A PACIFIC POWER ASSOCIATION PUBLICATION
VOLUME 34 ISSUE 1 - MARCH 2026

The Engineers Workshop in Palau, conducted in conjunction with the PPA 32nd Annual Conference & Trade Exhibition – 2025.

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PPA

March 2026, Volume 34 Issue 1

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PACIFIC POWER magazine is published four times a year.

Advertising
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Pacific Power Association, Suva, Fiji Islands

Layout & Design
Printhouse Pacific Pte Limited

This magazine is read by an audience of opinion leaders in governments, development partners, the public service, the academic community, the media in the Pacific and members of the Pacific Power Association. Subscription to Pacific Power magazine is available at US $60 a year from the association.

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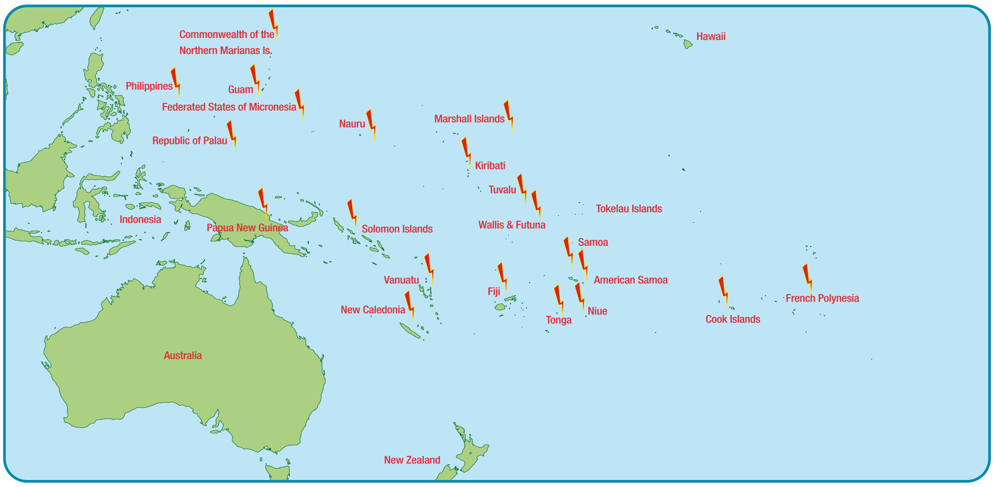

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Editor’s Note

Gordon Chang
Executive Director

Paradigm Shift in Diversity and Supply of Energy

John Benavente, General Manager,
Guam Power Authority

Guam Power Authority Charts a Bold Course Toward a Resilient, Renewable Energy Future

As island utilities around the world confront rising fuel costs, climate risk, and evolving reliability expectations, Guam Power Authority (GPA) is emerging as a model for how a small, isolated grid can lead with innovation, strategic planning, and resilience.

Serving as the sole electricity provider for Guam—including critical U.S. military installations—GPA supplies power to a population of roughly 160,000 across a geographically compact yet operationally complex system. With peak demand of approximately 272 MW and total generation capacity nearing 450 MW, the utility is undertaking a comprehensive transformation of its energy portfolio, infrastructure, and workforce to ensure reliable, affordable, and sustainable power for decades to come.

From Fuel Dependence to Portfolio Diversity

Historically dependent on imported petroleum fuels, GPA has embarked on a paradigm shift in how energy is sourced and delivered. The utility is transitioning from a single-fuel model toward a diversified mix that integrates renewables, high-efficiency conventional generation, and energy storage. This strategy reduces exposure to global fuel price volatility while strengthening energy security amid geopolitical uncertainty.

Central to this transition is GPA's long-term goal of achieving at least 40% renewable energy by 2028—an ambitious target for an island grid with limited land and no interconnections. Through competitive renewable contracts, fuel conversion initiatives, and new generation investments, GPA is steadily reducing fuel imports while maintaining grid reliability.

Ukudu Power Plant: A Cornerstone Investment

One of GPA's most significant milestones is the commissioning of the Ukudu Power Plant, a 198-MW high-efficiency facility designed to operate on ultra-low sulfur diesel and liquefied natural gas. Ukudu represents a major leap forward in efficiency, environmental compliance, and operational flexibility.

Operational as of December 2025, Ukudu has a thermal efficiency of approximately 51%—well above legacy oil-fired units—the plant is expected to reduce fuel oil imports by an estimated 930,000 barrels annually while improving system reliability and meeting U.S. Environmental Protection Agency standards. The project also integrates a 25-MW battery energy storage system, enhancing grid stability and fast-response capability.

Scaling Renewables and Storage

Beyond Ukudu, GPA is aggressively expanding its renewable and storage portfolio. Major utility-scale solar projects—paired with 50% battery energy-shifting storage systems—are advancing under GPA's Phase IV Renewable Energy procurement, with projects totaling over 300 MW of solar capacity. These investments address the operational challenges of solar integration, including the "duck curve," while displacing costly fuel generation.

Energy storage plays a central role in GPA's strategy. Plans for centralized energy storage systems totaling up to 180 MW and 900 MWh are designed to enhance reliability, support renewable penetration, and provide contingency capacity during extreme events.

Financial Discipline and Customer Impact

GPA's transformation is underpinned by strong financial stewardship. Despite fuel price volatility, the utility has maintained revenue stability while reducing payroll costs and improving operational efficiency.

Importantly, GPA's investments are projected to deliver tangible benefits to customers. Modeling shows that the combined impact of Ukudu and new renewable resources could significantly reduce customer bills under high fuel-price scenarios, reinforcing the utility's commitment to affordability.

Building Resilience Above and Below Ground

In a region prone to typhoons and other hazards, resilience is not optional—it is foundational. GPA continues to invest heavily in underground transmission, hardened substations, hybrid distribution systems, and IT/OT infrastructure. A long-term resilience plan, estimated at $6.4 billion, addresses physical hardening, hazard mitigation, and cybersecurity enhancements across the system.

Cybersecurity and physical security are treated as core operational priorities. GPA reports no material cyber incidents to date and continues to invest in staff training, system monitoring, and protective technologies.

Investing in People and Partnerships

Recognizing a looming wave of retirements, GPA is proactively strengthening its workforce through apprenticeships, internships, and in-house training programs. Succession planning and skills development are integral to sustaining operational excellence as the utility modernizes its assets and systems.

Collaboration is another hallmark of GPA's approach. The utility works closely with federal agencies, industry partners, and other Pacific utilities to share best practices, secure grant funding, and align long-term resource planning with community needs.

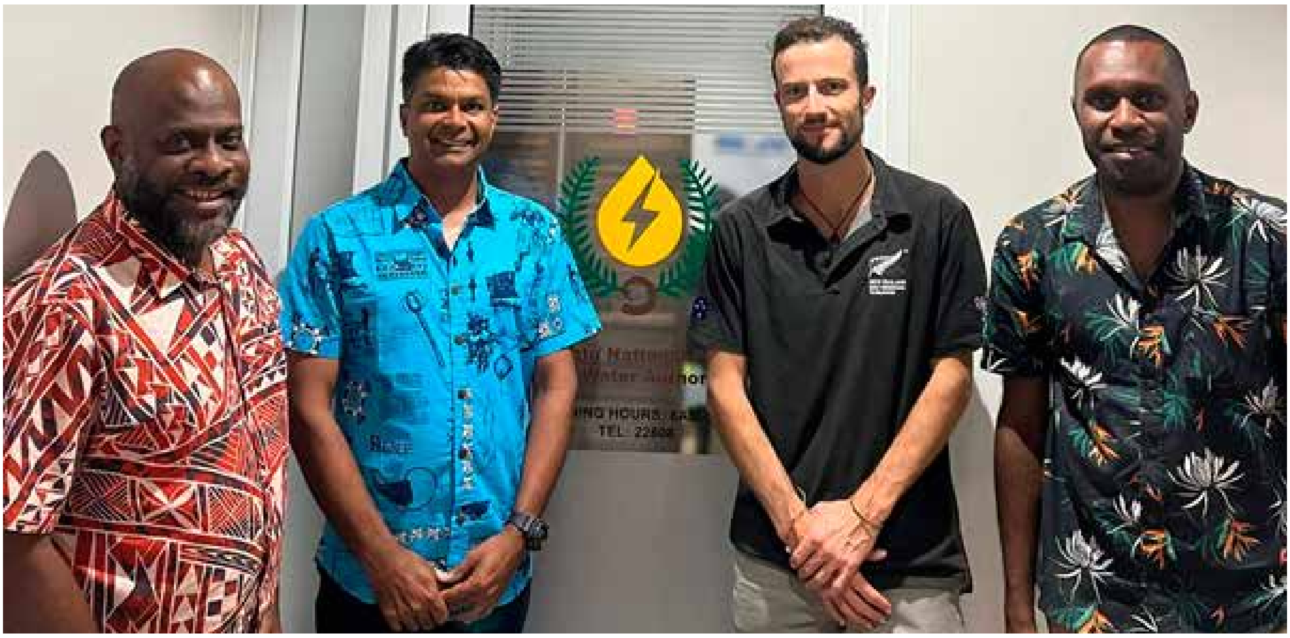
A Model for Island Utilities

Through disciplined planning, strategic investment, and a clear vision for the future, Guam Power Authority is redefining what is possible for island power systems. By integrating renewables, advanced generation, energy storage, and resilience at scale, GPA is not only lowering costs and emissions—it is building a more secure and sustainable energy future for Guam.

For utilities facing similar constraints and challenges, GPA's journey offers a compelling example of innovation in action.

From Diesel Dependence to Renewable-Ready: Scinergy's Work with VAN-PAWA in Vanuatu

Janendra Prasad, Director/Principal,
Scinergy Pacific (Fiji) Ltd/Scinergy International Ltd



RESSET Project Stakeholder Meeting – Coordinated discussions with government, VANPAWA and development partners to progress renewable system-strengthening initiatives.
Pictured: Romney Marum (General Manager, VAN-PAWA); Jay Prasad (Scinergy); Christopher Hartnett (MFAT); Matthew Tasale (Director of Energy, Vanuatu)

In the Pacific, the energy transition isn't playing out on vast continental grids but rather unfolding on small, remote island systems where every generator, every line and every litre of diesel counts.

Scinergy Pacific (Fiji) Pte Ltd sits at the heart of this transition. Based in the region and embedded in its realities, Scinergy specialises in helping island utilities move from reactive operations to resilient, renewable-ready power systems.

Instead of proposing complex, hard-to-maintain solutions, Scinergy focuses on practical, robust designs that local teams can own and operate, offering clear operating procedures, realistic maintenance regimes, and system layouts that simplify, rather than complicate, daily operations.

Inspection of the Brenwe Hydropower Sites, Malekula – Field assessment of hydropower assets supporting reliable and sustainable generation.

Pictured: Jay Prasad (Scinergy), Richard Morin (Operations Manager, Malekula)

Partnering with VAN-PAWA: Making Island Grids "Renewable-Ready"

When the Vanuatu National Power and Water Authority (VAN-PAWA) set out to transform its islanded power systems, it knew that adding solar alone wouldn't be enough. As an emerging national utility responsible for electricity and water services, VAN-PAWA oversees the challenging Tanna and Malekula grids, which operate in remote and harsh coastal and volcanic-ash environments where demand is rising, infrastructure is ageing, and redundancy is thin.

Like many Pacific Island Countries and Territories, these systems carry the burden of high fuel costs and growing expectations for clean, reliable and affordable power. With limited technological capacity VAN-PAWA's insight was simple but strategic: a renewable revolution only works if the underlying grid is strong.

In early 2026, VAN-PAWA adopted a phased roadmap to first stabilise and modernise operations then scale renewables in a controlled, sustainable way.

To deliver on this vision, VAN-PAWA engaged Scinergy under an Integrated Owner's Engineering and Technical Advisory Services Agreement, with a clear mandate, to make Tanna and Malekula "renewable-ready."

Knowing the Grid Before Turning Up the Solar

Scinergy began by looking under the hood of both systems. A Baseline Desktop Review and Technical Due Diligence examined:

- ✓ Generation assets and control strategies
- ✓ Network configuration and protection systems
- ✓ Demand trends and load growth
- ✓ Operating procedures and institutional arrangements

For small, isolated grids, this whole-of-system "x-ray" is critical since one weak link can derail renewable integration!

Data analysis was matched with time on the ground. Scinergy's engineers travelled to Tanna and Malekula to work alongside local operators, inspect generators and switchboards, and review maintenance and protection practices. Every recommendation was grounded in how the systems actually run and not just in models.

Treating the networks as integrated systems rather than scattered assets, Scinergy mapped generation dispatch, reserve margins, protection coordination and maintenance regimes together. The resulting roadmap identified enabling investments such as:

- ✓ Improved N-1 redundancy
- ✓ Refined switchboard layouts
- ✓ Updated generator control strategies
- ✓ Stronger maintenance planning

These are the nuts and bolts that quietly unlock higher renewable penetration.

Aligning 100% Renewable Ambition with Grid Reality

Vanuatu's national target of 100% renewable electricity by 2030 is bold and on small grids can become risky if pursued without discipline. Across the Pacific, rapid solar PV rollouts without corresponding grid upgrades have led to voltage swings, frequency instability, operational challenges, and stranded assets.

On Tanna, the MFAT-funded Renewable Energy Systems with Storage on Efate and Tanna (RESSET) programme will introduce solar PV and battery energy storage systems (BESS). Additional projects, like the proposed IPP, a 300 kW Mana Pacific solar facility must be integrated into the system and not simply bolted on.

VanPAWA field crew in undertaking low-voltage network extensions to enable new customer connections and improve access to electricity in Malekula

As Owner's Engineer, Scinergy is reviewing these projects for compatibility with existing infrastructure and long-term plans. Forthcoming detailed power-system studies and grid modelling will map:

- ✓ Optimal System Configuration
- ✓ Hosting capacity
- ✓ Reserve requirements
- ✓ Protection settings
- ✓ Dispatch and control strategies

The overarching goal is to ensure diesel, solar and BESS operate as one coordinated system that lifts renewable shares without sacrificing service quality.

A Phased Pathway: From Reliability to Resilience

Together, VAN-PAWA and Scinergy are following a staged roadmap:

Short term: Improve reliability and plant availability through critical spares, upgraded control systems and protection, better maintenance planning and tighter operating procedures such as reducing outages and creating a stable platform for investment.

Medium term: Move into structured renewable integration with stability studies and hosting-capacity, smarter dispatch, advanced control and protection schemes, improved data systems and robust technical specifications, supported by institutional training, financial planning and procurement support.

Long term: Build institutional strength and local technical capacity via planned and programmed asset management, expanded access, regulatory alignment, and the development of Vanuatu's own engineering capability.

The outcome is not just more solar panels, but a modern Pacific utility and a replicable model for other island systems navigating the same journey!

Powering Pacific Islands with Practical, Proven Renewable Solutions

Scinergy combines deep technical capability with on-the-ground experience across Pacific Island power systems. As an active member of SEAIPI and an Allied Member of the Pacific Power Association, we help shape regional energy initiatives while delivering practical solutions in Vanuatu, Solomon Islands, Timor-Leste, FSM, PNG and beyond. Our team understands the realities of dispersed island grids from limited redundancy and high transport costs to tight spare-parts supply and designs simple, robust systems that local operators can own and maintain. Led by Jay Prasad, a Chartered Professional Engineer with over 20 years' experience in renewable integration and utility advisory, Scinergy provides end-to-end support such as technical due diligence, renewable roadmaps and expansion modelling, grid integration and stability studies, Owner's Engineer and procurement advisory, generator and control system design, smart grid and protection planning, institutional strengthening, capacity development, and climate finance and mitigation programme design.

With a strong focus on partnership and practical delivery, Scinergy Pacific (Fiji) Pte Ltd works alongside utilities, governments and energy sector stakeholders to support Pacific Island energy transitions helping turn power systems into resilient, renewable-ready grids.

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Modernising Island Grids With Smart Hybrid Systems - A Case Study From Lombok, Indonesia

Kari Punnonen, Director-Energy Business,
Wartsila

Island utilities are navigating one of the most complex energy transitions in the world. Unlike large, interconnected power systems, island grids operate in complete isolation, and there is no neighboring region to lean on when supply tightens, frequency drifts, or renewable output suddenly drops. As a result, the pressures created by rising electricity demand and increasingly ambitious renewable targets are amplified in isolated island systems.

For most island grids, the energy transition is no longer a question of whether to adopt renewables, but how to integrate them reliably and cost-effectively. The variability in renewable output presents challenges for the grid stability, and island utilities must carefully balance reliability, affordability, and decarbonisation. The Lombok Island in Indonesia provides a practical example of how flexible engine power plants paired with solar PV can form a modern hybrid system that supports renewable growth while maintaining security of supply.

The operating reality of island grids

Island grids are relatively small, isolated, and often built around conventional thermal generation such as coal or oil-fired plants. These units were typically designed to operate at steady output. They are less suited to frequent starts, stops, and rapid output changes.

At the same time, solar PV is becoming more attractive. Capital costs continue to decline, and governments are encouraging cleaner generation. However, solar output varies throughout the day and drops rapidly in the late afternoon. Without flexible generation in the system, this variability can create operational stress.

Lombok reflects many of these characteristics. Electricity demand on the island is growing steadily and is projected to increase further toward 2030. The generation mix includes coal-fired steam plants, oil-based units, hydro, and solar PV. The challenge for PLN, the Indonesian state utility, has been clear: how to expand solar capacity while ensuring stable operation of the grid.

Lombok's growing demand and renewable ambitions

To assess future development options, Wärtsilä supported PLN in modelling Lombok's power system. The analysis examined how additional solar PV could be integrated while maintaining reliability and controlling costs.

The modelling indicated that Lombok could add around 40 to 50 MW of solar PV annually, provided that sufficient flexible balancing capacity was available. Reciprocating engines were identified as a key enabler of this pathway.

Under the optimised scenario of the modelling, renewable generation could gradually increase and reach approximately 17 percent of total generation by 2030. Coal's share would decline compared with a conventional expansion plan.

The central insight was clear: flexibility enables higher renewable penetration.

What is an engine power plant?

Flexibility is becoming increasingly crucial for modern power systems. As the share of renewables grows, power systems must be able to respond quickly to changes in supply and demand and to the variability introduced by renewables. Battery energy storage can handle millisecond and minute-level balancing, while flexible balancing engines can handle minute-level, daily and even seasonal variations. Flexible engines are ideal for providing the needed flexibility: they can start in minutes, ramp up and down quickly, and run efficiently at partial loads.

To understand the Lombok solution, it is helpful to look more closely at engine power plants and how they differ from traditional thermal generation. Engine power plants are based on reciprocating internal combustion engines that can run on gas, liquid fuels, or both in a dual-fuel configuration. Instead of relying on a single large unit, they consist of multiple modular engines operating in parallel. This modular design enables the plant to vary in size depending on the grid's requirements.

The 135 MW Lombok plant, commissioned in 2019 and owned by PLN, includes 13 Wärtsilä 34 dual-fuel engines. The facility is configured as a Flexicycle plant, meaning that waste heat from the engines is recovered through a steam turbine to improve overall efficiency. The engines can run on LNG or light fuel oil, providing fuel flexibility.

Engine power plants offer characteristics that are particularly valuable in island systems:

- Fast start capability, reaching full load within minutes
- Rapid ramping to follow changes in demand or renewable output
- High efficiency across a wide load range
- Modular operation, allowing units to start and stop individually

These features allow engine plants to move beyond a traditional baseload role and act as flexible balancing assets.

Dispatch in a hybrid system

A hybrid power system combines variable renewable energy (VRE), such as solar PV and wind, with highly flexible gas engines to reliably meet a defined load profile. By integrating low-marginal-cost renewable generation with fast-responding dispatchable capacity, the system provides firm power and grid stability while offering a flexible alternative to conventional baseload generation.

The daily dispatch profile illustrates how the hybrid system functions. During midday hours, when solar production is high, engine output decreases. Fuel consumption and emissions are reduced accordingly. As solar generation declines in the late afternoon, the engines ramp up to meet rising demand and the evening peak.

Because the engines can respond quickly, they stabilise frequency and ensure secure operation even as renewable output fluctuates.

The dispatch modelling based on Lombok's historical load data demonstrates this dynamic clearly. Solar energy serves daytime demand, while engines provide firm capacity when it is most needed.

Comparing three development scenarios

To quantify the impact of additional solar, three scenarios were analysed:

1. The existing engine power plant operating on its own
2. The engine power plant combined with 50 MW of new solar PV
3. The engine power plant combined with 100 MW of new solar PV

The analysis compared both levelised cost of electricity and emissions intensity.

When 100 MW of solar PV was added alongside the existing engines, annual system savings were estimated at approximately 7.4 million US dollars. The levelised cost of electricity declined from 12.3 to 11.1 US cents per kilowatt hour. Emissions intensity decreased from 0.46 to 0.35 tonnes of carbon dioxide per megawatt hour.

Importantly, these improvements were achieved without compromising system reliability. The engines provided the flexibility needed to integrate the additional solar output efficiently.

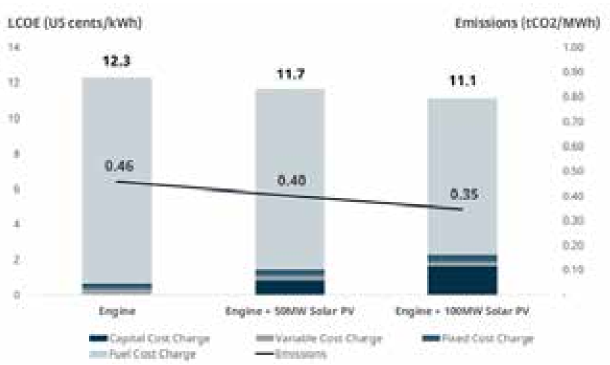
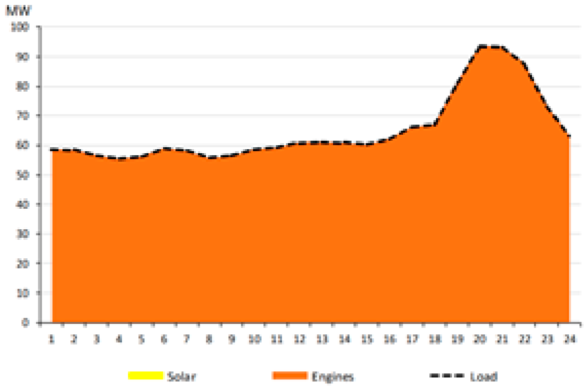


Figure 1. Comparison of levelised cost of electricity and emissions for three scenarios in Lombok: engine only, engine plus 50 MW solar PV, and engine plus 100 MW solar PV.

Lombok case study dispatch graph



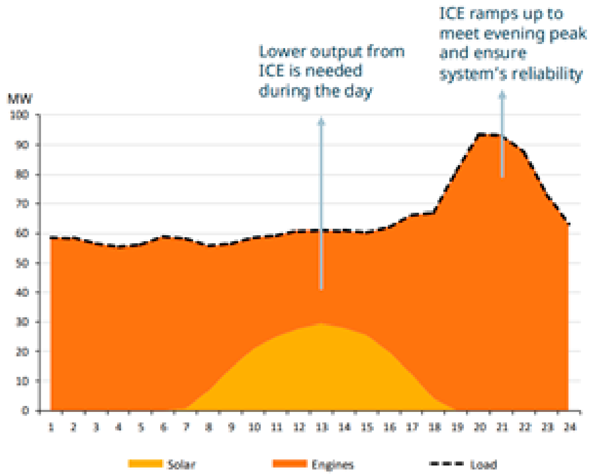


Figure 2. Example daily dispatch profile showing solar generation during daylight hours and engine output increasing to meet evening peak demand.

A practical pathway for island systems

The Lombok experience shows that flexible engine power plants do not compete with renewables. Instead, they create the operating conditions that allow solar capacity to expand without jeopardising reliability.

For island utilities across the Pacific, the key lesson is that renewable integration and system stability must be planned together. By pairing solar PV with flexible engine capacity, utilities can reduce costs, lower emissions, and maintain secure power supply as demand grows.

The transition pathway will differ from one island to another. However, the principle demonstrated in Lombok remains relevant: flexibility is essential for modernising island grids. Wärtsilä, with strong experience in powering island with flexible power sources, looks forward to continuing to support island utilities with advanced system modelling to design resilient, cost-optimal power systems that integrate the increasing shares of renewables.

Revenue Protection Through Field-Based Meter Site Analysis

Marcus Zickerfoose, Manager of Customer Solutions & Marketing,
Radian Research

Why Meter Accuracy Alone Isn't Enough

Every electric bill represents a financial transaction: energy is consumed, payment is exchanged, and both the utility and the customer expect it to be fair. Utilities invest heavily in meter testing programs to ensure meters meet regulatory and ANSI accuracy requirements. However, meter accuracy alone does not guarantee accurate billing.

A revenue meter can pass every laboratory test and still produce an incorrect bill once installed in the field. That's because the meter is only one component of a much larger measurement system that includes wiring, current transformers (CTs), potential transformers (PTs), test switches, burden, and billing system configuration.

Field-based meter site analysis evaluates the entire system under real-world conditions, uncovering issues that shop testing alone cannot detect.

Legal, Regulatory, and Business Drivers

Utilities test meters to comply with:

- Public Service Commission (PSC) requirements
- ANSI C12 standards
- Internal utility best practices

Standard shop testing verifies meter accuracy at full load, light load, and specific power factor conditions. These tests confirm the meter performs correctly in isolation.

They do not confirm that the meter is measuring the site accurately once installed.

Transformer-Rated Sites: Where Risk Increases

Transformer-rated metering sites introduce multiple additional sources of error, including:

- Wiring and phasing mistakes
- CT polarity and ratio errors
- Excessive or unbalanced burden
- Administrative configuration mistakes
- Undetected theft

Industry experience consistently shows:

- Up to 5% of transformer-rated sites contain significant errors
- Those few sites account for a disproportionate share of revenue loss
- Individual site losses often reach tens or hundreds of thousands of dollars over time

The magnitude of loss depends on:

- Type and severity of the error
- Duration (months, years, or decades)
- Size and load profile of the customer

Common Error Categories and Their Impact

Wiring Errors

Wiring issues at meter sockets, CT secondaries, or test switches can cause:

- Negative power registration
- Zero energy registration on one or more phases
- Partial loss that appears plausible but is materially incorrect

Because real energy is calculated using:

Watt-hours = Voltage × Current × Power Factor × Time

Even small phase-angle errors can significantly reduce recorded energy.

CT and PT Errors

CT-related problems include:

- Incorrect CT ratios
- Reversed polarity
- Cross-phased connections
- Excessive burden from long wire runs or improper terminations

Many CT accuracy classes have no defined performance specification below 10% rated load, which is where many sites operate for large portions of the day.

Administrative Errors

Revenue loss is not always electrical in nature. Common administrative issues include:

- Incorrect billing multipliers
- Configuration mismatches between field equipment and billing systems

- Data entry or setup errors

In some cases, administrative errors alone have resulted in six-figure annual losses.

Why Visual Inspections Fall Short

Visual inspections are often insufficient because:

- Meter sockets hide internal connections
- Aged or dirty wiring obscures polarity and phasing
- CT nameplates and polarity markings may be inaccessible
- Tracing conductors across multiple cabinets is difficult or impossible

Many serious revenue-impacting errors appear completely normal during a visual check.

Field Testing Methods That Reveal Hidden Problems

Customer Load Testing

Customer load testing evaluates the metering system under actual operating conditions, capturing:

- True load balance and harmonics
- Real phase relationships
- Environmental and connection-related issues

When the installation is correct, the meter and test equipment should see identical:

- Voltages
- Currents
- Phase angles
- Power and energy values

Any discrepancy indicates a site issue rather than a meter accuracy problem.

Phantom Load Testing

Phantom load testing applies a controlled voltage and current source through the installed wiring. This enables:

- ANSI accuracy testing through the test switch
- Four-quadrant power validation
- Element and phase verification

This method isolates wiring and configuration errors while removing customer load variability.

CT Testing

Field CT testing verifies:

- Ratio accuracy
- Phase-angle error
- Burden impact on performance

CT testing is especially critical at low current levels where accuracy class specifications may not apply.

Real-World Revenue Loss Scenarios

Field investigations routinely uncover:

- Two-thirds revenue loss from a single reversed phase
- Total loss caused by cross-phased current circuits
- One-third loss when a voltage or current phase is missing
- Significant overbilling caused by mismatched CT ratios

In many cases, the meter tests 100% accurate while billing errors exceed $100,000 per year due to installation or configuration issues.

Errors That Occur Even When Everything Is "Correct"

Even when wiring, CTs, and billing configuration are correct, revenue loss can still occur due to power factor.

Watts vs. Watt-hours: Why the Difference Matters

Watts (W) measure instantaneous power.
Watt-hours (Wh) measure energy consumed over time.

Customers are billed on watt-hours (Wh), not watts.

Utilities must deliver volt-amps (VA) to serve customer load, but billing is based on the real energy recorded in watt-hours:

Watt-hours = Voltage × Current × Power Factor × Time

When power factor is less than unity:

- The utility delivers more VA to supply the same watt-hours
- The difference represents unbilled energy unless mitigated

As power factor decreases, the gap between delivered energy and billed energy increases, creating measurable revenue loss even when all equipment is operating correctly.

Managing Power Factor-Related Losses

Utilities may address power factor-related losses through:

- Power factor penalties
- VAR or VAR-hour billing

Customers may mitigate these costs by:

- Installing capacitor banks
- Improving load characteristics

Building an Effective Revenue Protection Strategy

A comprehensive approach includes:

- Routine field site analysis for transformer-rated accounts
- Targeted testing of high-revenue customers
- Proper CT sizing and re-evaluation when load profiles change
- Burden control through wiring best practices
- Use of high-accuracy or extended-range CTs
- Verification of billing system configuration

The cost of field test equipment is small compared to the potential recovery of lost revenue.

Key Takeaway

Meter accuracy testing is necessary — but not sufficient.

True revenue protection requires field-based verification of the entire metering system.
Utilities that combine lab testing with comprehensive site analysis gain:

- Increased revenue assurance
- Improved customer confidence
- Reduced regulatory and legal risk

The largest revenue losses often come from a very small number of sites — and they remain invisible without field-based testing.

Meet the PWIP Mentors

Global Women's Network for the Energy Transition (GWNET)

We are honoured to present the mentors participating in the Pacific Women in Power (PWIP) Mentoring Programme — a group of highly experienced energy professionals from across the globe.

As part of this initiative, each of our 32 PWIP mentees have been thoughtfully paired with a dedicated mentor, carefully selected based on their individual career goals and aspirations. Mentors hold monthly one-on-one meetings with their mentees, providing valuable opportunities for professional development and career advancement.

We thank our dedicated mentors for volunteering their time and technical expertise to support the professional growth of women in the Pacific energy sector. Their contribution supports the application and exchange of technical expertise needed to deliver and expand the next generation of energy systems across the Pacific.

The PWIP Mentoring Program is run by The World Bank and GWNET. Learn more: https://lnkd.in/d_a2dTKh

Welcome to the First PWIP Cohort

Global Women's Network for the Energy Transition (GWNET)

It is a delight to introduce the 32 fantastic mentees selected for the inaugural Pacific Women in Power (PWIP) Mentoring Program, a special initiative run by GWNET and The World Bank.

This inspiring cohort brings together talented women from across the Pacific region — professionals working in energy utilities alongside Pacific STEM students. United by a shared passion for an inclusive, sustainable energy transition, these women represent the next generation of energy leaders in the Pacific.

Over the course of 8 months, mentees are taking part in one-on-one mentoring sessions, knowledge exchange, and networking opportunities designed to support their professional growth and leadership journeys. We are excited to follow their progress and cannot wait to see how they grow, connect, and make an impact in their communities and across the region.

Welcome to the PWIP mentoring program — we're excited to have you on this dynamic journey!

Learn about the World Bank PWIP program here: https://lnkd.in/d_a2dTKh

Conference C

32nd Annual PPA Conference

Group Photo

and Trade Exhibition, 2025

New Generation of Covered Conductors

Goran Stojadinovic, MCE, MEE Product and Innovation Manager,
Transnet NZ, New Zealand

BACKGROUND

Bare conductors on distribution lines have served the electricity industry well for more than a century as a simple, relatively inexpensive solution. However, they are increasingly an impediment to OHL modernisation and to emerging technologies that meet sustainability needs and improve resilience to climate change.

They cannot keep up with the impact of climate change, such as storms that cause power outages. The risk of bushfires is increasing due to bare conductors exposed to high winds, tree branches touching or breaking conductors, and other factors. Many feeders in rural bushy areas experience frequent outages and reliability issues.

They also pose direct and indirect safety hazards. In urban areas, many overhead lines run through trees, which must be cut, resulting in unsightly scars. Furthermore, such trees become increasingly susceptible to structural failure as they grow; for example, a limb may break during storms, resulting in a fall to the ground and damage to property or injury to people.

Wildlife is another big challenge. Electrocution of birds and other species has a detrimental environmental impact, while causing frequent power outages that affect SAIDI and SAIFI.

TRADITIONAL CCT (Covered Conductor Thick)

To mitigate these problems, some utilities introduced Covered Conductors Thick (CCT), with insulation up to 3.2 mm, to enhance abrasion and scratch resistance. However, most of them had significant design flaws and drawbacks and failed to fulfil their intended purpose, as follows:

- Many of them do not have a semiconductive layer to spread the electrical field along the conductor and to control stress
- Very difficult to peel off the insulation without damaging the conductor, even with dedicated tools
- In most installations, the integrity of the insulation coordination is compromised at joints, terminations, and T-offs (tap connectors) for connections to lightning arresters and temporary earths. The single layer of insulation, typically polyethylene (PE) or cross-linked polyethylene (XLPE), is designed to be weather- and UV-resistant, but is still susceptible to physical forces, environmental and electrical degradation
- Also, inconsistent insulation coordination makes CCT very susceptible to lightning strikes because it is difficult to design proper protection
- They are not resistant to tracking, as they do not maintain the insulation integrity and insulation coordination along a circuit
- An example of dielectric incompatibility among various components of the CCT systems, resulting in tracking, treeing, and failure

MORE FAILURE MODES OF TRADITIONAL CC AND CCT

In essence, CCT is a CC with thicker insulation. They share a similar, non-shielded design and are subject to the same degradation and failure mechanisms; however, CCT introduces a time delay and lasts slightly longer.

- The insulation wears down if the conductor constantly rubs against tree branches or supporting structures due to wind or vibration, while at the same time, it is continuously exposed to electrical stresses, resulting in PD and degradation.
- Problem of dielectric incompatibility among various components of the CC and CCT systems, resulting in tracking, treeing, punctures, and failure

NEW GENERATION COVERED CONDUCTOR SYSTEM (NGCC)

A new-generation covered-conductor system (NGCC), designed and manufactured in Sweden, is different.

- This novel concept delivers a fully engineered, complete solution with a design life of more than 40 years at approximately 10% of the cost of undergrounding, or just 20% more than bare conductors
- It comprises covered conductors and associated accessories.

- The purpose-designed IPC (Insulation Piercing Connectors) eliminates the need to peel off and remove insulation.

- It can significantly reduce bushfires and faults caused by clashing lines while improving safety and reliability.

- This system has been proven globally and tested against all relevant international standards.

This covered conductor has three layers of covering:

1. **Semi-conductive inner layer** provides stress control

2. **High-grade XLPE layer** in the middle provides electrical insulation

3. **Tough HDPE outer polymer jacket** provides further insulation and mechanical protection against abrasion, as well as intense UV light.

- It also has a longitudinal water blocking

The entire system, the covered conductor and its accessories, is effectively a fully sealed cable system that prevents water ingress and meets the EN 50397-1-2006 international standard. (Note: It is still considered not fully insulated like a cable (not touch safe), even though the insulation is much better than with standard CCTs)

- Advanced, lightweight insulation materials enable NGCC to be restrung on existing poles.

- According to CSIRO (Commonwealth Scientific and Industrial Research Organisation) this type of covered conductor reduces bushfire risk by 98%.

CROSS-SECTIONAL AREA OF A TYPICAL NGCC WITH ACS –ALUMINIUM CLAD STEEL CORE (other options are ACSR & AAAC)

ENGINEERING CONSIDERATIONS: STRESS CONTROL

The NGCC has a superior semi-conductive layer that serves the following two purposes:

Stress Control:

- This smooth, uniform semiconductive boundary layer fills air gaps and smooths the irregular surface of the stranded conductor, preventing the electric field from concentrating at sharp points.

- In other words, it effectively contains and homogenises the electric field within the insulation, and eliminates hot spots (electrical stress concentrations) that could otherwise cause premature conductor deterioration and failure.

- For example, it prevents or minimises partial discharge at points where a tree branch touches the conductor, which would otherwise degrade the insulation over time. Proximity to a supporting structure or contact with a tree creates a region of high-voltage stress on the conductor, unless a semiconductive layer mitigates it.

Insulation Integrity:

- This layer ensures a contaminant-free interface with the insulating material (XLPE), which is critical to maintaining the insulation's long-term integrity and reliability.

ENGINEERING CONSIDERATIONS: INSULATION COORDINATION

In earlier CCT installations and upgrades, most fittings were of mixed standards, e.g. with varying Basic Insulation Levels (BIL) or creepage distances, without accounting for their interactions. It compromised the integrity of the insulation coordination.

- With NGCC, its dedicated insulation piercing connectors (IPCs) and other accessories are designed and made to the same standard. They improve and maintain insulation coordination on medium-voltage (MV) systems, thereby preserving the network's insulation integrity.
- IPCs have a sealed, waterproof design in a UV-resistant polymer housing that prevents moisture ingress, a primary cause of insulation failure in outdoor or underground applications.
- IPCs use shear-head bolts that ensure the correct tightening force is applied during installation, guaranteeing optimal contact pressure and preventing damage to the conductor strands or over-compression of the insulation.
- A correctly installed IPC acts as a fully insulated, sealed component of the system, meeting the exact insulation coordination requirements of the rest of the insulated network.

IMPORTANCE OF INSULATION COORDINATION FOR THE PROPER DESIGN OF PROTECTION AGAINST TRANSIENT EVENTS AND LIGHTNING STRIKES

All electrical equipment is susceptible to transient events and lightning strikes. The same applies to covered conductors; e.g., there is no 100% protection. There are methods to mitigate these risks using protective devices such as lightning arresters and arc protection devices.

The key prerequisite is to achieve and maintain proper insulation coordination along the protected line, because:

- The arrester's protective voltage level must be set below the equipment's insulation level, creating a safety margin
- In other words, the arrester should be selected for the "Weakest Link", e.g. its clamping voltage must be lower than the equipment's flashover voltage, ensuring the arrester takes the hit, not the transformer or covered conductor.
- So, the "weakest link" in the insulation chain then becomes the arrester itself, allowing it to operate, protect more expensive equipment, and maintain system reliability, rather than having the main equipment fail.

Without knowing the equipment's true basic insulation level (BIL) and without full integrity of the insulation coordination, it is difficult to design an appropriate level of lightning protection (e.g. to select the right arresters) because the "weakest point" can be anywhere along the line (as in previous CCT designs, which frequently failed due to transients and lightning strikes).

The NGCC and associated accessories provide continuous insulation coordination along the entire circuit. It enables the selection of appropriate protective devices that can operate under temporary and transient overvoltages (lightning and switching surges), while minimising failures and ensuring cost-effectiveness. It is now up to the power company to properly design the lightning protection for its covered conductors.

ENGINEERING CONSIDERATIONS: TRACKING

Most early CCT designs had tracking problems, particularly under harsh conditions (pollution, moisture, UV), resulting in insulation degradation, carbonisation, and failure. Tracking is mainly caused by:

- Degradation of the insulation material due to rain, dust, sea spray, industrial pollution, and UV
- High voltage in combination with contaminants

or moisture causes surface discharges, leading to electrical tracking

- Over time, the insulation becomes brittle, cracks, or carbonises, forming conductive paths (tracks).

The NGCC system has:

- Tough, UV-protected HDPE outer layer with good track resistance.
- The tracking on NGCC is less than 1mA
- The connectors and clamps used with the system are also designed and tested to be compatible with this trackresistant conductor system.
- All accessories work effectively with the non-tracking properties of the conductor's outer sheath, ensuring the entire assembly remains highly reliable and safe.

KEY ADVANTAGES OF THE NEW COVERED CONDUCTOR SYSTEM

- Compact design; Corrosion resistant; made of new Advanced materials
- The extrusion of the entire conductor, including the semiconductive layer, the XLPE insulation and the outer HDPE protective layer (jacket), is done simultaneously and continuously in one go
- NGCC is stronger and lighter than old-fashioned CCT designs, e.g. the total thickness of all layers is between 2.4 and 3.4 mm, depending on the NGCC type.

NGCC (CCSX) vs traditional CCT (120mm2 at 22kV)

Characteristic	CCSX	CCT
Weight/km	506kg	720kg
Diameter	20.3mm	26.1mm
Minimum Breaking Load	34.9kN	27.1kN

- NGCC is much easier to install than traditional CCT
- No Stripping: No need to remove insulation, which simplifies installation and increases reliability
- Excellent tolerance of conductors clashing and trees leaning, thus reducing fire risks

Conductor	Bare Equivalent	Max Span Length
CCSX25	3/2.75	275m
CCSX62	7/3.0	170m
CCSX159	19/3.25	160m

- Good tolerance to withstand extreme weather conditions
- It allows retrofitting in most existing networks, without inter-polling
- Option of upgrading an old bare conductor, keeping the old structure

KEY BENEFITS OF THE NEW COVERED CONDUCTOR SYSTEM

- Maintains the integrity of the insulation coordination
- Much safer - protects line workers during installation and maintenance, and the general public from accidental, momentary contact hazards
- Provides much better wildlife protection
- 98% effective in preventing bushfires
- Increases reliability dramatically by preventing faults and power outages caused by vegetation or wildlife
- Improved supply quality and network resilience
- No stripping required, which eliminates the main failure cause of traditional CCT

**Note: Stripping is only required for the installation of straight joints, and for CCSX25 (25 mm²), which is used as a direct replacement for SWER steel conductors. However, NGCC insulation is much easier to strip than CCT insulation.*

- Up to 10 times cheaper than undergrounding while achieving the same resilience
- Reduced asset lifecycle operating costs due to fewer faults (estimated up to 4 times lower than CCT)
- Extended life and higher reliability in high corrosion zones

PERFORMANCE AND COST

NGCCs are used in Europe, Africa, Australia, South America and Asia. In Australia, more than 1,000 km has been installed over 9 years. Feedback from one of the Australian distribution companies is as follows:

Cost:

- "Overall, the cost increase was estimated at around 20% compared with bare wires.
- This provides an excellent return on investment (ROI) in terms of improved network resilience and security of customer supply and reduction in risk to wildlife and fire start incidents.
- It is well on the way to recovering the additional cost of NGCC over bare wire."

Performance:

- "The experience from the full-scale trials shows that the NGCC covered conductor is easy to install and work with.
- It will allow (the Company) to mitigate many of the potential risks that traditional open wire networks pose, at a reasonable cost, making it a viable standard replacement alternative.
- Reasons to install NGCC covered conductor include reducing customer outages and their duration (reliability), and the incidence of fire starts."

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Renewable Energy Developments in South Tarawa, Kiribati

David Drake, Chief Executive Officer,
Public Utilities Board

The South Tarawa Renewable Energy Project (STREP), carried out by the Public Utilities Board (PUB) across Phases 1 and 2, marks a significant step forward in Kiribati's sustainable development by utilising abundant solar energy to reduce dependence on imported fossil fuels and bolster energy resilience. Phase 1 lays the groundwork through installing modern solar photovoltaic systems and making key infrastructure upgrades, while Phase 2 builds on this progress with increased renewable capacity, advanced battery storage, floating solar PV systems, new overhead transmission lines, and the launch of an electric vehicle network. Collectively, these initiatives ensure a more dependable power supply, support the local economy, promote cleaner transport options, and guide South Tarawa toward a greener, climate-resilient future.

Supported by the Asian Development Bank (ADB) and the New Zealand Ministry of Foreign Affairs & Trade (MFAT), Phase 1 is in its final months of construction, and according to the contractor SinoSaurxxx, the remaining tasks will be finished in the coming months. This work includes completing the control centre building, the substation, electrical installation, and the ComAp control system. Testing and commissioning are planned for May – June, and SinoSaur will then oversee a 12-month Operations & Maintenance period, during which PUB staff will be fully trained and mentored on operating and managing a large solar farm.

Early days of Construction

Early Days of Construction

For South Tarawa, this represents the first significant solar input into the grid, with a current capacity of up to 2MW limited by the existing underground network infrastructure. However, this will mark a major shift in how electricity is managed and perceived, and PUB expects this to drive overall operational efficiencies and contribute to lower tariffs.

STREP 2 will have a new overhead transmission line completed by Q3 2027, enabling the delivery of the full 7.5MW [5MW is funded under STREP and an additional 2.5MW is funded under the STWSP project, but managed by SinoSaur] to the grid and significantly changing the source of electricity, PUB's operations, and the tariff.

Along with recent improvements in overall electricity availability through the use of rental generators, acquisition of new high-speed units, and the near completion of the new Betio PowerHouse, PUB is excited about its current and upcoming developments in the electricity sector.

As well as the new 33kVA overhead transmission line, STREP 2, funded by the ADB, will support an additional 4MW of floating solar, and will formalise the introduction of electric vehicles with Kiribati's first EV charging stations.

ADB has long supported new innovations, and STREP 2 introduces floating solar technology designed for small island developing states (SIDS). Unlike land-based systems, FPV needs no scarce dry land and rises with sea levels, making it especially suitable for Kiribati's low-lying atolls.

The STREP program has also supported institutional strengthening, notably the development of the Energy Act, 2022, which enhances regulatory control to support sustainable, well-managed utility operations.

PhotoVoltaic Arrays nearing completion

PUB is pleased to share this update on our RE journey, to help reduce greenhouse gas emissions and dependency on imported fuels, and to add significant capacity to support economic growth and sustainability.

STREP 1 and STREP 2 position Kiribati as a regional example of how Pacific utilities can combine renewable energy, climate adaptation, and institutional reform to create resilient power systems for the future.

The 22nd Pacific Islands Forum Diesel Maintenance Program

Yasuharu Ouaka, Manager Overseas Reprocessing Committee

INTRODUCTION AND BACKGROUND

This article provides a summary of the 22nd Pacific Islands Forum Diesel Maintenance Program held in Japan 26-30 January 2026.

The 22nd Pacific Islands Forum Diesel Maintenance Program was hosted by Overseas Reprocessing Committee (ORC), representative organization for Japanese electric power companies.

Since the beginning of the Pacific Islands Forum Diesel Maintenance Program in 2000, its focus has been on basic maintenance of diesel engines. Major work on diesel engines and generators in the respective power utilities are usually referred to the suppliers of the equipment due to limited manpower, knowledge, skills and availability of appropriate tools in the Pacific islands.

OBJECTIVES

The Pacific Islands Forum Diesel Maintenance Program consists of the following primary objectives:

- introduce participants to diesel engine and trouble shooting procedures, and operation; and
- highlight on the importance of safety in the work environment

PROGRAM OUTLINE AND CONTENT

The program was carried out at the Mitsubishi Heavy Industries Ltd(MHI)training center in Sagamihara, Kanagawa prefecture. Mitsubishi Heavy Industries Ltd delivered the training in the classroom and practical sessions. The general arrangements, management, training skills and hospitality were excellent and contributed to the success of the program, particularly the transfer of knowledge and skills on the operation and maintenance of diesel engines.

The training schedules were presented in lectures and hands-on practical sessions. In general, the program content was on the basics of diesel engines, maintenance and trouble shooting, safety, and the current developments in the respective technologies.

Date	AM (9:00-11:45)	PM (13:00-16:40)
January 26 (Mon)	Opening ceremony - Orientation Factory tour - Introduction of MHIET Fundamentals of engine (Lecture)	Structure and function of diesel engine (Lecture) (Small size engine: SL series) Welcome Reception (at Sagami Club)
January 27 (Tue)	Engine disassembling (Practice) S4L (1 unit / 2 persons)	Engine disassembling (Practice) Part measurement (Practice) (Piston, Cylinder liner, Valve)
January 28 (Wed)	Part measurement (continued) Engine reassembling (Practice) S4L (1 unit / 2 persons)	Engine reassembling (Practice) S4L (1 unit / 2 persons) Engine operation at no-load (Practice)
January 29 (Thu)	Explanation of loaded performance test with diesel generator set (Lecture)	Loaded performance test (Practice) - Data sampling - Calculation of fuel
January 30 (Fri)	Assembling Training for Circuit tester (Practice)	Fundamentals of electricity (Lecture) Generator basics (Lecture) Closing ceremony (15:00)

PARTICIPANTS VIEWPOINT

Five countries participated in the 22nd program. The participants consist of mechanics. The following provides a summary of the participants' views raised during the round table meeting at the conclusion of the training program.

How do you think that your acquired knowledge or skills through this Program would be useful in your daily operation or workplace?	• My future will look great and nice about my learning skill. I attend on Japan this training here was saw me about to what to do in engine • Especially to learned new skills and experience, plus specific tools and how we used. • To improve work efficiency as well as team building capacity.
Have you had any problems during your stay in Japan?	• I got no problem. I really safe during I stay in Japan from first day in Japan. • Hospitality is very nice.

CONCLUSION

The excellent arrangements, training skills and hospitality provided by the hosts and the enthusiasm and performance of the participants contributed to the overall success of the 22nd Pacific Islands Diesel Maintenance Program.

PARTICIPANTS LIST

Country	Participant	Utility / Institute	Designation
Kiribati	Ataria Teriaki	Public Utilities Boards	Mechanic
Nauru	Peter Jerome Togoran	Nauru Utilities Corporation	Power Generation Acting Manager
Tuvalu	Eliata Vaeluaga Taeka	Tuvalu Electricity Corporation	Mechanic
Marshall Islands	Anthony Jemkar	Marshalls Energy Company	Mechanic
Solomon Islands	Richie Fugui Makabo	Solomon Islands Electricity Authority	Mechanical Fitter

ACKNOWLEDGEMENTS

The following are gratefully acknowledged for their assistance in the organisation and during the course of the training program:

- Overseas Reprocessing Committee (ORC)
  Mr. Kei Ito, General Secretary
  Mr. Yukio Sakakibara, General Manager
  Mr. Teruo Ishii, Deputy General Manager
  Mr. Seiichi Sugai, Senior Expert
  Mr. Yasuharu Onaka, Manager
- Mitsubishi Heavy Industries Ltd (MHI)
  Mr Satoru Araki
- Mr Kazunori Toma (JTB)

It is also noteworthy to acknowledge the participants for their enthusiasm and performance during the course of the training program.

Welcome!

TO THE NEW ALLIED MEMBERS

There have been three (3) new Companies who have joined the PPA as Allied Members since our last PPA Magazine.

GLOBAL MARINE POWER LLC: Global Marine Power LLC is based in Texas, United States of America. Their primary activity is trade, service and repair.

HIKO POWER ENGINEERING: Hiko Power Engineering is based in Christchurch, New Zealand. Their primary activity is LV,MV, HV & EHV equipments. Their secondary activity is electrical equipment manufacture.

SCINERGY PACIFIC (FIJI) PTE LTD/SCINERGY INTERNATIONAL LTD: Scinergy Pacific (Fiji) Pte Ltd/Scinergy International Limited is based in Brisbane, Australia. Their primary activity is power systems & grid planning, renewable energy & clean energy development, institutional strengthening & capacity building. Their secondary activity is transaction, procurement & investment advisory, spatial, planning & technical assurance services, research innovation & technology pilots.