations, and can be damaged by higher voltage levels or trip with a minor drop in voltage. This can have serious consequences in process applications where it either takes considerable time to restart the interrupted process, or the work in progress is lost or a product spoiled.

Currently, it has become necessary for sensitive electrical and electronic equipment to operate with perfect sinusoidal voltage waveforms in order to achieve continuous operation. This condition is called the PQ requirement. Information on PQ events – particularly voltage sags – is very important. If any critical equipment suddenly trips during operation, the customer needs to ascertain the cause of the equipment failure. If it is due to external events, the customer can restart the machine and resume operations. If the reason is unknown, customers will need to spend time troubleshooting the machines, to identify the underlying problems. This will be a time-consuming process, which makes sharing relevant information about PQ very important towards guaranteeing customer satisfaction.

IMPROVED COMMUNICATION

TNB offers consultancy on measures to improve the immunity of sensitive equipment to voltage sags. The utility identifies cost-effective solutions to allow solid-state controlled equipment to operate normally, even when voltage sags occur.

TNB also finds the balance between meeting the expectations of customers when it comes to PQ and power reliability, while ensuring the entire grid, including electrical equipment and customer connections, remains safe at all times. To ensure customers are properly updated on PQ requirements, technical standards and the respective solutions on PQ, TNB frequently conducts PQ training for customers.

Effective communication and teamwork is essential as TNB strives to ensure Large Power Customers are updated after the occurrence of voltage sag events. By receiving information quickly, customers can immediately restart all their affected processes and continue with their production, thus minimising operation losses. Apart from sharing information on PQ events, TNB also focuses on improving the reliability of power systems, providing PQ consultancy and other services, as well as conducting awareness programmes for Large Power Customers. In addition, TNB is identifying and implementing more programmes to improve its customer services in relation to PQ-related matters.

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Why do we care?

Because their future is as important as our present

At Tenaga Nasional Berhad, we always strive to provide power to the Nation through world-class facilities that meet international environmental standards. We take great care in our operations to ensure that our future generations can continue to enjoy a clean environment. That is why we have built "green" power stations like the clean-coal powered *Sultan Azlan Shah* Power Station in Perak, Malaysia. We are also building a new power plant, adjacent to this power station, using the latest supercritical boiler technology. The plants feature anti-pollution measures and strict emission controls.

Tenaga Nasional Berhad - Powering a "green" nation.

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