PPA

A PACIFIC POWER ASSOCIATION PUBLICATION

VOLUME 29 ISSUE 1 - MARCH 2021

More power for your operations

We help you improve the output of your rotating equipment.

Sulzer supports you on your quest to reach the highest levels of reliability. With our customized solutions, we support you in keeping your operation and maintenance costs at a minimum while bringing your equipment to its best efficiency point. Field service, overhaul and inspection for your generator or motor are just a few of the many services you can expect.

Contact us to discover your best service solution.

www.sulzer.com

SULZER

CONTENTS




PPA

March 2021, Volume 29 Issue 1

Head office: Ground Floor, Naibati House, Goodenough Street, Suva, Fiji Islands
Mailing Address: Private Mail Bag, Suva, Fiji Islands.
Telephone: (679) 3306 022
Email: ppa@ppa.org.fj
www.ppa.org.fj

Chairman
Mr. Hasmukh Patel,
Chief Executive Officer
Energy Fiji Limited

Acting Executive Director
Gordon Chang

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

PACIFIC POWER magazine is published four times a year.

Advertising
Reena Suliana
Pacific Power Association, Suva, Fiji Islands

Layout & Design
Printhouse Limited

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

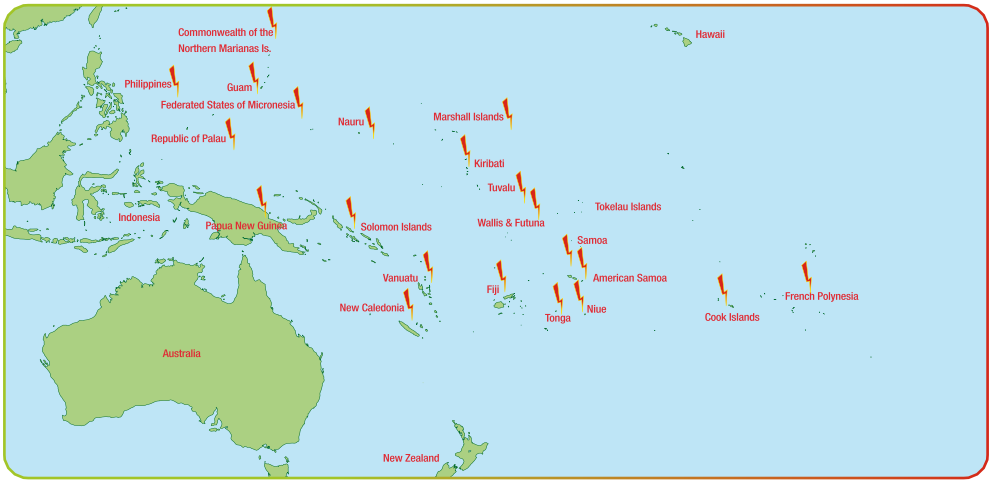
Correspondence should be addressed to: The Pacific Power Association, Private Mail Bag, Suva, Fiji Islands.

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

Cover Page Photograph - "The newly appointed Chief Executive Officer for Te Aponga Uira, Cook Islands".

ACTIVE MEMBERS

1. AMERICAN SAMOA POWER AUTHORITY, American Samoa
2. CHUUK PUBLIC UTILITY CORPORATION, Chuuk
3. COMMONWEALTH UTILITIES CORPORATION, Saipan
4. ELECTRICITE DE TAHITI, French Polynesia
5. ELECTRICITE ET EAU DE CALEDONIE, New Caledonia
6. ELECTRICITE ET EAU DE WALLIS ET FUTUNA, Wallis & Futuna
7. ELECTRIC POWER CORPORATION, Samoa
8. ENERCAL, New Caledonia
9. ENERGY FIJI LIMITED, Fiji
10. GUAM POWER AUTHORITY, Guam
11. KOSRAE UTILITIES AUTHORITY, Kosrae
12. KWAJALEIN ATOLL JOINT UTILITY RESOURCES, Marshall Islands
13. MARSHALLS ENERGY COMPANY, Marshalls Islands
14. NIUE POWER CORPORATION, Niue
15. NAURU UTILITIES CORPORATION, Nauru
16. PALAU PUBLIC UTILITIES CORPORATION, Palau
17. PNG POWER LTD, PNG
18. POHNPEI UTILITIES CORPORATION, Pohnpei
19. PUBLIC UTILITIES BOARD, Kiribati
20. SOLOMON POWER, Solomon Islands
21. TE APONGA UIRA O TUMU-TE-VAROVARO, Cook Islands
22. TUVALU ELECTRICITY CORPORATION, Tuvalu
23. TONGA POWER LIMITED, Tonga
24. UNELCO VANUATU LTD, Vanuatu
25. YAP STATE PUBLIC SERVICE CORPORATION, Yap



ALLIED MEMBERS

1. ABB TURBOCHARGES AUSTRALIA PTY LIMITED, Australia
2. ABB POWER GRIDS NZ LIMITED, New Zealand
3. ACO PTY LTD, Australia
4. AGGREKO (NZ) LIMITED, New Zealand
5. AKUO ENERGY PACIFIC, Australia
6. AMERICA'S BEST ELECTRICAL MART, USA
7. ANDRITZ HYDRO, New Zealand
8. AR INDUSTRIAL, Australia
9. ARTHUR D RILEY & CO LTD, New Zealand
10. AVO NZ, New Zealand
11. BALANCE UTILITY SOLUTIONS, Australia
12. BENSON GUAM ENTERPRISES, INC., Guam
13. BEIJING EASTWEST ENERGY CO. LTD, Fiji
14. B&R ENCLOSURES PTY LTD, Australia
15. BRUSH SWITCHGEAR, Australia
16. CARPTRAC, Fiji
17. CBS POWER SOLUTIONS, Fiji
18. COMAP PTY LTD, Australia
19. CUMMINS SOUTH PACIFIC, Australia
20. DATELINE EXPORTS INC, USA
21. DELSTAR NEW ZEALAND LIMITED, New Zealand
22. DOMINON WIRE & CABLES LIMITED, Fiji
23. EATON INDUSTRIES PTY LTD, Australia
24. EDMI NZ LTD, New Zealand
25. EIF INTERNATIONAL LIMITED, New Zealand
26. ELECTRATHERM, USA
27. EMACS ELECTRICAL & MECHANICAL REPAIRS, Australia
28. ERGON ENERGY, Australia
29. ETEL LIMITED, New Zealand
30. FIJI GAS LTD, Fiji
31. FSM PETROLEUM CORPORATION, Pohnpei
32. FUELCHIEF TRUSTEE LTD, New Zealand
33. GLOBAL SUSTAINABLE ENERGY SOLUTIONS PTY LIMITED, Australia
34. GLOBAL TURBOCHARGER SOLUTIONS, United Kingdom
35. HATZ DIESEL AUSTRALIA, Australia
36. HAWTHORNE POWER SYSTEMS, USA
37. HNAC TECHNOLOGY CO., LTD, China
38. HUBBELL POWER SYSTEMS, INC. (ASIA PACIFIC), Philippines
39. I S SYSTEMS, Australia
40. INFRATEC, New Zealand
41. INSTITUTE FOR ENVIRONMENTAL ANALYTICS, England
42. INTRACOR COMMODITY EXPORTS LTD, Auckland New Zealand
43. ITRON AUSTRLASIA PTY LTD, Australia
44. JAPAN ELECTRIC POWER INFORMATION CENTRE, Japan
45. KOPPERS WOOD PRODUCTS PTY LTD, Australia
46. MAN ENERGY SOLUTIONS, Australia
47. MANA PACIFIC, Hawaii
48. NAN ELECTRICAL CABLE AUSTRALIA PTY LIMITED, Australia
49. NEXANS OLEX, New Zealand
50. NZMT TURBOCHARGERS LIMITED, New Zealand
51. OCEANGAS SERVICES AUSTRALIA PTY LIMITED, Australia
52. OHM INTERNATIONAL CORPORATION, USA
53. ORIGIN ENERGY, Australia
54. PACIFC BULK FUEL LTD, New Zealand
55. PACIFIC ENERGY SWP LIMITED, Vanuatu
56. PACIFIC POWER ENGINEERING (AUST) PTY LIMITED, Australia
57. PERNIX GROUP, INC, USA
58. PLP ELECTROPAR NZ LTD, New Zealand
59. PETROLEUM & GAS COMPANY (FIJI) LTD T/A BLUE GAS, Fiji
60. POWER PROTECTION INDUSTRIES, Australia
61. PROTECH POWER INDUSTRIES PTY LTD, Australia
62. RICARDO ENERGY & ENVIRONMENT, United Kingdom
63. S&C ELECTRIC COMPANY, Australia
64. SELECTRONIC AUSTRALIA PTY LTD, Australia
65. SMA AUSTRALIA PTY LIMITED, Australia
66. SOUTH AUSTRAL PTY LIMITED, Australia
67. SOUTH PACIFIC TUBOCHARGERS NZ LTD, New Zealand
68. SOUTHERN CALIFORNIA EDISON, USA
69. STAMFORD AVK, Australia
70. SULZER DOWDING & MILLS, Australia
71. SUNERGISE INTERNATIONAL LTD, Fiji
72. TERRA CAT POWER SYSTEMS, New Zealand
73. TESLA, USA
74. TETRA TECH, USA
75. THE ENERGY NETWORK (AUST) PTY LTD, Australia
76. TOTAL OIL ASIA PACIFIC PTE LIMITED, Singapore
77. TRANSNET NZ LIMITED, New Zealand
78. VERGNET SA, France
79. WARTSILA AUSTRALIA PTY LIMITED, Australia

Editor's Note

Gordon Chang
Acting Executive Director

The year 2021 is well underway and the challenges due to the COVID-19 pandemic continues for the PPA Secretariat. It is hoped this year that all PICTs will soon be receiving the COVID-19 vaccine for its citizens and their borders will soon be opened for travel to begin.

This edition of the PPA Magazine profiles Ms. Lesley Katoa, the new Chief Executive Officer of the Te Aponga Uira O Tumu-Te-Varovaro (TAU). Ms. Katoa replaces Apii Timoti. Ms. Katoa was General Manager for one of the larger trustee companies in the Cook Islands for over twelve (12) years as well as having governance experience with TAU and To Tatou Vai Limited (Rarotonga Water & Sanitation Authority). Ms. Katoa has a Bachelor of Commerce from the University of Auckland, is a Chartered Accountant, with the Chartered Accountants Australia and New Zealand, and she is the current President of the Cook Islands Red Cross Society. In addition, she has experience across both the public and private sectors.

In addition, I would like to take this opportunity to welcome all the newly appointed CEOs for American Samoa Power Authority, Mr. Wallon Young, Electricite De Tahiti, Mr. Gregoire de Chillaz, ENERCAL, Mr. Jean-Garriel Faget, Public Utility Board, Kiribati, Mr. James Young, Electricite Et Eau de Caledonie, Mr. Francois Laforest, PNG Power Limited, Mr. Flagon Bekker, Electric Power Corporation, Faumui Iese Toimoana, and Solomon Power, Solomon Islands Mr. Donald Kiriau.

For this year we have received funding to fund participants for countries who are not members of the World Bank to attend any training that PPA and the World Bank will be implementing in 2021. This funding has been received from ROC-Taiwan and also a proposal for the Pacific Disaster Assistance Program (PDAP) has been submitted to their office for consideration. Once this program is approved and donors have pledged their funding, the funding by ROC-Taiwan will assist the utilities in paying their fees to take part in this program.

Our gratitude also needs to be extended to our allied members for their continued support to the PPA Secretariat. We take this opportunity to welcome our new members who joined PPA this year and wish the members who have withdrawn their membership all the best and hope they will rejoin their membership with the PPA family again soon.

The Secretariat looks forward to working with the Active members, Allied members, Affiliate members and donor partners during this difficult time.

Te Aponga Uira (TAU), Cook Islands, Newly Appointed Chief Executive Officer, Mrs. Lesley Katoa

Te Aponga Uira, Cook Islands

Photo: Cook Islands Red Cross

Mr. Mata Nooroa, Chairperson of Te Aponga Uira (TAU) announced the appointment of Mrs. Lesley Katoa to the position of Chief Executive Officer (CEO), effective from the 1st of February. She is the first female to head the Rarotonga Power Authority.

TAU is a statutory Corporation of the Cook Islands Government. It is a government-owned utility responsible for the generation, distribution and retailing of electricity on Rarotonga. Mr. Nooroa on behalf of TAU said they are pleased to appoint and welcome Mrs. Katoa to the CEO position, following a thorough and robust recruitment process, which attracted a large pool of quality applicants.

Lesley was General Manager for one of the larger trustee companies in the Cook Islands for over 12 years as well as having governance experience with TAU and To Tatou Vai Limited (Rarotonga Water & Sanitation Authority). She has a Bachelor of Commerce from the University of Auckland, is a Chartered Accountant with the Chartered Accountants Australia and New Zealand and current President of the Cook Islands Red Cross Society. She has experience across both the public and private sectors.

Mr. Nooroa also acknowledged the excellent leadership and service of the out-going CEO, Mr. Tereapii (Apii) Timoti, who has largely been the CEO of TAU since 2002. He acknowledged Mr. Timoti's service and work of strategic operations in alignment with the renewable energy direction and the ongoing transformation of Rarotonga's electricity system over the last eighteen years to the agency it is today.

akuo
Entrepreneurs by nature

GEM®

Green Energy in Motion

StorageGEM®

No more power outages!
A 20-ft container with a capacity of up to 1.3 MWh for 3+ hours of Battery backup.

SolarGEM®

A modular solar plant plug and play solution featuring a 20-ft container with >74 kWp of solar capacity.

PLUG & PLAY

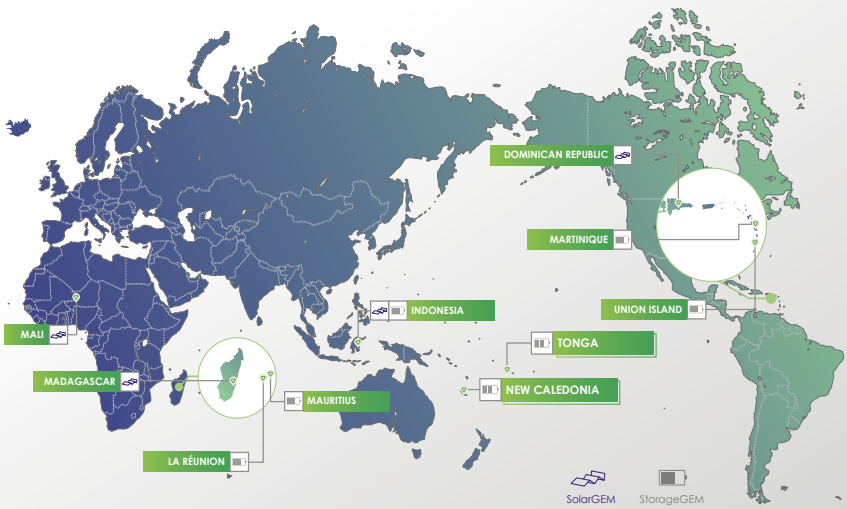
Akuo has developed off-grid and on-grid mobile solutions, designed for extreme conditions, customizable and scalable to fit your needs whatever your location, even in remote or cyclonic environments.

A strong track-record

on islands: Reunion Island, Corsica, Dominican Republic, the West Indies, **New Caledonia, Tonga,** Indonesia, Mauritius...

More than 70 containers

for 7.5 MW of production and 85 MWh of storage over 10 areas.



akuo +61 405 734 472 bock@akuoenergy.com akuoenergy.com

Papua New Guinea an Emerging Geothermal Energy Market

David Knight
Australian Geothermal Association

The Australian Geothermal Association (AGA) would like to highlight the geothermal potential in Papua New Guinea (PNG) in light of recent developments in light of the government's new Geothermal Resource Policy in late August 2020 which provides a clear legal framework for undertaking geothermal projects in the country.

PNG is composed of a group of islands in the south Pacific, only 150 kilometres north of Australia. PNG islands are remote, largely rural and dependent on diesel/fuel oil and hydropower for electricity generation and on rain harvesting for water (minimal groundwater). However, the volcanic islands of PNG are gifted with several natural resources including geothermal. While some geothermal exploration has been carried out, only one power plant exists, and other uses are based around tourism and cultural practises.

The utilisation of geothermal resources can contribute significantly to achieving water and energy related targets identified in PNG's Vision 2050.

https://www.treasury.gov.pg/html/publications/files/pub_files/2011/2011.png.vision.2050.pdf

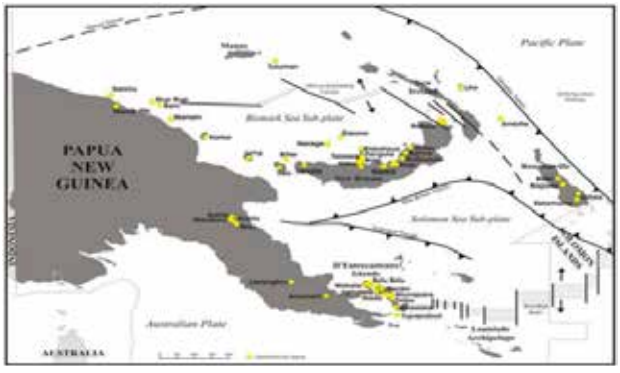


Figure 1: Geothermal manifestations from McCoy-West et al, 2011. in PNG

Mining is a part of the resources sector (mining and petroleum) in PNG, generating 26% of GDP (2017), and is the highest consumer of energy (~45 % of total). Existing and proposed mining operations are in remote areas throughout PNG where infrastructure is limited (electricity, water, road networks) and logistics is an ongoing challenge leading to high operating costs. As such, mining entities are open to innovative and technical solutions that can contribute to improving production and reducing costs while protecting the environment.

Other industries present in PNG could also benefit from geothermal heat and electricity. For example, in the census that AGA conducted in Australia in 2019, it was found that geothermal heat was used by a wide range of industry ranging from aquaculture, meat processing, remote communities and leisure and tourism. In PNG prospective industries include the fishing industry, the pulp paper and forestry industry, heavy industry such as smelters. Remote communities could also benefit greatly from geothermal developments.

PNG Geothermal Potential

PNG belongs to the Melanesian region of the Pacific islands and is home to >600 islands. The islands are located on the rim of the Pacific Ring of Fire, a tectonically active zone of earthquakes and volcanism. This zone is rather complex as it passes through PNG and includes island arcs associated oceanic trenches, volcanic belts and transform faults. The regional structure and history of igneous activity (particularly the Pre-Miocene igneous intrusions) led to the formation of several world class gold and copper deposits.

Geothermal resources associated with these volcanic chains have great economic and utilisation potential. Geothermal manifestations through the islands include hot springs fumaroles, mud geysers, sulphur deposits, hot and altered ground.

Over 50 areas with surface manifestations have been identified, but PNG has only one producing geothermal power plant: on Lihir Island (installed capacity of 56 MWe and temperatures of 240 to

300°C). Outside of Lihir, geothermal resources are limited to local utilisation for cooking and tourism. But geothermal resources have been described on e.g., New Britain, and the D'Entrecasteaux (Milne Bay) Islands with surface temperatures ranging from 60 to 100°C and reservoir temperatures (using geochemistry) estimated at 200 to 320°C.

The utilisation of geothermal resources can contribute significantly to achieving water and energy related targets identified in PNG's Vision 2050.

Opportunities for further development

Based on the data available and knowledge of geothermal systems we have identified potential applications discussed below.

Electricity Generation

Geothermal resources identified in PNG are generally remote, far away from populous areas. However, some are located near mining developments. This provides an opportunity for the utilisation of geothermal resources by mining companies for power generation thus decreasing operating expenses while also reducing the carbon footprint of those developments.

The Lihir geothermal powerplant provides a good (and unusual) example of geothermal power production in mining. Newcrest's Lihir Gold Mine, located on Lihir (Niolam) Island in the New Ireland Province of PNG, is one of the world's largest epithermal gold mines. During the development of the mine, a series of wells were drilled to de-pressurise the geothermal aquifers in order to allow mining to take place.

Two geothermal reservoirs were identified, a shallow reservoir (5-600 m) with temperatures of 240 to 250°C and a deep reservoir with temperatures of 250 to 300°C (>1000 m). In 2003, a 6 MWe geothermal powerplant (noncondensing unit) was commissioned resulting in savings of US$ 200,000 per month. In 2005, a 30 MWe (single flash, condensing geothermal unit) powerplant was commissioned with projected savings of $US 7 million (AU$ 8.82 million) for the remainder of 2005 and $US14 million in 2006. Since 2008, the powerplant's capacity sits at 56 MWe, approximately 75% of the operation's power needs. Additionally, the powerplant has contributed US$ 3.8 million (AU$ 4.5 million) in revenues from carbon credit sales.

Based on the review of available public data, similar geothermal resources to that of Lihir exist across PNG (200 to 320°C) and can be used to generate off grid production for other current or future mining operations.

Figure 2: Lihir geothermal project

District Heating and Cooling

Heat plays a significant role in several processes related to mineral extraction. Figure 3 illustrates the applications of geothermal fluids in terms of geothermal resource temperature in mining.

Figure 3: Lindal diagram showing applications of geothermal fluids based on temperatures in mining (after Patsa et al 2015)

Mining in PNG is dominated by gold, copper, silver, nickel and cobalt. Heap leaching is a method commonly used to recover metallic minerals, where broken ore is soaked with an aqueous

leachate solution for an extended period of time. Adding heat to this solution, commonly referred to as enhanced heap leaching, has been shown to accelerate mineral extraction, increasing gold extraction rates by 5-17 % and copper extraction rates by 1.2 % per °C change in the heap solution temperature.

Mining conditions throughout PNG are known to be hot. Low temperature geothermal resources (70-80 °C) could be used to improve working conditions via cooling using absorption/ adsorption chillers.

Water treatment

Water is a vital resource for mining operations as it is utilised for a wide variety of processes (ore processing, slurry transportation etc), as well as the employees. The remoteness of many mines adds another challenge for mine water security. In order to secure water supplies and to improve water management for mining operations, desalination has been used and is being considered by several mining entities globally. Throughout Chile operators including BHP Billiton, Antofagasta Minerals and Candelaria Mining are using desalination to provide potable water, water for mining operations and for wastewater treatment (since 2003). In 2009, a reverse osmosis desalination plant was commissioned in Newmont's Boddington open pit mine making it one of Australia's lowest cost gold mines. Several other desalination plants have been commissioned and/or are being developed in a variety of mines globally (e.g. uranium, iron ore, coal, copper) for example Olympic Dam in South Australia.

As noted above, desalination has been proven to be useful in many mining operations globally; however, it requires high energy input. To reduce costs, geothermal resources can be used to power desalination plants. Globally, a number of geothermal desalination projects have been carried out at temperatures of 60 to 100°C with produced water cost of USD1.2-1.6/m3.

Based on current available data, PNG's geothermal resources could be used to operate conventional and/or modular desalination systems, particularly multi-effect distillation which does not require the generation of electricity to drive the distillation process. Geothermal multi- effect distillation was extensively studied as part of the Western Australia Geothermal Centre of Excellence which operated between 2009 and 2012. This treated water can be used as potable water and or utilised throughout the mining process for, e.g., dust suppression, slurry transportation, cleaning of equipment, processing ore, etc.

Furthermore, there may be potential mutliple/ cascading uses for geothermal energy such as occurs at Warakei in New Zealand (eg power generation, multi-effect distillation, fish farms, greenhouses and/or other direct-use applications of the heat).

PNG geothermal resource policy

The PNG Government made a press release on 18 August 2020 in one of the daily newspapers (Post Courier) to introduce the new PNG Geothermal Resource Policy. In the press release, the Minister for Mining, Hon. Johnson Tuke, MP advised that the National Executive Council has endorsed the new policy.

Hon. Tuke stated that under the new policy, any exploration and development of geothermal resources in Papua New Guinea will be permitted under the PNG's Mining Act 1992.

Prior to this policy, there was no separate legislation, regulation or policy to assist with exploitation of geothermal resources in PNG. We note however that at least two applications were made historically under mineral exploration or mining legislation. Therefore, the endorsement of this new policy is a step in the right direction for future geothermal projects in PNG. This will also be a welcoming news for the global investment community.

The new policy will be administered by the Mineral Resources Authority of Papua New Guinea (https://mra.gov.pg). AGA will seek to provide updates on this recent development.

Historical PNG exploration

Geothermal investigations by government organisations, including those of Australia and New Zealand as well as PNG, go back more than half a century. Mosusu (2015) gives a good summary of recent work by PNG's Mineral Resources Authority.

Apart from Lihir, apparently there has been very

little field work by non-government entities. In 2011, licences to explore for geothermal energy in the Mt Lamington area and at Mt Trafalgar, Oro Province were granted to the Regency Mines – Direct Nickel joint venture, but no work was carried out and the licences were allowed to lapse. In the same year Iceland's Reykjavik Geothermal visited East New Britain and concluded that the region was prospective, but did not proceed through to tenure; due, at least in part, to the moratorium on granting licences.

In 2012 Kula Energy took a managing role in KUTh Energy (PNG) Ltd which holds applications to explore for geothermal energy over the Willaumez Peninsula in West New Britain and another two areas on Fergusson Island in Milne Bay. Warden's hearings were held at each site, with recommendations to proceed to grant. However, the applications remained 'on hold' while the sector was being reviewed.

As of February 2019 (the latest listing on the Authority's website), the only licence applications specifically for geothermal exploration in PNG are those held by KUTh over Talasea in West New Britain, and Iamalele and Salamo on Fergusson Island.

Figure 4: Fumerole at Talasea where reservoir temperatures have been estimated in the range 270-310°C (Lahan et al, 2015). Photograph by KUTH Energy (PNG) Ltd.

Recent developments in the region

Fortescue Metals Group

Fortescue Future Industries Pty Ltd, a wholly owned subsidiary of Fortescue Metals Group Ltd (Fortescue) has entered into a Deed of Agreement with the Government of the Republic of Indonesia [...].

The Deed of Agreement provides first priority to Fortescue Future Industries to conduct development studies into the feasibility of projects utilising Indonesia's [..] geothermal resources to support green industrial operations, principally for export to global markets.

https://www.fmgl.com.au/in-the-news/media-releases/2020/09/04/fortescue-future-industries- and-minderoo-foundation-in-indonesia

It has also been reported that Fortescue Metals, has had discussions and meetings on potential geothermal development in Papua New Guinea as well.

Pacific Centre for Renewable Energy and Energy Efficiency podcasts

Carbon and Energy Professionals (CEP), a New Zealand based association of energy efficiency and carbon reduction professionals, and the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE), a regional centre of excellence to promote sustainable energy investments, markets, industrial development and innovation in Pacific Island Countries are hosting three webinars on renewable energy in September.

https://cep.org.nz/webinar-series-accelerating-investments-in-renewable-energy-energy-efficiency- and-smart-mobility-in-the-pacific-islands/

Pohnpei Bulk Fuel Terminal
PV Battery Hybrid with Crude Nut Oil Generator

Balance Utility Solutions

The 607 islands of the Federate States of Micronesia (FSM), located in the middle of the Pacific are pointedly remote. This creates some challenges getting resources, such as fuel and fresh food to the country's some 105,000 residents. Energy across the islands is supplied mostly from costly diesel generation and many of the islands and areas remain un-electrified. The Micronesian islands however have an abundant coconut resource, a major untapped resource which is about to be utilised at a national commercial scale for the first time.

Vital FSMPC have diversified their revenue streams by owning and operating a Crude Nut oil processing facility in Pohnpei. To better enhance this business division, completed research over the past three years identified an area of high, wild coconut plantation density which Vital has managed to secure in Chuuk on the island of Tonoas. As a conclusion of this research a new agenda emerged to consider opportunities for hybrid renewable energy solutions, which make use of crude nut oil and coconut biomass for energy production on the FSM islands.

2018 marked the commissioning and completion of the Pohnpei Terminal's 40 kW Solar Hybrid UPS System with Crude Nut Oil (CNO) Generator. A first of its kind demonstration energy project in the Pacific, which uses 100% pure crude nut oil as a substitute to diesel.

Location: Pohnpei, Federated States of Micronesia

Project: Pohnpei Bulk Terminal – PV Hybrid UPS and Warehouse Upgrades

Solution: Balance PowerCore Solution 60kVA Inverter with 40kWh of Battery and 40kW of PV. Inclusive 35kVA CNO Generator and Auxiliary Power Components (Filter Skid, Feeder Board and Switch Board

Commissioned: June 2018

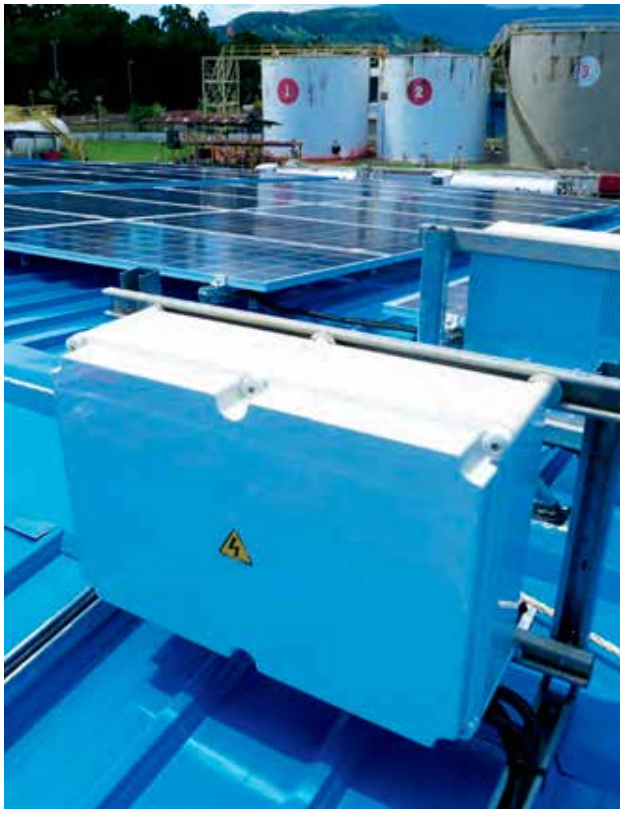
The PowerCore for this site has two modes of operation – Grid Preference Mode and CNO Generator Preference Mode. In Grid Preference Mode, the PowerCore controls the solar input into the loads and batteries on site and minimises any consumption of energy from the grid during the day. In the evening the battery will discharge the top portion of the battery.

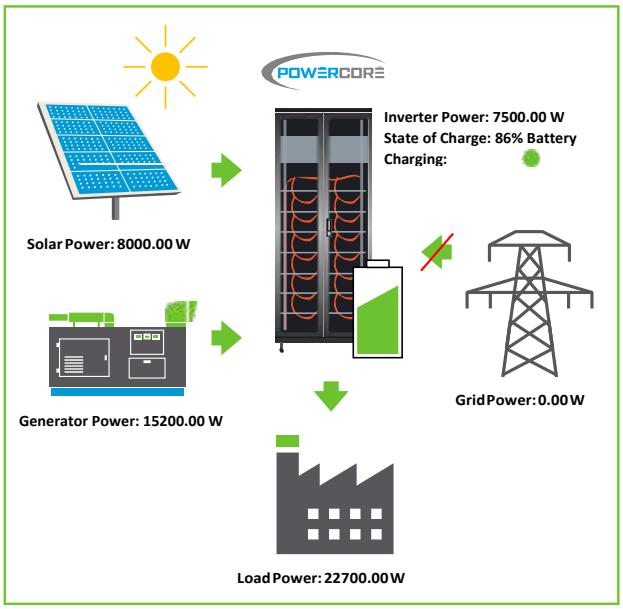
"The facility and supporting infrastructure will create economic value to the region, by providing jobs for local residents and develop new skills"
- Mr Matthias Lawrence (Vital Head of Strategy)

BALANCE SOLUTION

Design, Procure and Commission of 40kWp of Solar, 40kWh of LiFePO4 Batteries, 32kVA Crude Coconut Oil (CNO) Generator, CNO Filter Skid and Bulk Tank. Design, Procure and Commission of New Main Switch Board with soft starters for pumping station and new Feeder Board that manages the grid connection of inverter and islanding of system when required.

- Runs in Grid Preference Mode or CNO Generator mode dependent on if operator wants to burn more CNO fuel and not rely on grid.
- Supplies the entire bulk fuel terminal as a standalone solution when required.
- Fully automated solution and back up for Island Wide Power Outages.
- Fail Safe of 3 hours UPS Backup if Generator is not available and grid is not available in an emergency.
- Automatic transition from Grid to CNO Generator by shifting the Hybrid system into UPS Mode.
- Renewable generation load shift by storing excess PV in the system and discharging when PV is not available to the UPS State of Charge (60%).
- Online monitoring system using Mango Automation
- Automatic and configurable reporting presenting trends of solar generation, energy produced by CNO Generator and Grid usage.





RESULTS

The key result of this project is to showcase the hybrid systems ability to achieve an autonomous standalone system that produces 100% renewable energy with the use of Solar PV, Lithium based batteries and a CNO Generator - with or without a grid.

YOUR TRUSTED ASSET REPAIR SPECIALISTS

EMACS's highly experienced service and repair technicians are committed to meeting the demands of your power generation network. Our customized solutions, efficiency and reputation for excellence ensures your key assets remain reliable.

ELECTRICAL

- Generators and alternators
- AC & DC motors
- HV & LV electrical testing and rewinding
- 2.1MW load testing capabilities
- Overhaul, repair & replacement
- Capabilities from 1kW to 50MW
- White metal bearing service

MECHANICAL

- Pumps (centrifugal, vacuum, slurry, submersible, positive displacement)
- Fans and blowers (single and two-stage centrifugal)
- Gearboxes (in-line, multi-stage, parallel offset, planetary)
- Turbines & compressors
- Overhaul, repair & replacement

ONSITE

- HV & LV electrical testing
- Critical asset audits and inspections
- Onsite overhaul & rewinding up to 50MW
- Thermography, laser alignments, dynamic balancing
- Vibration analysis and ultrasonic
- Installation, supervision and commissioning

Electrical & Mechanical Repairs
Contact us to discuss our full range of services
Tel +61 7 3271 5599 **emacs.com.au**

EMACS

Low Temperature Micro Geothermal Power Generation Electratherm Power+Generator

David Knight
Business Development Analyst - ElectraTherm

Low temperature, micro geothermal resources provide renewable energy opportunities both in the Pacific and worldwide. In the past, low temperature geothermal and co-produced fluids have been considered a nuisance and uneconomical for power generation. Today advances in technology are available to tap this important resource to generate fuel-free, emission-free power.

In the Pacific region eight countries were highlighted, in a 2009 study, to having opportunities for tapping geothermal energy for power generation. These countries were Papua New Guinea, Vanuatu, Samoa, Tonga, Norther Mariana Islands, Fiji, New Caledonia and the Solomon Islands.

Power generation from these geothermal resources has not proceeded, apart from a generation plant at the Lihir Gold Project. This lack of development could be attributed to several factors including;

- focus on large scale development and previous failed regional geothermal projects,
- high equipment and infrastructure development costs,
- low temperatures of the resource and low electricity demand in the vicinity of the resource,
- locations in culturally and environmentally sensitive areas, and
- lack of knowledge of the technologies now available to economically exploit the low temperature resources.

ElectraTherm are working diligently to overcome both technology constraints and the knowledge gap, communicating with governments and utility authorities about the advancements in modular ORC technology that provides a viable solution for the development of these low grade resources.

Geothermal, unlike other renewable energy sources such as wind and solar, is a base load renewable energy solution that uses earth's heat for emission free power generation. The scope for increased geothermal power generation to contribute to meeting both the worlds and more specifically the Pacific region's energy demand remains high but issues such as resource development, environmental issues, capital costs and low economic return continue to restrict the development of new generating capacity.

With the advancement of smaller commercially proven waste heat to power generators, such as the Power+Generator, the opportunity now exists to utilize this equipment for power generation from available low grade geothermal resources.

As indicated ElectraTherm has been in the forefront of the development of small compact heat to power generators and was recognized as early as 2007 for their contribution to power generation using low temperature geothermal resources.

Since the first commercial release of the Power+Generator there have been many advances in technology which have resulted in a paradigm change in ORC design and application.

The current Power+Generator incorporates

- Best practice expander technology with

integration of the BITZER twin screw expander with a semi-hermetic design and built-in generator
- Latest technology control systems for improved performance optimisation and compliance with latest grid connection compliance codes.
- Increased output and improved efficiency through higher hot water input temperatures up to 1500C.
- Improved flexibility with combined heat and power capability (CHP) and integration as part of diverse heat to power generation systems.

Economically, improvements have involved measures to reduce equipment costs through selection and design, generating savings in manufacturing by modulization and increased sales and optimization of balance of plant requirements together with the ease of installation.

Development Factors

A key for the development of small low-grade geothermal resources, especially in cultural and environmental sensitive locations is to match power output to demand and to minimize onsite infrastructure. The Power+Generator has been designed with this requirement from conception and the design continues to be refined to further advance modulization, minimizing the impact on the environment.

The economics that support the development of a low-grade geothermal resources depend on various factors.

These factors include:

a) Availability of an existing resource that requires minimum development costs, such as an existing bore hole or natural hot spring, with temperatures and flow rates that match the operating parameters of the Power+Generator.

b) Availability of an active grid close to the resource and demand for electricity generated noting that the smaller modular systems do not require high demand usage.

c) Where possible the opportunity to use the geothermal resource more than once. ie. power generation and other direct use such as a tourist facility, food production etc.

d) Ability to achieve a strong Delta T, or difference in temperature between the heat in and cold water for the condensing circuit. Condensing water can be provided by an integrated dry cooler or an alternative cold water source such as sea water cooling.

e) Reasonable operating hours per annum. Typically micro geothermal sites are not limited in hours of operation and the general goal is to target sites that can operate 24/7/365.

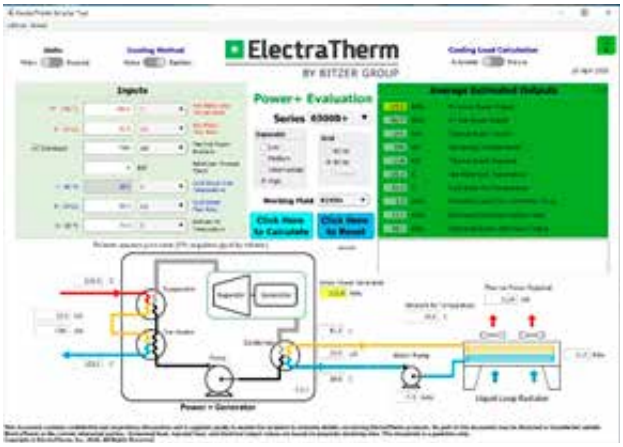
f) Minimizing capital costs for equipment and balance of plant.

g) Overcoming difficulty of installation. The modular nature of the Power+Generator provides opportunities for the development of difficult sites that would normally not be considered,

h) The value of power to the community to support the investment required.

Project Assessment

To assist in the initial evaluation of a potential geothermal application, ElectraTherm have developed internally a suite of tools that are used to determine the viability of a heat source to support the installation of an ORC system.



ElectraTherm Payback Estimating Tool

The factors that are used in the initial evaluation include details of the resource, potential electrical demand, estimated outputs, estimated costs and hours of operation and value of electricity

generated.

It should be noted that the value of electricity generated should not just include the value of the tariff but should also include allowance for improvements in grid stability, reduction in grid network losses and the important tangible benefits to the community from having a reliable electricity supply in quality of life, education and economic activity.

ElectraTherm Payback Estimating Tool

Using these tools, ElectraTherm are able to provide an initial indication on the viability of the geothermal resource before a commitment is made to develop a full proposal. In many instances the results from these assessments have surprised clients who were unaware of the potential economic return of a resource that they had previously discounted.

When the economics, including the value to the community, support the development of the geothermal resource then a commercially proven ORC System will provide a long-term solution for power generation and will bring many community based benefits.

Geothermal Installation Examples

The ElectraTherm Power+Generator is a commercially proven technology installed worldwide. Installations have also included various geothermal plants and we provide the following examples;

Oradea Romania

ElectraTherm supplied a Power+Generator for a micro geothermal project in Romania. The Power+Generator produced 50 kWe (gross) of electricity from a geothermal resource (1020C) without any fuel or emissions. To further increase the applications efficiency of the installation, once the geothermal water passed through the heat exchangers to pressurize the working fluid, it continued on to heat nearby residential buildings in the winter.

This site operated for several years and was supported economically by government feed-in-tariffs (FIT's) that supported geothermal power production. When the FIT ceased so did the economic viability of the project and the unit since ceased to be operated.

This clearly demonstrates the effect that government policies and the failure to attribute a value to the community and environmental benefits have on the development of small scale geothermal resources.

The ORC in Oradea Romania

Beppu Japan

An ElectraTherm Power+Generator is installed at Beppu Japan that utilizes the available heat from a low temperature geothermal system to generate renewable energy. This installation was an addition to an existing home district heating system to include power generation, taking advantage of a geothermal resource that was already being exploited.

ORC Installation at Beppu Japan

ORC Installation Central Japan

The ORC runs off varying flows of low tempera ture geothermal steam (approximately 1100C). As the ORC generates power, it also provides cooling with zero environmental impact or imposition on the onsen's primary function as a community resource. The power generated is sold to the local utility at an attractive feed-in-tariff rate for renewables.

This installation demonstrates the ability of the twin screw power plant to operate safely under varying heat flows and the importance of both dual use of the heat (power generation and district heating) and the dual operation of the ORC (generating electricity and cooling of resource)

Second Install Japan

A second Power+Generator has been installed in Japan using low temperature geothermal steam for the generation of renewable energy. The power generated is sold to the local utility at an attractive feed-in tariff for renewables.

The installation site for this unit was particularly difficult with innovative installation techniques required to place the Power+Generator in the required location.

This demonstrated the need for compact modular designs to enable installation in difficult and environmentally sensitive sites. The design of the Power+Generator is such that it has a small footprint and is unobtrusive, allowing it to blend into the environment making is suitable for installation in residential areas.

Japan has several advantages in the use of small geothermal resources that other countries do not, including thousands of existing bore holes for district heating systems and an advantageous feed-in-tariff for 24/7 renewable energy. These incentives increase the return of investment for ORC technology significantly offering opportunities for capital payback in the range of 3 to 5 years.

The Future

The future for low temperature ORC heat to power generation in the Pacific will continue to be principally driven by economics. It is expected that, through the placement of a value on the tangible benefits of geothermal power generation for the local communities and environment, an economic basis will be provided to support development of these resources.

The challenges remain but the continuing drive by ElectraTherm to further develop ORC technology will play an important role in future energy generation.

ElectraTherm remain committed to supporting the Pacific Nation communities and Power Authorities and welcome the opportunity to undertake assessments of potential geothermal and waste heat resources for power generation.

Two Results. **One Solution.**

Lower your truck roll costs.

How often are you sending trucks out to lateral lines to replace blown fuses? Each of those dispatches eats into your operations budget.

Put that budget to better use.

Reduce customer outages.

Over 80% of faults occur on lateral lines. Every outage impacts your customers, your call centre, and your bottom line.

It's time you change your protection strategy.

Reduce truck rolls **and** customer outages with
TripSaver® II Cutout-Mounted Reclosers

Learn more at sandc.com/TS2PACIFIC

© S&C Electric Company 2021, all rights reserved

U.S. Navy Transfers APRA Substation to Guam Power Authority

Patti L. Diego
Acting Communications Manager - Guam Power Authority

The Guam Power Authority (GPA) received ownership of the U.S. Navy's Apra Substation real property today. The Apra substation is operated by the Guam Power Authority and houses approximately $2 million of electric power utility equipment assets.

In 1987, US Public Law 100-202 authorized the Secretary of the Navy to transfer ownership of certain U.S. Navy-owned assets to GPA. In 1996, GPA began operating the U.S. Navy assets under a 50-year GPA-Navy Lease Agreement pending remediation of the properties in accordance with federal and local laws. Having met the requirements under the public law for the Apra transfer, and in partnership with the Governor's office, the Guam Legislature, and the Public Utilities Commission, and with the approval of the Consolidated Commission on Utilities, GPA continues to work with the U.S. Navy for future transfers.

"This land transfer has been 33 years in the making and is the first of many that the Navy has committed to, so it is truly a monumental event," said Capt. Tim Liberatore, commanding officer, Naval Facilities Engineering Systems Command Marianas and Regional Engineer, Joint Region Marianas. "I want to thank both teams and give credit especially to our real estate business line, Karianne Camacho and Cynthia Blas. To paraphrase Astronaut Neil Armstrong, it's one small piece of land, one giant leap for Guam, and highlights the Navy's commitment to One Guam and the net-negative pillar of that initiative. I look forward to future land transfer events and accelerating those transfers."

The transfer of the Apra substation to GPA is the first, and paves the way for more U.S. Navy property and assets to be transferred to GPA, including approximately 80 miles of transmission lines, 17 miles of distribution lines, 16.5 miles of fuel lines, and 5 sites totaling 37 acres. GPA has been maintaining and operating these assets for more than 20 years under the GPA-U.S. Navy Lease Agreement.

"Today's land conveyance is the culmination of many years of collaboration between GPA and the Department of the Navy to partner and build an electrical infrastructure that will serve our entire community. Our work is not over, as this is the first of several transfers to come," said GPA General Manager John Benavente, P.E. "I applaud the work of the professional employees of GPA and the U.S. Navy for their continuous work to fulfill the One Guam goals."

"The Apra substation is a critical link within the islandwide power system, which will connect to the 115kV transmission line Hanwha, renewable energy provider, will be constructing in partnership with GPA to link 60 megawatts of solar energy being built in southern Guam," Benavente added. The Apra substation serves over 2,200 families and businesses in Agat and Santa Rita villages; and, through one of its feeders, provides backup support to U.S. Navy power distribution lines in the area. GPA is the sole provider of bulk electricity to the U.S. Navy.

GPA and U.S. Navy officials attending the land transfer signing, today at the Gloria B. Nelson Public Service Building in Mangilao are shown above. Sitting (L-R): Stephanie Flores, Guam State Clearinghouse Director (representing Lt. Governor Joshua Tenorio); GPA General Manager John M. Benavente, P.E.; Consolidated Commission on Utilities Chairman Joey Duenas; CAPT Timothy Liberatore, commanding officer, Naval Facilities Engineering Systems Command Marianas and Regional Engineer, Joint Region Marianas; and Karianne Camacho, NFM Real Estate Contracting Officer.

Standing (L-R): Frances S. Reyes, GPA Administrative Officer-Engineering; Tricee P. Limtiaco, GPA Assistant General Manager Administration; Sylvia Ipanag, GPA Planning & Regulatory Manager; Melinda C. Mafnas, P.E., GPA Assistant General Manager Operations; Antonio Gumataotao, GPA Real Estate/ GIS Supervisor; John E. Kim, GPA Chief Financial Officer; D. Graham Botha, GPA Staff Attorney; Joven Acosta, P.E., GPA Manager of Engineering; John Aguon, NFM Legal Counsel; Cynthia Blas, NFM Realty Specialist; Victoria Zialcita, NFM One-Guam Electric Program Coordinator; Glenn Camacho, NFM Realty Specialist; Antonio R. Palomo, GPA Land Agent III and Martin Ogo, GPA GIS Analyst III.

Reducing the Waste Oil Stockpile

Marshalls Energy Company, Marshall Islands

A 30-year Build-up of Waste Oil

For the last 30 years, MEC has been tasked by the RMI government to store all waste oil in the Republic of the Marshall Islands (RMI). MEC is the sole government agency responsible for storing waste oil from the RMI vessel fleets, garages, and the MEC, Wotje, Jaluit and Ronrong power stations. By 2019, waste oil stores had built up to roughly 1.3 million gallons and stored in MEC's two 750,000-gallon tanks at the Delap Tank Farm and 120,000 gallons at the KAJUR Power Plant.

Although waste oil production is expected to decrease over time, the need to properly store and dispose of waste oil will continue into the foreseeable future. As of December 2020, MEC collects an average of 37,000 gallons of waste oil annually. Improved fuel quality and machinery efficiency has and will continue to decrease this propagation. However, substantial reductions in waste oil generation require significant changes to land and fishery fleet fuel grade quality, which are outside MEC's authority. With these considerations, MEC estimates collecting 28,800 gallons annually by 2025.

With waste oil production continuing, it became necessary for MEC to find an environmentally safe and economical method to dispose of the massive backlog and future waste oil stores.

Exporting RMI's Stores of Waste Oil

MEC began planning for waste oil reform in 2012 as part of a larger organizational, procedural, and physical reform of the agency. With the help of international funding, MEC began serious reform efforts in December 2018, which included physical improvements to increase safety measures and decrease negative environmental impacts. Among these efforts, was the laudable move to export the 30-year backlog of waste oil.

In late 2019, MEC entered into an export agreement with a South Korean firm. Under this contract, the firm pays MEC for its waste oil, which is shipped to Korea for disposal and recycling.

A massive effort to collect and package RMI's waste oil commenced. In October 2019, MEC in close coordination with its sister agency KAJUR, collected and packaged eight bladder containers — nearly 50,000 gallons — from the KAJUR Power Plant. MEC also drained the waste oil from its tanks, dropping the volume from over a million gallons to about 300,000 gallons in the Delap tank farm.

Beginning in November 2019, MEC started exporting waste oil to South Korea. Through this contract, MEC has exported 36,000 gallons of waste oil monthly from November 2019 to June of 2020. Beginning in July of 2020, this was increased to 60,000 gallons a month. Under the current schedule, MEC expects to complete exporting waste oil that has built up over 30 years by June 2021.

The Future of Waste Oil in RMI and Next Steps

With this agreement in place, MEC can continue to provide an invaluable service to the RMI community by safely storing and shipping its oil waste overseas.

However, reform is far from over. MEC continues to improve the management, operations, and infrastructure of its tank farms and petroleum business. On the organizational level, MEC is working tirelessly to hire necessary staff vacancies and train new and existing staff in required skills and petroleum terminal competencies. Procedurally, MEC is setting up the necessary health, safety, environment, and ergonomics (HSEE) management system, implementing emergency procedures, and improving quality control systems. In the next 30-years, MEC envisions a safer and more sustainable RMI.

Exclusive Roundtable Discussion at the Island Finance Forum Hosted by Mana Pacific and Island Innovation

Bryce Barbier
Business Analyst - Mana Pacific

The Island Finance Forum is an annual event which gathers regulators, financiers, and senior policymakers to offer novel solutions for sustainability, economic recovery, and growth by addressing the financial challenges that particularly impact island communities. The Forum is taking place virtually this 14-15 April, 2021.

A similar event hosted by Island Innovation, the Virtual Island Summit, occurs annually in September and attracts over 10,000 attendees.

Image shows: Mana Pacific and Island Finance Forum branding

This year Mana Pacific has partnered with Island Innovation to sponsor an exclusive roundtable event where a range of stakeholders of different backgrounds will be brought together and engaged to share insights, and discuss the challenges they experience developing and maintaining energy resilience throughout the Pacific.

With moderators guiding the discussion participants will co-create tangible and actionable solutions that address the Pacific's resilience needs. Furthermore, this event is an opportunity to catalyze further productive collaboration and relationships between attendees.

The exclusive nature of the event ensures a worthwhile networking and learning environment for all who participate. Mana Pacific's Founder and President, John Miller, states "This event will be the ideal space to facilitate conversations and innovative solutions on how to transition Pacific islands to a sustainable and resilient energy future." The event will be hosted using Island Innovation's cutting-edge web-based application, Remo, which will engage participants in an interactive and collaborative manner.

Image shows: Remo, a Web-Based Software application that provides an immersive virtual conference experience

This February 2021, Mana Pacific concluded its first of four preliminary focus group discussions/ working sessions as a build up to the grander Pacific Roundtable. The first brought Pacific Power Association utilities, manufacturing companies, and other stakeholders together to express challenges related to procurement, supply chain logistics, and systems standards. Keynote remarks were provided by Mr. Tom Tansy, Chairman of the Sunspec Alliance. Participant feedback from these focus groups will be distilled into critical questions and topics to explore at the Pacific Roundtable event.

Image shows: Focus Group on Cost of Equipment, hosted with Remo

More about the host, Mana Pacific is an impact-first Social Enterprise (Benefit Corp.) doing renewable energy project development and enhances islands' resiliency goals, climate change initiatives, and local economic development. Mana Pacific aims to accelerate the development of renewable energy resources in the Pacific islands through the use of a trans-

Pacific partnership approach. In doing so, the traditional development cycle is streamlined, opportunities for economies of scale arise, and risk is mitigated.
www.manapacific.com

Bringing renewable, reliable, and resilient power to the Pacific is a monumental challenge. Mana Pacific is hosting this roundtable with the intention to first understand the long road ahead from all perspectives. The Roundtable event will be a significant opportunity for participants to both contribute their specialized expertise and absorb that of others. For more information about the Roundtable visit:
islandinnovation.co/finance-forum-2021/

Network reliability heavily depends on the technical capability and competence of staff

Ask us about our power industry training solutions today

AVO®

0800 485 990 | www.avo.co.nz

sales@avo.co.nz

Megger
Power on

SWC50-The Century of Solar Celebration

ISES SWC50 The Century of Solar Stories & Vision Booklet

This month we provide

- A brief overview of solar research and applications pre-1950; and
- A focus on India

The overview of solar pre-1950's provides some key highlights taken from the booklet:
ISES SWC50 The Century of Solar Stories and Vision Booklet

For more highlights, please refer to the booklet or the ISES Solar Energy Museum – Past, Present and Future

Photovoltaic's Pre-1950

The modern-day PV cell was developed in the 1950's however two significant events in the history of PV pre-
1950 include:

- In 1839 French scientist Edmond Becquerel discovered the photovoltaic effect while experimenting with an electrolytic cell made up of two metal electrodes placed in an electrically conductive solution where the electricity generated increased when exposed to light.
- In 1876, William Grylls Adams and Richard Evans Day (UK) discovered that selenium produces electricity (photovoltaic effect) when exposed to light. Although selenium solar cells failed to convert enough sunlight to power electrical equipment, they proved that a solid material could change light into electricity without heat or moving parts.

Solar Thermal Pre-1950

Using the sun to heat water was commercially available in West Coast USA in 1891(Clarence Kemp with Climax Solar) however some significant events prior to that include:

- In 1767 Horace-Bénédict de Saussure built his "hot box" plate collector.
- Starting in 1860, the French mathematics professor Augustin Mouchot constructed a series of solar water heaters made of reflectors in various shapes and water-flowing cylindrical absorbers made of blackened copper. Mouchot used these devices partly as solar stoves, partly as distillation apparatus for brandy and partly to produce steam to drive motors and pumps.

What is SWC50 – The Century of Solar?

In 1970 solar research pioneers met at the first International Solar Energy Society (ISES) Conference in Melbourne Australia. ISES is commemorating this first Solar World Conference with a special 50th Anniversary Virtual Conference, called the Solar World Congress at 50 (SWC50).

During these past 50 years solar energy has grown from being emerging technologies to a vibrant industry. The Century of Solar highlights the transformation in the global energy sector that has taken place since the first Solar World Congress in 1970 and looks forward to the next 50 years when solar energy will be a major cornerstone of the global energy system. While the focus of the Century of Solar is on the evolution of solar energy, the importance of other renewable energy sources working together to reach the 100% renewable energy world goal will be a central theme.

SWC50 - The Century of Solar is about the people: researchers, industry players, policy makers, and leaders of NGOs and Non-profit organizations who have all contributed to make solar energy the fastest growing contributor to new electricity capacity.

SWC50 Programme: The SWC50 virtual conference was held on 3 - 4 December 2020, with two follow up webinars due in 2021.

Concentrating Solar Power Pre 1950

As early as the 3rd century, Dositheius, a mathematician, observed that solar rays bouncing off a parabolic mirror focused on a point could produce high temperatures while around 1515, Leonardo da Vinci developed drawings

for industrial applications of solar energy using parabolic mirrors. However, two early working machines include:

- In 1878, for World Fair in Paris, Augustin Mouchot constructed a solar machine that had a conical reflector five meters in diameter . This was able to drive a pump that could transport around 2,000 liters of water per hour.
- The American Frank Shuman built a power plant from 1913 onwards in the then British protectorate of Egypt. It consisted of five elongated parabolic trough collectors that reflected solar heat onto a zinc pipe suspended in its focal point and heated water in it. Shuman's power plant achieved an output of 55 horsepower and, given the coal prices in Egypt at the time, was also competitive with fossil fuel power plants. This plant used an insulated tank to store hot water to allow the plant to run 24 hours a day.

Solar Architecture/Buildings

Out of all the applications for solar, making use of the sun to heat buildings is the oldest, for example:

- In China during the Zhou Dynasty (before 12th century BC) the government instructed builders to use gnomon to determine where what we now call solar noon was at the equinoxes and solstices and by 7th century BC positioning buildings to face true south. Note : Gnomon, developed in about 2000 BC, were sticks or rocks perpendicular to the ground used to track the movement of the sun.
- Socrates in ancient Greece promoted that houses should be pleasant to live in and be cool in summer and warm in winter by having buildings that provided shade when the sun was high and provided warmth on porches when sun was low. Archaeologists found a rectangular building near Athens, where Socrates lived, that faced south with the entrance and courtyard in that direction and the main rooms on the north.
- Olynthus was northeast of Athens . Around 345 BC a new district was created in area called North Hill. The streets ran east-west so that the houses could be built facing south. The streets were spaced wide enough so that they would all get the winter sun.
- Vitruvius was a Roman architect in first century BC and is believed to have visited Greece as a military engineer . He wrote The Ten Books of Architecture and in this he advised architects and builders in more temperate parts of the Roman Empire that " buildings should be thoroughly shut in rather than exposed towards the north, and the main portion should face the warmer(south) side"

The above examples show that using solar energy is not new. Though it is often stated it is the way of the future, it has been the way of the past and has been applied for centuries.

For more highlights, please refer to the booklet or the ISES Solar Energy Museum – Past, Present and Future.

Focus on India

The origin of the Solar Energy Society of India (SESI) goes back to the year 1967, when a Solar Energy Working Group was constituted at the Central Salt and Marine Chemical Research Institute (CSMCRI), Bhavnagar (Gujarat-India). Dr. R. L. Datta, Dr. Gomkale, Dr. Chaman Lal Gupta, Ms. Anna Mani and Mr. J. C. Kapoor were the key players during the formative days of the Society. In the run-up to the formal establishment of SESI as a registered body and as the national section of ISES, several meetings and conferences on solar energy were organized under the auspices of the Working Group, with Dr. R. L. Datta as its first secretary. A conference on solar energy was first held followed by several meetings during 1967–68. In 1974–75 the All India Solar Energy Working Group formally became affiliated with the International Solar Energy Society and was named Solar Energy Society of India (SESI). The Solar Energy Society of India was formally registered under the Societies' Act with a full governing council and office bearers, and its first national convention was held at Jadavpur University in 1976. (Further information on the early years of SESI can be found in the *The Fifty-Year History of the International Solar Energy Society and its National Sections'*.

Today SESI has total membership strength of 2000. Majority of them are engaged in the research, development, manufacturing and programme implementation activities etc.

SESI is administered by its Governing Council of twenty members elected once in two years, consisting of the President, six Vice Presidents, a Treasurer, a Secretary General and 11 members of whom one is the immediate past President. The council meets two or three times a year. The Annual General Meeting of the members is normally held at the time of the International Congress on Renewable Energy (ICORE).

Day to day administration is provided by the Society Secretariat headed by the Director General.

Indian ISES Presidents and Solar World Congresses

India has had one ISES President:

Dr. R. L. Datta 1978-79

India hosted the Solar World Congress in Delhi in 1977. The 2021 SWC was due to be hosted by India however due to the pandemic the 2021 SWC will be online, however 2023 SWC will be held in New Delhi.

Sample of India Pioneers Pre-1980

Each month this Newsletter will have a sample of people involved with renewable energy prior to 1980, coming from both research and industry.

It is impossible in this monthly newsletter to cover the thousands who have contributed to the development of renewable energy prior to 1980. What is included in each newsletter is just a snapshot of those included SWC50 celebratory booklet: *The Century of Solar-Stories and Visions.*

Dr R. L. Datta

Dr. R . L. Datta (India) was educated in India and England, with degrees in Chemistry and Applied Chemistry. He studied separation processes at the Max Planck Institute in Germany and worked at the Central Salt and Marine Chemicals Research Institute in India. His contributions to solar energy R&D were in the field of salt production by solar evaporation, solar distillation, solar ponds, and space cooling. He was active in a wide variety of energy agencies, including as chairman of the All-India Solar Energy Working Group, Convener of the Energy Research Committee of CSIR (the government of India), Member of the ad hoc Committee of the USA Academy of Sciences for Solar Energy for Developing Countries, and others.

Prof (Dr) H.P Garg

A pioneer in Renewable Energy Research and Education in India, Prof. (Dr.) H.P. Garg has achieved National and International recognition for his outstanding original contributions to the development and design of solar energy technology applications. Largely due to the zeal and perseverance of Prof. (Dr.) H.P. Garg, a range of quality assurance processes have been adopted in India and abroad which has earned him the credit of Renewable Energy Man. In addition, Prof. Garg has spearheaded the establishment of academic programmes focusing on research and training in renewable energy at the Indian Institute of Technology (IIT) Delhi as well as at many other engineering institutions in the country. He has also led the effort to develop suitable training material for several of these academic programmes, including his 18 books, more than 520 research papers, 80 technical reports and supervising 30 Ph.D. students. Prof. Garg has been actively engaged in Teaching; Research, Development and Demonstration (RD&D), and Consultancy in the field of Renewable Energy; Technical & higher education, Management and Energy Education and Administration for the last 55 years, mainly at the Indian Institute of Technology (IITD), New Delhi, India as Professor (Solar Energy) and Head. In between, on deputation, he was Director General and Principal Secretary, Department of Science & Technology, M.P. Govt., India during 2002-2004. Presently Prof. Garg is the Director General at Trinity Group of Educational Institutions, New Delhi and Adjunct Professor, Netaji Subhash University of Technology, New Delhi.

Prof Biswajit Ghosh

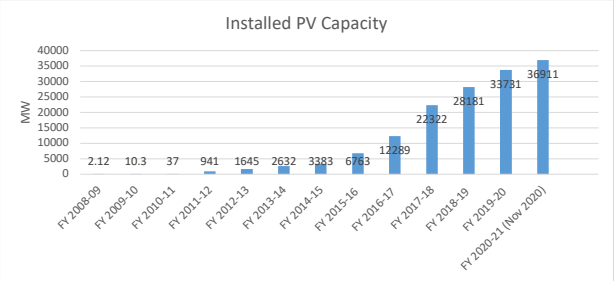
Prof Biswajit Ghosh started his research career as PhD Student in the field of CdTe Thin film solar cells at Jadavpur University, India in the year 1978. He has more than 42 years of experience in Teaching and Research in the field of Solar

Photovoltaic. He was Professor and Director at School of Energy Studies, Jadavpur University, Visiting Professor at Kalinga Institute of Industrial Technology, Adjunct Professor, Manipal University and Leverhulme Visiting Professor at Newcastle University, UK. Presently he is serving as Vice-Chancellor of The Neotia University, Kolkata, India. He has worked as Visiting Research Scientist at University of Stuttgart, Germany; as Fellow, European Commission at Northumbria University, UK; as Academic Visitor at Imperial College, London; as Royal Society Overseas Scientist at University of Surrey, UK and as Visiting Professor at Newcastle University, UK. He has received D. Sc. (Engg.) from Jadavpur University in 2008 and D.Sc. (Honoris Causa) for outstanding contribution in Science, Engineering and Education by the National Institute of Technology, Agartala, in the year 2017. He was nominated for prestigious European award by World Renewable Energy Council for 'Edmond Becquerel Prize' and received Best Scientific Poster Award by the EU at 24th EU PVSEC, at Hamburg, Germany.

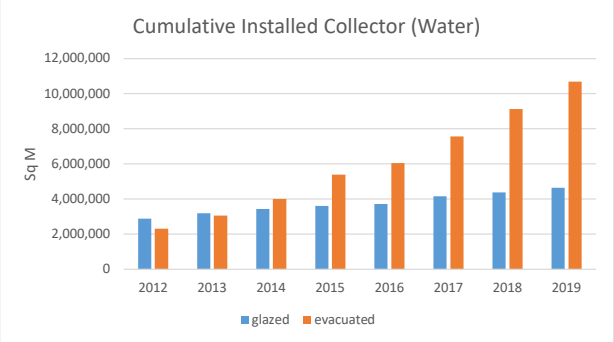
Within the booklet there are a number of people of Indian origin who started their research in India but then moved to other countries where they spent most or all of their working lives. Other Indians that are listed as pioneers in the booklet include:

Name	Year Started	Research or Industry
Ravikumar Gurumurti	1982	Industry
Rabindra Satpathy	1982	Industry
Dr Gouri Datta	1984	Research
Deepak Gadhia	1985	Industry
Dr. Jami Hossain	1985	Industry
Dr. Mrs. Janak Palta McGilligan	1985	Industry
Dwipen Boruah	1990	Industry
Dr Harish Hande	1992	Industry
Jaideep Malaviya	1995	Research and Industry

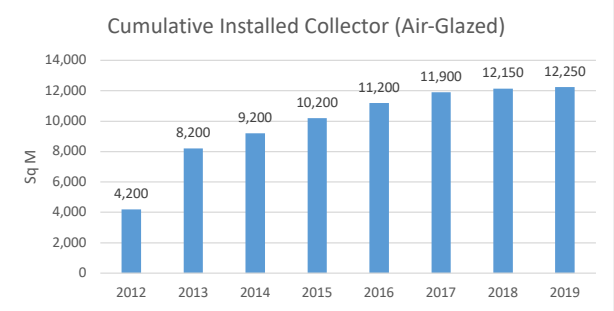
India's Growth in Solar



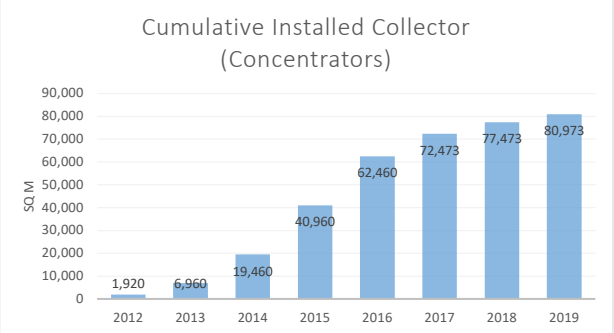
Source: Ministry of New and Renewable Energy (MNRE)



Source: Malaviya Solar Energy Consultancy



Source: Malaviya Solar Energy Consultancy



Source: Malaviya Solar Energy Consultancy

Renewable Energy Pioneers

Without the efforts of individual researchers, system designers, system installers, business leaders, policy makers and those within the

donor community, the renewable energy industry would not have grown from watts to Gigawatts in the last 50 years. ISES' way of acknowledging the many people was by issuing a call for the submission of Renewable Energy Pioneers to be listed in the celebratory booklet.

ISES will be releasing an updated version of the booklet in December 2021 and therefore **ISES is re- issuing the call for submissions of the names of individuals covering the following two categories:**

1. **Research Pioneers:** Individuals who started their research in 1995 or earlier.
2. **Industry Pioneers:** Individuals who actively started working in or with the renewable energy industry in 1995 or earlier.

Partners of SWC50

ISES acknowledges the support provided by the Platinum Partners: GSES from Australia and NREL from USA; Gold Partner: Smart Energy from Turkey.

Welcome!

New Allied Member

There hasn't been any new Company that has joined PPA as Allied Members since our last PPA Magazine

High-quality solutions for energy utilities

Power Protection Industries delivers customised electrical solutions throughout Australia and Asia Pacific

We offer a wide range of world-leading products

- Line hardware
- Earthing solutions
- Fuses
- Insulators and surge arrestors
- Transformers

Our expert services

EARTHING SYSTEM DESIGN | SUBSTATION EARTHING AUDITS | LIGHTNING PROTECTION AUDITS | RENEWABLE ENERGY DESIGN | RENEWABLE ENERGY FEASIBILITY STUDY

Call: +61 7 3734 715 I Email: sales@ppindustries.com.au
www.ppindustries.com.au

PPI Power Protection Industries

NEWAGE® | STAMFORD® | AvK®

Powering the world with confidence since 1904

NEWAGE | STAMFORD | AvK
Sales Manager: Craig Cowland
craig.cowland@cummins.com
Tel: (+61)4 00751667

www.stamford-avk.com