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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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Cover Page Photograph – Solomon Power's Taro Island Solar/Diesel Hybrid Installation. (Photo courtesy of Solomon Power)

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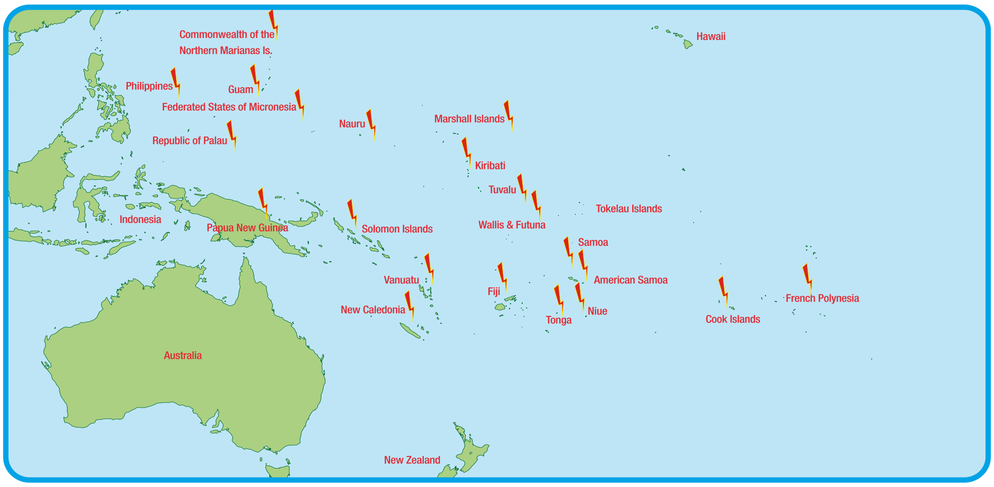

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Editor's Notes

Andrew D. Daka
Executive Director

Bula vinaka and greetings from Suva.

As a member of the Council of Regional Organizations of the Pacific (CROP), the Pacific Power Association plays a vital role is supporting the Pacific Islands countries through its works with the member utilities. Hence it is important for members to take note of the reforms in the working of the CROP agencies following the Sir Mekere Morauta led review of the Pacific Plan in 2013 which led to the new "Framework for Pacific Regionalism" that was endorsed by the Pacific Leaders in 2014.

One of the recommendations of the review is to ensure a collaborative and coordinated approach to project financing and implementation at the regional level. As a result of the recommendation a lot of effort has been made at the CROP Executives level to ensure there is reporting to the Forum Leaders' decisions at the annual Forum Leaders' Meeting as well as identifying ways forward to strengthen CROP coherence and engagement in pursuit of effective regionalism.

With COP23 held and the outcomes agreed to, countries must now gear themselves for the translation of the Nationally Determined Contributions (NDCs) into actions to achieve the desired impacts on climate change. A number of regional events have taken place and I am sure there will be more in the future to tackle this issue. There is the need to identify concrete opportunities for action in translating NDCs into actionable projects, in particular in the energy sector to contribute to NDC goals, including linkages with sectoral planning. Of course finance considerations, including private-sector engagement in the context of NDC implementation will play a vital role to the transition in the energy sector.

The issue of climate change and disaster risks are intertwined with the subject being high priority in the COP23 agenda in Bonn. There are presently initiatives within the region supported by development partners to establish mechanisms to support PICs deal with the impacts of climate change.

Utilities need to note these developments in their respective countries so that they can contribute positively to their relevant national initiatives to address climate change.

The articles in this publication is the final batch of the papers presented at the 26th Annual Conference in Apia, Samoa, during the conference last year, 2017. These articles continue with the theme of renewable energy integration. There are also a number of projects in the utilities; PNG Power Ltd, Tonga Power Ltd and Electric Power Corporation of Samoa that are featured in the publication.

In parallel, the PPA in implementing the Sustainable Energy Industry Development Project (SEIDP) has commenced a number of activities that will support the member utilities in addressing the renewable energy integration issues. Similarly, it is also partnering JICA and the Fiji Government as well as the Fiji Electricity Authority in working with the utilities in Kiribati, Tuvalu, FSM, RMI and Palau on a similar project.

Member who have accessed our website recently would have noted that much information relevant to the upcoming 27th Annual Conference to be held in Palau has been uploaded. With the early bird registration closing shortly, the PPA Secretariat would like to encourage members intending to attend the conference to register early to take advantage of the discounts.

Last but not the least, I would like to welcome Trina Energy Storage Solutions, Jean Mueller New Zealand Limited and Zero-Carbon Island Corporation Limited as the Association's newest Allied Members. Welcome!

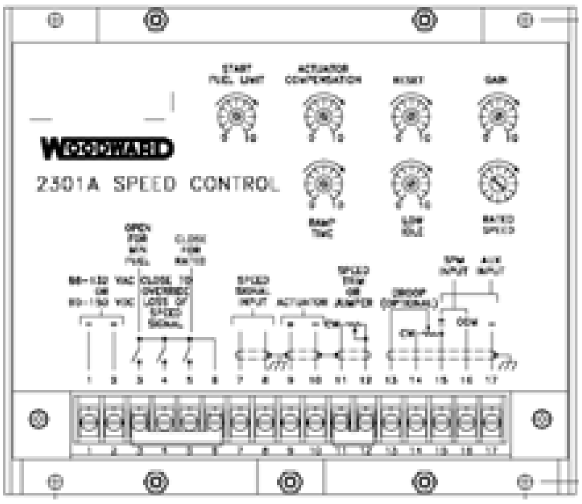
Cheers

Modern PLC Based Generation Controls

Aidan Priestley
Project Engineer- Electrical, Vortex Group Ltd

A Modern PLC, able to process multiple governor functions in a single package

Closed loop control of any process requires low latency in the processing. Governing the speed of a turbine is a typical closed loop control process, traditionally provided an analogue circuit, or machine. Many analogue governors or controllers are still available.



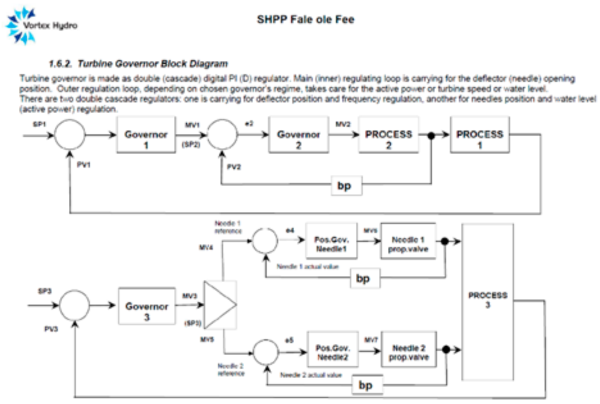
An example of a Analog Governor

However to control a multi-nozzle deflector governed hydro turbine for island capable operation, with head pond level or power demand set points a controller like this would have multiple control loops (or governors), some of them cascaded, i.e. one for each needle, one for the deflector, and overall demand control loops for head pond or power level set points.

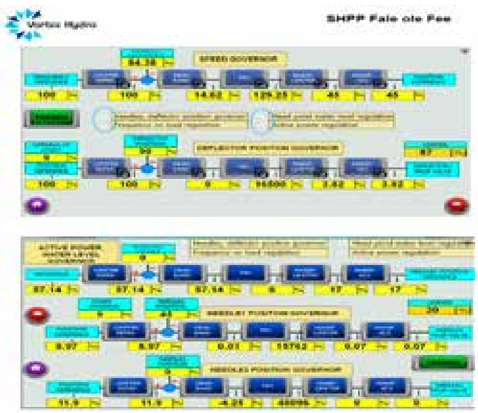
However when many control loops are required at once it becomes very difficult to implement multiple controllers and adjust the controller parameters individually without affecting the other controllers.

This is the significant advantage of a PLC or digital based governor. The control parameters are easily adjusted, and do not drift or impact other parts of the controller when changed. Multiple Governing functions and machine controls can be implemented within a modern high-speed controller

Limits and alarms are easily applied to protect the machine, which can be adjusted and fine-tuned easily (delays, or logic functions implemented)



Example of a cascaded multi stage governor



Screen shot of the parameter page of the PLC based governors used at the Fale Ole Fee HPP.
The Fale Ole Fee Turbine Governors are cascaded, Individual adjustment of all parameters is possible

Auxiliary functions

There is significant processing power required to implement multiple cascaded governors, and adding numerous Additional auxiliary functions requires even more processing power and memory.

Typical auxiliary systems that can benefit from PLC supervision and control:

- Generator and Transformer condition monitoring and protection
- Cooling system
- Lubrication System
- Hydraulic system
- Ventilation system
- Drainage systems / flooding protection
- Site Security
- AC/DC Power supply supervision
- Building services

Fortunately there are high speed modern PLC's available that can perform all of these functions at once. A lot of older designs were limited by the processor speed constraint, and earlier PLC technology was not as reliable, so Multiple PLC's were specified to manage the various functions.

In some cases multiple processors or controllers are required to allow for redundancy of control, but the complexity of implementing redundant systems – and costs which is usually MORE than double make this prohibitive. Especially when manual controls are made available, the majority of failures are field related (sensors, actuators) or systems are actually mutually required (so a failure in cooling system means a shutdown anyway), so redundant processors offer little advantage in that respect.

Station PLC functions

Control -

- Starting Motors i.e. Duty changeover, Based on temperature/Pressure/Flow/Level/Start-Stop Sequence etc
- Proportional controls i.e. Nozzle/deflector positioning,
- Valve controls, Heaters, Fans etc
- Monitoring
- Oil and Water Pressures, Coolant flow, Temperatures, filter clog, tank levels, Control switches, position sensors etc.
- Self Diagnostics and condition monitoring of all systems – both internally (watchdog etc) and external – Trend analysis (bearing vibration increasing overtime for example)
- Feedback
- Operating parameters (Normal/out of range) , Alarm system – historical and real-time,
- Visual information for operators, Pre-requisite Starting conditions, Service and maintenance guides etc

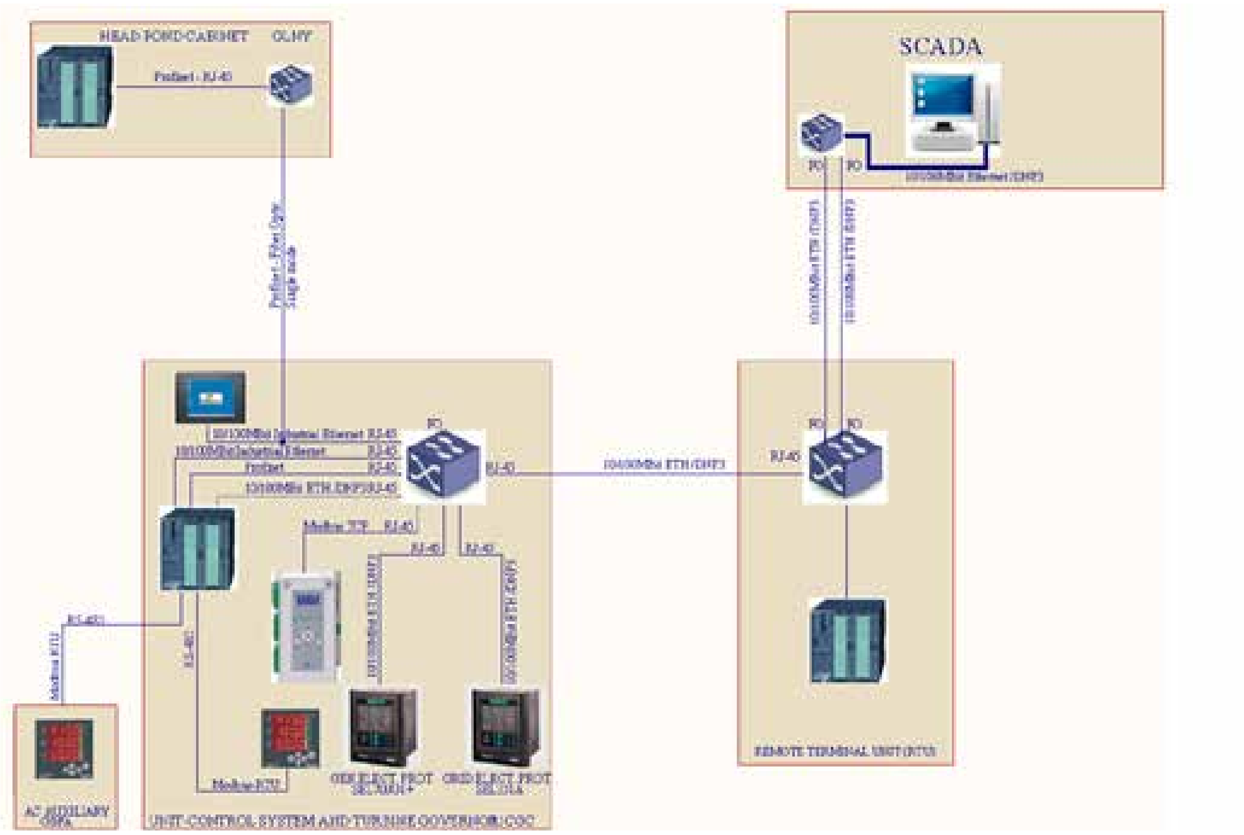
Webpage access

PLC's can now be connected to via a web browser, and can incorporate a data concentrator and historian within the PLC or HMI panels. Removing the need for a dedicate SCADA RTU in many cases. HMI Screen information presentation and operator controls with high resolution, colour and touch screen functions a readily implemented and communication buses allow a common Station LAN to connect directly with other smart devices i.e. Protection Relays, revenue meters, SCADA Systems, AVR's, DC Charge controllers - allowing the PLC access to a broad range of system information with the minimum of cabling and connections.

Communications

One of the huge advantages of modern PLC's is the ability to communication over many types of networks.

Multiple protocols can be implemented with communication controller options, and different hardware layers can be used for example RS232, RS485, Ethernet (Fibre or Copper) and TCPIP and DNP3, Profibus etc. from the same PLC. This allows smart and reliable communications to be established with many makes and types of devices.



Example of a typical modern PLC based Hydro power station.

Data Concentration (and compression) can be implemented saving bandwidth for remote sites. Allowing the remote communication link to only send the bits of information required from each smart device, not everything from every device.

Security

Easily implemented remote access security, encryption protocols and firewall implementation
Less software licences – less ongoing operating costs.

Summary

High levels of integration = LESS MATERIALS, SPARES, WIRING, PARISITIC LOADS, TRAINING and better administration and control of plant.
Modern PLC's are fast enough and have advanced communication modules to allow high levels of integration, Allowing secure and reliable local and remote connection with other modern networked devices - Protection Relays, AVR's, Metering systems, DC systems for example.
Remote administration / diagnostics of the power station can also be easily implemented due to the advent of modern secure remote protocols.

Modern Microprocessor Electrical protection relays can easily be integrated into the controls to allow seamless controls, SCADA monitoring and data concentration for the simplest of remote controls to the most modern.

Cloud Cameras – Saving Fuel and Costs

Richard Bird, MBA
Consultant, ComAp Pty Limited

ComAp has been delivering generating set automatic control systems into the Pacific region for over ten years. Much of the early work was done by Greenbird Technology which was taken over by ComAp in 2010. As one of the world's leading suppliers of genset control systems this work has now led to such systems being used in twelve member countries of the Pacific Power Association.

This has been a progressive journey to minimise costs and reduce fuel consumption in the area. The initial work was to fully automate the existing manual stations with two objectives in mind. Firstly, an automatic station is far more efficient. By monitoring and controlling the amount of spinning reserve each set could operate at a better point on the fuel consumption curve and on stations where there were a variety of sizes and types of generators an automatic system could rotate them as load changed to maximise efficiency in a way that an operator would never be able to do.

An automated control system for a four-set power station

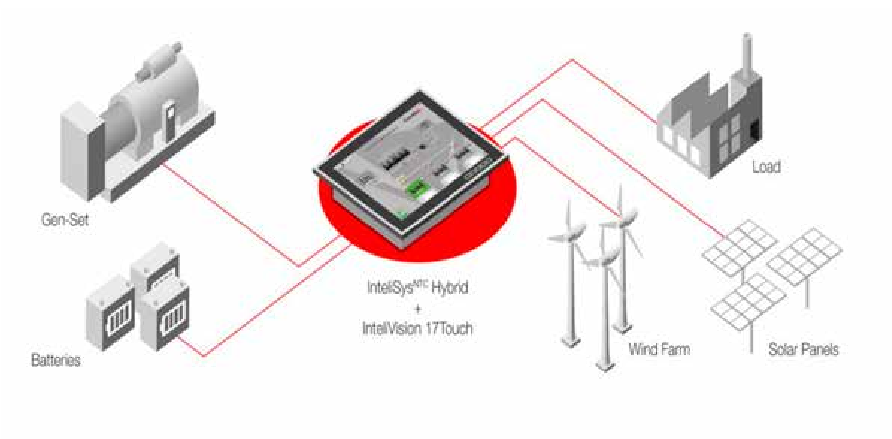
InteliMonitor SCADA screen for a four-set power station

Secondly the object of the automation was to make the stations "hybrid ready". Because of the rapidly changing amount of electricity being generated by a PV system due the effects of clouds it is necessary to bring more sets on line very fast and also to rotate the sets as required to meet the ever-changing requirements.

The second stage of ComAp's involvement in the pacific region was in these Hybrid systems. As a world leader in control systems ComAp was ideally suited to becoming involved in this area, and was one of the first to realise that control of the gensets was key to optimising a successful Hybrid System.

When output from the PV changed, it was not sufficient or efficient just to "start a set". In stations with mixed sets it begged the question "which set?" Once this new set was started another question arose – do we now have the most efficient combination of sets running and if not how do we rotate them?

To dramatically improve this situation ComAp developed the Hybrid Controller which communicates with all of the other components of the Hybrid System – inverters, batteries, weather stations etc. and utilises all of this data to not only decide which sets to run but also to optimise the system to ensure that the gensets are running efficiently and at an optimum level of spinning reserve. There is no point in saving cost and diesel fuel by installing PV and then burning up some of the savings in the power station because the sets are running with high levels of spinning reserve.



A Hybrid system based around a ComAp Hybrid controller

In addition, ComAp's InteliMonitor SCADA system is already a high-level system that monitors the thousands of data points that are generated by a diesel power station with multiple sets. Adding in the additional points that are generated by the other components of the Hybrid system leads to a total system SCADA that provides operators, engineers and managers with a total overview of a system that is designed to operate automatically and unmanned.

However there is a delay before sets can be started up – typically at least 30 seconds. Consequently, when a cloud passes over a PV array the power generated drops off very fast – about 11 seconds – and the whole system is liable to collapse unless an alternative source is provided. Traditionally this has been achieved in a couple of ways – by operating the generating sets with high spinning reserves or by the use of batteries.

Neither of these are low cost solutions. Running diesel generators at low loads lifts the fuel consumption per kWh dramatically. Typically the fuel consumption rises by 20% when a set is operated at 50% load compared with operating at 80% which is the normal operating load for maximum life.

Batteries are also a very expensive solution because they do not generate any energy themselves and the charging –discharging cycle normally uses 4% of the energy generated. At high levels of PV generation batteries have a very valuable role to play by enabling load shifting and also for use at night when PV energy is not available.

However at low penetration levels there is no excess PV energy available to charge the batteries so the batteries are actually charged by the diesel generators.

Cloud cameras have been developed to provide a low-cost solution to this problem. Cloud cameras have been available for many years but the early models were not very accurate as they were developed for different purposes and cost hundreds of thousands of dollars. The new generation of cameras have been developed specifically for accurately and rapidly plotting the movements of clouds approaching the PV array. The camera takes an image every few seconds and the software processes these images to produce a plot of the movement so that it can predict the arrival of the clouds at the PV array and send a signal to the power station to start additional sets. Consequently the sets can be operated at optimum load levels without large amounts of spinning reserve.

The camera system will normally provide up to ten minutes notice of approaching clouds however the reason for taking an image every few seconds is because of the risk of a cloud actually forming in the path between the sun and the PV array. This can be a particular problem in the Pacific because of the mountainous nature of many islands. As the prevailing wind approaches it gets lifted by the terrain which can sometimes form clouds immediately above the PV array.

Batteries have a very valuable role to play in high penetration Hybrid systems, but until that level is reached they are a very expensive way to solve the cloud problem.

A cloud camera system is a very low cost alternative with systems available for less than $30,000 and ComAp has now added cloud camera systems to its portfolio of products to complete its range of control system products to meet all the requirements for the Hybrid power systems of the future.

Renewables and The Role of Energy Storage & Digitalization In The Transition Away From Fossil Fuels

Tom Mactier
Business Development Manager, Siemens Limited

1. Abstract

Geographically dispersed and highly reliant on diesel generated electricity the Pacific Island Countries (PICS) experience some of the highest electricity tariffs in the world. Highly influenced by the floating oil price out of Singapore, and impacted by currency movements – the electricity tariff is not only high – but also volatile. Increasing amounts of Solar PV have been added in recent years in an attempt to alleviate this situation – however as the penetration of Solar PV increases above about 20% electricity system reliability and resilience is affected. Maintaining a stable frequency and voltage becomes challenging hence there is a requirement to consider the energy system holistically, with an effective renewable energy integration strategy. Microgrids – considered as an energy system powered by distributed energy sources with distributed loads – are well placed to handle all the challenges associated with high penetration PV – when designed and integrated effectively. Here we present a template for the development of such a Microgrid. Paramount in this process is a thorough understanding of the projects motivation. We discuss the technical and economic modelling – with the use of a tool such as PSS DE – in order build up a 'digital twin' of the Microgrid to gain a deeper understanding of the systems performance to allow the evaluation of alternative concepts. Here we can refine the control philosophy – deciding between a single site 'Microgrid Controller' (MGC) or a more sophisticated 'Microgrid Management System' (MGMS) incorporating complete SCADA functionality. Subsequently, we cover the next steps in the Microgrid Development process including Partnering and Procurement, Engineering, Site Implementation and Operation and Maintenance. Finally, we present the concept of 'Power to Gas' – that is, using excess renewable energy to power a PEM (Proton Exchange Membrane) Silyzer - taking the Hydrogen out of water – and making that hydrogen available for subsequent use for power generation or industrial processes. We present a working hydrogen production facility based in Mainz, Germany and highlight the benefits achieved, with regard to grid balancing. We outline a Microgrid project in the Mediterranean – where we successfully partnered with the local utility to deliver a project resulting in improved grid stability and a reduction in diesel generated electricity. Finally, we highlight the 'ACT Renewable Transport Fuels Test Birth', where we are supplying a Silyzer to the ACT government to power a fleet of government vehicles as well as for research and development purposes.

2. Power in the Pacific

The Pacific islands region encompasses about a third of the earth's surface, but less than a thousandth of the world's population lives in this vast area, scattered over hundreds of islands. Kiribati for example - with a population of approx. 100,000 living on 32 atolls - is spread across an area extending 4,200 kilometres from east to west and 2,000 kilometres from north to south. Here there is roughly 5MW of generation with a 52% contribution for diesel generated electricity – as the Utilities Regulation Authority of Vanuatu demonstrated in Comparative Report – Pacific Region Electricity Bills [1].

In many countries here, electricity generation from diesel accounts for 100% of grid supplied electricity, with an average of 80% [1].

This geographical spread - and the high reliance on imported diesel - points to some of the reasons why this region experiences very high electricity tariffs (the average charge for a 'small domestic customer' is roughly USD 0.32/kWh [1]).

In addition to the high price, diesel also has a direct impact on the volatility of the cost of electricity. For example, in Tonga, over a 4 year period (with a 98% reliance on diesel for electricity) – the Electricity tariff varied by over 50% as a result of the swing in the diesel prices out of Singapore [2], and currency fluctuations.

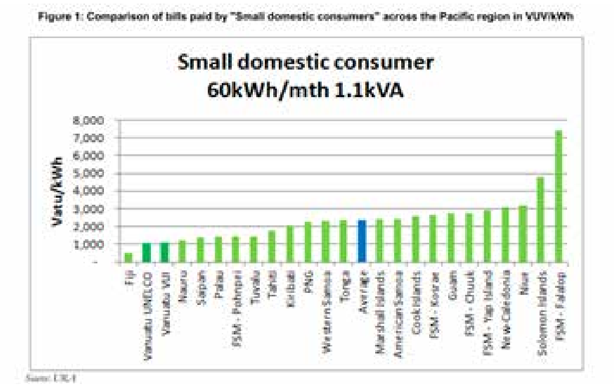


Figure 1 - High Power Prices in the Pacific [1]

The response in recent years has been to increase the penetration of renewables – thus reducing the reliance on diesel. Solar PV in particular can fit well with the daily load curves. Indeed – in 2012, was the first nation in the world to become 100% powered by renewables (with backup generation).

Aggressive renewable energy targets are now in place for most island nations in the pacific, with many setting '100% RE targets' to be achieved by 2020/30.

2.1 The Challenges

While the upside of increasing the penetration of PV in an electricity grid is quite often the reduction in diesel generated electricity – there is also an impact on the reliability and resilience of the local electricity network.

Here we highlight the effect of solar PV on a distribution substation in Germany. In 2003, the load profile is fairly flat and predictable over the 7 day period. Eight years later, with the adoption high penetration solar PV you can see the effect of this 'negative load'. Around midday every day, the system experiences significant negative load fluctuations.

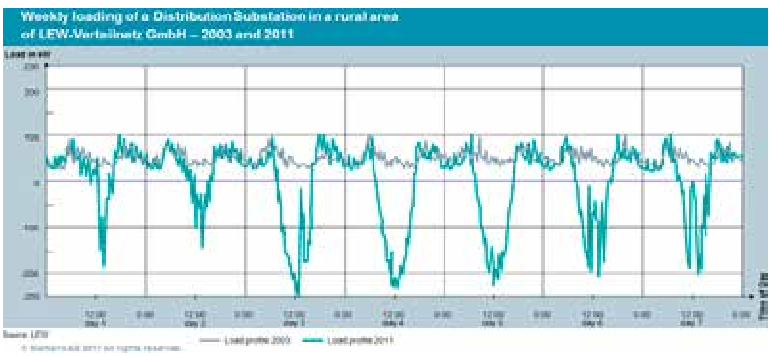


Figure 2 - Weekly loading of a Distribution Substation - before and after the installation of High Penetration PV

At the Medium Voltage level this leads to all sorts of challenges which directly affect the utilities ability to provide continuous, reliable power. Here is a brief over of some of those challenges, as presented by Passey et al [3]:

1. **Voltage Fluctuations** – Reliant on fluctuating renewable resources, Solar PV can adversely affect the grid voltage level i) By contributing to phase-imbalance – e.g. by increasing voltage on individual phases, this results in a phase-phase difference potentially leading to damage to network equipment and connected loads, ii)By Disconnecting from the grid following a response to a voltage disturbance outside nominal limits (possibly caused by other renewable generation), iii) As a result of excess localised generation potentially resulting in reverse power flows affecting the ability of the utility to maintain a consistent voltage level throughout the network.

2. **Frequency variation & Harmonics** – Frequency control has historically been built into the control loops of synchronous generators connected to the grid (i.e. their governor), resulting in a stable frequency. With High penetration PV – the complexity of managing grid frequencies increases. PV inverters are regulated to produce very low Total harmonic Distortion (AS4777.2 stipulates <5%) – however for high levels of PV penetration a filtering strategy needs to be considered to reduce the level of harmonics on electricity system.

3. **Unintentional islanding** – Continuing to deliver power to the network after the Solar PV has been disconnected (e.g. following a rapid fluctuation in voltage) can lead to safety issues and result in equipment damage. Anti-islanding detection is a required consideration for network design. Further, following the separation from the grid of a PV Inverter (the loss of a generation source) – there needs to be a strategy for making up the generation deficit. An energy storage system could be one possible solution here.

2.2 PV Penetration – High Vs Low – The Strategy

In their workshop in Palau in 2013 [4] IRENA mapped out a pathway for addressing the integration challenges when considering adopting increasing levels of PV.

IRENA suggest adapting the renewable energy integration strategy based on PV Penetration, highlighting the unquestionable link between PV Penetration and the voltage and frequency based challenges presented earlier.

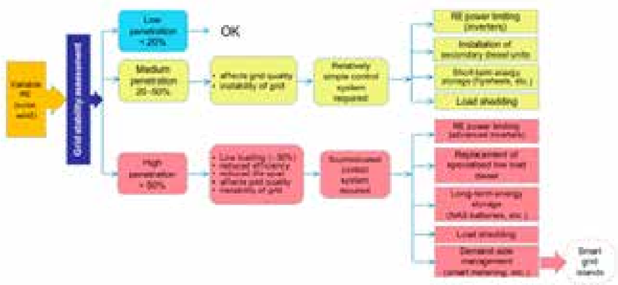


Figure 3 - PV Integration strategy based on level of PV Penetration [4]

While it is possible to introduce low penetration PV into a grid with minimal system wide considerations, medium and high penetration systems require a different approach.
A high penetration system, as proposed by many Pacific Island Countries (PICS) requires a much more integrated approach, considering all aspects of grid stability and control holistically. This includes:

1. Grid Control System
2. Integration with Distributed & storage generation assets
3. Upgrade/replacement of existing synchronous generation fleet
4. Energy Storage – providing capacity firming, time shifting, diesel offset, frequency regulation and even black start capabilities.
5. Potential adoption of demand side management/Load Shedding

We will now look at what Siemens see as the solution for high renewable penetration.

3. Microgrid Philosophy

Industry has long argued the definition of a Microgrid. Rather than having a rigid definition – we have an open mindset – considering a Microgrid to be an energy system powered by distributed energy sources, with distributed loads. So rather than a centralised 'hub & spoke' generation model with unidirectional power flows, in a Microgrid, assets are geographically dispersed and are considered to be active. The Microgrid may be the only electricity network present in the region – such as is the case on many PICS - or it may be connected to the larger utility scale grid via a point of common coupling. While it is application specific – the ultimate objective of any Microgrid is to deliver electricity network reliability and resiliency while improving the degree of access for consumers.

A Microgrid of the not too distant future could appear as that shown in Figure 4 - Microgrid Possibilities – below. This showcases the plethora of generation, energy storage, and loads that all contribute to the Microgrid.

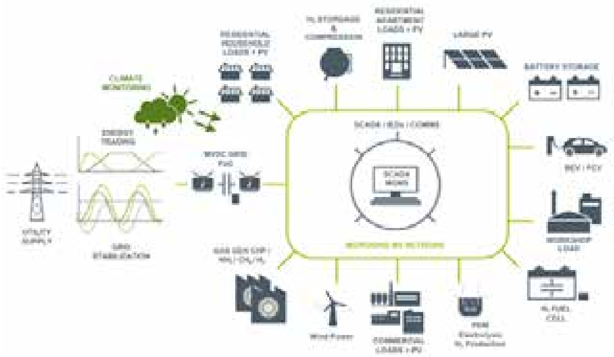


Figure 4 - Microgrid Possibilities

An abundance of equipment suppliers can provide product that, in general, is suitable for Microgrid applications. And for low penetration systems, as highlighted earlier, overall design integration activities are limited. The challenge for ensuring a reliable, resilient grid comes when high-penetration PV is added. Here, while product performance is paramount – the emphasis shifts towards the overall system design and renewable energy integration strategy. When implemented effectively, we see a Microgrid of this nature well placed to handle all the challenges associated with high penetration PV – while providing a flexible basis for future augmentation.

4. Microgrid development

No two Microgrids are the same hence the development process of each Microgrid often differs slightly. However, from our experience there is a core set of activities that drive a successful Microgrid – ensuring the key objectives are achieved. This is shown in the Figure below.

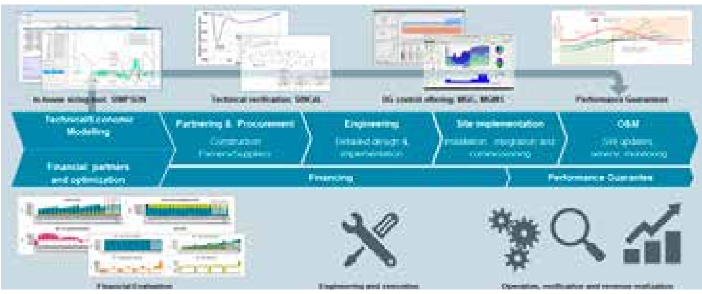


Figure 5 - Microgrid Development Process

The first step in any Microgrid project is to define the project motivation. What is the ultimate goal of the Microgrid? Is it to increase access to electricity to a section of the community that is currently isolated? Is it to reduce the reliance on diesel generated electricity – highly exposed to exchange rate and oil price fluctuations? Is it to ensure a reliable and resilient power system after high penetrations of distributed PV has been added to the network? Often, the answer is a combination of these broad objectives.

Once the broad objectives are known, we can begin to look at the types of business models that will support the Microgrid development. Looking at a more granular level, we can then ask: What are the specific financial targets for the project? In parallel with this we establish the current baseline by looking at the Single Line Diagram, load profiles (and expected growth), fuel price, presence of thermal loads, current network performance and electricity access levels.

Once this broad baseline has been established, we see a standardised approach as follows, noting that overall the process is iterative in nature:

1. **Technical/Economic Modelling:**
   a. With the broad objectives defined, we can build a model for the system – starting with defining the range of generation, storage and load variables to be included. How much PV is required to achieve the broad objectives? Do we need to include energy storage in the Microgrid – if so how much and what type of storage would be best suited? Would lithium-Ion technology be appropriate (such as **SIESTORAGE**)? Could Hydrogen production & storage, and use play a role here (e.g. **Silyzer** – to be discussed below) – creating hydrogen from excess RE – for subsequent use for generation and in agriculture applications.
   b. Our specialised software tool **PSS DE** provides a technical and economic model of the plant. With this software we can effectively create a 'digital twin' of the Microgrid looking at Generation & Storage, Network Integration and overall System technical and financial performance.
   c. Modelling – an iterative process – may result in several alternative Microgrid concepts – that need to be reviewed in further detail. Here, for each alternative we ask: What is the system performance? LCOE? Power Purchase Price? Following this evaluation, there may be a couple of alternatives that are put forward.
   d. The output from the modelling process will influence the control philosophy – but we also need to understand how the Microgrid will be integrated with the existing network. Do we need to integrate with an existing utility communication network (if one exists)? Is there to be remote control or local only? How many new and existing assets must we integrate with – and over what communication protocol? Must SCADA functionality be built into the solution to allow for archival & remote process control and monitoring? We can use this information to refine the control philosophy – e.g. would a single 'Microgrid Controller' (MGC) be suitable – or would a more sophisticated 'Microgrid Management System' (MGMS)– complete with SCADA functionality – be required.

2. Partnering/Procurement: With a Microgrid concept defined, the next step is to identify the appropriate partners for the project. Here we can look at who has the most appropriate skill set and experience to deliver this project. Can existing relationships with this partner be leveraged to improve the project outcomes – having worked closely on Microgrid projects in other regions of the world? Does the partner already have experience in this specific location/ country?

3. Engineering: This stage covers all the detailed engineering design and implementation. Defined in a Functional Design Specification (FDS) –which has been approved by the client - this includes activities such as power system studies (e.g. steady state system analysis, protection simulation and co-ordination with PSS SINCAL), Network Protection Design, Communication network design, Software Engineering and Integration, Factory Acceptance Testing. It is critical here that this design for the new Microgrid is properly integrated with the existing network (if applicable). Detailed programs are prepared for installing, integration and commissioning the equipment at the final location – ensuring minimal disruption while the system is cutover. Here, choosing a trusted partner with a deep level of power system experience is crucial.

4. Site Implementation: Installation, Integration and Commissioning completes delivery of the Microgrid project. Onsite construction is executed when required, and existing network infrastructure in augmented with the new design. The new generation and storage assets are delivered, and integrated into the network. The control system is installed – and integrated with the existing communications network (if applicable). Finally, an Integrated Site Acceptance Test validates the Microgrid functionality against the FDS and the system is formally handed over to the O & M team.

5. Operation and Maintenance: The local utility or service organisation responsible for operation and maintenance have at this stage taken ownership of the Microgrid. It is important that the plant is properly maintained to ensure longevity of operation. Here, remote access to the plant can be used for remote monitoring and diagnostics – detecting any potential issues to avoid the potential deterioration in network performance. Additionally, with remote access we can seek to optimise and continually improve the Microgrid by taking advantage of improvements in technology and control algorithms.

5. Power to Gas

While thoroughly proven for other industrial applications, Electrolysis is increasingly being seen as a possible solution to the challenge of integrating high penetration renewable energy into the electricity grid. The process is simple. Use excess renewable energy that would otherwise be curtailed – to power an electrolysis process – taking the Hydrogen out of water – and making that hydrogen available for subsequent use for power generation or industrial processes. The benefits are two-fold. Network stability is improved and a new fuel is produced that can be used to generate electricity at times of high demand – or used in industrial process say for example in the production of ammonia for agriculture. Where dumping resistors where previously employed, a Silyzer (outlined below) could be used – eliminating the need to spill renewable energy that would otherwise be wasted. A high level industry flow chart is shown below.

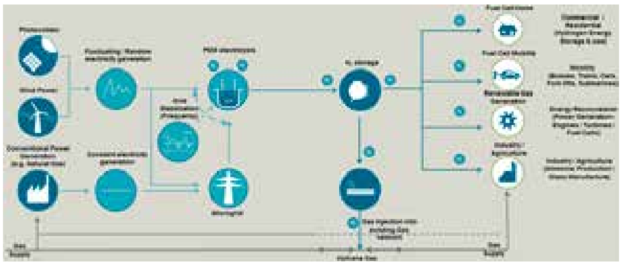


Figure 6 - Power to Gas

5.1 Energy Park Mainz

Siemens have developed a production machine - the Silyzer - based on the Proton Exchange Membrane (PEM) technique. This unit can produce up to 225 Nm3/h at a rated stack power of 1.25MW. In partnership with Linde, The Municipality of Mainz, and RheinMain University – Siemens have provided 3 X Silyzer 200's and engineering support for a working hydrogen production facility at Mainz.

This project aimed to demonstrate the economic and technical benefits of linking hydrogen production with the power grid – facilitating the provision of ancillary services and providing hydrogen for industrial processes and injection in to the local gas network.

Connected to a 10MW wind farm, this plant has been operating since late 2015.

This plant has a peak capacity of 6MW supplied by 3 X PEM Silyzers (each approx 1.25MW nominal rating). With a hydrogen output of 65kg/h, this equates to a power output of around 2.6MW.

Figure 7 - Energy Park Mainz - Silyzer Hall

In Germany the Transmission System Operators (TSOs) have the responsibility to maintain grid stability – hence they procure a control reserve when feed in deviates from consumption. Primary CR needs to be available within 30 seconds and Secondary control reserve within 5 minutes. Based on PEM's quick start characteristics, the Silyzer has the opportunity to participate in this control reserve market.

As per the technical and economic evaluation by Messrs Kopp et al [5] - Prequalification for participation in the Secondary Control reserve market required to ramp up to full load within 5 minutes, maintained for 15 minutes before ramping down in 5 minute. The Silyzer reached this level in 1 m, 10s = 86kW/s. However – the unit is designed to achieve 200kW/s, a key benefit of PEM technology.

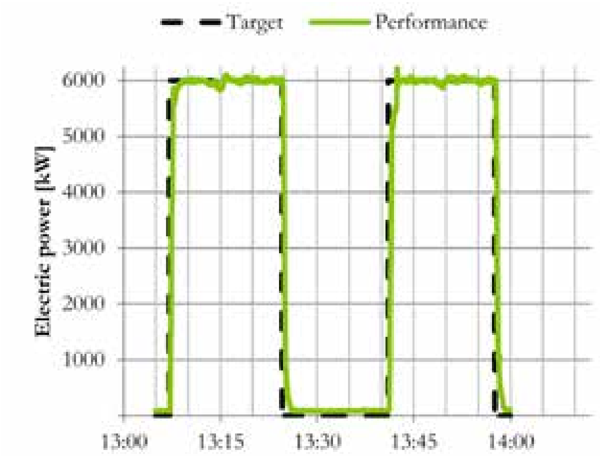


Figure 8 - Prequalification Test for Secondary Control Reserve [5]

The project evaluated the economic differences between 1. Acquiring electricity from the Wind Farm, 2. Acquiring Electricity from the Spot market, and 3. Employing the plant to participate in the Control Reserve market. In the comparison of the three options considered, it was shown that participating in the SCR (Secondary Control Reserve) market was the most profitable (See Figure 9 below). For example, with a hydrogen production rate of 100,000 kg/year the cost of hydrogen production is €3/kg when the grid 'surcharges' (consisting mainly of charges to support RE project development in the German grid) of €70/MWh were considered. Importantly, if these surcharges were eliminated the cost per kg of hydrogen production drops to -€1.5. In other words –the plant is paid simply to balance the grid – with hydrogen being a free by-product – for use in other processes.

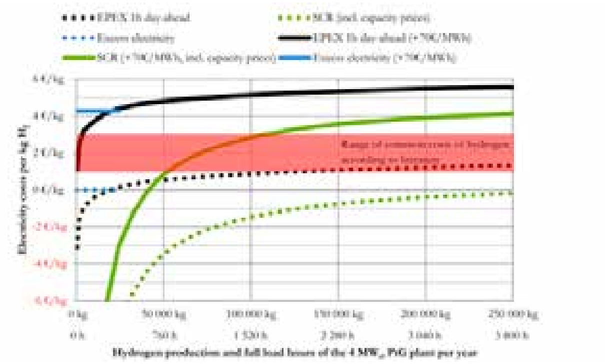


Figure 9 – Electricity Costs per kg of Hydrogen Vs Annual Output with different energy procurement strategies [5]

5.2 Load curve with Silyzer implemented

Here we take another look at the load profile for that same distribution substation that we looked at earlier – although this time – with a Silyzer integrated into the network. Just to recall – after high penetration PV was added to the network, a large negative load was experienced.

Here we show how a Silyzer can bring balance to this part of the grid. As a result of its fast loading and unloading of the network, we can dynamically balance demand and generation, alleviating pressure on the distribution grid whilst at the same time producing Renewable Fuel for storage during the peak demand periods of each day. Based on overall system requirements –and a thorough technical evaluation – this could be implemented on a Microgrid.

Figure 10 - Load profile for distribution substation with Silyzer Implemented

5.3 ACT Renewable Transport Fuels Test Birth
In Australia we are involved in the development of a 'Renewable Transport Fuels Test Birth'. As part of the 315MW Hornsdale Wind Farm, Siemens are providing a Silyzer 200 to the ACT government to supply hydrogen to a fleet of government vehicles as well as for research and development purposes. The Silyzer is expected to be placed into service in 2018. Importantly, following on from our work in Mainz, this will provide an opportunity for the local utilities to understand how a Silyzer can be used to manage fluctuating renewable energy entering the grid – while creating additional value streams from the Hydrogen fuel.

Figure 11 – Renewable Transport Fuels Test Berth – Silyzer 200

5.4 Ventotene Italy – Enabling Electrical Independence
Finally, we would like to highlight a Microgrid project in Italy where the solution managed to reduce fuel consumption and improve grid resilience.
Ventotene, an island in the Mediterranean had 4 X 600kVA diesel gen sets supplying the islands load. The engines struggled to cope with the significant load variations as the population swelled from 700 to 3,000 in the summer peak every year. As more and more PV was added by local residents, and the frequency of outages was on the rise, ENEL – the local utility – decided to act.

Siemens partnered with ENEL to supply a turnkey solution consisting of a SIESTORAGE Battery Energy Storage System of 500kW/600kWh and a Microgrid Controller.

The MGC manages supply and demand intelligently, reducing the problems of seasonal volatility and fluctuations inherent in the solar energy sources.

Combined with the SIESTORAGE Battery Energy Storage System – the following functionality was included:

- Black start capability
- Ramping control
- Time shifting
- Capacity firming
- Diesel offset
- Frequency regulation
- Peak-load management

As a result of this project, the island's grid stability has increased and due to the reduction in operating hours for the diesel generators – CO2 and NOx emissions have reduced as well as maintenance costs.

Figure 12 – The Island of Ventotene – Site of the Microgrid with SIESTORAGE

6. Conclusion
High power prices and their volatility has been a key driver for PICS adopting increasing amounts of Solar PV. At high penetrations an effective renewable energy integration strategy is critical to ensure the electricity network is stable and resilient. We see Microgrids as answering this challenge – provided the approach taken

considers all aspects of grid stability and control holistically. Here we have outlined a template for the development of such a Microgrid, emphasising the critical design aspects, such as the early stage technical and economic modelling of the plant and the engineering activities that must be considered to make the project a success. We have presented the concept of 'Power to Gas' and argued that this may be an answer to the challenges associated with integrating increasing levels of renewable energy into the grid. Without having to 'spill' excess renewable energy, this energy can be used to create hydrogen for subsequent power generation or use in industrial processes. The example of Mainz was introduced as a working hydrogen production facility, providing ancillary grid services. Our involvement in the 'ACT Renewable Transport Fuels Test Birth' was highlighted as part of the 315MW Hornsdale Wind Farm. Finally, from Ventotene Italy, we have presented a Microgrid project where real improvements were made to grid stability while reducing reliance on diesel generated electricity.

References

1. **Utilities Regulation Authority of Vanuatu-** Comparative Report – Pacific Region Electricity Bills, June 2016.

2. **Asian Development Bank**, Outer Island Renewable Energy Project – Economic Analysis (RRP TON 43452)

3. **Passey, R., Spooner, T., MacGill, I., Watt, M. and Syngellakis**, K., 2011. The potential impacts of grid-connected distributed generation and how to address them: A review of technical and non-technical factors. Energy Policy, 39(10), pp.6280-6290.

4. **IRENA – International Renewable Energy Agency**. Efficient Renewable Energy Integration in the Pacific Islands region. Koror, Republic of Palau. 8-12 April 2013.

5. **Kopp, M., Coleman, D., Stiller, C., Scheffer, K., Aichinger, J. and Scheppat**, B., 2017. Energiepark Mainz: Technical and economic analysis of the worldwide largest Power-to-Gas plant with PEM electrolysis. International Journal of Hydrogen Energy, 42(19), pp.13311-13320.

Biography:

Tom Mactier is a Business Development Manager for the Digital Grid business for Siemens Australia focused on energy system modernisation across the areas of SCADA, protection, control and automation.

Tom has a broad range of experience gained over a period of 15 years across automotive, rail, food and beverage, power generation and distribution. In recent years, Tom's primary focus has been on improving the reliability of the grid through automation.

With a keen interest in distributed energy systems – and their role in ensuring reliable, cost effective and highly available energy for all He sees significant opportunities for all energy system stakeholders to benefit from emerging technologies and business models.

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Lower Lifetime Costs With Halo Solid Ring Main Units

Karl Henry
Sales & Support Engineer, Arthur D. Riley Co. Limited

The New Zealand electricity distribution network relies heavily on ring main units (RMUs) to reticulate medium voltage power to customers. With many oil-insulated RMUs now ap- proaching the end of their service life, it's time to look at the options for their replacement.

These options include gas and solid (resin-based) units, says Alastair Neil, with the greatest advantage for network owners and industrial users coming from solid insulation systems that are not only best suited for their purpose but safer for operators, the public and the environment.

As Arthur D Riley & Co's sales and development manager, Alastair Neil has developed a good measure of expertise in the development of RMU solutions and was part of the company's team that developed the Halo Solid Ring Main Unit (SRMU) for ADR four years ago.

"Before we came up with the concept for the new Halo system, we looked at all the options and the key features network companies needed to deliver the best ring main solution for all types of MV distribution systems. It wasn't long before we ruled out gas insulation because of its high lifetime cost, significant auditing and maintenance issues, environmental risks in the event of gas leakage, and safety risks in the event of a fire.

"We were already selling overhead load break and padmount switchgear from En- tec that used an epoxy resin as an insulator and asked the Entec design engineers if they could apply the same technology to switch ring units. The answer was yes so we set about designing a ring main unit using solid insulation.

The key to the new concept was incor- porating into the base design the automation that allows operators to close and open switchgear remotely to immediately limit the effect of outages and provide redundancy.

Scalable and customisable modular Halo Solid Ring Main Units take seismic, arc fault and public safety to new levels

While the base model of the Halo SRMU can now be purchased without the automation, automation and indication are integral to the design and not add-ons.

Alastair Neil says at first glance gas units appear cheaper but, once you incorporate SAIDI reducing automation, the Halo is im- mediately price competitive and when you start designing a ring main installation the savings and performance gains delivered by Halo's flexibility and modular design add to this price advantage.

"The Halo SRMU as a solid insulated, 12 kV vacuum break, extensible, outdoor ring main unit ensures minimal maintenance and delivers the lowest cost of ownership over its life and a very competitive up-front price for a well-featured unit."

He says the Halo SRMU is designed to be customised for every user through the se- lection of individual, reconfigurable modular units that connect via a plug-in bus arrange- ment. This allows network and industrial site owners full flexibility to meet their specific needs.

"We believe there is no better fit- for-purpose solution, particularly for small zone-based substations. The scalable Halo SRMU will also future-proof your network with its open architecture and ease of expansion by simply bolting on modules."

"While a typical base unit will provide a switch/ breaker/switch set-up, any con- figuration of modules can be enhanced with a range of options such as CT, volt- age indication, remote indication, control, power supply and humidity control."

Halo SRMU is designed for New Zealand conditions, constructed in painted stainless steel and requires no additional enclosure because of its IP55 rating. It has a small footprint and a double-skinned, open-front cable box, and easily integrates into existing and future SCADA systems.

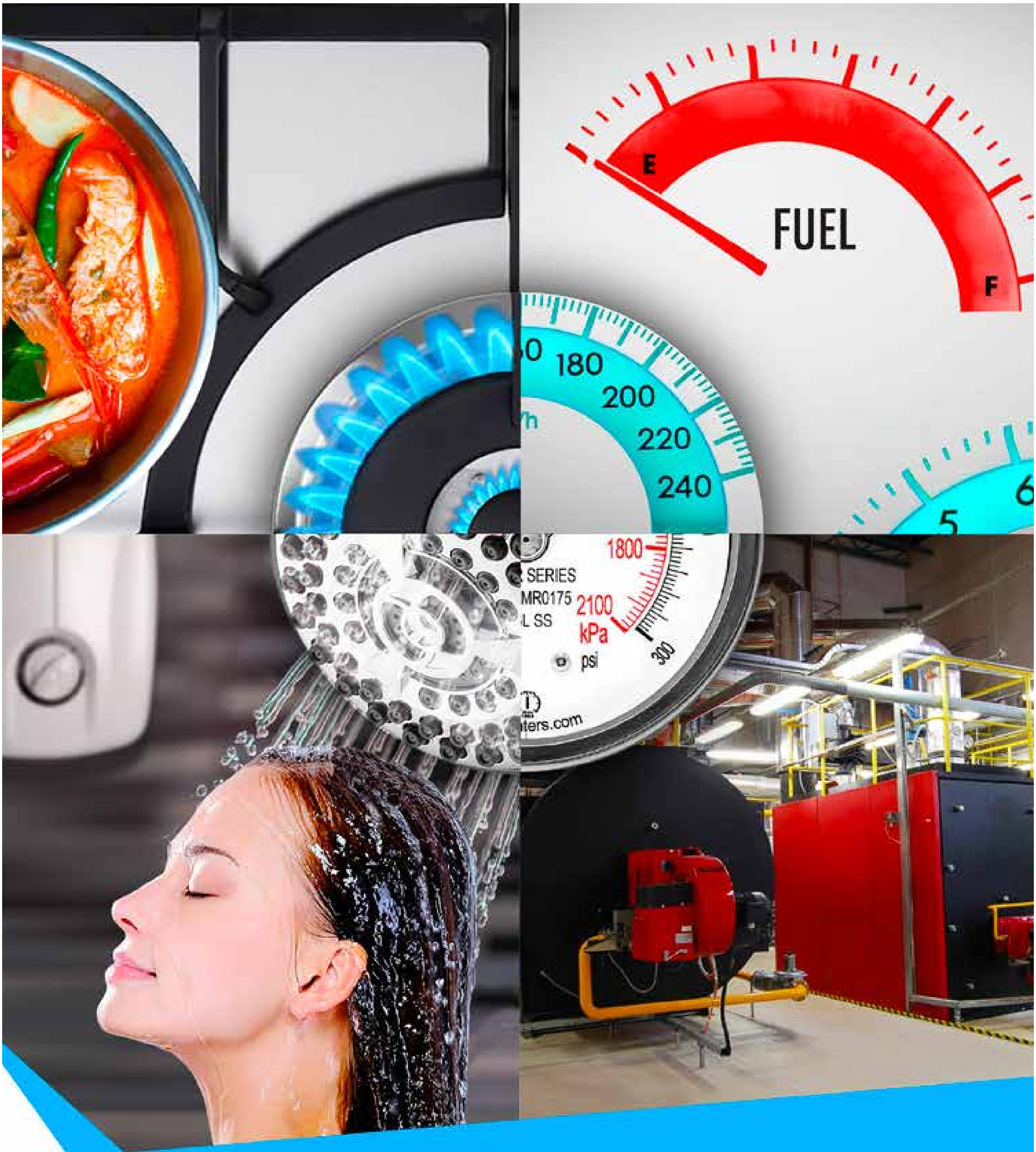
ADR has also designed safety into each unit to deal with major risks including seis- mic and arc flash. The seismic rating is IEEE 693 High and the highest internal arc fault management rating of B(FLR) provides safe and unrestricted public access around every roadside installation and on industrial sites.

"If you want a safe, innovative, feature- rich and cost-effective ring main solution that will guarantee far more effective and remote SAIDI management, the Halo SRMU runs rings around conventional gas and oil units."

Halo ring main units from Arthur D Riley offer the perfect replacement for your ageing oil-insulated ring main units.
Solid epoxy resin insulation provides safe, innovative, feature rich and cost effective ring main units for networks and industrial sites.

Halo solid ring main units are scalable. New modules and functionality can be added later to meet future requirements.

Lower lifetime cost	• Low maintenance • Fewer audits • IP55	• No additional enclosure • Small footprint • SAIDI reducing automation
Scalable modular design	• Plug-in bus arrangement • Circuit breaker • Load break switch • Direct connect onto busbar • Fuse module	• Pre-charge circuit breaker with reclose function • Metering/voltage transformer • VT & SCADA - multifunction relay
Customisable open architecture	• Remote switching (fibre/cellular/radio) • Remote operation • Voltage indication	• Remote indication • Any combination and number of modules • Humidity control • Fault ID and location
Safer for operators, the public & the environment	• IEEE 693 High seismic rating • B(FLR) rated arc flash protection	• Leading edge solid resin • Individual module padlock access
Simple installation, commissioning and operation	• Extensible, both sides	• Open front cable box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Grid Connected Solar PV Overview

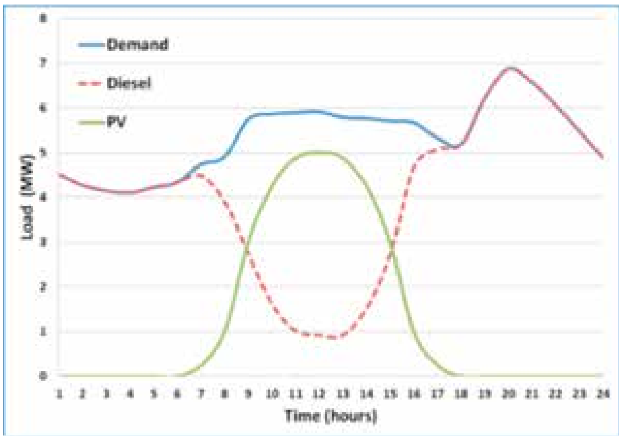
Dr. Herb Wade
Consultant, The World Bank

Although there has been over 30 years of commercial experience with grid-connected solar PV, until recently, the cost of solar panels has been too high to compete with most commercial electricity generation from coal, nuclear and gas. But dramatic price reductions for solar panels over the past 10 years has brought the cost of solar generated electricity down to the point where it is competitive with most forms of commercial generation. That is particularly true for those grids where generation is mostly by diesel engines, as it is in most of the Pacific Islands.

Partly driven by those cost reductions and partly by the need to reduce carbon emissions to meet global climate change goals, over 1,000,000 MW of solar panel capacity is estimated to be installed and connected to the grid in the world with most of that capacity located in Europe, Japan, USA, Australia, India and China. In the Pacific Islands over 50 MW of grid connected solar is installed or committed making the countries of the Pacific region one of the highest per-capita users of grid connected solar in the world.

Though the present cost of electricity from solar PV is less than from diesel, unfortunately there are two issues that need to be addressed before it can provide the majority of the Pacific Island's electricity supply.

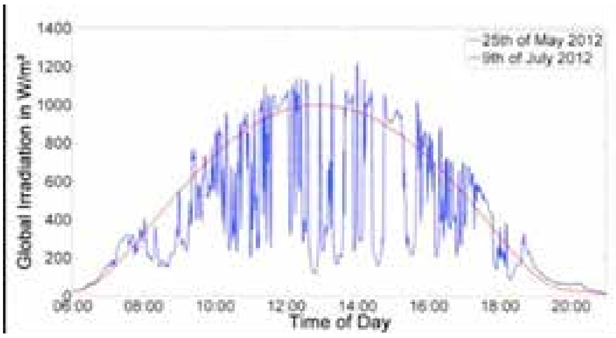
Fig. 1 - Generation / Load Curves over a 24 hour period



Issue 1: The fact that solar generation only occurs during the day means that some type of expensive energy storage must be added if solar is to provide any night-time electricity supply. Since most of the island grids have a peak load during the day – mostly due to government and commercial building air-conditioning – the addition of solar still makes good economic sense. However, the island grids may also have an evening load peak due to residential use that solar cannot support without the addition of energy storage.

Issue 2: The second major issue is the variability of solar energy over the day. Not only is the solar energy changing slowly as the sun moves across the sky, it also changes rapidly as clouds move between the solar array and the sun. This is a major issue in the Pacific where the majority of days are partly cloudy. When completely cloudy days occur during stormy weather, the clouds do not cause rapid variations in solar output since the output from the solar is low and varies slowly. Then, the impact of the variations are easily handled by the diesel generators. But when it is partly cloudy, solar arrays go from full sun to partial sun quickly as a cloud passes between the sun and the array. Then the full output returns equally quickly when the cloud passes by. While the slow variations due to the sun's travels across the sky are predictable and can be easily managed by adjusting the inputs from other generation sources, the variations due to clouds passing over the solar arrays on partly cloudy days that are very rapid and unpredictable do present problems for the diesel generators. They must equally rapidly increase and decrease their output to fill in the gaps caused by the variations of the solar generation. If those rapid variations are a significant percentage of the total load on the grid, there can be serious fluctuations in voltage or frequency of the grid supply because the conventional generators simply cannot keep up with the rapidly changing output from the solar. At best, that can result in poor power quality and at worst, it can cause the diesel generators to trip off-line with power outages the result.

Fig. 2 - Solar Output in Partly Cloudy Conditions



In general, experience has shown that variability issues from solar installations are not usually a problem if the noon-time output from the solar is no more than 20% of the noon-time load. The noon-time value is used since that is the time of the highest output from the solar and therefore the time when its variations will be largest and have the most effect on the grid. With two or three widely separated large solar farms (over about 5km separation) of roughly equal size, their combined noontime generation can be as much as 30% to 40% of the noon time load without serious problems. if the solar installations are small and dispersed all over the island – as can be the case with the installation of many small roof-top solar installations – as much as 50% of the noon-time peak may be provided by solar without serious grid stability issues. This is possible because as clouds pass over a single large array, all the solar is impacted by the shadow of the cloud at the same time and the entire solar output varies rapidly. If the solar installations are widely dispersed, then clouds that pass over some solar panels in one part of the island will not affect the output from the rest of the solar. Thus, the total variation in solar input seen by the diesel generators is much, much less than if all the solar panels were shaded by the cloud at the same time as would be the case with a large array.

An example of dispersing the solar generation is seen on Tarawa, Kiribati. The relatively large solar installations on Tarawa (Fig. 3) are widely separated and are able to provide a larger percentage of the load without stability issues than would be the case if all were located at one site. The Betio and Bairiki installations are mostly roof top installations on government buildings while the Bonriki installation is a ground-mounted array at a large unpopulated area near the airport. The central Bikenibeu installation is a combination of roof and ground mounted solar at the main power station.

Fig. 3 - Tarawa Solar Distribution

Planning for Increased Generation by Grid-Connected Solar

In general, planners should consider planning for the following series of stages for grid-connected solar development:

Stage 1. Installing a few large solar farms that are widely dispersed to minimize overall variations. if possible, these should be located to avoid the need for the construction of expensive long transmission lines to carry large amounts of power from the solar farm to the main grid. As much as possible, size each solar array so that the existing nearby grid can handle the output from the solar installation. These solar farms may be owned by the utility or by Independent Power Producers (IPPs) who own the solar arrays and sell power to the utility under a Power Purchase Agreement (PPA).

Advantages of large PV arrays owned by the utility:

- Construction management is simplified. All components are installed in just a few locations.
- Ease of management and maintenance. Everything can be easily accessed and system O&M management is simplified, particularly if all installations use the same basic components.
- May provide the lowest cost per kWp of solar–

though where land costs are high, that can increase the cost to higher than power from roof-top solar.
- It is generally easier to get finance for a large array than for multiple small arrays.
- Large arrays look impressive to government, aid donors and customers.

Disadvantages of a few large arrays

- It is more difficult to maintain grid stability on partly cloudy days because variations are large and rapid.
- There often is a higher environmental cost due to large land areas being cleared for the solar arrays.
- There is a sharp noon time peak in power output with most of the generation provided from about 0900-1500 during the day.

Advantages of IPP based solar generation include:

- No large capital outlay required by the utility
- All land acquisition, financing and construction is typically provided by the IPP as well as all operating and maintenance costs.
- There is a predetermined, contract based long term cost of energy from the installation.

Disadvantages of IPP based solar installations include:

- The utility is forced to purchase all the power generated by the IPP or pay a penalty for throttling power at times when the solar input msy causr stability problems for the utility. In particular, throttling may be necessary on weekends when the load typically is much lower than during the work week.
- There is less flexibility in system design and operating characteristics than for a utility owned system.
- Lower cost finance may be available to the utility (often outright grants) than to the IPP making actual solar power generation cheaper for utilty owned solar than for IPP produced power.
- The IPP has to make a profit and that becomes part of the power charge and may result in lower profits for the utility or higher costs to the consumer.

Whether utility owned or IPP owned, the utility should require construction of solar arrays to meet strict utility developed standards to ensure that the installation will survive major storms and can operate successfully for the long term in the difficult salt air and high temperature environment of the Pacific Islands.

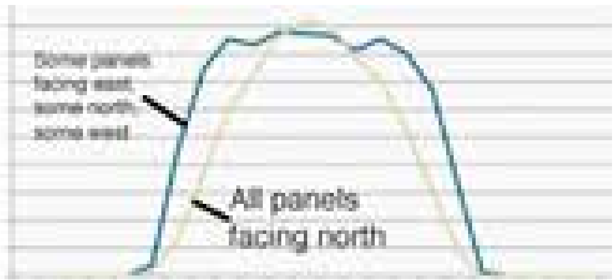
Stage 2. Include a number of dispersed, rooftop installations on government owned buildings (schools, warehouses, power stations, office buildings, airports, etc.). They will have less effect on the stability of the grid than the same total capacity located in one large solar array. Also because they will not have all the panels oriented in the same direction, the output over the day from those installations will not have the strong noon-time peak that occurs with a single large solar array. That is because those rooftop panels tilted toward the west will increase the afternoon generation while those facing toward the east will increase the morning generation. Those facing mostly north or south will have their peak output around noon. When all the various roof-top installations are added together, they will (a) not have a strong noon-time peak so the output variations will be lower overall and (b) the output from all the solar together will be well distributed over the day and more closely aligned with the load pattern over the day. These two benefits make it easier for the diesel generators to function well with the solar and allow the solar to provide a larger percentage of power to the grid than comparably sized arrays all tilted toward the equator as is the usual convention for ground mounted solar.

Stage 3. Allow customers to install privately owned roof mounted grid-connected solar that is of a size consistent with the building's load and will not require increased feeder capacity. The systems should be widely dispersed and meet utility standards for equipment and installation.

Advantages of dispersed roof mounted arrays:

- Fewer problems with grid stability due to solar variations. This is the result of having installations widely dispersed so cloud passages do not affect all of the solar panels at the same time, and to the diversity of orientations of the panels that "flattens" amd "widens" the power output curve so it better fits the load curve (see Fig. 4). The peak power from the solar is not concentrated at noon but spread over the day and results in a lower maximum delivered power relative to the usual sharp noon-time peak of most ground mounted solar arrays. This means that the variations are also smaller and more easily managed.

Fig 4. – Solar output with varied panel orientations vs all facing the equator



- The failure of one installation does not seriously reduce the overall solar input.
- There is no land cost.
- Helps keep the roof cool and therefore reduces any air-conditioning load in the building.
- No special transmission lines are needed; the existing feeder wires are usually sufficient to safely deliver the power to the grid.
- All installations can be made using identical low power, modular components thereby simplifying spare parts support and personnel training requirements
- It is easier for the grid to absorb dispersed small independent generators than a single large one.
- Distribution losses are reduced because most, if not all, of the delivered energy goes to the host building or will go to buildings near to the site of the solar generator. This avoids some wire losses and most transformer losses.

Disadvantages of small roof mounted dispersed arrays:

- Requires a more complex system for monitoring such as through the mobile phone system, the Internet or by using special "smart" meters.
- Roofs may need to be rehabilitated before the installation of panels.
- It is more difficult to access panel wiring after the installation.
- It may be more difficult to finance many small arrays than a large central array.
- The utility must deal with many site owners instead of just a few. This problem is minimized if only roofs of government owned building are used,

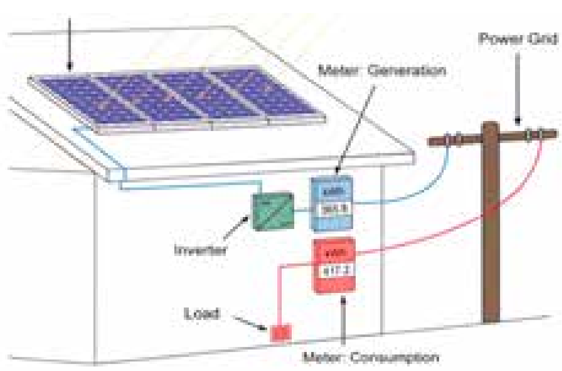
Metering of customers having a roof top solar installation.

Options include:

- Use only one meter that runs backward when the solar generates more than the customer uses (cannot be used with pre-payment type meters).
- Use two separate meters, one for the solar and one for the total energy used in the customer's building. The meter for the total energy can be a pre-payment type meter.
- A "smart" meter that measures both total solar and total building use and sends the data to the utility through the grid or the Internet.

The option with two meters is recommended since it is the cheapest option that provides information on both the amount of energy coming from the solar and the total amount of energy used by the customer. That is important both to the customer – who wants to know if the solar is working properly and how much it is generating – and the utility who needs to know the total energy used by the building so planning for grid expansions and for energy efficiency measures can be properly carried out. Also, without knowledge of the energy flows in feeders it will be difficult for the utility to determine losses in the grid.

To connect the two meters, the existing building meter is left in place and the output from the solar meter is connected on the grid side of the building meter. To compute the bill, both meters are read and the solar kWh is subtracted from the total kWh to determine how many kWh came from the grid and needs to be charged to the customer. If it turns out that the amount from the solar exceeds the amount used by the building usually there is some sort of credit or payment given for the surplus solar electricity that was generated.



Dual Meter Connection Arrangement

The existing building meter is left in place and the solar panels are connected to the grid side of that meter through an inverter that converts the DC electricity from the solar to AC power that automatically synchronizes with the voltage and frequency of the grid.

Benefits of connecting the solar directly to the grid with separate metering of solar and building usage include:

- Allows the utility to have a strong say in the standards and components used in the installation. If all the connections are on the building side of the meter, in principle the customer can install any type of equipment they want. But if the equipment is connected directly to the grid, the utility can choose to not allow the connection unless the proper utility standards are met.
- The utility cannot be held liable for fires or other problems in the building that appear to be caused by the solar installation since the connection to the grid is external to the house.
- Data is readily available to support both the utility and the customer's need for information to properly operate and maintain the solar and the local components of the utility grid.

Billing for power used in government buildings with rooftop solar

Assuming that the government division that is occupying the building has to pay its own utility bills, there are two approaches to billing that have worked well:

- The utility can pay the end user a monthly fixed fee for "renting" the roof area and then just bill normally for the total kWh used by the building. In this approach, the rental payment offsets the charges for the actual kWh used in the building but the user still has an incentive to use energy efficiency measures to reduce their bill. Also, this approach is very simple for the utility to implement since the payment for the roof rent is a fixed amount. This approach is typically used when the size of the solar array is sufficient to generate substantially more power than the building uses. Essentially the array is intended to be a generator for the utility more than a way to offset the electricity use in the building.
- The user is billed for power used but receives a credit based on the total kWh that has been generated by the solar during the billing period. In this approach, the end user could end up with a monthly payment from the utility if the internal use of the building is low (a warehouse for example) and the solar is large enough to always generate more than the building uses. This approach is not best for government owned buildings unless the size of the solar is too small to ever generate a significantly greater amount of kWh than is used by the building owner.

Private roof-top solar installations on residences and commercial facilities:

- Generally each residential installation is small (typically one to three kWp of solar panels) and the capacity of the existing grid is more than adequate for the power levels being generated at each residence.
- Adding private grid-connected solar installations can provide sufficient geographic diversity to allow a much greater percentage of solar generated power to enter the grid without stability problems that would be possible with a large array of the same total capacity.
- For commercial buildings that have a large roof area and solar installations can be made quite large, the utility must ensure that the existing feeder to the building connection is adequate for the level of generation that will be present at peak power from the solar.
- The addition of solar to the grid does not significantly reduce the need for diesel or other conventional generation capacity though the full capacity is only needed on cloudy days.
- A more complex billing system may be needed in order to allow for credits when solar generation exceeds the use of the building.
- The size of the private solar should be limited to a size consistent with that of the load of the building affected.
- The installation must meet the standards and guidelines prepared by the utility for grid-connected solar installations.

"Net Metering" for private solar installations

At its simplest, net metering means that when there is excess electricity sent to the grid, a credit for that many kWh is provided by the utility. That credit can be used for future usage by that customer. The credit can be for direct replacement of kWh (e.g.

a credit for 100 kWh means that 100 kWh can be used sometime later with no added charge) or it can be a credit based on payment per kWh for the surplus that is less than the regular kWh tariff. That type of payment is usually called a "feed-in tariff" and is typically set at an amount that reflects the cost savings a utility has as a result of the power fed into the grid by the customer (mostly fuel savings). For example if there is a surplus of 100 kWh and its retail cost to the customer is normally $40, then with pure net metering, a $40 credit would be issued. With a feed-in tariff, the credit would be less than $40, the amount depending on the cost savings to the utility attributable to the surplus solar sent to the grid which varies according to the current cost of diesel fuel.

Net metering is particularly important to develop residential solar because the generation of the solar system is all during the day while the electricity use in the residence is usually largest in the evening when lighting and entertainment systems are operating. This means that most of the daytime generation goes into the grid and the utility sells it to other customers but the residence will use most of its electricity in the night time and that will all come from the grid as there will be no generation by the solar at night. Without net metering, there is therefore little incentive for the private homeowner to invest in solar for their residence. An exception may be where there is day time air-conditioning in the home, but few Pacific Island customers use home A/C and where they do, it is mostly used at night to cool sleeping rooms.

For commercial customers, the time for the greatest electricity use is typically in the daytime when the solar is generating. Therefore the availability of net metering is less important for that class of customers than it is for residential customers.

Feed-in Tariffs

A feed-in tariff is the amount per kWh that the utility pays for electricity fed into the grid from private generators. That may be electricity from an IPP solar array where all the generated energy goes into the grid and is paid for at the feed-in tariff rate, or it may be the amount of surplus kWh that is generated by roof top solar but not used in the building. That surplus is then available to be sold by the utility to other customers. To provide a large incentive for installing solar – as was the case in Germany in the early 2000's – the solar feed-in tariff may be set substantially higher than the kWh cost of purchasing electricity from the grid. In that case, there is an incentive to install solar generation and send all the solar generated energy into the grid for payment by the utility. A feed-in tariff is also established for the energy delivered to the grid by an IPP with the tariff set in a Power Purchase Agreement. In the Pacific, a few countries have a feed-in tariff for the monthly surplus from private solar installations. In those cases, the feed-in tariff is much less than the per kWh cost of power delivered from the grid. Typically it is just the value of the fuel that is saved by the utility when they accept the surplus solar generated energy from the customer. This approach encourages the customer to install no more solar than is actually needed to cover the building load since the customer will not make much money on the surplus that goes into the grid.

The recommended net metering arrangement is to pay a feed-in tariff credit for any surplus power generated by the customer's solar. The feed-in tariff should be no less than the amount that is equal to the avoided cost of electricity delivered from the utility. In most utilities, the surplus generation credit cannot be converted to cash, only used to purchase more kWh at the regular retail rate.

A particular concern of island utilities is the loss of revenue that will occur if private grid connected solar on homes and businesses is allowed. To help offset this loss of revenue there are several possible approaches.

Those include:

- The utility becomes a financier, a provider and an installer of private solar installations. This approach ensures that the installations meet utility standards as well as providing substantial income to the utility.
- Make avaialble a maintenance contract for private solar installations. Most island countries have few persons competent to maintain solar installations outside of the utility. So it makes good sense for the utility to sell maintenance services to private operators of grid-connected solar installations.
- Increase the tariff for purchasing kWh from the grid to offset the lower total revenue caused by private solar on the grid. This would impact all electricity users, not just those with solar installations. As long as the kWh from the solar is a fraction of the total kWh the utility sells, the rate increase would be small.

- Charge a modest monthly 'standby power' fee to end users with solar installations. It is common for a utility to charge a monthly standby power fee to commercial users that generate their own electricity but sometimes must buy power from the grid. In essence the grid becomes a stand-by source when the solar does not meet the end user's load. This standby power fee can be a fixed monthly charge or can be an additional per kWh charge for energy needed from the grid when the solar cannot cover the load.
- Get government to cover the utility losses caused by private solar generation as one of the costs of meeting international greenhouse gas reduction goals.
- Some combination of the above options.

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TRANSDIESEL

Building on Success with Electricity, Tonga Expands Use of OpenWay Riva™ Technology To Improve Water Efficiency

Itron Australasia Pty Limited

Located in the South Pacific just over 3,000 miles east of Australia, the Kingdom of Tonga is a Polynesian sovereign state and archipelago that is home to more than 100,000 people. In 2016, the Kingdom, through the efforts of its government-owned utility, Tonga Power Limited, took bold steps toward becoming the world's first "Smart Island" by installing a smart network over its main island of Tongatapu to improve energy efficiency, reduce losses and prepare its power grid for the future.

To achieve these outcomes, Tonga Power Limited (TPL) became one of the first utilities in the world to deploy Itron's OpenWay Riva™ technology, the latest generation of Itron's widely deployed OpenWay solution. TPL has completed installation of nearly 15,000 OpenWay Riva-equipped electricity meters on Tongatapu.

TPL is utilizing the system initially to reduce non-technical losses, provide remote disconnection and reconnection of service, monitor voltage on the distribution system, and support a customer pre-payment program. The network is maintained and operated by Itron through a managed services contract, relieving TPL of the resource burdens associated with network management.

As installation of the full system is completed, TPL will utilize the full capabilities of OpenWay Riva —including distributed computing power in every smart electric meter — to support new applications and services such as transformer load monitoring, and the integration of renewable energy resources to meet the Kingdom's goal of 50 percent clean energy by 2020.

Now the Kingdom of Tonga is turning its attention to managing its precious water resources more intelligently. Using the same communication network infrastructure installed by TPL for electricity, the Tonga Water Board (TWB) installed and tested Itron's highly accurate static water meters equipped with OpenWay Riva technology to reduce water losses associated with leaks and capture lost revenue due to non-payment.

Similar to electricity, the Kingdom of Tonga stands to make significant gains in water efficiency if they can reduce both technical and non-technical losses according to their goals. By utilizing the same unified network infrastructure to address both energy and water challenges on the island and partnering with Itron to operate the system through a managed services contract strengthens the business case and accelerates the time to value.

A combination of old infrastructure, inaccurate consumption measurement and unpaid invoices has pushed losses to unacceptable limits in some areas of the island.

"This new work in Tonga is important for multiple reasons," said Gavin Van Tonder, president of Itron's Global Water Business Line. "With OpenWay Riva technology, water consumption will be measured accurately, leaks will be detected more rapidly, and the collection and analysis of more detailed data over the network enables TWB to allow consumers to monitor their consumption on a continuous basis."

Through a comprehensive resource management program that addresses challenges in energy, water and smart communities enabled through the OpenWay Riva solution, the island Kingdom of Tonga is showing that it is both smart and connected.

EPC Samoa Focuses on Clean Energy for Ally

Electric Power Corporation (EPC), Samoa

In December 2017, three hydro power plant schemes were officially commissioned following substantive damages caused by flooding from Tropical Cyclone Evan in December 2012 in the island of Upolu. The three re-commissioned hydro plants add 4.6MW of capacity and 13 million generated per year to grid.

Funded under the Renewable Energy Development and Power Sector Rehabilitation Project, the total contract cost at approximately 9.30million US dollars plus 4.8million Samoan Tala. This project is one of the many projects funded through the kind assistance of donors that are the Asian Development Bank, the European Union, the Government of New Zealand and the Government of Samoa as well as the Japan International Co-operation Agency (JICA) and the Government of Australia for Power Sector Expansion Project

Civil works during construction and the laying of pipelines

Construction of damaged pipeworks, power houses and hydro intakes were carried out by Pernix MAP Projects JV with subcontractors MTL, Vortex Group from New Zealand and local sub-contractor Bluebird Construction Limited. The implementation of the mechanical and electrical components of the rehabilitation works were undertaken by Vortex Hydro of Rotorua, New Zealand, whilst the overall management and financial administration of works were carried out by Pernix.

Clearing of the Samasoni Hydro Power Plant pond and the newly constructed Alaoa east intake

In addition to the rehabilitation of these hydro power schemes, the Supervisory Control and Data Acquisition (SCADA) system has also been integrated into the operation of the three (3) hydro schemes where the National Control Centre of the Electric Power Corporation centrally operates the electricity network for both Upolu and Savaii islands.

The total installed capacity of the three hydro schemes is 4,655 kilowatts with an estimated energy output of 13 million units of electricity. This is 10% of Samoa's electricity energy demand for one year. Annual expected savings of 3.0 million litres of diesel which is equivalent to approximately 7 million Samoan Tala per year which contributes greatly to the reduced use of fossil fuel in the production of electricity in the island of Upolu. It is anticipated, that an expected contribution to the reduction of 8,295 metric tonnes of CO_2 emission annually though small on a global scale, but it is Samoa's share in compliance with international standards towards a clean provision of energy for today's and future generations to come.

Laying the foundation for the Loto Samasoni generator and the official commissioning of the all 3 hydro schemes in which Donor representatives, the Government and Contractors as well as EPC were explained the use of the SCADA system in remote controlling of operation from one of the hydro plants (Loto Samasoni).

There are also three (3) remaining micro hydro power schemes presently under construction funded under the ADB Renewable Energy Development and Power Sector Rehabilitation Project is expected to be completed by the middle of 2018. They are, the Fuluasouand Tafitoala/ Fausaga Micro-Hydro Power Plants in Upolu and the Vailoa Micro- Hydro Power Plant in Savaii.

The renewable energy developments mentioned above are part of EPC's commitment to the Government of Samoa's long term strategy to be 100% reliant on renewable energy by the year 2025, displacing fossil fuels as a means for generating electricity. Another recently completed renewable project is the Vailoa Wind Farm Project at Aleipata-Upolu funded by the United Arab Emirates.

Port Moresby Power Grid - Kilakila Substation Project

Peter Tangwari
Manager, Port Moresby Power Grid

Project Rationale:

The rationale of the Port Moresby Power Grid Project is to reduce fossil fuel consumption, increase electricity access and improve network reliability on the Port Moresby Power Grid.

KILAKILA SUB- STATION PROJECT (A way forward for clean, green energy power generation)

PNG Power Limited has embarked again on another project of constructing a sub-station using clean green energy to generate power supply in the nation's capital Port Moresby.

The project, funded under the Asian Development Bank (ADB fund) is a key project; PNG Power Limited has taken on board to ensure reliable power supply is provided for its users.

Kilakila Sub-Station:

The Kilakila Substation project is one of the 6 subprojects under the Port Moresby Power Grid development project. The aim of this project is to ease the overloading of its major city substations. These distribution substations are Konedobu, Boroko, Bomana and Waigani substation including parts of Gerehu suburbs.

Funding of this project is covered under a loan arrangement between the Government of Papua New Guinea (GoPNG) and the Asian Development Bank, to a tune of US$89 million for the 6 subprojects. From this, the Kilakila 40MVA substation and 66kV double circuit transmission lines project alone was awarded at the total cost of US$11.6 million.

Kilakila Sub Station launch: (From left- State Enterprise Minister William Duma having a chat with Kumul Consolidated Holdings Limited Board Chairman Paul Nerau, after officiating the ground breaking ceremony.

The EPC contract was signed between PNG Power Ltd and a Malaysian company and awarded on the 8th of May, 2017.

The construction of the Kilakila substation project will be in two parts constructed in parallel, the construction of a 40MVA AIS sub-station, and the 6.1 kilometres of a 66kV double circuit transmission line.

As planned, once the substation is completed and commissioned, it will have two express feeders dedicated for the Central Business District (CBD) of Port Moresby.

The aim of the two express feeders are primarily to relieve the overloading of the current city substation which is Konedobu feeding the CBD and parts of Downtown-Port Moresby as well as parts of Boroko, Hohola, Waigani, Bomana and Gerehu suburbs.

Other adjacent subprojects, one of which is the mesh-loop connection of the entire Port Moresby Distribution Grid. This subproject includes an estimated connection of 3,000 peri-urban households, upgrading the existing distribution system to a mesh loop design, including the implementation of the loss reduction program. The project is expected to connect 16% of households currently not connected to the grid and increase the access rate in Port Moresby by 5%. It is also estimated that the mesh-loop exercise and the distribution network upgrade will reduce the average outage duration to consumers by 42% and 80% significantly within the Port Moresby CBD areas.

Currently the construction of Kilakila substation is at its preliminary stage, the site office has been constructed and completed. PNG Power Ltd have also approved the civil designs and the excavation works for the platform and the foundations for the switchgear foundation are expected to start by end of February 2018. The contract projects for completion and commissioning of this project is by 20th of August 2019.

Renewable Energy Front:

PNG Power Limited and the Asian Development Bank (ADB) is embarking on the utilization of renewable energy generation in Papua New Guinea, reducing carbon emission on the use of fossil fuels and increase the rate of use of natural resources in providing cleaner, green energy and environmentally friendly.

The Port Moresby Grid alone has an estimated hydropower generation capacity of more than 60% compare to thermal generation. The Kilakila substation project will also be connected from the hydropower generated from the Rouna cascade. The project will also provide spin-off business in terms of small to medium enterprises (SME's) stimulate local growth and the overall economy, influence poverty reduction and increase rate of access to electricity connection in Papua New Guinea especially for peri-urban households.

PNG Power Ltd also has a vision to contributing back to its local people and customers. This is also in-line with the PNG National Government's vision 2050 and the Medium Term Development goals to electrify 70% of the local household population within the country by 2030 with reliable, affordable and cleaner energy.

"The change of having technology generated from a renewable energy to our customers' door-step is the way forward for PNG Power Ltd." (Peter Tangwari – Manager Port Moresby Power Grid)

Kilakila Sub Station Launch 2: (From right) Former PNG Power Limited Board Chairman Andrew Ogil signing the final contract papers for contractor Pestech to begin construction of the new Kilakila Sub-station project last year 2017.

The Project of Hybrid Power Generation System in Pacific Island Countries

Regional Technical Cooperation Project by 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 properly operate and maintain both Diesel Engine Generator(DEG) and RE power generation systems. Smart integration of RE requires healthy operation and maintenance conditions of DEG, which is the reason this Project was designed as "Hybrid", instead of simply integrating RE into the existing grid. Experts from Japan conducted both hands-on and classroom training in all countries, and will assist in establishing a regional training center in Fiji in cooperation with PPA, FEA and DOE.

Initial discussions were completed and baseline information was collected in all countries, to compile the "Training Needs Assessment Report" in order to identify topics to be covered under the Project. With regards to the O&M of DEG, there is a strong need from all countries to enhance in-house capacity of engineers and technicians to reduce the cost of services by outsourcing companies. In some countries, almost no maintenance works have been done for electrical equipment such as generators and protection relays. For the grid integration of RE, field tests such as a dump load test will be required to come up with reliable data for grid-modelling, as there is no available information at the moment especially for dynamic modelling. For these issues, experts from Japan will work with their counterparts to establish manuals for planning, operation and maintenance of HPGS.

11 participants from 5 countries were invited to Japan for the counterpart training to join classroom lecture and site visits from 16th February to 2nd March 2018. They were provided with opportunities to visit similar HPGS in remote islands of Okinawa, research institutes and manufacturers in Japan. They are expected to work for the Project with the experience and knowledge from Japan in accordance with their own action plan in each country. This year, Training for Trainers (ToT) will be initiated for the candidate trainers in Fiji, in parallel with on- site trainings in the remaining 4 countries.

Hands-on Training in Tuvalu

Counterpart Training in Japan

Variable Renewable Energy (VRE) Study Inception Meeting

Pacific Power Association

Utility representatives from 8 PPA Utilities, the World Bank and consultancy firm Richardo Energy & Environment gathered for the Inception Meeting for the VRE Studies and SCADA/EMS work funded by the World Bank as part of the Sustainable Energy Industry Development Project (SEIDP). The utilities participating in the study includes EPC (Samoa), TPL (Tonga), YSPSC (Yap State, FSM), CPUC (Chuuk State, FSM), PUC (Pohnpei State, FSM), KUA (Kosrae State, FSM), TEC (Tuvalu) and MEC (Marshall Islands).

The objectives of the study are the following four interrelated tasks. They include:

1. Task 1: Grid integration and planning studies,
2. Task 2: Assessment of energy storage applications in power utilities,
3. Task 3: Supporting the Develop or Revision of the Grid codes and
4. Task 3: Assessment of the needs for Supervisory control and data acquisition (SCADA) and Energy Management System (EMS).

The beneficiary utilities in the project have been identified through consultation with the member utilities and are as outlined below.

Grid integration studies and SCADA/EMS design	**SCADA/EMS design only**
• Kosrae Utilities Authority (Federated States of Micronesia)	• Yap State Public Service Corporation (Federated States of Micronesia)*
• Chuuk Public Utilities Corporation (Federated States of Micronesia)	• Marshalls Energy Company (Marshalls Islands)
• Pohnpei Utility Corporation (Federated States of Micronesia)*	• Tuvalu Electricity Corporation (Tuvalu)
• Electric Power Corporation (Samoa)	
• Tonga Power Limited (Tonga)	

The meeting was also an opportunity to introduce the utility participants to the objectives of the study and what is required from the participating utilities. It also provided the consultants an opportunity to meet the officers they will be working in the utilities during the course of the study.

The first day was spent going over the different components of the project and the data requirements for the studies. This was followed by individual utility consultations with the consultancy team on the second day.

The inception meeting was followed immediately with filed missions by the consultants to all the participating utilities.

Welcome!

To New Allied Members

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

TRINA ENERGY STORAGE SOLUTIONS: Trina Energy Storage Solutions is based in Alexandria, Australia. Their primary activity is battery energy storage system and their secondary activity is PV + BESS Turnkey Solution, project management.

JEAN MUELLER NEW ZEALAND LIMITED: Jean Mueller New Zealand Limited is based in Taranaki, New Zealand. Their primary activities are fused switchgear, low voltage switchgear assemblies and electronic and their secondary activities are monitoring systems and energy management for power reticulation.

ZERO-CARBON ISLAND CORPORATION LIMITED: Zero-Carbon Island Corporation Limited is based in Lautoka, Fiji. Their primary activities are clean energy solutions on PV, wind, hydro, waste incineration and geothermal power generation and their secondary activity is independent power provider.


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