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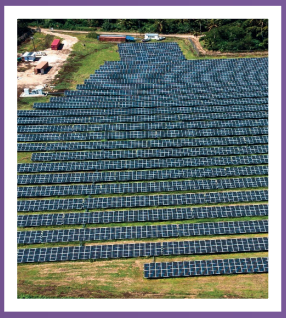
CONTENTS



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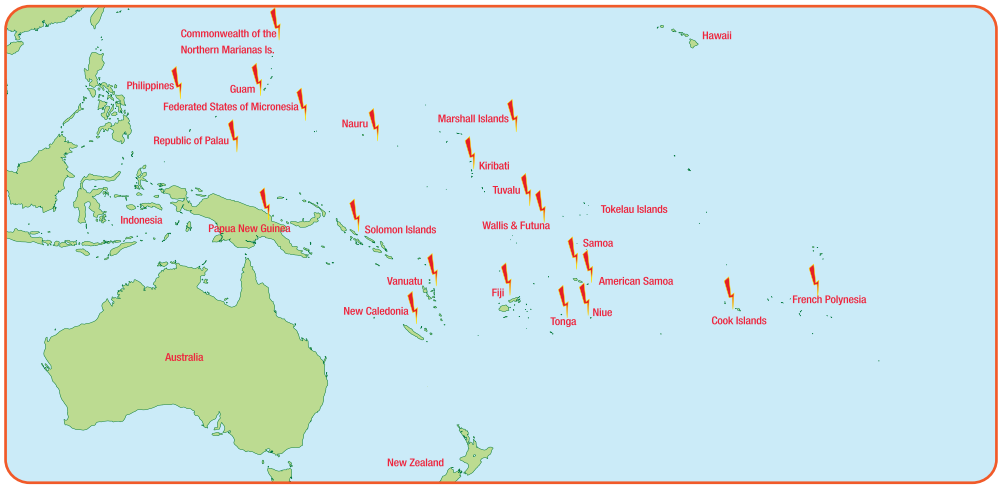

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Editor's Note

Gordon Chang
Acting Executive Director

We are well into the 2023 year now and I am sure everybody is into implementing their respective work programs for the year. When we pause a moment to think about it, time certainly flies, and we need to be on top of activities to be able to achieve our goals for this year.

The PPA Secretariat's World Bank SEIDP grant came to an end at the end of February 2023. The Secretariat at this time would like to thank the World Bank and their staff whose contributions has certainly made the activities within this project a success. The PPA Secretariat is already in discussion with the World Bank for a new project to be approved and implemented. The activities for this new project will be Electric Vehicles, Renewable Energy training and other activities and Capacity Building and should be approved around 2024. In addition, the ADB has approved around US$900,000.00 for the continuation of the Benchmarking exercise when the World Bank project came to an end. This activity should start around June 2023.

This year the PPA Annual Conference will be held at the Commonwealth of Northern Marianas from the 25-28 September 2023 and the PPA Secretariat looks forward to all our members participation in making this conference a huge success. In addition, we will be seeking sponsorship from our allied members and donor partners for the conference activities and will be contacting those generous partners soon.

I also take this opportunity to welcome our new Allied Members Solar Hub, EIF International and HNAC Technology.
We look forward to seeing you in Saipan, Commonwealth of the Northern Marianas.

Thank you.

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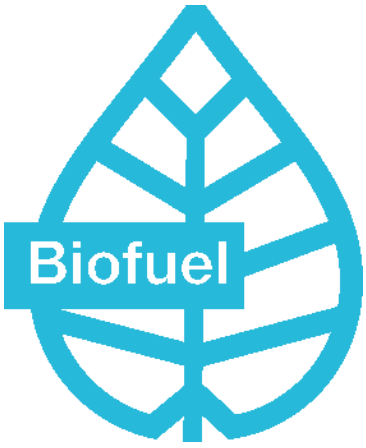
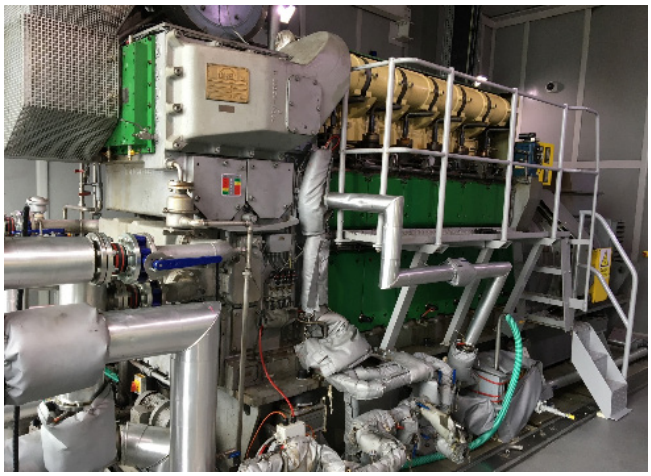
Reducing CO_2 Emissions with Alternative Fuels

Lachlan Colquhuon
Sales Manager – MAN Energy Solutions

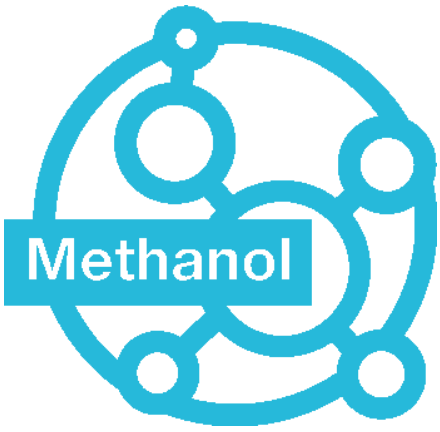
1897 was the culmination of many years of development for Rudolf Diesel when MAN successfully ran his revolutionary 'diesel' internal combustion engine at our workshops in Augsburg, Germany. With considerable advances in efficiency, longevity, reliability and compactness over other technologies, the diesel engine has become a mainstay of today's world. In the 50's and 60's diesel engines started running on refining waste product Heavy Fuel Oil (HFO). HFO was cheap and had limited other markets. HFO is historically a very low quality fuel with contaminants like Catalytic Fines (CAT Fines) from the refining process. CAT Fines are hard particles which cause engine wear. Since the introduction of HFO fuel engine manufacturers including MAN Energy Solutions (MAN ES) have continually developed our engine technologies to better handle lower quality fuels like HFO. Fortunately these and other technological advances mean today's engines and generators are capable of operating on a diverse range of low CO_2 alternative fuels.



Introducing biofuel allows owners of MAN diesel generators to reduce the nett CO_2 emissions of their operations today. Generally speaking biofuels are fuels which are partly or wholly produced from renewable sources and include fuels like fatty-acid-methyl-ether (FAME), hydrogenated vegetable oil (HVO), biocrude, bio-dimethyl ether (BioDME), ethanol and algae fuels. Some examples of biofuel feedstocks are rapeseed oil, sunflower oil, soybean oil, animal fat and fish oil. Considerable supply of biofuels already exists, for example the USA currently produces approximately 9 million tonnes of biodiesel per year. Biodiesel is also produced in large quantities in Brazil and parts of South-East Asia. MAN engines and generators can run on up to 100% biofuel depending on the fuel type, in some cases without any effect on the time between overhaul of the engine's components compared to fossil based diesel fuel. An example of the versatility of MAN Energy Solutions engines is a MAN 21/31 at ABP Foods abattoir in Ellesmere, Oswestry in the United Kingdom which runs on pure cow fat producing up to 1 MW of power. This engine has demonstrated an impressive 24,000 hour time between overhauls. For many years MAN 32/40 Generators in the Port Vila Power Station in Vanuatu have run on coconut oil as another example of the potential to decarbonize electricity generation with renewable biofuel.



MAN 21/31 running on cow fat in Oswestry UK



> *"Green methanol is the best scalable green fuel solution for this decade, and we are excited to see several other shipowners choosing this path. It adds further momentum to the rapid scaling of availability needed to bring down the premium on green methanol and accelerate the evolution of climate neutral shipping,"* said **Palle Laursen,** Chief Fleet & Technical Officer at Maersk.

In addition to biofuel, methanol produced using energy from renewable sources, so called 'green methanol', can be used to reduce the nett CO_2 emissions of power generators. MAN ES has already developed dual fuel methanol propulsion engines for product tankers used to ship bulk methanol around the world. Methanol is a widely traded commodity with a well-established global supply chain. As supply of green methanol develops it is relatively simple fuel to introduce to the power generation industry. As evidence of the growing interest in Methanol the world's largest shipping company, Maersk, has placed an order for seventeen methanol powered container ships and, together with partners, is developing a supply chain of approximately 600,000 tonnes of green methanol per year by 2025 to power these vessel. This bold initiative is generating enormous interest in green methanol across many sectors including power generators.

MAN has recently announced our new MAN 21/31DF-M dual fuel methanol engine, a derivative of our well proven MAN 21/31 diesel engine, which uses relatively simple ported methanol fuel injection technology. MAN 21/31DF-M generators will be available for sale mid-2023. During 2023 we will make further announcements about other dual fuel methanol engine models. As these new products are released to the market MAN will also release retrofit packages which will allow existing diesel power plants to be retrofit to run on methanol.

Looking further into the future considerable development is going into Ammonia and Hydrogen as a fuel for internal combustion engines for power generation applications, fuels which have the distinct feature of containing no carbon atoms. Given the intermittency of solar, wind and other renewable energy sources it is likely internal combustion engines will have a significant role to play for many years to come. The challenge for generation asset owners will be identifying cost effective and reliable supply chains of low CO_2 fuels for their business. Developing the competence of your staff so they can safely operate equipment running on an alternative fuel will also be a challenge, particularly for fuels like ammonia and hydrogen. MAN Energy Solutions looks forward to supporting the Pacific nations as they navigate the transition to a low carbon future for their baseload and firming electricity generation needs.

Improving the Reliability and Life Cycle of Air Break Switch by Using a New Design

Goran Stojadinovic, MCE, MEE,
Product & Innovation Manager - TransNet NZ

Introduction

The overall confidence in conventional Air Break Switch (ABS) in New Zealand and Australia has fallen over the last several years for various reasons:

- Contact failures (e.g. arcing, corrosion, overheating, contact fusing, etc.)
- Insulator failures
- Requires regular two-yearly maintenance (e.g. contacts re-alignment, greasing...)

Furthermore, if there is no regular maintenance of ABSs due to live-line work restrictions,
the ABS contacts deteriorate quickly, becoming inoperable, unreliable, and hazardous.

This article discusses a different design of ABS that dramatically improves its life cycle & reliability and makes it virtually maintenance-free. The new design has a different geometry and relative arrangements of the moving components, compared with the conventional ABS.

The conventional ABS design and its deficiencies

Conventional ABS has three (3) insulators per phase. The middle insulator rotates on an axis to make or break contact, while the other two insulators are stationary (fixed). The operating mechanism and the middle (rotating) insulators are heavy and have big inertia. The proper operation of ABS depends on the low-resistance contact between the moving contact (blade) and fixed contact (fork) because this contact carries a high load current.

The key weakness of conventional ABS is in its inherited design of the main contacts i.e. relative position (geometry) of contacts and rotating insulator, as follows:

- The rotating insulator, the contact surfaces of the moving blade, and the fixed fork are in the same plane, and they move relative to each other in the same (vertical) plane.
- Any perpendicular vibration of the operating mechanism and/or the rotating insulator causes the contact surfaces between the blade and fork to vibrate relative to each other.
- This vibration affects the contact surfaces on both sides of the contact blade as follows:
  - Fretting wear and corrosion on the contact surfaces on one side,
  - Micro-arcing and pitting on the other side due to increased contact resistance
  - This process alternates from one side to another and is self-perpetuating
  - It is further exacerbated by the environmental conditions e.g. moisture, salty air, contaminants, and thermal expansion, which accelerate galvanic processes

Indeed, the maintenance crews have observed contact erosion, pitting on contact surfaces, burns due to arcing and contact misalignment, even if ABS was never or rarely operated.

Fig. 1 – Common type of ABS in New Zealand

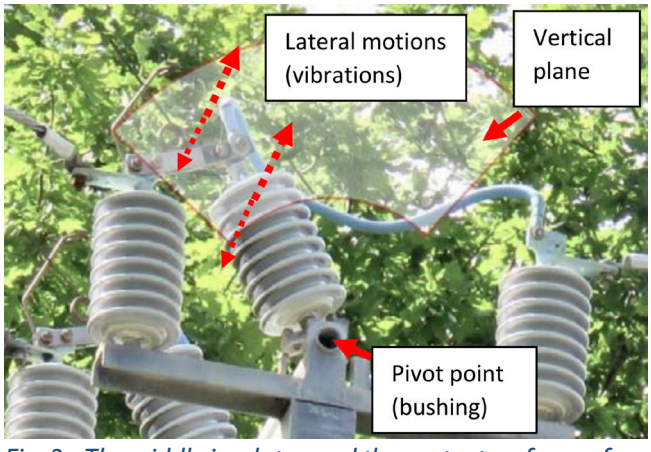


Fig. 2 - The middle insulator, and the contact surfaces of the moving blade and fixed fork are in the same plane (vertical).

Any lateral movement of the middle insulator will directly affect the contact surfaces between the blade and fork e.g. blade vibrates against the fork all the time.

2.1 Failure mechanism of contacts of conventional ABS

- "Fretting corrosion is one of the most important failure mechanisms for separable contacts with base-metal materials." [1]

2.1.1 Analogy of ABS contacts with bus-stab contacts in substations

The failure mechanisms of the main contacts of the conventional ABS and the bus-stab contacts on busbars in substations are very similar. The main difference is:

- The cause of vibrations is different (in most cases)
- The ABS contacts carry full load current, while the bus stab is mechanical support only

As per Braunovic [2], the bus-stab contacts are exposed to three types of vibrations (see Fig.3):

1) A-A motion - slow slide motion due to thermal expansion, but negligible on ABS contacts
2) B-B vibrations induced electromagnetically due to heavy currents flowing in adjacent busbars. The ABS contacts are exposed to vibrations of similar amplitude and frequency but from different sources, like Aeolian vibrations, passing traffic, etc.
3) C-C transverse displacements that cause surface micro slips due to B-B vibrations. As the busbar moves to the right or left from its neutral position, the stab's two contacts are forced to move in a transverse direction i.e. up and down. It causes fretting wear on contact surfaces resulting in pitting, erosion, and burning of contact surfaces, increased contact resistance, overheating, and contact failure.

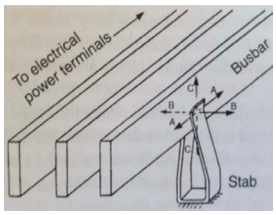


Fig. 3 – Typical arrangement of busbar on a supporting stab. Arrows show the direction of motions acting on bus-stab contacts ([2] Fig. 7.16).

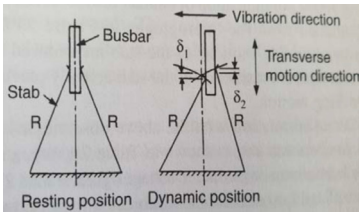


Fig. 4 – Transverse (Fretting) motion of stab contact along busbar width ([2] Fig. 7.16). The frequency of rubbing transverse movements on bus-stubs is 100 Hz, which is similar to Aeolian vibrations on ABS.

The same failure mechanism applies to the contacts of conventional ABS. The only difference is the source of vibrations. However, the consequences are much worse because the ABS contacts carry a full load current. This design is inherently flawed if ABS is exposed to vibrations and harsh environments. It will ultimately result in high maintenance, reduced service life, and failure.

Fig. 5 – Real-life example of fretting wear, heavy arcing, pitting, and erosion of the main contacts on 33kV ABS exposed to Aeolian vibrations

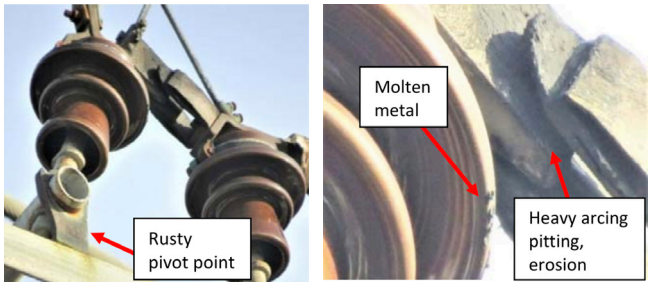


Fig. 6 – Real-life example of fretting wear, heavy arcing, molten metal, pitting, and erosion of the main contacts on 11kV ABS in a closed position

2.2 What can cause vibrations that affect contacts of conventional ABS

- Self-induced vibrations by ABS operation (closing and opening):
- Vibrations induced by the operation of other hardware on the same line
- Mechanical vibrations induced by regular winds and storms that
- Aeolian vibrations (10 to 120 Hz) are transferred from the OH conductors to the pole
- Mechanical vibrations from the passing traffic
- Vibrations introduced by road irregularities, or via loose soil on reclaimed land [5],

3. The 'Allied ABS' and its superior design

Fig. 7 – Allied ABS in the open and closed position

3.1 Why vibrations do not affect the Allied ABS design?

In this new-old design, the blade vibrations do not move against the finger contacts. The blade moves in parallel with finger contacts (e.g. it slides between contacts), and there

Fig. 8 – The contacts of the new ABS design do not require regular maintenance or re- alignment. Once pre-set in the factory, the only recommended maintenance is a visual inspection every 8 years

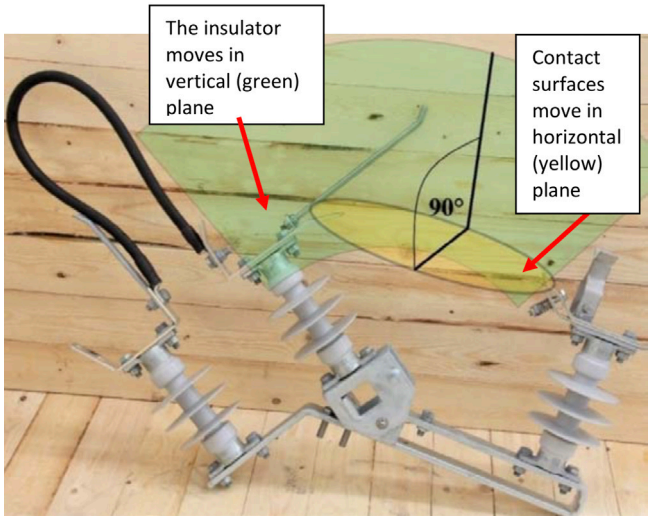


Fig. 9 – The middle insulator and main contacts (blade & fork) are in two different planes at 90° to each other. A lateral vibration of the middle insulator has no effect on the contact surfaces between the blade & fork.

If the blade vibrates laterally, it does not hit the fork, it slides between the fork fingers i.e. it moves parallel with the fork fingers. Note: The slide distance is in µm and does not affect the contacts.

3.2 A simple proof of vibrations on OH lines - direct and indirect:

Maintenance crews regularly observe badly damaged contacts on conventional ABS even if it has never been operated e.g pitting, erosion, burns, heavy arcing, and misalignments after less than a year in service. The Author of this article has observed this failure mode in real-life cases in different networks across Australasia during the acoustic inspections of OH networks. What is common in most of these cases is that ABSs have been exposed to some vibrations. The presence of vibrations can be confirmed either directly on indirectly, as follows:

Direct confirmation: These vibrations are subtle, in micrometers. Human skin is sensitive to vibrations up to 1,000 Hz, with a peak sensitivity of around 250 Hz [6]. By simply putting a hand on a power pole or supporting structure in an area exposed to Aeolian vibrations, wind, or passing traffic, one can feel vibrations.

Indirect confirmation: There are many loosened nuts & bolts on OH power lines hardware. If there were no vibrations, they would simply not get loose. Although the initial loosening may start with thermal expansion, it will continue and self-perpetuate with mechanical vibrations.

4. Energy losses (thermal losses) from ABS during normal operation

New separable connections, including the ABS, have a slightly higher contact resistance than permanent connections, resulting in higher energy losses. However, connections that experience fretting wear, arcing, and erosion, have a major increase in contact resistance over time, resulting in significant heating and energy losses until they finally fail.
If ABS contacts fail beyond repair, it becomes inoperable, possibly increasing the SAIDI costs because they can't be operated when needed. Furthermore, it continuously dissipates energy (heat), adding to the cost. Therefore, due to energy losses alone, the true cost of conventional ABS over its service life can drastically exceed its original price. (Refer to [7] for the analogy). In addition, there is always the risk of bushfires ignited by molten metal from arcing contacts.
In contrast - the true life-cycle cost of Allied ABS doesn't increase because it has stable contact resistance, and is a virtually maintenance-free and highly-reliable device.

5. Discussion

The failure mechanism of conventional ABS contacts under normal operating conditions has been attributed to the effects of fretting vibrations and micro arcing, as follows:

- Fretting movements and wear on one side of the separable contact, and
- Micro arcing and surface damage on the other side due to reduced contact pressure and increased contact resistance

These two effects alternate from one side to another according to the frequency of vibrations, causing irreparable damage to both sides of the contact, and ultimate failure. That's why frequent maintenance is needed i.e. cleaning contacts, greasing, and re-alignment.
In contrast - Allied ABS has none of these problems and is virtually maintenance-free.

5.1 The results speak for themselves

The Allied ABS design has been around for more than 40 years. It successfully survived the test of time in harsh conditions. The maintenance of such an ABS was non-existent or minimal compared with New Zealand's experience with conventional design.

Power utilities that adopted this design have experienced:

- Improved network reliability, resilience, SAIDI, and SAIFI
- Reduced risk of feeder faults due to failed ABS contacts

- Improved public and personnel safety e.g. no molten metal during operation
- Easy to install, compact, modular design, one person can carry individual components

6. Conclusions and recommendations

There are thousands of conventional ABSs in distribution networks. They are exposed to harsh environments, winds, Aeolian vibrations, growing vegetation, sea spray, and storms. Also, most of them are along the roads, exposed to vibrations from passing traffic. There is a steady increase in ABS failures over recent years, with a significant impact on SAIDI/SAIFI.

In contrast - the Allied ABS design stood the test of time in harsh environmental conditions in the UK for more than 40 years.

Over the last several years New Zealand distribution networks installed close to 1,000 Allied ABSs.

"A picture is worth a thousand words"

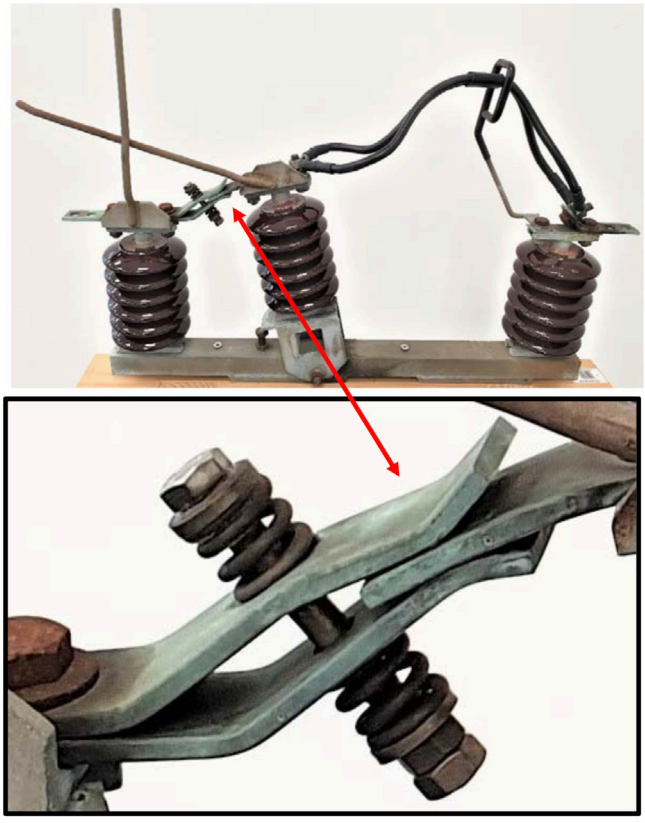


Fig.10 – A recently replaced Allied ABS with near-perfect contacts after 40 years in service with virtually no maintenance

References:

1. Neizen. J., at al.; Fretting Corrosion of Tin Coated Electrical Contacts, *IEEE Transactions on Components, Hybrids, and Manufacturing Technology (Volume:10, Issue: 1, Mar **1987**)*
2. Braunovic, M., Konchits, V.V., Myshkin, N.K.; Electrical Contacts – Fundamentals, Applications and Technology, *CRC Press, Taylor and Francis Group, **2007***
3. Handling shaft deflection, runout, vibration, & axial motion, *Kalsi Seals Handbook **(2019)***
4. Vibration from Car Engine During Morning Commute https://endaq.com/pages/measurement analysis vibration from car engine during morning commute
5. M. Agostinacchio at al.; The vibrations induced by surface irregularities in road pavements, *Eur. Transp. Res. Rev. **(2014)** 6:267–275*
6. Serhat.G, Kuchenbecker.K.; Free and Forced Vibration Modes of the Human Fingertip, *Applied Science, MDPI, Article, **2021***
7. Evaluating Efficiency and Losses of Various Circuit Protective Devices, *White Paper AP08324002E, EATON, **2010*** https://www.eaton.com/content/dam/eaton/markets/machinebuilding/whitepaper/circuit protective devices.pdf
8. Slade, P.G; Electrical Contacts – Principles and Applications. *CRC Press, Taylor and Francis Group, **2014***
9. MÜLLER, P., at al.; Uni. Stuttgart & Siemens AG, Germany, Current Characteristics of Serial & Parallel Low Current Arc Faults in Distribution Networks, *CIRED, 21st International Conference on Electricity Distribution Frankfurt, Paper 0181 2/4, **2011***
10. Stojadinovic, G.; Ultrasonic defect detection for predictive maintenance of power lines and bushfire risk mitigation. *Australian Utility Week Conference, Sydney. **2016***

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Project and Business Developer – HDF Energy

Fossil fuel dependence and rising cost of electricity

Despite being the utmost vulnerable to the ever more present effects of climate change, and having committed to an ambitious green transition, Pacific Islands' energy mix still heavily relies on fossil fuels for power generation and mobility. Most countries in the region do not have access to locally produced fossil fuels and are highly dependent on imported diesel, LPG and heavy fuel oil. This situation affects their economy with a large share of their wealth being shifted out of the local economy for fuel import, by far the most important import item in the region.

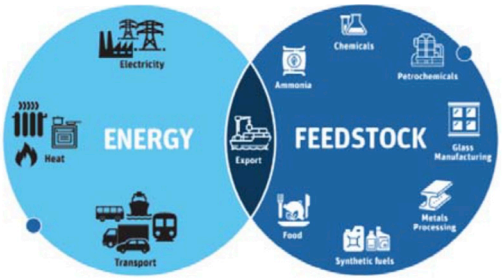
Rising costs of fuels have had a detrimental effect on the local economies, which have no bargaining power in terms of price due to the size of their market and high shipping costs. Recent events such as the Ukrainian war have showcased the vulnerability of Pacific Islands economies to highly volatile fuel prices.

Considering these overwhelming disruptions, Pacific Islands urgently ought to reduce their reliance on fossil fuels and need to undertake their energy transition. The Republic of Fiji has set ambitious targets by committing to reduce its carbon emissions by 30% by 2030, to achieve 100% green electricity by 2036 and to reach net zero emission by 2050. The geopolitical context is now more favorable than ever considering Pacific islands have not invested massively in gas and coal infrastructure, leaving room to build on sustainable foundations. Numerous stakeholders are now eager to support Pacific Islands' green energy transition.

Green hydrogen: an emerging solution to answer sustainable energy challenges.

Green hydrogen is defined as hydrogen produced by splitting water into hydrogen and oxygen, using renewable electricity. More specifically, the electrolysis process uses a mix of green electricity from solar panels or wind turbines to split each water molecule into two molecules: one molecule of hydrogen and one molecule of oxygen. This process of production does not emit any greenhouse gases and accredits green hydrogen as completely environment friendly.

Hydrogen is highly versatile and can be implemented for the decarbonization of numerous key sectors of the economy, one of them being hard to abate high power industries (see below).

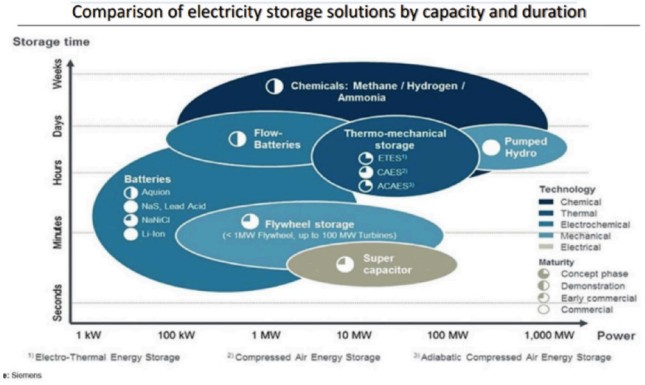


For some sectors, no alternative to green hydrogen exists. In addition, hydrogen will be used as a fuel source for heavy and long-distance mobility due to its high-power density. Models running on hydrogen like Toyota Mirai and Hyundai NEXO cars are already available for sale and hydrogen buses already operate in France, Poland, and Australia and a hydrogen fast-ferry is to be started operations in San Francisco. Finally, the Alstom hydrogen train recently ran 1000 Km in Germany without needing refuelling.

Toyota Mirai

Alstom Train, Germany

In the power sector, hydrogen as a form of energy storage is very appealing as it brings a solution to the challenge of intermittence and dispatchability in renewable energy technologies. Indeed, current intermittent renewable power plants such as photovoltaics fields cause mismatches between supply and demand which put undesired pressure on the power grid and electric system. Hydrogen is as well a very cost-effective way to store electricity for long period of times, from kW to MWe scale.



As a result, many European countries, the United States, Japan, Australia, China, and South Korea are already massively investing in hydrogen. According to the International Energy Agency (IEA), tens of billions will be invested in hydrogen projects and associated technologies by 2030. Cost of hydrogen production is then expected to decrease very quickly in the coming years due to economies of scale and billions of investments in hydrogen technology.

Undoubtedly, hydrogen will play a decisive role in the energy transition and the fight against climate change.

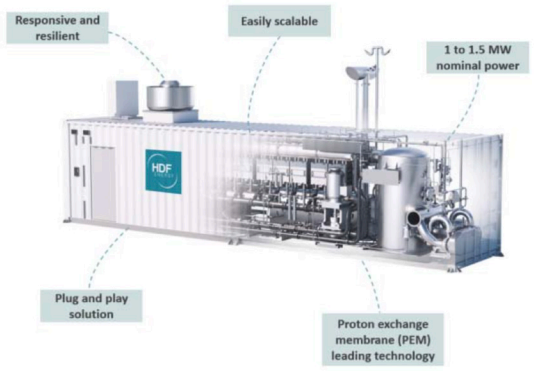
Solutions offered by HDF Energy's technology

HDF energy is a global pioneer in hydrogen technology offers green hydrogen-based turnkey solutions as well as hydrogen-powered fuel cells.

HDF Fuel Cell

Hydrogen can generate electricity on demand by feeding it to an hydrogen fuel cell, just like a genset using diesel. To this end, HDF Energy has developed the most powerful and most efficient hydrogen fuel cell in the world for stationary use and is the world leader for hydrogen electricity production.

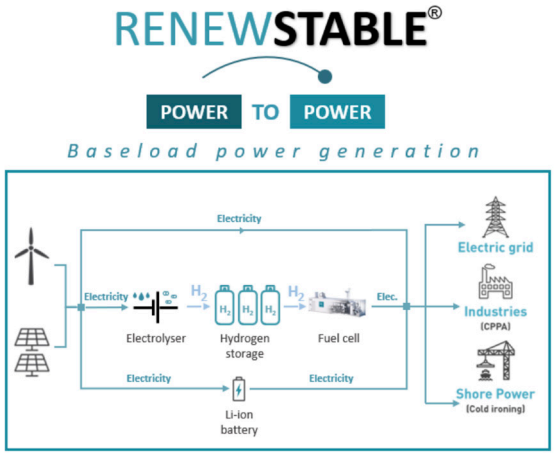
Each of HDF Energy's fuel cell can generate up to 1,5 MW of emission-free electricity. Equipped with PEM stack technology, the fully integrated system provides reliability and flexibility to meet the requirements of high-power activities.



The fuel cell has been implemented by HDF Energy in 2019 in Martinique, in the Caribbean, to provide electricity to a plant. With a capacity of 1.5MW baseload, the fuel cell can produce up to 13 GWh/year. Its aim is to produce stable and continuous electricity, day and night. While saving 5,000 tons of CO2 emission per year, the electricity generated from this project is cheaper than the existing diesel generators.

HDF Renewstable® for Hydrogen storage

Thanks to its fuel cell technology combined to long-term hydrogen storage, HDF Energy has developed a power-to-power solution called Renewstable® to produce continuous, fully dispatchable renewable electricity.



Benefits of such solutions are the following:

- Power flexibility (on demand energy, morning and evening peak response)
- Ancillary services (frequency, voltage and network control)
- System restoration (black start, island mode)
- Long-term storage and back-up capability (capacity contract, green hydrogen availability)

HDF Energy is deploying its Renewstable® solution around the world. A first project called the CEOG project is currently under construction in French Guyana and should be in operation by the end of 2023. This project is the world's largest green hydrogen facility combining solar panels and hydrogen storage with a combined 10 MW daytime capacity and a 3 MW night-time capacity. It will produce stable and continuous electricity for 10,000 households, in the same way as a thermal power plant but without emitting any pollution. Around 40,000 tons of CO2 emissions will be saved up each year. Other projects in countries, such as in Fiji and Barbados, will use HDF's Renewstable® solution.

Pacific islands at the forefront of the hydrogen revolution

Pacific Islands are blessed with sun, water, and land; some distinctive land amenities that are ideal for the production of green hydrogen. Consequently, the Pacific islands should embrace the hydrogen revolution for power generation and green mobility. HDF Energy expects green hydrogen to play a pivotal role in the energetic independence of the Pacific Islands as well as to support the growth of local economies while fighting climate change.

South Pacific's Largest Solar Power Plant Opens in Tonga.

Clay Energy
SEIAPI Magazine

In the presence of Their Majesties King Tupou VI & Queen Nanasipau!u, The King & Queen of The Kingdom of Tonga, Tonga's new 6MW solar power plant was officially launched in December, 2022 at Fualu, Tongatapu by Prime Minister of the Kingdom of Tonga, Hon. Hu'akavameiliku. Implemented by New Zealand company Sunergise, alongside Tonga Power Limited, the Sunergise Tongatapu Solar Farm will assist the Government of Tonga's plans towards reducing the country's reliance on imported fossil fuels, reducing energy costs and achieving renewable energy targets. The Sunergise Tongatapu Solar Farm is the largest in the South Pacific. It was built as part of a power purchase agreement between Sunergise New Zealand Limited, a Todd Corporation solar company and Tonga Power Limited, with support from the Asian Development Bank. The Solar Farm is capable of producing 6.9MWp of renewable power, helping lower power costs to Tonga and producing enough renewable energy to offset 18% of Tongatapu's current diesel-powered generation.

Comprising three interconnected 2.3MWp ground mounted solar arrays in western Tongatapu, the construction phase successfully met the extreme challenges presented by the 2022 Hunga Tonga–Hunga Ha'apai volcanic eruption and resulting tsunami, as well as the COVID-19 pandemic. Local Tongan civil, mechanical and electrical sub-contractors were engaged to work under the supervision of Sunergise engineering subsidiary Clay Energy and accounted for up to 70% of the construction labour for the project. As a result, Tongan companies also developed extensive experience in the construction of large solar power plants, increasing Tonga's in-country renewable energy skills capacity. Equipment selection and system design, for all three sites, was based on the need for longevity, climate resilience and ease of maintenance, given the maritime environment and tropical conditions at Tongatapu. Producing energy since August this year, and providing power for up to 10,336 households, the Solar Farm is helping The Government of Tonga pursue its National Energy Roadmap plans to see up to 70% of Tongatapu's electricity generation sourced from renewables by the end of 2025. Prime Minister, Hon. Hu'akavameiliku announced at the launch, “The successful completion of the Sunergise 6MW Independent Power Producer solar generation system today, demonstrates the major role renewable energy independent power producers play towards achieving our 70% target by end of year 2025.

Although, the majority of our renewable generation sites are from donor partners who are with us here today, Tonga will also need to pursue the partnership and collaborations from independent power producers." Sunergise Chief Operating Officer, David Mulholland said, “Sunergise has a long history in the Pacific and is aligned with the Kingdom of Tonga's inspirational vision for a cleaner future with renewable energy." Mr. Mulholland added, “Getting to this point, through COVID-19 lockdowns and a devastating tsunami is testament to the dedication and skills of our people and partners in Tonga. “During the pandemic, we were fortunate to be granted one of the first exemptions for non-residents to assist with the scaling up and training of the local workforce. Then the devastating submarine volcano and tsunami hit.

While we were greatly concerned for the people of Tonga, when communications were finally reestablished the teams from Sunergise, Clay Energy, Tonga Power just got on and got the job done." Sunergise is the leading developer and operator of solar generation in the Pacific Islands and has delivered over 20MW of solar power implementations in New Zealand, Fiji, Tonga and the South Pacific.

5KV Insulation Testing – A Review of the Basics to Ensure Best Results.

Trevor Lord,
Managing Director - AVO NZ Limited

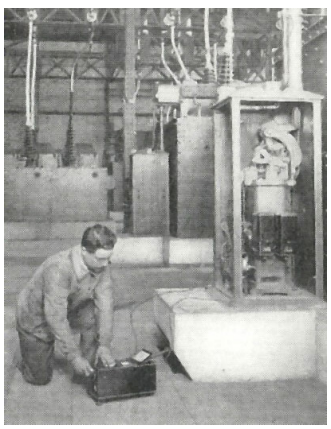
Effectively applied 5kV insulation resistance testing has served the industry now for over a century and remains the base-line test when assessing the condition of electrical apparatus. Surprisingly perhaps the correct understanding and use of such testers is a persistent issue of concern, which likely compromises its use.

This article will cover the following topics, in an attempt to refresh the reader on the effective use of this vital testing device:

- Importance of testing insulation above 1kV
- Electrical properties of insulation
- Understanding DC diagnostics & assessments
- The use of a guard terminal
- Selecting the best IRT for your application.
- Safety, Best Practice and test equipment accuracy.

The goal of effective insulation testing is to ensure continuity and stability of supply while avoiding harm to people and equipment, as well as keeping the lights on and people safe. Short term applications include: pre-commissioning new equipment; repair/maintenance work; ensuring that the IR is good for service; and outage fault investigation.

Conversely, the mid to Long term value of regular insulation testing is borne about because insulation degrades over time, through such mechanisms as: lack of maintenance; thermal stress; mechanical stress; condition of joints; fault events, moisture ingress etc.). Such periodic testing assists with condition assessment through year-onyear trending and DC diagnostics, as well as supporting pro-active maintenance planning and informed decisions. In other words, the importance of periodic IR testing is knowing the condition of assets and equipment, this being paramount to delivering our ultimate goal of ongoing reliability and maximum equipment service life.



DC insulation testing is applicable to a wide variety of power systems assets, including: Transformers, Circuit breakers, Switchboards, Bushings, CT's &VT's, Cables...pretty much any general insulation needs.

Taking a look firstly at the electrical properties of insulation, materials are essentially either conductors or insulators. That said, there are no pure conductors, nor pure insulators. Therefore, resistance in insulation is expected but ideally is as high as practicable. Insulation resistance is determined by the leakage current through the insulation. Insulation is also a dielectric material and has the ability to absorb and store electrical energy. This means that insulation has resistive, capacitive, and absorption properties. These properties behave differently during a test and therefore we need to expect and understand these differences and dynamics. Insulation also potentially changes and degrades over time. Therefore, it is best to test and monitor the behaviour of insulation periodically and at key times (e.g.: at commissioning).

Instead of a simple pass/fail approach to insulation testing, it is important to conduct a true condition assessment of insulation which relies on the reaction of the insulation to an elevated voltage stress ("pressure test"). It is all about scale and consequence. Different insulation assessment methods exist...some performed at low & some at high voltages. These methods of testing insulation include a variety of approaches, including DC, VLF, AC Hi-pot, Tan Delta, DFR, Damped AC, and Partial discharge diagnostics. This discussion will focus solely on DC insulation analysis and the use of DC insulation resistance testing equipment.

In order to understand DC diagnostic concepts for insulation assessment, we need to be aware of what constitutes the various components of a final measured insulation value. When a DC test polarity is applied to an insulation sample there are three distinct currents arising, all of which contribute to the final insulation resistance value and its profile with time. These are as follows: **Capacitive** charging current (the current required to charge the capacitance of the test

sample); **Absorption** current (the current required to align the molecules of the insulation ["dipoles"] to the electric field applied)...this measurement is particularly sensitive to moisture in the insulation; and **Leakage** current (essentiality the constant current required to support surface or insulation leakage, or both). See Figures 1 and 2.

Figure 1: Behaviour of insulation when exposed to a DC testing voltage.

In an insulation medium without applied DC voltage (A), there are random distribution of charged insulation molecules (called 'diploes').

When a DC insulation voltage is applied (B), there are three things that happen: surface leakage current flows across the external surfaces of the insulation; the insulation charges up to hold a net charge (acting as a capacitor); and the charged dipole insulation molecules progressively align with the polarity of the DC test voltage.

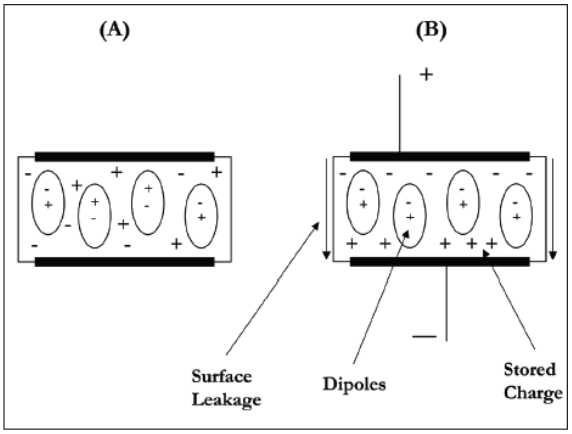
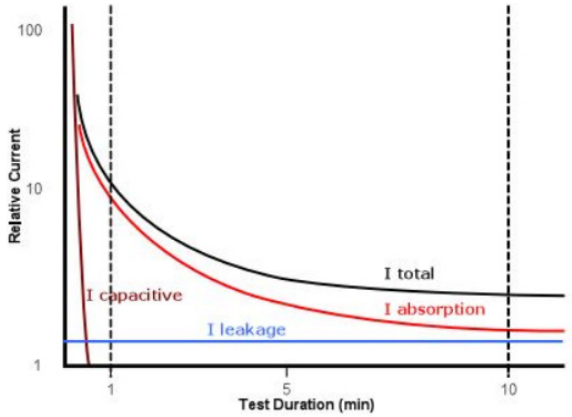


Figure 2: Behaviour of currents in an insulation sample when exposed to a DC testing voltage.

Upon applying a DC insulation voltage: surface leakage current flows across the external surfaces of the insulation as a steady current; as the insulation charges up to hold a net charge the charging current drops quickly; and as the charged dipole insulation molecules progressively align with the polarity of the DC test voltage there is a so-called absorption current which more slowly drops with time.



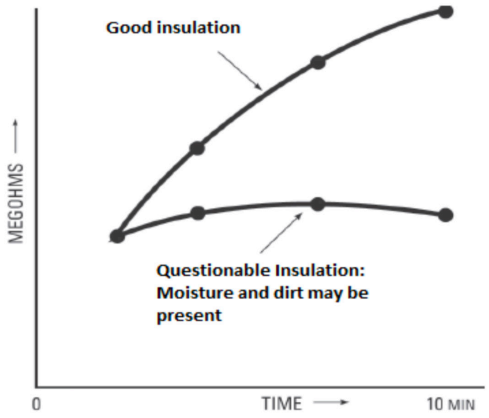
Let us now look at the various types of DC insulation assessment tests we can perform with a modern 5kV insulation tester:

a) **'Resistance Curves'.** There are two such types:

- **IR - Insulation Resistance (Not timed).** This test is typically looking for a threshold (pass/fail). Even this exercise is an art as the concept of pass fail is often relative to other phases and is subjective!! For this reason, this testing practice is not encouraged.
- **IR(t) - Insulation Resistance (time).** This test is a timed IR test...e.g.: 1min spot test Assessment will require desired pass/fail criteria for specific equipment. Spot test values can also be monitored during year-on-year trending but are not regarded as diagnostic testing per se and thus do not figure in such testing regimes.

b) **'Resistive Ratio Tests':**

- **PI - Polarization Index** (10 min) Ratio of 10min/1min resistance values. This is ideal for older insulation types but potentially has less relevance for short lengths of XLPE cable (as IR at >1 min. is generally already stabilised). As a general rule, and subject to suitable guarding being done during the test (see Guarding section below)



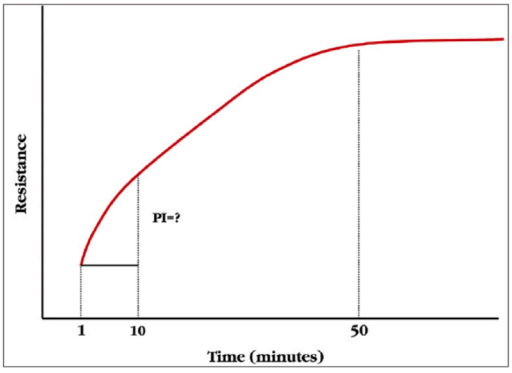


Figure 3 and 4: Generalised behaviour of IR with time in a Polarization Index Test.

- DAR - Dielectric Absorption Ratio ('DAR'). This is typically either a ratio of the insulation resistance at 60sec/30sec, or 30sec/15sec. DAR is more influenced

by the absorption current behaviour. Modern IR testers will produce such readings directly, if required.

By way of a general comment, in making such assessments it is vital to consider your test object (Size, age, materials), and test times. For example: with a short new piece of XLPE cable, DAR might be more appropriate and likely the 30/15second IR ratio would be chosen (because the absorption current is very short lived in XLPE cable).

TABLE I — Condition of Insulation Indicated by Dielectric Absorption Ratios*

INSULATION CONDITION	60/30-SECOND RATIO	10/1-MINUTE RATIO (POLARIZATION INDEX)
Dangerous	—	Less than 1
Questionable	1.0 to 1.25	1.0 to 2***
Good	1.4 to 1.6	2 to 4
Excellent	Above 1.6**	Above 4**

It is worth noting that the techniques of timed resistance tests haven't changed over many years, but the test equipment has become more sophisticated to deal with the wide range of insulation quality and dielectric materials now found in today's electrical systems. Tables, such as Table 1, provide guidance for insulation types but, that said, the figures in Table 1 are more representative of older wound paper insulation than XLPE. Thus, the testing technician should always be mindful of the type of insulation being tested and the likely behaviour and profile of such things as timed resistance ratio concepts in order that pass/fail criteria are correctly applied.

c) **Diagnostic Tests:**

- **Dielectric Discharge ('DD')** testing was developed about 15 years ago by Electricity de France to test large hydro power generator stators and all "wound" insulation, which effectively comprises of many capacitors in series. The technique in doing this test is as follows:
  The insulation is firstly charged up for 30min at a fixed voltage, after which the test equipment then connects a resistive load to the charged insulation and measures the capacity of the discharge of the insulation over a fixed time period. The size of the motor/generator will present an expected charge for good insulation. The tester calculates the discharge capacity and this is compared to the actual measured results, so as to determine a pass or fail outcome. Poor insulation (e.g. where some of the wound insulation may have poor capacitance) will show a weak discharge capacity.

  The DD test is a lesser-known test but is excellent for large wound motors and generators.

- **Step Voltage Testing (SV').** In step voltage testing the test voltage is increased in five equal steps at one-minute increments, with the final insulation resistance at each level being recorded. Ideally the measured insulation should not decrease as the test voltage is increased. Any marked or unusual resistance reduction is an indication of incipient weakness (cracks or voids). Modern electronics allows these readings to be captured automatically. A good test for older insulation... especially older PILC cables but still has relevance for XLPE cable systems (especially examining workmanship issues in joints and terminations).

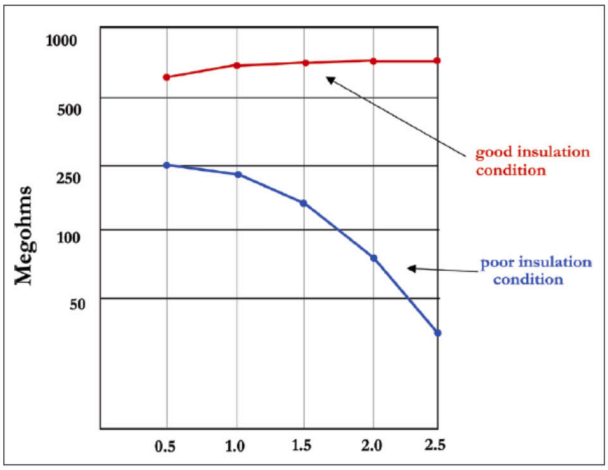


Figure 5: Step Voltage Insulation Testing, showing how IR in good insulation should increase with test voltage, but that in poor insulation this will not be the case.

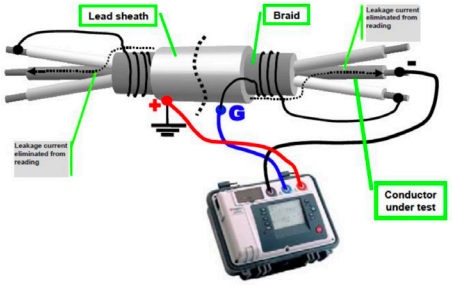
- Ramp Test: This test applies a steady increase of voltage and is thus a gentler alternative to the SV test. When using this test method, the test voltage is gradually increased at a set rate to a final level, which results in an increase in the current. In assessing the outcome, any variations in current compared to the increase in applied test voltage can provide useful diagnostic information about the condition of the insulation. This test is a more specialised one, more commonly used on rotating machinery, detecting defects such as: Cracks, Surface contamination, Uncured resin, Moisture absorption, Delamination.

Use of the Guard Terminal....Two Illustrative Examples:

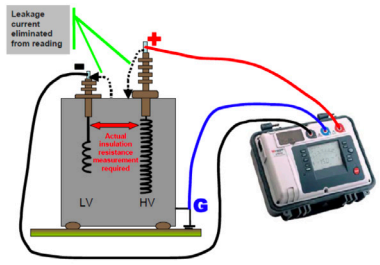
One of the least understood aspects of a 5kV insulation tester is the purpose and application of the Guard terminals. Total Leakage current = Insulation leakage plus surface leakage, where insulation leakage is the current through the insulation and surface leakage is the current across the surface of the insulation. In short, the Guard lead allows the removal of surface leakage current from a test sample, correcting the IR reading to reflect the true insulation resistance itself. Suffice to say, without its correct use most IR readings will be of no value! Thus, it is vital that the use of this lead is

now described, and two relevant examples serve to illustrate this:

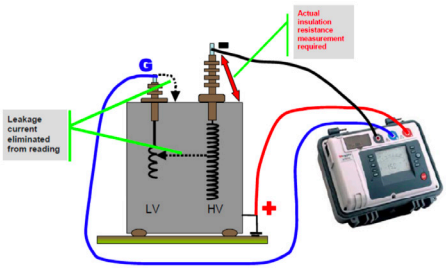
- **Example 1: Testing a power cable.**
  Importantly, for short lengths of cable (such as a feed to an overhead line) where IR values will likely be in the Tera-ohms, guarding of both ends of the cable will be vital, if that is practicable. The process is not hard and can use spare cores to achieve the guarding process.



Example 2: Transformer testing:
The selective use of the Guard Terminal allows one to test specific insulation paths on a more complex test object.



Transformer winding insulation test with the Guard used ' to eliminate leakage current', due to the surface path - across dirty porcelain insulators



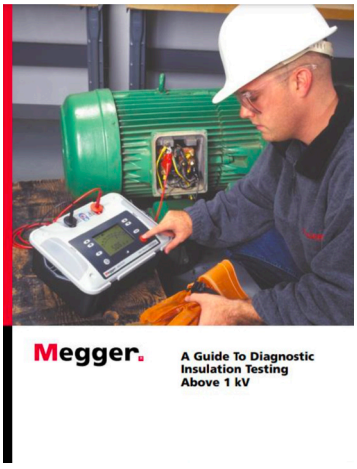
Transformer winding insulation test with the Guard used 'to eliminate leakage current', between windings and across LV bushing

Selection of a 5KV Insulation Resistance Tester:
When selecting the best insulation resistance tester ('IRT') for your application the important factors to consider include the following: Safety...Equipment CAT rating; Automated discharge... ideally with remaining voltage indicated; Appropriate Voltages; Sufficient Range for the insulation types to be tested; Capacity...Available s/c current (important on higher capacitance loads); Noise filtering; Averaging filters; DC diagnostic capability and ability to present calculated ratios directly; Result storage; Allowance of a temperature input; Portability factor: IP rating; and the quality of the leads and clamps. Ability to service and calibrate the IRT, and training in the art, are also vital selection criteria when considering a supplier.

Tips when using a 5kV Insulation Resistance Tester:
Finally, let us consider several important tips when using an IRT to best effect:

- Safety: Even though IRT are small they 'pack a punch' and have the capacity to kill a user if not handled carefully. Stored energy of test objects poses a high risk. Always ensure that the test object is discharged for typically 5 times the test time. Training, and understanding of these risks, is essential!
- Test Polarity: always connect the positive lead to earth (due to "electro-end- osmosis" effect)
- Note the test sample temperature and, where possible, normalise the readings to 15 Deg. C. As a rough rule of thumb: Insulation resistance readings typically double for every 10 degrees about 15 Deg. C and halve for every 10 Degrees below. Thus, if test temperature is not normalised, trending of tests over longer periods of time will be not possible, or will certainly lead the operator to make incorrect conclusions!
- Be wary of cable lengths in assessing expected IR values. Short lengths (say <100m) will have extremely high test values (Perhaps many Tera-ohms), but 1km of the same cable will have proportionately less resistance. Again, ensure good guarding at all times!
- Comparison of readings between phases is an excellent discipline.
- Best Practice in managing test leads: A bad lead setup can affect test results. Do a quick no lead test prior to commencing a test on the first job of the day. Opposite polarity leads should not be in contact or coiled on the ground. A final quick test with leads connected but safely isolated from ground before testing will confirm functionality and ensure most accurate results. – It is best to have spare leads available!!
- Equipment accuracy: Portable calibration boxes are available and should be used
  regularly.

Further reading: AVO New Zealand offer free to PPA members a copy of the Megger Application Guide: 'A Guide to Insulation Testing Above 1kV'.



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PLUG & PLAY

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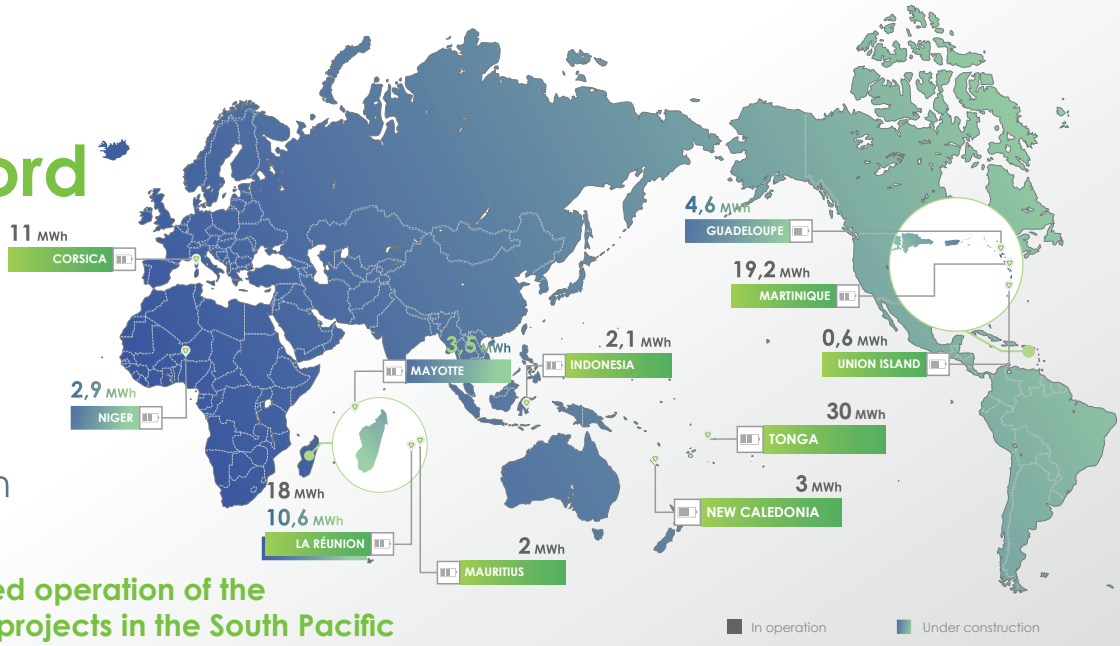
A strong track-record

80 MWh
In operation

22 MWh
Under construction



Akuo successfully started operation of the largest battery storage projects in the South Pacific totaling 30 MWh in Tonga in the end of 2021!

Akuo +61 405 734 472 bock@akuoenergy.com akuoenergy.com

Resilience Assessment Tools for Power Utilities Workshop, 7th and 8th February 2023, Samoa.

Pacific Power Association

On the 7th and 8th of February 2023, 24 participants from 14 PPA member utilities gathered at the Millennium Hotel, in Apia, Samoa to attend the workshop for "Resilience Assessment Tools for Power Utilities"
Under the Sustainable Energy Industry Development Projects funded by the World Bank, the consultants SMEC and ECA had carried out a study for EPC of Samoa, TEC of Tuvalu, and PPL of Papua New Guinea to prepare an Investment Plan to improve the resilience of the power grid.

In addition to the Investment plans for the three utilities, a Resilience Assessment tool and a Viability tool was developed to enable utilities to carry out a self-assessment of their vulnerability to natural and climate change disasters. The Resilience Assessment tool assists in the identification of risk exposures, the severity and impact of those risk events, and the options for mitigating the risk. The Viability tool assist in evaluating the economic viability of mitigation actions to provide justification for undertaking such projects. The workshop was developed and conducted by Richard Bramley and Alexander Joseph SCHMID of ECA.

The Utilities and their representatives who attended the workshop were:

	UTILITY	COUNTRY	#	NOMINEE	TITLE/ POSITION	EMAIL ADDRESS
1	Commonwealth Utlities Corporation	Saipan	1	Alfredo Palattao	Acting Chief Electrical Engineer	alfred.palattao@cucgov.org
2	Electric Power Corporation Samoa	Samoa	2	Leata Polataivao Tangatauli	Emgineering Officer Electrical - Renewal Energy	manuleleuafe@epc.ws
			3	Moeona Leo	Manager Savaii Operations	
			4	Mevaraea Vaiaso	Network System Controller Trainee	
			5	Jonathan Yoshida	Senior Engineer Renewable Power Generation	Yoshida.j@epc.ws
3	Kosrae Utilities Authority	Kosrae	6	Casey Freddy	Assistant General Manager/Legal Counsel	caseyfreddy5@gmail.com
			7	Robert Taulupe	Operation Manager	taualuper@gmail.com
4	Marshalls Energy Company INC	Marshall	8	Wayne Raymi Kijiner	Junior Electrical Engineer	wayne.kijiner@mecrmi.net
5	Chuuk Public Utility Corporation	Chuuk	9	Albert Francis	Head of Regional Utility	albert.francis@cpuc.fm
6			10	Kembo Mida	CEO	kembo.mida@cpuc.fm
	Nauru Utilities Corporation (NUC)	Nauru	11	Ken Blake	General Manager Generation	ken.blake@nuc.com.nr
8	Palau Public Utilities Corporation	Palau	12	Samuel Hesus	Plant Electrician	d.ngirameked@ppuc.com/f.kyota@ppuc.com/m.okada@ppuc.com/a.santos@ppuc.com
			13	Tilden Telltall	Plant Electrician	tteltull1995@gmail.com
9	Pohnpei Utilities Corporation	FSM	14	O'neal Lebehn	IT Manager	oneal@mypuc.fm
			15	Ioanis Henry	GI & IP Manager	ihenry@mypuc.fm
10	Public Utilities Board, Kiribati	Kiribati	16	James Young	CEO	james.young@pub.com.ki
			17	Tiaon Aukitino	Project Manager, South Tarawa Renewable Energy Project	aukitino@gmail.com
11	Solomon Power	Solomon	18	Dickson Alamania	Manager Generation & Outstation	Dickson.Alamania@solomonpower.com.sb
			19	Graham Kidoe	Manager Projects, Capital Works Division	GrahamK@solomonpower.co
12	Tonga Power Ltd	Tonga	20	Finau Moa	Acting CEO	moafinau4@gmail.com/hlavemai@tongapower.to
			21	Andrew Kautoke	Strategic & Business Development Manager	akautoka@tongapower.to
13	Tuvalu Electricity Corporation	Tuvalu	22	Taaku Sekielu	Manager Distribution	taaku.sekielu@gmail.com
			23	Mafalu Lotolua	General Manager	mafaluloto2@gmail.com
14	Te Aponga Uira	Cook Islands	24	Alistair Newbigging	Senior Engineering/Planner Officer	anewbigging@electricity.co.ck

Many participants appreciated the comprehensive methodology imposed by the tools to develop plans to improve the resilience of their power grid.

The Participants at the Resiliance Assessment Tools for Power Utilities Workshop in Samoa, 2023

Electric Power Corporation Power Station and Hydro

Renewable Energy and Green Economy Trainings for Remote Rural Communities in Fiji, Vanuatu, Papua New Guinea and Solomon Island.

SEIAPI Magazine
Mohammed Tazil (GGGI)

The Global Green Growth Institute (GGGI) conducted community level trainings in Fiji, Vanuatu, Papua New Guinea and Solomon Islands under its project titled "Capacity Building to Strengthen Sustainable Implementation of Renewable Energy Technologies for Rural Energy Access". This initiative was part of a 4-year regional project, funded by the Republic of Korea through the Korea International Corporation Agency (KOICA) in partnership with GGGI.

The project aimed at training 3000 people in all 4 countries, including 40% women and 20% vulnerable groups. The target groups were local government officials, small businesses, local technicians, and traditional and community leaders. The project's main objective was to strengthen informed and inclusive decision-making by resource owners and local government officials for integration of green economy and renewable energy into local level planning and to strengthen implementation of renewable energy infrastructure for rural electrification.

GGGI has worked closely with local partners and developed 10 training modules, complete with detailed Trainer Guides as well as simplified local language translated Learner Workbooks on the topics listed below. Each of the 4 countries has its own customized version of the modules to make it more relevant to the local context.

1. Green Economy General Principles
2. Green Business Basics
3. Energy Efficiency Basics
4. Inclusive Development
5. Renewable Energy General Principles
6. Renewable Energy Project Financial Management
7. Solar in the Community
8. Solar Operations and Maintenance basics
9. Pico- Hydro in the Community
10. Pico- Hydro Operations and Maintenance basics.

Figure 1: Participants from Vunisea in Kadavu (Fiji) working on the pico-hydro system demonstration.

A total of 32 experienced local trainers had undergone 2 weeks of Training of Trainers workshops in 4 countries, out of which 16 were mobilized to the selected remote rural communities to deliver the trainings. In Fiji, the communities trained were Bukuya in Vitilevu, Vunisea in Kadavu, Rukua in Beqa, Buca in Vanualevu and Tutu in Taveuni.
In Vanuatu, the communities trained were Parissa and Small (Big) Nanuku in Santo, Tisman and Vinmavis in Malekula and Melsisi in Pentecost.

In PNG, the communities trained were Imuagoro, Kwikila station, Keapara, Alukuni, Karawa and Kalo in Rigo district. In Solomon Islands, the communities currently being trained are Lambi, Barana, GPPOL and Selwyn College in Guadalcanal as well as Tulagi and Bishop Koete in Central Province. For the development of some of the technical training modules, SEIAPI standards were adopted and acknowledged. All 4 countries training modules and project information are available for free online at: https://greeneducationportal.org/.

We look forward to you downloading and sharing the training modules amongst your networks.

Figure 2: Participants from Melsisi in Pentecost (Vanuatu) conducting wiring exercise on the solar home system demonstration kit.

Power Systems Analysis Workshop, 13-17 February 2023, Fiji

Pacific Power Association

From the 13th February 2023, 26 participants from 15 PPA utility members attended a workshop at the Novotel Hotel in Nadi, Fiji, on the power system analysis software – PowerFactory.

The PPA has acquired 2 licenses for the PowerFactory application from DigSilent, Germany, and will may access available to utility members to carry out power system analysis. The workshop presenters were Mr Wayne Ong and Mr Navjot Gill of DigSilent, Australia.

The workshop included hands-on exercises on the following topics:

a. PF-1-01 PowerFactory user interface
b. PF-1-02 Network Construction and Data Entry
c. PF-2-02 Introduction to Load-flow Calculations
d. PF-2-02 Introduction to Short Circuit Calculations
e. PF-2-05 Analysing results in PowerFactory
f. PF-2-07 Medium voltage network analysis
g. PF-2-10 Operation Scenarios
h. PF-3-02 Parameter characteristics

2.5 days Analysis

a. PF-3-05 Protection elements
b. PF-3-06 Time-overcurrent protection analysis
c. PF-3-32 Cable Sizing
d. PF-2-16 Quasi-dynamic simulation
e. PF-3-20 Introduction to Time Domain simulations
f. PF-3-22 Motor Start-Up Simulations
g. PF-3-14 Introduction to power system harmonics in PowerFactory
h. PF-3-15 Harmonic Load-flow analysis tools
i. PF-3-16 Harmonics: Network Frequency response

The participants in the workshop were:

	UTILITY	COUNTRY	#	NOMINEE	TITLE
1	Electric Power Corporation Samoa	Samoa	1	Helena Stowers	Graduate Engineer - Electrical
			2	Sueina Vaatausili	Graduate Engineer - Electrical
			3	Brendan Gwilliams	Senior Engineer Thermal
	Commonwealth Utilities Corporation	Saipan	4	Abundio Cano	Electrical Engineer
2	Chuuk Public Utility Corporation	Chuuk	5	Chris Killion	RE Technician
3	Kosrae Utilities Authority (KUA)	Kosrae	6	Atelea Taualupe	KUA Operation Manager
			7	Casey J Freddy	Assistant General Manager/Legal Counsel
4	Marshalls Energy Company INC	Marshalls	8	Wayne Raymi Kijiner	Junior Electrical Engineer
5	Nauru Utilities Corporation (NUC)	Nauru	9	Jonpeal Rodiben	General Manager Network Operations
			10	Detroit Jacobs	Overhead Teamleader - Power Distribution
8	Palau Public Utilities Corporation	Palau	11	Tito Cabunagan	PGD Manager
			12	Josiah Immanuel	Plant Electrician
9	Pohnpei Utilities Corporation	FSM	13	Ioanis Henry	GI & IP Manager
			14	O'neal Lebehn	IT Manager
10	Public Utilities Board (Kiribati)	Kiribati	15	Bauro Mikaere	Instrumentation & Control System Engineer
			16	Ioata Remon	Electrical Network Engineer
11	Solomon Power	Solomon Islands	17	Lawrence Terry	
			18	Silas Daefa	Distribution Engineers
12	Tonga Power Ltd	Tonga	19	Viliami Ongosia	Network Design & Planning Manager
			20	Matapa Sialevani Havea	Project Engineer
13	Tuvalu Electricity Corporation	Tuvalu	21	Taaku Sekielu	Lawrence Terry
			22	Mafalu Lotolua	General Manager
14	UNELCO	Vanuatu	23	Ron Jaquier	Distribution Network Maintenance Manager
			24	Raymond Rory	Control and Measurement Manager
15	Te Aponga Uira	Cook Islands	25	Makara Murare	Field Services Manager
			26	Daniel Webb	Electrician/RE Officer/Faultman

PowerFactory is a necessary tool in the planning, design and operations of a power grid and all participants agreed that more training was required to fully exploit the capabilities of thie software application.

The Participants at the Power Systems Analysis Workshop in Fiji, 2023

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RE Infrastructure Should be Designed for Climate Resilience and Energy Security

SEIAPI Magazine

New energy infrastructure is generally designed to function for 30 years or more and this is as valid for solar PV as for diesel systems. High quality panels can be expected to provide 25 years of energy output at 80% or more of rated output but some there are recent claims of 80-88% after 40 years. Lithium battery output and lifetimes vary considerably depending on quality, usage patterns and battery chemistry with EV batteries lasting longer than expected, exceeding guarantee periods. In general, a long lifetime is feasible for a well-designed PV system.

SEIAPI members need to be aware of the projected changes in climate and weather during the expected system lifetime – 2050 or beyond – for the countries and specific localities for which they design RE systems: design and build today for the expected environment of 2050. Among these changes is the expected severity of future hurricanes/cyclones. For Fiji, hurricane wind speeds have increased in the past decade and this is reflected in a new building code. Implications for SEIAPI can be covered in a future article if there is interest.

For the Pacific overall, the southern hemisphere is very stormy. The northern hemisphere has nothing comparable to the extreme storms, winds and waves of the south, which is about 24% stormier than the north Pacific. Recent research shows that the southern hemisphere is getting even stormier over time, whereas the north is not, and this is consistent with what climate models simulate for a warming world. Increased storminess can result in more extreme winds, temperatures and rainfall. The implication for us is that design standards for (for example) the robustness of PV systems based on tropical conditions globally may overestimate the residence of systems for the south.

[1] Solar Panel Lifespan Guide: How Long Do Solar Panels Last? (GreenCoast 19 Aug 2022) https://greencoast.org/solar- panel-lifespan/

[2] Lithium Battery Cycle Life (Climatebiz 15 Nov 2022) https://climatebiz.com/lithium-battery-cycle-life/

[3] How Long Does an Electric Car Battery Last? (EV Connect, 8 Nov 2022) https://www.evconnect.com/blog/how-long- does-an-electric-car-battery-last (Car & Driver 27 Oct 2022) https://www.caranddriver.com/research/a31875141/electric-car- battery-life/

[4] Why the southern hemisphere is stormier than the northern (CarbonBrief 12 Dec 2022) https://www.carbonbrief.org/guest-post-why-the-southern-hemisphere-is-stormier-than-the-northern/

Solomon Power Output-Based Aid Program SOLOMON ISLANDS

B&R Enclosures

THE PROJECT

Solomon Power is managing a grant-financing project from the Global Partnership on Output-Based Aid (GPOBA) adminstered by the World Bank for an Output-Based Aid (OBA) program. This program is designed to help low income households pay for the on-off upfront initial connection fee to access grid electricity.

The Output-Based Aid (OBA) program aims to energise a total of 2,565 households in the Solomon Islands.
The Solomon Islands Electricity Authority (SIEA) trading as Solomon Power (SP) is a State Owned Enterprise (SOE) constituted under the Solomon Islands Electricity Act of 1969. They are responsible for the generation, transmission, distribution and retail of electricity. This body also has the responsibility for providing electricity efficiently and profitably throughout the Solomon Islands.

Low income households tend not to connect to the power grid because of the high up-front costs, being left with no access to income-producing benefits and improved welfare from grid electrification. Residents tend to spend more on expensive and low quality electricity supply, such as car batteries or small solar home systems.

The OBA Program is designed to provide one-off subsidies to eligible low-income households to cover a portion of the upfront cost of electricity service connections in the Honiara grid (existing service area and planned expansion areas), and in the outstations. The OBA subsidy covers materials and installation of the service line and auxiliary pole, when needed; and in-house wiring including protection, earthing, and two LED light bulbs in accordance with the AS/NZS Wiring Rules 3000 and Solomon Islands Electricity Act & Regulations.

Solomon Power continues their tendering process to purchase House Wiring Materials from respectable suppliers for this OBA Project globally.

"We just wanted to find someone that could give us what we wanted, not what they thought we wanted. B&R did this for us"

THE B&R SOLUTION

The supply of the electrical enclosures was done in two stages with the first stage of supply consisting of 200 units of Temporary Power enclosures TB1212/U. A second order was placed with B&R for the Temporary Power TB1212/U that were fully wired with switchgear, GPO's and lights supplied within the enclosure.

This ensured ease of managing the rollout with the installing contractors and were custom built to suit their needs. B&R used extensive experience through their value add services team to manage the wiring and fit out of the enclosure. This ensured strong and consistent connections with switchgear and accessories suppliers in Australia to provide a complete package offer.

B&R hosted Solomon Island's Electrical Authority Regulatory Manager, Mr Kitione Maluguleva in late 2016. Mr Maluguleva visited to tour the facilities in Heathwood, Brisbane. His visit included discussion on how B&R could assist with providing a turnkey offer ensuring ease of supply and installation.

Welcome!

to the New Allied Members and Members Re-Joining the Secretariat

One (1) new Company has joined and two (2) has re-joined PPA as Allied Members since our last PPA Magazine.

The new Allied Member is:
SOLAR HUB: Solar Hub is based in Suva, Fiji. Their primary activity is solar power (consultancy, design, supply and install).

The re-joined members are:
EIF INTERNATIONAL: EIF International is based in Auckland, New Zealand Limited. Their primary activity is freight forwarding logistics. Their secondary activity is project cargo handling and shipping.

HNAC TECHNOLOGY: HNAC Technology Limited is based in Hunan Province, China. Their primary activity is Hydropower station, pumping station, water treatment, photovoltaic EPC general contract. Their secondary activity if supply of equipment and service.

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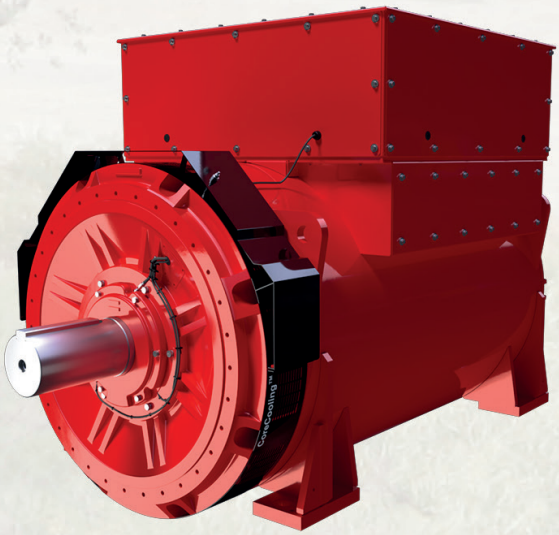

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