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# September 2023, Volume 31 Issue 3

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Pacific Power Association, Suva, Fiji Islands. The PPA is an inter-governmental agency and member of the Council of Regional Organisations in the Pacific (CROP) established to promote the direct cooperation of the Pacific Island Power Utilities in technical training, exchange of information, sharing of senior managment and engineering expertise and other activities of benefit to the members.

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# EDITORIALS



# Editor's Note

Gordon Chang Acting Executive Director

Bula Vinaka and greetings from Suva.

The 30th Annual Conference and Trade Exhibition held in Saipan, Commonwealth of Northern Marianas, and hosted by Commonwealth Utilities Corporation (CUC) has been hugely successful attracting a total of 219 delegates to the event. In the next PPA Magazine in the December issue, the Secretariat will provide more coverage on the 30th Annual PPA Conference & Trade Exhibition.

A lot of focus recently in the region and internationally has been the discussions on Climate Change leading up to the PPA Conference & Trade Exhibition. For the Pacific Island Countries and Territories, although very small emitters of greenhouse gas, are in the frontline in terms of the impacts of climate change. We also see the impacts of climate change through adverse weather causing damage on the utility infrastructure and increased demand. The Pacific Power Association members in their planning will need to consider designing disaster resilient infrastructure and utilizing renewable energy and energy efficiency solutions to play their part in the global solution.

Recent developments in renewable energy, energy storage and integration technology has shown that high levels of renewable energy generation can be achieved. Overall, technological challenges to renewable energy integration can be addressed. However, it is the regulatory and policy issues that take longer to resolve and tend to hold investment in renewable energy. The article on energy storage illustrates the various actual applications that make renewable energy now technically possible. There are other examples such as the King Island system in Tasmania, Australia that prove that 100 percent renewable energy in the Pacific Islands can be done.

The Currents section in this edition of the magazine highlights recent events within Tuvalu Electricity Corporation, The Pacific Women in Power (PWIP) Program funded by the World Bank, Strategic Planning Meeting to inform the Micronesian Gender Equality Framework and the SPC Gender Equality Flagship.

Lastly but not least may I welcome on behalf of all the PPA Members the following organizations who have recently joined the Association as Allied Members and two companies for re-joining the membership.

DHInfrastructure LLC. EIPGRID Inc. I-Environment inHance Utilities Utilligence Limited WSK International WR Carpenter (PNG) Limited Elemental Group Cables Fiji Limited – Re-join Mana Pacific – Re-join

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# Navigating Challenges and Charting Solutions for Public Utilities Board (PUB)

James Young, Chief Executive Officer, Public Utilities Board David Drake, Financial Adviser, Public Utilities Board

# 1. Introduction

The Public Utilities Board - Kiribati (PUB) has been grappling with significant financial challenges and has been steadily heading towards asset bankruptcy for the past decade. Successive management teams deserve recognition for their efforts in maintaining operational continuity, though the problems faced through 2022-24 pose greater challenges.

In essence, PUB has been facing a significant crisis due to prolonged and systematic negligence in asset refurbishment, flawed financial management, inadequate allocation of funds for operations and maintenance (O&M) of assets, weak governance, and a steady decline in revenue. This has been exacerbated by an overreliance on government subsidies and subsidies below the cost of service. Consequently, PUB finds itself in a state of structural insolvency. In recent times, PUB has been struggling to fulfill both immediate and future operational commitments.

Adding to PUB's challenges is the imminent risk of catastrophic failure of its diesel generators. The situation is aggravated by delays in arranging critical maintenance tasks, which has resulted in 3 years continuous load shedding, severely limiting economic growth and impacting the health and wellbeing of the community.

PUB confronts three pivotal asset-related risks:

- Projected Generation Asset Failure: Foreseen breakdowns in generation assets has result in extended, periods of blackouts.
- Unprecedented surge in Power Demand: The rapid, increase in power demand is close to 35% for the past 4 years.
- Emergency Drought and Water Quality Concerns: The synergy between power failures and restricted water supply highlights the connection between public health and power supply.

# 2. Neglecting our Assets

Projecting generator failure follows years of inadequate funding that have inflicted considerable damage upon PUB's infrastructure, evident through recurrent donor missions to South Tarawa. Notably, the subpar condition of generators and the persistent gap between peak demand and the available generation capacity are glaring concerns. A 2019 report from ITPower<sup>1</sup> underscores the urgency of bolstering generation capacity to match escalating peak demand, proposing the acquisition of new diesel generators. In 2020, two ADB<sup>2</sup> renewable energy projects delved into grid integration modelling, considering various new solar, battery, and desalination ventures. These studies endorsed the addition of diesel generation to enhance grid stability. Despite this, the existing generation capacity remains insufficient, obliging PUB to resort to load shedding and operating generators beyond their intended capacities, which undermines their longevity.

Add to this mix, the limitations on the grid capacity, transformer failures, and inherent system losses and PUB effectively wastes over 20% of production through endemic system losses. With each passing year, the generators have been de-rating at an increasing rate.

Table 1 serves to emphasize the deteriorating state of current generators, heightening the risks of catastrophic failures and underscoring the pressing need for extensive overhauls. This precarious generator situation amplifies vulnerabilities in both power and water supply.

 $^{\rm I}$  ITPower were appointed under an urgent technical assistance support programme, funded by MFAT NZ

<sup>2</sup> The ADB South Tarawa Renewable Energy Project (STREP) and the Financial Recovery Action Plan (FRAP) which is a component of STREP 1

# **Table 1: Current Generator Condition**

DG No.	Maker	Installed Date	Running Hrs	Last Overhaul Date	Comments	Risk Ranking
3	Daihatsu Installed Capacity: 1400 Derated Capacity: 1000	2002	5000(hrs after last overhaul) Over 150,000hrs after first installation	10-Oct-21	Recently overhauled, water cooling system in cylinder heads has cavitation damage, cylinder heads were replaced in 2022. Overhaul scheduled for early 2024. Operating without issue at the moment	High Risk
4	Daihtasu Installed Capacity: 1400 Derated Capacity: 1250	2002	1967(hrs after last overhaul) Over 150,000hrs after first installation	23 Feb 2022	Suffered Arc Flash Failure of the Termination Panel that required emergency replacement. Previously Piston skirt cracked due to excessive heat, caused by lack of lubrication. Pistons and Skirt replaced, however Generator Heads were replaced in 2022. Bearings twisted blocking the oil flow to the piston. Bearing locks missing. Combustion gas leaks out of the head gaskets due to worn cylinder heads or gasket seats on the liner for Cylinder 3 & 4. Actual integrity of engine and stator is OK,	High Risk
5	Daihtasu Installed Capacity: 1400 Derated Capacity: 1250	2005	58,000hrs after last overhaul	15-Dec-15	6 years without maintenance work. Generator cuts out at 80% due to radiator condition, repair costs estimated at \$300K. 3 week shutdown in 2023 – Assistance from JICA allowed the replacement of the alternator. Currently running with limited problems except high temperature of lube oil during high load situation therefore PUB limit the max capacity to 1250kW. To fix this, DG5 needs major overhaul asap. Cooling system requires replacement including a new radiator.	High Risk
6	Cummins Installed Capacity: 823 Derated Capacity: 400	2018	248	N/A	Failed Cooling system unable to keep Generator below maximum operating temperatures	Failed
7	TidePower Installed Capacity 1500 Derated 1200	2023	500	N/A	Generator Fan and Fanbelt failed, causing damage to the engine cooling system	Failed
8	TidePower Installed Capacity 1500 Derated 1200	2023	500	N/A	(For both DG 7&8 the transformer limits the output to 800KW)	Not Installed – requires modification. Will be installed and replace DG 7 and operating by mid September 2023.
9	Pramac(MFAT) Installed Capacity 1400 Derated 1200	2023				Installed – Commissioned mid September 2023
10	Pramac(MFAT) Installed Capacity 1400 Derated 1200	2023				Installed – Commissioned mid September 2023

The deteriorating condition of current generators necessitates their disassembly for assessment, entailing extended periods of inactivity. Given their age and irregular maintenance, the probability of a catastrophic failure within the next year is alarmingly high. Our development partner engineers (JICA) have further supported the urgency of procuring supplementary generation capacity to preempt severe power disruptions. This is described in the 2022 PUB Kiribati Power Asset Management Plan prepared by the Okinawa Engineering Corporation.

The persistent uptick in electricity demand, compounded by the introduction of water desalination plants, places further strain on power resources. Although previous forecasts have varied due to supply limitations, the most recent technical data and load growth patterns point to a surge in peak loads. Collaborative insights with independent experts lend credibility to these predictions, demonstrating a 35% increase in electricity consumption over the past four years.

Water quality and water capacity have long been a concern and the threat of bacteriological infestation is very high, which has led to several development partner interventions. A recent extensive drought has exacerbated the situation and led to emergency funding for desalination production and water network strengthening. The implementation of the South Tarawa Water supply project (STWSP) promises to alleviate major concerns but at a very high cost, with desalination plants and new network capacity that remains difficult to envisage as either viable assets for PUB in the long term or that will potentially tie PUB to a dependence on government subsidy funding for years into the future.

# 3. Flawed Financial Management

PUB has suffered greatly from flawed financial management practices. Historically the MYOB accounting system was used to post and collate transactional documents and to provide a basis for financial reports. A failure to attach value to regular financial reporting, and a lack of concerns to upgrade the system, led to its neglect and unreliability. Spreadsheets became the preferred and default mechanism to manage relevant data. Over several years, more than 20 recurrent spreadsheets became integral to the web of financial monitoring systems from reconciling the bank accounts to identifying purchase orders outstanding. A mammoth spreadsheet was developed and added to, year-on-year to record budget data against an extensive GL allocation and was used to post and compare actual to budget.

The excess of manual input and the size of the spreadsheet both added to its unreliability and reduced its functionality in the hands of the long-serving finance manager. When she departed in early 2022, after increasing pressure on finances, liquidity and systems, PUB lacked any coherent systems or competence in financial management. Internal reports had been late or non-existent and the demand for in-year reports, from the government, went unanswered.

PUB's billing system, Datelstream, is among the leading software in utilities customer care services. However, PUB, years earlier, declined the support mechanisms and associated fees and failed to secure upgrades or access to essential system features. The result was a cumbersome build-up of '000s of accounts, many that quickly became inactive with meter failures and incorrect readings, and an accumulation of outstanding balances beyond PUB's resources and ability to collect or to effectively manage. Weak credit control, cumbersome and time-consuming chasing of debtors, deliberate customer default, electricity theft, use of fictitious account names, and a host of problems compound the system.

With a lifeline tariff at \$0.10 per KwH, up to 100KwH per month, many accounts host small balances and the inefficiencies in account management are extreme, contributing to under-performance, revenue insecurity and liquidity issues.

The spreadsheet was used as the basis for preparing financial statements and these were submitted one-to-two years late. By December 2022, the latest audit report was for the year ending December 2019. This report and those prior were heavily qualified with respect to:

- Verification of fixed asset balances,
- Uncollectable trade debtor balances and inadequate provision for doubtful debts,
- Other receivable balances (including staff debtors) that are uncollectable,
- Verification of prior period items,

- An inaccurate CashFlow statement,
- Incorrect provision for trade creditors,
- Verification of CSO/subsidy received,
- Verification of payroll for specific months,
- Procedures for purchasing and procurement.

The draft financial statements for FY20 and FY21 were submitted for audit, with most of the same balances being carried forward following changes in personnel, the collapse of the MYOB accounting system, and some loss of records, all leading to uncertainty as to how to correct this position.

PUB's viability as an ongoing operation was compromised by excessive asset liabilities and ongoing delays in Government Ministries with substantive debts to PUB. PUB has operated an overdraft account and has been bankrolling Government responsibilities in service delivery as well as continuing to supply services to Government Ministries. Government Ministries owed a cumulative circa \$2.5 Million AUD at the end of 2021. A priority for PUB has been to recover debts from the Ministries.

Clearly, a priority for PUB in its FY23 Statement of Intent is *"Getting PUB's financial house in order"* through engaging qualified personnel, donor support towards an effective IMS and the training and introduction of robust governance systems and procedures.

Traditionally the power business indirectly subsidised water and sewerage as water charges have been difficult to collect from domestic users and with a high-leaking network and limited consistent supply, PUB (and the government) has agreed to develop the supply and network prior to further tariff review. There was a small reduction in electricity tariff in 2016/17 and fuel price increases in 2018 and PUB performances have continued to suffer.

For several years PUB faced weekly cash flow crises relating to the buying of fuel and/or settlement of other obligations. The major supplier, KOIL required cash on delivery, following an accumulation of outstanding debt up to 2016, that will never be settled. Over time this has forced limited operational investment, a run-down of assets and uncertainties surrounding planned improvements and potential investments. This was compounded by a static charge for diesel of \$1.27/ litre for many years, allowing the importer, KOIL, to manage price fluctuations and enjoy super-profits and accumulate cash reserves over an extended period.

In the use of MYOB to record financial transactions, staff have accumulated many invoices into single-entry postings, kept spreadsheet details, and then, due to unfamiliarity with MYOB system closing, they have opened new files repeatedly, to negate any capacity for the system to provide financial reports. The classification of expenditures has been weak. The dependence on spreadsheet analysis has been used to collate

# MAIN ARTICLE

and analyse financial data, leading to many uncertainties around the balance sheet values and operational unit costs, as well as leading to delays in reporting and auditing. Many of the issues and problems being identified and currently being addressed have been noted in earlier project evaluations and reports, dating back beyond 7 or 8 years.

# 4. Weak Governance

As with all SOEs, the PUB Board is appointed by the Responsible Ministers, under the State-owned Enterprise Act, 2013. There is a limited pool of experienced, competent directors in Kiribati and appointments become more of a political reward than a commercially astute appointment.

Many elements of operations and governance have continued for years as a legacy from the days of public service, with directors being awarded a nominal sitting fee, rather than a commercial remuneration. As such, the board lacks the capacity to implement strong directives and mechanisms for accountability and falls short in its legal and commercial role.

Most national issues, either directly or indirectly were referred to the Minister or to the government and the transition to a more commercial operation has been slow, stifled, and problematic. The presence of a heavy-handed government is a political policy in Kiribati and is common in small island states, with limited economic output, reliance on imports for essential products and high costs of goods due to its remote location and disperse population among multiple small islands.

Such remoteness and natural surroundings, leave strong customs that govern society and influence the expectations and resilience of the people. While PUB strives for significant improvements across its business operations, the community is more than a little tolerant and accepting of sub-standard services, which is a blessing that also serves as a deterrent to much-needed reforms.

The warranting of funds and National Procurement Policy/ Legislation are slow and have severely hindered delivery.

Underpinning any commercial orientation has been a requirement for basic service provision, a reduction in power outages, a reduction in the deterioration of the quality of water and an emphasis on safety and health. Equally, the issue of price and affordability remains. Currently, the electricity tariff is viable but is based on unreliable data, weak billing, problems with some meters, and a lack of funding for asset maintenance and management.

Electricity should be profitable. Costs around 45c/KwH can be managed with a sensible tariff – a model that ensures consistent pricing, tiered to reflect both peak usage and to protect domestic users from industrial usage rates. A tariff is essentially a pricing model that may include pre-agreed adjustments for components of the price inputs that vary. Pricing inputs are relevant costs, inflationary impacts etc., such that while salaries might be fixed over time, fuel may fluctuate. Tariffs may be agreed upon for a period of up to 3 years and are then a matter of public record, although it may also be that PUB and the Kiribati customers will benefit from waiting for stability in a tariff model until the infrastructure projects (significant new solar capacity and new desalination plants) are complete or near-completion. There is a need for a mechanism to adjust tariffs at short notice as fuel prices fluctuate.

At present there is no charge for residential water or sewerage service; the only (water and sewer) revenues are accrued from government and non-domestic customers, who are serviced by tanker trucks.

In 2021 a new agreement was reached whereby PUB paid a margin above KOIL's landed cost (averaged over the prior 3 months) plus overhead allocation and this indicated up to 30% lower prices for PUB and a potential \$3m per annum saving. However, recent fuel price increases have removed most of this "saving" and PUB continues to seek a stronger agreement and validation of import prices to justify its arrangements with KOIL. (KOIL's) Market tenders should be frequent enough to ensure comfort that fuel imports and fuel prices are competitive.

Increasingly, the vulnerability of essential services and the dependency on development partners' financial support has also raised awareness of the need to improve governance. Work is commencing in this area, while it will require a combination of political will and external pressure to fully reform and allow PUB to operate as a viable commercial entity.

In lieu of subsidy, the State-owned Enterprise Act, 2013, provides for a CSO payment if an SOE is required to conduct non-commercial activity. PUB identifies the water & sewer business as a CSO. In past years, under-funded maintenance and emergency asset rehabilitation have also been requested, but historically PUB has been under-funded in CSO requirements, adding to its burden to continue to manage the water & sewer network and provide power, with liquidity risk. PUB has liquidity issues, GoK underpays the CSO request meaning PUB will have challenges continuing to operate in 2023. GoK/PUB is in breach of ADB Grant funding requirements under the STREP.

Government is a major customer of PUB. Improving PUB's cash collection would be assisted by Government agreeing to become a "good customer" that always pays bills on time. This would significantly improve cash flow, and aid operating performance.

While the relative stability in both fuel price inputs and the electricity tariff, provided some benefits to PUB, it is evident in hindsight that this situation also contributed to a clouding of

the severity of the problems, the liquidity risks and the overall revenue insecurities.

# 5. Financial Recovery and Marching forth

PUB is dealing with challenges on multiple fronts and while they are discrete if complex issues, performance improvement requires a significant shift in each of the following areas:

- Finances, funding, and effective financial management
- Policy and governance requirements for prosperity
- Dealing with asset bankruptcy
- People capability and capacity building

Such reforms within PUB have been tagged for a considerable time. It is debatable how PUB has continued to operate through so much adversity and with significant liquidity challenges. PUB's task is to oversee fundamental changes in business processes and asset management during this period of reform, 2022 - 2024.

Addressing the many operational problems is, itself, challenging and initial plans including securing donor assistance were delayed. Only in late 2022 have the projects really ramped up after borders opened and advisers and contractors began travelling.

A series of initiatives were devised to address the situation, with added commitment following the appointment of new CEO, James Young in 2021. Recognising the severity of the situation and the opportunities arising from development partner inputs in infrastructure, and the Kiribati Utilities Reform Project (KURP), a collaborative initiative between the New Zealand and Kiribati governments, PUB aims to enhance utility delivery. Overseen by FCG, KURP strives to bolster governance, workforce proficiency, energy generation, distribution, and maintenance practices. The proactive engagement of PUB management and international advisors, spearheads reform endeavours\ encompassing process enhancements, training programs, network upgrades, and improved financial management.

In late 2022 an international CFO was recruited and in early 2023 a local Finance Manager. These appointments, while being essential have had a positive impact, if in some different ways to initial expectations.

Past and recent efforts to rectify the myriad of financial systems delinquency have been thwarted by persistent balance issues, attributed to personnel changes, the collapse of the MYOB accounting system, and record losses. The FY22 financial year-end holds the potential for rectifying the PUB Statement of Financial Position, ensuring accuracy, and reflecting underlying values (or acceptable approximations of such value) of the stated assets and liabilities.

Steps towards this goal include preparing a preliminary Statement of Financial Position using retained PUB finance

records. Simultaneously, the implementation of TeqSuite IMS aims to rectify existing system vulnerabilities, with improvements slated for July/August 2023. Meanwhile, proposed adjustments and corrections to the preliminary position aim to provide a fair valuation of assets and liabilities.

Addressing certain liability accounts poses a challenge, especially if they could potentially be proven as due and payable. Resolution hinges on formal debt forgiveness agreements with respective creditors. To formalize and close old debts, PUB is actively pursuing agreements with KOIL and the Ministry of Finance & Economic Development (MFED).

The recovery effort necessitated tough decisions, including estimating asset write-offs prior to a formal analysis being completed. This enabled an FY22 Statement of Financial Position to be completed for audit, and a year-to-date report for April to be prepared for the Board.

Board review and approvals enhance the process and strengthen accountability. Since then, work has progressed on fixed asset valuations and in identifying individual debtor accounts for write-off, disconnection, and closure. A more robust and representative debtor's sub-ledger will pave the way for the upcoming pre-paid meter rollout.

During 2023, the evidence is that PUB, benefitting from a favourable fuel price of \$1/litre has made a satisfactory return, noting the continued issues of generator declining efficiency, the growth in demand for power and the continued under-funding of the subsidised water and sewer business.

Much work is still to be done, including:

- Asset management plans should be developed for all three service activities with the identification of all assets their condition and remaining useful life, the risk and consequence of failure, the feasible renewal options (repair, refurbish, replace), the cost of those options, and formal checklists for maintenance.
- Standard operating procedures should be developed and documented for all significant aspects of operations.
- A concerted effort to identify and eliminate illegal power connections and a focus on reducing water losses and boosting water pressure in the network. Likewise, the sewerage department needs to campaign to identify and eliminate illegal connections, or illegal stormwater discharge to the sewerage systems.
- Identifying appropriate costs for operations and assets and designing a new tariff model to capture appropriate costs is a priority, with 3-year forecasting and a firm commitment to compliance with reporting requirements.
- PUB needs to develop new standard operating procedures and map and determine measures for key business processes. Financial Management Practices need re-design, with one entry standardisation and full audit trails for each authorised transaction.
- Completion of the new IMS, through the second half of

# MAIN ARTICLE

2023, will strengthen budget management and financial forecasting and enable effective financial reporting using accrual accounting with a transition to IFRS standards.

- Implementing a pre-paid meter rollout as a business management mechanism, but also as an efficiency, credit control and cashflow initiative.
- PUB still need to manage debtors, to resolve outstanding debtor issues, including:
  - **1.** settlement arrangements made prior to further supply of electricity,
  - **2.** All accounts with a balance >\$1000 > 4 months outstanding should be targeted to disconnect the meters and cease further supply,
  - **3.** Given the numeracy of domestic accounts that are long overdue and over \$2000 outstanding, (very few households have the capacity to regularly spend over \$500 per month on electricity and thus a \$2000 outstanding is 4 months or more) it is probable that another purge of accounts will need to be done, following this initial update and probably prior to the end of FY23 and in conjunction with the pre-paid meter roll-out.
- Implementation of the comprehensive HR and training program that is underway and will upskill employees in a range of basic business skills (Using Excel, IT competence, O,H & S protocols, and others) as well as specific technical and operational skills training.

# 6. Strategic Actions to Ensure Power Supply Stability

PUB's strategic approach encompasses several critical measures:

- Seeking expert reviews from JICA and MFAT to comprehensively evaluate the current power scenario,
- Procuring essential spare parts and new Rotors/Stators for generators,
- Collaborating with JICA to execute sequential generator overhauls through 2023 and 2024,
- Developing robust communication plans for extended outages anticipated in 2022.
- Collaborating with partners to replace the 10MW Baseload Generation by 2025.
- Implementing renewable energy strategies, including Hydrogen Generation, aligned with the National Energy Policy.
- Ensuring compliance with the Energy Act to achieve financial independence.
- Reviewing operational structures between Water/Sewer and Energy divisions.
- Executing STREP/STREP2 initiatives to facilitate a seamless transition to renewable energy, aligning with PUB's role as the implementing authority.

# 7. Conclusion

In recent years production statistics and generation risks were well documented and widely shared, but without the veracity of the financial reports [and an audience both able and willing to read such reports], the messages seemed diluted, appeared complex and failed, in many instances, to fully register. Actions and responses from the government were relatively lukewarm and so much was left to development partner interventions.

PUB's arduous journey, plagued by financial setbacks and asset deterioration, necessitates prompt and comprehensive interventions. Collaborative initiatives, strategic reforms, and substantial investments in robust energy solutions are essential to secure power supply, mitigate risks, and pave the way for a sustainable future for Kiribati's utilities.

Reflecting upon this journey indicates the significance of reliable accounting and the need for regular financial reporting, to inform key stakeholders of such vulnerability and critical financial risks that were evident, but were not well noticed, in part, due to the lack of reliable and timely reporting.

So, what have we achieved in the past 9 months?

- Strengthened financial management,
  - Engaged a financial advisor to structure in-year financial reports,
  - o Write-back assets to identifiable, realisable values,
  - o Extract relevant data for input to new FMIS,
  - o Strengthen systems with the kick-off of the FMIS,
- Improved liquidity,
  - o Negotiated favourable prices and terms for diesel,
  - Reconciled, recovered, and then made settlements for old government debts,
  - Strengthened forecasting financial needs, and cash flows on a regular basis to improve liquidity management,
  - Expanded generation capacity,
    - o Commissioned a new Chinese generator,
    - o Overhaul of DG 5,
  - Powerhouse construction to enable new MFAT-funded generators before the year-end,
- Reconciled differences to remove impediments to infrastructure projects,
  - o Identified major issues of challenge in both STREP and STWSP projects,
  - Negotiated for better terms for PUB (some successes, some ongoing),
  - o Clarified bottlenecks for the government stakeholders,
- Extensive capacity building,
  - Multiple staff members attending at various technical forums,
  - In-house training for soft skills, basic business skills and specific technical skills is ongoing via KURP funding and support.

PUB management looks forward to continuing the journey into 2024 and beyond.

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# MAIN ARTICLE

# FUTURE OF INTERNAL COMBUSTION ENGINES AS PART OF POWER GENERATION IN THE PACIFIC

### **David Knight**

Business Development Analyst, ElectraTherm Inc.

The importance of achieving climate goals of Net Zero by 2050, if not before, is paramount if the warming of the climate is to be limited to the target of 20C. Recent catastrophic climate events around the world have provided an insight to the future if action is not taken.

In the Pacific the effects of climate change have already been experienced with increase intensities of cyclonic weather events and rising sea levels.

A key component in achieving net zero is the decarbonisation or better defossilisation of the Power Generation Networks through the replacement of fossil fuels. The challenges for all Pacific Power Authorities is the need to provide constant reliable electricity supply to 100% of their population and to meet the increased demand for electricity which is being driven by the need to electrify everything whilst achieving defossilisation.

Defossilisation can only be achieved through a combination of strategies including engine based generation, variable renewable energy sources, battery systems and energy efficiency including waste heat to power generation.

Experience indicates that current solutions promoted by developers and financial instructions are principally focussed on Solar PV and Wind to the detriment of existing power generation technologies. These technologies have issues including land use, visual impact and resilience to tropical storms.

Through the reluctance of institutions to provide funding for diesel powered engine based power generation they are not only com- promising the ability of the power utilities to meet their statutory requirements but they are also ignoring the flexibility provided by engine based generation, the advancements in engine development and the development of alternative sources of sustainable fuels.

The latest engine-based power generation systems, incorporating waste heat to power generation, have improved performance and efficiency and are designed to utilise the new fuels being developed to replace existing fossil fuels. These next generation fuels include hydrogen, ammonia and plant based sustainable biofuels.

Engine based power plants have several advantages over other forms of renewable energy including;

- Compact installation greater kW/m2 than wind or solar.
- Flexibility to meet variable power demand
- Generate power regardless of climate conditions.
- Provides baseload power with ability to load follow.
- Maintains grid quality.



Chart courtesy of J.E. Access Ltd

The development of next generation fuels for the replacement of diesel is well advanced. These developments are principally aimed at fuel replacement for the maritime industry but have the same applications for power generation.

As an example of sustainable fuels under development, J.E. Access Ltd are developing a replacement fuel derived from biomass. Cambio Fuel is a straightforward carbon negative fuel for power generation diesels.



The Cambio process uses residual biomass which is then converted into approximately 50% carbon neutral renewable diesel and 50% bio bitumen, ratio depending on feedstock.

This is different from other processes that use transesterified liquids from vegetable oils/ animal fats to produce bio-diesel. Whereas bio-diesel feedstock is restricted, the availability of residual biomass is virtually unlimited with 10.5 billion tonnes of agricultural crop waste being incinerated each year, which is sufficient to produce 2.5 to 3 billion tonnes of renewable diesel.

The process for the production of renewable diesel from lignocellulosic biomass is a proven technology that is currently being scaled up with the construction of a commercial sized pilot plant.



The sustainable renewable diesel will be a drop-in fuel that requires no change to engines or infrastructure. This is particularly important for island nations that do not have the capacity to invest in significant changes to fuel handling and storage systems.

The Bio-Bitumen side product produced during the process is added to asphalt as a sustainable road coating that locks the carbon away permanently and is an effect method of Carbon Capture and Sequestration CCS.

The advent of sustainable fuels will be a game changer in defossilisation of power generation systems whilst meeting the needs for reliable power generation and a reduction in environmental emissions through the removal of fossil fuels.

With new technology fuels the need for efficient power generation will still be an important component. Immediate efficiency gains are achievable through the incorporation of waste heat recovery for additional power generation.

ElectraTherm provide ORC based solutions for both engine exhaust waste heat and jacket water cooling.



ElectraTherm ORC Solutions include the Power+6500B+ 125kw ORC and the Power Module PM75 75 kw ORC systems.

For the provision of energy efficient engine cooling the ElectraTherm Active Cooler AC800 uses the waste heat contained within the jacket water to provide the power to operate the cooling system.



The Active Cooler replaces traditional power consuming engine radiators and provides a nett electricity gain through the generation of excess power and savings from offsetting power consumption of the traditional radiator.

ORC technology has successfully been implemented in the Pacific with the recent commissioned of three ORC systems installed at the Nanpohmal Power Station in Pohnpei.



This system consists of three containerised ElectraTherm Power+6500B+ ORC's using waste heat from both the engine exhaust and jacket water systems. The latest technology dry coolers installed provide the cooling water for the ORC condensing circuits and the engines with the more efficient engine cooling contributing to the increase in power output.

The provision of sustainable fuels and the incorporation of waste heat recovery systems based on ORC technology will provide the basis for long-term use of the internal combustion engine for power generation in the Pacific with the added bonus, that when using renewable diesel such as Cambio, the engine will remove more CO2 from the atmosphere than is discharged from the exhaust. Engine based power generation will then become part of the carbon sequestering process (CCS) something alternative renewable energy sources are unable to provide.

# V-LOK Nuts with Anti-Loosening Screw Threads

# Goran Stojadinovic,

MCE, MEE / Product and Innovation Manager, TransNet NZ

# Little things that make a big difference

Threaded fasteners (bolts and nuts) are basic yet essential components that are applied widely in electrical, mechanical, civil, and marine engineering, and many other areas in daily life. They are vital in providing the functions of fastening, connecting, and sealing. [1]

In the electricity industry – threaded fasteners (bolts and nuts) are used mainly for:

- Construction of substations and line-supporting structures (transmission towers, power poles, etc.)
- Assembly of electrical equipment in substations and on supporting structures
- Electrical connections

Threaded fasteners naturally tend to loosen under vibration, impact, or alternating thermal load due to changes in the load current.

- The loosening is usually exacerbated by severe environmental exposure e.g. daily and seasonal changes in ambient temperature, moisture, galvanic processes, Aeolian vibrations, etc.
- It is difficult to identify loose nuts before it is too late or more damage is done to the equipment.

There are many methods and nut designs that claim anti-loosening properties [2]. They include various types of washers, double nuts, and specially designed nuts.

- However, most of these conventional methods are ineffective or provide just temporary postponement of the inevitable loosening of the nuts and bolts over time
- Consequences can be quite serious and costly, as follows:

# Examples of loose bolts and nuts on transmission lines





# Examples of loose nuts and bolts on distribution lines



Loose hardware will ultimately lead to electrical and mechanical failures

- Arcing between live conductors and other hardware due to loose nuts and bolts can cause cross-arm fires, or potentially bush fires by igniting dry vegetation
- Transformers falling to the ground due to loose nuts and bolts can cause even more damage

# Solution: V-LOK nuts & bolts with antiloosening screw threads [3]

V-LOK is a patented screw-thread technology with a proven anti-loosening function. [3] It prevents the bolts and nuts from loosening caused by:

- Mechanical impact or vibrations, including Aeolian vibrations
- Thermal expansions e.g. due to thermal load cycling, overheating, etc.
- There is no need for spring washers, double nuts, adhesives, etc. [3]







V-LOK fasteners are available in Stainless Steel and Galvanised options. They're clearly marked for ease of identification



V-LOK is superior to all other known types of fasteners [3].

# MAIN ARTICLE

# The key features & how it works Basic thread concept of standard bolts and nuts:



A single crest along the thread of standard bolts and nuts

A thread is a continuous helical ridge formed inside a nut, and outside of the bolt. This ridge is called the crest (or the peak). Between each crest is space, called the root or the valley. Threads are set at an angle to the axis of the bolt or nut. Standard bolts and nuts have one crest only along the thread.

However, the threads of the V-LOK bolt & nut consist of:



V-LOK nuts and bolts have 2 parallel crests along the same ridge of the thread, which doubles the contact line with the opposite thread, maximises the friction, and prevents loosening

- Two parallel crests next to each other on the same ridge
- These two crests induce double contact lines (locking points) between threads
- It maximises the static friction force between the bolt and nut threads and prevents loosening

Note: V-LOK nuts and V-LOK bolts should never be used in combination with each other.

V-LOK nuts are used with standard bolts and V-LOK bolts are used with standard nuts to achieve a strong locking effect and prevent loosening.

# Junker test report [3] – a comparison between V-LOK nuts and other types of nuts & fasteners under vibration test



No	Test sample	Initial load	End load	Maximum load	Minimum Ioad
19- 3-3	Common nut	3217.68 N	475.20 N	3217.68 N	475.20 N
19- 4-1	Common nut & Plain washer	3082.47 N	470.09 N	3082.47 N	470.09 N
19- 4-2	Common nut & Plain washer & Spring washer	3417.33 N	498.26 N	3417.33N	498.26 N
19- 4-4	Common nylon nut	3110.32 N	902.15 N	3110.32 N	887.59 N
19- 4-5	V-LOK nut	3138.45 N	2337.69 N	3249.34 N	2327.71 N

- Standard nut without a washer 1, with a plain washer 2, and with a plain & spring washer 3 all loosened in 1 min
- Standard nylon nut 4 stayed fastened with the end load decreased by 71% compared to the initial load
- V-LOK nut 5 stayed fastened with the end load decreased by only 25% compared to the initial load

# Why do standard nuts with spring washers get loose while V-LOK nuts don't?

Both concepts depend on introducing & maintaining strong friction between the bolt and nut threads. There are 4 types of friction: static, sliding, rolling, and fluid. By far - the strongest one is the static friction.

### Standard bolts and nuts with washers:

A spring washer initially applies compression force to lock the nut into place. As the washer is fully compressed, static friction is introduced between the threads. If the washer keeps the pressure, it prevents the nut from loosening. Therefore, this connection depends entirely on keeping constant pressure from the washer's spring effect.

# MAIN ARTICLE

However, over time that pressure is reduced by thermal cycling, corrosion, or vibrations, resulting in small relative movements between two threads, which turns the static friction into much weaker sliding friction. Thus, a loosening process starts and then self-perpetuates due to intermittent change from strong static to weak sliding friction. Every time it happens - the washer's spring effect gets weaker, until complete loosening.

# V-LOK concept

V-LOK relies on strong static friction that is initially created by two contact lines between the threads:

The two contact lines between the threads of a V-LOK nut and a standard bolt double the static friction. I.e. if one contact line slightly reduces static friction with a tendency to become sliding friction, the other contact line will keep strong static friction and prevent the loosening.

In other words - it is highly unlikely that both contact lines would reduce or lose the strong static friction at the same time.

The double static frictions make the V-LOK connection much more resistant to thermal changes, vibrations, and other environmental forces and will maintain a tight connection much longer than any other known fastening method.

# In summary – a small component like V-LOK nuts can make a big difference in the electricity industry

# **Applications:**

Electrical connections, cable terminations, joints, etc.

• Preventing unnecessary electrical faults and outages due to loose connections

Mechanical structures and assemblies - substation hardware, transmission towers, distribution poles, etc.

• Preventing mechanical/structural failures and maintaining structural integrity

### Benefits:

- Improved reliability (SAIDI, SAIFI) and resilience
- Improved public and personnel safety
- Reduced energy losses due to bad connections
- Reduced losses and damage to property due to unnecessary electrical and mechanical failures
- Reduced likelihood of bush fires due to loose nuts & bolts on electrical contacts
- Significant cost savings on maintenance and preventable faults
- Positive environmental effect

# **References:**

1. Vibration loosening of bolts and threaded fasteners – An article in BOLT Science (5/03/2016)

- 2. Review of anti-loosening methods for threaded fasteners
- School of Mechanical Engineering, Being Institute of Technology, China (2021)
- 3. V-LOK manufacturer data (available on request)





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# **Typhoon Mawar and the Path Forward**

Guam Power Authority (GPA)

In the aftermath of the devastation of Typhoon Mawar and with the very real potential of more severe weather events in our region, GPA recognizes the importance of investing in storm mitigation and resiliency efforts to address Guam's vulnerability to catastrophic wind strengths and rains. The process of developing a comprehensive energy plan constantly evolves and includes specific strategies for calculating future risks, enhancing critical infrastructure and quantifying needed improvements.

GPA's continued efforts involve preparation for electrical grid infrastructure hardening, which would improve its survival and recovery time after super typhoons. Efforts also include upgrading and stocking a sufficient inventory of vulnerable components and strengthening existing structures.

# **Prior Mitigation Efforts Proved Successful**

GPA's restoration from Typhoon Mawar is the fastest recovery period from super-typhoon strength winds of 150+ mph the Island Wide Power System (IWPS) has ever experienced. It is also the first time that the IWPS did not experience a "system blackout," or a total shutdown of the power grid. Avoiding a system blackout allowed for quick recovery for customers served by substations feeding through underground transmission lines already in place for the Guam Memorial Hospital, Tumon Bay, and Andersen Air Force Base. In stark contrast, all 115kV and most 34.5kV transmission lines sustained serious damage and took weeks, special equipment, and assistance from partner power companies to repair.

Baseload generators suffered some damage but returned to service and supported customers who were being restored during the recovery period. The Yigo 20 MW Combustion Turbine has not returned to service due to turbine and generator issues. The result is that GPA does not have adequate generation capacity to retire Cabras any earlier than after the commissioning of Ukudu and will be looking at alternatives for generation capacity in order to deliver energy to homes and businesses reliably as it continues with the construction of the new 198MW Ukudu Combined Cycle plant.

Despite the damage done by flying debris to lines, crossarms and other hardware, the concrete pole system that ratepayers invested in over the past few decades has served the entire island community well with 99% having survived Typhoon Mawar's 150+ mph winds. Comparatively, recoveries from prior typhoons took months longer, with much of the response effort directed toward pole replacement in the past. The expansion of concrete poles was also made possible by FEMA mitigation funds received and investments made by the U.S. Air Force to place transmission systems underground.

# **Infrastructure Resiliency Plan**

As conversations advance the importance of moving more of Guam's power grid underground, it is very important that the federal government and the local community work together to mitigate Guam's vulnerability to natural disasters and military conflicts. Today, the national defense environment has changed substantially over the past two decades and it is important to prepare Guam's electrical grid infrastructure for potential threats, natural and otherwise. A full underground system, excluding 115kV transmission, could cost about \$7B, an unaffordable price for ratepayers to bear on their own while trying to maintain affordable power rates for residents. For context, the preliminary damage assessment from Typhoon Mawar is just between \$25-\$35 million. GPA's ability to obtain funding for the billions in investments needed is doubtful. GPA will reach out to FEMA, US Military branches and other federal entities to invest in Guam's future energy resiliency. Federal government investments are needed today to make Guam a highly resilient community and strategic military base for the nation. A substantial investment by the federal government into Guam's infrastructure could provide returns over the decades to come.

# **Typhoon Mawar Restoration Process**



# Cost Estimate: Infrastructure Resiliency Plan

GPA's preliminary estimate follows.

Detailed project descriptions will be presented to the CCU at its August 2023 meeting.

DESCRIPTION	ESTIH	ESTIMATED COST				
ITEM 1: Underground Transmi	ssion Lines & Indoor Suit	ostation		\$ 833		
ITEM 2: Critical Distribution S	ystem Mitigation		1 2	\$ 813		
ITEM 3: Other Critical Infrastr		\$ 730				
SUBTOTA	L - Immediate Critical Realiency Projec	Infrasti ts (iter	no f-3):	\$ 2,376		
ITEM 4: Underground Remain	ing Distribution System		1 3	\$ 4,025		
	TOTAL - All Resiliency Projects					
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# Floating Solar Photovoltaic System Installation Completed in Tuvalu

Mafalu Lotolua - General Manager, Tuvalu Electricity Corporation



# September 1, 2023

Funafuti, Tuvalu: The installation of Tuvalu's inaugural Floating Solar Photovoltaic (FSPV) system has been successfully completed, with this cutting-edge system seeing 184 solar panels positioned on Tafua Pond in Funafuti.

Like many Small Island Developing States (SIDS), Tuvalu has been heavily reliant on imported fuel for its diesel-based power generation system. Through this new FSPV system 174.2 megawatts per hour of electricity will be generated each year, meeting two percent of Funafuti's annual energy demand.

This innovative clean energy source will reduce the country's reliance on diesel-powered energy generation by 47,100 litres per year – a saving of approximately US\$68,000.

The Facilitation of the Achievement of the Sustainable National Energy Targets of Tuvalu Project (FASNETT) – implemented by the United Nations Development Programme Pacific Office in Fiji in partnership with the Government of Tuvalu is supported by the Global Environment Facility. The project aims to facilitate the development and utilisation of feasible renewable energy resources and applications of energy efficient technologies in Tuvalu.

The disruptive impact of global fuel prices has had significant repercussions on both local businesses and households, particularly in the Tuvalu's remote islands. The Government of Tuvalu has been passionately engaged in harnessing renewable energy solutions that align with the country's climate mitigation agenda.

With the successful installation of the FSPV system, the Government of Tuvalu draws closer to its national energy objective of achieving a complete reduction in greenhouse gas emissions from the electricity generation sector by 2025, in alignment with the country's Nationally Determined Contributions (NDC).

General Manager of Tuvalu Energy Corporation, Mafalu Lotolua, underscored the Government of Tuvalu's pledge toward the use of innovative solutions, and stressed that without such action Tuvalu will continue to be hit hardest in the face of global climate change implications.

"This aspiration not only charts a promising path for the growth of renewable energy and energy-efficient enterprises but also serves as a testament to Tuvalu's unwavering commitment to sustainable methodologies as we strive for a greener, brighter future," he said.

UNDP Pacific Office in Fiji Resident Representative, Munkhtuya Altangerel, visited the site at Tafua Pond and said the installation signifies a determined leap forward on Tuvalu's sustainable journey.

"Energy stands as the primary driver of climate change, responsible for almost 60 percent of overall global greenhouse gas emissions. This work seamlessly links with the United Nations Sustainable Development agenda, and through its successful implementation the Government of Tuvalu is taking substantial strides towards reducing greenhouse gas emissions," Ms. Altangerel said.

In addition to the installation of the FSPV system, the FAS-NETT project has supported the Government of Tuvalu with the commissioning of a solar powered capacitive deionization water desalination system, installation of a demand management response system, a rooftop solar photovoltaic system in the TEC Demo Fale, and implementation of stand-alone solar home system energy storage enhancement for Funaota.

The installation of the FSPV system was completed by the JGH Group of Denmark.

### For more information please contact:

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Nick Turner, Communications and Advocacy Specialist, UNDP Pacific Office in Fiji; nicholas.turner@undp.org

# The Pacific Women in Power (PWIP) Program begins data collection across the Pacific

### Mue Bentley Fisher, Senior Communications Consultant - World Bank

The World Bank's Pacific Women in Power (PWIP) Program has started gathering gender baseline data from Pacific energy utilities and Government energy departments across the region to help inform the program's direction.

The PWIP Program aims to enhance women's employment and economic empowerment across Pacific Island energy institutions including ministries, utilities and the private sector. The Program is being implemented by the World Bank in partnership with the Pacific Power Association (PPA) and in collaboration with the Pacific Community (SPC).

A key component of the program is to establish gender-disaggregated baseline data in the Pacific energy sector.

"At this initial stage of the program, we first need to get our bearings right," Helle Buchhave, Global Gender Lead with the Social Inclusion Practice of the World Bank, said. "We are prioritizing identifying current, creditable and detailed sex-disaggregated employment data and information on policies, interventions and goals for promoting a diverse labor force from energy utilities and energy departments across the Pacific Region. Practically, this involves a comprehensive survey, focus groups discussions and strategic interviews, to establish a baseline and assess the needs of each client."

The data will inform the wider program and support energy institutions to design and invest in innovations, partnerships and policies to increase women's participation in the energy sector.

The program launched a 'call for participation' in the survey to PPA utility members and Pacific government departments responsible for the energy sector in June 2023. The survey is focused on gender-disaggregated workforce data, identifying existing and planned company policies and procedures, and initiatives and challenges to promote a gender diverse workforce.

PWIP team members have recently visited utilities and energy departments in Samoa, Tonga, Tuvalu, the Republic of the Marshall Islands, the Federated States of Micronesia, and Fiji to support data collection efforts. This follows virtual support provided through group briefing and one-on-one sessions with representatives from government departments of energy and utilities.

"We look forward to sharing and discussing some of our preliminary findings of this important initiative at the 30th Annual PPA Conference this month in Saipan," Ms Buchhave added.

PWIP is funded by the Canada-World Bank Clean Energy and Forests Climate Facility managed by World Bank's Energy Sector Management Assistance Program (ESMAP). The program was launched in May this year at the 5th Pacific Regional Energy and Transport Ministers Meeting held in Vanuatu and has been endorsed by Pacific Energy Ministers.

To follow developments on the Pacific Women in Power Program, follow the hashtag #PaficiWomenInPower on social media and here on Facebook: Pacific Women in Power



All female STEM focus group in Tonga with PWIP team, Mr, Tsubasa Enomoto, Social Development Specialist and Ms. Lilika Fusimalohi, Senior Pacific Gender Program Specialist (consultant).



Pohnpei Public Utility Corporation (PPUC) all male STEM focus group members with PWIP's Ms. Lilika Fusimalohi, Senior Pacific Gender Program Specialist (consultant) and PPUC Human Resource Manager, Amaryllis Shoniber



All female STEM focus group with Samoa Electric Power Corporation.



All female STEM focus group members and colleagues from Energy Fiji Limited (EFL), with PIWP team members Ms. Lilika Fusimalohi, Senior Pacific Gender Program Specialist (consultant) (standing, second from right) and Ms. Mue Bentley Fisher, Senior Communications Specialist (consultant) (standing second from left)

# Strategic Planning Meeting to inform the Micronesian Gender Equality Framework and the SPC Gender Equality Flagship

### **Pacific Power Association**

In a significant step towards promoting gender equality and women and girl's empowerment in the Pacific region, the Pacific Forum Leaders endorsed the region's Gender Equality Declaration in 2012.

This landmark declaration aimed to uplift the status of women and girls, and empower them across economic, political, and social spheres. Building upon this commitment, the Pacific Leaders, during the 51st Pacific Forum Leaders' meeting in July 2022, further solidified their dedication by endorsing the visionary 2050 Strategy for the Blue Pacific Continent. The strategic values and pathways outlined in this strategy reflect the core principles of inclusivity, equity, and equality. Notably, the meeting also celebrated the successful convening of the inaugural Pacific Women Leaders, highlighting the collective commitment of our leaders to ensure that regional priorities are informed by gender-balanced and inclusive views and perspectives.

The meeting aims to initiate the planning process for two crucial mechanisms that will enhance and strengthen efforts to promote gender equality in Micronesia and the broader Pacific region. These mechanisms include the development of a Gender Equality Framework specifically tailored for Micronesia, as well as the establishment of the Gender Equality Flagship.

The Gender Equality Flagship will serve as a comprehensive framework for addressing the pervasive issue of gender inequality.

The meeting was supported by SPC and the Pacific Islands Development Programme (PIDP). It is based on a request from Chair of the MIF Gender Equality Working Committee to SPC. Funding and technical support has been drawn from the Executive Office, the Human Rights and Social Development Division, the Pacific Women Lead at SPC and the Women in Leadership Programme.





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# CURRENTS

# Pacific Power Association participates at the 2023 Resilient Pacific Islands Leaders Fellowship

# **Pacific Power Association**

The Pacific Islands Development Program (PIDP) invited the PPA Secretariat to be a guest speaker during the 2023 Resilient Pacific Islands Leaders (RPIL) Fellowship. Reena Suliana, represented the PPA Secretariat and participated in a series of activities and events during the period 10-14 July 2023 which has been assigned the theme of "Planet", including a panel discussion at the IMIN Conference Center on the East-West Center Campus. The RIPL Fellowship is a U.S funded Pacific leadership development program that includes a residency in Hawaii and field immersion in Washington D.C. This program provided a cohort of 25 emerging professionals selected from across all sectors and Pacific Islands Conference of Leaders (PICL) network with other leaders from across the Pacific and the U.S. The program will strengthen participants' knowledge and understanding of key regional economic, social, political, health, educational and environmental issues and cultivate culturally sustaining leadership capacities.



# NEW MEMBERS



# to the New Allied Members

Eight (8) new Companies have joined the PPA as Allied Members since our last PPA Magazine and Two (2) Companies re-join.

The new Allied Members are:

**DHINFRASTRUCTURE LLC:** DHInfrastructure is Northampton, United States of America. Their primary activity is economic and regulatory consulting. Their secondary activity is public private partnerships.

**EIPGRID INC.:** EIPGRID Inc. is based in Seoul, South Korea. Their primary activity is Control and Monitoring Systems. Their secondary activity is energy efficiency.

**I-ENVIRONMENT.:** I-Environment Investments Pacific Pty Ltd is based in Sydney, Australia. Their primary activity is infrastructure investment and project delivery.

**INHANCE UTILITIES.:** inHance Utilities is based in Texas, United States of America. Their primary activity is customer information systems and utility billing software. Their secondary activity is utility workforce management.

**UTILLIGENCE LIMITED:** Utilligence Limited is based in West Sussex, United Kingdom. Their primary activity is IPC, EPC renewable energy, resources, and efficiency. Their secondary activity is high voltage (HV), low voltage (LV).

**WSK INTERNATIONAL.:** WSK International is based in Skawina, Poland. Their primary activity is production and sales of spare parts for fuel and oil separators and plate heat exchangers. Their secondary activity is technical advisory.

**WR CARPENTER (PNG) LIMITED.:** WR Carpenter (PNG) Limited is based in Port Moresby, Papua New Guinea. Their primary activity is automotive. Their secondary activity is merchandising.

**ELEMENTAL GROUP :** Elemental Group is based in Auckland, New Zealand. Their primary activity is energy consultancy. Their secondary activity is energy development.

Allied Member re-joining:

**CABLES FIJI LIMITED.:** Cables Fiji Limited is based in Suva, Fiji. Cables Pte Limited is based in Suva, Fiji. Their primary activity is manufacturing of power cables for domestic, industrial, and commercial purposes.

**MANA PACIFIC:** Mana Pacific is based in Honolulu, Hawaii. Their primary activity is clean energy project developer. Their secondary activity is infrastructure project financing.

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