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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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The articles published in this magazine do not necessarily represent the policies of the Board of Pacific Power Association

Cover Page Photograph – The Honorable Henry Puna & Ms. Teiiti Nia of TAU at the official opening of the PPA 28th Annual Conference & Trade Exhibition, Rarotonga, Cook Islands.

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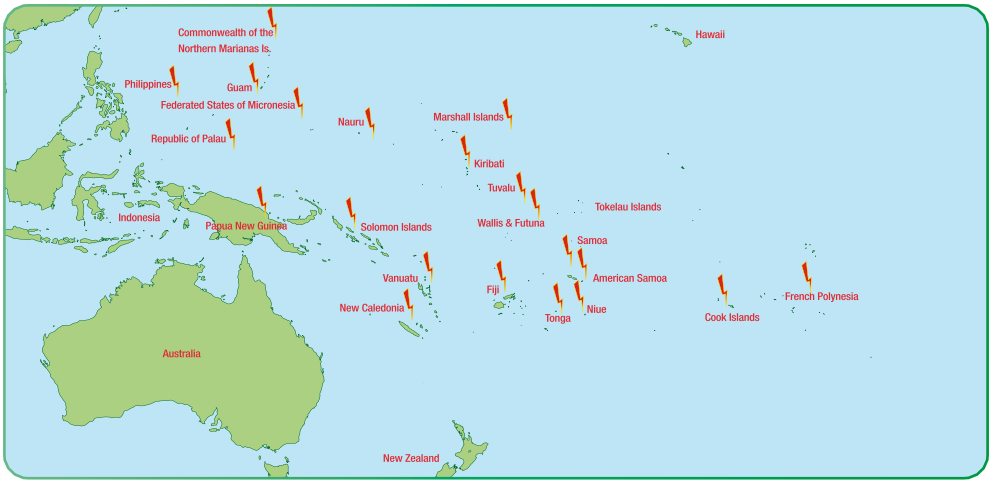

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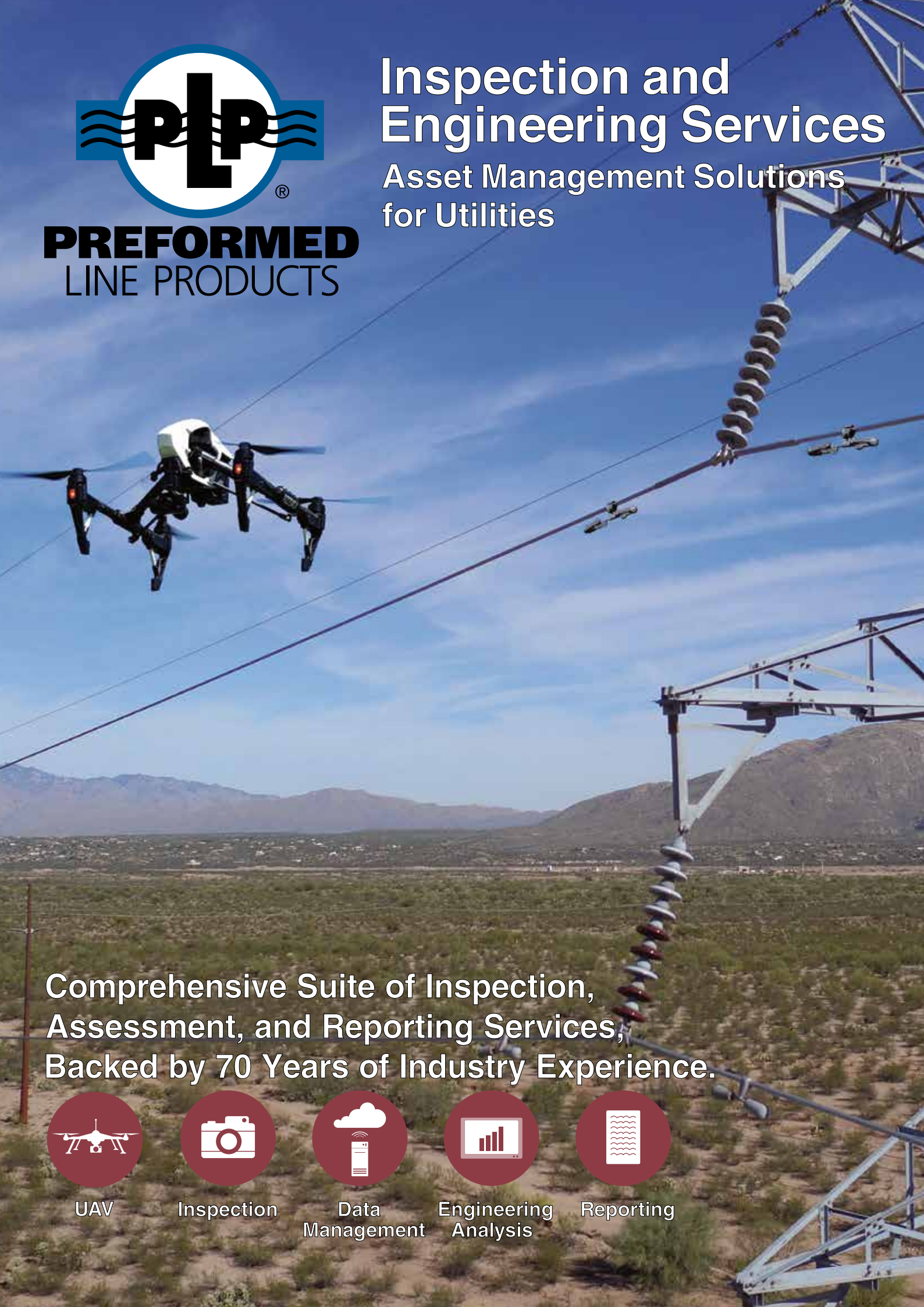

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Editor's Notes

Andrew D. Daka
Executive Director

Bula Vinaka and greetings form Suva

The Association held another successful Annual Conference this year generously hosted by Te Aponga Uira (TAU) in Rarotonga, Cook Islands. The turnout by both the Active and Allied Members was excellent, thanks in no small part to the host's exceptional organization working closely with the PPA Secretariat, Allied Member sponsors.

Details of the conference is provided in the magazine but it would be remiss of me not to express the Association's gratitude to the Government of the Cook Islands for the support of the event and the Prime Minister for availing himself to officiate in the opening ceremony.

Our thanks also to the keynote speaker , Mr. Justin Locke, Director of the Islands Program of the Rocky Mountain Institute for accepting our invitation to deliver the keynote address.

The Board at the conference discussed a number of very important initiatives which will have a significant impact on the Association including Regional Training for the Energy Sector, PPA Disaster Mutual Assistance Program and the PPA Insurance Scheme.

Climate change continues to be in the forefront of discussions at the regional level as indicated in the outcomes of recent Pacific Forum Leaders meeting. The PPA utility members are continuing to support this work through the increased renewable energy activities. The Association is contributing to that effort with the commencement of the field surveys for the solar and wind resource mapping of the World Bank funded Sustainable Energy Industry Development Project.

In this edition of the magazine we also publish the first of the papers presented at the recent 28th Annual Conference. These papers are based around the theme of the conference" Su stainable, reliable and affordable renewable energy."

Let me at this point welcome the following organisations who have recently joined the Association as Allied Members. OTEL Onehunga Transport Engineering Limited is based in Auckland, New Zealand, South Pacific Turbocharges NZ (2018) Limited, based in Nelson, New Zealand and Green Globe Solutions American Samoa Inc., based in Pago-Pago, American Samoa.

Vinaka

Welcome Message from the Chairman of Pacific Power Association

Hasmukh Patel
CEO - Energy Fiji Limited

Kia Orana, and may I on behalf of the Board and the Association welcome all the delegates to the 28th Annual Conference of the Pacific Power Association in beautiful Rarotonga, Cook Islands.

I am pleased to inform all delegates that the conference programme this year has something for everyone from – Utility Board, Directors to CEO's, Development Partner representatives, Engineer Technical and Non-technical utility delegates.

No doubt the bulk of our discussions and deliberations during the course of the event will be around ways and means to increase the contribution of Renewable Energy to our island's energy mix in with a sustainable affordable and efficient manner knowing fully well that private sector plays an important role in being able to take up the investment required on behalf of utilities and government for that to happen we need the right conditions through addressing existing financial risks. The ADB through its Renewable Energy Investment Program looks to lower the risks.

Every year the Pacific Islands experience adverse weather conditions which impact on the power supply network in the islands resulting in severe damage and economic loss.

The World Bank Group has begun discussions with the Association to explore an insurance initiative for the Association to reduce the financial impact of such disasters to the PPA Members Utilities.

Lastly but not the least the Association acknowledge the continued support of all Members through their participation at this year's conference.

Meitaki.

Welcome Message from the Prime Minister of Cook Islands

Honorable Henry Puna

Kia Orana,

It is an honour and pleasure to sincerely welcome you all to the 28th Pacific Power Association Annual Conference and Trade Exhibition and 10th Engineer's Workshop, that will be held from the 1st to the 5th of July 2019 here in Rarotonga. On behalf of the Government and people of the Cook Islands "Turou, Oro Mai"

As members of the Pacific Power Association you have all, in your own fields, kept the lights on in the homes of our Pacific people over many decades. You all provide an essential service, one which provides the platform for the advancement of our Pacific economies nestled within our vast oceans.

This year's conference theme: **Sustainable, reliable and affordable renewable energy**, highlights challenges that the energy industry in our region is faced with. Our challenge is not only using more renewably sourced energy, our challenge is providing a smart future that is able to expand horizons and transform economies, the livelihood of our people, to one that is built on a low carbon future

I congratulate Te Aponga Uira O Tumu-Te-Varovaro for being awarded; for the third time, the privilege to host this prestigious event in its 28th year. I am grateful for the opportunity presented, for you to come together as peers, stakeholders and experts to engage with each other and openly discuss new technologies, address energy issues, exchange knowledge and build business as well as set key goals for the future of electric utilities in our Pacific region.

I am equally excited to share that Te Aponga Uira O Tumu-Te-Varovaro is this year adding a unique Cook Islands cultural layer to your conference experience; immersing you in a showcase of our country and what makes us who we are.

Kia Orana e Kia Manuia

Seizing the Opportunity: Together, We will go Further

Justin Locke
Director - Rocky Mountain Institute

Bishop Tutai Pere, Prime Minister - the Honorable Henry Puna, Deputy Prime Minister – the Honorable Mark Brown, Members of Cabinet, Chairman of the Te Aponga Board, Mr. Mata Norooa, distinguished Developments Partners, Chairman of the PPA Board and Directors, ladies and gentlemen, kia orana.

First of all, it is wonderful to be back here in Rarotonga. A place I know well from my days as a Development Specialist fresh, when I was with the United Nations Development Program multi-country office based in Samoa. During my flight here, I was trying to remember the last time I was actually here in Raro. It dawned on me – first, how time flies, second, that the last time I was here was to support the hurricane recovery efforts for Aitutaki after Cyclone Pat hit in early 2010, which I believe was a CAT 3 cyclone, that totally devastated Aitutaki. Not the best of circumstances. If I remember correctly, around 80% of all homes on the island were damaged or destroyed – not to mention that the local agriculture sector was completely destroyed.

Of course, events like Cyclone Pat are not new to the Cook Islands, nor to the broader Pacific region. In fact, over the last decade, these events have unfortunately become the norm. As we all know too well, the Pacific region is at the epicenter of the climate challenge, which manifests itself in the form of rising seas, increased intensity of cyclones and eroding coastlines. For atoll nations, climate change poses an existential threat – particularly in the Micronesian region but also in the northern Cook Islands and neighboring islands like Tokelau. For these countries and islands, and many others in both the Caribbean region and Indian Ocean, we must face the fact that their way of life is in danger and their future will look very different than it does today.

I have experienced this tragedy first hand. I spent my early 20s in Kiribati, which averages less than 2 meters above sea level. I lived on an island called Tabiteau Maiaki (known for its fierce warriors and knife carrying culture), which measures just over 1 meter above sea level. As you can see, I quickly became part of the family. And since then, I've dedicated the last 15 years of my life working with islands nations to adapt their economies and communities to face the climate challenge.

The first part of my career, I believed that the way to "address the

climate challenge" and support island nations was to adapt coastal areas and retrofit infrastructure – by building sea walls, breakwaters, and building flood protection infrastructure. Basically, attempting to build our way out of the problem.

But it was not until I started really delving into these issues to better understand the bigger picture that I realized that a majority of islands and coastal communities will never be able to build their way out of the problem. For the global island community to survive, they must address the root of the problem. And in order to do that, island nations must become the solution to create the catalyst for global change. And while most industrialized countries are looking inward for solutions, trying to go at things alone, the people of the Pacific know that in order to be successful in combating a crisis as big and complex as the climate challenge, you will have to work together. Having lived and worked in the Pacific for nearly a decade, I am convinced and assured that working together is in the very DNA of the Pacific Islander.

The good news is that many islands across the globe have already started their energy transition. And in many cases. have made significant progress. Case in point, under the leadership of this administration the Cook Islands has set a goal to have all the outer islands powered by 100% RE by 2020, and has already made significant strides to achieve this goal. In the process, islands around the world are developing a scalable blueprint for what an equitable energy transition looks like from a technical, economic, financial, and regulatory perspective - while demonstrating the enabling business models and regulatory frameworks required to scale. As a result, whether you asked for it or not – this community, the PPA utility community, now finds itself at epicenter of the global energy transition.

At my organization Rocky Mountain Institute, we have a front row seat to the Caribbean energy transition - working with more than 15 countries in the Caribbean to accelerate and guide their energy transition.

Countries participating in Rocky Mountain Institute's Islands Energy Program go through a deliberate, concerted process – which we tailor to the local context, and has led to replicable success with over half a dozen countries. In fact, we have taken several countries from <1% RE penetration to double digit penetration over the last 3 years alone – while bringing 12 RE projects to market for competitive tender (most of which were commercially financed) – leveraging over $200M in clean energy investment. This proven process is designed to transition an island economy regardless of the challenges. For example:

- In Montserrat – we have redesigned the energy matrix to be fully renewable with the goal to lower the cost of electricity and entice the diaspora to re-populate the island after a devastating volcano destroyed almost the entire country over a decade ago.
- In Bermuda – we are working hand in hand with the Department of Public Transportation and the utility to convert the entire public transportation system to electric vehicles – transitioning Bermuda to the deepest EV penetration country in the world.
- In Saint Lucia – we bridged the divide between the investor-owned utility and the government to collaborate effectively and chart out a joint vision for Saint Lucia's energy transition, which resulted in the country's first utility scale solar PV project.
- In St Vincent and the Grenadines – a multi-island island nation, we are working to provide a modern, more reliable and cheaper energy supply to isolated communities in the Grenadines islets – through high renewable penetration microgrids.
- In Barbuda and British Virgin Islands – following hurricane Maria and Irma – both CAT 5 hurricanes that hit the Caribbean within two weeks of each other, we have redesigned the electricity system, which was nearly 100% destroyed, to a cleaner, cheaper and more resilient renewable based system. Barbuda is constructing their new system now, which will be nearly 100% renewable.

We have learned through addressing these challenges that there are key ingredients required to transition an economy – regardless of its size, which you may think are intuitive, but are rarely implemented in practice….

First, you need a Plan that enables you to get from where you are today to where you want to go. It is critical that stakeholders (government, utility, regulator and the public) align around a core vision and jointly develop this plan, in an inclusive manner to achieve that vision.

When you move from a centralized energy supply – where electricity is produced in a room of this size hidden away somewhere to a decentralized energy supply – where these new assets become

part of the natural landscape, it is a very personal thing in an island context – where everyone wants and should have a say in what they want the world around them to look like. This plan should be based on a strong understanding of the technical parameters of the electrical grid as well as the underlying economics of the electricity sector – if the plan is too aspirational or high level, it can often restrict progress as opposed to accelerate it. It should chart the least cost pathway that leads to a transition, and it must have buy-in from all stakeholders…or else you will just run into pitfalls later in the journey.

Next, Stakeholders need to act. Whether it's a big step or a baby step, it is critical to take action required to build inertia to move the energy transition process forward – thereby proving that the vision and the plan can be actualized. Of course, this takes leadership at multiple levels. Without it, things will inevitably stall. Most importantly, the utility must demonstrate leadership in the process. The harder you fight against change, the more difficult the inevitable transition will be.

I am looking at the utilities in this room when I say this, it is important to step out of your comfort zone and take risks. Many of the utilities we work with in the Caribbean are terrified of change. They do what they know, and they do it well. But with new technologies reaching the market at much more affordable price points than traditional fossil fuel generation – we are seeing utilities and governments make important strides. No more prevalent is this seen than in the uptick in deployment of utility scale battery storage. Battery storage is the game changer for the island energy transition – as it provides readily deployable power supply that enables intermittent renewables to deliver sustained and reliable power.

Just in the last two years, the cost of large-scale lithium ion battery storage has dropped over 60%, which have made renewable technologies more reliable in addition to being cost effective in comparison to traditional fossil fuel technologies. Islands are where these applications are being tested and deployed at scale. In parallel to deployment, it is critical that islands take the necessary steps to build the requisite expertise to operate and maintain these new technologies. In turn, creating new jobs and industries.

Lastly, and most importantly it is critical to collaborate if the energy transition is to be realized. No one utility, government or country can facilitate an energy transition alone, and most islands do not have the capital to make a mistake….you only get one chance at this – so you must learn from others. It requires collaboration between stakeholders and with outside knowledge providers - and most importantly with other islands going through the same journey. The energy transition requires human energy most of all – and it flourishes when given a collaborative and learning environment. At Rocky Mountain Institute we've nourished the energy transition through the Caribbean renewable energy community of practice, and now are seeing utility engineers, government policymakers, and regulatory staff all learn from one another and tackle enormous challenges together.

The world is watching, as the insights gleaned from the islands today will ultimately shape how to scale the energy transition globally tomorrow. Now is the time to seize the opportunity. At a time when the world is retreating behind its' borders, islands have no other choice but to take this journey and attack this enormous challenge together, as an island nation and utility community. As the famous African parable said, you may go fast alone, but you will go further together. Thank you. Kia orana.

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Optimising Revenue with Solar

Alan Parker
Director - Datelstream Ltd

Change is coming
Solar generation of power is happening now, and wind generation is also becoming viable. As this develops new opportunities arise.

Your consumers can also obtain solar generation equipment. As a supplier you should consider providing this equipment and an installation service. It is a source of revenue.

Should you allow electricity generated by your customers to be imported to the grid? This is becoming more popular. This also means that you need more advanced systems. Meters that can record electricity generation as well as consumption need more advanced customer management to take advantage of this.

Instead of just charging a rate pre kWh, more advanced charging options are becoming popular. Not just different rates for different types of customer, but stepped rating and different charges for different times of day that can be done with smart meters.

Meter types
Standard – common meter is read typically once per month

Prepaid – there are different types, but the advantages are getting paid in advance, no need for a meter reader, and no debt to manage. See below for more on this.

Two-way meter – This type of meter will record any solar generation by the customer that is fed back to the grid. Some come with a single reading (so the meter could go backwards) and some come with a separate reading for the solar, or even a separate meter. Your billing system will need to handle negative readings, and even readings that may roll back from 00000 to 99999.

Smart – These are usually controlled remotely, but anything goes here. There are new types of smart meter being launched all the time. You can then vary your charges by time of day according to your costs and generation capacity.

To take advantage of all these opportunities, you need a customer management and billing system that can adapt to change as it happens.

Prepaid
The advantages are obvious, but there are limitations too.

Most prepaid meters (maybe all) are not two-way, and so will not allow solar generation by consumers to go back to the grid. But change is coming. It is likely that someone will provide a smart, prepaid, two-way meter in the future.

One standard that is popular is STS – Standard Transfer Specification. These are highly secure prepaid meters that require specialised software to generate the top-up vouchers that consumers buy. Note that "STS Edition 2" is coming and all existing STS systems will need to change to this Edition 2. This requires a software upgrade of all existing meters as well as the voucher generation software and equipment.

If you do go prepaid, then you need to consider how customers will top-up at any time of day or night. There are solutions to this, including for STS, if your voucher generation system allows this.

If you want to also allow for some solar generation by customers you really need a customer management and billing system that can adapt as things change. Having a single system that can handle everything is a major advantage.

Solar generation by customers
You can make money by selling solar generation equipment to customers. You can also benefit from cheap power generated by these customers when sent back to the grid.

If you are to buy imported kWh, what rate should you offer? Certainly not the same rate that you sell kWh at! This power will usually be available in the middle of sunny days. Is that when you can use

this additional power? Offering half the rate at which you sell kWh may be appropriate. You still want to encourage this.

If the customer is generating power by wind, then that can occur at night, so the buyback may be better value.

If you do pay customers for the power that they generate, you need to allow for the situation where they are in credit for a month. Do you actually pay them? Or just let the credit roll-over to the following month? If they are always in credit and you are not actually paying them, then what should you do long term?

You need to put sensible policies in place before deployment. Also you need systems that can handle all options and combinations.

Managing debt
Your systems for managing debt should be integral with your overall billing and customer management system.

Consider Payment Arrangements and possibly moving the customer to prepaid.

Your customer management system should track and identify all past customers so that you can easily check if the customer or the location has a poor payment history.

Managing debt is more difficult if you have different systems for different meter types.

Single customer management system
There is a need for a customer management system that can do everything.

- Fault management

- Bill all types of meter including Solar and prepaid and all charging policies

- Workflow management and tracking

- Integration with other systems including accounts and stores

- Invoices and reminders delivered by SMS or email

- Customer portal

- Be fully auditable with every action recorded

- Adaptable to whatever the future brings!

IoT & Renewable Integration

Nick Philips
Head of Technical Sales (APAC) - Itron Australasia Pty Ltd

Abstract:
The paper presents the history and latest ongoing case study of IoT and renewable integration in Tonga Power Limited (TPL). Following the implementation of smart metering alongside an IPv6 mesh IoT capable communication canopy, TPL have commenced the rollout of smart water metering using the same communication canopy.

This year, we are focusing on enabling reliable demand response by deploying a pilot of IoT solar irradiance sensors to the communication canopy. These IoT sensors would monitor sunlight levels from locations in Tongatapu using the same IPv6 mesh and by correlating their output with the measured consumption from the smart meters, will allow TPL to have greater visibility to instantaneous PV and load demand behind the meter, providing valuable information for long term planning and operational stability.

This paper discusses the past deployments, presents the new Pilot and summarizes the benefits of the IoT infrastructure and what must be considered for a successful long term IoT strategy.

Background
As nations modernize and expand, existing Utility infrastructure, and in particular generation, must expand if growth is to be maintained. Of particular difficulty to small Island nations is how generation growth can be achieved when traditional sources rely on diesel for generation. Typically, the fuel for this generation becomes one of the major import costs to a nation and can impact national growth.

Tonga Power Limited is near completion of its initial 2010 – 2020 roadmap to introduce a high proportion of renewable energy into the generation mix. The initial target of 50% renewables by 2020 being composed of around 6 MW Wind and Solar, along with 2MW of battery and the remaining being through biomass & biofuels. PV is thus expected to play a role in supporting about 20% of the daytime need.

Most of the embedded PV capability will be provided through medium sized PV site installations connected through a grid ring topology. The original roadmap also included an anticipation of private solar capacity, small at first at about 3 – 5% of total solar, but potentially growing.

With a 50% renewable energy capacity, comes the requirements for reliability in dispatch from both Wind and Solar. Both are subject to weather patterns and thus a key success factor in this delivery is an accurate forecasting model of both the capacity to generate, as well as load growth.

The Challenge for PV Generation
Accurate Forecasting of PV generation is required at two levels within a Utility.

- For Solar Plants, a 36 hour – One week ahead forecast of solar production is needed to allow for accurate dispatch modelling of the generation as well as ex post Settlements, where solar plants are obligated to meet the scheduled generation subject to penalties.

- For Distributed Energy Resources the problem is cleaner cut, but potentially more difficult to solve. The net generated by a site is the aggregate of the Load consumed by the site subtracted from the Generated solar capacity. The issue here is that the meter can not differentiate between the two values – it cannot see "Behind the Meter (BTM). For example, measured low export power may be caused either by a dip in generation or an increase in internal load. This "load masking", and the lack of generation output visibility prevents system operators and engineers from determining the real system load conditions which can inhibit the ability to plan

and operate the distribution system. This load masking condition is caused equally by both exporting and non-exporting DER installations and is a trait of distributed energy resources (DER).

In both cases, without reliable modelling of Solar capacity, the ability to run an affordable, sustainable, secure & reliable network can be compromised.

Traditional Forecasting is not well suited for Weather Pattern Dependencies

If BTM solar PV electricity production was stable, the forecast performance of day-ahead and real-time load forecasts would not be adversely impacted by deep penetration of BTM solar PV. This is not the case with solar PV generation, which varies with the time of the day, season, and prevailing weather conditions. The latter, specifically cloud cover, causes swings in measured loads at a much higher frequency than most load forecast models are designed to capture. In general, load forecast models are designed to capture non-weather sensitive load variation associated with the time-of-the-day, day-of-the-week, and season separately from weather driven space heating and space cooling. Non-weather sensitive loads tend to follow relatively smooth and predictable cycles that have a slow seasonal frequency, a relatively faster day-of-the-week frequency, and a fast-daily frequency. Time trends, season and monthly binary variables, and day-of-the-week binary variables are designed to capture these varying load frequencies. Except for storm fronts, temperatures and the associated weather-sensitive loads tend to evolve slowly over the course of a season, week, and day. As a result, statistical models can capture accurately movements in weather-sensitive loads using variables designed around hourly temperatures.

Solar PV generation adds a higher frequency of load variation that the traditional relatively slower moving set of variables used in a statistical load forecast model are not designed to capture. As a result, variables designed around estimates of solar PV generation or cloud cover movements need to be introduced to capture this higher frequency load variation.

Itron & Tonga Power Pilot Proposal

At the commencement of the year, Itron approached Tonga Power to discuss both aspects of modelling for Solar PV generation – the macro day to week forecasting as well as the BTM modelling problem. Itron's load forecasting models and products like MetrixIDR are used extensively by Utility companies (locally by the Energy Market Operator, AEMO in Australia), and recent work in California has resulted in Itron enhancing these models.

The aim of the discussion was to engage in a partnership study to look at how:

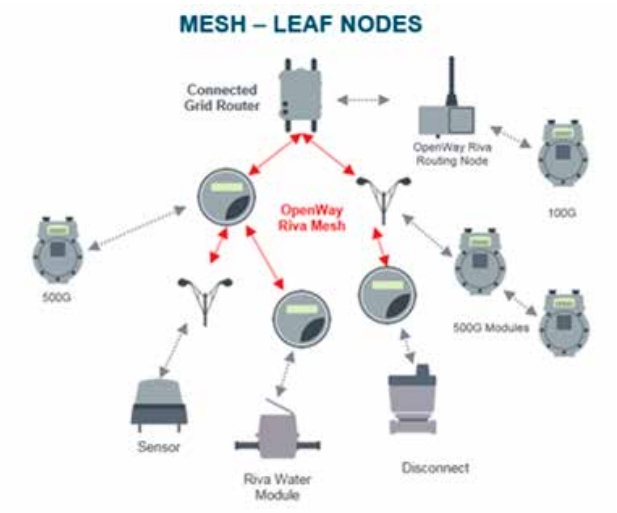
- The introduction of IoT based solar irradiance sensors could be used to monitor real-time change in sunlight, and be used to predict changes in PV generation from sites in the local geography;

- Historical and current production data from the Solar farms, correlated with weather data could be used within Itron's Load forecasting software to better produce short term forecasting for Operational dispatch.

In the first case, the immediate goal being to trial IoT sensors and use the extracted data to validate and fine-tune the accuracy of the new algorithms. Tonga Power Ltd was a natural choice for this study as, apart from the high Renewable Energy target, the Utility has already deployed the Itron RIVA smart communications RF network – a network which is capable of sustaining not only metering equipment, but also IoT devices.

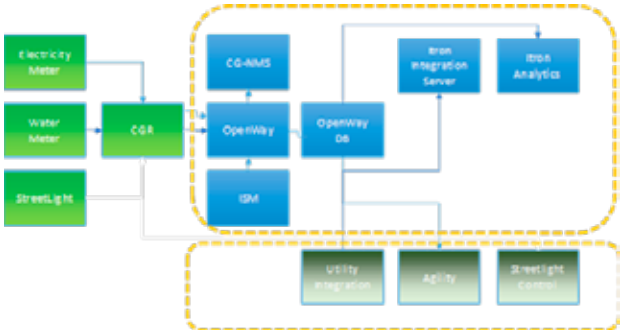
The TPL Openway RIVA network

Over the past 4 years, Tonga Power Ltd have progressively moved to a Smart Metering Network Infrastructure, with first the installation of island wide Smart electricity meters and then with the addition of smart water metering. Both metering solutions take advantage of a SINGLE Itron RIVA IPv6 RF mesh communications canopy that now spans the population of Tongatapu.



Devices within the field communicate through each other to create a self-healing communications mesh, eventually returning data out to a Connected Grid Router. The key to the interconnectivity between devices is the use of a single standards based Ipv6 communication layer through which meters, be they electricity, water or gas, alongside Streetlighting and IoT Sensors can be installed and run in parallel – reducing operational costs.

Adding the systems to manage these assets is equally simple, with a backend centralized IoT control system (Openway) then relaying data back to Tonga Utilities to analyze, bill and control. This was conducted last year with the addition of water meters to the existing Electricity mesh rolled out in 2016.



To this ecosystem, the addition of further IoT sensor technologies for Solar forecasting is then a matter of providing the sensor with RIVA compliant communications and security, and then funneling the data from Openway to the Forecasting algorithms – and the results to the end users in TPL.

Pilot Implementation

The end goal of the pilot is to deploy a number of IoT sensors that measure solar irradiance and which can then be used to predict the amount of solar BTM generation at Sites within Tongatapu.

The pilot program of work is split into a stepped set of activities:

1. Establishing a set of BTM meter embedded Solar PV sites within Tonga to act as a target population;

2. Provisioning of the forecasting algorithms in Azure hosted environment;

3. The creation of Solar irradiance prototype detectors. These should be battery / solar powered devices and capable of using industry standard (CoAP) IoT based communication protocols;

4. Preliminary benchmark testing of the devices in the field against a known domestic solar installation and algorithm testing;

5. Field Test of the IoT prototype devices in Tonga and input into forecasting algorithms alongside metering data from the target population;

6. Confirmation of the prototype design and creation of RIVA LE based mesh version of the IoT sensor capable of being used on the Tonga Openway mesh.

Should the steps prove successful, the eventual goal would be to incorporate the device into a unit such as a smart streetlight unit. Incorporated into such a form factor, the device would have a naturally raised and clear position to monitor solar irradiance, away from low lying vegetation and with a built-in power supply.

Over the last 3 months these steps have progressed to the point of step 5, and while not completed totally, have proved out some of the initial results to confirm the value of the solution.

Candidate Installations

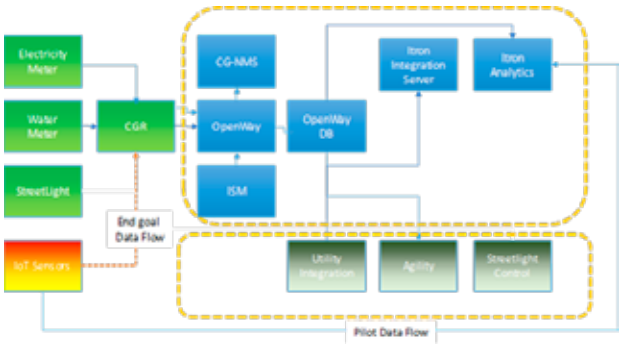
TPL identified a population of 30 embedded solar installations that they are aware of having PV generation and this forms the candidate population. These installations ranged from individual consumers, through Colleges and Religious buildings and with PV sizes from 10kW up to 100kW. Of these 13 have Openway RIVA meters installed and measuring interval data and are thus suitable for use in the pilot.

Hosted Itron Forecasting

Itron provides accurate forecasting services to many Utilities around the world and can deploy solutions as both an on-premise and hosted solution. In the case of the Pilot, the data processing is conducted in an Azure instance which collects both data from the Tonga Openway RIVA smart metering instance, as well as from the sensors in the field.

From the point of TPL's data flows, adding Itron forecasting analytics is simply a matter of configuring a data feed to the Itron services. For the

prototype sensor data, irradiance measurements are returned via cellular backhaul. Though in the target state for the mesh version (7), data would be captured in an identical manner to any other smart RIVA devices, across TPL's network canopy as a simple extension to the existing architecture and illustrated below.



The steps for processing the data using Itron's forecasting systems are:

1. IoT device data is retrieved from the IoT sensors in the field and automatically transferred to Itron's azure IoT data hub – Itron's automated forecasting solution, ***MetrixIDR*** which is hosted on azure cloud;

2. The device data is combined with meta data that describe each solar instance including size orientation tilt shading factors etc.;

3. The IoT device data is translated into a Cloud Cover Index. This index is applied to full sun estimates of solar PV generation for each site or collection of sites and results in a real-time estimate of solar PV generation.

4. These estimates are first published to forecast tables stored in Microsoft Azure. From there the estimates can be routed to downstream applications like billing and distribution planning

5. At the same time the estimates are passed to a real-time load forecast model. This will produce a solar adjusted load forecast that system operators can use to dispatch generation.

The purpose of the Pilot is to demonstrate that the estimates of the cloud cover (and the subsequent estimate of PV generation) accurately match the data from a known solar installation (in step 4) of the Pilot process, and then to determine the accuracy and applicability of the results delivery to Tonga Power (in step 5), as well as fine tuning the algorithms on an ongoing basis through the Pilot.

Prototype IoT Sensor

Four sensors were created in Itron's Idea Labs in San Diego. This facility conducts R&D for Itron products investigating new Sensor technologies that may be used within Riva as well as how Itron concepts may be incorpor wider topical utility discussions – such as Micro Grids, Micro-transactions & Crypto-currencies and Consumer engagement devices to name a few recent actions.

The 4 devices were created using commercial UBlock 3G chipsets and connected to

- A small solar array to monitor irradiance
- A temperature sensor, to detect ambient temperature
- A photo-cell to mark and manage day-night cycles

The solar array acts to provide a measure of the solar irradiance as well as a means to provide charging to the battery packs in the devices to enhance battery life. The photo-cell was also incorporated to detect the presence of nightfall and to shut down the device during nighttime hours. Outside this time, the device was created with a duty-cycle to wake from a dormant sleep mode every 5 minutes to send a light reading to the analytics servers before then reverting to a sleep mode to conserve battery.

Power management on the devices was detected early as an issue with the power demands of the communications component of the IoT sensor being prominent. Itron has encountered similar issues with nb-IoT sensors in Australia where the issue is not just with the manner in which the device (in isolation) communicates, but also in the length of time that the sensor must remain "on-line" in each duty cycle –a factor driven by the cellular service provider and largely out of the control of the designer.

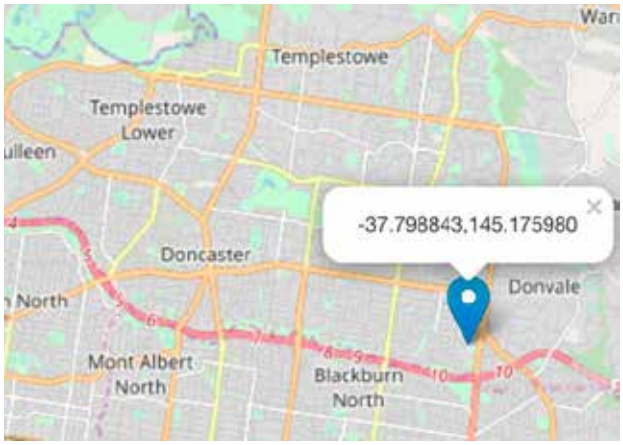
In testing, while the device was found to charge well on sunny days, extended periods of low light (caused by cloudy conditions) alongside a 5 minute reporting cycle resulted in the need for a secondary battery backup to tide the device over extended periods.

For a device intended to be collocated with a

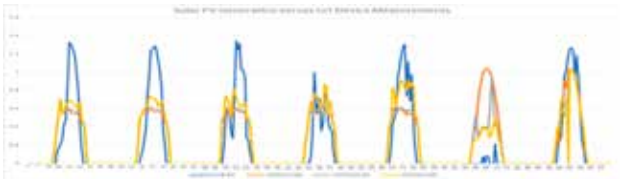
streetlight, ultimately battery life would not be an issue, but it did firmly highlight that where an IoT device is intended to be active for significant periods across a day, the less power that can be used for communications and the more control over that communication link that can be exerted – the better. And in this case the Itron RIVA mesh, with low power and near communication links from the network canopy would be preferable over 2G or 3G cellular options.

Field Testing in Melbourne, Australia

At the conclusion of initial testing conducted in Idea Labs, San Diego, the devices were shipped to Melbourne where they underwent a period of trials against a known solar installation. The purpose of this phase was to take accurate measurements from a known PV site alongside the irradiance measurements and fine tune the cloud coverage index creation.



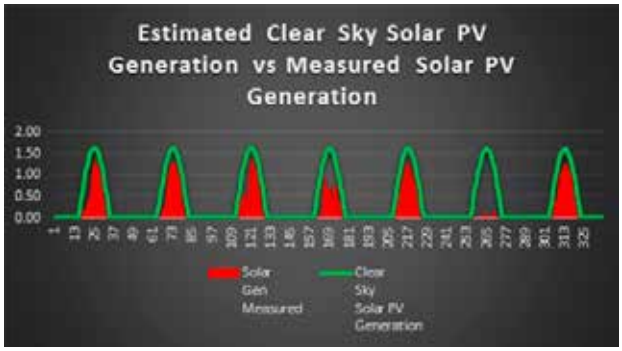
The selected installation comprised of a 6.5kW solar installation which was monitored over the period of a week at both the inverter output as well as the delivered and received power at the main meter of the site. Power data was fed back to the Analytics platform as well as the 5-minute irradiance data from the sensors.



A partial data set is illustrated in the above raw data graph. The correlation between solar from the PV installation and the sensor data is seen to be accurate. Also, what can be seen is that at the "fringes" of the day (early day and towards evening, the correlation between solar and sensor appears to diverge – though this is in large caused by the fact that the solar panels have a tilt and inclination (10 panels facing North at 18o, with another 8 panels facing West at 18o), while the sensors are a horizontal flat plate. Allowing for this factor in the modelling accounts for this variance, but it does illustrate the need for a proper solar model.

An early, and not unexpected finding from the IoT sensors was the significant difference between the sunlight measured by the units and the amount predicted from the local weather forecast. Not only did the sensors provide a far greater granularity of data, but were a Utility to be depending on a forecasting algorithm that predicted the solar irradiance, rather than measured it they would have overestimated the amount of PV capacity available.

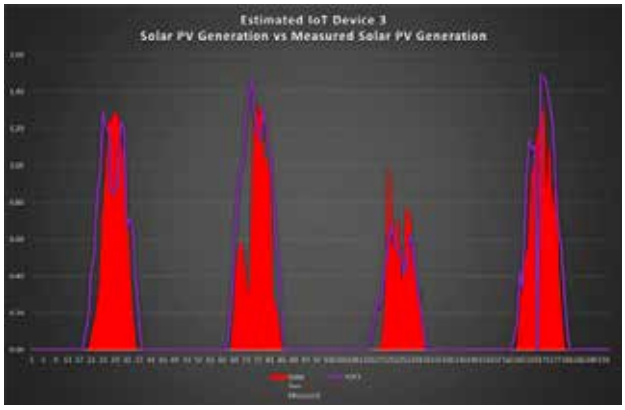
Both models, when accounting for the weather do create a considerable improvement in the accuracy of predicting solar generation. The chart following takes the measured consumption from the site and compares that to the expected, Clear Sky solar model (Weather for the tested period can be seen at the end of the paper).



As can be seen, on largely sunny days, a rough match between the two is observed but on days when significant cloud cover is encountered (specifically day 6 in the commissioning) orders of magnitude errors are introduced – and even on

partial days an error of 50% over a straight prediction can be introduced[1].

When this is then compared to the model returned from the IoT Sensors a greatly increased initial model results which, for both clear sky as well as occluded days provides an accurate model to be used in forecasting.



Following from this successfully phase, the units were moved in mid-June to Tonga to progress phase 5, the field testing.

Field Installation

Each of the IoT sensors monitors local sunlight and can thus give an approximation to the amount of light that would fall upon a Solar installation within the locality. The amount of sunlight falling on each sensor is a factor of the time of year (height of the sun over the horizon), the time of day and the weather conditions. Weather patterns will cause temporal dips in the amount of solar detected by the sensors as the weather passes overhead.

Appreciating that weather "passes over" a specific point allows an algorithm to not only predict the PV generation in the locality of the sensor, but also (with a knowledge of the wind speed and direction) the probably pattern of peaks and troughs in generation "downwind" of the sensor. For instance (a weather forecast of 30km/hr NW is likely to result in the pattern of peaks and troughs in PV generation passing over a point 15km downwind 30 mins after it is first monitored).

To exploit this, and to also test the accuracy of such a hypothesis, TPL and Itron selected the sensor installation sites to match not only the Consumer sites in the Pilot, but also to form a "triangle" deployment model.

This deployment topology introduces long legs between each sensors that would result in passing cloud formations potentially being able to be tracked with the 5min sample period of the device, 15 km leg distances and a max 30km/hr wind).

Current Pilot Status

Just before the conference, the 4 units were shipped to Tonga to commence installation and to start providing data through to the Forecasting service. A last-minute issue with access for the sensor devices to the local cellular provider service has meant that the devices are still awaiting deployment and to return results from Tonga. When this is overcome, results will be available to both TPL and Itron and the validation of the Forecasting algorithm conducted. It will be our intents to share the data with the PPA members so that they can also see how IoT sensor introductions, such as this, can enhance Solar forecasting and thus make better and more efficient use of Renewable Energy Resources.

Early Results

While the devices await deployment in Tonga, the early results for the commissioning phase show that accurate solar irradiance measurements taken close to a solar installation significantly over

[1] It should be noted that the installation selected was a new installation, under 1 year in age and the panels were inspected for dirt prior to testing to remove any bias due to lowered solar efficiency

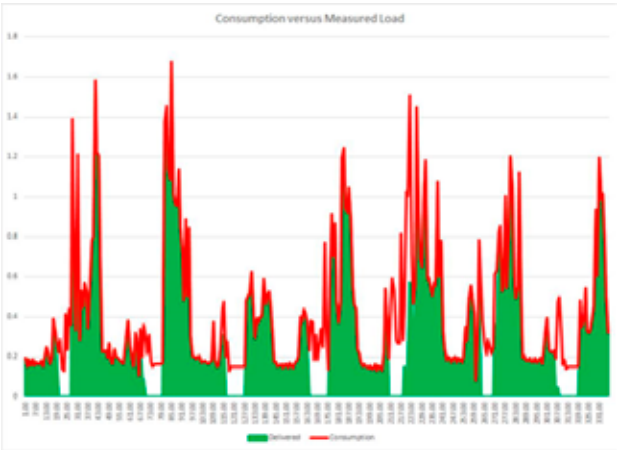
perform academic modelling, even when weather modelling is taken into account.

It should also be remembered that the modelling required to create an individual estimate of a homes solar consumption is a factor of the azimuth and tilt of the installed panels as well as the weather. Thus to accurately calculate the model requires individual calculations per installation. To maintain the same 5 minute resolution to the IoT Sensors would thus require calculations to be run for potentially thousands (in the case of Tonga) to millions of sites every 5 minutes – a significant processing burden for any system based on weather, cloud scanning or satellite based imagery solutions.

Monitoring irradiance in situ and sending data to cloud analytics provides an accurate, and instantaneous mechanism to create PV generation models. With near-real time data from smart metering as well, this then enables an accurate view of Consumer loading.

All Load Forecast Models are designed to explain Consumption -the red line illustrated below. With Behind the Meter Solar (soon include storage) what we measure as Consumption is the Green. It is difficult to get a Load Forecast Model to explain Net Zero Consumption.

It is for this reason that we need strong estimates of Behind-the-Meter solar so we can compute Consumption and maintain accurate load forecast models. Naturally, this also requires a strong forecast of Behind-the-Meter solar because ultimately what the Distribution Operations must operate against is the Green line (not Red).



Itron's contention is that by getting real time measurement of solar irradiance as close to the solar panels as possible, real-time estimates will improve and:

- From a real-time embedded PV point of view, the Utility will have an accurate view of Consumer loading (and thus the impact of the effect of sudden cloud cover);

- And have a significantly better overall view of week ahead solar generation for dispatch planning, through enhanced modelling.

Both such outcomes increase the efficiency for a solar installation and show that adding IoT sensors alongside renewable energy resources can make a material benefit to the return on investment and reliability.

Itron will be happy to update the PPA on the progress of the Pilot as we get to the final deployment components in Tonga.

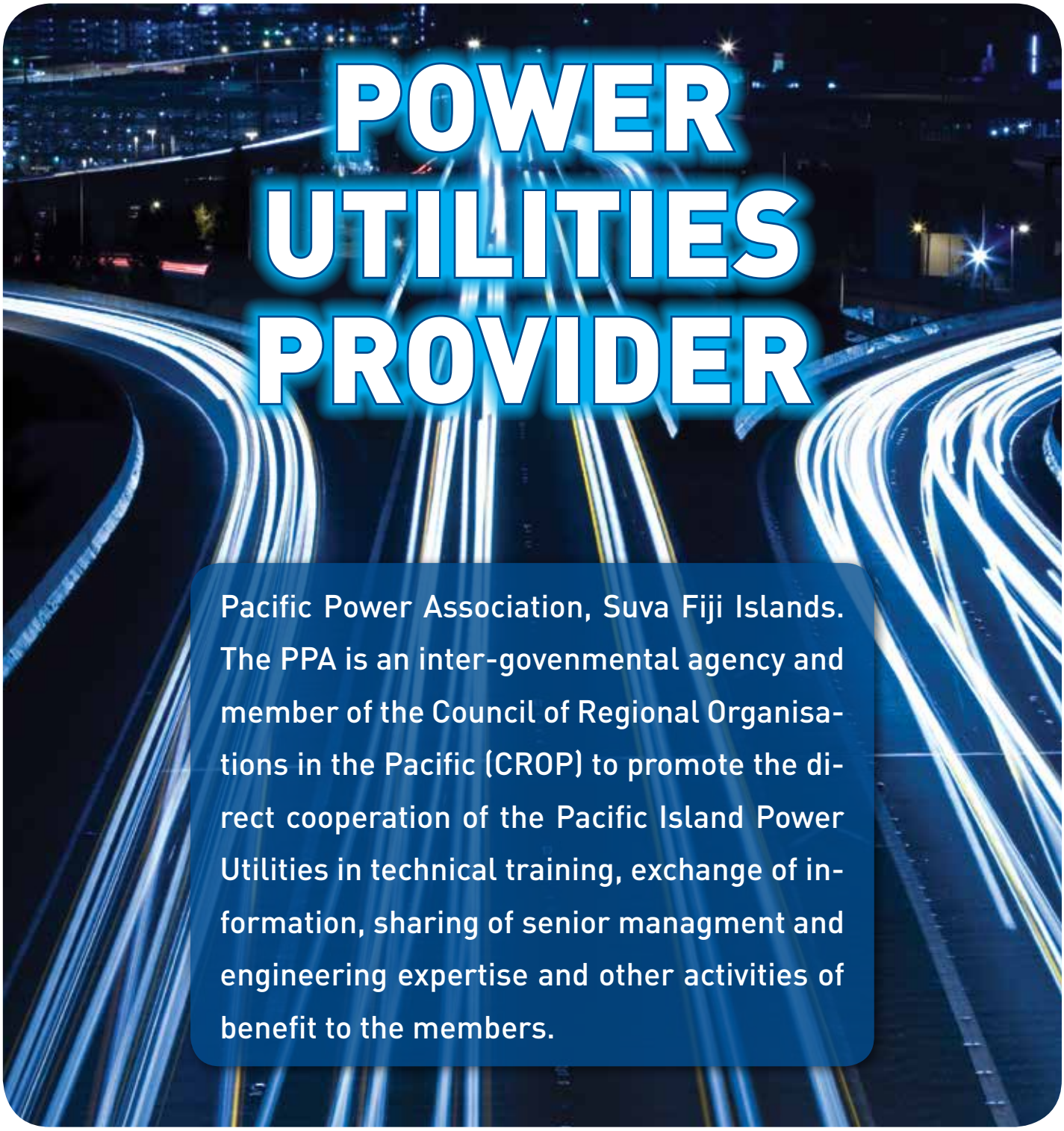
Appendix A – Weather data for commissioning phase

The following table from the Australian Bureau of Metrology provides a record of the measured weather conditions for the commissioning phase. The units recorded data across a period of days at the commencement of June (6th June – 13th June). Of particular note is the weather for the 12th, where (as noted in the text of the paper, almost no solar PV was generated as a result of significant overcast and dark winter weather.

Watsonia, Victoria
June 2019 Daily Weather Observations

Most observations taken from Viewbank, other observations taken from Melbourne Airport.

Date	Day	Min °C	Max °C	Rain mm	Evap mm	Sun hours	Max wind gust Dir	Spd km/h	Time local	9 am Temp °C	RH %	Cld 8ths	At 9 am in the morning	3 pm Temp °C	RH %	Cld 8ths	Dir	Spd km/h	MSLP hPa
1	Sa	11.0	13.9	5.2	0.6	0.5	SSW	30	00:22	12.4	94	7	SSW 7 1032.4	13.8	70	7	SSW	11	1030.9
2	Su	10.3	14.8	0	1.0	2.3	WSW	48	16:25	10.9	90	7	SW 6 1028.3	13.7	65	7	WSW	11	1022.7
3	Mo	7.6	11.8	15.4	2.4	0.0	S	33	18:48	8.7	100	8	SW 7 1019.7	11.0	86	7	SSW	15	1021.0
4	Tu	6.4	12.5	2.4	2.4	4.3	SSW	30	15:05	8.3	82	7	S 9 1027.1	11.9	58	4	SSW	13	1027.8
5	We	7.2	12.5	0	0.8	0.7	WSW	26	15:34	9.4	97	7	WSW 7 1032.6	12.2	63	7	WSW	13	1031.2
6	Th	9.4	14.6	0.2	1.2	1.7	SSW	28	12:34	10.6	100	7	WSW 7 1034.7	13.9	79	7	SSW	13	1034.1
7	Fr	10.6	17.1	0.4	1.2	6.5	SSW	15	00:07	11.4	89	7	Calm 1036.7	16.9	57	1	ENE	4	1032.9
8	Sa	3.7	17.8	0	2.4	8.1	N	37	13:32	6.0	99	2	Calm 1028.9	17.5	51	1	N	13	1024.0
9	Su	6.0	18.5	0	2.6	6.2	N	37	13:14	9.8	99	3	NE 6 1022.2	17.3	47	3	NNW	15	1018.2
10	Mo	9.8	18.2	3.2	2.4	6.9	NW	48	11:37	14.6	85	7	N 19 1011.7	17.8	46	5	WNW	17	1013.1
11	Tu	5.9	18.3	0.2	3.2	9.8	N	41	12:47	9.4	99	8	ENE 4 1022.6	17.3	67	1	NNE	13	1021.1
12	We	9.3	16.3	0	3.8	0.0	N	52	14:31	16.3	78	8	N 24 1013.9	15.8	86	8	NW	20	1010.9
13	Th	7.2	16.5	3.8	1.4	8.0	NW	35	15:02	10.6	96	3	N 13 1016.2	15.1	58	1	NNW	17	1015.4
14	Fr	10.1	16.6	1.6	2.4	5.8	NW	37	12:49	11.9	87	7	N 11 1018.5	15.6	62	7	NNW	17	1016.3
15	Sa	4.7	14.6	4.2	2.8	0.8	N	19	10:41	8.9	100	7	ENE 4 1021.7	14.3	70	7	NNW	6	1020.3
16	Su	6.3	16.1	0.2	0.8	5.4	WSW	19	16:03	7.8	100	7	ENE 9 1023.2	15.5	63	6	NNE	7	1021.4
17	Mo	4.2	16.8	3.8	1.0	8.8	NNW	26	13:16	6.7	100	3	E 9 1023.8	16.3	59	1	NNW	13	1020.7
18	Tu	5.7	12.3	0	2.2	0.9				10.2	83	7	N 17 1017.7	9.7	82	7	WSW	19	1019.0
19	We	3.7	11.6		4.0	3.1						5		10.1	74	7	SW	11	1025.7
20	Th	3.7		2.2	0.4					5.8	100	7	Calm 1026.6	9.2	84	7	SW	11	1024.6



Pacific Power Association, Suva Fiji Islands. The PPA is an inter-govenmental agency and member of the Council of Regional Organisations in the Pacific (CROP) 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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Conference C

28th Annual PPA Confer

Group Photo

rence & Trade Exhibition

28th Annual PPA Conference and Trade Exhibition

held at The National Auditorium, Rarotonga, Cook Islands
1-5 July 2019

Introduction
This year's conference attracted a total of 278 delegates with 110 delegates representing 19 Active Utility members, 109 delegates from the 69 Allied Members, 17 spouses and 25 speakers from development partners, government representatives and multilateral aid agencies and 13 conference committee members[1] .

Such was the interest in attending the conference that the Secretariat was still registering delegates and new Allied Members in the week leading up to the conference. Delegates wanted to be part of this great networking platform which the PPA conference had to offer and also to take part in the trade exhibition showcasing their services and products.

The PPA Secretariat welcomes the following new Allied Members who joined prior to the conference:

1. Datelstream Limited
2. PowerSmart Limited
3. Gentrack Limited
4. Skyward Power Controls
5. HNAC Technology Co. Ltd
6. Texas Power & Associates
7. Japan Electric Power Information Centre
8. Engine Supplies & Services Pty Ltd
9. CCME Marine Engineering Power
10. EIF International Limited
11. Intracor Commodity Exports Ltd
12. Institute for Environmental Analytics
13. Tekconnec Inc
14. Tetra Tech
15. Southern California Edison (SCE)

We take this opportunity to welcome them into the PPA family and trust that the conference was of benefit to their companies and that they will continue to be members of the PPA. There were forty six (46) trade booths and only forty four (44) companies participated in the Trade Exhibition including the host utility, Te Aponga Uira (TAU).

The conference activities started with the Executive Committee meeting at 10.13am and followed by the conference registration at 2.00pm on Sunday, June 30 at the Edgewater Resort and Spa. The PPA Secretariat acknowledges the huge effort put into the pre-conference preparation by Alana Short, Glenda Tuaine, Michelle Vakatini, Tiraa Marsters, Karo Tararo, David Herman, Apii Matai, Ben Bolatagici and the team at Te Aponga Uira (TAU) who also assisted in the registration and distribution of the conference packages to the delegates.

Day 1 - Monday 1 July
Utility Board Directors' Workshop
For the first time, the Utility Board of Directors had a two day workshop. The first day, on Monday, where the Utility Board of Directors Workshop was facilitated by Ms. Caren Rangi which was conducted at the Mitiaro Hostel #1 at the National Auditorium where twenty-three (23) Board members from the different PPA Utilities participated. This gave all the Board members an uninterrupted opportunity to assist directors of power associations and utility boards across the Pacific region to strengthen their governance skills through, refreshing key information on governance roles and responsibilities and examining practices for effective governance.

1 Registered financial PPA members can access the full delegates listing from the PPA website.

Figure 1: Utility Board Directors' Workshop Day 1 in progress facilitated by Ms. Caren Rangi

CEOs' Retreat

The half day workshop on Monday for the Utility CEOs' was conducted at the Mauke Hostel #2 at the National Auditorium where fifteen (15) CEO's and representatives from the different PPA Utilities participated in the half day event. This gave all the CEOs' an opportunity to discuss, following presentations regarding, Scoping Study – Establishing a Regional Energy Training, discussions with the Development Partners, the overall progress of the World Bank project and other Board matters.

Figure 2: CEO's meeting in progress

PPA acknowledges the kind sponsorship of Marshalls Energy Company for the morning tea and afternoon tea and Te Aponga Uira for the lunch.

Allied Members Meeting

The formal Allied Members' meeting was held after the afternoon tea. The Allied Members' Alternate Chairman, Trevor Lord, together with the Executive Director of PPA conducted the meeting at the National Auditorium.

Figure 3: Allied Members' formal meeting in progress

Delegates were treated to dinner and entertainment at a welcome dinner in the evening at the Arorangi Sports Federation, Raemau Park, kindly sponsored by the host utility, TAU.

Figure 4: Entertainment during the Welcome Reception at the Arorangi Sports Federation, Raemau Park

Day 2 Tuesday 2 July
The conference was officially opened by the Honorable Henry Puna, Prime Minister of the Cook Islands, with the keynote address delivered by Mr. Justin Locke, the Director of the Rocky Mountain Institute's Empowering Clean Economies and Islands Energy Program.

Figure 5: Official Opening of the 28th Annual PPA Conference

Figure 6: The Honorable Henry Puna, Prime Minister of the Cook Islands with Ms. Teiiti Nia of Te Aponga Uira

Figure 7: The Keynote Speaker, Mr. Justin Locke, Director of Rocky Mountain Institute With Ms. Teiiti Nia of Te Aponga Uira

The Official Opening Ceremony was followed by the official group photograph session and morning tea.

Session 3: Development Partners
Chair: Mr. Hasmukh Patel, CEO, EFL

1030-1050 - "Disaster Risk Finance for Pacific Power Utilities", Mr. Hideaki Hamada, The World Bank.
1050-1110 - "ADB's Pacific Renewable Guarantee Programme", Ms. Alix Burrell, Asian Development Bank (ADB)
1110-1140 - "Delivering a bright energy future for Papua New Guinea – A Strategic reform for PNG Power Limited", Mr. Josua Naisau
1140-1200 - Q&A

Figure 8: Mr. Hideaki Hamada of World Bank

Figure 9: Ms. Alix Burrell of Asian Development Bank

Figure 10: Mr. Josua Naisau of PNG Power Limited

Session 2: Speed Networking

After lunch session two started off with the Allied Members speed networking where nineteen (19) Utilities participated. Due to the high demand from the Allied Members from last year's conference, the PPA included another session of the Speed Networking event where the Allied Members have four minutes discussions with each Utility CEO or representative.

Figure 11: Bardot Ocean with EDT

Figure 12: Hatz Diesel with SP

Figure 13: Delstar with TAU

Figure 14: Arthur D Riley with MEC

PPA acknowledges the kind sponsorship of Itron Australasia Pty Ltd for the morning tea and afternoon tea and S&C Electric Company Limited for the lunch.

PPA Board Meeting

The PPA Board meeting which is open to all members began at 3:57pm and concluded at 5:18pm.

Figure 15: Board Members' meeting at progress at the National Auditorium

Engineers Workshop – Benchmarking
The Engineers Workshop conducted a two day training on Benchmarking where the first day, on Monday, training was held at the Edgewater Resort and Spa and on the second day, on Tuesday, at the National Auditorium. This was facilitated by Mr. Krishnan Nair, consultant of PPA.

Figure 16: Engineers Workshop – Benchmarking Training

Opening of the Trade Exhibition
The evening saw the opening of the Trade Exhibition with the cocktail kindly sponsored by Wartsila.

Figure 17: Chief Guest Mark Brown Deputy Prime Minister of Cook

Figure 18: Wartsila the sponsors for the opening of the Trade Exhibition

The Trade Exhibition was officially opened by Honorable Mark Brown, Deputy Prime Minister, of the Cook Islands. In his remarks Mr. Brown mentioned that the Trade Exhibition is a chance to look at the technology brought in by the companies that were exhibiting and no doubt, that in future, Cook Islands will be doing more businesses with these companies. He further stated that this will ensure to keep our prosperity and wellbeing of our people at the forefront.

The following forty four (44) Allied members participated and the host utility in the Trade Exhibition:

1. PLP Electropar
2. Generator Rental Services
3. Sulzer
4. STAMFORD AvK
5. Nexans New Zealand
6. Delstar NZ Ltd
7. Itron Australasia Pty Ltd
8. Hawthorne Power Systems
9. ABB NZ Ltd
10. Global Sustainable Energy Solutions
11. Jean Mueller
12. Texas Power & Associates
13. The Institute of Environmental Analytics
14. Selectronic Australia Pty Ltd
15. Hubbell Power Systems
16. Schweitzer Engineering Laboratory
17. NZMT Turbochargers
18. Transdiesel
19. Arthur D Riley
20. Petroleum Gas (T/A – Blue Gas)
21. Etel Ltd
22. Te Aponga Uira
23. ElectraTherm
24. Maskell Productions
25. Transnet NZ Ltd
26. ComAp NZ Ltd
27. Fuelchief Trustee Ltd
28. Cummins South Pacific
29. AR Industrial
30. EIF International Ltd
31. Clean Energy Technologies
32. Global Turbocharger Solutions Australia
33. Datelstream Ltd
34. Goughcat Power Systems
35. McMahon
36. Bardot Ocean Group
37. AVO NZ Ltd
38. Aggreko (NZ) Ltd
39. Komaihaltec Inc.
40. EDMI Ltd
41. B&R Enclosures
42. Engine Supplies & Services
43. S&C Electric Company
44. Power Protection Industries
45. Hatz Diesel

Figure 19: Rob Emrich, Ellen Emrich, Mala Galani & David Knight of ElectraTherm

Figure 20: Grant Kirchmann & Adrian Constable of Goughcat Power Systems

Figure 21: Jason Lander, Eduardo Soares & Ebony Edwards Of S&C Electric with Reena Suliana of PPA

Figure 22: Rod Scott of Selectronic, Chris Pye of ComAp Ltd & Greg McCarthy of Goughcat Power Systems

Figure 23: Tony Davis of Maskell Productions Ltd

Figure 24: Siuea Tairi & Poutai Rouru of TAU

Figure 25: Collin McKinnon of Institute of Environmental Analytics with Mata Herman & Vaine Tua of TAU

Figure 26: Leiko Toyoda of Komaihaltec with TAU delegates

Figure 27: Scott Lomate & Greg Monteith of Cummins South Pacific Ltd with Kamlesh Doshi of MEC

Figure 28: Daniel Hurley of AVO NZ Ltd

Figure 29: Stephen Peters & John Butcher of McMahon Ltd With Alistair Newbigging of TAU

Figure 30: Marvin Bolanos of AR Industrial with Jean-Pierre of EDT

Figure 31: Kam & B Mahdi of CETY with John Adolph of PUC & Leihani Anjain of MEC

Figure 32: Rod & Maureen Iliff of Global Turbochargers Solutions Australia Pty Ltd

Figure 33: Tenikoria Katauea of PUB with Alan Parker of Datelstream

Figure 34: Julien Blanc of Bardot Ocean with PUC delegates

Figure 35: Trevayne Esiel, Anna Bruce & Peter MacKenzie & Martin Saville of Arthur D. Riley

Figure 36: Ajai Punja & Aniruddha Prasad of Petroleum Gas with Lei Wang & Song Guowei of Zero-Carbon Corp.

Figure 37: Sami Almogawish & Ian O'Callaghan of Hatz Diesel

Figure 38: Justin Harris & Ashley Finn of Power Protection Industries with James Mason & Ray Massie of Hydro Tasmania

Figure 39: Troy Balderston of ETEL Ltd with TAU delegates

Figure 40: Ben Gardiner of CCME Marine Engineering, Steve & Craig Codd of Engine Supplies & Services Ltd with TAU delegate

Figure 41: Mark Gosper & Paul DiGiorgio of B&R Enclosures With John Malaki of PLP Electropar

Figure 42: Cliff Yuen of Hawthorne

Figure 43: Tina Lin, Lucille Petersen, Paul Arrastia & Mark Atkinson Of Itron Australasia with Ravi Khire of Delstar NZ Ltd

Figure 44: Craig Cowland of STAMFORD AvK

Figure 45: Gary Lewis & Grant Cooper of Generator Rental Services

Figure 46: Brad Raphael of Sulzer with Jean-Pierre of EDT

Figure 47: Peter McGill & Spencer Winn of Transnet NZ Ltd

Figure 48: Simon Perks & David Griffiths of Nexans

Figure 49: Bernard Mercado of Hubbell Power Systems

Figure 50: Grant Yule & Anthony Abela of ABB Ltd

Figure 51: Kiran Naran of EDMI & Peni Bolatagici of TAU

Figure 52: Tere Akava of TAU with Brad Raphael of Sulzer

Figure 53: Kamlesh Prasad & John Malaki of PLPL Electropar with TAU delegates

Figure 54: Marc Palmer & Paul Goodison of SEL with CPUC delegate

Figure 55: Geoff Stapleton & Sandip Kumar of GSES

Figure 56: Ravi Khire & Gaurav Khire of Delstar NZ Limited

Figure 57: Russell Endicott & Volker Jaenke of Texas Power & Associates with PUC delegates

Day 3: Networking Day Wednesday 3 July

Petroluem Gas trading as Blue Gas Fiji sponsored Wednesday's Networking Day which was held at Motu Koromiri & Nukupure Park at Mauri Beach, Ngatangiia.

Figure 58: Motu Koromiri & Nukupure Park at Mauri Beach, Ngatagiia

Day 4 Thursday 4 July
Session 3: PPA Utility Projects
Chair: Mr. Apii Timoti, CEO, TAU

0830-0850 - "Mukur Dogin Naoero: A journey of change", Mr. Abraham Simpson, NUC
0850-0910 - "Enabling network upgrades projects for a 50% renewable energy supply in Tonga", Mr. Simon Wilson, Tonga Power Limited
0910-0930 - "Social sustainability in Southern Cooks solar mini-grids", Mr. Chris Service, Infratec
0930-1000 – Q & A

Figure 59: Chris Service of Infratec, Simon Wilson of TPL & Abraham Simpson of NUC

Session 4: Renewable Energy Technology
Chair: Mr. Kasio Kemba Mida Jr., CEO, CPUC

1030-1050 - "Tonga's Renewable Energy sprint towards a Sustainable, Reliable and Affordable Future", Mr. Setitaia Chen, TPL
1050-1110 - "Waste Heat to Power", Mr. Robert Emrich, ElectraTherm
1110-1130 - "Romblon wind power generation and mobile battery project", Ms. Leiko Toyoda, Komaihaltec
1130-1150 - "OTEC, the virtuous water-energy mexus technology", Mr. Julien Blanc, Bardot Ocean Group
1150-1200 - Q&A

Figure 60: Setitaia Chen of TPL, Rob Emrich of ElectraTherm, Leiko Toyoda of Komaihaltec & Julien Blanc of Bardot Ocean Group.

Session 5: Renewable Energy Integration
Chair: Mr. Setitaia Chen, CEO, TPL

1300-1320 - "Integrating existing diesel assets and renewable sources for reliability and sustainability", Mr. Chris Pye, ComAp Pty Ltd.
1320-1340 - "Complex micro grid use cases", Mr. Wilhelm van Butselaar, Wartsila
1340-1400 - "Island's renewable energy integration", Mr. Manuel Coxe, International Renewable Energy Agency (IRENA)
1400-1420 - "IoT and renewable integration", Mr. Nick Philips, Itron Australasia Pty Ltd
1420-1450 - "Opportunities to leverage private investment in energy generation in the Pacific", Mr. Chris Blanksby, Entura
1450-1500 - Q&A

Figure 61: Chris Pye of ComAp Ltd, Thomas Hellmich & Wilhelm van Butselaar of Wartsila, Manuel Coxe of IRENA, Nick Phillips of Itron Australasia Ltd & Chris Blanksby of Entura Hydro Tasmania

PPA acknowledges the kind sponsorship of Itron Australasia Pty Ltd for the morning tea and afternoon teas and TAU for lunch.

Engineers Workshop – Day 2 Leadership Training
The Engineers had a two day workshop facilitated by Mr. Shaun Belding based on Leadership Training.

Figure 62: Engineers Leadership training in progress.

Closing of the Trade Exhibition
The Trade Exhibition was formally closed by TAU's Board Chairman, Mr. Mata Nooroa. In his closing remarks he thanked the Allied Members who have put a lot of effort in participating in the exhibition.

Figure 63: Closure of the Trade Exhibition by Board Chairman of TAU Mr. Mata Nooroa

PPA acknowledges the kind sponsorship of GoughCat Power Systems for the conference dinner, Nexans Olex for the conference lanyards, MTQ Engine Systems (Aust) Pty Ltd for the conference satchels, CBS Power Solutions (Fiji) Ltd for the conference shirts & blouse, Global Sustainable Energy Solutions for the conference programmes and PLP Electropar for the conference caps.

Conference Dinner
The conference dinner was held at the Aroa Nui Community Hall, Puaikura, Arorangi. Delegates were treated to the wonderful local cuisine and lots of entertainment.

Figure 64: Conference Dinner at the Aroa Nui Community Hall, Puaikura, Arorangi

Day 5 Friday 5 July
Session 6: Energy Storage & Renewable Energy Capacity Building
Chair: Mr. Mafalu Lotolua, GM, TEC

0830-0850 - "Why energy management and battery energy storage solutions are critical to delivering renewable energy in the Pacific", Mr. Shazad Ibnul, PowerSmart NZ Ltd.
0850-0910 - "Enabling cost effective microgrids to accelerate the world's transition to sustainable energy", Mr. Shane Bannister, Tesla
0910-0930 - "Update on quality technical training initiatives for the Pacific", Mr. Geoff Stapleton, Global Sustainable Energy Solutions.
0930-1000 - Q&A

Figure 65: Shazad Ibnul of PowerSmart NZ Ltd, Shane Bannister of Tesla & Geoff Knight of Global Sustainable Energy Solutions

Session 7: Renewable Energy Hybrids
Chair: Mr. Jack Chong-Gum, CEO, MEC

1030-1050 - "Replacing off grid diesel power with a hybrid solution maximizing renewable energy sources, reducing emission output and maintaining reliability", Mr. Adrian Constable, Goughcat Power Systems
1050-1110 - "Hybrid plant in YAP", Mr. Istvan Ponsot, Vergnet
1110-1130 - "Leader in clean Island power solutions", Mr. Patrick Webb, Texas Power & Associates

Figure 66: Adrian Constable of Goughcat Power Systems, Istvan Ponsot or Vergnet & Patrick Webb Of Texas Power & Associates

Session 8: Solar Cable Networks & Effective Energy
Chair: Mr. Nixon Anson, CEO, PUC

1300-1330 - "Optimizing revenue with solar", Mr. Alan Parker, Datelstream Ltd
1330-1400 - "Powering the Rarotonga Renewable Energy Journey", Ms. Dallas Young, Ms, Teiiti Paio-Nia & Mr. Tama Heather, TAU
1400-1430 - "Renewable Pathway: Journey and Challenges in the Cook Island", Mr. Tangi Tereapii, Renewable Energy Development Division of the office of the Prime Minister
1430-1500 -"Wind Power with battery Storage", Mr. Chris Thunken, Green Globe Solutions American Samoa Inc.
1500-1510 - Q&A

Figure 67: Alan Parker of Datelstream, Tama Heather & Teiiti Nia of TAU

Figure 68: Dallas Young of TAU, Tangi Tereapii from the PM's office of Cook Islands & Chris Thunken of Green Globe Solutions American Samoa Inc.

Annual General Meeting

The Annual General Meeting was held at the National Auditorium.

Figure 69: Annual General Meeting in progress

At the meeting the Executive Director provided a summary of the resolutions from the Board meeting held on Tuesday. The Board members endorsed the election of Mr. Kasio Kemba Mida Jnr. as the PPA Alternate Chairman, Mr. Trevor Lord as the PPA Allied Members Chairman and Mr. Christopher Pye as the Alternate Allied Members Chairman. The meeting also approved the theme for the 2020 conference which will be "Supporting Utilities towards Environmental Stewardship. Operational Performance and Financial Sustainability" as voted by majority of the members that attended the Annual General Meeting.

The PPA acknowledges the contribution of the following sponsors whose assistance has ensured a successful conference.

Sponsorships	Sponsors
Welcome Reception	Te Aponga Uira
Monday Morning & Afternoon Tea	Marshalls Energy Company
Monday Lunch	Te Aponga Uira
Tuesday Morning & Afternoon Tea	Itron Australasia Pty Ltd
Tuesday Lunch	S&C Electric Company
Opening of Trade Exhibition Cocktail	Itron Australasia Pty Ltd
Wednesday Networking Day	Petroleum Gas t/a Blue Gas Fiji
Thursday Morning & Afternoon Tea	Itron Australasia Pty Ltd
Thursday Lunch	Te Aponga Uira
Closing of Trade Exhibition Cocktail	Contribution from each trade exhibitors
Thursday Conference Dinner	Goughcat Power Systems & TAU
Friday Morning & Afternoon Tea	Te Aponga Uira
Friday Lunch	Te Aponga Uira
Accessories	
Conference Program	Global Sustainable Energy Solutions
Conference Shirt & Blouse	CBS Power Solutions
Conference Caps	PLP Electropar
Conference Satchels	MTQ Engine Systems (Aust) Pty Limited

The PPA secretariat would like to commend and acknowledge this year's host utility, Te Aponga Uira for their tremendous effort and hard work in hosting a hugely successful conference. We also thank all the delegates who made all the effort to attend the conference and also the presenters who had taken the time to prepare and present the presentations. Without you all, the Conference would not be the same. Thank you all so very much for all the support, hard work and effort put in.

We invite you all to come and join the PPA for the 29th Annual Conference and Trade Exhibition and the 11th Engineers' Workshop in Pohnpei, Federated States of Micronesia 2020.

1-5 July 2019 - Rarotonga, Cook Islands

Members of the Pacific Power Association representing 19 electric utilities, 168 Allied Members and Development Partners gathered in Rarotonga, Cooks islands for their 28th Annual Conference and Trade Exhibition hosted by the local utility, Te Aponga Uira (TAU), from 1 - 5 July 2019.

The conference was formally opened by the Prime Minister of Cook Islands, Honorable Henry Puna. In his opening address the Prime Minister highlighted the Cook Islands government's efforts to fight climate change through their efforts in the acceleration to replace all fossil fuel energy sources with renewable energy. This transformation has seen the entire Southern Islands of Cook Islands have mini PV grids installed.

The keynote address was delivered by Mr. Justin Locke, Director, Islands Program at the Rocky Mountain Institute. In his address Mr. Locke highlighted that for all atoll nations, "change posed an existential threat with the Pacific region being at the epicenter of the climate challenge. He reiterated that while many international organisations address this through adaptation, the realization is that the majority of the coastal communities will never be able build their way out of it. They must address the root of the problem. And in order to do that, island nations must become the solution to create the catalyst for global change. And while most industrialized countries are looking inward for solutions, trying to go at things alone, the people of the Pacific know that in order to be successful in combating a crisis as big and complex as the climate challenge, you will have to work together. Having lived and worked in the Pacific for nearly a decade, Mr. Locke is convinced and assured that working together is in the very DNA of the Pacific Islanders.

The good news is that many islands across the globe have already started their energy transition. And in many cases, have made significant progress. Case in point, under the leadership of this administration the Cook Islands has set a goal to have all the outer islands powered by 100% RE by 2020, and has already made significant strides to achieve this goal. In the process, islands around the world are developing a scalable blueprint for what an equitable energy transition looks like from a technical, economic, financial, and regulatory perspective - while demonstrating the enabling business models and regulatory frameworks required to scale. As a result, whether you asked for it or not – this community, the PPA utility community, now finds itself at epicenter of the global energy transition".

As well as the technical presentations at the event, the PPA Secretariat had also organized a one-day workshop on Board governance for the Board Directors of the utilities that attended as well as a 2 day benchmarking workshop to familiarize utility staff with the recently launched on-line benchmarking portal

The CEOs also discussed a proposed initiative of the Association to initiate a Mutual Assistance Program to help utility members in the event of a disaster in other member utilities. In addition the Association agreed to explore an insurance scheme for the utilities in the event of any disasters. Both initiatives are supported by the World Bank.

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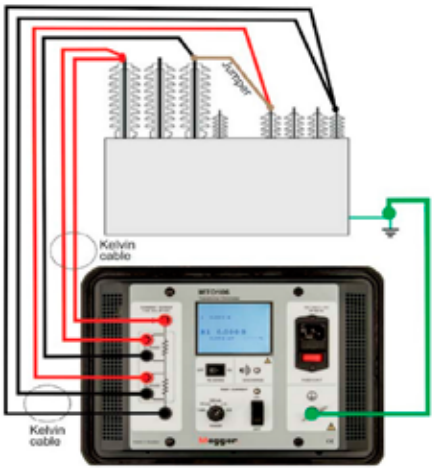

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The Project for Introduction of Hybrid Power Generation System in Pacific Island Countries – Regional Technical Cooperation Project by JICA –

Tadayuki OGAWA
Chief Advisor - JICA

Japan International Cooperation Agency (JICA) has been engaged in the captioned project in Fiji, FSM, RMI, Kiribati and Tuvalu since March, 2017. The objective of the Project is to promote "Hybrid Power Generation System (HPGS)", aiming to achieve proper Operation and Maintenance (O&M) of Diesel Engine Generators (DEG) and RE power generation systems. Smart integration of RE requires healthy O&M conditions of DEG, which is the reason why we designed this Project as "Hybrid", instead of simply integrating RE into the existing grid. In addition, the project is trying to establish the regional training system to facilitate efficient and effective training programme in Fiji as a hub for small Pacific Island countries. In Fiji the Project is implemented by Department of Energy under Ministry of Infrastructure, Transport, Disaster Management & Meteorological Services (MITDMMS), Energy Fiji Limited (EFL) and logistically supported by PPA. As a result of the past trainings for trainers in Fiji, following training courses will be offered under the 1st regional training in Fiji in November 2019, inviting core counterparts from FSM, RMI, Kiribati and Tuvalu.

1) Operation & Maintenance for Diesel Engine Generators

2) Grid Integration of Renewable Energy Generation Systems

3) Operation & Maintenance of Renewable Energy generation Systems (Solar PV)

In June and July 2019, a series of Seminars have been conducted in each country to disseminate the experience and knowledge acquired under the project with stakeholders (government, academia, development partners etc.) concerned. JICA Experts explained the concept of Hybrid Island Programme, and progress of the Project activity. Counterpart Ministry and utility made presentations to share their experience under the trainings in Japan and country-focused trainings. In addition, JICA Experts shared the tentative results of technical feasibility project in a remote island of Okinawa to maximize the penetration of variable RE.

In Fiji, MITDMMS Minister Hon. Jone Usamate highlighted the intention of Fiji Government to establish regional training programme at EFL training center in Lautoka, together with the plan of introducing HPGS to transform energy supply for more than 200 families in rural Fiji. In Kiribati, Secretary Ms. Saitofi Mika for Ministry of Infrastructure and Sustainable Energy (MISE) emphasized the importance of the Project as a series of hands-on trainings for the staff of the Ministry and utility have been introduced as well as class-room trainings under the Project. In Tuvalu, Assistant Secretary Ms. Siemai Apinelu for Ministry of Public Utilities and Infrastructure (MPUI) addressed opening remarks of the Seminar highlighted the importance of continuous capacity development for engineers & technicians in energy sector, and expressed the support for an initiative to start the regional training in Fiji.

In RMI, Minister of Works, Infrastructure, and Utilities Hon. Tony Muller emphasized the importance of human resource development for all staff in charge of dissemination of RE as well as O&M of DEG, in order to attain the national target of net zero GHG emission under energy sector by 2050. Chief Operations Officer Ms. Kayo Yamaguchi extended opening remarks on behalf of Marshalls Energy Company (MEC), saying that the Project is appreciated by all RMI counterparts including MEC. She also mentioned that related staff shall make the best use of the opportunity for a series of trainings provided by JICA. In Yap State of FSM, Governor Hon. Henry Falan highlighted the importance of capacity development for related staff responsible for O&M of DEG and RE which is primarily covered under the Project. Assistant General Manager Mr. Victor Nabeyan made a presentation to share the latest development plan (~2037) in power sector as well as his experience and knowledge acquired in the past counterpart training in Japan.

The JICA Experts will try their best to further coordinate with counterparts in Fiji as well as the other 4 countries to prepare for the 1st regional training under the Project. Selected candidate trainers from EFL and DOE are looking forward to providing their resources for all counterparts in PICs under the support by JICA Experts.

Opening Remarks by Minister Jone Usamate (Fiji)

Explanation of Hybrid Island Programme by JICA Expert (Tuvalu)

Opening Remarks by Minister Anthony Muller (RMI)

Wellcoming Remarks by Governor Henry Falan (Yap State in FSM)

Welcome!

New Allied Members

Three (3) new companies have joined PPA as Allied Members since our last PPA Magazine. The new members are:

OTEL ONEHUNGA TRANSPORT ENGINEERING LIMITED: OTEL Onehunga Transport Engineering Limited is based in Auckland, New Zealand. Their primary activity is vehicles. Their secondary activity is mechanical repairs.

SOUTH PACIFIC TURBOCHARGERS NZ (2018) LIMITED: South Pacific Turbocharges NZ (2018) Limited is based in Nelson, New Zealand. Their primary activity is turbocharger servicing, repairs and sales.

GREEN GLOBE SOLUTIONS AMERICAN SAMOA INC.: Green Globe Solutions American Samoa Inc. is based in Pago-Pago, American Samoa. Their primary activity is B/O/O/T Hybrid renewables wind/solar/ESS/e-Mobility and W-2-E.

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