Sun, wind and fire

Renewable energy in the Pacific

One of the ironies of anthropogenic climate change is that Pacific Islands threatened by rising sea levels are also highly dependent on carbon-emitting fossil fuels for their energy needs. So as the Pacific Island nations plead for the major nations to reduce their reliance on carbon-emitting fuels and save these island paradises, action is also urgently needed to reduce the Pacific Islanders' carbon dependence.

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Half of Fiji's electricity supply is provided through diesel power stations spread across the three main islands, with Vanua Levu – the second largest island – entirely dependent on diesel. In Samoa, over two thirds of electricity demand is met through diesel generators, with

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In the Cook Islands, importation of diesel costs as much as 28% of GDP

the largest island of Savai'i also entirely powered by diesel.

For the smaller island nations, Tonga is almost exclusively dependent on diesel for power generation. Similarly, the Cook Islands electricity grid is based on 9 diesel generators, primarily situated on the main island of Rarotonga, while Vanuatu is dependent on diesel generators for over 80% of the archipelago's electricity. This diesel dependency also exists in the USA territory of American Samoa, as demonstrated in 2009 when a tsunami damaged the Satala diesel power plant in Pago Pago. This withdrew 23 MW of generation capacity, approximately 60% of the territory's total capacity. Unfortunately, rather than promote renewable energy resources, the power plant was merely replaced with more efficient diesel generators.

The use of diesel power is not restricted to the developing countries of the Pacific. The USA state of Hawaii generates over 90% of its energy from diesel and coal. Hawaii has no fossil fuel reserves and so this fuel needs to be imported, which makes electricity prices in Hawaii the highest in the USA, generally over double the price in continental USA.

A perfect demonstration of this occurred during the 2000 California energy crisis, where electricity prices spiked on the west coast of the USA because of the removal of generator capacity and market manipulation by the now bankrupt Enron. However, at the same time the outer Hawaiian island of Kauai, isolated from the crisis, had electricity price on average higher than California during the crisis, because of its dependence on imported diesel and old, less efficient, power generators.

The large dependency on diesel for power does not translate into Pacific Islanders having a large carbon footprint, with the average Fijian only producing 0.61 tonnes per year; in comparison, the average Australian produces 18.3 tonnes of carbon per year. This low carbon footprint is due to a lack of heavy industry in the Pacific, a small transport sector, an electrical grid limited to the major urban areas, a spread of population across isolated communities on numerous islands and the low energy demand in these isolated communities.

For all the dependence the Pacific countries have on diesel, there are no fossil fuel reserves within Polynesia, Micronesia and only small deposits within Melanesia. Hence, all of the diesel must be imported. This exposes Pacific countries to risks associated with foreign exchange fluctuations and fuel price increases. This is believed to be partly responsible for low economic growth in the Pacific. For example, in the Cook Islands, importation of diesel

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The Pacific's dependency on diesel has been built up over decades through domestic and foreign investment as well as foreign aid, especially when oil prices were low. Hence, there is urgent need for the Pacific to develop renewable energy based on indigenous resources. This will enable the region to become energy independent, improve regional security and is also expected to improve economic development in the Pacific through lower energy prices promoting investment.

Harnessing the Future

There are some limited renewable projects currently underway in the Pacific. For example, in the Kingdom of Tonga a solar facility provides 1.4 MW to the island of Tongatapu, while the Maama Mai solar facility was commissioned in 2012. This solar installation consists of 5,760 photovoltaic panels and was funded by the New Zealand Government. The Maama Mai facility saves Tonga almost 500,000 litres of diesel per annum. There are also much smaller solar power facilities on outer islands powering isolated communities.

In the Cook Islands there is renewable energy in the form of both solar and wind, but is currently only limited to 40 kW. Fiji and Samoa, consisting of mountainous islands, have some hydroelectric generation. On Viti Levu, Fiji, there are the Monasavu and Nadarivatu hydroelectric schemes based on the fast flowing rivers from the island's interior. Monasavu was commissioned in 1983 with a generation capacity of 80 MW, while the Nadarivatu scheme was commissioned in 2012 with half that capacity.

In Samoa, on the main island of Upolu, 11.5 MW is generated by hydroelectric. There is also wind generation capacity, with Fiji having over 37 turbines producing a combined output of 10 MW, this saves the island nation 8000 tonnes of diesel per year, which is calculated to also reduce 25,000 tonnes of carbon dioxide from being released into the atmosphere per year.

Most solar and wind generation capacity is primarily for individual consumers usage and not associated with national electricity grids. This is clearly evident in the holiday resorts scattered throughout the Pacific nations, where utilities are generated and consumed in-house; rarely are they connected to the local grid.

Pacific nations do have renewable energy targets, with Tonga setting the ambitious objective of reducing their reliance on fossil fuel for electricity generation by 50% by 2020, and Samoa aims to have 20% of its power needs met by renewable energy in 2030. Hawaii has an aggressive renewable policy, aiming for 100% renewables by 2045, and is a signatory to the Paris Agreement. In comparison, Australia has a renewable energy target of achieving 23% by 2020.

These targets will be met by replacing existing diesel generation capacity with renewable, as well as building new renewable capacity to meet the island nations' growing demand. The good news is that the Pacific islands have some exciting opportunities for renewable energy, and the Melbourne Energy Institute at the University

IMAGE: © NOAA

of Melbourne is in the process of determining the renewable generation capacity available, the infrastructure and financial support needed to develop these projects, as well as setting out the roadmap to provide assistance to Pacific nations to meet their renewable targets.

Solar energy is the most obvious renewable in the Pacific, given the islands are tropical paradises. There is outstanding solar potential in all Pacific nations and when coupled with battery storage will be able to provide essentially all of the region's current and future power demand. To date, the majority of solar generation capacity is limited to tourist resorts, small scale installations in rural communities and isolated islands. These facilities clearly demonstrate the success of solar and, given the relatively high cost of imported diesel, means that solar energy is economically competitive.

However, to achieve wide uptake of solar power there needs to be substantial investment in solar panel infrastructure as well as adapting and building each country's electricity distribution grid. This has been demonstrated on Ta'ū in American Samoa, where 5000 solar panels and 60 Tesla power packs have been installed, which has completely decoupled the island from diesel.

The investment for solar power has been estimated to cost hundreds of thousands to tens of millions of dollars, depending on an island's size

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IMAGE: © Jim Brooks - US Navy

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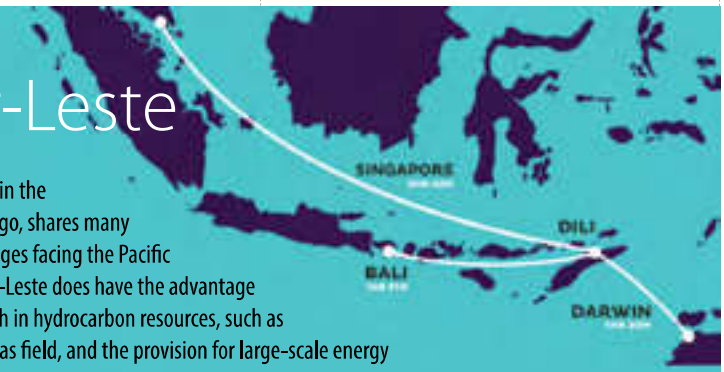
and population. This is a substantial investment, which will most likely take the form of foreign aid as Pacific islands' energy needs are small compared to global demand, meaning large multinational energy providers are unlikely to find the Pacific an attractive market to enter. This aid investment has already been demonstrated by Non-Governmental Organisations (NGOs) who are installing small-scale solar facilities in rural and isolated communities to provide lighting, localised electricity and power essential services.

Wind is another viable renewable, with trade winds blowing across the majority of the islands of the Pacific. There is already limited wind capacity on many islands, where small scale turbines are used for individual residential consumers. This form of renewable is ideally suited for small and isolated islands because of the ability to locate generation near consumers without the need for long distance transmission lines. Indeed, for many small communities wind generation is more viable than solar, because of the consistency of the wind source day and night. However, these small scale wind farms will not generate the large scale power needed for significant economic growth. Large scale wind generation is currently limited to Fiji.

The ability to grow wind generation capacity in the Pacific is again strongly dependent on foreign investment and will require foreign aid. NGOs are also active in wind energy on the local level, providing isolated communities with small scale wind facilities that can offset their reliance on diesel. It is important to point out that the availability of wind is not equal in the Pacific. Kiribati's main archipelagos are located at the equator, meaning the islands lie in the 'doldrums'. Here the prevailing winds are calm and hence wind generation is extremely limited in comparison to the island chains further south.

Geothermal is a renewable that can provide cheap base load power in substantial quantity to a number of Pacific countries. Papua New Guinea and Fiji have the highest potential for geothermal, followed by Vanuatu, Solomon Islands, Samoa and Tonga. The electricity is generated from superheated water powered by volcanic sources deep underground. On the island of Efate in Vanuatu, such hot water takes the form of natural springs that are a local tourist attraction, where the source reservoir deep underground has a temperature greater than 160°C. Directly accessing this deep hot water

Timor-Leste



Timor-Leste, located in the Indonesian archipelago, shares many of the energy challenges facing the Pacific island nations. Timor-Leste does have the advantage that it is relatively rich in hydrocarbon resources, such as the Greater Sunrise gas field, and the provision for large-scale energy infrastructure are core components of Timorese development strategies. This provides a greater scope for Timor-Leste to drive its own economic growth than is found in the Pacific region. There are also smaller-scale opportunities for localised power generation associated with natural methane seeps, which are located along the relatively remote south coast.

The Melbourne Energy Institute is actively investigating the potential of gas seep harvesting in Timor-Leste, which has previously attracted World Bank support. These natural gas seeps, many of which are strong enough to sustain flame, provide a potential opportunity to achieve a development trifecta by diversifying the economy, abating greenhouse gas emissions and improving power security in remote regional areas.

The Institute is using its expertise and capacity to carry out assessments of the geological context, distribution, source and flux of the methane along the extended seep corridors on the south coast. This information will provide the feasibility for localised power generation. Such projects are attractive for their eligibility for Australian Carbon Offset Credits for methane abatement.

IMAGE: © Hawaii National Park Service

and bringing it to the surface as steam to generate power, is achievable with technology already implemented in Iceland.

The geothermal reserves available have the potential to power major centres in the Pacific, for example the geothermal springs of Efate could power Port Vila, the capital of Vanuatu. The development of geothermal energy in the Pacific is a very active area. A number of small to medium-sized energy companies are actively pursuing a range of potential projects. However, while governmental approvals have been given to investigate the feasibility and develop business cases, no project has been given the green light.

A significant issue with geothermal power generation in the Pacific is the social license needed to construct the power stations, with many of the volcanoes and associated geologically active areas holding strong reverence in the various island cultures. Hence, there will be strong objections to the drilling of geothermal wells and the removal of spring water from the ground, and in many situations it is likely that this social objection will not be overcome.

The ocean can also provide a source of renewable energy, associated with tidal and wave power. In the Pacific, tidal flows are greatest around Vanuatu and the Solomon Islands as well as the Mariana Islands. This is because the flow of the tides is constricted in the straits between the numerous islands resulting in a rapid movement of water that can be used to spin turbines. On the larger islands of Fiji and Samoa, tidal energy is less favorable because the tidal movement is smaller, and power generation in these locations will require a substantial number of tidal turbines, which make the economics unattractive.

Wave energy is another renewable energy option, but is strongly dependent on geographical location. The strongest wave energies are associated with the temperate and polar oceans, while the tropics generally have calmer water. Viable wave energy of 20 kilowatts per metre or above are accessible for islands located south of latitude 20°, with the Cook Islands, Tonga and New Caledonia the best candidates. The ability to convert wave energy into power is the most problematic of renewable energy options, because wave energy converters are an immature technology, with three viable but different designs currently being tested worldwide. No commercial wave-farms currently exist globally, and it is doubtful such wave power stations will be built within a reasonable timeframe.

Bioenergy from biomass is currently limited to rural residential demand for cooking. In Kiribati this takes the form of coconut husks and shells as well as coconut fronds and mangrove wood. This is able to meet the small demand need in these households, but is not viable for large scale electricity production. There is limited energy generation from biomass in Samoa, associated with the coconut hulks waste from the local coconut industry and similar schemes are present in the islands of Vanuatu.

These biomass processes are not efficient but do consume a waste product from an export industry. Expanding these biomass schemes for base load power generation is possible, but the issue for the majority of the Pacific nations is that they do not generate enough biomass to support large-scale sustainable bioenergy. The alternative would be to use native

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Education and training must be an important aspect of all renewable energy projects.

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vegetation, but such an industry could not be considered sustainable, because of the lack of land area and vegetation growth rates. Hence, there is only a limited scope for expanding the bioenergy from biomass sector in the Pacific.

Challenges

There are some location specific issues for developing renewable energy in the Pacific, compared to the rest of the world. The geographical isolation of islands and communities means that a central generation source with a wide distribution electrical grid is not viable except for the larger islands of Fiji and Samoa. This favours certain renewable sources over others, such as solar and wind which can be constructed and installed at various sizes and easily enlarged through their modular nature.

In contrast, geothermal and biomass power generation is only viable on a large scale. The isolated nature of communities also impacts electricity distribution. In Vanuatu, the main centres of Port Vila and Luganville have 75% of households connected to the grid, but drops to less than 28% in outlying communities. This isolation means economy of scale cannot assist in keeping energy prices low and reduce investment risk. It also means a larger investment in the distribution grid per generation capacity than is common in OECD countries. This isolation therefore strongly favors small scale generation capacity on a community level, and hence requires support on a local community level to ensure continual operation.

This will necessitate the development of a skilled labour force to support the renewable energy infrastructure. The ability to teach these skills and educate communities is currently limited in the Pacific, as demonstrated in other aid development projects; where critical infrastructure such as freshwater production and sewerage treatment are wasted because the locals are not adequately skilled to provide the necessary regular maintenance. Hence, education and training must be an important aspect of all renewable energy projects.

The nations of the Pacific have a challenging and exciting future ahead in developing renewable energy options to reduce their dependence on imported fossil fuels. Many of these challenges are specific for the region, and will require engineering, regulatory and community solutions that involve a wide range of stakeholders. Developing renewable energy in the Pacific, and importantly getting it right, may become the template for improving energy infrastructure in other developing regions globally. AQ

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