PPA

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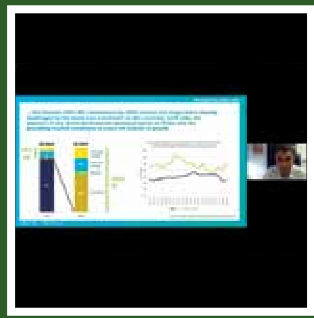




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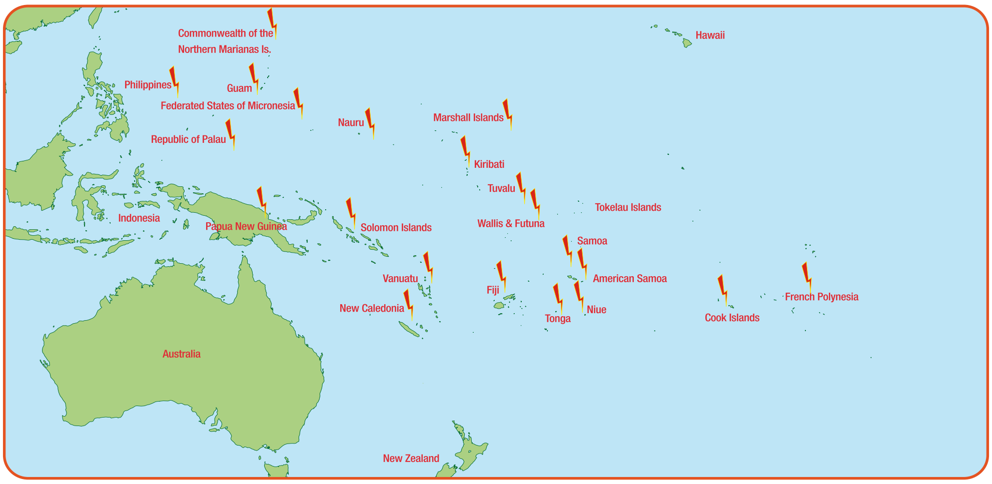


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# Editor’s Note

**Gordon Chang**
Acting Executive Director

The Secretariat is only now beginning to settle down after the COVID-19 restriction in coming to work in the office. There is news that Fiji will be opening their International Borders in November 2021.

This main article in this edition of the magazine is a very interesting paper presented by Global Sustainable Energy Solutions (GSES) Australia on Specialized Cable Sizing of Complex Electrical Circuits, cable sizing and derating are a critical element in any electrical project, not just solar power installations. Most electricians rely on Australian/ New Zealand Standards AS/NZS 3008.1.1 and AS/NZS 3000 to provide the answers necessary to adequately size and derate cables for a given load in any situation. In some scenarios, a specific site or installation may present conditions that are different to those upon which AS/NZS 3008.1.1 was developed, and other specifications or calculation methods that allow greater flexibility may become necessary to select an adequate cable. In this article, we will compare the AS/NZS 3008.1.1 and IEC 60287 cable sizing and derating methods to solve the thermal current carrying capacity limits of selected cables. In doing so, we will illustrate the cases in which AS/NZS 3008.1.1 was designed to be used, where more detailed engineering solutions provide tailored inputs for site specific conditions, and provide a comparison between the two.

In this edition of the PPA Magazine, I would like to thank all the PPA members who attended and those that did presentations at the PPA Conference Virtual on Thursday 26 August 2021. You can read more on about this conference on pages 41-43.

In addition, I would like to thank all those who contributed articles, and especially those who have advertised in this edition of the PPA Magazine, without you there would be no PPA Magazine. Thank you.

I sincerely hope that you take the time to read the magazine, as the articles are really enlightening and that you will find it worth your while.

Vinaka Vakalevu.

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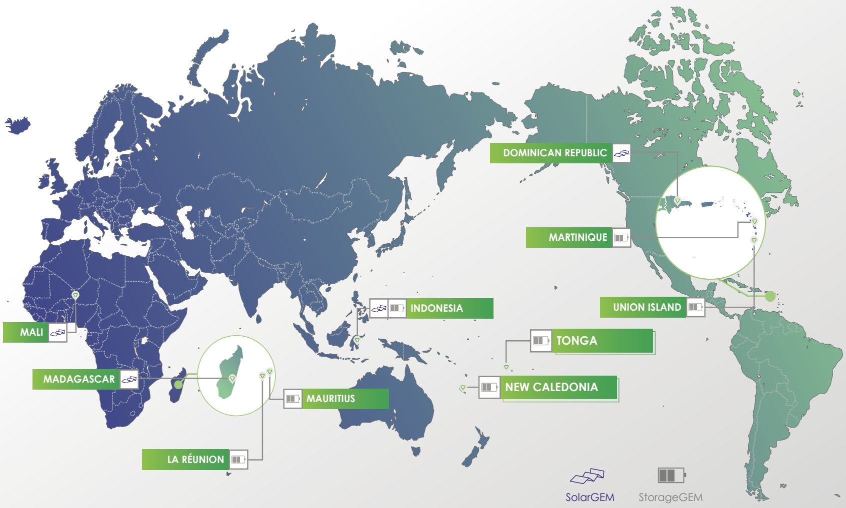


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# Specialised Cable Sizing Of Complex Electrical Circuits

GSES Technical Team
Global Sustainable Energy Solutions (GSES), Australia

**Introduction**

Cable sizing and derating are a critical element in any electrical project, not just solar power installations. Most electricians rely on Australian/New Zealand Standards AS/NZS 3008.1.1 and AS/NZS 3000 to provide the answers necessary to adequately size and derate cables for a given load in any situation. In some scenarios, a specific site or installation may present conditions that are different to those upon which AS/NZS 3008.1.1 was developed, and other specifications or calculation methods that allow greater flexibility may become necessary to select an adequate cable. In this article, we will compare the AS/NZS 3008.1.1 and IEC 60287 cable sizing and derating methods to solve the thermal current carrying capacity limits of selected cables. In doing so, we will illustrate the cases in which AS/NZS 3008.1.1 was designed to be used, where more detailed engineering solutions provide tailored inputs for site specific conditions, and provide a comparison between the two.

**What is Current Carrying Capacity?**

In any electrical installation, whether LV or HV, it is crucial that the cables are appropriately sized to carry the operational current of the devices or equipment they power. In addition, the cables need to do so without significant resistive losses, and also be protected against overcurrent in the event of a fault.

A cable's current carrying capacity (or CCC) is deemed suitable when:

$I_B \leq I_Z$, where:

- $I_B$ = design current of circuit, i.e. maximum demand for a load or maximum generation for a generator
- $I_Z$ = continuous current carrying capacity of the chosen cable, derated according to installation method, grouping with other cables (mutual heating effects) and environmental conditions
- *It is also important to note that $I_Z$ shall also be greater than the trip rating of any protection devices, such as a fuse or circuit breaker, used on that circuit, in accordance with AS/NZS 3000 or AS/NZS 5033 as appropriate. This is especially crucial in PV DC circuits where fusing is installed.*

In Australia and New Zealand, AS/NZS 3008.1.1 – *Cables for alternating voltages up to and including 0.6/1 kV* is the primary resource for calculating the value of Iz, providing tabulated CCC and derating values for the most common installation scenarios in these regions, making it an incredibly useful resource for a wide range of applications. Section 1.3 of AS/NZS 3008.1.1 names alternative specifications that are permitted to be used for calculation of $I_z$ under the installation methods/scenarios that are not covered by AS/NZS 3008.1.1, one of which is by calculation according to IEC 60287.

For a detailed explanation of the AS/NZS 3008.1.1 cable selection process for DC circuits, take a look at our previous technical article at the link below: *https://www.gses.com.au/dc-cable-sizing-using-as-nzs-3008/*

**Solar PV and Cable Selection**

As PV systems continue to decrease in cost and the development of large, uniform commercial rooftops and ground-mount systems become increasingly common, there is a decreased reliance on individual string or MPPT circuits and a shift towards central (or so-called "distributed central") inverters, which allow for fewer, larger sub-array cables to be run between the array and the inverter/s. As the sub-array cables are typically sized much more closely to their design currents than string cables, it is essential that deratings be correctly applied to the sub-array cables.

The installation and application conditions for a typical photovoltaic generator's DC circuits are notably different to the conditions offered in AS/NZS 3008.1.1. The use of this standard can produce conservative values of IZ, resulting in cables being sized larger than may be necessary. At the same time, while the tabulated deratings presented in AS/NZS 3008.1.1 are useful for simple trenches, more complex trenches can introduce additional deratings that further reduce the CCC beyond the deratings in AS/NZS 3008.1.1. This article will explore some of the key differences between the results AS/NZS 3008.1.1 and IEC 60287 when determining the CCC of underground circuits, considering:

1. Simple comparison:
   a. DC rather than AC voltage and current
   b. Daily load profile
2. Tiered trench designs
3. Minimum clearance between trenches to avoid mutual derating
4. Thermal derating for cables where $I_B < 35\%$ of $I_Z$

The IEC 60287 calculations will be performed using the Cableizer software package, which uses computational analysis based on IEC standards to calculate thermal cable ratings, i.e. the maximum steady-state current that can be carried by a circuit without exceeding its maximum permissible operating temperature. The software offers a range of different calculation methods published in the international standards (IEC) and other technical specifications. Models can be built with comprehensive specification of electrical, mechanical, thermal and environmental input parameters for site-specific simulations.

**AS/NZS 3008.1.1 and IEC 60287: Comparisons**

**1. Comparison for cables in underground wiring enclosures**

**Case 1.1 – AC Circuits**

In the base case, we will compare the maximum continuous current calculated according to IEC 60287 with the tabulated result from AS/NZS 3008.1.1. The modelled circuit is:

1. 400V (ph-ph) AC
2. x1C/ph 400mm² Cu X-90 cables (one circuit per conduit). Note that the neutral is omitted in this model as it is assumed that the three phases are balanced, i.e. there is no neutral current and therefore no heat contribution from the neutral conductor.
3. 2 x150mm conduits buried with 500mm coverage, touching in one row
4. Ambient soil temperature of 25°C, thermal resistivity of 1.2mK/W

*Figure 1: Case 1.1 – 400V AC circuit with two circuits in individual conduits*

| Case | CCC per circuit (AS/NZS 3008.1.1) | CCC per circuit (IEC 60287) | % Difference |
|---|---|---|---|
| **1.1 - AC Circuit** | 498.0 A | 498.3 A | 0.060% |

The results from the two methods support each other with a negligible margin of difference.

**Case 1.2 – DC Circuits (Constant Load)**

Next, we keep all elements of the design consistent, but change the circuit voltage to 1000V (+ve to -ve) DC, with two current-carrying cables per circuit.

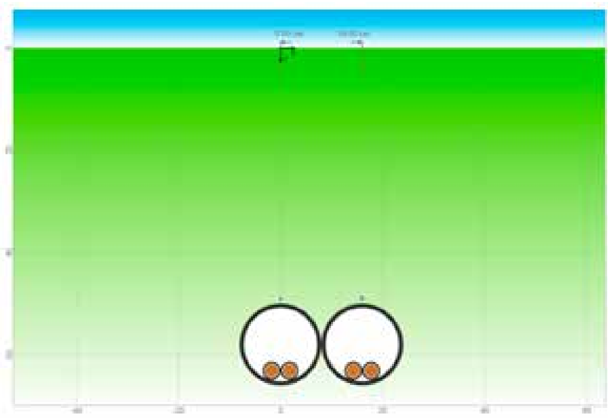


*Figure 2: Case 1.2 – 1000V DC circuit with two cables in individual conduits*

Using AS/NZS 3008.1.1, we refer to the tables for two single-core cables, rather than three single-core as in Case 1.1. Note however that as AS/NZS 3008.1.1 applies specifically to AC circuits, the CCC produced by this method is applicable, but still not entirely accurate for solar DC circuits, and we now expect some deviation in the calculated results. Watch this space, however, as future releases of the AS/NZS 3008.1 series may soon include the CCC for DC circuits to account for the difference in operational characteristics compared to AC cables.

| Case | AC CCC per circuit (AS/NZS 3008.1.1) | DC CCC per circuit (IEC 60287) | % Difference |
|---|---|---|---|
| 1.2 - DC Circuit (continuous load) | 584.0 A | 619.6 A | 6.10% |

The IEC 60287 calculations permit a higher CCC (for DC circuits) for this configuration. This can be attributed to the phenomena of the skin effect and the proximity effect, which both increase the AC resistance of a conductor but have no effect on DC resistance. (You can read more on the theory of these and other derating phenomena in our technical article here: https://www.gses.com.au/why-do-we-need-to-derate-electrical-cables/)

**Case 1.3 – DC Circuits (Cyclic Load)**

The tabulated values in AS/NZS 3008.1.1 are based on the continuous operation of the circuit at the design current (i.e. full load). This is an appropriate assumption when the load profile of a circuit is highly variable or unknown. When considering solar PV circuits, however, the load current follows a highly consistent and predictable daily generation profile throughout the year, wherein the cables are loaded for a significantly lower proportion of time.

***Calculation of Daily Loss Factor (IEC 60853)***

The Daily Loss Factor (represented by the symbol μ) describes the ratio of the average current of a circuit (can be either consumed or produced) in an hourly interval to the maximum current within a given day, and can be defined with the following formula:

$$Daily\ Loss\ Factor\ (\mu) = \sum_{i=1}^{i=24} \frac{I_i^{\,2}}{I_{max}^{\,2}} \times \frac{1}{24}$$

- $I_i$ = average current within the hourly time interval (i) of a given day, in A
- $I_{max}$ = maximum instantaneous current reached within said day, in A

Provided the hourly interval data for a specific solar generator (this can be simulated from software such as PVsyst), it is possible to calculate the loss factor for every day in a year and use the 24hr period with the highest value of μ as a representative. The example graph below compares a simulated PV system load profile (μ = 0.28) with a sinusoidal load profile (μ = 0.40) and a continuous load profile (μ = 1). The daily loss factor for a PV system will typically fall between 0.2 and 0.38, depending on the location, type of installation (fixed or tracking) and time of year. The Cableizer software package allows for a minimum loss factor of 0.4, so this value will be used for our analysis.

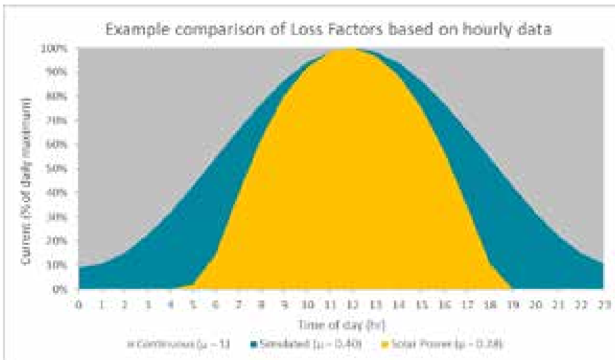



*Figure 3: Example of load profiles with varying daily operating capacity, where the load profile of Case 1.3 is represented in blue*

| Case | Continuous AC CCC per circuit (AS/NZS 3008.1.1) | Cyclic DC CCC per circuit (IEC 60287 and IEC 60853) | % Difference |
|---|---|---|---|
| 1.3 - DC Circuit (Cyclic Load, *μ* = 0.4) | 584.0 A | 793.5 A | 35.87% |

When the loss factor of 0.4 is applied we can see that the simulation calculates a further 29% increase in the CCC of the cables, for a total 35% increase over the AS/NZS 3008.1.1 value. This is a result of the PV system circuits being underloaded for a large fraction of the day, enabling the cable environment to cool down periodically and thus allowing a higher current to flow through the circuit than when compared to a continuous load.

**2. Tiered trench designs**

Like the current carrying capacities, the derating methods presented in AS/NZS 3008.1.1 have been developed to cover the most prevalent trench configurations, but notably do not cover multi-tiered trenches (per Section 1.3 (c) of the standard). Multi-tiered trenches may become desirable in cases where physical constraints (e.g. a small or densely occupied site, or equipment specifications) cannot accommodate an increasingly wide trench of cables in a single row (or "tier"). As soon as conduits are arranged in two or more tiers, these inputs begin to deviate significantly from the inputs in AS/NZS 3008.1.1, thus it becomes necessary to use alternate standards or calculation methods to accurately determine the CCC of the circuit/s.

The following example compares the CCC of a circuit as determined by IEC 60287 with the CCC as determined through **inappropriate application** of AS/NZS 3008.1.1, to highlight the importance of using the correct inputs. Both methods allow the conductor temperature to reach a maximum of 90°C for X-90 insulation, in accordance with the limits specified in AS/NZS 3008.1.1.

The modelled trench is defined as follows:

1. 400V (ph-ph) AC
2. Continuous full load (μ = 1)
3. 3x1C/ph 400mm² Cu X-90 cables, then 6x1C/ph 400mm² Cu X-90, using one circuit per conduit in both cases.
4. 3x100mm conduits buried at 500mm, then 6x100mm conduits (two tiers) buried at 500mm (same depth of cover in both cases).

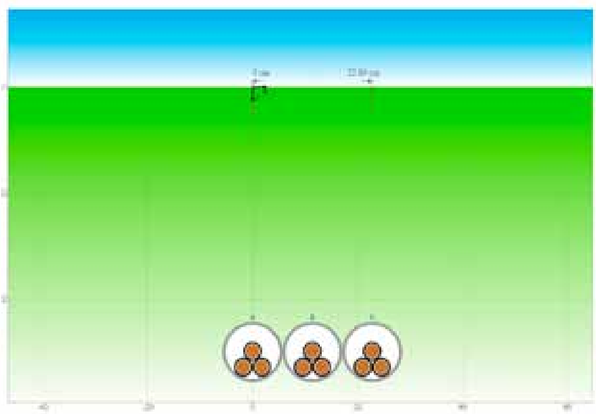


*Figure 4: Case 2a – 3 circuits in one tier*

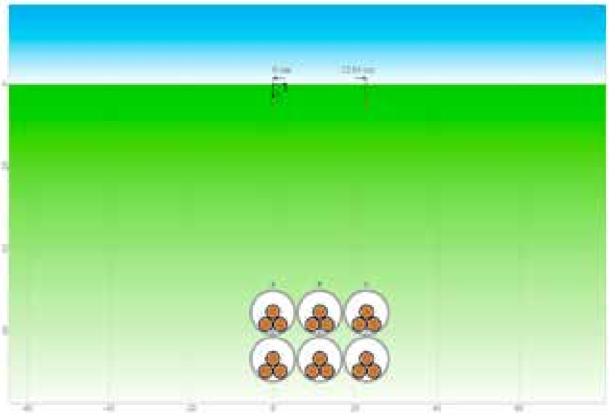


*Figure 5: Case 2b – 6 circuits in two tiers*

| Case | CCC per circuit (AS/NZS 3008.1.1) | CCC per circuit (IEC 60287) | % Decrease |
|---|---|---|---|
| **2a - 3 circuits in one tier** | 450.0 A | 432.9 A | 3.800% |

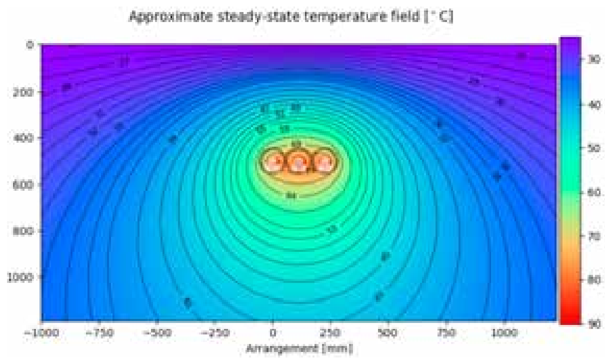



*Figure 6: Case 2a – 3 circuits in one tier (thermal heat map simulation)*

| | | | |
|---|---|---|---|
| **2b - 6 circuits in two tiers** | 396.0 A*1 | 336.4 A | 15.05% |

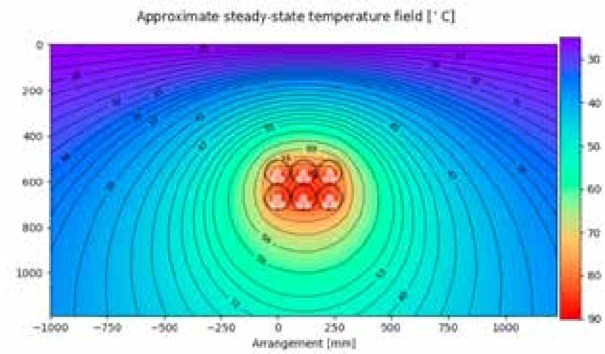



*Figure 7: Case 2b – 6 circuits in two tiers (thermal heat map simulation)*

**1 AS/NZS 3008.1.1 result for two-tiered trench derived by improperly treating trench as a single row of conduits buried at the depth of the deepest conduit in the two-tiered trench.*

The results show that despite a fairly high degree of agreeance for the single tiered trench, AS/NZS 3008.1.1 significantly overstates the CCC of the circuit if inappropriately applied to a two-tiered trench. If designed to carry 396A, the cables in the two-tiered trench would be at risk of overheating, potentially resulting in fire and/or damage to the cables and connected equipment. As AS/NZS 3008.1.1 uses specific assumptions that limit the application of the derating factors for underground cables laid in tier formation, a large variation in results is observed. This is why it is critical to understand how to apply the standard and where alternative standards or calculation methods like IEC 60287 should be used to ensure safe loading of the cables.

### 3. Minimum clearances between trenches to avoid mutual derating

Certain installations will require that multiple circuits be installed underground in close proximity to each other, sometimes running in parallel for short sections or crossing over each other. This is particularly relevant where large, centralised equipment is involved, for example central inverters with multiple DC combiner box inputs, or main switchboards with multiple incoming and/or outgoing circuits.

Where site constraints and equipment specifications allow, it is generally best practice to avoid or minimise derating between circuits in order to keep component costs down. This can be achieved by spacing trenches out to reduce their mutual thermal derating effects. AS/NZS 3008.1.1 stipulates that the minimum clearance between conduits that will avoid mutual derating is 2m. The following two test cases examine the extent to which this rule can be applied depending on the complexity of a trench design.

#### Case 3.1 – Simple Trench

In the first case, we will look at a single buried circuit as defined below; first completely isolated and then spaced at 2m clearance from an identical circuit. The CCC of the circuit in both cases will be compared.

1. 1000V (+ve to -ve) DC
2. 2x1C 300mm² Al X-90 cables per circuit (one circuit per conduit)
3. Load Factor = 0.5
4. 100mm conduits buried with 500mm coverage

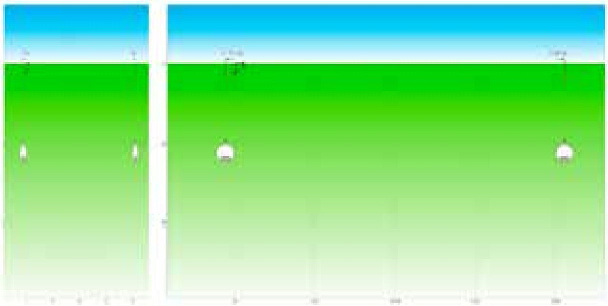


*Figure 8: Case 3.1 – 1 circuit in trench (left), 2 circuits with 2m clearance (right)*

| Case | CCC – 1x circuit (IEC 60287) | CCC – 2x circuit (IEC 60287) | % Decrease |
|---|---|---|---|
| 3.1 - Simple Trench | 532.1 A | 530.0 A | 0.395% |

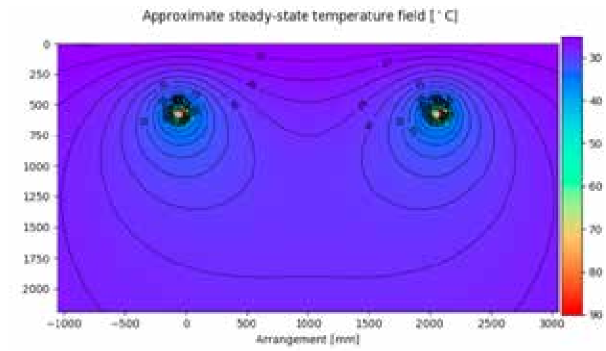



*Figure 9: Case 3.1 – 2 circuits with 2m clearance (thermal heat map simulation)*

The results show that with two simple trenches composed of a single conduit each, spaced at 2m, the mutual effect on thermal derating between trenches is indeed negligible.

#### Case 3.2 – Tiered Trench

In the next case, we will repeat the experiment above but with a trench composed of 6 conduits, arranged in two rows of three. Each individual conduit will be defined identically to each conduit in Case 3.1.

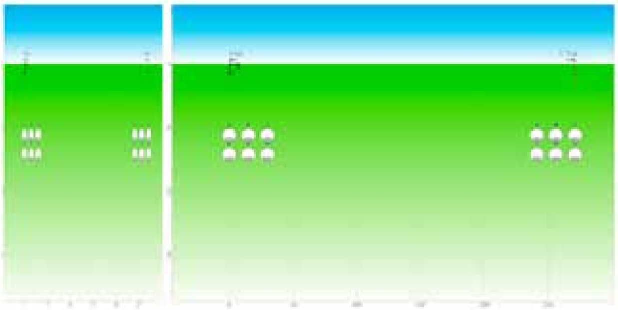


*Figure 10: Case 3.2 – 6 circuits in two tiers (left), 12 circuits in two tiers with 2m spacing (right)*

| Case | CCC - 6 circuit (IEC 60287) | CCC - 12 circuit (IEC 60287) | % Decrease |
|---|---|---|---|
| **3.2 - Tiered Trench** | 399.0 A | 391.9 A | 1.779% |

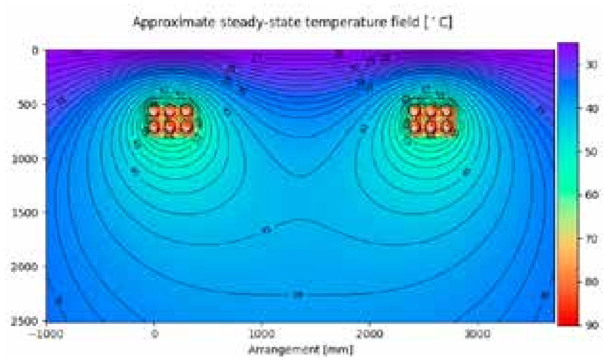



*Figure 11: Case 3.2 – 12 circuits in two tiers with 2m spacing (thermal heat map simulation)*

Although the impact to the CCC per circuit when the second trench is introduced is relatively small, there is still an increase in derating when compared to Case 3.1. As each trench becomes larger (i.e. more and more conduits get incorporated into each), the 2m clearance between the trenches gets smaller relative to the effective size of the trenches. As this continues, we can expect the CCC to continue decreasing to a non-negligible degree. It is recommended that a project-specific trench design verification be undertaken for all grouped trenches to ensure the effects of mutual thermal derating are within the limits of the components being used.

## 4. Verification of negligible derating for cables where $I_B$ < 35% of $I_Z$

In cases where the design current of a circuit is significantly lower (<35%) than the sustained CCC of the cable, AS/NZS 3008.1.1 does not require that the circuit's CCC be derated due to grouping or bunching, but still requires derating due to environmental conditions such as ambient temperature (clause 3.5.2.2 (d) of the standard). Often this will be applicable in DC string circuits, where a typical module lead or string cable size of 4-6mm² has a CCC much higher than the typical string current of ~10A. However, remember that Iz is still the current rating of the cable in the relevant type of installation (e.g. in air, enclosed etc.), and that other derating factors such as ambient temperature and depth of bury still need to be considered.

Based on a common test case below, we will use IEC 60287 calculations to assess the maximum temperature reached by underground trenches composed of various quantities of adjacent lightly-loaded circuits. The modelled circuit is:

1. 1000V (+ve to -ve) DC
2. 2x1C 6mm² Cu X-90 cables per circuit (two circuits per conduit)
3. 10A per cable/circuit, continuous load (μ = 1)
4. 50mm conduits buried with 500mm coverage, touching in different configurations

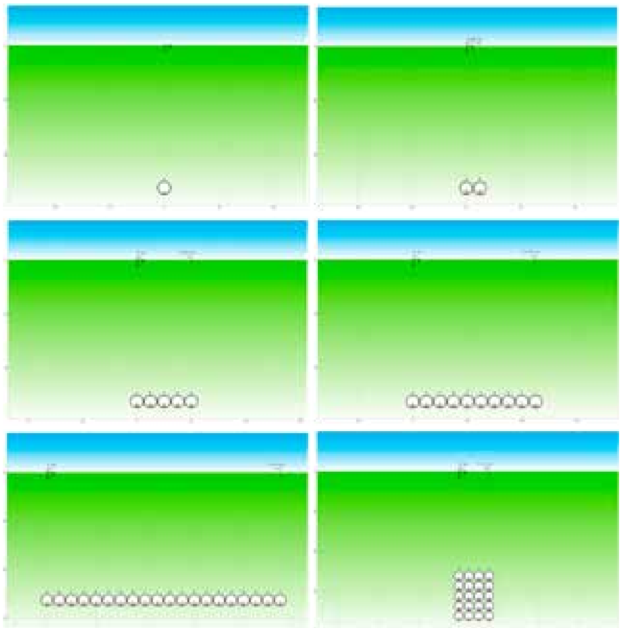


*Figure 12: Case 4.1 – Trench with 1x circuit(top left), Case 4.2 – 4x circuits(top right), Case 4.3 – 10x circuits (middle left), Case 4.4 – 20x circuits (middle right), Case 4.5 – 40x circuits (bottom left), and Case 4.6 – 40x circuits arranged in five rows of eight (bottom right)..*

| Case | Max Cable Temp (IEC 60287) | % Increase | % of Max Allowable Temp |
|---|---|---|---|
| **4.1 - 1x circuit** | 26.4°C | 0% | 29.33% |
| **4.2 - 4x circuits** | 28.5°C | 8% | 31.67% |
| **4.3 - 10x circuits** | 30.6°C | 16% | 34.00% |
| **4.4 - 20x circuits** | 33.0°C | 25% | 36.67% |
| **4.5 - 40x circuits** | 36.1°C | 37% | 40.11% |
| **4.6 - 40x circuits (five rows)** | 42.0°C | 59% | 46.67% |

Even in the most extreme case (4.6), where the conduits are bunched in an arrangement with the minimum effective surface area, the highest temperature attained by any cable is still less than half of the maximum allowable. While the mutual thermal derating effect is not negligible, it has been demonstrated that for most conceivable quantities of lightly loaded cables the maximum temperature reached is well below the cable's limit. Linear extrapolation indicates that under the conditions used in this particular example, the maximum sheath temperature of 90°C will not be reached until the number of adjacent circuits (laid flat in one row) is over 250. However, note that this number would be lower if the cables were installed in a common wiring enclosure and the numbers in this article should not be relied upon for verification purposes.

**Conclusion**

For the safe, efficient and reliable operation of electrical cables and the equipment they service, it is essential to verify that they are rated for the currents that they are designed to carry. AS/NZS 3008.1.1 offers a convenient, easily applicable and reliable method for calculating the current carrying capacity of buried cables in simple configurations within the assumptions of the standard, but more specialised methods are recommended for DC and intermittently loaded circuits that require the use of specific inputs based on cable installation methods, and are required for more complex trench designs that are not covered in the scope of AS/NZS 3008.1.1. The Cableizer software package utilises IEC 60287 calculations to verify the suitability of these circuits and trench designs, providing the most economically efficient solution while ensuring safety and reliability of the electrical system.

GSES offers detailed cable sizing and derating analysis tailored specifically to our clients' needs and those of their site. If you would like to find out more about the services GSES can offer please contact our design team on design@gses.com.au.

# Make The Workmanship Surpass The Materials

Goran Stojadinovic, MCE, Meng, (EI)
Product and Innovation Manager – TransNet NZ Limited

## Workmanship

- **Workmanship** is about quality; good or bad
- Unskilled workers, unsuitable equipment and materials, and lack of supervision or project management are just a few things that can lead to poor workmanship
- **Workmanship** in the Electricity Industry is the skill and quality put into installing hardware and maintaining network
- **Workmanship** defects typically result from the workman's/ contractor's failure to follow the Network Standards, or the Best Industry Practices, or the Manufacturer's Installation Instructions


## Learning from forensic investigations of cable failures

**EA Technology (UK)** has conducted multiple forensic investigations and analyses of MV extruded cable failures. They included failures in the terminations, joints, connectors, and mid-cable failures.
Key findings:

- 66% of all failures are caused by bad workmanship!
- 11% of all failures are caused by the poor quality of cable accessories!
- Therefore - 77% of all failures (or more) are preventable!
- Most failures occurred in the terminations, joints, and connectors (only 5% in cables)

Reference:
*"Review of Medium-Voltage Asset Failure Investigations" by W. & K. Higinbotham (EA Technology LLC & University of Connecticut); presented at POWERTEST Conference 26/02/2018 (hosted by NETA)*

**Medium voltage extruded cable failures Ultimate Cause**

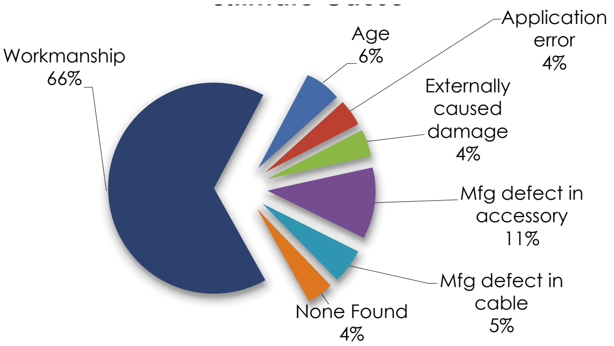



*Figure 9 from the "Review of Medium-Voltage Asset Failure Investigations" by W. & K. Higinbotham (EA Technology LLC and University of Connecticut); POWERTEST Conference 26/02/2018 (hosted by NETA)*

### Learning from the author's experience with the acoustic inspection of cable terminations across Australasia

The Author has many years of experience with the Ultrasonic inspections of OH networks in New Zealand, Pacific, and Australia, including the mining industry:

- Inspection of thousands of kilometers of Distribution and Transmission Lines
- Analysis of various failure modes of thousands of defects detected

Key findings regarding the failure modes of cable terminations:

- Most cable termination defects are caused by poor workmanship (approx. 75%)
- Some defects can be attributed to the poor quality of cable termination accessories
- All these defects were leading to the ultimate failure of cable terminations (feeder faults)

Note: The cable termination defects caused by poor workmanship or the poor-quality materials are further exacerbated due to exposure to weather elements.

### The root cause of the problem: Jointer workmanship and manufacturer quality

Workmanship errors and jointing issues were the ultimate cause of failure in most cases:

- Lack of training or low-quality training i.e. 'loose' internal refresher courses do not work
- Errors in jointing due to inexperience, including any sloppy work & lack of care
- Lack of written records (i.e. who, when, where and what), and consequently lack of learning from mistakes, and lack of corrective actions
- Application errors

Manufacturing issues were the second biggest cause of failures:

- Poor quality of jointing accessories Unclear instructions and procedures
- Lack of jointer retraining and competency assessments i.e. lack of verifiable competency
- A lack of effective communication between manufacturers and installers

### Impact of workmanship on SAIDI & SAIFI

'A chain is only as strong as its weakest link'

- Medium voltage cables are an integral part of modern power systems
- They are the backbone cables ('chains') of urban underground networks, often interwoven with overhead lines
- Terminations, joints, and connections are the weakest links in a cable (chain)
- When they fail, they typically have a big impact on SAIDI and SAIFI in both the Underground and Overhead networks
- These faults can also weaken the entire feeder (chain) and can cause so-called 'secondary faults' (upstream)
- The costs of cable failures can be extremely high
- The impact on the environment is also very high

**Further to SAIDI & SAIFI losses, there are more negative effects of preventable cable failures**

Network owners are often left in the dark.
Typically, they do not know:
- The type of cable jointing product installed When it was installed
- Who installed it
- Where it's installed (GPS)

Consequently:
- It is hard to enforce the Contractor's/Installer's defect liability period (DLP)
- Can't claim the manufacturer's extended warranty (i.e. TE offer 20yrs on Raychem*)
- Can't apply & claim the accelerated asset depreciation method, and therefore can't reduce the taxable income
- Increased insurance costs

**Solution – Quality product, capable Staff**
- Address the ultimate cause of jointer training, and most of the workmanship issues and potential failures will be minimized or eliminated
- Install the best quality and well-proven cable jointing accessories, and most of the remaining manufacturer quality issues will be addressed
- TransNet offer trusted quality brands such as Raychem, Utilux and AMP to ensure network reliability
- Raychem Cable Accessory kits have been designed and type tested as a complete solution to offer a long service life
- Raychem, part of TE Connectivity incorporates other quality TE branded products in their cable accessory kitsets offering full traceability to source, for all components
- Take advantage of extended manufacturer warranty and secure peace of mind about the preventable cable/feeder failures
- Record the installation details - where, when, who, what. This is easily achieved with the Raychem CIC and installer app (contact TransNet for details)
- Raychem CIC and installer app enable TE to offer a 20yr extended warranty on Raychem MV cable accessories logged on the app

**Way forward - A systemic and disciplined approach**

Network Owners, Contractors, and Suppliers/Manufacturers need to work together to prevent further failures of weak links:
- Introduce proper training and certification - TransNet with supply partner TE, offer this through the Raychem CIC programme
- Use only well known, trusted and proven, high quality brands
- Reiterate the consequences of incorrect installations
- Restore the Network Owners confidence in Contractors'/Installers' ability to install hardware properly
- Restore the Contractors/Installers self-confidence in their ability to install hardware properly (i.e. no improvisations anymore)

**Just ask yourself**

As a network owner would you like to know in advance:
- The type of cable jointing product installed?
- When it was installed?
- Who installed it?
- Where it was installed?
    1. Basically – would you like to have an extended product warranty?
    2. Would you like to be able to depreciate assets faster and claim tax benefits?
    3. Would you like to reduce the insurance costs?

As a Contractor/Installer – would you like to:
- Know Who, When, What, and Where your jointer(s) installed a product?
- Have a written work history?
- Become a "Qualified Provider/Installer of Choice" for your Customer?

**If the answer is 'YES', then TransNet will provide a solution for you – for free!**

# As/Nzs 4777.2 2020 Updates - What You Need To Know

GSES Technical Team
Global Sustainable Energy Solutions, Australia

## Introduction

The 2020 updates to the inverter Standard AS/NZS 4777.2 *Grid connection of energy systems via inverters, Part 2: Inverter Requirements* is now available.

If you're a solar professional, you're probably already familiar with the 2015 version of the Standard. But in December 2020, it was updated to reflect changing conditions in the industry.

To save you some effort, we've gone through the updates ourselves and made a list of the key changes. This should give you an idea of how they might affect you or your business, and ideally minimise any risk involved with transitioning to the updated version.

*The updated version of the Standard can be purchased from* Standards Australia *or* SAI Global.

*Also note that this is a product standard, meaning that by December 2021, all new inverters in Australia and New Zealand will need to be certified to AS/NZS 4777.2:2020.*

## What's New in 4777.2 2020?

To begin with, the updated standard is much longer than the previous version. It's now 143 pages, rather than 81. On top of the new page count, several old clauses have been rewritten or restructured, meaning the standard has changed significantly.

But why are these changes necessary? In short, the revised Standard aims to address a few key issues, which were not adequately addressed in the previous version:

- Grid security concerns, specifically related to increased penetration of solar PV systems
- Grid connection requirements
- Inverter testing and test templates
- Energy storage
- Standalone power systems
- Electric vehicles
- Quality of life improvements

The changes largely affect inverter manufacturers, as well as PV designers and installers in the commercial and industrial (C&I) space. However, it also has implications for connection application managers, battery inverter and electric vehicle (EV) manufacturers, and those working on residential systems.

### 1. Grid Security/Power Quality

*Likely to affect: Inverter manufacturers, PV installers and designers (C&I), connection application managers, distribution network service providers (DNSPs)*

The main goal of AS/NZS4777.2:2020 is to address grid security and power quality concerns. As nationwide solar capacity increases, network operators will struggle to keep grids stable. To address this, new requirements have been introduced for the power quality response modes and passive anti-islanding requirements of inverters.

Specifically, setpoints for the following have been updated:

- Volt-Var response mode (Clause 3.3.2)
- Volt-Watt response mode (Clause 3.3.2)
- Passive anti-islanding voltage limits (Clause 4.4)
- Passive anti-islanding frequency limits (Clause 4.4)
- Sustained operation limits for voltage variations (Clause 4.5.2)
- Sustained operation limits for frequency variations (Clause 4.5.3)

These changes have been introduced for two main reasons:

1. To provide a staggered response to transmission-level events, so that inverter systems can stay connected to the grid in these cases.
2. To adequately protect distribution networks from islanding.

These values are commonly referenced during C&I network applications, meaning that setpoints listed in these applications will need to satisfy the values in AS/NZS 4777.2:2020 as a minimum. Anyone managing connection applications will need to be aware of the updated values to minimise disruptions to the application process.

Additionally, all new inverters installed in Australia and New Zealand from December 2021 will need to be capable of operating per these updated setpoints. This responsibility will fall to inverter manufacturers, who will need to ensure that their inverters comply with the updated Standard prior to the transition date. There is a chance that some inverters will become non- compliant if they cannot operate according to these setpoints, meaning they could not be legally installed in Australia or New Zealand until compliance is demonstrated. PV designers and installers will need to keep this in mind as the transition date approaches, and check that all inverters specified in their systems will be compliant at the date of installation. The easiest method for doing so will be via the CEC's Approved Inverters list, which will be updated once AS/NZS 4777.2:2020 comes into full effect.

The way specific setpoints are described has also been updated. Setpoints are now defined by region of installation, as per the following categories:

- **Australia A:** For large interconnected power systems, e.g. the National Energy Market (NEM).
- **Australia B:** For small interconnected power systems, e.g. the South West Interconnected System (SWIS) in Western Australia.
- **Australia C:** For isolated or remote power systems (e.g. Horizon Power in Western Australia).
- **New Zealand:** All systems in New Zealand.

Referring back to network applications, this means that there may be different setpoints required for different projects (depending on the locations of each). As the Standard does not explicitly define the difference between large and small interconnected systems, network operators (DNSPs) will ultimately decide which regions their networks fall under. As such, following the transition to AS/NZS 4777.2:2020, DNSP documentation (i.e. the connection agreement) should be checked to confirm the preferred setpoints for each network. It is strongly recommended that system designers and connection application managers make themselves aware of all setpoint requirements prior to December 2021.

**2. Changes to Energy Storage, Standalone Systems, and Electric Vehicles in 4777.2:2020**
*Likely to affect: PV/battery designers and installers (all); Battery inverter and EV manufacturers*

Significant effort has gone into future-proofing this standard, with dozens of new references to energy storage, standalone systems, and electric vehicles being introduced.

The authors have gone to significant effort to clarify that this standard applies to electric vehicles when exporting energy to the grid. The Standard's definitions and references (Clauses 1.4 and 1.3 respectively) have been updated to accommodate this. Additionally, Clauses 2.3.1 and 2.3.3.2 now specify requirements around external connections for EVs (which will largely be an issue for EV system manufacturers and installers to address). These changes are likely to play a significant role in the future, as EVs become more prominent. PV/battery system designers will also need to be aware of the new requirements, as they may impact system design requirements in the future.

There are also a number of new requirements around energy storage and standalone power systems (SAPS). One of the most significant of these is Section 2.4.2, which introduces new requirements for earth fault alarms on multimode inverters. According to this new clause,
*"Where an inverter has a port for connecting a battery system installation that requires an alarm for monitoring of earth faults in conformance to AS/NZS 5139, the inverter should provide an alarm. Where no alarm is provided in the inverter, the inverter documentation shall require the addition of an external alarm and monitoring device."* This clause will have implications for multimode/battery inverter manufacturers and installers. Installers of these inverters should be aware of any fault alarm

capabilities of the inverters they're installing, as they will need to install an external alarm and monitoring device if not.

### 3. Export/Generation Limitation

*Likely to affect: PV designers and installers (all), connection application managers, distribution network service providers (DNSPs)*

There are now formal definitions around generation and export limits of inverters. Both soft and hard limits are defined, and requirements for both are explored throughout the Standard.

This is another concept that was already common in grid-connected projects, but was not formally defined in the Standard until now. This change is likely to have implications for systems with limits on export or generation, as these systems will now need to comply with the requirements introduced in Clauses 6.2 and 6.3 as a minimum.

For generation limit control (Clause 6.2), inverters will need to shut down within:

- 15 seconds if the soft limit is exceeded, OR
- 5 seconds if the hard limit is exceeded for at least 15 seconds continuously

For export limit control (Clause 6.3), inverters will need to shut down within:

1. 15 seconds if the soft limit exceeded, OR
2. 5 seconds if the hard limit is exceeded

These changes are likely to have a broad impact on the industry, as export limits on PV systems are becoming increasingly common. However, similar limits were already imposed on most generation and export-limited systems, so these updated definitions are likely to have limited effect. These are most likely to affect system designers and installers, as well as DNSPs and connection application managers. However, potential issues associated with these changes can be addressed by noting the requirements discussed above.

### 4. Installation and Documentation

*Likely to affect: Inverter manufacturers*

The new updates to AS4777.2 introduce new requirements around inverter marking and documentation. Many of these (e.g. marking requirements in Table 7.1) are minor, and reflect this standard's new emphasis on grid stability and energy storage. One major note is that several new ratings are required for inverters containing isolating devices, as per Clause 7.3.3. These will need to be addressed by inverter manufacturers, and could potentially cause inverters to become non-compliant if documentation is not updated to include these ratings.

There are also new requirements around firmware documentation in Clause 7.3.8, which states: *"The documentation shall provide instructions for viewing of the inverter firmware version and the selected regional settings and any variations to the default inverter settings in read-only mode. This is to prevent unauthorized modification of inverter settings.*

*Documentation on the initial configuration and selection of regional settings and other settings at commissioning shall be provided to authorized persons.*

*Restricted information on accessing and changing the regional settings, other settings and firmware after initial configuration shall be provided to authorized persons only."*

This will all need to be considered by inverter manufacturers installers, as all relevant details will need to be supplied with the inverter itself.

### 5. General

*Likely to affect: PV designers, inverter manufacturers, connection application managers*

Some changes will have ongoing implications for PV systems, but don't fall into the categories listed above. Below are some of the more interesting ones. Note that these are not likely to have significant impacts, but it is still valuable to be aware of them.

1. As per Clause 5.2, current imbalance on multiphase systems can now exceed 5kVA (21.7A) per phase for up to 15 seconds. This is only a minor change from the previous version of this requirement (which didn't have the 15-second limit). However, it may still have some implications during system design.
2. As per Clause 2.6, all inverters will need to be able to absorb or supply reactive power in line with power quality response modes (e.g. volt-var, volt-watt). This will need to be addressed by inverter manufacturers prior to the transition to the new version of the Standard.
3. In addition to the modification of existing settings, Rate Of Change Of Frequency (ROCOF) is now explicitly defined in AS/NZS 4777.2:2020 (Clause 4.5.6). This was a common restriction imposed by DNSPs during network applications, but until now has not been defined in the Standard itself. Now, the withstand limit for ROCOF is limited to ±4Hz/s over a duration of 0.25s. This means that inverters will respond to network conditions at or above this value. This must be considered by system designers and those managing network connection applications. Additionally, further limits may be imposed by DNSPs to ensure network stability.

### Conclusion

The 2020 update to AS/NZS 4777.2 is significant, and will become mandatory in December 2021. It should ensure that during peak generation periods from solar PV systems and other distributed energy resources (DERs), DERs will help to manage grid events instead of exacerbating them. However, with increased requirements on inverters, PV industry professionals must become familiar with the new version of the standard, to minimise the impact of the transition to AS/NZS 4777.2:2020.

In particular, the following groups are likely to be the most affected by the updates to the Standard:

- **Inverter manufacturers.** Inverter manufacturers are likely to be the most affected by the changes to AS/NZS4777.2. They will need to ensure that all inverters comply with all new power quality response mode and anti-islanding settings. They will be affected by updated requirements around energy storage. And they will need to update system documentation to meet all new requirements.
- **PV/battery designers and installers.** PV installers will be affected by similar issues as inverter manufacturers, but without significantly being affected by updated inverter documentation.
- **Connection application managers.** Will be affected in largely the same way as PV/battery designers.
- **Network operators (DNSPs).** Will need to be aware of new requirements, and will need to dictate their network type as per categories Australia A, Australia B, etc.

# New Generation Of Swer-Line Reclosers Reduces Outages For Rural New Zealand Customers

S&C Electric Company

Customer Challenge

PowerNet Limited is the fourth-largest investor-owned utility in New Zealand based on the regulatory value of the network it manages. Serving more than 70,000 customers, the company operates at the southernmost tip of the South Island. Its electrical grid consists of a wide range of medium-voltage distribution equipment, including one of the country's largest single-wire earth return (SWER) networks.

These lines were originally designed in New Zealand nearly a century ago as a cost-effective way to bring electricity to rural communities. Because of its simple construction and low cost compared to two- or three-phase systems, the design is still preferred across parts of New Zealand and Australia for rural power distribution.

PowerNet, like many other utilities, had been using hydraulic reclosers for protection and fault testing along its SWER lines. However, because of their age, the vast majority of hydraulic reclosers were disabled to avoid potential catastrophic failures. This led to higher O&M costs for these lines and, critical to the community, more customers experiencing frequent outages.

Because hydraulic reclosers rely on oil and relatively complex mechanical parts to operate, those that were still in use required frequent maintenance and lengthy repairs. When significant repairs were needed, procuring parts became more difficult and expensive, forcing PowerNet to use spare parts from backup inventory and refurbished units. That added to the overall operation costs because backup inventory of reclosers was also needed to cover emergency replacements when units failed in the field. PowerNet decided to reexamine its protection strategy.

*"S&C's TripSaver II reclosers are projected to save us 10 call outs per week, resulting in a significant reduction in O&M costs versus conventional hydraulic reclosers. More importantly, it means improved reliability for our customers located in the most remote areas of our system."*
*– Jacques Vergottini*
*Project Manager, PowerNet Limited*

S&C Solution

PowerNet explored alternatives similar to hydraulic reclosers that required less maintenance, could reclose up to four times, reduce inventory requirements, and ultimately decrease the number of outages—while also maintaining the same protection operation characteristics found in hydraulic devices.

The utility was first introduced to S&C's TripSaver II Cutout-Mounted Recloser at a conference for electricity engineers in New Zealand. At the event, S&C conducted a live demonstration followed by face-to- face visits highlighting the benefits of a TripSaver II recloser pilot. PowerNet believed the device's biggest selling points were its easy installation and minimal maintenance requirements throughout its service life.

PowerNet saw how the TripSaver II reclosers' adaptability and configuration options also provided several benefits over other SWER-line protection options. Unlike hydraulic reclosers, which are fixed mechanical devices, TripSaver II reclosers are user-configured and contain a microprocessor-based relay that gives utilities exact TCC curves and improved coordination capabilities, including fuse-saving features. The reclosers' smart capabilities also log data for PowerNet, allowing the utility to better analyse events and optimise its system. Using the TripSaver II reclosers also meant PowerNet could reduce inventory costs, trim annual maintenance expenses, and allow crews to avoid multi-hour road trips for outages.

Recognising how the TripSaver II reclosers could improve reliability in its most remote locations, PowerNet moved forward with an initial trial of six reclosers. S&C supported PowerNet with complete training for both the engineering team and operation crews to ensure familiarity and comfort in deploying the devices. Throughout the trial period, S&C provided ongoing support, data collection, and a review during the midpoint of the pilot.

Results

PowerNet was thrilled with the initial success of the project and decided to increase the number of devices deployed on its power grid. The expanded trial, composed of roughly two-dozen units, has already saved the utility a total of 121 call outs. By successfully keeping temporary faults from becoming permanent outages, the TripSaver II reclosers saved an average of eight call outs per unit per year, providing PowerNet a swift return on investment.

The clear benefits led PowerNet to expand the pilot to a deployment of 65 TripSaver II reclosers across all SWER lines in the next few years. When the devices are fully deployed, PowerNet expects they will save approximately 520 call outs annually, or more than 1,000 crew hours per year on avoided fault-management tasks. That translates to roughly 10 avoided call outs per week for PowerNet and a significant reduction in the utility's O&M costs versus conventional hydraulic reclosers.

# Application Brief: Solar Powering The "Digital Oilfield"

Mark Cerasuolo
Marketing Director - Morning Star Corp.

*Solar-powered Remote Terminal Unit (RTU) at a pumping site using a Morningstar HazLoc-rated SunKeeper controller. Courtesy of SunWize*

**What exactly is meant by the "Digital Oilfield?"**

From its origins in the early 1970s when the first pressure/temperature gauges were fitted into subsea wells and data logging via satellite began, the "Digital Oilfield" concept has evolved from simple data gathering activity to the automation, control, and optimization of nearly every process involved upstream (exploration, development, and production) and midstream (transport and storage). Initially adopted for offshore, deep-water facilities where the extremely remote and hazardous nature of operations made automation an asset, Digital Oilfield technology is expanding rapidly into all facets of on-shore operations.

New technologies have transformed the concept from simple data acquisition and monitoring to a fully-digitized management system, one that frees-up valuable engineering resources for analysis, planning and implementation activities rather than reading screens and watching gauges. Key elements of a Digital Oilfield today include (but are not limited to):

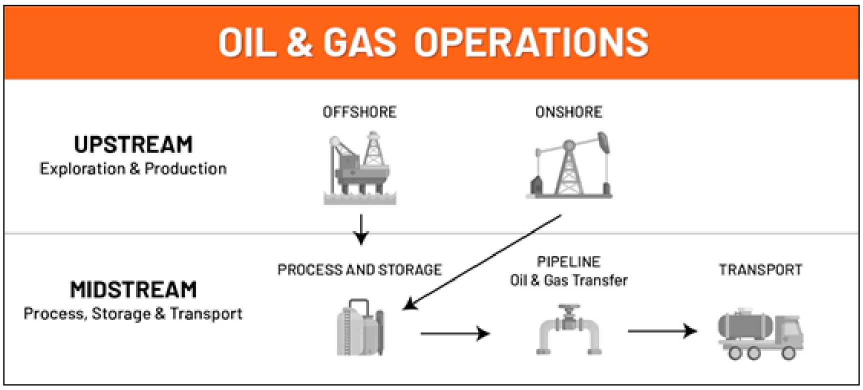
- Data management
- Process automation
- Drilling and production optimization
- Control and monitoring
- Sensors and instrumentation
- Pipeline integrity, including cathodic protection
- Robotic drilling and "smart wells"
- Security
- Lighting (fields and platforms)
- Safety management

Of the many definitions of what exactly constitutes a "Digital Oilfield," one of the simplest is "the sensors, telecommunications networks, simulation and optimization, and robotics, coupled with advanced condition monitoring and computational power, which enable major changes to working methods."

**What are its advantages for Oil & Gas operations?**

Those working method changes drive real-world results. Recent industry reports indicate that Digital Oilfield implementation can deliver on the average an 11% bottom line improvement and 7% increase in productivity. One report highlighting a major oil producer as a case study credits Digital Oilfield adoption with saving the company some $200 million in capital operating expense (CAPEX); one example mentioned was reducing the time it took to check pipeline integrity from seven days manually to just 30 minutes using Digital Oilfield automation technology.

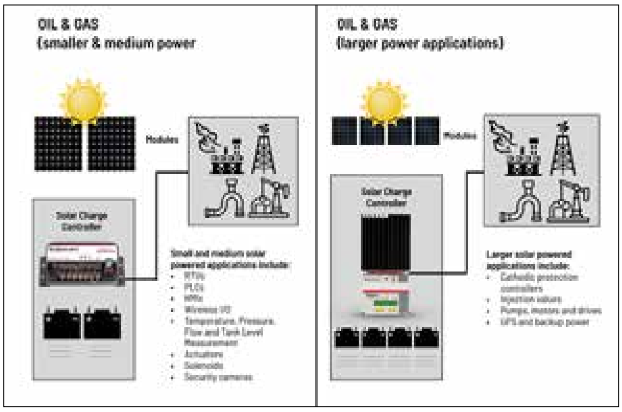
As operators make up for lost time in the post-pandemic environment, they are discovering that the digitization of the oilfield is essential to unleashing productivity by freeing up resources for more productive purposes. As a result, the modern Digital Oilfield represents a direct response to industry demand for increased production and decreased down-time, through process optimization and remote management. All this is why the Digital Oilfield market is expected to reach an estimated $28.5 billion USD over the next five years.




*Above: operational areas where solar electricity is most applicable to Digital Oilfield processes*

### Solar electricity in the Digital Oilfield

Globally there are well over 2 million miles/3.2 million kilometers of oil & gas pipelines, the longest of which stretches over 5,400 miles/8,700 kilometers. The oil & gas extraction sites they support total over 65,000 worldwide, with some 9,000 off-shore. The sheer size and scope of this network means that many operations occur in locations far removed from any electrical grid—yet on-site electricity is needed for every mile of pipeline and at every wellhead and terminal, to provide critical power for the monitoring, control, process automation and production optimization functions that comprise the Digital Oilfield.




*Solar electric system implementation on the Digital Oilfield*

Diesel and gas generators initially provided a solution at extraction sites, but as Digital Oilfield technology expanded across pipeline networks installing, running, and supporting more and more generators became less practical due to two reasons: they require regular maintenance and periodic teardowns which are expensive, and they must be refueled which further increases operating costs (OPEX). A third liability with generators is that, as a source of noise and emissions pollution, their very use compromises any "oilfield greening" initiatives important to operators today. For these reasons operators with remote powering needs have embraced renewable energy for on-site electricity generation, and solar in particular.

Solar's value proposition for the Digital Oilfield stems from the fact that, unlike generators, solar requires no fueling. Equally important, unlike both generators and wind turbines, solar electric systems have no moving parts and therefore no need for costly regular maintenance or "teardowns."

Along with solar's inherently higher reliability and significantly lower OPEX, the CAPEX side can be offset by new, advanced technology batteries for energy storage for 24/7 operation, particularly lithium-iron/phosphate (LiFePo) types which are both safe and, because they can last 10x longer than conventional batteries in off-grid solar systems, can "pencil out" more economically than other battery types over the long term.

*Solar electric array with Morningstar controllers powering oilfield lighting in the desert, for Kuwait Petroleum Corporation. Courtesy EcoSol Energy Systems*

Also, unlike generators and wind turbines, solar is unaffected by environmental extremes. In fact, solar panels or modules actually become more efficient and work better the colder it gets. This can be maximized to great effect in a field installation through advanced charge controlling technology such as Morningstar's TrakStar MPPT (maximum power point tracking) which effectively extracts every possible Watt from a system for running a load for storage for later. Equipped with the right batteries for the application, solar can function equally well under harsh conditions at sea, in deserts, on mountaintops, and even at the poles.

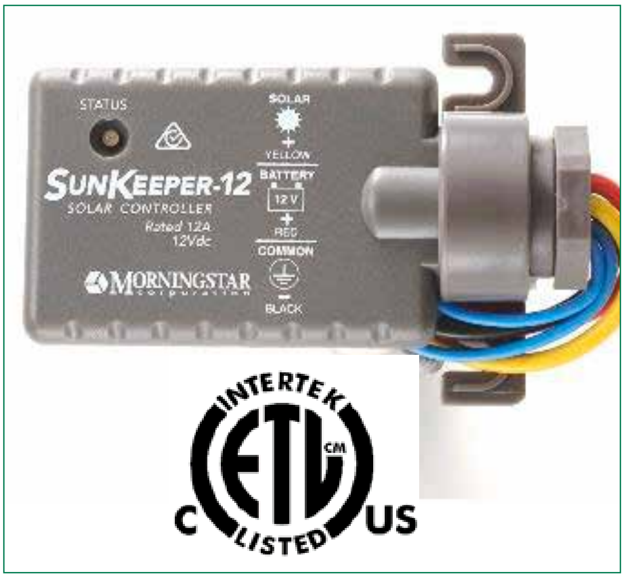
*North Sea platform using solar electricity with Morningstar controllers to power telecom, navigation aid, bird deterrence, foghorn, and other critical systems. Courtesy JCE Energy*

**Using solar electricity to power the Digital Oilfield**
Nearly any off-grid powering scheme can be upgraded to solar electricity. Because the many different Digital Oilfield applications and environments out there mean that there are hundreds of possible system configurations and specifications, the detail, design, and components needed are best discussed with a professional system integrator with solar expertise. The following are a few general guidelines applicable to any industrial off-grid solar electric system equipped with energy storage.

Solar electric system types, like electricity itself, comes in two "flavors:" AC (alternating current) and DC (direct current). Since solar electricity produced by modules or panels is DC, these systems are usually simpler and can be used to power and control DC loads and also charge batteries without the need for any power conversion. If the system to be powered had AC components, an inverter is added to provide DC-AC conversion.

Because the module-produced solar electricity must be controlled and regulated to charge batteries and power loads safely and effectively, the "heart and brain" of an off-grid solar electric powering system is the solar charge controller. Depending on the system design and capacity, solar charge controllers can vary in battery bank voltage from 6V to 48V (depending on the type of batteries) and with solar input power capacities typically ranging from 200W to over 3,000W; for larger systems multiple charge controllers are usually specified.

*Morningstar's line of ProStar™ (upper) and SunSaver™ (lower) solar charge controllers with UL/CSA and IECEx/ATEX Hazardous Location certifications, widely-used in on and off-shore oil & gas operations around the globe.*




*The SunKeeper™ (below) is a small UL/CSA-rated controller used with single-panel systems*

For all the brand and model diversity, charge controllers come in essentially two types:

- PWM (pulse-width modulation): simple and cost-

effective, PWM controllers are basically a switch that "throttles back" solar electricity to prevent battery overcharging. They are ideal for locations with very consistent sunlight, minimal shading, and no physical space limitations. Typical uses are with pole-mounted 36 or 72-cell solar panels which are typical in smaller industrial systems.
- MPPT (maximum power-point tracking): while more costly and complex, they have the advantage of maximizing solar array output in areas where it can widely "swing:" in cold climates where solar modules are actually more efficient, or where shading or inconsistent sunlight affects solar "harvesting." They work by balancing voltage and amperage to find the optimum blend for the panel's output. MPPT controllers are better suited for larger arrays as well as the new PERC (passive emitter) technology higher-output solar cells. Morningstar MPPT controllers have the added advantage of proprietary TrakStar™ technology, based on patented algorithms that enable them to harvest solar energy even more effectively.

MPPT controllers can convert all available solar energy into electricity, while PWM controllers typically "throw away" some of it—but in areas of strong, consistent sunlight that is less of a concern. The point being is that there is no inherent quality difference between PWM and MPPT controller technology. It's simply a matter of which is the right tool for the job. With the solar charge controller doing the heavy "electronic lifting," the rest of the off-grid industrial solar powering system is comprised of usually three elements:

- Solar panels or modules and racking/masting to support them
- Batteries for energy storage. Most commonly used are advanced lead acid (sealed gel or valve-regulated AGM), with both lithium iron-phosphate and nickel-cadmium becoming increasingly popular depending on the application
- An enclosure with suitable breakers, connectors, and possibly additional load-management or communications electronics on board

**Solar in Hazardous Location (HazLoc) applications**

For oil & gas and other uses where hazardous gasses and liquids might be present (such as mines), having the proper certifications for use in hazardous locations is critical. A hazardous area is defined as one where three fundamental components are in place:

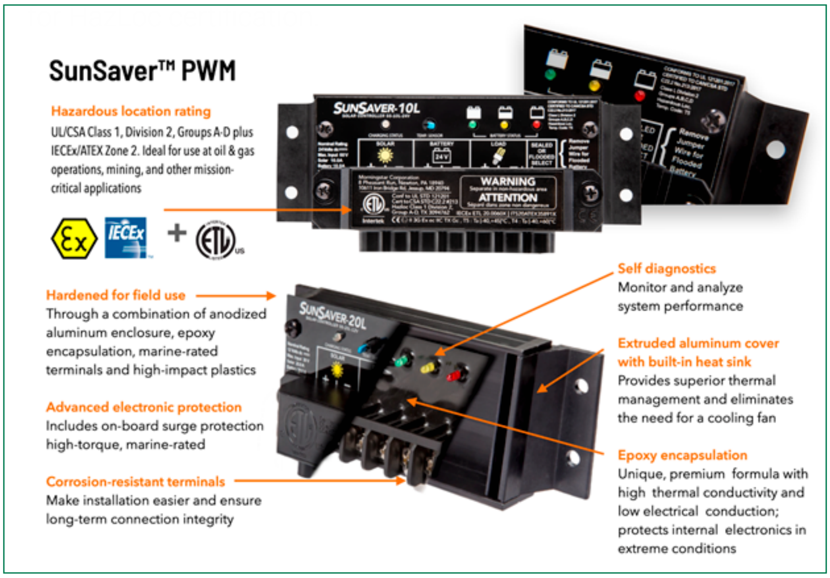
1. A flammable substance:
   a. Gas, vapor, or liquid
   b. Dust
   c. Fibers
2. An ignition source: spark, open flame, excessive heat, etc..
3. An oxidizer: oxygen present in the open air

With that, there are three primary ways to prevent an electronic device from causing an explosion

1. **Explosion-proof:** isolate or protect from an explosion through an explosion proof device or enclosure
2. **Intrinsic safety:** design and build to remove the possibility of a spark or other source of ignition (i.e., by keeping operating temperature low)
3. **Isolate the explosive substance** from anything that could possibly ignite that material (not always possible)

Morningstar ProStar and SunSaver charge controllers are designed around intrinsic safety principles, to meet HazLoc certifications. In selected models that includes:

- Fanless design—many charge controllers, and nearly all higher-powered ones, use cooling fans to get rid of excess heat during operation. But in addition to their inherent reliability and efficiency issues, cooling fans require air-flow around hot internal components to work and exposing the controller's innards to potentially hazardous vapors. Removing the fan removes the hazard—which Morningstar does across its entire product line. That's accomplished through advanced electronic and mechanical design for superior thermal management, and a hallmark of Morningstar engineering.
- Encapsulated components—selected Morningstar models have internal components sealed in superior-grade epoxy plastic, to further insulate them from hazardous and extreme environments.
- Designing to HazLoc standards—all internal circuitry and external connections are designed for intrinsic safety, to eliminate sparks or overheating that could cause ignition of hazardous gases. Besides the superior control of energy, the integrated design and construction of Morningstar products reflects enhanced safety in all aspects, to prevent risk factors accumulating
- Comprehensive and ongoing testing and evaluation to rigorous HazLoc standards, to ensure safety and compliancy and achieve the necessary Quality Assurance Notifications and Registrations required




*Above: the Morningstar SunSaver solar charge controller used in oil & gas production around the globe. Called "the most successful solar controller in the industry," the SunSaver is in its third decade of production and has earned the highest reputation for reliability through the industry's lowest failure rate. SunSavers now meet both UL/CSA North Americas and IECEx/ATEX HazLoc International/European certification standards*

When it comes to charge controllers and other critical components, it's vital for system planners to be aware of the agencies and certifications behind a fully-compliant, safe solar electric powering scheme:

- **North America:** UL (Underwriters Laboratories) and CSA (Canadian Standards Association). Compliant devices will have an ETL label, which (summarized) means that they meet the UL/CSA standards for Class 1/Division 2 (areas where explosive concentrations of gasses, vapors and liquids are not normally present but may accidentally exist) and Groups A-D substances (which include Acetylene, Hydrogen, Propane, Gasoline and Methane among others).
- **Rest-of-World:** IECEx (International, various agencies) and ATEX (Europe, also various agencies). Their Zone system is roughly comparable to the Class/Division scheme in North America, with Zone 2 approval applicable to areas where an explosive atmosphere is unlikely to occur under normal conditions except for short periods, from propane, ethylene, or gasses and vapors of equivalent hazard.

Morningstar ProStar and SunSaver controllers meet both UL/CSA and IECEx/ATEX standards, and the Morningstar SunKeeper controller (used in small, single panel systems). meets U/CSA. In addition, both standards also have operating temperature requirements and the devices are rated for safe operation to the maximum ambient temperature marked while not exceeding the surface temperature limit designated, i.e., 212° F/100° C (which is boiling water) for T5.

## To learn more

Morningstar Corporation's free guide to Solar Powered Industrial Systems profiles over 30 successful projects including oil & gas, and provides product information and specifications. Download it here: https://www.morningstarcorp.com/landing_page/download-guide-solar-powered-industrial-systems/

For those interested in solar-powered solutions for the Digital Oilfield and other industrial applications, Morningstar has a distribution network spanning over 100 countries, with access to the leading solar professionals around the globe. To access them, contact Morningstar Corporation directly at sales@morningstarcorp.com

# Cable Faults Are A Fact Of Life For A Power Distribution Utility.

Daniel Hurley
AVO New Zealand

Most local distribution cables are buried underground with other services as it is practical and desirable to install them away from public access and out of sight. However, cable faults are one of the main causes of power outages. So what happens if an underground cable develops a fault?

It's likely that fault will trip the protection devices and cause the customer to lose power. The Power Distribution Utility is then in a race against time to find and repair the fault so that customers can have power restored and the Utility can reduce costs and losses associated with outages.

Where is the fault? The cable may be many hundreds of meters or even kilometres long. It is therefore invaluable to have a fault locator that can tell the engineer the distance to the fault and pinpoint its exact location in the field. Otherwise it's down to digging lots of trenches to find the fault…which of course is disruptive, time consuming, expensive and in itself risks further damaging the cable.

Many Power Distribution Utilities around the world use the Megger EZ-Thump as a first responder. It is a quick and relatively low cost method of finding a cable fault fast on the distribution network. In the event of a cable fault, the battery powered EZ-Thump and Digiphone can be taken to site in the boot of a car. The EZ-Thump is small (34kg, 36x39x50cm) and is great to be used in the first instance to find cable faults prior to rolling out the large thumpers or cable fault vans.

*Fig 1. EZThump is small and can fit in the boot of a car*

If it can be found quickly, the fault can be rectified and the power turned back on again with minimal expense and disruption to the customer. This time saving alone will effectively pay for the unit within a few uses.

In one Power Distribution Utility's experience, trials with the EZ-Thump resulted in nearly all faults being found on their 11kV network, saving a huge amount of time and money, as it allowed them to restore the power to more customers more quickly. This also saved money in penalties for Customer Minutes Lost, improved their performance statistics with the regulator and their reputation with customers.

There are some faults which might not be found by the EZ-Thump, as they may require higher voltages or energy to break down. In that case, a more powerful fault location system or test van can be brought in. Moreover, the EZ-Thump and larger Cable fault systems are complimentary. The combination of the two methods has led to a massive improvement in response times. Increased geographical coverage with the EZ-Thump with back up support from larger fault locating systems has revolutionised cable fault location in distribution networks. Taking this a step further, Megger's modern cable fault location systems now have a similar interface on all systems, meaning technicians can switch between cable fault location systems easily.

*Fig 2. All of Meggers modern Cable fault location systems now have a similar interface*

The EZ-Thumps' simple operation guides the user through the fault location process, allowing a wide range of individuals to use it; so there is always someone available to respond to an outage.

The EZ-THUMP has a 12 kV model and also 3 and 4kV models to cover LV faults. It is a compact and lightweight, battery and AC line operated, portable cable fault location system. It is designed for quick, effective, accurate and safe fault locating operations to greatly reduce system customer outage minutes. Due to its portable and robust enclosure, it is ideally suited for all typical fault locating operations on MV cables. The 12 kV model is typically used as part of a "satellite" fault locating concept for remote areas and when simple operation, light weight and economics are important, or for hard to access locations.

*Fig 3. Technician is able to get to site quickly with the small and portable EZThump*

The unit typically requires no adjustments and is operated via the unique and easy to follow E-TRAY GUI and a rotary control knob. It guides the user automatically through the entire fault locating process, starting with a Hipot Test and followed by both a Prelocation and Pinpointing step. During this 3 step process the test data will be stored and used in difficult fault locating situations to interpret the result and provide advice to the user of what to do next.

**FEATURES:**

- TDR method to prelocate very low resistance cable faults, either phase to phase or phase to neutral, or by pair comparison
- Arc Reflection Method (ARM®) prelocation of high resistance flashover faults.
- Single stage 500 Joule surge generator for pinpointing of high resistive faults up to 12kV
- DC HiPot testing for withstand and breakdown detection.
- Insulation resistance measurement.
- Sheath testing and sheath fault locating

## APPLICATIONS

**HV Testing (proof/insulation testing, sheath testing)**
Used to test the dielectric strength of the cable or sheath insulation and, if the test fails, to determine the breakdown voltage. For this purpose a test voltage up to 12 kV (sheath test typically limited to 5kV) is applied to the cable under test indicating the resistance value.

**Fault prelocation**
After identifying the fault as a high resistance/ flashover type, the fault in any concentric neutral type MV cable can be prelocated using ARM. In ARM, the arc of the flashover creates a temporary "jumper " to the neutral ground. During this condition, a standard TDR measurement is made into what is basically a short circuit fault providing a negative reflection at the location of the fault. Faults identified as very low resistance / non-flashover in shielded cables can be prelocated using the TDR method.

**Pinpoint fault location**
Accurate pinpoint fault location of the typical high resistance/flashover faults is achieved using the "Thunder & Lightning" method whereby the 500 Joule surge generator (thumper) and an acoustic/ electromagnetic receiver are used (Megger Digiphone 2)

## FEATURES

- Aside from the expert mode, the quick-step mode is especially convenient where users may not operate the unit on a regular basis.
- Automatic fault locating procedure.
- Operating of unit via unique E-Tray GUI and rotary control knob.
- Automatic end of cable and distance to fault location.
- Automatic breakdown detection.
- Key switch safety interlock standard (available also without).
- Operation from internal battery or from an AC source, featuring simultaneous AC operation and battery charging
- Rugged, lightweight, high impact resistant

Ask AVO New Zealand to find out more about The EZThump or how we can assist with training or application support for your Cable Fault Location testing requirements


## PREVENT TEMPORARY FAULTS FROM BECOMING SUSTAINED OUTAGES.

### ENHANCE YOUR SPUR/LATERAL PROTECTION STRATEGY WITH S&C'S TRIPSAVER® II CUTOUT-MOUNTED RECLOSER

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# The Public Utilities Board (PUB) And Asset Bankruptcy

James Young
CEO - Public Utilities Board
Robert Matthews
Team Lead - KURP, Kiribati


Chronic and systemic long-term underinvestment in asset refurbishment and renewals, inappropriate financial management, limited funding for O&M asset management, weak governance and systemic revenue erosion issues including an ongoing reliance on government through Community Service Obligation subsidy payments, has left PUB structurally insolvent and incapable of funding current and future operation obligations.

The resulting lack of financial capacity has left PUB facing the difficult challenge of managing the high probability of a catastrophic failure of a diesel generator(s) and further delays in scheduling of major maintenance activities, which is likely to result in continuous load shedding for a protracted period of up to 12 months with limited power supply.

Linked to the financial issues described in section 2, PUB is faced with 3 major asset risks;

1. Predicted failure of generation assets resulting in protracted blackouts (beyond 12 months)
2. Unpredictable and rapid power demand growth requiring urgent investment which will need to be constrained
3. Emergency drought action and water quality issues (linked to both power failure and limited water supply)

**Power Generation**

PUB has suffered from critical funding shortfalls for a number of years and findings from numerous donor mission to South Tarawa going back over a decade have consistently  describes the poor condition of generators.

A common observation has been the gap between peak demand and the available generation capacity.

A 2019, an ITPower1 report highlighted the following "currently there is no reserve to undertake maintenance works. This will be exacerbated by plans for new connections and subsequent load growth. PUB forecast peak demand will exceed 7MW by 2021/22 and approaching 9MW by 2030.  An increase in generation capacity is required urgently, and this is best done through the procurement of a new diesel generator or generators. Based on the current state and information uncovered in the mission, ITP estimate this would require at least an additional 2.3MVA of prime rated generation capacity to achieve this immediately. ITP would recommend this generation would be new from factory, medium speed and of similar make and model to the existing Daihatsu units, as PUB are familiar with these units and are upskilling on their refurbishment. As these are long lead times (Est.

6-12 months) the procurement process should begin as soon as possible."

In 2020, two ADB renewable energy projects undertook grid integration modelling to assess the expected grid impact of planned and extensive new solar, battery and water desalination projects [3,4,5,6]. These studies included a proposed future 2 MW generator located in the Betio powerhouse with similar response behavior to the existing Daihatsu generators. A review of these studies identified that adding additional diesel generation at Betio powerhouse would have a positive impact on grid stability.

Subsequent to the investigations highlighted above, the situation has changed in a number of ways.

The available generation remains less than island peak loads, requiring a combination of load shedding and running generators above there derated capacities to provide electricity. This will reduce the remaining available life of the generators as they have been derated to avoid failure due to overheating. The lack of redundancy prevents PUB from attending to generators, now well overdue for major servicing. As a result there is catastrophic risk of further generator failures.

The condition of the existing generators (Shown in Table 1) has declined further and poses extreme risk to security of supply for both power and water:

Table 1: Elemental Group ltd South Tarawa peak load forecast

| DG No. | Manufacturer | Installed Date | Running Hrs | Last Overhaul | Comments | Risk Ranking |
|---|---|---|---|---|---|---|
| 1 | Daihatsu Installed Capacity: 1250 Derated Capacity: 900 | 2003 | 21062 | Nov 2015 | Radiator Replaced 2015, 6 years without maintenance work. | Catastrophic Failure Risk |
| 2 | Cummins Installed Capacity: 625 Derated Capacity: 400 | 2017 | N/A | N/A | Catastrophically Failed | Failed |
| 3 | Daihatsu Installed Capacity: 1400 Derated Capacity: 800 | 2002 | 43392 | Apr 2016 | 5 years without maintenance work. Failed Stator temperature sensors | Catastrophic Failure Risk |
| 4 | Daihatsu Installed Capacity: 1400 Derated Capacity: 1250 | 2002 | 39515 | Dec 2019 | Major overhaul on engine has been completed along with stator rewinding | Major Failure Risk |
| 5 | Daihatsu Installed Capacity: 1400 Derated Capacity: 1200 | 2005 | 36869 | Dec 2015 | 6 years without maintenance work. | Catastrophic Failure Risk |
| 6 | Cummins Installed Capacity: 823 Derated Capacity: 400 | 2018 | 248 | N/A | Catastrophically Failed | Failed |

**Future Demand**

Electricity demand is growing year on year, increasing the peak loads which need to be met. The South Tarawa Water Supply Project intends to add two reverse osmosis water desalination plants, further increasing electricity demand. Previous studies have provided a range of load forecasts. It is difficult to determine the existing latent demand for electricity as supply is currently constrained. Based on the latest technical information supplied regarding the planned water desalination plants and PUB observation of load growth trends, PUB's Technical Advisors Elemental Group ltd NZ have developed the peak load forecast of Figure 2.

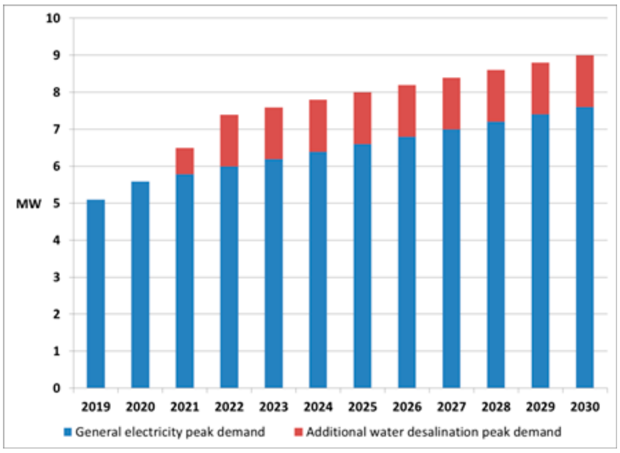


*Figure 2: Elemental Group ltd South Tarawa peak load forecast*

PUB is currently working with a JICA expert engineering team to peer review the current power situation and they have confirmed the Elemental Group ltd study and have provided the power forecast shown in figure 2.

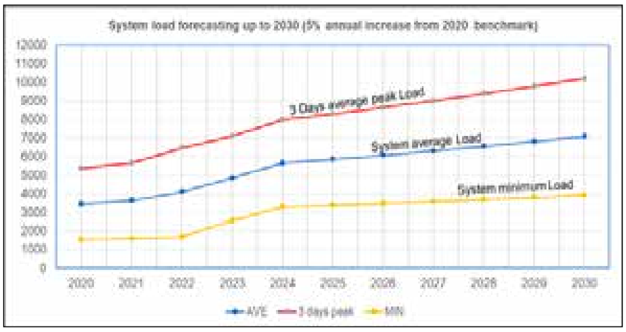


*Figure 2: JICA peak load forecast*

The condition and remaining lifetime of existing generators cannot be ascertained without disassembly, requiring a potentially prolonged period out of service for each assessment. Given that some generators are near 20 years old and that recommended service intervals have been unable to be met, it is expected that at least one of the existing generators will catastrophically fail within the next 12 months.

JICA Engineers concluded that in order for PUB to be able to carry out the overhaul works on the existing DGs in 2022, an additional 2 units of 2.0MW (4.0MW) are needed to avoid major power interruptions in Tarawa (forecast to last 12 months). MFAT are funding a new 2MW generator however a further 2MW of new or temporary generation capacity is urgently needed by Q2, 2022. Overhauls are also required to be completed in 2025.

Additionally, in order to carry out the scheduled overhaul works in 2025 and to provide sufficient power to operate the South Tarawa Water Supply Project (Scheduled to be commissioned in early 2023), the following options have been recommended:

(1) Commissioning another 2.0MW DG before 2025 (in addition to the 4.0MW recommended above) or

(2) Commissioning additional PV 5.0 MW & BESS 2 MWh before 2025

In response to the long run issues described above, the Kiribati Utilities Reform Project (KURP) is a partnership between the Governments of New Zealand and Kiribati to strengthen delivery of critical utilities on South Tarawa and Kiritimati Islands. The multi-year project has been developed to assist with the reform of the utilities Sector in Kiribati. The overall goal of KURP is to ensure that I-Kiribati have reliable and safe access to public utilities and amenities.

FCG was appointed as management consultants to the project. FCG has an experienced team of specialist consultants which is led by Robert Matthews (Former CEO Tonga Power). FCG, in partnership with the Public Utilities Board CEO, James Young, is driving a major reform agenda, scheduled over 5 years, which has the following key objectives:

1. Strengthened governance and management of basic utilities through business process and system improvements to aid decision making and support efficiencies. This includes the introduction of new Information Management Systems to link finance, HR, procurement, asset and inventory management, budgets and work plans..
2. Improved confidence and competence of the utilities workforce to deliver and manage reliable, safe, and affordable electricity and water services that meet customer expectations. This will be underpinned through delivering a capacity building programme of professional training and development for senior staff and delivery of formal trade qualification for technical staff.
3. Increased energy generation, energy security, and safe distribution of supply. This includesthe installation and optimisation of new diesel generator(s), fibre optics and communications hardware, including network upgrades and the rollout of more than 10,000 pre-paid electrical

meters

4. Improvements and imbedded practice of routine maintenance to ensure more dependable energy supply with fewer outages and identifying overlap and potential duplication in O&M training and capacity building under other donor funded programs

In addition, the KURP Team Leader is working closely with the PUB CEO and senior staff on a number of inter-related reform initiatives2 including the following;

- Improved financial and cash flow management
- Improved revenue and profitability of PUB operation
- Procurement process mapping and efficiency improvements
- Strategic planning and positioning for sustainable growth
- Coordination of donor funding power and water projects
- Restructuring PUB business operations
- Board governance, training, and reporting
- Diesel fuel and lube oil delivery and supply costs
- New Energy Bill (ADB STREP) and impact on PUB operations
- Existing energy and SOE acts and related ordinances and legislation
- New Electricity Tariff model (ADB STREP) based on full cost recovery
- Asset revaluation and replacement strategy

## STRATEGIC ACTIONS POWER SUPPLY

The following actions will be taken by PUB to stabilize the current power generation situation, provision for future power demand and ensure PUB maximizes renewable energy penetration into the Power Grid:

(i) Seek JICA and MFAT expert team reviews of the current power situation.

(ii) Procure overhaul spare parts for Generators 1,3,4,5 and take delivery of the new Rotors/ Stators for Generators 3 & 5.

(iii) Work with JICA Experts to overhaul the generators (sequentially in 2022)

(iv) Develop and implement community communications plans for protracted outages in 2022.

(v) Work with GoK and development partners to fund and deliver the required 4.0MW to take existing generators offline for 2022

(vi) Work with GoK and development partners to replace Baseload Generation(old generators) 10 MW by 2025

(vii) Deliver STREP/STREP2 and Develop/ Implement Hydrogen Generation Strategy to move to renewable energy targets in accordance with National Energy Policy

(viii) Ensure Energy Act enables PUB to meet funding covenants and become financially independent of GoK

(ix) Review operating structure between Water/ Sewer and the Energy business, noting the Water/Sewer business will require long term GoK subsidy.

Note STREP & STREP2 refers to the South Tarawa Renewable Energy project phase 1 & 2. The Public Utilities Board is the implementing Authority for both of these project. STREP Phase 1 is scheduled to come online in late 2023.

1. ITPower were appointed under an urgent technical assistance support programme, funded by MFAT NZ
2. These reforms are also being supported by the Asia Development Bank South Tarawa Renewable Energy Project team via the Financial Recovery Action Plan

# As seen at the recent PPA Online Conference...

## Megger Oil Dielectric Breakdown Test Set


- Test voltages up to 60 kV or 80 kV
- Lock in precision oil vessel - lockable gap setting
- Easy clean chamber with oil drain
- Light-weight, rugged, portable
- Intuitive user interface with 19 pre-programmed automated test sequences available.
- Temperature is measured continuously
- Safe operation with dual redundant micro switches
- Virtual training complementary with each set

## Megger EZ Thump Cable Fault Locator

- Small portable Cable Fault Locations System
- 34kg, fits in the boot of car
- Full surge energy at 1.5, 3, 4, 12kV
- Intuitive system – steps users through entire process
- Required minimal training
- Virtual training complementary with each set


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# Renewable Energy In The State Of Yap, In Micronesia, In 2021 An Update Summary By The Yap State Public Service Corporation

Vincent Bouet
Electrical engineer - Yap State Public Service Corporation

Renewable energy was first introduced in the Outer-Islands of Yap in 2009. Since then, it has definitely modified the landscape of the power facilities of this traditional state of the FSM.

As background data, before 2020, Yap main islands were equipped with new high speed diesel Caterpillar generators: two 1.6MW and one 830kW funded by the Asian Development Bank (ADB) and the World Bank (WB) were commissioned in 2017 and produce in parallel with:

- 200kWp of ground mounted PV Solar installed by JICA (PEC) in 2014
- 300kWp of Roof top Solar installed on public buildings through YREDP (ADB Yap renewable energy development plan) in 2016
- three 275kW Wind turbines installed in 2017 with YREDP

  Vergnet SA installed the Hybrid wizard control system which maximizes the Renewable Energy penetration.

Besides, a new 5MVA transformer and Substation switchgears were installed by YSPSC with World Bank funding.

In the Outer-Islands of Yap, a succession of PV solar projects funded by the European Union have almost completed the electrification of the State: 28kWp on Fadrai, 19kWp on Asor with EDF9 in 2009; 47.88kWp on Mogmog, 62.7kWp on Ulithi Falalop, 66.12kWp on Fais, 41.04kWp on Woleai, 61.56kWp on Satawal, with North REP which have been impacted by Cat 5 Typhoon Maysak in 2015; 300kWp of stand-alone PV solar in fourteen remote islands with EFII in 2014.

In 2020 and 2021, YSPSC remains active in its efforts to increase the Renewable Energy share. It has been working with ADB, FSM national government, Entura for determining new RE assets and the procurement phase, up to bidding award. Besides it maintains and completes services of the Wind assets according to Vergnet's manufacturer standards. It maintains, troubleshoots its Solar systems and their electronics. YSPSC also prepares the extension of its new substation 13.8kV/4.16kV to accommodate two RE feeders for the coming new projects. On the other hand, the Outer-Islands see their operations consolidated. Battery banks are changed in Asor and Fadai after 12 years of operation. In Mogmog, Fais and Satawal, assets are repaired from typhon damages, solar houses reconstructed, PV arrays replaced, Electronics redesigned and replaced.

A second major implementation phase is scheduled in 2022 and 2023, and will consists in the installation of a second 830kW high-speed generator for better baseload dispatch during high RE penetration and low loads (funded by WB); the construction of new solar facilities totalizing 2MWp of installed capacity, mainly ground mounted on a site close to the diesel power plant (project funded by ADB), the installation of a BESS Li-ion system of 800kW / 800kWh capacity next to the existing substation (funded by ADB as well, potentially a similar storage will be built in the North of Yap), the upgrade of the whole integration & control system optimizing the RE production with the above new assets and the existing wind farm and solar farms.

On the Outer-Islands, the future next projects will rebuild and upgrade Ulithi Falalop solar system with a capacity of 60kWp next the existing YSPSC complex, and electrify the islands of Ifalik and Lamotrek with six PV solar micro-grids to achieve the full electrification of the whole state of Yap.

| 2019 20% | 2020 19% | Half 2021 18% | 2024 37.9% |
|---|---|---|---|
| Wind<br>1,557,500kWh<br>Solar<br>678,233kWh<br>Diesel<br>8,758,773kWh | Wind<br>1,318,200kWh<br>Solar<br>676,399kWh<br>Diesel<br>8,689,599kWh | Wind<br>614,100kWh<br>Solar<br>326,327kWh<br>Diesel<br>4,223,223kWh | RE contribution projected<br>Yap Feasibility Study by<br>ENTURA<br>9 July 2019 |

*Progression of share of Renewable Energy*

We faced some challenges, for examples, typhoons on the Outer-Islands facilities, especially in the Ulithi atoll; failures of electronics of solar facilities, especially the inverters designed for mainland public markets (and not utilities)

As maintenance is concerned, a centralized continuous monitoring at the power plant helps trigger troubleshooting quickly to maintain 100% operability; complete and sufficient stocks of spare parts are necessary, especially for the wind turbines hydraulics and control, and the solar electronics.

To accompany RE, we build the right assets, consolidate the conventional ones, such as substation additional feeders, protections & control, with supervision in control room. We also renew the AC/DC auxiliary systems in the power plant. Assets increase in number and diversity, thus maximum standardization and simplicity in the overall designs are required where and when possible.

Overall, it may be said that the renewable energy production gives stability to the utility cost of energy, at customers' benefit. The diesel assets run at lower load, with less risk of failures due to wear and tear. The redundancy in the diesel plant is increased. This is extremely important nowadays with the pandemic slowing down any specialized technical missions. Tariffs remain unchanged and YSPSC can consolidate the fragile operations in the Outer-Islands. The future projects in RE with battery energy storage systems look promising to pursue a stable tariff strategy as YSPSC staff gains experience in maintaining these diverse assets. YSPSC thanks the World Bank, the Asian Development Bank, the EU, SPC, USDA, IOM, JICA for their precious contributions.



# What Is fiPMG

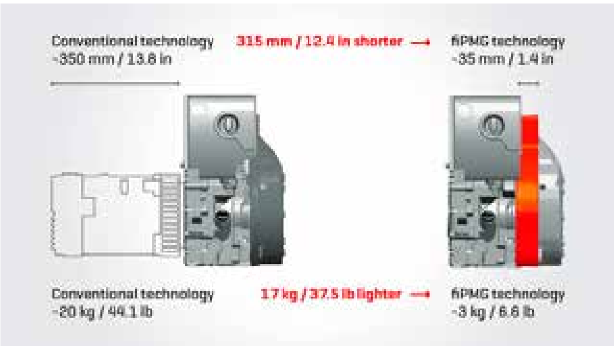
Hatz Diesel

What is fiPMG and what are the benefits to you.

First let's explain what is fiPMG. Flywheel Integrated Permanent Magnet Generator. We at Hatz have integrated the conventional generator into our engines flywheel.

Picture below gives you an example of what our engineers have done.

**Minimal size and weight was the objective**




Does this perform as well as a conventional generator? Yes it does and as you can see it takes up much less space and has also reduced the weight of the combined units.

The Permanent Magnet Generator used is contact less and has a high degree of efficiency, whether from AC to DC or AC to AC the related inverters ensure you get consistently high-power quality and they also enable adjustment of the engine speed according to the load demands.

So, what does all this mean to the operator/ owner.

Reduced running cost as well as reduced total ownership costs.

How is this possible.

This is possible by reduced downtime as maintenance is not required as often, and with the engine only working hard when needed this reduces fuel consumption along with noise levels.

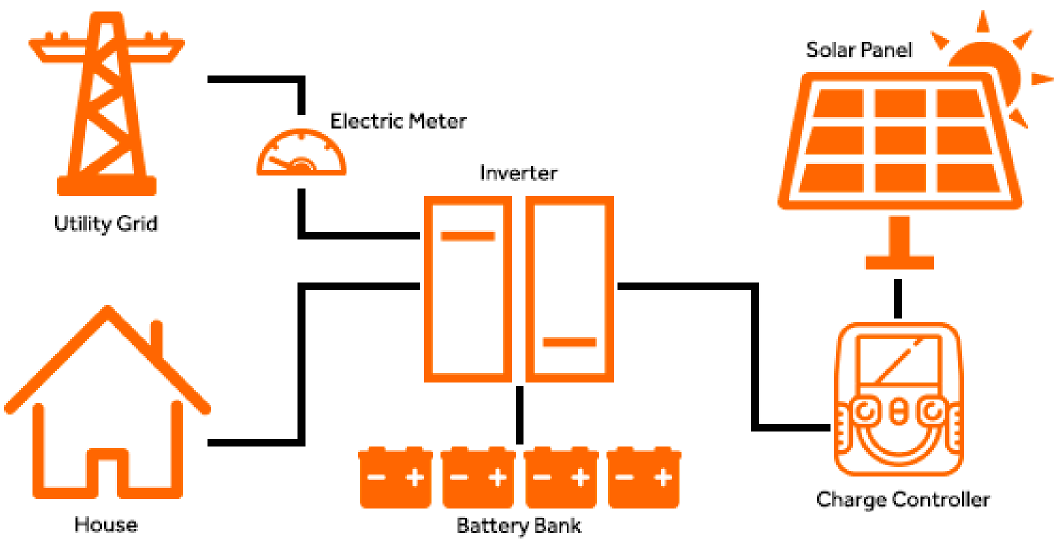
So, in summary fiPMG from Hatz will save you space, weight, total running cost and be quieter in the process.

Hatz fiPMG engines are also well suited and adaptable to solar systems.

The Solar concept as renewable energy sources are increasing, the use of solar energy systems is increased with hybrid setups.

Our Hatz battery charger from 1.500 to 3.200 rpm, full variable according to load, with options from 24Vdc -100 A, 24V-200A, 48V-60A or 48V-100A means we have a solution for a range of application.

Circuit for recharging Lead-Acid battery using Solar panel



| Model | BATTERY CHARGER | | | | GENERATORS | | |
|---|---|---|---|---|---|---|---|
| | PMDC-28-100 | PMDC-28-200 | PMDC-56-60 | PMDC-56-100 | PMAC-230/5-2,4 PMAC-120/6-1,6 | PMAC-230/5-3,0 PMAC-120/6-1,6 | PMAC-120/6-3,5 |
| Max. power @ cos(φ) 1.0 [kW] | 2.8 | 5.6 | 3.4 | 5.6 | 2,4 \| 1,6 | 3,0 \| 1,6 | 3.5 |
| Max. current [A] | 100 | 200 | 60 | 100 | 13 | 13 | 29 |
| Voltage [V] | 28 | 28 | 56 | 56 | 230 \| 120 | 230 \| 120 | 120 |
| Frequency [Hz] | – | | | | 50 \| 60 | 50 \| 60 | 60 |
| Type of voltage | DC | | | | AC | | |
| Generator | permanent magnet, flywheel-integrated | | | | | | |
| Inverter output accuracy acc. ISO 8528-5 | class G4 | | | | class G2 | | |
| Electrial efficiency [%] | 85 | | | | | | |
| Engine | 1B30E // 1B30VE | 1B50/E | 1B30E / 1B30VE | 1B50/E | 1B20 | 1B30E // 1B30VE | |
| Speed range [rpm] | from 1.500 to 3.200 rpm, full variable according to load | | | | | | |
| Start system | electric, 12 volt | | | | | | |
| Emision Certificate | Dual type plate: EU Stage-V and US Tier-4 Carb | | | | EU Stage-V | Dual type plate: EU Stage-V + US Tier-4 Carb | |
| Noise level at 7 meters [dB(A)] | 72 @ 2.300 rpm | 76 @ 2.300 rpm | 72 @ 2.300 rpm | 76 @ 2.300 rpm | 69 @ 2.300 rpm | 70 @ 2.000 rpm | 68 @ 1.500 rpm |
| Fuel consumption @ ¾ load [l/h / gal/h] | 0,7 / 0,18 @ 2.300 rpm | 1,2 / 0,31 @ 2.300 rpm | 0,7 / 0,18 @ 2.300 rpm | 1,2 / 0,31 @ 2.300 rpm | 0,56 / 0,15 @ 2.300 rpm | 0,7 / 0,18 @ 2.000 rpm | 0,5 / 0,13 @ 1.500 rpm |
| Dimensions L x W x H [mm / in] | 355 x 398 x 430 13,9 x 15,7 x 16,9 | 363 x 425 x 480 14,3 x 16,7 x 18,9 | 355 x 398 x 430 13,9 x 15,7 x 16,9 | 363 x 425 x 480 14,3 x 16,7 x 18,9 | 326 x 368 x 401 12,8 x 14,4 x 15,7 | 355 x 398 x 430 13,9 x 15,7 x 16,9 | 360 x 372 x 430 14,2 x 14,6 x 16,9 |
| Weight [kg / lb] | 54 / 119 | 71 / 157 | 54 / 119 | 71 / 157 | 43 / 95 | 54 / 119 | 52 / 115 |


Numerous applications benefit from the advantages of Hatz fiPMG. These include among others:

- Mobile light towers
- Solar and conventional mobile road signal equipment
- Mobile communications infrastructure
- 5G Smart Towers
- Electrical lifting equipment
- Motor homes
- Trade show trailers
- Battery driven equipment
- Auxiliary Power Units in construction equipment
- On-highway truck applications

For more information, please visit hatz.com.au or phone 1300 796 900.

# Public Utilities Board (PUB), Kiribati, New Chief Executive Officer

Public Utilities Board (PUB), Kiribati

*Mr. James Young*

Chief Executive Officer James Young is a chartered professional Engineer with more than 25 years utility management and infrastructure experience. James has strong corporate management background and has worked in Australia, Papua New Guinea, Kiribati, India, Vietnam and the Philippines and has held a number of board level positions. James has an ambitious reform agenda for the Public Utilities Board of Kiribati, including the stabilisation of the energy system, delivery of new water supplies, changes to financial management and governance structures.

"At the core of the difficulties faced by PUB is are the gaps in corporate governance. Our ambition to become a leading utility in the Pacific can only be realised through our people and our people need good leadership. The Government of Kiribati is supporting my reform agenda and I am delighted by the strong relationships I've formed and support I've received. A successful and prosperous Kiribati can only be realised when we have a stable power supply, safe and abundant drinking water and a clean environment and in that regard we are committed to making a difference to our community".

# First PPA Virtual Conference A Major Success

Pacific Power Association

Concerned at not being able to hold the scheduled PPA 2020 and 2021 annual conferences due to Covid 19 restrictions, the PPA Executive became increasingly anxious as to the effects of this situation on the very viability of the PPA organisation itself. Of mounting worry were three things:

- A significant loss of revenue to the PPA from being unable to run the conference events, this also preventing the appointment of a new PPA CEO.
- A major and progressive decline in the Allied membership, this also exacerbating the state of the PPA financial position
- The inability to have meaningful dialogue and technical interaction between Active and Allied Members, this of course being a major feature and attraction of the annual conferences.


What to do?

In mid-2020, Executive Committee member and Allied Member Chairman, Mr Trevor Lord, first tabled a proposal for the PPA to consider the prospect of a virtual conference of some sort, such tools and experiences being greatly honed during the early 2020 lockdowns. This did not proceed.

With the worsening state of the PPA finances and support base over 2021, and immediately following the unavoidable decision to again postpone the annual conference, Mr Lord not only revised his earlier proposal for a virtual conference but also fleshed out an accompanying plan of the day and additionally offered both to run the event and for his company, AVO New Zealand, to underwrite the costs and time involved. "As I saw it", comments Mr Lord, "with the prospect of a conference not being able to be held until July 2022, the PPA was in much danger of effectively failing its members and support base, and even potentially having to consider its very future viability. I was not prepared to stand by and see this very important organisation fail so stepped up with the next best option…a one day very comprehensive virtual conference". The PPA Executive endorsed the proposal with gratitude and the hard work began.

Pondering how best to maximise the participation and content of the event, to achieve a good and fair balance of input from the Active and Allied members, and to make it attractive to all members, Mr Lord conceived a programme model quickly which required little alternation. In essence, the key attribute of the very finite timing of the day (to accommodate the many time zones involved) was to have many but short presentations. Contrary to most conference events, and initially raising some eyebrows, the model chosen was a mix of 5- and 10-minute Powerpoint presentations with an informative and 'punchy' commercial video presentation montage from Allied members in the 'middle of the day'. The planned structure was for the day to start with a 10-minute musical interlude, formal welcomes, a prayer, then a series of 5-minute updates from the CEOs of the Active members. A bracket of 10-minute presentations by Allied members was to follow, then the commercial interlude, a series of 10-minute presentations by Active members, then closing remarks.

A licensed ZOOM package was chosen at the outset as the working platform and proved very suitable.

With the day outline drafted, an announcement was made to all members (including recent non-financial members) that such a conference was to take place. The announcement was accompanied by a call for presentations via the PPA Secretariat. Mr Lord worked with his team and Christchurch-based graphic artist, Mr Chris Brown, to prepare a special conference web site just for the event and the result was stunning.

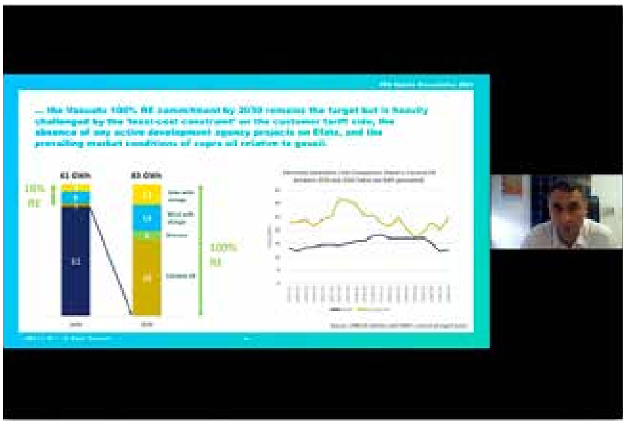

Initially set for a date of June 11th, this was deferred after an initially poor support. A new date of August 26th was set, and much hard work then invested by Mr Lord and his team. Special thanks also go to. Ms Reena Suliana, assisted by Mr Gordon Chang, of the PPA secretariat for their hard work in chasing support from presenters.

The day ran from 10:20 to 4:10 pm NZ and Fiji time, with Mr Lord very ably taking up the role of MC in a professional virtual studio backdrop specially constructed by artist Mr Brown.


The day ran very well for time which greatly surprised many, there being little room for delays to be incurred. Importantly for the smooth running of the event, all presentations were sent to Mr Lord and his team in advance, allowing for any presenters having communication difficulties on the day to still have their presentation heard. Two cases on the day required this intervention but it we seamless to the audience.  The 5- and 10-minute presentation slots proved very effective indeed, with messages being concisely presented but also allowing a surprisingly good level of detail and interesting content to be conveyed.

In all some 90 people attended the event, a huge success by any yardstick.

Active members attending and presenting were:  EFL Fiji, Nauru Utilities Corporation, Tuvalu Electricity Corporation, Pohnpei Utilities Corporation, UNELCO Engie (Port Villa), Te Aponga Uira Cook Islands, Marshalls Energy Company, Palau Public Utilities Corporation, Solomon Power, Yap State Public Service Corporation, Public Utilities Board (Kiribati), Electric Power Corporation Samoa, Tonga Power Ltd, and Chuuk Public Utilities Corporation.




Allied members taking part were: Vergnet Group, Akuo Energy, Transnet, ElectraTherm, S&C Electric Company, Mana Pacific, AVO New Zealand, ComAP Ltd, Global Sustainable Energy Solutions, Sterling and Wilson Ltd, Infratec, NiuPower Ltd, Hawthorne Power Systems, Andritz Hydro GmbH, and LORD Power Equipment.


One thing that was clearly a vital ingredient for the smooth running and success of the day was the active input of Ms Simone Rikustad who not only complied and sent out prior a full set of written and video guidance to presenters on working the Zoom platform, but who also kept all the presenter transitions very 'slick' indeed.

In wrapping up the day, PPA Chairman Mr Hasmukh Patel, thanked the PPA Executive and all those who took part.  He went on to confide that when Mr Lord had first suggested a virtual conference, he had been sceptical that it would both work technically and be supported by the PPA membership.  Instead, he very kindly stated that Mr Lord had proven him wrong in these views and that he was most grateful to Mr Lord for the immense work he had invested into the event and to AVO New Zealand for underwriting the significant investment of both time and money into making the day a success.

A questionnaire was subsequently complied by Mr Lord's team and both the complied results and chat room on the day strongly suggest that all who attended enjoyed the event, deemed it a success, and would welcome another virtual conference if it were to be arranged.  All papers and segments of the day will be posted on the Conference website https://ppa2021.com .

# *Welcome!*

## *New Allied Member*

There are no new Companies that have joined PPA as Allied Members since our last PPA Magazine.






AvK