THE LAST NAUTICAL MILE

Emerging Energy Transitions for Pacific Islands

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EXECUTIVE SUMMARY

Access to reliable, affordable, and sustainable electricity remains a critical challenge across Pacific Island Countries (PICs), particularly in remote and outer island communities. Despite progress in expanding energy access, many PICs still face significant barriers due to geographic isolation, dispersed populations, limited infrastructure, and high dependence on imported fossil fuels. This policy paper introduces the concept of the **"last nautical mile"** to reframe energy access challenges in the Pacific, highlighting the unique logistical and planning complexities posed by oceanic distances and island geographies.

The report advocates for a **whole-of-island approach** to energy planning—one that integrates energy systems with local economies, infrastructure, and community needs. This approach moves beyond fragmented, project-based interventions and promotes inclusive, place-based strategies that align with national energy goals and the United Nations Sustainable Development Goal 7 (SDG7).

Drawing on six detailed case studies—Abaiang (Kiribati), Arno (Marshall Islands), Tanna (Vanuatu), Malaita (Solomon Islands), Viwa (Fiji), and Uman (Micronesia)—the report explores the lived realities of energy access across diverse Pacific island contexts. These case studies reveal common themes: widespread adoption of solar home systems (SHSs), challenges with maintenance and system degradation, limited productive use of energy, and the need for culturally grounded governance and financing models.

The paper emphasises the importance of energy justice, using a three-part framework: distributional (equitable access and burden-sharing), procedural (inclusive decision-making), and recognition (valuing local knowledge and cultural practices). It highlights the gendered dimensions of energy access, noting that women often bear the brunt of energy poverty while being underrepresented in energy governance and technical roles.

Technological solutions must be tailored to local contexts. While solar photovoltaic (PV) technology is the most widely adopted and viable option, other technologies—such as micro-hydro, wind, and biomass—offer potential when matched to specific geographies. However, the sustainability of these technologies hinges on robust maintenance, repair, and end-of-life management strategies, which are often lacking in current deployments.

Financing remains a key enabler. The report reviews various models, including donor-funded programs, catalytic funding, pay-as-you-go (PAYG) systems, and community-owned approaches. It calls for creative financing and funding strategies that balance affordability, equity, and long-term viability.

The report concludes with a set of actionable recommendations, including the development of a whole-of-island energy planning toolkit, regional data platforms, standardised solar product ratings, embedded solar repair training, and coordinated financing mechanisms. It also calls for greater regional cooperation, improved e-waste management, and the promotion of e-mobility solutions tailored to island geographies.

Ultimately, bridging the last nautical mile is not just about extending infrastructure—it is about co-creating resilient, inclusive, and future-fit energy systems that empower communities, enhance livelihoods, and support long-term development across the Pacific.

INTRODUCTION

1.1 OVERVIEW

Access to electricity in Pacific Island Countries (PICs) faces significant challenges, particularly regarding infrastructure, supply reliability, and affordability. Many PICs are made up of archipelagos with atolls or mountainous terrain, which makes expanding centralised grids for all communities both costly and often impractical. Economic and social progress is also challenging for reasons including their remoteness. As a result, nations such as the Solomon Islands and Vanuatu have some of the lowest grid electricity access rates globally, with only an estimated 16% and 30% of their populations connected, respectively.[1,2] Despite these challenges, several PICs are approaching universal electricity access. Even this success, however, is tempered by their energy supply's heavy dependence on expensive and polluting imported fossil fuels, leading to some of the highest electricity tariffs in the world,[3] and leaving these grids highly vulnerable to economic fluctuations and climate-related disruptions.

This report aims to investigate inventive methods for enhancing electricity access, reliability, and affordability for isolated island communities throughout the Pacific. Despite facing some of the most pressing energy challenges globally, the Pacific region has often been sidelined in global discussions on energy poverty and renewable energy transitions—which tend to focus on more populous regions like Africa and Asia. Consequently, the Pacific contexts remain poorly adapted to many off-grid energy solutions. We draw on the conceptual framing of the "last nautical mile" to help encapsulate the unique challenges that the Pacific region faces with remote electricity access and promote a whole-of-island approach as a means of providing the necessary resolution for planning energy futures for the PICs. We use six case study island examples, from Fiji, Vanuatu, the Solomon Islands, the Marshall Islands, the Federated States of Micronesia, and Kiribati, to ground our arguments.

Expanding access to reliable electricity can significantly enhance livelihoods, reduce health risks, improve educational outcomes, and boost economic productivity,[4] it is therefore critical to address it. For PICs, renewable energy technologies are especially vital—not only to extend access but also to reduce reliance on expensive fossil fuel imports and to build long-term resilience against climate and economic shocks. This imperative is captured in the United Nations' Sustainable Development Goal 7 (SDG7), which aims to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030. Adopted as part of the United Nations' 2030 Agenda, SDG7 recognises that energy is central to nearly every major challenge and opportunity the world faces—from eradicating poverty and improving health and education to battling climate change and supporting inclusive economic growth. SDG7 includes key targets such as achieving universal access to electricity, substantially increasing the share of renewable energy in the global mix, and doubling the rate of improvement in energy efficiency.

Traditionally, energy planning in the region has focused on either the regional level—such as through the *Framework for Energy Security and Resilience in the Pacific* (FESRIP)—or the national level.[5] These strategies have largely prioritised utility grid expansion, while off-grid energy planning has often assumed a secondary role or followed a general national approach that fails to reflect the specific contexts of individual islands.

In contrast, a whole-of-island approach integrates energy system design with local economies, geographies, infrastructure, and community needs. This strategy recognises the importance of linking electricity access with broader development goals—such as livelihoods, service delivery, and market participation. For example, schools and health clinics can serve as anchor points for mini-grid systems, while trade ports can streamline the delivery of spare parts and tools for maintaining off-grid systems. Improved electricity access can also be a catalyst for increasing women's participation in the energy sector and directly support local economic activities and livelihoods in remote areas.[6]

Ultimately, this approach promotes community-driven, co-designed energy solutions that reflect the full range of energy needs across each island. It offers a more effective foundation for project design, implementation, and long-term sustainability.

Our report proposes a whole-of-island framework to explore community-led models that support a just energy transition and improve livelihoods in remote and rural communities across the Pacific. It will examine a range of dimensions —including financing, technology, productive uses of energy, capacity building, governance, and energy justice—tailored to the distinct vulnerabilities and challenges of each context. Special attention is given to understanding how improved energy access—whether from renewable or conventional sources—can generate broader social and economic benefits and support other sectors such as health, education, and livelihoods.

While the report takes a Pacific-wide perspective, it aims to identify opportunities for coordination across countries—supporting regional coherence while respecting national priorities. The analysis aligns with existing national energy plans and regional frameworks to support government-led action across the region.

The ultimate goal is for this strategic policy-oriented report to serve as a practical resource for policymakers and planners, guiding the implementation of national and regional energy strategies and master plans. It will also provide evidence and insights for donors, investors, and development partners to strengthen the business case for investing in inclusive, sustainable energy solutions across the Pacific. Our specific objectives are:

1. To identify and analyse key gaps and barriers to achieving a just energy transition in the Pacific, with attention to energy justice principles and structural inequities

2. To identify context-specific success factors from case studies and delineate adaptable approaches for clean energy transitions and last-mile electrification in Pacific Island Countries.

3. To identify context-specific success factors from case studies and delineate adaptable approaches for clean energy transitions and last-mile electrification in Pacific Island Countries.

4. To scope out actionable, regionally coordinated policy recommendations for advancing a just energy transition in Pacific Island Countries.

The remainder of the report begins with an overview of energy challenges in the Pacific, followed by a review of different models for off-grid electricity expansion and the development of a framework for a whole-of-island approach. This framework is then illustrated through six case study islands from across the Pacific, and then the report concludes with a series of recommendations.

1.2 FRAMING THE PACIFIC ENERGY SEASCAPE: THE LAST NAUTICAL MILE

The idea of the "last mile" in electricity access as a challenge for achieving universal electricity access is a common figure of speech in the off-grid energy sector and has often been used as a means to frame the issues of supplying electricity to remote, sparsely populated communities.[7-9] This framing has predominantly been used in the context of Africa and draws on the struggles and the challenges of delivering off-grid solutions via poor road networks to distant populations. Our use of the "last nautical mile" concept plays on this framing and seeks to reformulate it for a PIC context. In this situation, the main obstacle is not inadequate road access but the challenges posed by distant ocean travel and its associated uncertainties. By using this tailored concept, the goal is to develop targeted and actionable policy recommendations that recognise how the unique geographies of PICs create distinct opportunities and challenges for last-mile off-grid electrification.

A simple map of the Pacific region (see Figure 1) demonstrates the imperative of the nautical. The region's roughly 15 million people live on 1,000 inhabited islands spread across the region's 21 island states and territories, located in 186 million square kilometres of ocean (about 15 percent of the Earth's surface).[10] The region speaks more than 1,400 languages, making it the most linguistically diverse in the world.[11] The region is bigger than any land continent, yet its distinct physical regional geography and demographic features create unique challenges for electricity access.

Data from recent censuses and reports indicate that approximately 1.5 million people in the Pacific region do not have direct access to an electricity grid (see Table 2 below). While this is a significant number, the region accounts for only 0.2% of the estimated 756 million people worldwide who, according to the International Energy Agency (IEA), do not have direct access to an electricity grid.[12] This relatively small global proportion, combined with the Pacific's low population density, has often resulted in the region being marginalised in global discussions about access to electricity.[13] This neglect undoubtedly negatively impacts the attainment of the Sustainable Development Goal 7 (SDG7) and, more importantly, contravenes the principle of "leave no one behind."

For instance, the IEA's influential *World Energy Outlook* report, which annually publishes global grid electricity access statistics, has never reported individual access rates for Pacific nations.[12] Instead, these countries are subsumed under the ambiguous and geographically inaccurate category of "Other Asia." Similarly, the World Bank-supported Energy Sector Management Assistance Program's (ESMAP) *Off-Grid Solar Market Trends Report 2024* does not mention the Pacific region, focusing entirely on Africa and Asia. A heat map of "unelectrified people" in the world presented in the report excludes the entire Pacific region.[14] Additionally, the Global Association for the Off-Grid Solar Industry (GOGLA), in its mapping of investments in the off-grid sector, omits the Pacific as a distinct region. This omission likely reflects the negligible level of investments in the region, further perpetuating its exclusion from critical energy access dialogues. Indeed, during the initial worldwide boom of off-grid solar from 2010 to 2013,[15] many countries in the Pacific struggled to import off-grid solar products since all manufacturing capacity was focused on serving the larger markets in the Global South.[15]

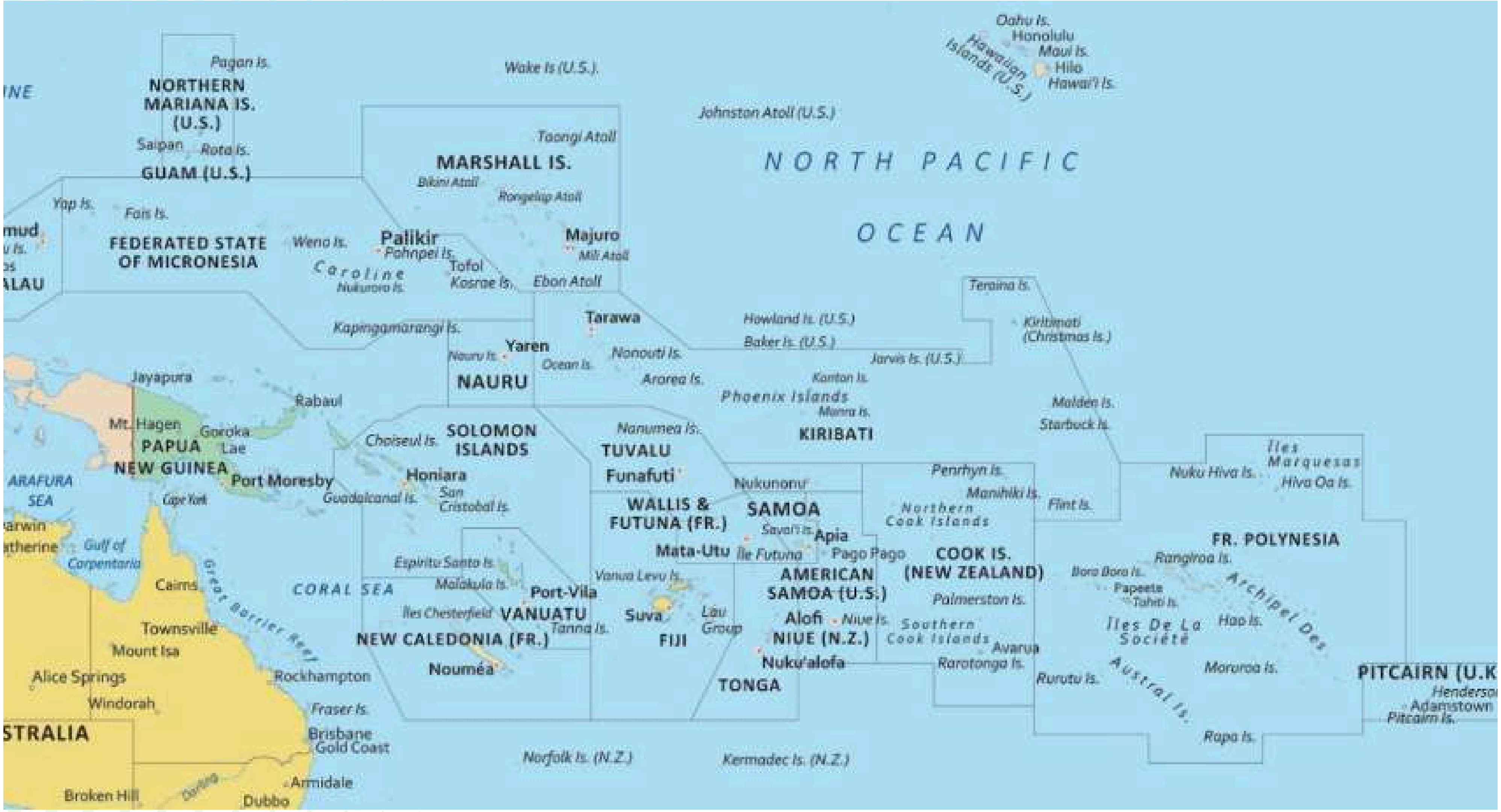


FIGURE 1 - MAP OF PACIFIC ISLAND COUNTRIES (PICS) AND TERRITORIES

Historically, major investments, technologies, and approaches to improving electricity access have been geared towards the challenges faced in Africa and Asia. As a result, these solutions are often poorly suited to the Pacific, where social, demographic, economic, and physical conditions differ significantly. To address this gap, we introduce the concept of the “last nautical mile”—a distinct geographical framing that highlights the specific energy access issues faced by remote island communities in the Pacific. This framing underscores the urgent need to raise awareness of these challenges and mobilise greater financing to support equitable energy transitions across the region’s diverse island landscapes.

Pacific Island Countries (PICs) are among the most climate-vulnerable regions in the world, facing rising sea levels, stronger cyclones, prolonged droughts, and increasing temperatures. These climate impacts can directly disrupt energy supply—for example, by damaging generation assets, transmission lines, or storage systems during extreme weather events. At the same time, higher ambient temperatures and shifting rainfall patterns can drive up electricity demand, particularly for cooling systems, refrigeration, and water pumping. This combination of disrupted supply and rising demand creates a dual pressure that can exacerbate existing energy access challenges, especially in remote or off-grid communities where repair logistics are complex and costly.[13,16,17]

In the following sections, we examine the varied and complex challenges across the Pacific, focusing on both on-grid and off-grid electricity access. This analysis serves to illustrate the unique circumstances that define the last nautical mile and to inform the development of more context-appropriate, innovative energy solutions.

While the Pacific region faces unique challenges with "last mile" electricity access compared to other parts of the Global South, it is also important to take into account the significant heterogeneity in electricity access challenges across the Pacific, as shown in Table 1. The region's 13 Pacific Island Countries (PICs) vary widely in terrain, ranging from forested volcanic high islands to low-lying coral atolls with limited land space. National populations range from fewer than 2,000 people (e.g., Niue) to nearly a million (e.g., Fiji), while land areas span from as little as 21 km² to nearly 30,000 km². Some nations, such as Nauru, and Niue, consist of a single island, whereas others, like Fiji and the Solomon Islands, are archipelagos with populations distributed across more than 100 islands. Perhaps most critically, there is also great diversity within each of these nations. Vitu Levu Island in Fiji, for example, is home to more than 750,000 people, while there are many islands across the nation that are home to less than 100 people. Human Development Index (HDI) rankings are generally low but are also highly diverse. This is why, as we develop in detail below, we advocate for a whole-of-island approach as a necessary scale to think about challenges and opportunities.

TABLE 1 – GEOGRAPHICAL OVERVIEW OF PICS.

Country	Region	Land area (km²)	Population	Geographic Type	Number of Inhabited Islands (2023)	HDI Score (Rank out of 193)
Solomon Islands	Melanesia	29,785	652,857	High islands + atolls	147	0.584 (156)
Fiji	Melanesia	18,376	929,276	High islands + atolls	110	0.731 (111)
Vanuatu	Melanesia	12,189	307,815	High islands + atolls	65	0.621 (146)
Micronesia	Micronesia	702	104,468	High islands + atolls	65	0.615 (149)
Marshall Islands	Micronesia	720	58,413	Atolls	24	0.733 (108)
Kiribati	Micronesia	726	119,000	Atolls	21	0.644 (140)
Palau	Micronesia	475	17,907	High islands + atolls	8	0.786 (84)
Nauru	Micronesia	21	10,670	Raised coral island	1	0.703 (124)
Tonga	Polynesia	696	100,651	High islands	36	0.769 (92)
Cook Islands	Polynesia	180	17,459	High islands + atolls	13	n/a
Tuvalu	Polynesia	26	11,646	Atolls	8	0.689 (129)
Samoa	Polynesia	2,934	202,506	High islands	4	0.708 (122)
Niue	Polynesia	258	1,620	Raised coral island	1	n/a

Data sourced from the World Bank's Open Data portal, and the United National Development Programme.[15]

Electricity access is often defined in binary, quantitative terms—for example, by institutions like the IEA, where “access” may simply mean having a grid connection or exceeding a minimal consumption threshold. However, this approach can be analytically limiting. Electricity access is better understood as a qualitative process shaped by local contexts and influenced by socio-political, economic, and infrastructural factors.[19]

The World Bank’s Multi-Tier Framework (MTF) offers a more nuanced alternative to the simple “connected” or “not connected” measure. It assesses access across six tiers (Tier 0 to Tier 5) based on multiple attributes: capacity, duration of supply, reliability, quality, affordability, legality, and safety. Lower tiers (0–2) capture limited access — such as basic lighting and phone charging for a few hours a day — while higher tiers (3–5) reflect greater capacity and service quality, enabling productive uses, appliances, and near-continuous supply.[20] By considering these dimensions, the MTF shows that energy access is best understood through a multi-dimensional lens, recognising that quality, reliability, and affordability are just as important as a physical connection.

For off-grid electricity access—meaning access beyond utility grids—two main delivery approaches dominate: (1) community-level mini-grids powered by sources such as solar, diesel generators, or micro-hydro; and (2) household-level systems, typically based on solar technologies or small diesel or petrol generators. The sections below explore the role of utility grids, mini-grids, and household-level off-grid systems in shaping electricity access across the Pacific.

1.4 GRID ELECTRICITY AND ENERGY POVERTY IN THE PACIFIC

Grid electricity connectivity rates vary greatly in the Pacific, ranging from 16% in the Solomon Islands to near 100% in countries such as Nauru and Palau (see Table 2). In general, PICs with fewer numbers of inhabited islands and smaller populations have had greater success in achieving near-universal grid electricity access. Indeed, grid electricity tends to mainly be present around major urban centres or on bigger, more central islands.[13,17] Nevertheless, even where utility grid electricity is available in the Pacific, it is often beset by numerous issues and challenges.

Most grid power systems in PICs tend to have small customer bases with relatively low incomes.[21] Distribution losses in these networks are often high,[22] and most systems rely heavily on imported fossil fuels, with significant transportation costs, making them particularly vulnerable to global fuel price volatility and supply shortages.[21,23] These factors make it challenging, even for the most efficient electricity utilities, to establish electricity tariffs that appropriately cover utility investment and operating costs.[21]

Despite this, many Pacific Island utilities are expected to operate sustainably and even provide dividends to their governments.[21] As a result, the Pacific region has some of the highest electricity tariff rates for grid power in the world.[24] For example, the Solomon Islands currently has the highest average grid-electricity tariff at US$0.692 per kWh,[25] which is over four times the global average. Eight PICs rank among the top 30 globally for expensive grid electricity tariffs (see Table 2). Fiji stands out as the only country in the region with tariffs below the global average, likely due to its larger customer base and significant reliance on renewable energy sources. Overall, such high tariffs have a major impact on economic productivity and household-level electricity use.

This situation also limits the commercial incentive for utilities to extend their grids into rural areas. Expanding into new regions often results in financial losses for power providers, further driving up tariff rates and exacerbating the financial burden on consumers.[13]

TABLE 2– ELECTRICITY ACCESS, RENEWABLE ENERGY SOURCE, AND GRID PRICE TARIFFS FOR PICS. GREEN INDICATES STRONG PROGRESS, RED INDICATES AREAS REQUIRING URGENT ATTENTION OR SIGNIFICANT IMPROVEMENT

Country	No. inhabited islands	Grid Conne-ctivity	Grid Tariff (per kWh)	Rank (out of 230)	Grid % renewable Source	Renewable Energy Used
Solomon Islands	147	16%	$0.69	230	6.6%	Solar PV; Hydro; Biomass
Fiji	110	83%	$0.14	114	60.1%	Solar PV; Biomass; Wind; Hydro
Vanuatu	65	30%	$0.59	228	25.5%	Solar PV; Hydro
Micronesia	65	75%	$0.48	226	4.9%	Solar PV; Hydro, Wind
Marshall Islands	24	74%	$0.35	216	2.4%	Solar PV; Wind
Kiribati	21	34%	$0.29	204	16.4%	Solar PV
Palau	1	98%	$0.27	195	4.6%	Solar PV
Nauru	1	99%	$0.23	179	9.8%	Solar PV
Tonga	35	98%	$0.35	218	14.2%	Solar PV; Wind
Cook Islands	13	97%	$0.52	227	21.1%	Solar PV
Tuvalu	8	97%	$0.27	196	15.8%	Solar PV
Samoa	4	94%	$0.29	201	49.1%	Solar PV; Hydro; Wind; Biomass
Niue	1	97%	$0.44	225	13.9%	Solar PV

Data sourced from most recent census reports, IRENA and Cable.[1,2,20,22-29]

Photo: Sebastian Ganso

Given this context and the escalating threats posed by climate change, PICs have strong economic, political, and environmental incentives to transition from imported fossil fuels to renewable energy technologies. Many PICs have set ambitious renewable energy targets as part of their national energy roadmaps. The availability of local renewable energy resources—particularly solar, along with wind, hydro, tidal, and geothermal in some countries—makes this transition a feasible proposition. However, achieving these goals often depends heavily on donor funding and technical capacity development, meaning that it requires sustained financial and technical support.[35]

The transition to renewable energy across the region, while progressing, has encountered several challenges. One significant issue is that well-meaning aid agencies often donate renewable energy systems. However, these donations typically include capital grants but do not provide provisions for ongoing operation, maintenance, or equipment replacement, nor do they support grid upgrades or the technical capacity building necessary to operate systems with variable renewable energy generation. This can place a considerable burden on incumbent utilities when they must then integrate the new infrastructure into their asset base and bear the associated costs.[21]

As a result, while utilities appreciate the support, they often find themselves replacing reliance on fossil fuel imports with a high dependency on technical expertise, given the complexity of many modern renewable energy technologies. This underscores the need for comprehensive support mechanisms that address not only installation but also long-term sustainability.[21,36]

1.5 MINI-GRID ELECTRICITY AND ENERGY POVERTY IN THE PACIFIC

An alternative to utility grids in PICs, particularly in areas with moderate population sizes and densities, has been the use of mini-grids—small-scale grid installations typically up to 10 MW in size. Smaller iterations of these systems are sometimes referred to as micro-grids or nano-grids. Given the relatively small scale of some utility grids in PICs, the distinction between mini-grids and utility grids can sometimes become unclear.

Mini-grids have been implemented across various parts of the PICs since the 1980s, typically governed by one of four models:

- **Utility Model: Operated like a traditional utility grid, with ownership and management by a single company or government entity.**
- **Renewable Energy Service Company (RESCO) Model: The government owns the mini-grid but outsources its operation to a private company.**
- **Cooperative Scheme: A non-profit entity, usually composed of end-users, manages the mini-grid.**
- **Village/Community Committee Model: A local committee of end-users is established to oversee the mini-grid's management.[33]**

Early mini-grids in PICs were predominantly powered by diesel generators. However, there is now an increasing shift towards renewable energy sources, such as solar, wind, and micro-hydro, either as standalone systems or in hybrid configurations with diesel generators.[38] Despite their potential, a comprehensive analysis of the experiences, successes, and challenges of mini-grids in PICs has yet to be conducted. Some existing studies, nevertheless, indicate that mini-grids have often faced significant struggles, and in particular the successful design, implementation, and operation of hybrid mini-grid systems can be more complex than extending main utility grids or adopting off-grid solutions.[38] These challenges arise due to difficulties in establishing appropriate tariff structures (balancing affordability for residents with the need to cover operational costs), attracting upfront financing, and addressing trade-offs between cost and robustness, particularly in remote locations where asset management, including maintenance and component replacements at end of life can be logistically complex and expensive.[39]

Expanding grid electricity and improving its cost-effectiveness through renewable energy are critical strategies to extend electricity access and reduce energy poverty in the Pacific. However, these approaches face significant limitations. Currently, utility-scale electrical grids exist on only 50 of the more than 700 inhabited islands across the 13 Pacific Island Countries (PICs), while mini-grids have been utilised with mixed-success in moderately populated settlements across the region.[38,40] Ultimately, establishing small grids or mini-grids on many of the smaller, more sparsely populated islands is prohibitively expensive,[17] especially when grids are already financially strained on the more populous islands. This highlights an important distinction between the “last mile” and the “last nautical mile.” In much of the Global South, the “last mile” challenge is often a matter of when the electrical grid will reach underserved areas. In the Pacific, the “last nautical mile” presents a question of if the grid could ever be feasible at all. As a result, off-grid electricity alternatives are not just complementary but are imperative in addressing the unique energy access challenges of the region.

1.6 HOUSEHOLD-LEVEL OFF-GRID ELECTRICITY AND ENERGY POVERTY IN THE PACIFIC

In areas beyond electricity grids in the Pacific, the adoption of off-grid solar has surged over the past decade, particularly in Pacific Island Countries (PICs) with relatively low levels of grid electricity connection (see Figure 2). This increase is even more pronounced on outer islands across the region. For instance, on Pentecost Island in Vanuatu, the proportion of households using off-grid solar as their primary source of lighting skyrocketed from just 2.6% in 2009 to 97.5% in 2020.[1,41] Similarly, Arno Atoll in the Marshall Islands saw an increase from 16% in 1999 to 99.1% in 2021. On Abaiang Atoll in Kiribati, the share rose from 7.4% in 2000 to 92.5% in 2015.[27,30] Today, off-grid solar products are nearly ubiquitous across the Pacific, with almost every household owning at least one to meet their lighting needs.

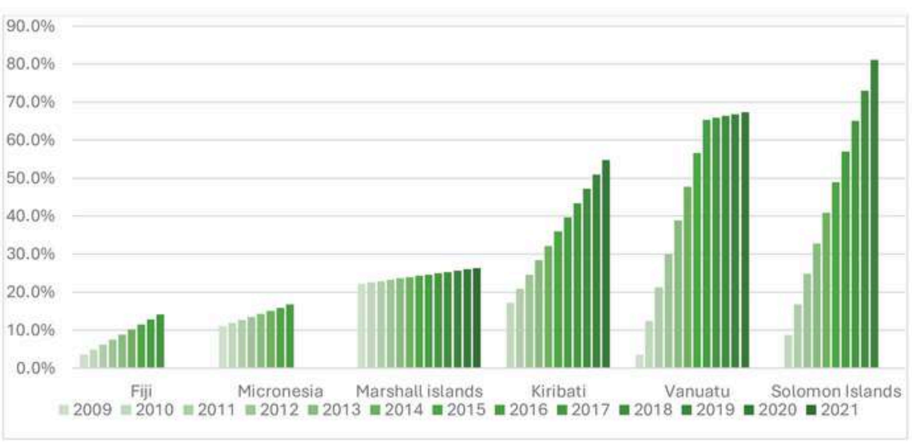


FIGURE 2 – OFF-GRID SOLAR AS THE MAIN SOURCE OF LIGHTING IN SIX PICS, CHANGES BETWEEN 2009 AND 2021 BASED ON CENSUS DATA.[1,2,23,26,38]

The broad category of household off-grid solar can generally be divided into three distinct types of systems: 1) solar lamps: small off-grid solar products that just supply lighting; 2) plug-n-play off-grid solar home systems: solar products that are sold as all-in-one kits. Mostly these have the capacity to just supply power for a few lights and mobile phone recharging; and 3) Component-based setups (i.e., individually bought batteries, controllers, and panels) that tend to be bigger systems.

Several factors have driven this boom. For one, broader technological and economic changes, particularly the rapid reduction in the costs of photovoltaic technologies and LED lighting, have provided a crucial foundation for the development of relatively affordable solar lamps and solar home systems.[43] Additionally, the establishment of a small-scale off-grid solar sector—initially centred on the East African market—has played a key role. This sector included a range of distribution and manufacturing companies, various channels for debt and equity, and the creation of an industry body, the Global Off-Grid Lighting Association (GOGLA), in 2012.[44] These developments have contributed to the mass proliferation of off-grid solar products. Although the Pacific region has been peripheral, and at times neglected, by the off-grid solar industry (which has primarily focused on Africa and, to a lesser extent, Asia), ripple effects from this sector have brought many products, first trialled in Africa, to the Pacific. Notable examples of major off-grid solar companies, such as d.light and SunKing branded products, have since gained prominence in the region.[45]

The impact of this solar boom has now meant that kerosene lamps, once a ubiquitous source of lighting in the Pacific during the 1980s and 1990s, are now essentially not in use anymore. Small diesel or petrol generators are also becoming less common for households, according to recent census data for Kiribati, Vanuatu, and the Solomon Islands over the past decade (Table 3), with Kiribati and Vanuatu reporting a significant drop in personal generator use. Solomon Islands, in contrast, reported a modest increase overall, but this was driven by a significant increase in generator use by households on the country's main island, Guadalcanal. Most outer islands in the country reported a drop in generator use.

TABLE 3 – GENERATOR USE IN KIRIBATI, VANUATU AND SOLOMON ISLANDS.

Country	2009/10	2019/2020
Kiribati	2.90%	0.10%
Vanuatu	1.80%	0.30%
Solomon Islands	0.70%	0.90%

Data source from national census reports.[1,2,23]

There are three main ways in which solar products and systems have been distributed across the islands of the Pacific. The first is through aid or gift delivery, where they have been provided through aid programs, a practice with a long history. For example, solar home systems (SHS) were delivered to rural households in French Polynesia and the Cook Islands as early as the 1970s.[17] Aid projects have also consistently installed off-grid solar systems in schools and health centres across the Pacific, a practice that continues to this day. Additionally, solar products, particularly solar lanterns, are often distributed in large quantities as part of disaster response programs following cyclones. In some countries, such as Vanuatu and the Solomon Islands, it is common for solar products to be distributed during political campaigns.[46]

A second method of distributing solar products has been through Renewable Energy Service Companies (RESCOs). While RESCOs have been trialled in various countries, they are most established in Kiribati and Fiji. Often described as a "solar utility" model, this approach involves the operating institution retaining ownership of the solar installations. The institution employs and trains technicians responsible for maintenance and charges users a monthly fee intended to cover costs such as battery replacement and preventive maintenance.[17]

The Kiribati Solar Electric Company (KSEC), with aid donor support, implemented this model in Kiribati in the 1990s. KSEC provided and effectively rented solar products to households on outer islands.[17] However, the program has faced financial sustainability challenges and has reportedly been in decline in recent years.[17,47] In 2020, the company was reformed and renamed as Kiribati Green Energy Solution (KGES), broadening the agency's services to include not only solar energy but also wave, wind, and other applicable renewable energy technologies. In Fiji, the initiative has been even more extensive. With funding from development partners, the Fiji Department of Energy purchased and installed solar home systems for several thousand rural households. Users were charged an ongoing monthly fee for these systems, but the fee was insufficient to cover maintenance costs, leading to reliance on ongoing government subsidies.[13]

The final avenue for distributing solar home systems (SHS) has been through market-based models, where households purchase and acquire their own solar systems and products. Facilitating this approach has been a key focus for aid agencies recently. For instance, the Vanuatu Rural Electrification Project (VREP) (2016–2022), supported by the World Bank and the New Zealand Government, provided consumer subsidies of up to 50% for off-grid solar products. This initiative led to the sale of an impressive 27,000 SHS at a time when Vanuatu had an estimated 55,000 households.[45] Across Pacific Island Countries (PICs), there is now a significant private sector presence in the off-grid solar market. Typically based in capital cities or larger urban centres, various companies specialise in selling, installing, and distributing solar products, offering systems ranging from basic solar lamps to large-scale solutions for households or businesses. Smaller off-grid solar products are also widely available in supermarkets and variety stores across the region. In many communities, remittances play a crucial role in financing the purchase of these systems, making them more accessible to households.[48]

While the off-grid solar boom across Pacific Island Countries (PICs) has been impressive, several shortcomings have been observed in how it provides electricity access. Many households rely on pico-solar products (<10W), such as solar lamps with a single LED light. Since these do not include provision for a wider range of appliances, whether such use qualifies as meaningful electricity access is debatable.[17] For instance, in Vanuatu, while 67.3% of households report using solar as their main source of lighting, nearly half of these (31.1%) rely solely on solar lamps.[1]

The shift to market-based distribution models has also created disparities in access, with many households only able to afford solar lamps or basic solar home systems (SHSs). In rural areas, where subsistence agriculture often dominates livelihoods, cash income for purchasing solar products is typically limited.[13] Furthermore, research indicates that the installation of basic off-grid solar systems in remote areas has not necessarily led to income-generating activities.[35]

Perhaps the most significant concern is the durability, maintenance, and repair of off-grid solar systems in PICs. These regions present challenging conditions, including corrosive, warm, humid, salt-laden air and destructive tropical cyclones. Many products last only a couple of years before breaking down, and rural areas often lack locally available technical skills, tools, and spare parts needed for repairs.[17]

As a result, many systems end up as solar e-waste, which cannot be recycled in remote islands. High transport costs further exacerbate this issue, leaving waste to accumulate locally.[35] This scenario is particularly problematic on atolls, where land space can be extremely limited.

1.7 THE LINKAGES BETWEEN ENERGY ACCESS AND TRANSPORTATION IN THE PACIFIC

The transportation sector plays a key role in discussions about electricity access in Pacific Island Countries (PICs). Despite the current limited use of e-mobility in the region, its importance is growing as we consider the energy futures of PICs. There are three main types of transportation to consider in terms of energy: air, land, and maritime transport. Air transport, while vital for connecting many islands, is the most expensive and is primarily used by tourists, diaspora communities, and wealthier households.[49] At present, there are no plans for the adoption of e-mobility in the aviation sector in the Pacific, so it will not be addressed here.

However, both maritime and land transport are essential components of a comprehensive, island-wide energy strategy, with significant potential for e-mobility applications. Therefore, any future electricity planning should prioritise these sectors.

Maritime transportation is important in islands across the Pacific in terms of connecting outlying islands with urban centres and main islands, in terms of the connection of PICs with broader global trading networks, and for internal island (or nearby island) travel with smaller boating vessels. Echoing challenges in the grid-utility sector, maritime transport between islands in PICs is highly reliant on fossil fuels that are becoming increasingly unaffordable and unsustainable.[50] Maritime transportation in the region is highly unique and challenging, characterised by micro-communities positioned at the end of long maritime routes with imbalanced inward versus outward loadings,[51] arguably making them some of the most challenging routes to maintain per capita and per sea mile.[50] This is further complicated by financing barriers, high operational risk, and high infrastructural costs, often resulting in a vicious cycle of poor commercial returns resulting in old vessels being replaced by additional old or benevolently donated vessels.[51]

Recent efforts have emerged to address the heavy reliance on fossil fuels for intra-island shipping in PICs. Notably, in collaboration with the University of the South Pacific,[50] the governments of Fiji and the Republic of the Marshall Islands are spearheading a multi-country initiative to transition to sustainable, resilient, and low-carbon shipping. Their goal is to achieve zero-carbon domestic shipping across participating PICs by 2050, with an interim target of a 40% reduction by 2030.[51] Current experiments and trials are primarily focused on retrofitting existing maritime vessels with hybrid propulsion systems. This includes research on wind-hybrid propulsion technologies, which can significantly reduce fuel consumption,[51] and trials involving the retrofitting of solar photovoltaic systems on vessels in Vanuatu and Samoa as proof-of-concept demonstrations for reducing fossil fuel dependency. Advancing these efforts is critical for islands across the region.[51] If successful, the transition could deliver significant environmental and economic benefits, particularly for last-mile maritime communities in PICs. Given the scale and complexity of the challenge, a coordinated regional approach is essential to effectively address this issue.

More relevant to the whole-of-island approach is the critical role that small boats often play in facilitating travel within/along remote islands or to nearby islands. Most of this travel relies on small vessels using outboard motors. Fuel for these is expensive, and its supply is reliant on long, unreliable, and complex commodity chains. As part of a recent Climate Action Pathways for Island Transport (CAP-IT) project, a feasibility study on the available low-carbon outboard motors for fishing and transport vessels has recently been conducted, leading now to current plans to pilot low-carbon outboard motor solutions for Samoa's small vessels and fishing fleet.[52]

In terms of land transportation, outer islands in the Pacific with road infrastructure typically rely on a mix of trucks, cars, and motorbikes, all running on petrol. These vehicles face similar cost and fuel access challenges as small maritime vessels. Recently, there has been growing interest and experimentation with electric vehicles (EVs) across Pacific Island Countries (PICs), including trials of electric buses in the Solomon Islands,[53] and Nauru,[54] as well as the installation of solar charging stations in Suva, Fiji, to serve the city's expanding EV market.[55] To date, EV use on outer islands has not been implemented, but it is recognised as having significant potential and impact.[55,56] Key challenges include establishing charging infrastructure and developing local skills for EV maintenance and repair, and addressing the economic and logistical barriers to transition. Many households in the region purchase second-hand vehicles from Japan, Korea, and the United States, while new EVs remain prohibitively expensive for most.[57] Without substantial subsidies and incentives, uptake is likely to be gradual.

1.8 CONCLUSION

To achieve meaningful progress on energy access in Pacific Island Countries, there is a need to move beyond generic, one-size-fits-all solutions. The distinct geographies, development needs, and vulnerabilities of Pacific communities require energy planning approaches that are deeply embedded in place and grounded in local realities. The whole-of-island framework and the concept of the last nautical mile offer new ways to reframe both the problem and the solutions —focusing attention on the island-level specifics that too often get overlooked in national and regional energy strategies.

By centring community-led models and embedding energy systems within local economies, infrastructure, and service delivery, we can design more sustainable, resilient, and equitable energy transitions. This strategic report aims to contribute to that shift—offering practical insights to inform policy, guide investment, and strengthen the business case for inclusive energy solutions tailored to the Pacific. Ultimately, bridging the last nautical mile is not just about extending infrastructure—it is about creating just, future-fit energy systems that empower communities, enhance livelihoods, and support long-term development across the region. In order to make significant advancements in energy access in Pacific Island Countries, we must transcend generic, universal solutions. The distinct geographies, development needs, and vulnerabilities of Pacific communities require energy planning approaches that are deeply embedded in place and grounded in local realities. The whole-of-island framework and the concept of the last nautical mile offer new ways to reframe both the problem and the solutions —focusing attention on the island-level specifics that too often get overlooked in national and regional energy strategies. By exploring potential opportunities for scale, strengthening coordination, and reducing duplication, whole-of-island approaches can also help overcome the challenges of remoteness, geographic dispersion, and small populations, creating new pathways for more resilient and efficient energy systems.

By centring community-led models and embedding energy systems within local economies, infrastructure, and service delivery, it is possible to design more sustainable, resilient, and equitable energy transitions. This strategic report aims to contribute to that shift—offering practical insights to inform policy, guide investment, and strengthen the business case for inclusive energy solutions tailored to the Pacific. Ultimately, bridging the last nautical mile is not just about extending infrastructure—it is about creating just, future-fit energy systems that empower communities, enhance livelihoods, and support long-term development across the region.

EXISTING MODELS FOR LAST NAUTICAL MILE ENERGY ACCESS

Many PICs have set ambitious renewable energy targets, motivated by goals to enhance energy access, improve energy security by reducing reliance on fossil fuel imports, and demonstrate leadership in climate action.[58] Although current initiatives are falling short of these targets,[59] the region has seen the deployment of various renewable energy technologies, financial instruments, and governance models. This section explores three interconnected aspects of existing off-grid energy access models: energy planning and community engagement, renewable energy technologies, and deployment and funding strategies.

2.1 ENERGY PLANNING AND COMMUNITY ENGAGEMENT

Energy planning in the Pacific region has predominantly concentrated on grid-based electricity supply, addressing challenges such as attracting private investment for new capacity, managing ageing generation assets, and effectively siting renewable energy projects. These efforts must navigate constraints related to limited land access and the necessity for resilience against increasing disaster risks.[58,60]

Recent regional initiatives, such as the *Framework for Energy Security and Resilience in the Pacific* (FESRIP), provide a valuable framework for coordination in this sector. However, effective energy planning is hindered by insufficient investment, inadequate field data, a lack of advanced modelling tools, inadequate technical standards (e.g., energy efficiency), and limited local technical capacity.[5,58] These planning challenges are particularly pronounced in remote rural areas, where small populations are dispersed across numerous atolls and small islands. This dispersion impedes these communities' ability to actively participate in national energy planning processes. Additionally, these geographies are often deemed too small and risky to attract private investment in off-grid renewable energy generation.

There is recognition that existing planning processes need to better incorporate the needs and perspectives of rural communities, particularly groups that are systematically underrepresented such as women and people with disabilities.[58,60] While appraisals of renewable energy potential, spatial features, and technical requirements for these contexts have progressed, the inclusion of socio-cultural insights remains a challenge. Such knowledge is particularly vital for navigating land disputes when siting projects, ensuring that local energy service needs are met, and ensuring that there is local capacity to manage, operate, and maintain systems in these remote geographies.[58,60] This is especially salient in the Pacific region, where the geographical necessity for decentralised electricity sources, coupled with vulnerability to extreme weather events, significantly increases the reliance on households to self-manage these systems.[58,60]

Another significant challenge in energy planning is developing a local workforce capable of supporting, operating, and maintaining renewable energy infrastructure in PICs. While donor-funded renewable energy projects have evolved from focusing solely on physical infrastructure to incorporating social infrastructure through capacity-building initiatives, the economic geographies of PICs lead to migration flows of skilled workers to Pacific Rim nations like Australia, New Zealand, and the USA, exacerbating difficulties in establishing and retaining local workforces.[61] Additionally, the renewable energy sector in the Pacific, mirroring global trends, is male-dominated (especially in non-administrative roles) and has offered limited opportunities to others. Cultural norms and gender biases restrict women's participation,[6] while a lack of accessible infrastructure and training programs for people with disabilities has hindered the development of a more inclusive workforce.[62]

These challenges demonstrate the importance of deep community consultation as part of energy planning processes. However, the incorporation of participatory Pasifika cultural deliberation methods, such as Talanoa and Talanga, appears to be at a nascent stage of adoption in energy planning in the region.[63] Talanoa, made of two words, *tala* (talk) with *noa* (without a fixed agenda), sessions are used to gather community input through the sharing of stories, build consensus, and ensure that they align with local needs and values.[64] For example, the Talanoa sessions were instrumental in the planning and implementation of the Fiji Renewable Energy Programme, ensuring community buy-in and support. A similar approach was used to develop Tonga's "long-term strategy for reducing greenhouse gas emissions" (LT-LEDS) using participatory and qualitative methods that were "rooted in Tongan culture and values" to create appropriate pathways to a shared energy future.[63] However, there has been a legacy of donor-led projects failing to meet the needs of communities in the region due to a lack of deep consultation in their design and implementation,[63] resulting in a lack of knowledge of traditions, conflicts, and governance structures.[65] There is often a lack of donor coordination and policy alignment that hinders overcoming barriers to energy planning and workforce development.

Indigenous forms of deliberation contrast against typically narrow procedural approaches to gathering community input —they tend to focus on respectful and reciprocal sharing of life experiences to build strong interpersonal connections and foster respect.[64] There is significant diversity in cultural deliberation approaches across the region. Therefore, it is crucial not to assume that Talanoa or Talanga approaches, the latter being more structured and decision-oriented, are universally applicable to all PICs – each nation and indeed, community, may have unique approaches that need to be carefully understood.[63]

TABLE 4 – KEY PRINCIPLES AND ACTIVITIES OF TALANOA & TALANGA APPROACHES IN RENEWABLE ENERGY PROJECTS.

Approach	Core Principles	Key Activities	Application in Renewable Energy Projects
Talanoa	- Inclusive dialogue - Storytelling - Empathy - Building trust - Community engagement	- Facilitating open-ended conversations without an agenda - Encouraging sharing of personal stories and experiences - Creating a safe and respectful space for dialogue - Building relationships through empathy and understanding	- Building trust and mutual respect through open sharing - Ensuring that the voices of all stakeholders are heard and valued e.g. women and members with disabilities. - Gathering insights and feedback from community members - Addressing community energy aspirations and concerns through storytelling
Talanga	- Structured discussion - Consensus building - Problem-solving - Decision-making - Community engagement	- Organising facilitated discussions and workshops - Conducting structured meetings with clear agendas - Identifying and addressing specific community needs and issues - Reaching consensus on project decisions through collaborative dialogue	- Conducting structured consultations with community leaders and stakeholders on energy needs and aspirations - Developing action plans based on community input and agreement on land-access. - Ensuring transparent and inclusive decision-making processes across the project. - Implementing solutions that reflect the collective agreement of the community

Adapted from Park et al

2.2 RENEWABLE ENERGY TECHNOLOGIES

In the Pacific region, traditional grid extensions are often not viable due to geographical challenges, necessitating decentralised approaches to electrification.[13] The abundant renewable energy in the region presents a significant opportunity to displace high diesel usage for electricity generation, addressing both climate and financial concerns.[59] This section provides an overview of the key renewable energy technologies commonly employed or being piloted in the region, highlighting their common strengths, limitations and resilience implications (summarised in Table 5)

TABLE 5 – OVERVIEW OF RENEWABLE ENERGY TECHNOLOGIES IN PACIFIC ISLAND COUNTRIES

Scale of access	Type of Renewable Energy	Strengths	Limitations	Resilience Implications	Program/Project Examples
Household **(Tier 1 and 2 on Multi-Tier Framework)**	Solar lanterns	Affordable, easy to distribute and use, portable	Limited power capacity	Provides basic lighting during disasters, but limited in scale and duration	Lighting Vanuatu (AusAid, 2011-2013)
	Solar Home Systems (Plug & Play/Modular)	More powerful than lanterns, supports multiple devices/appliances	Higher initial cost, limited scalability, maintenance required Waste Disposal.	Enhances household energy resilience, but panels and batteries can be vulnerable to extreme weather	VREP-1 (Vanuatu) (World Bank 2016-2022) Fiji Solar Home System (SHS) Programme (Fijian Government, Since 2000)
Community **(Tier 3+ on Multi-Tier Framework)**	Micro Grids (including storage and renewable energy hybrid configurations)	Flexible, can integrate various energy sources	High setup and maintenance costs	Enhances resilience by diversifying energy sources, but infrastructure can still be vulnerable to extreme weather	VREP-2 (Vanuatu) (World Bank 2018-2022)
	Micro-Hydro	Reliable, low operational costs, suitable for small streams	Site-specific, potential environmental impact	Provides consistent power, but dependent on water flow which can be affected by droughts and floods	Solomon Islands Micro-Hydro Project (Asian Development Bank, 2017)
	Mini Grids (including storage and renewable energy hybrid configurations)	Can power entire communities, scalable	Requires significant investment, complex management	Requires significant investment, complex management, ongoing maintenance	Tonga Renewable Energy Project (Masdar) (Abu Dhabi Fund for Development, 2012 - 2013)
	Wind	Sustainable, low operational costs	Very site-specific, low potential in the region, intermittent energy supply	Sustainable, low operational costs	Samoa Wind Farm (Masdar) (Abu Dhabi Fund for Development, 2014)
	Bioenergy	Uses local biomass resources, supports local livelihoods, reduces waste	Requires ongoing supply of biomass, complex technology	Supports local energy production, but biomass supply chains can be disrupted by natural disasters	Fiji Biomass Gasification Project (Fiji Government, 2017 onwards)
	Green Hydrogen	High energy density, versatile applications (electricity generation, transportation, industrial processes)	Expensive production, storage challenges	Offers long-term energy storage, but production and storage facilities are vulnerable to extreme weather	Fiji Hydrogen Energy Pilot Project, Sojitz Green Hydrogen Project (Sojitz Corporation, 2021-2024)

Household Solar Products

PICs possess significant solar energy potential due to their high levels of solar irradiance. According to the Global Solar Atlas, many Pacific islands receive an average solar irradiance of 5-6 kWh/m^2/day,[66] making solar PV a highly viable option for electricity generation. This is reflected in a broad array of initiatives that have promoted off-grid solar solutions at both a household and community-scale over the past decade.

Solar lanterns and solar home systems are the most common forms of off-grid rural electrification in PICs. A variety of market-based programs, often incorporating subsidies to address affordability, have been implemented to promote the adoption of household-scale solar products in PICs. These products, which continue to be adopted at a massive scale in Sub-Saharan Africa and South Asia, are recognised as being relatively cost-effective means of delivering access to basic energy services such as lighting, charging mobile phones, and even powering small appliances.[58,67] In terms of the World Bank's Multi-Tier Framework for energy access, these products deliver Tier 1 and 2 levels of access.[68] Significant examples of Tier 1 and Tier 2 focused solar programs include the Vanuatu Renewable Energy Program (Stage 1), which concentrated on distributing subsidised plug-and-play solar home systems (SHS); the Solomon Islands Renewable Energy Access Project (SIREAP), which focused on the distribution of both solar lanterns and SHS, and the Fiji Solar Home System (SHS) Programme, which adopted a quasi-renewable energy service company (RESCO) model to reduce the upfront costs of SHS through a fee-for-service approach.

Household-scale solar solutions have limitations and resilience implications. Solar lanterns, while affordable and easy to distribute, offer limited power capacity and are primarily useful for basic lighting needs. Their small size makes them portable but also means they can be easily damaged or lost during extreme weather events. SHSs provide more substantial power, supporting multiple devices and improving household energy resilience.[43] However, they are still often underpowered for larger appliances such as fridges and washing machines and require higher initial investments and ongoing maintenance compared to solar lanterns. Their key components, such as solar panels and batteries, can be vulnerable to damage from cyclones, heavy rains, and saltwater corrosion.

Recent research also indicates that these products often feature restrictive designs that impede repair and use non-standard parts that are difficult to source through local supply chains.[49] This contributes to growing issues of solar e-waste, compounded by a lack of waste management infrastructure and the high costs of transporting e-waste in island geographies. Despite these challenges, both technologies enhance energy access and can be rapidly deployed in disaster-recovery scenarios, contributing to community resilience by ensuring that basic energy needs are met even in the aftermath of climate disasters. A recent example of this is the International Red Cross, including solar lanterns as part of their immediate disaster response in Vanuatu post Cyclone Lola in Vanuatu.[69]

Solar micro and mini grids

Solar micro and mini-grids, including hybrid systems, offer significant advantages for off-grid electrification in PICs. Compared to their household-scale counterparts, these systems can provide reliable and scalable energy solutions for entire communities, addressing the limitations of individual household systems. Hybrid configurations, which combine solar with other renewable sources like wind or bioenergy, enhance energy reliability and reduce dependency on a single energy source. This diversification is crucial for climate resilience, as it ensures a continuous power supply even when one source is compromised by extreme weather events.

However, these projects face several challenges. The high initial investment and cost of component replacements, willingness to pay, and complex management requirements can be significant barriers, particularly for small island economies with limited financial resources.[59] Additionally, the infrastructure for micro and mini grids is vulnerable to natural disasters such as cyclones and floods, which are common in the Pacific region. Ensuring the resilience of these systems requires robust design and regular maintenance, which can be logistically challenging in remote areas. Furthermore, community engagement and land ownership issues can complicate project implementation. The limited success of the Vanuatu Renewable Energy Program (Stage 2) exemplifies these challenges. The project aimed to provide access to five rural communities through five mini-grid installations. However, a lack of culturally appropriate community consultation and co-design led to inappropriate approaches to securing communal land access, ultimately resulting in zero mini grids being constructed.[63]

Micro-Hydro Power

The potential for micro-hydro power is notable in larger, mountainous islands such as Fiji, Samoa, the Solomon Islands, and Vanuatu. Numerous rivers and streams in these countries are suitable for small-scale hydro projects. The *World Small Hydropower Development Report 2022* highlights that these islands collectively have an estimated potential of over 1 GW for small hydropower.[70] In Fiji, the Nabouwalu micro-hydro project has provided sustainable energy to rural villages, reducing reliance on diesel and petrol generators.[34] Among comparable studies in other PICs, the Japan International Cooperation Agency (JICA) in 2000 identified 130 potential hydropower sites with a total maximum capacity of 326 MW in the Solomon Islands.[71] However, a significant limitation of the technology is that projects are highly site-specific and cannot be deployed as rapidly as small-scale solar projects. Lessons learned to date indicate that while micro-hydro projects can be highly effective, they require careful site selection based on geological conditions, community involvement to ensure appropriate land access, and robust maintenance plans to address issues such as sedimentation and seasonal water flow variations.[72]

Wind Energy

Relative to other forms of renewable energy, such as solar and hydro, wind energy has seen limited adoption among PICs to date.[59] This is partly explained given that wind energy potential varies across the Pacific; however, some islands have significant wind resources. For instance, wind speeds in parts of Fiji, Samoa, and Vanuatu range from 6 to 8 m/s at 50 metres high, which is suitable for wind power generation.[73] An example of harnessing this potential is highlighted in the wind-solar hybrid system (24MWp with 60MWh of storage) on the island of Rarotonga in the Cook Islands, which has improved energy stability and reduced fuel imports.[74] However, the intermittent nature of wind and the high costs associated with both installation and maintenance present significant challenges. Successful projects have highlighted the importance of integrating wind energy with other renewable sources, e.g. solar or hydro, and ensuring local capacity for maintenance. For example, the failure of a wind project in Tonga due to inadequate wind resource assessment and high maintenance costs calls attention to the need for comprehensive resource assessments and sustainable financial planning.

Biomass

The Pacific region's substantial biomass energy potential, particularly from coconut oil and husks, has long been cited as an attractive solution for off-grid electrification in the region.[65] However, bioenergy-based electricity still represents a fraction of the renewable energy mix for electricity across the region. In Vanuatu and New Caledonia, ENGIE-owned energy companies have been tapping into existing supply chains to power diesel generators with coconut oil (including blends) as a cheaper and more environmentally sustainable alternative.[76,77] Coconut oil has also featured in Fiji's rural electrification program for rural and remote islands, but as evidenced through projects on Koro and Cicia islands, there have been several unresolved challenges in sustaining them.[65] Key lessons include the need for reliable supply chains for biomass (also considering changing climatic conditions), understanding the dynamics of local electricity demand in remote communities, community engagement in the collection and processing of materials, as well as addressing significant technical challenges related to bioenergy conversion technologies.[65,78]

Green Hydrogen:

Green hydrogen (Green H2), produced using renewable energy sources, is emerging as a potential sustainable energy option in the region. The Pacific Hydrogen Roadmap outlines the significant potential for green hydrogen production, leveraging the region's abundant solar and wind resources. This technology offers a way to store and transport energy, addressing the challenges of intermittency associated with solar and wind power. Green H2 can be used for electricity generation, transportation, and industrial applications, contributing to energy security and decarbonisation goals.[79] However, the very high costs of production and the need for substantial infrastructure investments pose significant barriers. Pilot projects will be essential to demonstrate feasibility and build local expertise. Lessons from early-stage green hydrogen projects in other regions highlight the importance of securing long-term funding and developing robust infrastructure to support hydrogen production and distribution.[80] At the time of writing, the potential for applications in off-grid electrification is still emerging. One of the more significant trials of Green H2 in the Pacific is in Fiji, where Green H2 produced using geothermal energy in New Zealand is being shipped for use at Lautoka Gas Terminal—displacing the extent of fossil fuel use at this facility.[81] Nevertheless, it appears unlikely that H2 will be a feasible option for electricity generation in the region in the near to medium term.

Other Technologies

Several Pacific Island Countries (PICs) possess significant geothermal energy potential, particularly those situated within the geologically active “Ring of Fire,” where tectonic activity is prevalent. Nations such as Fiji, Samoa, Tonga, Vanuatu, and the Solomon Islands are considered to have high to moderate prospects for geothermal resource development. However, at present, there are no operational applications of geothermal energy for electricity generation in the region.[82-84]

Tidal and wave power have also been explored as alternative renewable energy sources, with various studies assessing their potential in PICs.[85] In 2023, Tonga announced plans to develop a 10-megawatt wave power park off the main island of Tongatapu in partnership with the Ireland-based company Seabased.[86] The project remains in the pre-development stage, with environmental and permitting processes still underway.

Photo: Obayashi Corporation

2.3 DEPLOYMENT STRATEGIES

In the context of off-grid electrification in small Pacific islands, several deployment and funding mechanisms have been employed to promote renewable energy projects. These mechanisms aim to address the unique challenges faced by these islands, such as their remoteness, small population sizes, and limited financial resources. Table 6 provides an overview of the key deployment strategies identified.

TABLE 6 – OVERVIEW OF DIFFERENT DEPLOYMENT STRATEGIES

Approach	Description	Examples	Benefits	Limitations
Donor-funded programs and subsidies	Grants, technical assistance, and financial incentives from international organisations, foreign governments, and local authorities.	Pacific Climate Infrastructure Financing Partnership (PCIFP); Vanuatu Rural Electrification Project (VREP) Phase I	Reduces financial barriers and reliance on debt-financing	Sustainability of funding, priorities contingent on donor priorities.
Catalytic Funding	investment that accepts higher risk, with the goal of generating positive impacts and attracting further investment	Pacific Climate Infrastructure Financing Partnership (PCIFP)	Reduces financial barriers and strategic leverages external funding sources	Sustainability of funding. Limited private sector investment
Finance Mechanisms	Financial vehicles that are set up to raise funds and investment in renewable projects	Fiji Rural Electrification Fund (FREF) and National Green Energy Fud (NGEF) Vanuatu	Allows for longer-term national level strategies for financial projects.	Sustainability of funding, still reliant on donor fundings. Limited private sector investment.
Pay-As-You-Go (PAYG) solar	Consumers pay for solar energy systems in small, manageable instalments.	Kiribati Solar Energy Company (KSEC)	Greater affordability and scalability; increased access for low-income households.	Affordability without subsidies, requires robust mobile payment infrastructure.
Renewable Energy Service Companies (RESCOs)	Companies install, maintain, and operate renewable energy systems under long-term contracts.	Fiji Renewable Energy Power Project (FREPP)	Professional management and technical expertise; higher system reliability.	Financial viability in sparsely populated areas; need for substantial initial investment.
Renewable Energy Independent Power Producers (RE IPPs)	Companies install, maintain, and operate renewable energy systems under long-term contracts.	Tonga Power Limited (TPL)	Bring in private investment, in-house expertise to operate and maintain infrastructure.	Viability depends on policy environment, access to finance and market size (economics of scale).
Community-owned models	Local communities own and manage renewable energy projects.	Barefoot College in Fiji; Hoahu Cooperative in Moloka'i	Local engagement: benefits retained within the community; empowerment of local women.	Governance issues; decision-making processes; financial management; insufficient training.

Donor-funded programs and subsidies are common approaches, with international organisations, foreign governments, and local authorities providing grants, technical assistance, and financial incentives. For example, the Tonga Outer Island Renewable Energy Project was a multi-donor initiative led by the Asian Development Bank and co-financed by the Australian Government (DFAT), the European Union, the Green Climate Fund, and others that invested around USD 28 million (between 2013 and 2023) to enhance solar photovoltaic capacity with a mix of grid-connected, mini-grid, and off-grid installations across eight remote outer Tongan islands.[87] Additionally, subsidies are often provided to reduce the upfront costs of renewable energy systems, making them more affordable for consumers. The Vanuatu Rural Electrification Project Stage I (VREP-I), funded by the World Bank, combined donor funding with a 50% consumer-end subsidy to increase access to Tier 1-2 'plug and play' solar home systems. VREP-I successfully distributed 20,565 solar home system units to households, businesses, and community organisations, significantly exceeding its original goal of 17,500 SHS.[88]

Catalytic Funding is a type of investment that accepts higher risk or lower financial returns than conventional investments, with the goal of generating positive social or environmental impact and attracting further investment. The Australian Government, through its Pacific Climate Infrastructure Financing Partnership (PCIFP), has been notably active in this space through two major initiatives: the Business Partnerships Platform (BPP) and the REnew Pacific program, which provide co-funding for off-grid renewable energy projects in the region. The BPP initiative, launched in 2023, funded pilot and scaling partnerships with private sector and civil society organisations to deliver off-grid solar, micro-hydro, biogas, and mini-grid solutions. As of mid-2025, the BPP partnerships have supported initiatives across countries, including Papua New Guinea, Solomon Islands, Kiribati, Timor-Leste, Vanuatu, and Fiji. Building on this, the REnew Pacific program—launched in late 2024 as a $75 million, five-year investment—aims to scale up these efforts by delivering community-scale renewable energy systems (including solar, wind, hydro, and battery storage) to enhance lighting, clean water, health care, agriculture, and e-mobility services across the region. Both initiatives have prioritised gender and disability inclusion, locally led delivery models, and climate-resilient infrastructure to ensure long-term impact in some of the Pacific's most remote and underserved communities. These initiatives have had some success in attracting co-investment into off-grid projects in the Pacific; however, the region is still largely devoid of the large-scale impact investors, venture capital funds, private equity firms, corporate investors and asset-backed securities investing in the sector. These types of investors have been highly active in Africa's off-grid market;[44] however, the Pacific region is relatively smaller and more highly dispersed, making it a much less lucrative market than Africa, even with the presence of catalytic funding.[89]

Financing Mechanisms, structured funding arrangements to provide capital for specific purposes, have been a common strategy for setting up funding ecosystems to support renewable energy investment. In the Pacific, there have been large funds established as collaborations between national governments and aid agencies. For example, the Fiji Rural Electrification Fund (FREF), established in partnership with the Government of Fiji and the United Nations Development Programme (UNDP), is a national initiative aimed at expanding access to clean, affordable, and reliable electricity in rural and remote communities. The fund supports the development of mini- and off-grid renewable energy systems, including solar-powered solutions, to reduce reliance on diesel and diversify Fiji's energy mix. FREF was designed to electrify approximately 300 rural communities.[90] Another is the National Green Energy Fund (NGEF) that was established in 2018 by the Government of Vanuatu, with technical and financial support from the Global Green Growth Institute (GGGI). NGEF is a sustainable financing mechanism designed to help Vanuatu achieve its National Energy Roadmap targets by mobilising both public and private investment in clean energy infrastructure. The fund is being used to support a range of technologies, including stand-alone solar PV systems, solar water pumps, and solar streetlights, particularly in off-grid and remote island communities. NGEF offers a mix of concessional loans, grants, and blended finance products and is governed by a board that includes representatives from government and civil society.[91]

Pay-As-You-Go (PAYG) solar models for solar home systems are gaining some traction in PICs. This approach allows consumers to pay for solar energy systems in small, manageable instalments, making them more accessible for low-income households. Large solar companies like SunKing and d.light have successfully implemented PAYG solar in Sub-Saharan Africa and South Asia, and similar models are being adapted for PICs. The success of PAYG solar lies in its ability to improve the affordability of SHS and scalability in rural and remote areas (through digital collection of repayments), though it requires robust mobile payment infrastructure and effective customer service to thrive. As an example, the Kiribati Solar Energy Company (KSEC) has implemented PAYG solar with mixed results, as the lack of mobile banking infrastructure has hindered widespread adoption. Another limitation is that small-scale solar technologies, such as PAYG SHS, typically provide Tier 1-2 energy services and thus have limitations in fulfilling the energy aspirations of rural communities.[92,93] More broadly, there is growing critical scholarship that focuses on the ethical and financial burdens that PAYG models might place on low-income households,[94] and growing attention to the financial viability of debt-financed PAYG solar enterprises operating in challenging markets, often characterised by high inflation, currency fluctuations, and costly logistics.[44] The latter is a key contributor to the relative dearth of PAYG operators in PICs.

Renewable Energy Service Companies (RESCOs) install, maintain, and operate renewable energy systems, often under long-term contracts with communities or governments. This model offers benefits such as professional management and technical expertise, which can enhance system reliability and performance. However, the financial viability of RESCOs can be challenging, particularly in sparsely populated areas where economies of scale are difficult to achieve.

The case of Fiji's long-running Solar Home System (SHS) program provides valuable insights. Since 2009, the program has successfully distributed 13,500 systems to rural and remote communities.[52] However, as recent findings indicate,[92,93] this statistic does not account for common experiences of lack of electricity access due to 'defunct systems'. Under the SHS program Fijian Department of Energy (DoE) retains ownership of the assets, while RESCOs handle installation and maintenance for a fee. Reviews of the program highlight specific design challenges, such as energy policy inconsistencies, a lack of community engagement, and misaligned incentives for RESCOs due to the lack of asset ownership. Additionally, common issues in operating and maintaining SHS in rural and remote settings, such as improper usage practices and limited access to repair services, were noted.[52]

A recent analysis indicates high levels of system failure and even instances where households regressed to using basic pico-solar lanterns for lighting due to insufficient support for restoring government-owned SHS, which RESCOs were not financially incentivised to address.[52] Therefore, key factors such as local energy demand, asset ownership, incentives, and user education must be carefully considered in this deployment model, noting that the small and geographically distributed nature of many PICs might necessitate greater state involvement, as market-based models might be infeasible as a means to provide equitable electricity access.[52]

Renewable Energy Independent Power Producers (RE IPPs) are playing an important role in deploying renewable energy in off-grid contexts across the region. Renewable energy IPPs are private entities that develop, finance, and operate renewable energy projects. They generate electricity from renewable sources such as wind, solar, hydro, and biomass and sell this electricity to utilities or directly to consumers under long-term power purchase agreements (PPAs). RE IPPs tend to focus on large-scale projects and are often involved in the entire project lifecycle, from development to operation.
RE IPPs are favoured for two key reasons. First, RE IPPs attract substantial private sector investment, thereby alleviating the financial burden on governments and donors. This model emphasises long-term financial sustainability and scalability, driven by the private investor's pursuit of returns on investment. Second, RE IPPs typically possess the in-house technical expertise and operational experience required to manage complex renewable energy projects, ensuring higher efficiency and reliability. In contrast, donor-funded projects may encounter sustainability challenges once the initial funding is exhausted, and community-owned projects may lack the technical and managerial capacity for sustained operation.
However, the success of RE IPPs is contingent upon PICs maintaining consistent energy policies and providing access to affordable credit to facilitate long-term capital investments. Additionally, these operations often necessitate PPAs that cater to substantial market sizes with stable energy demand, a condition that small islands in PICs frequently cannot meet, particularly in the smaller and more remote islands.

Community-owned models involve local communities owning and managing renewable energy projects. This approach promotes local involvement and guarantees the preservation of project benefits within the community. Successful examples include community solar projects in Fiji and Vanuatu, where local ownership has led to better maintenance and higher acceptance of the technology. The Barefoot College in Fiji, which trains women to become solar engineers, has been a notable success, empowering communities and ensuring long-term project sustainability.[95] However, other projects have faced challenges due to insufficient training and support for local management. For instance, the Hoahu Cooperative in Moloka'i, supported by Mana Pacific, aims to be 100% community-owned but has encountered governance issues related to decision-making processes and financial management.[96] Effective governance structures are crucial for the success of community-owned models, as they ensure transparency, accountability, and the equitable distribution of benefits. When these structures are in place, community-owned systems can deliver sustained economic and social benefits, as seen in the solar-powered freezer project in Wainika, Fiji. Installed in 2015, this initiative provided a community-owned renewable energy solution for food storage, enhancing food security, expanding income-generating opportunities, and contributing to wider social gains, including improved education, healthcare access, gender equity, and local infrastructure development.[97]

Overall, while these deployment and funding mechanisms have shown promise, they also indicate that there must be tailored solutions that consider the specific socio-economic and geographic contexts of each island. Balancing initial investment, long-term sustainability, and community involvement remains crucial for the success of renewable energy projects in PICs.

2.4 CONCLUSION

While no single model offers a perfect blueprint, the diverse range of existing energy access initiatives across the Pacific demonstrates the value of context-specific design, community engagement, and adaptive governance. These experiences underscore that successful energy planning is not merely a technical exercise but one that must be deeply attuned to the social, cultural, and institutional realities of each island context. Each case, whether it involves participatory planning processes, village-based energy committees, hybrid renewable systems, or donor-supported funding mechanisms, provides insights into what makes off-grid and decentralised systems work in practice.

A critical lesson across these models is the importance of aligning technical solutions—whether solar mini-grids, standalone PV systems, or battery storage—with local needs, capacities, and aspirations. Systems that are technologically sound can still fail without adequate community ownership, training, or financial mechanisms for maintenance and repair. Conversely, even modest technologies can deliver lasting impact when supported by inclusive planning processes, strong local governance, and long-term institutional support.

These examples underscore the importance of regional cooperation, knowledge sharing, and donor coordination, particularly in situations where government capacity and resources are scarce. Initiatives that embed mechanisms for monitoring, learning, and adaptation are better positioned to respond to changing climate risks, demographic shifts, and evolving energy demands. As such, ongoing support—technical, financial, and institutional—is not a luxury but a necessity for sustaining energy access gains over time.

Taken together, these diverse models provide not only technical and governance blueprints but also vital building blocks for designing whole-of-island energy strategies that are resilient, inclusive, and rooted in local priorities. They show that the path to energy security and sustainability in the Pacific is not one-size-fits-all but rather one that must be co-created with communities and continuously adapted through learning, partnership, and innovation.

WHOLE OF ISLAND APPROACH

This section introduces a whole-of-island approach to energy planning, offering a more integrated and context-sensitive alternative to the dominant models currently in place across the Pacific.

To date, energy planning in the Pacific has largely focused on regional frameworks—most recently, the *Framework for Energy Security and Resilience in the Pacific* (FESRIP)—and, particularly, national strategies that often prioritise expanding centralised utility grids. Off-grid energy solutions are often acknowledged, but they are typically treated as secondary considerations, approached through generalised models that overlook the distinct needs and conditions of individual islands.

Consequently, one-off, project-based interventions frequently implement efforts to improve electricity access across PICs. These initiatives often address narrow technical problems—such as equipment upgrades or grid extensions—without fully engaging with the broader social, economic, and infrastructural context of island communities.

In response to these limitations, we propose a whole-of-island approach that embeds energy planning within the wider fabric of island life. This strategy seeks to align energy initiatives with local economies, infrastructure, and social services. Rather than viewing electricity access in isolation, it emphasises how power systems can support vital functions, such as education, healthcare, livelihoods, and local commerce.

Crucially, this model redefines how we view energy poverty. Traditional metrics often focus narrowly on household electricity connections. Nevertheless, a household with reliable lighting is still energy-poor if the local school or clinic lacks consistent power. The whole-of-island approach calls for a broader, more qualitative understanding of energy access—recognising electricity not just as infrastructure but as a foundational service that enables community well-being and economic development.

By shifting the focus from isolated technical fixes to inclusive, island-wide planning, this approach supports the design and implementation of energy systems that are more resilient, equitable, and responsive to the real needs of Pacific communities.

3.1 WHY IS A WHOLE-OF-ISLAND APPROACH IMPORTANT FOR ENERGY PLANNING?

Whole-of-island approaches have already had some limited application in climate adaptation policy space in PICs,[98,99] and have emphasised the need to move beyond project-by-project approaches and to plan with an appreciation of the interconnectedness of social and ecological systems and that any intervention should be driven by local ownership and implementation.[98] We build on these principles with our energy planning whole-of-island approach, but also look to include a whole-of-island approach that incorporates energy justice and gender and social inclusion as core principles in the framework of a just energy transition.

The notion of a whole-of-island approach is not to replace regional or national level planning in terms of energy—as some aspects of energy planning need larger scales—rather, it is complementary. For example, efforts to decarbonise maritime transport across PICs are currently a region-wide initiative (led by Fiji and the Marshall Islands) is certainly the appropriate scale for addressing this energy challenge, considering its scope.

Furthermore, national-level plans and road mapping are critical for galvanising broad energy planning resources and mapping out grid-electricity governance and expansion. Nevertheless, we see a whole-of-island approach being critical in guiding energy-focused (and beyond) projects on islands in the Pacific to ensure they are designed, implemented, and sustained in a manner that is beneficial to all occupants on the targeted island in a context-specific way. Too often, individual electricity access projects and interventions in PICs have been blinkered in their application, causing either duplications or missed opportunities for greater impacts, resulting in an inefficient use of resources and time. These often occur due to governance bottlenecks—such as overlapping mandates between national utilities and donor-funded projects, a lack of standardised regulations for off-grid solutions, and challenges in maintaining cross-agency data platforms.

Two vignettes below provide tangible examples of these inefficiencies.

The first relates to a Senior Secondary School located on an outer island in Vanuatu that boards more than 300 students from around the island and neighbouring islands. Electricity is critical for the school operations, powering lighting for classrooms and accommodation (for students and staff), office equipment such as computers and printers, fridges for storing food items, and small electrical devices like radios and mobile phones. In the past 15 years, the school has had three separate solar systems installed—each by a different donor. The first system ceased to function due to batteries reaching their end-of-life; the second due to PV module damage from a cyclone; the third is functioning, although it is experiencing some issues.

What is most extraordinary about these multiple installations is how each installation was conducted in a siloed approach. Rather than repairing or replacing broken components or expanding the previous off-grid solar system, each new project instead promoted the installation of a completely new system. This was not just in terms of power supply (e.g., PV solar array) and storage (e.g., batteries), but also in terms of wiring throughout the entire school.

This parallel project approach can be seen in its most extreme form with lighting in the building, in which each room in the school has three light switches and lights, each attached to a separate PV solar array. Given the high costs and complicated logistics of transportation of all this infrastructure (modules, batteries, wires, switches, lights), overall, this strategy represents an extraordinarily inefficient approach to improving the school's electricity. There are functioning solar modules, wiring, inverters, and batteries lying around at the school that are not in use, as each new project has ignored this existing infrastructure.

The second vignette is a coastal community in northeastern Fiji, located five hours from the nearest major town by bus and boat. Solar Home Systems (SHS) are widespread, supplied through the Fijian Department of Energy's (DOE) Solar Home System Programme. The community also depends on a solar-powered pump, installed by the Fiji Department of Mineral Resources (DOMR), to draw bore water—essential due to the settlement's isolation and the limited drinking water available from rain tanks.

In 2023, the solar pump failed, and the community reported the fault to DOMR. At the same time, they informed the DOE that about 15% of SHS units were completely non-functional, and a further 40% were providing significantly reduced energy services due to damage or malfunction.

In early 2024, DOMR dispatched a solar contractor to repair the pump. This same contractor also works for the DOE, installing SHS in the community and surrounding areas. Although the pump was successfully repaired, the contractor could not address the faulty SHS units, despite requests from the community, as this work was not included in their agreement. Consequently, despite the high cost and logistical effort of sending a technician to such a remote location, SHS repairs were left for an unspecified future date, highlighting the impact of institutional silos on service delivery.

Together, these vignettes illustrate how fragmented, project-by-project interventions undermine the efficiency, cost-effectiveness, and long-term sustainability of energy services in remote island settings.

In the Vanuatu school example, donor projects operated in isolation, replacing rather than integrating or upgrading existing infrastructure. This led to duplication of equipment, wasted functional components, and unnecessarily high transport and installation costs—all in a location where logistics are particularly challenging.

In the Fiji community example, parallel institutional mandates prevented coordinated service delivery. Even when technical expertise was already on-site, rigid funding and contractual boundaries meant that urgent repairs to energy systems could not be carried out, delaying restoration of services and increasing costs for future interventions.

Both cases highlight the absence of a whole-of-island planning and governance framework that could:

- **Map and integrate existing assets into new projects.**
- **Align donor and government investments across sectors.**
- **Coordinate technical visits to maximise outcomes per trip.**
- **Ensure that service delivery is designed around community needs rather than institutional silos.**

A genuine whole-of-island approach would embed energy planning within broader social, educational, and water infrastructure planning, enabling repairs, upgrades, and new installations to be undertaken in a coordinated, asset-optimising way.

3.2 ENERGY JUSTICE

An energy justice approach to energy planning and improving electricity access in the Pacific can be effectively guided by a triumvirate framework that emphasises distributional, procedural, and recognition dimensions of energy justice. [100,101]

The first tenet of the triumvirate is **distributional energy justice**, which focuses on the equitable distribution of both the benefits and burdens associated with energy. Universal electricity access (that is, affordable) is a key goal within this justice ethic, ensuring that energy access is widespread, particularly for socially disadvantaged and historically marginalised groups. However, this approach also goes beyond simply providing electricity to households; it requires attention to household dynamics to ensure that all members—especially women, children, and other vulnerable individuals—benefit from energy access. Equally important to distributional justice are the negative impacts, or 'ills,' associated with energy projects, such as energy waste (including solar e-waste) and the environmental and health risks posed by improperly managed waste. This includes examining where waste is disposed of and who is exposed to the hazardous materials it may contain. Additionally, the siting of energy projects must be carefully considered, taking into account the land tenure systems that shape these locations and the potential for disruption to local communities. A distributional energy justice framework calls for a careful balance between promoting access and addressing the social, environmental, and cultural impacts of energy development.

The second tenet, **procedural energy justice,** emphasises the importance of inclusive participation and democratic decision-making in energy projects and developments. It focuses on the mechanisms in place to ensure that local communities have meaningful input and influence over energy decisions. How are energy projects governed, and are these processes transparent, accountable, and responsive to local needs and aspirations? At its core, procedural energy justice calls for effective and responsible governance frameworks that ensure local voices are central in all stages of energy planning, project implementation, and the management and development of energy infrastructure.

The final tenet is **recognition energy justice**, which addresses questions about how information is gathered and whose knowledge and voices are included in energy planning. This goes beyond procedural justice, focusing not just on the process but also on the methodologies used to shape energy planning. Specifically, Pacific methodologies have highlighted the importance of upholding Pacific worldviews during the gathering of information and planning processes. Technical and engineering perspectives have traditionally dominated energy planning. However, to maximise its impact, it must also be socially and culturally grounded. An example of a pan-Pacific methodology is Talanoa, a process of open, inclusive, and transparent dialogue. Talanoa creates safe spaces for conversations, allowing knowledge to be shared freely.[102] Talanoa is applied differently across Pacific regions. There are also other region-specific methodologies, such as *Tivaevae* in the Cook Islands; *Fonua* and *Kakala* in Tonga,[102] as well as *Fonofale, Ula, Teu Le Va* and *Fa'afaletui.*[102-106] To incorporate essential voices and knowledge into any initiative, energy planning projects should engage with local communities using contextually appropriate methodologies. This approach helps align energy projects with the social and cultural fabric of the Pacific, fostering more effective and sustainable solutions.

3.3 GENDER, ENERGY DEVELOPMENT AND A WHOLE-OF-ISLAND APPROACH

Gender equity and electricity access are central to all energy justice tenets. Energy access and equity, deeply intertwined with gender development in the Pacific region, play critical roles in advancing gender equality. Due to their typical responsibilities for energy-dependent household tasks like cooking, heating, and lighting, women often face the brunt of energy poverty. Limited or unreliable energy access disproportionately impacts women's time, health, and opportunities for education and income generation. Despite being the primary users of household energy, decision-making regarding energy purchases is often dominated by men.[6] This indicates that it is necessary to integrate gender perspectives into energy planning to address the specific challenges faced by women.

Gender imbalances extend beyond the household, which poses a major obstacle for the energy sector, where decision-making is predominantly male-dominated. According to the International Energy Agency (IEA), globally, there are 76% fewer women than men working in the energy sector, compared to an 8% gender gap in the overall workforce. In PICs, only one out of 13 energy ministers is a woman, underscoring the gender disparity in leadership roles within the region. [6]

An intersectional lens reveals that gender inequality in energy access is compounded by other forms of disadvantage, such as age, disability, geographic isolation, and socio-economic status.[107] For example, women in remote or outer islands may face greater barriers to energy access due to higher service costs, limited infrastructure, and fewer opportunities for training and employment. Women with disabilities may experience additional exclusion, not only in physical access to energy technologies but also in participation in community decision-making forums. Similarly, younger and older women can encounter distinct challenges—youth often struggle to gain influence in male-dominated leadership spaces, while older women may be overlooked despite holding valuable knowledge of local energy practices. Recognising these interconnected inequalities ensures that energy policies and programmes address the full spectrum of barriers faced by different groups of women, leading to more inclusive and equitable outcomes.[107]

To address these inequities, effective gender-inclusive energy policies must actively engage women in decision-making processes, recognising them not only as beneficiaries but also as key stakeholders and agents of change. A whole-of-island approach should create platforms for women to voice their concerns and contribute their knowledge and insights to energy planning and implementation. Additionally, such initiatives should prioritise enhancing women's access to training and employment in the energy sector, fostering gender balance, and empowering women economically.

3.4 FACETS OF A WHOLE-OF-ISLAND APPROACH

Planning must move beyond fragmented and one-size-fits-all approaches to create energy systems that are resilient, inclusive, and sustainable across the Pacific Islands. A whole-of-island framework offers a practical, place-based pathway—grounding energy solutions in the unique social, economic, and geographic realities of each island. This approach unfolds across four interlinked components: energy assessment, technology mix, deployment models, and guiding principles.

Energy Assessment: Understanding Context and Opportunity

The foundation of this approach lies in a robust, community-led energy assessment. This begins with mapping the relationships between socio-cultural needs, economic capacity, and energy usage—ensuring that community voices shape planning decisions.

It also involves technical analysis of local renewable energy potential—solar, hydro, wind—and a review of existing infrastructure. Understanding population distribution and identifying key infrastructure (e.g. ports, clinics, schools, cooperatives) is critical to pinpointing anchor points for energy systems and logistics hubs for deployment and maintenance. By combining spatial and social mapping, planners can identify where energy investments will deliver the greatest social and economic value.

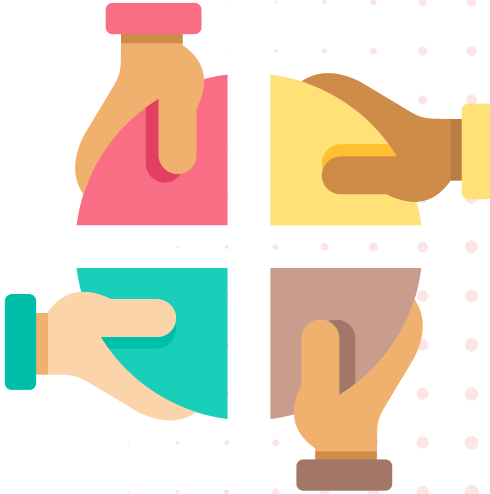
Technology Mix: Matching Solutions to Local Realities

Once energy needs and opportunities are assessed, planners can tailor a technology mix that meets both household and community demands:

- Household-scale solutions such as plug-and-play solar kits or modular systems provide basic services like lighting, phone charging, and small appliances. These are ideal for low-density or remote settlements.

- Community-scale systems, including solar microgrids, micro-hydro, or hybrid setups, can serve multiple users and anchor services to essential infrastructure (e.g., clinics, schools). These systems support more complex uses but require robust management, equitable access, and ongoing maintenance.

- Productive uses of energy—such as efficient refrigeration, grain milling, and solar irrigation—amplify the development impact of electrification by improving livelihoods and supporting income generation. They also enhance the financial sustainability of energy systems by strengthening users' ability to contribute to operational costs.



Deployment: Financing and Governance

Scaling up energy systems demands adaptable financing and governance models. Effective approaches often blend market-based mechanisms, public funding, and donor/philanthropic support—each suited to different aspects of the local context.

In many Pacific Island communities, subsidies are essential—both to lower upfront capital costs and to support ongoing maintenance. Global evidence underscores that subsidies can be critical for bridging affordability gaps and ensuring equitable energy access.

Governance must be locally appropriate. Energy assessments should guide whether systems are best managed by community associations, cooperatives, or local institutions—and what capacity-building is needed to support their long-term sustainability.

Guiding Principles: Towards Justice and Resilience

The whole-of-island model is rooted in a broader vision of development. Energy systems must do more than deliver electricity—they should foster equity, resilience, and wellbeing. Guiding principles include:

- Enhancing local livelihoods and economic opportunities.
- Improving household wellbeing with safe, reliable, and affordable energy.
- Promoting the participation of women and marginalised groups in energy decisions.
- Strengthening resilience to climate and economic shocks.
- Building local skills and governance capacity for long-term system sustainability.

By aligning energy planning with the geography, social fabric, and development pathways of each island, the whole-of-island approach provides a transformative model—one that is locally driven, inclusive, and resilient.

A summary table—Table 7—can be used to synthesise these elements into a systematic planning framework.

TABLE 7 – ENERGY PLANNING – WHOLE OF ISLAND APPROACH

1. Foundational Principles		• **Contextual Integration: Align energy planning with local economies, infrastructure, and social services.** • **Energy Justice: Embed distributional, procedural, and recognition justice.** • **Gender Inclusion: Ensure women are active participants and beneficiaries in energy planning and governance.** • **Complementarity: Support and complement national and regional energy strategies.**
2. Core Components	**a. Community-Led Assessment**	• **Socio-cultural mapping**: Identify community needs, values, and energy use patterns. • **Technical analysis:** Assess renewable energy potential (solar, wind, hydro) and existing infrastructure. • **Spatial mapping:** Highlight key infrastructure (schools, clinics, ports) as anchor points. • **Participatory methods**: Use culturally grounded approaches like *Talanoa, Vanua, Fonofale*, etc.
	b. Tailored Technology Mix	• **Household-scale:** Plug-and-play solar kits, modular systems for basic needs. • **Community-scale:** Microgrids, hybrid systems for shared infrastructure. • **Productive uses:** Energy for livelihoods (e.g., refrigeration, milling, irrigation). • **Resilience focus:** Design for climate durability and modularity
	c. Deployment & Governance	• **Flexible financing**: Combine subsidies, donor support, and market-based models. • **Local governance**: Empower cooperatives, community groups, or local institutions. • **Capacity building**: Train local residents in system operation, maintenance, and governance. • **Avoid duplication**: Coordinate across donors and agencies to prevent siloed projects.
3. Implementation Principles		• **Inclusivity**: Engage all community members, especially women and marginalised groups. • **Resilience**: Design systems to withstand climate and economic shocks. • **Efficiency**: Build on existing infrastructure; avoid redundant installations. • **Sustainability**: Ensure long-term operability through local ownership and training. • **Transparency**: Foster open decision-making and accountability.
4. Monitoring & Evaluation		• **Beyond connections**: Measure energy access through community wellbeing (e.g., school and clinic electrification). • **Gender-sensitive indicators**: Track women's participation and benefits. • **Feedback loops**: Use community feedback to adapt and improve systems.
		• **Lifecycle tracking**: Monitor system performance, maintenance, and end-of-life management (e.g., solar e-waste).

3.5 CONCLUSION

The whole-of-island approach offers a vital rethinking of how energy systems are designed, deployed, and governed across Pacific Island countries. It moves beyond fragmented, short-term, and technically narrow interventions to embrace a more integrated, inclusive, and place-based framework. By embedding energy planning within the broader context of island life—its infrastructure, social systems, economies, and cultures—this approach ensures that electricity access is not just expanded but made meaningful and sustainable.

Critically, the approach foregrounds principles of energy justice, gender equity, and local ownership, recognising that resilient energy systems must reflect the lived realities and aspirations of Pacific communities. It encourages deep engagement with local knowledge, culturally grounded planning methods, and flexible implementation models that can adapt to the unique characteristics of each island. In doing so, the whole-of-island approach supports a just energy transition that empowers communities, enhances wellbeing, and lays the foundation for inclusive development in a climate-challenged region.

In the following six chapters, we apply this framework to conduct a preliminary analysis of six case study islands across Fiji, Vanuatu, the Solomon Islands, the Marshall Islands, the Federated States of Micronesia, and Kiribati. Each chapter begins with a detailed overview of the respective island, followed by a discussion that outlines some initial guiding parameters for adopting a whole-of-island energy planning approach. Importantly, these chapters do not present detailed energy plans—such plans, in keeping with the whole-of-island framework, must be developed with strong input from local communities. However, drawing on desk-based research, the analysis offers preliminary insights into what such an approach might look like in each context.

CASE STUDIES

ABAIANG ATOLL

4.1 GEOGRAPHICAL AND ECONOMIC LANDSCAPE

Abaiang is an atoll located in the Gilbert Islands region in the northwest of Kiribati. The Atoll is classified as 'highly vulnerable' to climate change by the Government of Kiribati (GoK) and experiences severe climatic and environmental changes such as coastal erosion, saltwater intrusion, and tidal inundation.[108] Abaiang, like most atolls, is characterised by its coastal reefs and a ring-shaped chain of low-lying islets surrounding a central lagoon. The lagoon's area is 240 km² and opens through several passes in a barrier reef on the western side of the atoll.[108] Abaiang's land area is approximately 17 km², although the atoll is 37 km long and no wider than 1 km at any given point.

Spread across 18 villages and 1,065 households, Abaiang is home to 5,815 people, making it the fourth most populous atoll in the nation. Most of the villages are connected and accessible by road; however, Ribono and Nuotaea are situated on separate islets to the north and are accessible only via boat. The majority of the island's population lives along the lagoonal coast in the east and south-east, while the small western islets are mostly used for fishing, tourism, and collecting copra, the white flesh of the coconut. This area generally has no permanent structures for housing.

Abaiang lies just a few kilometres north of the Tarawa Atoll, where Kiribati's capital city of Tarawa is located (on the urbanised South Tarawa Island within the atoll).[27]

FIGURE 3– MAP OF KIRIBATI

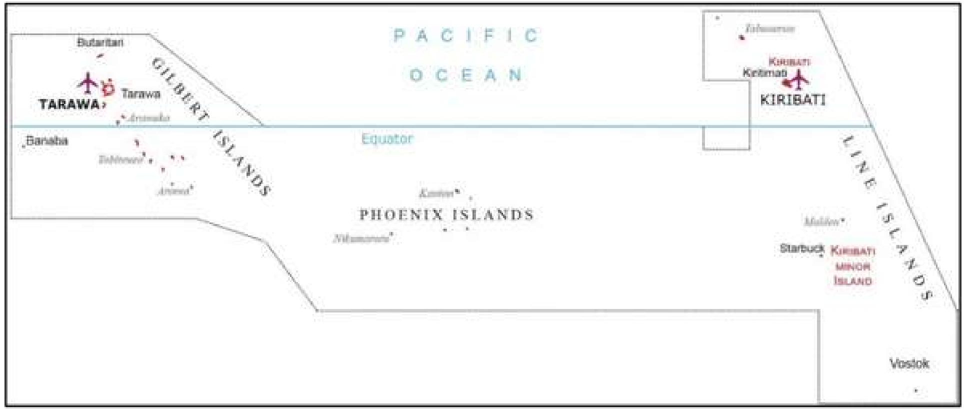


FIGURE 4 – MAP OF ABAIANG ATOLL

4.2 LIVELIHOODS

There are few opportunities for income generation in Abaiang, and copra is therefore a critical source of cash.[109] Income from copra nevertheless varies greatly due to fluctuations in market price and periods of low production caused by droughts or tidal inundations.[108] Farmed seaweed and coastal cucumbers are also important sources of income, along with the sale of handicrafts and surplus food. The harvesting of black-lipped pearl oysters for commercial sale has historically been a source of income on the island,[110] and in the early 2000s, a hatchery for pearl oyster farming was set up on Abaiang.[111] The current status of this livelihood, however, is unclear. There is some limited tourism activity on the island, with two tourist accommodation options—the Tebero Te Rau bungalow resort on the main part of the atoll near the airport,[112] and the Teiro Islet Resort, which is located on its own island in the west of the atoll.

Salaried work is available through the Island Council, health clinics, or schools, and temporary labour is also available when required for the construction and maintenance of development projects. In total, 42% of the population over 15 years old engages in the labour force.[27]

In Abaiang, a significant portion of the population relies on subsistence-based lifeways, which include fishing, harvesting marine resources, and cultivating crops such as coconut, banana, and taro.[113] The penetration of imported foods, however, like rice, flour, sugar, canned fish, and biscuits, is slowly transforming local diets, which is decreasing the prevalence of subsistence activities.[109] The limited economic opportunities, combined with diets increasingly based on imported foods, cash contributions to the church, and the purchase and consumption of imported kava, place considerable financial pressure on the local population.[109]

4.3 SOCIAL AND CULTURAL GEOGRAPHIES

Religion is ubiquitous in the daily lives of the I-Kiribati, with over 95% of the country affiliating with a Christian denomination.[27] Christianity was first introduced in the 1850s by Protestant missionaries;[113] however, traditional social structures and hierarchies are still represented in Abaiang.[109] Within villages, the social hierarchy is bound by the *unimane* (elder males in the village) who hold decision-making power, with the eldest male holding the highest position. Each village also has an elected councillor who organises village groups, meetings, and events and acts as the link between other villages, the island council and South Tarawa.

Modern political power is generally concentrated with the Western-educated class in South Tarawa; however, behaviour within this class is heavily constrained by cultural norms and values.[114] In particular, there is strong local kinship and an expectation that personal interests will be subordinated to those of family and community, while personal aggrandisement and displays of individual wealth are looked upon negatively. These values, which are associated with *te katei ni Kiribati* (the Kiribati way), are upheld formally in political processes as well as informally by the *unimane*. I-Kiribati identify primarily with family, village, and island, whereas national cohesion remains fragile after being introduced during British colonial rule.[114] *Maneabas*, which are traditional community meeting houses, are the focus of village life, yet their contemporary socio-political role remains informal, and their significance varies between islands. Traditional customs are generally considered weaker in the Northern Gilbert Islands, where Abaiang is located, compared to some other regions of Kiribati.[114]

Abaiang - Overview	
Population	5,815
Households	1,065
Villages	18
Land area	17.47 km2
Population Density	333 people per km2

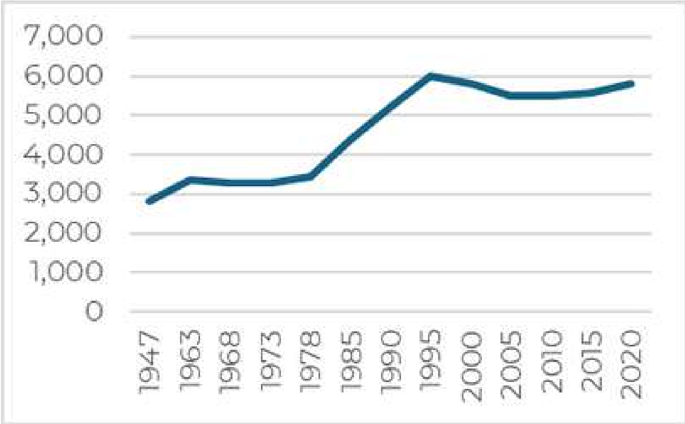


FIGURE 5 – ABAIANG POPULATION GROWTH

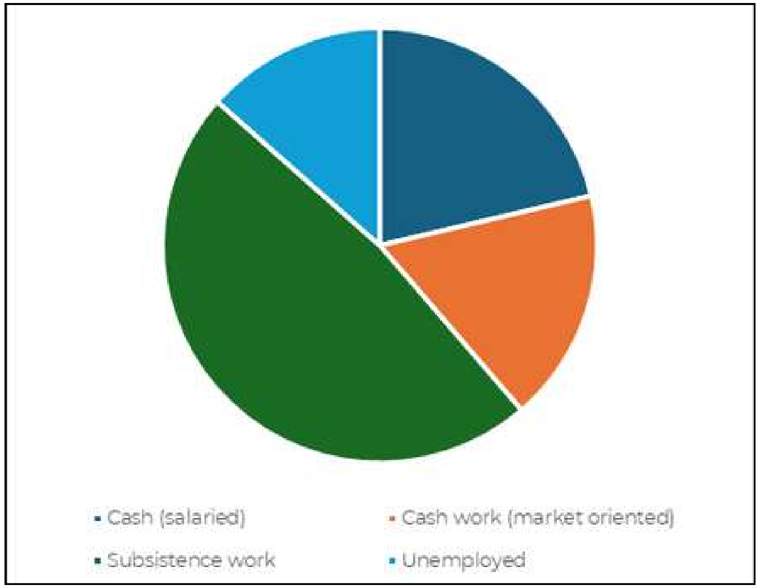


FIGURE 6 – ABAIANG EMPLOYMENT

4.4 PHYSICAL INFRASTRUCTURE AND TRANSPORTATION

In terms of infrastructural capital, most houses on Abaiang are constructed with locally sourced materials with thatched roofs, although iron slats are growing in popularity for this purpose. Some maneabas and churches have iron slats as roofs, as do most school buildings.[108]

Most of the population draws its water from groundwater using wells, with some supplementation from rainwater tanks. Most wells use handpumps or buckets for extraction, but a small percentage (mainly schools and health clinics) use solar or electric pumps. Saline intrusion is a major challenge with groundwater on the island, and in the wake of a 2022 drought, the Australian Government distributed solar distillation units on the island, as well as setting up a solar-powered water pumping and piped distribution system in the village of Ubwanteman on Abiang.[115]

Human waste disposal remains a challenge on the island due to a lack of infrastructure; 68% of people defecate into the environment (beach, sea, or bush), and the remainder use flushing toilets connected to septic tanks. As a result, the use of self-composting toilets is growing in popularity in Abaiang, although governance and management in this area remain limited.[108]

The most popular means of transportation within the island is via motorcycle, and the frequency of travel depends largely on day-to-day livelihoods and activities. Aside from these, there are around 10 vehicles on the island (trucks and sedans). Movement is generally for fishing or some other livelihood, gathering and buying food, and schooling. Travel between islands is quite rare for most inhabitants of Abaiang and generally occurs on an annual basis for most men, women, and children. The main road is unsealed, made from compacted sand and gravel. This incurs considerable wear and tear on vehicles and makes them prone to flooding during heavy rains and dust during dry spells.

The two villages on separate islets to the North, Ribono and Nuotea, are usually accessed by canoe or ferry, although during low tide it is possible to arrive on Ribono by foot from Takarano village.

Abaiang is connected to Tarawa capital via three main transportation options:

- **A four-hour public ferry trip, offering services several times a week. These ferries are often unreliable: departure times vary considerably, and they may not depart at all if there are not enough passengers or cargo on board.** [98]
- **A two-hour chartered boat ride or a speed ferry that usually travels to the island everyone second day; or**
- **A flight via Air Kiribati also offered a couple of times a week.**[98] **Flights to and from Tarawa, which occur twice a week, are subsidised by the GoK and the fare is $67AUD one way.**[97]

There are 13 schools on the island, 10 primary, 1 junior secondary and 2 senior secondary. Some schools have access to groundwater or wells, where visitors often come to ask for fresh water. There is 1 health clinic and 8 medical outposts, each has a rainwater tank for storing water for medical purposes. However, sometimes these become disconnected when villagers need freshwater, which creates a risk that there is an insufficient supply of medical water. For severe diseases that require medical treatment, patients must travel to Tarawa.

4.5 CURRENT ENERGY GEOGRAPHY

In 2015, the GoK initiated the development of its *Kiribati Integrated Energy Roadmap 2017-2025* (KIER) which functions as an implementation plan for the *Kiribati National Energy Policy 2009* (KNEP).[116] The KNEP serves to provide a framework from which the public and private sectors can make informed decisions regarding energy development. KNEP was developed with 6 guiding principles: sustainability, good governance, environmental compatibility, stakeholder participation, gender equity, and cultural and traditional compatibility. Quantitatively, KIER has set out to achieve the targets listed in Table 8 by 2025.

TABLE 8 – KIRIBATI ENERGY TARGETS

Location	2025 fossil fuel reduction goal	Renewable Energy	Energy Efficiency
South Tarawa	45%	23%	22%
Kiritimati	60%	40%	20%
Outer Islands	60%	40%	20%

Abaiang is classified as an outer island, where “the goal for rural public and private institutions (e.g., boarding schools, the Island Council, private amenities, and households) is to meet 100% electricity demand with renewable energy by 2025”.[116] KIER set out to achieve these ends by expanding the distribution of solar home systems (SHSs) to Abaiang and other outer islands. As Figure 7 shows, even before the establishment of the roadmap, there had been remarkable success with disseminating SHSs across Abaiang Atoll, from 7.4% of households using solar in the year 2000 to more than 92% of households using solar home systems by the year 2015. The Kiribati Solar Energy Company (KSEC) and its Renewable Energy Service Company program – which has been in operation since the early 2000s – with Solar Home Systems has played a major role in disseminating these SHSs. The Chinese Government is also active in disseminating off-grid solar products on Abaiang through its China Aid program.

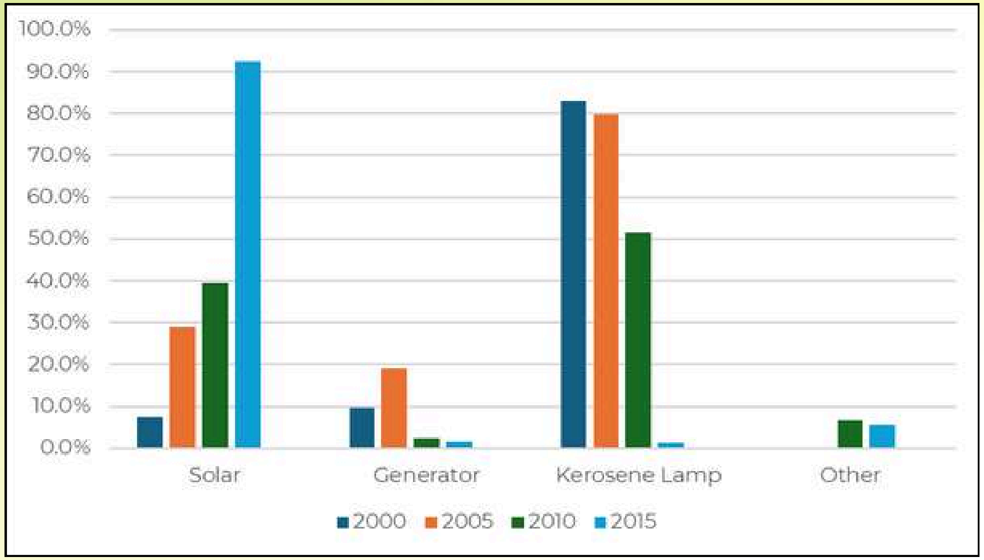


FIGURE 7 - MAIN SOURCE OF LIGHTING ON ABAIANG (CENSUS DATA)

Through various aid projects, solar PV has been installed at the health centre and many of the medical outposts, although many have had issues, and some systems have failed. The European Union supported the installation of photovoltaic power arrays (16kWp each) at the two high schools on the island in 2012, which include power for lighting, appliances, and water pumping.[117] MISE and KGES are currently in the process of rehabilitating these systems. One of the primary schools (Wakaam Primary School) also has a PV system installed. Solar PV, with generator support and backup, is also used at the tourism bungalows on the island.[112] The two mobile towers on the island use solar PV power supplies.[108]

In 2021, the United Nations Development Programme (UNDP) partnered with the GoK to implement the Promoting Outer Island Development Through the Integrated Energy Roadmap (POIDIER) Project.[118] The goal of POIDIER is to enhance outer island development by achieving the renewable energy and energy efficiency targets defined in KIER. POIDIER adopted a multipronged approach to addressing energy challenges in outer islands, which includes:

- **addressing capacity gaps through training and outreach,**
- **financing renewable energy sources; and**
- **expanding the emphasis to include community-oriented energy systems that can support revenue generating activity.**[118]

The project also includes feasibility studies for solar mini-grid systems in the outer islands. Abaiang was selected as one of the demo sites for a solar mini-grid system, and in October 2021, a technical assessment was performed in conjunction with an outreach program aimed at raising awareness on safe working practices related to SHSs, solar water pumps, and other renewable energy technologies.[119] This outreach program was titled 'solar mamas and papas,' which provided training for 14 women and 14 men on the installation and repair of SHSs and solar lighting kits. The training had the added effect of contributing to gender equity by ensuring women were represented in a space traditionally occupied by men.[119] The technical assessment for a potential solar mini-grid involved the selection of potential government-leased land (likely placed within or near schools) that could be utilised for such a system, as well as a survey of 356 houses. Most households responded positively and were excited for the potential benefits that a mini-grid system could bring, such as easing financial pressure since they no longer need to worry about the costs of maintenance or spare parts.[119]

In 2022, the state-owned Kiribati Green Energy Solutions (KGES) installed a mini-grid system, powered by a 7kWp PB array, on the outer islet of Nuotaea, which provides power for the community as well as a water desalination plant.

4.6 RENEWABLE ENERGY RESOURCES

The main renewable energy resources available on Abaiang for electricity production are solar and wind. As a small, low-lying atoll, there are no opportunities for hydro power, and very little biofuel potential.

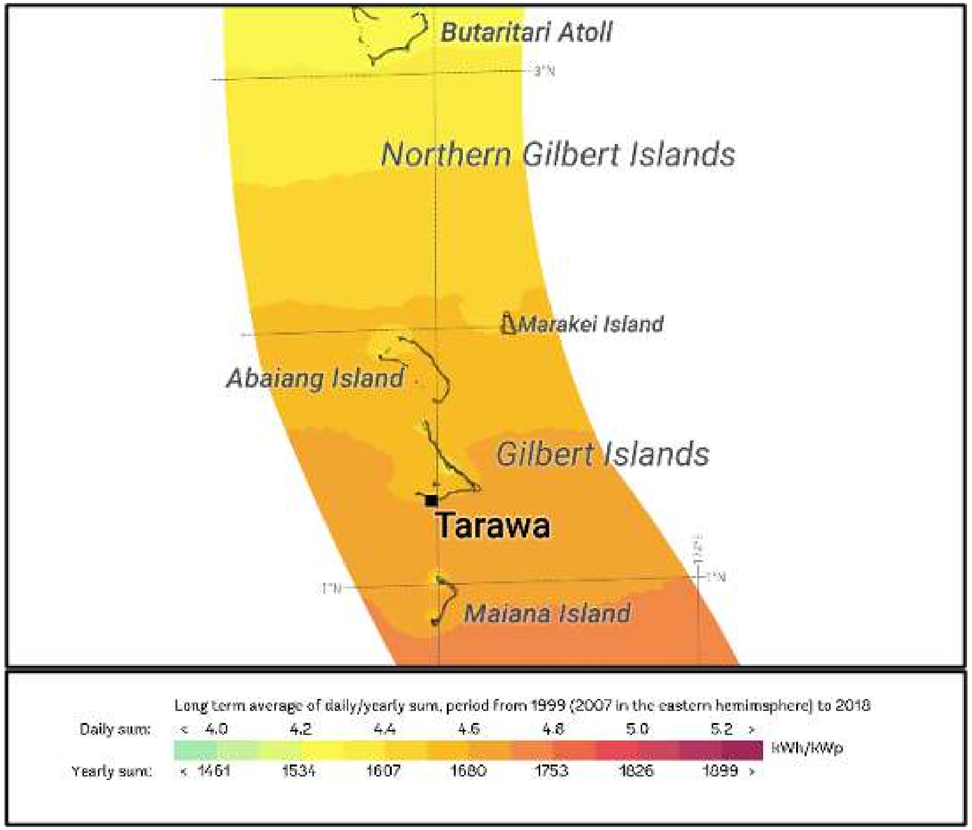


FIGURE 8 – SOLAR POTENTIAL ON KIRIBATI (SOURCE FROM THE GLOBAL SOLA ATLAS PROGRAM

The World Bank Group, through its Global Solar Atlas (GSA) program, has mapped out the photovoltaic power potential across Kiribati, mapping the PV power-producing potential of a 1kW solar PV power plant based on data between 1999 and 2018. The potential for Abaiang was calculated at around 4.5 kWh/kWp per day (around 1650 kWh/kWp per year) (see Figure 8).[120] The result indicates a strong potential for solar PV applications.

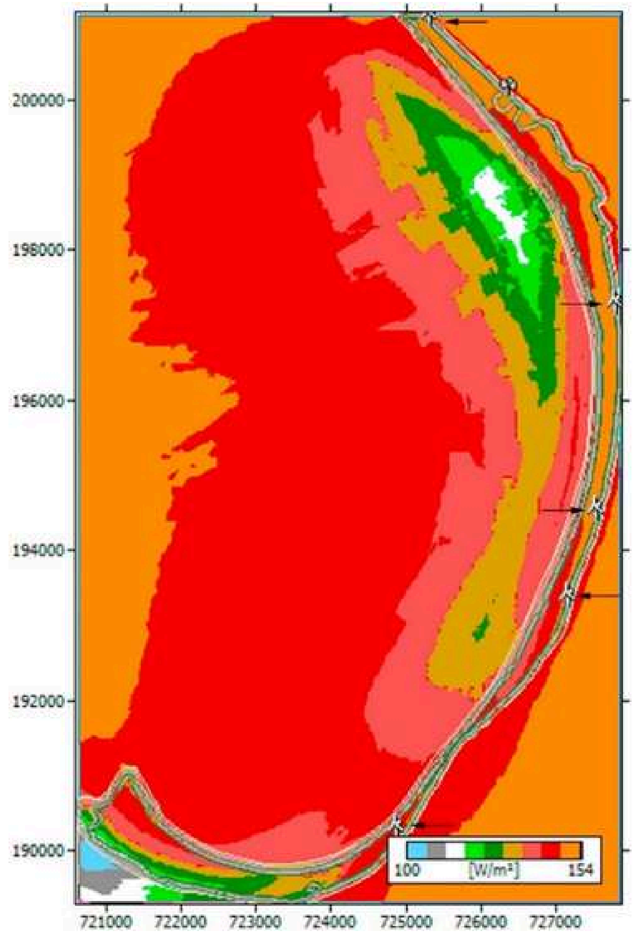


FIGURE 9 WIND POTENTIAL ON ABAIANG (SOURCED FROM AUKITINO ET AL 2017)

In terms of wind potential, a wind resource assessment was carried out on Abaiang in 2016, measuring the data of wind speeds at 20m and 34m above ground level.[121] The measuring site on Abaiang was Taburao, near the atoll's airport.[122] The assessment measured wind speeds of 5.5 m/s at 34 m above sea level. The study concluded that there is substantial potential for the use of wind power resources on Abaiang. The study included an economic analysis with Vergnet 275 kW wind turbines (which are commonly used in the Pacific) and suggested a potential payback period between 5 and 9 years for the installation, based on the current government tariffs. It also noted that the wind turbines, which can be used in combination with solar PV systems, can be used to cater for the energy needs of the country.

The study recommended five potential sites where wind turbines could be used on Abaiang (see Figure 9)

4.7 WHOLE-OF-ISLAND ENERGY PLANNING APPROACH FOR ABAIANG ATOLL

The main renewable energy resources available on Abaiang for electricity production are solar and wind. As a small low-lying atoll, there are no opportunities for hydro power, and very little biofuel potential.

Foundational Principles

Historically, Abaiang has demonstrated strong alignment with decentralised renewable energies, particularly solar. By 2015, over 92% of households were using solar home systems (SHSs), with widespread dissemination driven by national initiatives and donor programs. This uptake reflects not only technical suitability but also a degree of social preparedness for decentralised energy solutions. Yet behind this headline success lie important challenges: maintenance issues, a fragmented energy landscape, and limited access to productive energy uses that could support livelihoods.

The energy planning process for Abaiang must be deeply contextualised. The dispersed geography and heavy reliance on marine access highlight the importance of designing systems that are both resilient and tailored to local realities. Schools and health facilities use solar water pumps, while most households rely on hand-drawn well water. A recent solar-powered piped water system in the village of Ubwanteman is a promising step towards integrated energy-water solutions. These successes illustrate the value of embedding energy planning within broader infrastructure and service delivery, particularly in light of increasing climate risks.

Justice considerations are central to energy planning in Abaiang. Distributional justice has improved with the rollout of SHSs, but procedural justice requires more consistent community engagement in planning and governance. The 'solar mamas and papas' program, which trained equal numbers of women and men in SHS installation and repair, is a noteworthy initiative that goes beyond technical skills to challenge gendered divisions of labour. Programs like this should be expanded and embedded in ongoing governance structures to ensure women's participation in decision-making and benefit sharing.

Abaiang's energy planning must also remain complementary to national frameworks such as the *Kiribati Integrated Energy Roadmap* (KIER), which calls for outer islands like Abaiang to meet 100% of their electricity demand with renewable energy by 2025. Local initiatives align well with this goal and show how tailored, community-based implementation can establish national strategies.

Core Components

Understanding community needs requires close attention to the social and cultural dynamics that shape island life. Traditional village hierarchies, led by *unimane* (elder men), continue to influence decision-making, though their authority has become less central in the Northern Gilberts compared to other regions. Engagement strategies should be culturally grounded yet adaptable, involving both traditional leaders and younger, more technically oriented community members. Participatory methods such as storytelling or community mapping may help bring out local energy priorities and identify key anchor points like schools, clinics, and tourism facilities.

Technical assessments already underway have identified sites for potential mini-grids, such as the pilot system installed on Nuotaea islet, which also powers a desalination plant. The rehabilitation of older solar systems at health centres and schools is also essential to building system reliability. A combination of household-scale SHSs and community-scale mini-grids seems most appropriate, given the mix of clustered and remote settlements across the atoll.

Productive uses of energy remain limited but offer great potential. Copra drying, seaweed processing, refrigeration for fisheries, and electric water pumping are all viable pathways for energy-enabled livelihoods. As an island connected primarily by sea, there is also growing potential to explore electric boats as a clean transport solution, particularly for trips between islets like Ribono and Nuotaea or even to Tarawa. While still emergent, this form of e-mobility could complement existing transport modes and reduce diesel dependence.

Deploying and managing energy infrastructure on Abaiang requires coordinated governance and flexible financing. Local councils and traditional leaders should be integrated into energy planning bodies and supported by a cadre of trained technicians, including women and youth. Capacity building is essential to ensure the long-term operability of systems. Financing will need to be blended from multiple sources. Beyond donor funding, Abaiang can access government budgets and climate adaptation financing. Financial models must ensure equitable access through affordable tariffs or subsidies, especially for vulnerable households, while also generating funds for maintenance and eventual system upgrades.

Implementation Principles

Implementation must be inclusive and resilient. The two remote islet villages, where logistical challenges often delay services, require special attention. Systems must be robust against extreme weather, and planning should prioritise upgrading existing infrastructure rather than duplicating efforts. Transparent governance, such as publicly available audits, inclusive committees, and open processes for tariff-setting and service standards, will strengthen community trust.

Inclusivity also demands that women and youth are not only participants but also leaders in energy governance and operations. Decentralised control and localised technical capacity can further embed resilience, while building on existing installations rather than reinventing systems will enhance efficiency. Sustainability, meanwhile, hinges on local ownership, adequate training, and well-structured financing models that support long-term functionality.

Monitoring & Evaluation

Measuring energy access must go beyond the number of connections. Monitoring should track improvements in wellbeing, such as whether schools can reliably use lighting, clinics can run cold chains, or women can access new income-generating opportunities. Gender-sensitive indicators should be integrated into evaluation frameworks, and regular feedback from village meetings can provide a basis for adapting systems and addressing local concerns.

Lifecycle tracking is another emerging priority. As the first wave of SHS components begins to fail, systems must be in place to manage solar waste, recycle components, and replace key infrastructure. Establishing asset registers and maintenance schedules will help extend the life of both household and community-scale systems.

Conclusion

Abaiang offers a compelling case for how energy planning can be shaped by local realities while contributing to national and regional goals. Building on its high solar adoption and growing experience with community-scale infrastructure, the island is well-positioned to pioneer an integrated, inclusive model of whole-of-island energy development. While challenges remain, including system maintenance and financing, the foundation has been laid. If more money is invested, rules are improved, and energy is used for productive and transport-related purposes, Abaiang can show how communities can change in a way that withstands climate challenges.

ARNO ATOLL

5.1 GEOGRAPHICAL AND ECONOMIC LANDSCAPE

Arno Atoll lies 15 km from Majuro, the capital of the Republic of the Marshall Islands (RMI) and is classified as part of the Ratak Island Chain in the east of the country. [123] The Arno community is vulnerable to the impacts of climate change and faces exposure to periodic hazards, which are becoming increasingly unpredictable. These include droughts, particularly during El Niño years, typhoons, and sea level rise, which have caused saltwater intrusion, coastal erosion, and annual king tides during the month of February. Like most coral atolls, Arno is characterised by its coastal reefs and a ring-shaped chain of low-lying islets surrounding a central lagoon. Arno is one of the largest atolls in the Marshall group, with a land area of 13 km^2 and a circumference of 120 km that surrounds a lagoon measuring 340 km^2. Arno also has a unique feature that differentiates it from most other atolls in the Pacific; rather than surrounding just one large central lagoon, it also contains two smaller 'pinched' lagoons in the Northwest and Northeast of the atoll.

Arno Atoll's population is 1,141, distributed in 217 households and dispersed across 133 islets. The atoll has experienced significant population decline over the past two decades, potentially outmigration driven by the impact of droughts, high tides, and storms that have impacted the Atoll in recent years. Arno village, located on Arno Island in the Southwest, is considered the capital of the atoll. This island in the atoll has a dock, which is the main point of transportation to and from Majuro Atoll, and better access to internet and communication infrastructure, as well as medical facilities and imported foods, than the other inhabited islands in the atoll. Any benefits that stem from being in close proximity to the capital, Majuro, are generally limited to Arno village, as the outer islands are more challenging to reach by boat and are therefore considered quite remote.

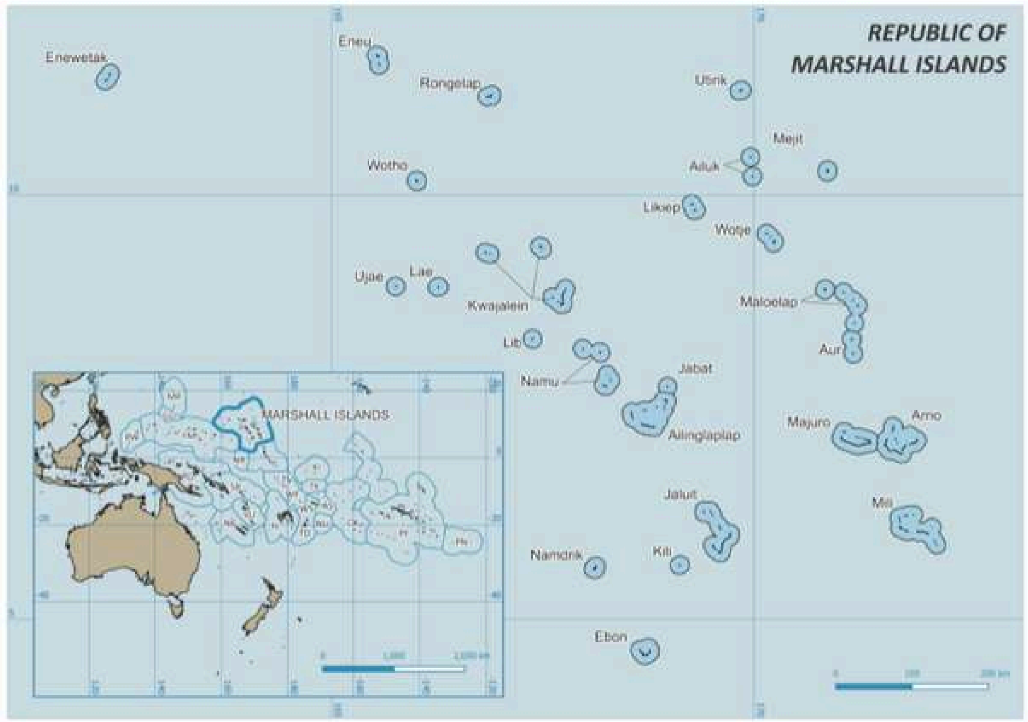


FIGURE 10 - MAP OF THE MARSHALL ISLANDS

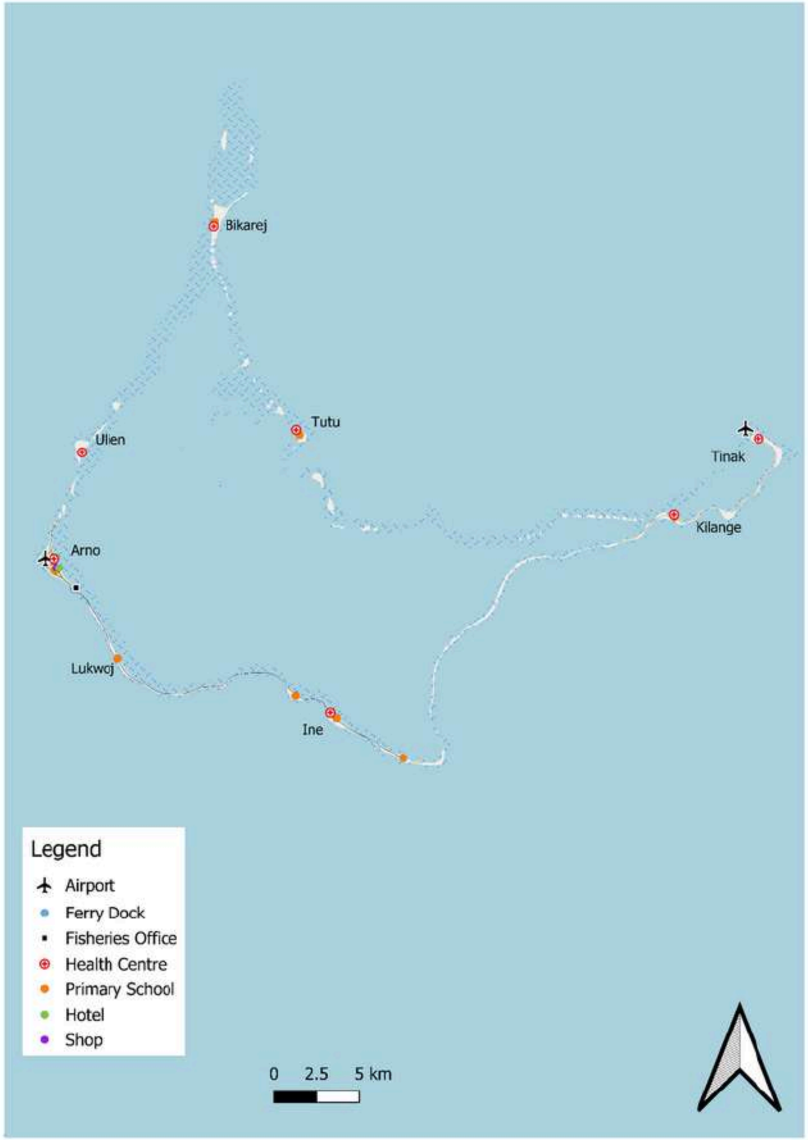


FIGURE 11 – MAP OF ARNO ATOLL

5.2 LIVELIHOODS

The median age on Arno Atoll is 22, and there are limited opportunities for income generation, with the median income being US$6,000. The primary source of income for over 70% of households is through the sale of products, such as fish, crops, handicrafts or copra.

Fishing in particular is an important industry and is facilitated by a Marshall Islands Marine Resources Authority (MIMRA) fish base located on Arno Island, near Arno Village, as well as a sub-fish base located at Ine. These bases help to bring catch into domestic and international markets, as well as serve as an aquaculture facility targeted at increasing food security through fish farming and collecting giant clams.[124] The fish office in Arno has ice-making capabilities as well as giant clam and fish hatcheries. Arno Atoll—in part due to its proximity—is the biggest supplier for the Outer Islands Fish Market Centre (OIFMC) in Majuro Atoll, and reportedly sold more than 8,000kg of fish to the OIFMC in 2023, worth US$35,800.[125]

Arno Atoll also received $100,000 during a visit by Pacific Islands Tuna Provisions (PITP) for sustainably caught tuna supplied to the United States supermarket chain Walmart. The giant clam hatchery at Arno was not in operation in 2023 due to renovations, but it will also be an important source of income.[125] Arno is also a relatively major producer of copra in the context of the Marshall Islands. In 2020, the Atoll produced 391 tonnes of copra, which was sold to the Tobolar Copra Processing Authority in Majuro, at a total market value of around US$450,000.[126]

Beyond fisheries and copra, additional sources of income on the island included wage work for government employees at schools, medical posts, or in administration positions, as well as work at two small resorts offering employment located in Arno Village (the Arno Beachcomber Lodge and the Arno Beach Resort). There are currently plans to expand tourism on the atoll (discussed below).

There is also a considerable degree of subsistence-based lifeways in Arno, and daily life, particularly for women, revolves around daily chores such as tending to crops (e.g., pandanus and taro) and livestock (e.g., chickens) and completing other household duties. These lifeways have been placed under considerable stress in recent years due to the effects of climate change. Climatological disasters—notably king tides, droughts, and typhoons (cyclones)—regularly impact the availability of potable water so that it needs to be rationed more carefully, and saltwater intrusion has impacted the quality of soil.[123]

5.3 SOCIAL AND CULTURAL GEOGRAPHIES

Contemporary Arno identity revolves around Christianity and the Church, which was first introduced by Protestant missionaries in 1857.[127] Marshallese languages have historically lacked a written script, and cultural disruptions since colonisation make it difficult to ascertain information about the pre-colonial culture and religion. It is known, however, that religion was polytheistic and societal structures were based on matrilineal social hierarchies, in that rights to land were inherited through the mother. Socially, the *Irooj* (Chiefs) held the most power, followed by the *Alap* (Noblemen), and then the *Dri-Jerbal* (Labourer); there are also oral legends about a war between two Arno chiefs, Lokmanman and Lojete. Daily life continues to entrench traditional gender roles for men and women. For example, men learn to catch fish from a young age, whereas women learn to weave baskets, called Alele, made from pandanus leaves. These baskets hold a family's most valued possessions, which then get passed on to the eldest woman of each generation.[128]

Today, Arno has its regional government, of which there are thirty-three in the Marshall Islands, and it can elect its representative to the Nitijela (National Parliament).[129] Connection to traditional lands and resources remains a critical value in contemporary Arno culture, along with the freedom and independence that come with being self-sufficient![123] In a recent survey conducted by the International Organisation for Migration (IOM), respondents placed the value of 'natural resources' above even family, friends, and the church. Attachment to land and place is the highest in the country and is one of the primary reasons most people from Arno Atoll are planning to stay and adapt, rather than migrate, even as environmental conditions deteriorate due to the impacts of climate change.[123]

Arno - Overview	
Population	1,141
Households	217
Villages	22
Land area	12.95 km2
Population Density	88.1 people per km2

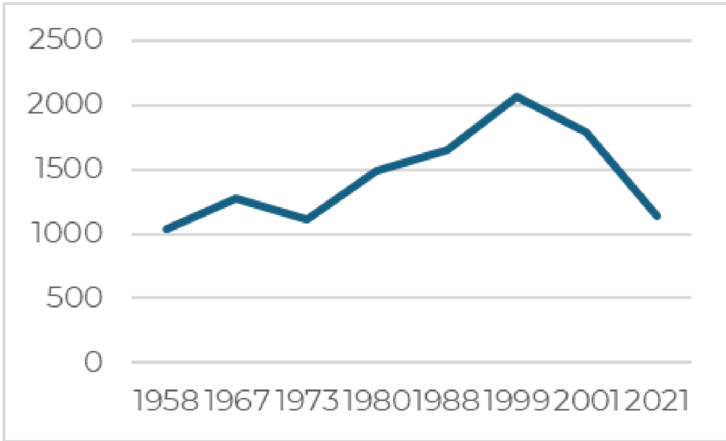


FIGURE 12 – POPULATION GROWTH ON ARNO (CENSUS DATA)

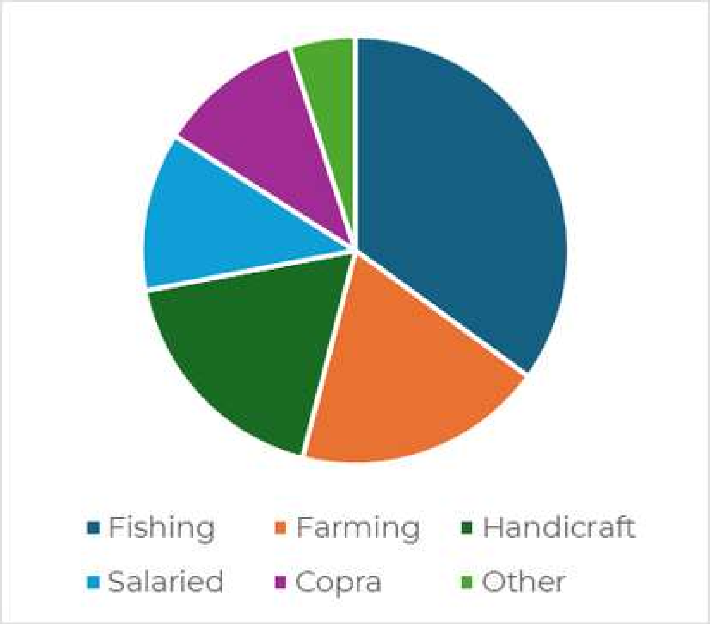


FIGURE 13 – MAIN SOURCES OF INCOME ON ARNO (CENSUS DATA)

Daily patterns of life are beginning to change due to climate change and have led to social isolation within the communities on Arno Atoll. Climate change impacts have particularly affected women, leading to numerous reports of physical and emotional abuse.[123] Communities are beginning to become socially isolated, and any gatherings, daily chores, or physical activities need to occur after 4 pm due to the extreme heat. Women have also noted that resources for weaving and handicraft making are beginning to become depleted, and there are not enough spaces to get together and collaborate with other women.

5.4 PHYSICAL INFRASTRUCTURE AND TRANSPORTATION

Transportation to and from the atoll predominantly happens via a boat that makes a return trip to Majuro from the dock on Arno, which takes approximately one hour, depending on weather, and runs three times per week.[123] There are two airstrips on the atoll, one in Arno and one in Tinak in the North-east; however, no commercial airlines are servicing these airstrips. Despite having a single gravel road that connects the islands in the Southwest half of the atoll (Ulien, Arno, Lukwej and Ine), there are very few cars or trucks within Arno Atoll (24 in total on the island, according to the 2021 census). Most 'on-land' intra-atoll travel is done on foot or by way of riding a bicycle; however, only a few of these are individually owned.[30] Otherwise, transportation is done via boats, especially to the outer islands not connected to the gravel road (Kilage, Tinak, Longar, Tutu, Bikarej and Malel). Bikarej and Tutu are particularly isolated from the other villages. The former is isolated from other inhabited islands, while the latter lacks a safe boat entry point.

In total, there are 11 schools dispersed across Arno Atoll, 10 public and 1 private (Tinak), all of which are primary schools.[130] Students need to travel to Majuro to complete their high school education, and the high school graduation rate in Arno is 58%.[123] Arno Atoll has 7 health clinics in operation, which are in poor condition and have only 8 health assistants between them.[131]

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This situation means the RMI Ministry of Health and Human Services needs to conduct periodic visits to Arno to provide enough healthcare to serve the population.[132] In response to the lack of services, some communities in Arno Atoll have initiated community-run projects and action plans in case of emergencies. For example, there are coastal reforestation and crop replanting programs managed by Women United Together Marshall Islands (WUTMI).[123]

In 2021, the Bank of the Marshall Islands (BOMI) and Marshall Islands Service Corporation (MISC) building was set up in Arno Village, providing the island's residents with banking services (e.g., deposits, withdrawals, loans, and moneygram), acting as a trading hub for barter, and selling groceries and handicrafts.[133] There is also a Marshall Islands Marine Resources Authority (MIMRA) fish office based near Arno Village, and a sub-fisheries office near Ine.

5.5 CURRENT ENERGY GEOGRAPHY

Energy planning in the Marshall Islands is informed by several key documents, including the *National Energy Policy* (2009), the *Electricity Roadmap* (2018), and the *Energy Master Plan (2021–2030)*. Together, these articulate a vision for providing affordable, reliable, and sustainable energy to all Marshallese, with a specific focus on energy security and climate resilience. Building on earlier policies, the 2019 and 2021 plans commit to achieving 100% renewable energy generation in the capital, Majuro, and on the island of Ebeye by 2030. Strategic priorities include upgrading grid infrastructure, deploying solar-diesel hybrid systems, expanding battery storage, and supporting community-based solar installations in the outer atolls. The plans also emphasise capacity building, regulatory reform, and improvements to utility performance while aligning the energy transition with the country's climate commitments under its Nationally Determined Contributions (NDCs).

RMI has committed to a reduction of 45% of greenhouse gas (GHG) emissions by 2030 compared to 2010 levels and to achieving net-zero emissions by 2050.[134] To achieve this, the government initiated the *Marshall Islands Electricity Roadmap* (MIER) in 2018, which intends to develop a shared vision between the government and development partners—in alignment with the international climate change agenda and the Paris Agreement targets—for the nation's energy future.[134] The Marshall Islands is heavily reliant on external sources of funding for development, and over the last decade, projects have often lacked coordination between investors, the government, and other stakeholders. The MIER intends to address this challenge with costed, technically sound pathways for the energy sector to achieve RMI's 2030 targets and offers a brief outline for pathways towards decarbonisation in 2050.

Solar Home Systems (SHSs) are the main source of electricity on Arno Atoll, according to the most recent census, with more than 95% of households owning an SHS.[30] A major driver of this uptake was likely an SHS dissemination project by the Government of Taiwan, which involved the installation of 359 SHSs on Arno Atoll between 2007 and 2008.[135] A small number of households use petrol generators as their main source of lighting (3.5%), although a further 18.5% own generators, presumably using them as a backup supply. In terms of electrical items and appliances—according to the most recent 2021 census—84% of households owned a mobile phone, 28% owned a washing machine, 15% owned a fridge or freezer, 14% owned a TV, and 3% owned a sewing machine.[30]

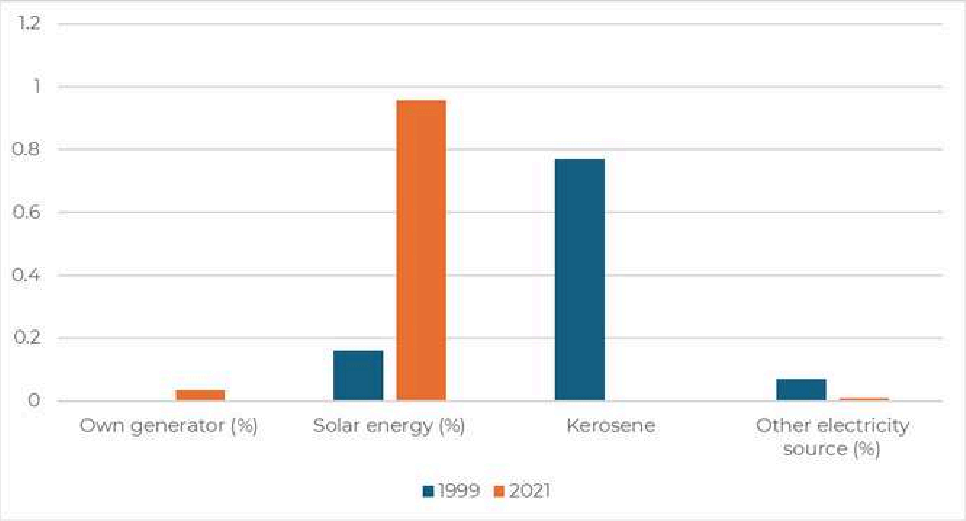


FIGURE 14 – MAIN SOURCE OF LIGHTING ON ARNO. DATA SOURCE FROM CENSUSES

In terms of broader community energy infrastructure, in the early 2000s—with funding from Japan —a hybrid solar PV and wind system was installed at the Tinak Elementary School, which provided power for a photocopier, television, and lighting.[136] While in 2009—with funding from the European Union —a 6.12 kW off-grid solar system was installed at the Ine Elementary School.[137] The current status of these installations is unclear. Although reports on Arno have noted more broadly that there have been challenges with solar panels being damaged by typhoons/cyclones, as well as being corroded and damaged during high tide events.[123] The most recent Education Sector Plan in the Marshall Islands nevertheless includes an objective of installing solar PV at all schools in the country.[138] Most of the health clinics of Arno have off-grid solar PV systems, installed by Island Eco—a solar company based in Majuro—as part of an aid-funded project.

A somewhat novel renewable energy project was implemented at Ine Village on Arno in 2010, when the Global Reef Alliance installed a wind turbine on the coast as part of a coastal protection project. The small windmill is designed to send electrical currents to seventeen biorock structures that were constructed underwater near the coast. Biorock is a cement-like engineering material formed by passing a small electric current between submerged metal electrodes in seawater. This process causes dissolved minerals in the water to accumulate on the cathode, forming a thick layer of limestone. Known as the accretion process, this technique can be used to produce building materials or to create artificial electrified reefs, which support coral growth and benefit marine life. The project has thus been designed to restore near-shore coral reefs and fisheries habitat, protecting beaches from wave erosion and allowing them to grow.[139]

Most recently, Green Energy Solutions—a renewable energy company based in nearby Majuro Atoll—has been involved in installing larger off-grid solar systems on Arno. This has included a 5kW solar system installed at Arno Beach Resort, another installation at the MISCO/ BOMI (market/bank) building in Arno Village. The second tourist hotel also uses solar power for lighting, and there are some solar streetlights along the dock. The fisheries office in Arne Village uses a small generator for its fisheries and ice-making machine.

There is a proposal from the World Bank for the development of a hybrid mini grid system for electrification in Arno and Ine islands of Arno Atoll.[140] This is because the Ministry of Tourism has identified Arno Atoll for its potential to become an international tourist destination and plans to construct new hotels over the coming years in both Arno and Ine islands. This project is encompassed within the Renewable Energy Generation and Access Increase (REGAIN) project, which came into effect in early 2024. The purpose of the project is to provide higher-level electricity access and to replace the current use of solar home systems (SHS) with approximately 400 kW of photovoltaic (PV) panels, along with 0.37 MWh of battery storage, inverters, and transformers. There will be a further two units of 40 kW diesel generators to back up energy needs overnight. As well as servicing the tourism sector, the mini grid will be targeted at 130 households, telecommunications, small businesses, two fish bases, two medical clinics, and two public schools. There is considerable infrastructure that needs to accompany this project, including a 30-day fuel storage compound, oil storage, a recycling shed, an administration office, a distribution system, security fencing, transformers, and pipelines to funnel fuel from the dock to tanks. All these works must be elevated above existing ground levels to avoid flooding caused by tidal surges and king tides.140 Old SHSs will be removed and sent to Majuro for potential recycling and refurbishment. In cases where this is not feasible, there will be a designated overseas disposal facility

5.6 RENEWABLE ENERGY RESOURCE

There are three main renewable energy sources available in the Marshall Islands that have the potential to power electricity access: wind, biofuel (from copra), and solar. There are no studies mapping out the potential wind resource of Arno Atoll; nevertheless, the technology has already been used at a couple of sites: Tinak Elementary School in the early 2000s and the Biorock project at Ine in 2010. The RMI government recognises that more detailed area-based studies are needed across Arno and the rest of the country before a higher level of implementation can be achieved.[123] There have been some feasibility studies in the Marshall Islands surrounding the potential use of biofuel derived from copra as a substitute for diesel fuel in generators. The Tobalar copra Mill in Majuro does have the capacity to create fuel from coconut oil, and some experiments have occurred with people using it in their cars and boats. There has also been some consideration of whether it is possible to use copra oil production from the outer islands as a fuel. While the studies are now somewhat outdated (i.e., conducted in the early 2000s), the general conclusion is that it could not compete on price with solar PV at the household level.[71] Currently, copra biofuel is likely of little relevance in Arno Atoll, despite the high production of copra, because of the presence of large generators and vehicles; however, it could become more relevant if the aforementioned World Bank REGAIN project is implemented.

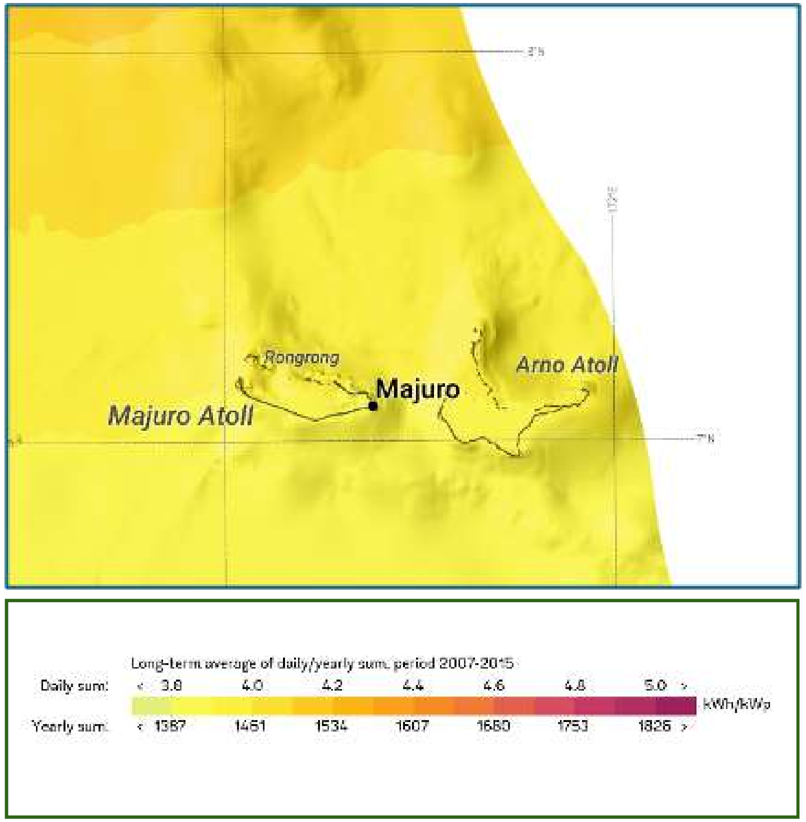


FIGURE 15 – SOLAR POWER POTENTIAL MAP OF ARNO (SOURCE FROM GLOBAL SOLAR ATLAS)

The World Bank Group, through its Global Solar Atlas (GSA) program, has mapped out the photovoltaic power potential across the Marshall Islands, mapping the PV power-producing potential of a 1 kW solar PV power plant based on data between 1999 and 2018. The potential for Arno was calculated at around 4 kWh/kWp per day (around 1650 kWh/kWp per year) (see Figure 15). This shows a high potential for PV solar use on Arno, and unsurprisingly, the technology has already been used extensively.

5.7 WHOLE-OF-ISLAND ENERGY PLANNING APPROACH FOR ARNO ATOLL

Foundational Principles

Arno's geographic, cultural, and economic realities must shape its energy future. With a population of just over 1,100 spread across a large atoll, infrastructure development is challenging and uneven. Arno Atoll, where the main dock and services are located, benefits from its closeness to Majuro, but the outer islets are harder to access and more underserved. Cultural attachment to land, matrilineal inheritance systems, and a strong preference for adaptation over migration reflect the community's resilience.

Energy justice must be central to planning. While more than 95% of households have solar home systems (SHSs), there are major issues with system maintenance, performance under extreme weather, and equitable access to infrastructure such as ice machines or water pumps. Gender inclusion must also be prioritised, given the compounded burdens women face due to climate change, resource scarcity, and social isolation. Community-led reforestation and women's initiatives, such as those by WUTMI, provide a valuable foundation for ensuring women are not just included but are leaders in shaping energy futures.

Importantly, any whole-of-island energy strategy must complement the RMI's broader energy commitments. National policies such as the *Electricity Roadmap* (2018) and *National Energy Policy* and *Energy Action Plan* set ambitious targets for renewable energy, grid upgrades, and energy efficiency. Arno's alignment with these plans—and its inclusion in strategic projects like REGAIN—positions it to play a key role in the Marshall Islands' broader energy transformation.

Core Components

Understanding Arno's needs requires a deep engagement with its socio-economic and spatial characteristics. Most livelihoods are based on fishing, copra production, and subsistence agriculture. The fish base in Arno Village, and its sub-base at Ine, support both domestic sales and international exports, including to Walmart. Yet most of the atoll's economic infrastructure—like ice machines and fish storage—depends on diesel power and limited solar installations.

Energy interventions must support both domestic and productive uses. SHSs provide basic lighting and mobile phone charging, but are insufficient for powering small businesses or community infrastructure. The proposed hybrid mini-grid system under the REGAIN project aims to change this by installing 400 kW of solar PV and 0.37 MWh of battery storage on Arno and Ine islands. This system will support 130 households, schools, medical clinics, fish bases, and tourism facilities. Importantly, it will also include backup diesel generators and flood-resilient infrastructure, ensuring reliability and climate readiness.

Electric mobility, including the potential use of e-boats, could complement Arno's energy strategy by improving transport to and from outer islets. This would support fisheries, tourism, and medical services, while reducing dependence on imported fuels. Given the limited road infrastructure and the central role of boat travel, e-mobility solutions could provide high-impact, locally appropriate alternatives. Community input must guide these transitions. With a strong attachment to land and traditions, Arno residents are well-placed to contribute to participatory planning processes. Traditional leaders (*Irooj*), women's groups, and youth networks should be actively engaged to shape the deployment and governance of new systems.

Implementation Principles

Equity, resilience, and sustainability must guide implementation. This means ensuring that energy infrastructure is not only physically resilient to typhoons and salt spray but also socially inclusive. Energy systems should reach isolated villages like Bikarej and Tutu, which currently lack safe transport routes and are rarely serviced.

Arno's implementation strategy should build on existing infrastructure, such as solar installations at health clinics and schools, as well as past projects like the biorock reef restoration at Ine. Where previous systems have failed due to corrosion or lack of maintenance, the new rollout must include long-term training, spare parts supply chains, and community monitoring.

A crucial factor to consider is financing. Arno can access funding through national budgets, climate adaptation financing, and international donors. Projects like REGAIN exemplify blended funding models. These efforts must be complemented by locally affordable tariff structures or subsidies, ensuring that even the most vulnerable households can access energy without falling into debt. The financial design must also incorporate operations and maintenance costs from the outset.

Monitoring & Evaluation

Monitoring in Arno must go beyond counting SHS installations. Metrics should track the quality and reliability of energy services, including hours of lighting, water pump operation, ice machine uptime, and school and clinic performance. Community wellbeing, livelihood productivity, and gender outcomes should form part of the evaluation framework.

Feedback loops are critical. Village-based energy committees, traditional leadership, and women's groups should be empowered to report issues, evaluate service quality, and suggest adaptations. Asset registers, maintenance logs, and waste management protocols (including for battery recycling) should be standard components of the monitoring toolkit.

Photo by Richard Foresnky

Conclusion

Arno Atoll is a unique case for energy transformation in the Marshall Islands. Its proximity to Majuro offers logistical advantages, but the diversity and remoteness of its islets present complex energy challenges. The community's strong cultural ties, economic resilience, and high solar uptake provide a foundation to build on. With new investments such as the REGAIN mini-grid and a commitment to participatory governance, Arno can demonstrate how decentralised, resilient, and inclusive energy systems can support climate adaptation, economic development, and cultural continuity in atoll nations.

TANNA ISLAND

6.1 GEOGRAPHICAL AND ECONOMIC LANDSCAPE

Tanna Island, located in the southern part of Vanuatu, is the country's sixth largest (with a land area of 555 km²), and third most populous (with a population of 40,603 persons) island.[141] Lenakel, located on the west coast of Tanna, is the commercial centre of the island and is located 228 km south of Vanuatu's capital, Port Vila, which takes 12 hours on a ferry, although exact times vary depending on weather conditions. Tanna is also serviced by Whitegrass Airport, located near Lenakel, which hosts flights to and from Port Vila through Air Vanuatu; however, their frequency varies due to the precarious financial position of Air Vanuatu, which went into liquidation in early 2024.[142]

Tanna Island is also the economic and population centre of the Tafea Province, which comprises the nation's five southernmost islands (Tanna, Aniwa, Futuna, Erromango, Aneityum). Small villages spread across Tanna, housing approximately 80% of Tafea's population.[143]

There is no public transport within the island, and villages are mostly connected by a network of dirt roads that require a 4WD, with some sealed roads around the coast and into the centre of the island. There is also no public ferry service connecting Lenakel to any of the outer islands, which means people need to organise their boat transportation or gain passage on a private vessel (e.g., Tiwi Traders Shipping, Pierre Brunett Shipping) should they wish to participate in Lenakel's markets or another commercial activity.

The island has a striking and diverse physical geography shaped by its volcanic origins. Dominated by Mount Yasur, in the Southeast of the island, which has been erupting, with moderate explosiveness and short-lived intermittent bursts, since about 1270 CE.[144] The island features dramatic ash plains, geothermal activity, and a rugged, mountainous interior with peaks rising to 1,000 metres. Its coastline is a mix of black sand beaches, coral reefs, coves, and rugged cliffs, while fertile volcanic soil supports rainforests, coconut palms, and tropical plantations.

Short, fast-flowing rivers descend from the central highlands of Tanna. The island's tropical climate, with high rainfall and warm temperatures, sustains its rich biodiversity but also leaves it vulnerable to cyclones. Indeed, the Tafea Province is considered the most disaster-prone region in Vanuatu, and faces environmental threats such as sea-level rise, intense cyclones, volcanic ash fall, and an increasing polarity of weather patterns.[143] Most tourism on the island revolves around sightseeing within the region that surrounds the volcano, along with some limited beach tourism. The summit of Mount Tukosmera, also located in the south of the island, is Tanna's highest peak and reaches 1,084 m above sea level.

An electrical grid services Lenakel and its surrounding area within the West Tanna area. It is one of only four within Vanuatu, with the others located in Port Vila, Malekula, and Luganville.[145] The other villages within Tanna are reliant on off-grid electrical options such as individually owned solar home systems or a hydropower-solar hybrid mini-grid. There are also twelve known hot springs in Tanna, which pre-feasibility studies have shown may be suitable for geothermal energy production.[83]

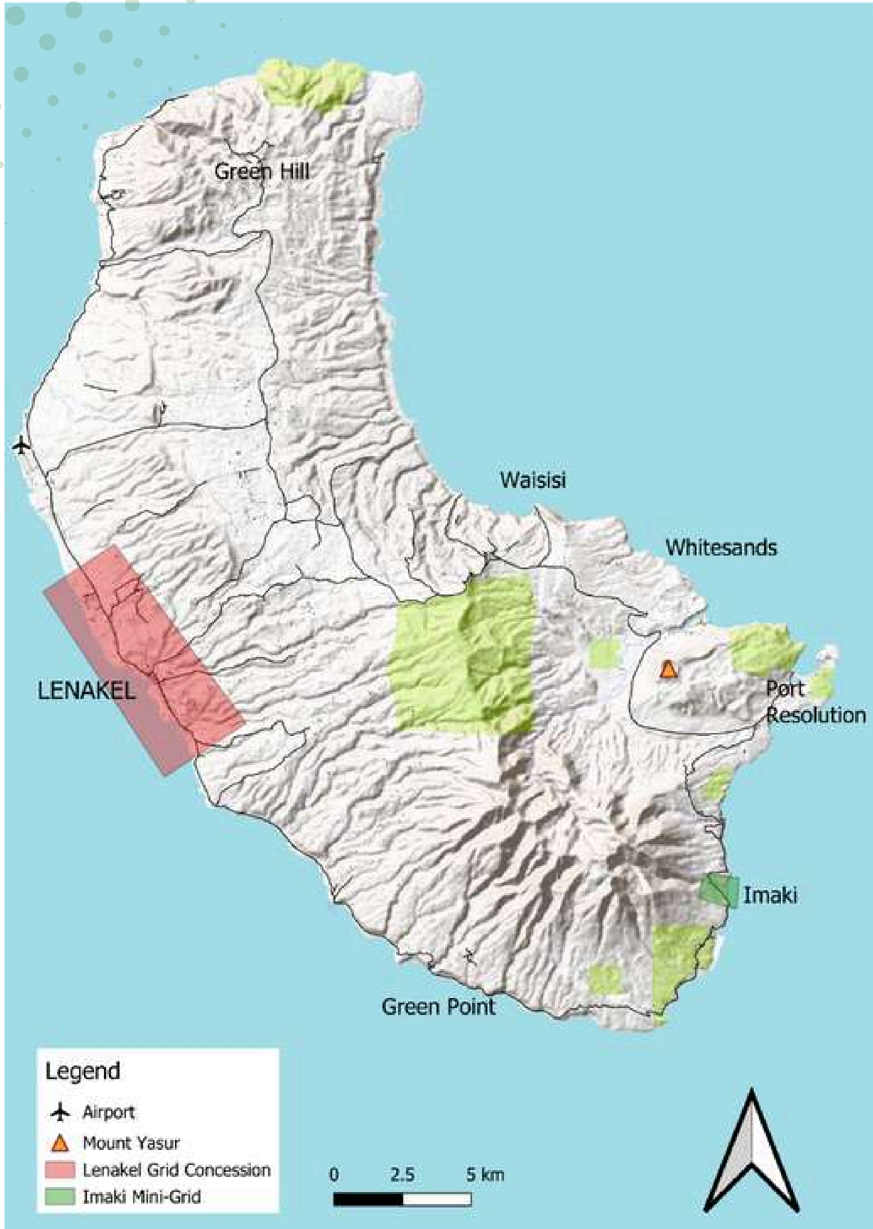


FIGURE 16 – MAP OF TANNA ISLAND AND ITS ELECTRICITY CONCESSIONS

6.2 LIVELIHOODS

Agriculture, which 98.6% of households on the island engage with, is a key livelihood in Tanna, both in terms of following subsistence lifeways and producing crops to sell at markets. Across the various area councils in Tanna, the prevalence of subsistence farmers ranges from 54% (in West Tanna) to 84% (in Southwest Tanna).[146] About 40% of the island's workforce makes their living from the agricultural industry.

Most crops grown for subsistence purposes are root crops such as taro, yams and manioc, whereas kava, and to a lesser degree copra or coffee, generate cash income. There has been considerable investment to promote the coffee sector on Tanna;[148] however, like elsewhere in Vanuatu, damage from cyclones has caused substantial challenges for this sector and others. [149]

Food drying is also a common practice among Tannese people, as it improves the shelf life of produce and extends the window in which they can be bought and sold at the market.[83] Fishing (46.5% of households) and livestock rearing (92.2% of households) are also important sources of subsistence or cash generation for most households in Tanna. On average, households own between 1-3 cattle, 2-7 pigs and [1]7-12 chickens. When households use agriculture as a source of income generation, crops are usually sold at one of the several markets that take place in Lenakel.

Remittance networks are another key source of income for many households in Tanna, with the World Bank estimating that income from remittance networks contributes to over 20% of Vanuatu's total GDP.[147] Over 12 months, 26% of households received income through remittance networks, and of those remittances, 37% were sent from Port Vila, 57% were sent from elsewhere in Vanuatu, and 7% were sent internationally.[1] International remittances are generally obtained through Australia's Pacific Australia Labour Mobility (PALM) scheme or New Zealand's Strengthening Pacific Labour Mobility (SPLM) programme, which offer temporary migration visas to individuals from Pacific Island countries to engage in seasonal work.[61]

In terms of income, the average wage for Tannese people is under AUD 1,000 per year; however, this number is skewed by the volume of people who engage with the economy in non-cash-based ways. For example, a nurse working at a public hospital will typically receive a salary in the range of $15,000-18,000 AUD.[150] There is also a geographic asymmetry for wage earners in Tanna, as incomes generally increase in proximity to Lenakel and Isangel (just south of Lenakel), where labour is more readily available for government jobs or basic services.[151] Historically, there has been a relatively healthy tourism sector in Tanna, with more than 15,000 tourists visiting the island a year (a substantial amount, considering its population of just over 40,000 people).[152] This figure, however, was for 2017, and tourism numbers in Vanuatu (outside of cruise tourism) have declined since COVID-19.[153] There are more than 30 guest houses across the island; in particular, they are concentrated on the coast near Lenakel and around the area of the Mount Yasur volcano in the south-east. This tourism revolves around the island's coastline and beaches as well as visits to the volcano. There is also some cultural tourism, with tourists viewing *Kastom* (custom) dances and ceremonies.[152] However, this does not necessarily translate to high employment numbers or link to greater development within local communities.[154,155]

According to the 2020 census, the tourism sector directly employed only 66 individuals in Tanna (although this figure would have been affected by the Covid-19 pandemic at the time).[1] Furthermore, the absence of tourism training programmes in Tanna has resulted in many employees being immigrants from Port Vila. Resorts also tend to source their food from Port Vila due to the limited availability, consistency, and quality of local produce.[155] Nationally, Vanuatu's tourism industry is dominated by cruise ship visitors. While Tanna is not included in cruise itineraries, it still benefits indirectly—many Tanna residents living in Port Vila earn income from tourism, and their remittances contribute significantly to the island's economy, which relies heavily on foreign cash brought in by visitors.

6.3 SOCIAL AND CULTURAL GEOGRAPHIES

Tanna has a particularly youthful population. The median age of Tanna's population is 17, and over 50% of the population is younger than 20 years of age.[1] Tafea province has the youngest median age of all administrative areas in Vanuatu, the national median age being 20. The population of Tanna is expected to follow the same patterns of rapid population growth as Vanuatu nationally over the coming decades.[141]

Mount Yasur has a unique influence on Southeastern Tanna's social and cultural landscape and presents unique challenges for development and climate adaptation projects.[143] The volcano causes large amounts of ash to fall to the ground and on houses, which generally kills crops and soils solar panels.[83] Previous adaptation projects in the East Tanna area council have had limited impact in cases where Mount Yasur's localised impact hasn't been adequately accounted for.[143] Notably, however, past projects have had success in promoting gender equity and social empowerment. There are indications that community attitudes are shifting regarding the important role of women in adaptation and community engagement.[143]

Tanna has experienced profound and rapid cultural change since European contact and the arrival of Christian missionaries in the nineteenth century. As a result, Tanna has become a religious and cultural kaleidoscope with a mix of beliefs that originate from Christianity and Kastom. Tanna is also home to several 'Cargo Cults', which themselves are a mix of Kastom and Christianity and largely emerged in the first half of the twentieth century as a Kastom revival movement alongside a nationalist political agenda that rebelled against Christianity and colonial structures of the British and French.[151]
This tradition survived until Vanuatu's independence in 1980, as Tanna was a stronghold for the independence movement, which emphasised the importance of Kastom. There are often blurred lines between religious practices, and modern Tanna is ultimately a mix of old and new cultural systems. Cargo cults themselves, for example, are notable for their idealisation of Western technologies as a result of their interactions with US military forces during World War II.[83]

Tanna Island is divided into seven area councils (North Tanna, West Tanna, Central, East Tanna, South Tanna, South West and South East Tanna). In addition to these council areas, Tannese communities are organised into small hamlets of households, which are then linked to a Nakamal, a meeting place for ceremonies, and an area where men often drink kava at sundown. Land inheritance is patrilineal, and only Indigenous Ni-Vanuatu people and the government can own land. Customary land titles are not generally bought and sold; however, in larger Christian coastal villages, some accommodation has been needed because of the centralisation that comes with influence from the church, tourism, trade, and commercialisation. Communities dominated by Kastom beliefs tend to value money less and perceive it as a threat to traditional practices. There exists a *kastom ekonomi,* which is a cashless traditional economy based on hierarchies, relationships, and trade; however, this economy is not applied to things like imported commodities or school fees. [83] In general, Christianity is strongest in coastal communities, and Kastom is strongest in the highlands of Central Tanna and North Tanna. This distinction is primarily due to the locations of old missionaries in coastal areas.

There are five distinct Indigenous languages across the island, although most Tannese people speak Bislama, a French-English creole, and few speak English or French, despite schools offering education in these languages along a relatively even split.

Tanna - Overview	
Population	40,603
Households	7,298
Highest Elevation	1.084m
Land area	550 km2
Population Density	73.8 people per km2

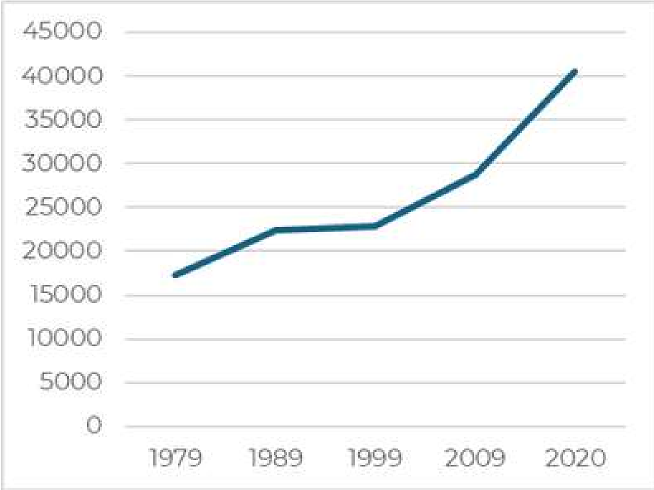


FIGURE 17 – TANNA ISLAND POPULATION GROWTH (CENSUS DATA

	Total Population	School attendees
North Tanna	4,701	1,301
West Tanna	13,221	3,784
Central Tanna	6,893	2,412
South West Tanna	6,523	1,331
South East East Tanna	7,664	2,399
South Tanna	1,601	590
Total	**40,603**	**11,817**

6.4 PHYSICAL INFRASTRUCTURE AND TRANSPORTATION

Travelling to Tanna invariably involves entering and exiting the town of Lenakel. Air Vanuatu operates flights to and from Port Vila to Whitegrass Airport, situated a 20-minute drive from Lenakel. Alternatively, there is a passenger ferry service that travels between Port Vila and Lenakel (and a port terminal at Lenakel); however, schedules are erratic and can change at short notice depending on the number of passengers, weather conditions, or other factors. The operator generally posts on Facebook several days before the departure date to notify potential passengers.

Travel within Tanna often requires a 4WD due to the prevalence of dirt roads. Pickup trucks and utility vehicles are ubiquitous on the island, and they are often seen with many passengers sitting in the back of them. Roads are often unpassable during rainy seasons, although there have recently been interventions to improve road quality in line with *Vanuatu's National Sustainable Development Plan (2016-2030)*.[156] The Tanna Island Road Project, for example, is part of the China-aided road upgrading project that covers several islands in Vanuatu.[157] The project has built new paved roads over existing dirt roads, which has improved access to Lenakel for Tannese people who live away from the commercial centre. Another is the Isangel Loop Project, delivered in partnership with Australia, which has involved the construction of a 1.7 km concrete pavement road just to the south of Lenakel (connecting the towns of Lenami, Isangel and Ureneap).[158] Hotels on the island are mainly located along the west coast, north of Lenakel or in the area surrounding Mount Yasur. In Lenakel, there are numerous shops, hardware stores, and restaurants. There are also government and NGO (CARE International, World Vision) offices in Lenakel, as well as a Western Union branch, post office, and Bank of Vanuatu branch. A second Bank of Vanuatu branch is located in Whitesands on the east coast of Tanna.

There is a single hospital on Tanna, located in Lenakel, along with five health clinics and dispensaries, which have a trained nurse and are operated by the Department of Health, and about twenty aid posts which are operated by local communities.[159] Dispersed across the island, there are also fifty-seven primary schools (29 English and 28 French) which serve students from years 1-6 (two of them are for years 1-8); ten junior secondary schools (6 English and 4 French); and five senior secondary schools (years 7-12/13).[160] All of the Senior Secondary Schools are in the west of the island, in relatively close proximity to Lenakel.

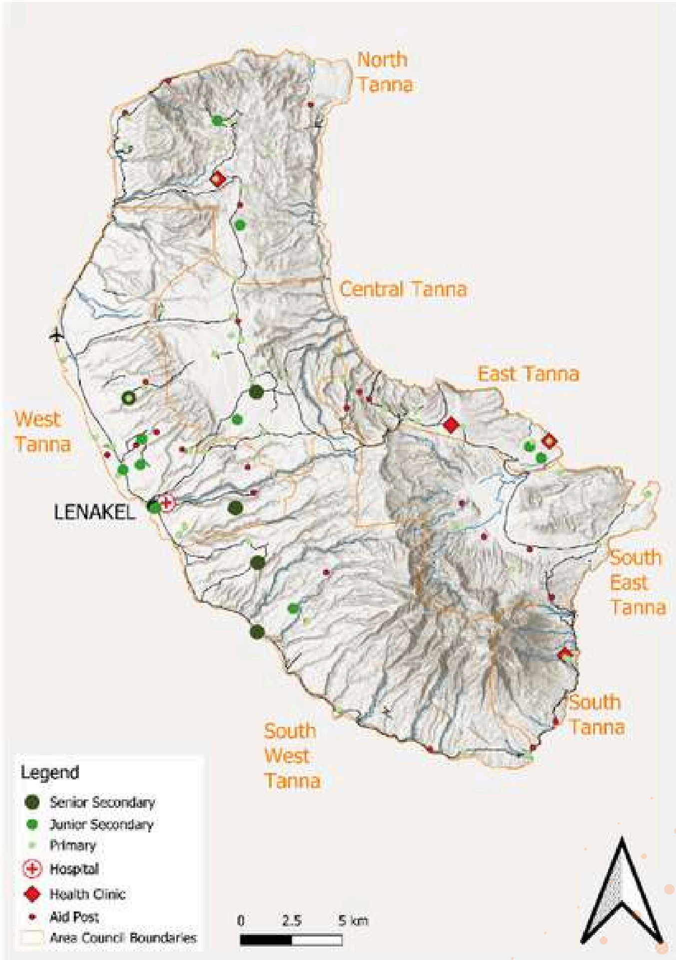


FIGURE 18 –MAP OF TANNA ISLAND INFRASTRUCTURE

6.5 CURRENT ENERGY GEOGRAPHY

The main energy planning document in Vanuatu is the *updated National Energy Road Map (NERM) 2016–2030*, which outlines five key goals: access, affordability, energy security, energy efficiency, and climate resilience.[161] It commits to achieving 100% electrification in concession areas and ensuring that all off-grid communities have access to modern energy for cooking and lighting by 2030. The roadmap sets targets of 65% renewable electricity generation by 2030, a 14% reduction in energy use through efficiency measures, and a doubling of petroleum storage capacity. Designed to be inclusive of both urban and rural needs, the NERM places a strong emphasis on decentralised solar and hybrid energy systems for outer islands. Its implementation is guided by an institutional framework that includes the Department of Energy, the Utilities Regulatory Authority, and a dedicated Green Energy Fund.

Tanna contains one of Vanuatu's four utility electrical grid networks, which is centred on Lenakel, close to the airport, a secondary school, several west-coast resorts and nearby settlements. The grid runs on a mixture of diesel fuel (394 kW) and solar energy (32kw) and provides energy for approximately 1,000 households as well as a number of businesses, the hospital, schools, and public buildings, all of which are located in West Tanna.[159] This means that the grid provides energy to 13% of total households in Tanna and 47% of households in West Tanna (rising from 8% of households since 2009).[1] Most of the communities in other regions of Tanna are energy-poor; however, the island is rich in solar and geothermal energy sources, and its energy geography has transformed rapidly over the past decade.[159] This energy transition has largely been driven by the Government of Vanuatu's adoption of the Vanuatu Rural Electrification Project (VREP), which ran from 2016 to 2022. VREP was designed to support Vanuatu's National Energy Road Map (NERM) by bringing reliable energy access to rural Ni-Vanuatu populations by 2030.[161] The primary mechanism by which VREP set out to accomplish rural electrification has been through the provision of World Bank-funded subsidies for customers worth up to 50% of the market value of an approved off-grid solar product.[145] Since the initiation of VREP, individually owned solar home systems have become ubiquitous in almost every 'off-grid' village in Tanna. Households using off-grid solar as their main source of lighting in 2009 were 6%; by 2020, this increased to 83% using off-grid solar (a mix of solar lanterns (65.3%) and solar home systems (17.7%)).

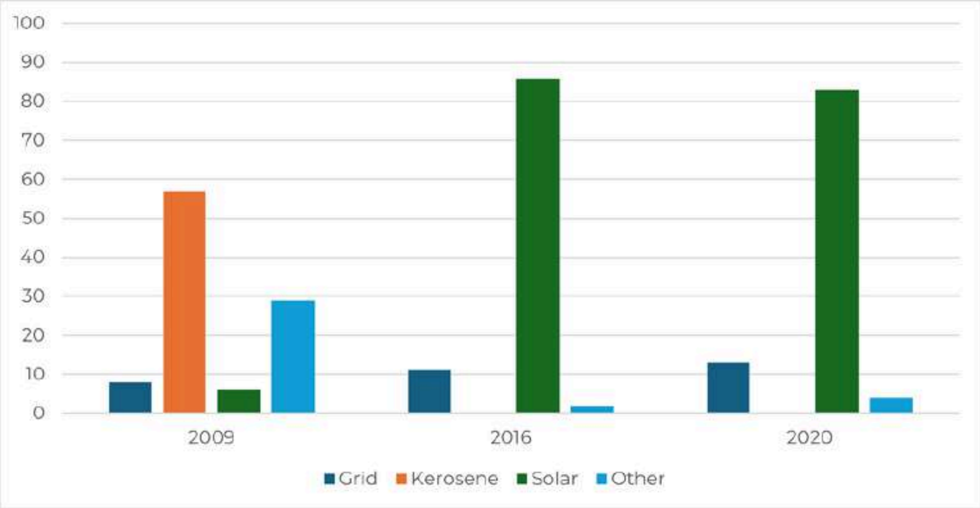


FIGURE 19 – MAIN SOURCE OF LIGHTING ON TANNA ISLAND

There is also a hydro-solar PV hybrid mini-grid in Imaki, South Tanna, which powers the local school and medical dispensary, as well as other community buildings and some households in the village. This minigrid was installed in 2022 and allowed the local community to transition away from diesel generators, which also incur ongoing costs because of the need to purchase fuel from foreign sources. There was previously a pico hydropower minigrid in the same location that was set up in 2009/10; however, this was destroyed in 2015 by Cyclone Pam, which devastated much of Tanna Island and forced the school and other buildings to revert to petrol/diesel-fuelled energy and solar lanterns.[159] There were plans to develop two PV solar (with diesel backup) mini-grids in east Tanna in 2016 (in the villages of Ipikel and Ipkangien); however, these plans never materialised.[162]

Finally, there have been a wide variety of different off-grid solar products across Tanna, including installations in schools, with funding from a range of government and charitable sources.[163] One recent innovation has been the establishment of a solar power system supplying water to 700 households in Lenakela and the surrounding area to improve piped water supply.[164] ActionAid, in partnership with Women TokTok Tugeta (WITT) Network, with funding from the Australian Government, is currently working with the remote Lawital community of North Tanna to foster training, networks, and technology to enable their community to access safe and reliable energy to set up lighting and device charging systems for 115 households and five community centres in the Lawital community. The project is using a monthly PAYG payment system so that the users will gain ownership of their systems over approximately three years.[165]

Since 2007, the University of New South Wales (UNSW) has been heavily involved in promoting renewable energy projects in Tanna Island, particularly led by Dr Richard Corkish through UNSW Energie Renouvelable Vanuatu (UNSWERV). The projects have included solar-powered lighting and phone charging facilities across rural health aid posts, as Tanna updated renewable energy services for schools, worked on the mini-grid project in Imaki village, surveyed geothermal potential, and developed solar power user guides in Bislama and English.[159,166] UNSW, in collaboration with Vanuatu Institute of Technology and the Department of Energy, is also currently leading a project to facilitate off-grid solar repair in Vanuatu; Tanna Island is one of the project's case studies.

6.6 RENEWABLE ENERGY RESOURCES

Tanna Island has a plethora of renewable energy resources, including solar, hydro, and geothermal. While technically biodiesel sources of energy exist, studies indicate that it is not really a viable option on Tanna Island. No mapping of wind power potential has occurred on Tanna Island, although wind turbine technology has been used in other parts of Vanuatu.

The World Bank Group, through its Global Solar Atlas (GSA) program, has mapped out the photovoltaic power potential across Tanna Island, mapping the PV power-producing potential of a 1kW solar PV power plant based on data between 1999 and 2018. The potential for Tanna was calculated to be between 2.3 and 4 kWh/kWp per day (around 1400 kWh/kWp per year) (see Figure 20). The result is a high level of solar irradiation, and it is unsurprising that PV technology is already used extensively on the island for both household and public building applications.

The volcanic activity in south-east Tanna has also been the subject of field research investigating the potential of geothermal energy for villages that are proximate to the Siwi caldera zone around the Mount Yasur Volcano.[83] These include water sampling studies and developing hydrothermal models for the behaviour of geothermal activity in the region. Preliminary studies have indicated that there is a presence of a low-depth, high-temperature heat source within underground water reservoirs. Given that the development of geothermal energy generation incurs large upfront costs, is technically challenging, and requires drilling (although given that Tanna's heat source is relatively low-depth this is not as daunting as it can be in other regions with geothermal potential), any proposals for geothermal energy in Tanna must be designed and arranged from a holistic perspective. This involves building robust systems focused on the careful and efficient integration of nature, along with considering and accounting for the sociocultural particularities of the local population. Large-scale geothermal energy production is likely not to be commercially viable and has added risks during cyclones. The potential for geothermal energy's success stems from its capacity to provide energy on a smaller "village scale" by incurring relatively low ongoing costs and using low-risk heat sources for its energy production.[167]

Given its mountainous terrain and relatively high rainfall, there is some hydropower potential on Tanna. Nevertheless, the geographic characteristics of Tanna render it unsuitable for largescale dam-impounded storage ponds, which means more localised 'run-of-the-river' type installations are generally a more suitable and economically viable option.[167] This is, however, heavily locally-specific and depends on what water resources are proximate to a community and requires several years of extensive assessment to determine the energy potential of a site. Earlier studies have identified the Lapilmai and Lowanau (Ikonoula) rivers as having high micro-hydro potential on Tanna Island. While a micro-hydro mini-grid is already functioning in Imaki.[168]

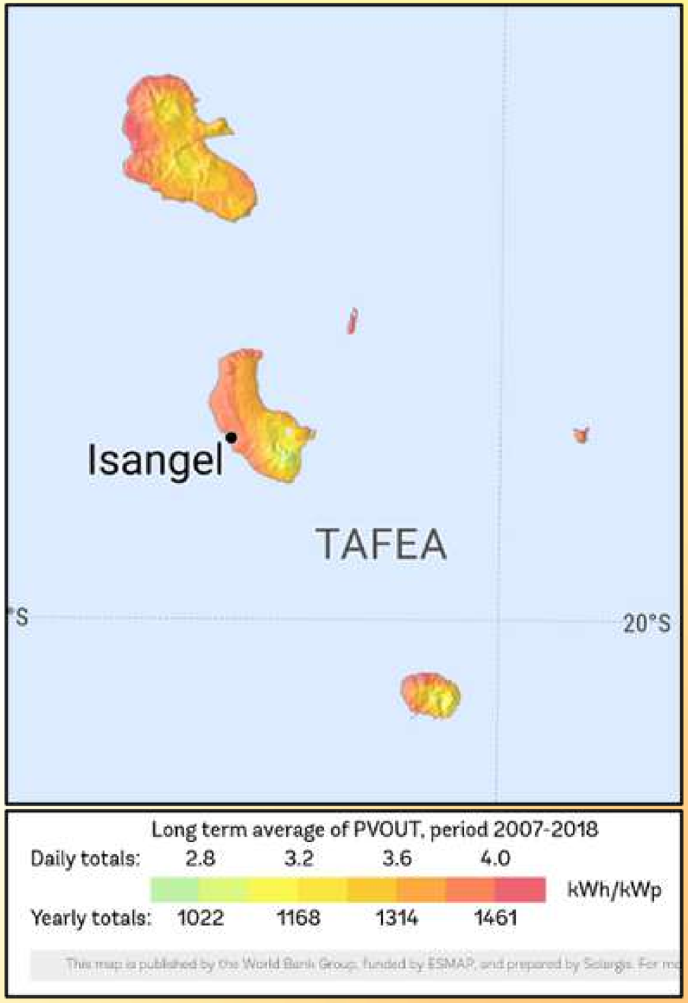


FIGURE 20 - SOLAR ENERGY POTENTIAL ON TANNA ISLAND

6.7 WHOLE-OF-ISLAND ENERGY PLANNING APPROACH FOR TANNA ISLAND

Foundational Principles

Tanna's energy planning must begin with contextual sensitivity. Despite the existence of a utility grid in Lenakel, only 13% of the island's households are connected. The vast majority rely on off-grid solutions like solar lanterns and home systems. The government's Vanuatu Rural Electrification Project (VREP) has significantly expanded solar adoption in recent years, with over 83% of households now using solar lighting.

Equity is critical in this landscape. Geographical isolation and uneven development mean that access to services is concentrated around West Tanna, while Central, North, and East Tanna often remain energy-poor. Gender inclusion and youth engagement are likewise important. Cultural dynamics—especially the contrast between coastal Christian communities and inland Kastom villages—require nuanced approaches that respect traditional governance while also empowering marginalised groups.

Energy justice must also navigate environmental vulnerabilities. Tanna is frequently impacted by volcanic ash, cyclones, and heavy rainfall, all of which can damage energy infrastructure. Projects must therefore be resilient by design and align with Vanuatu's broader frameworks, such as the *National Energy Road Map* (NERM) and *National Sustainable Development Plan* (NSDP).

Core Components

Community-led assessment is essential for success in Tanna. The diversity of its seven administrative regions and the widespread reliance on subsistence livelihoods—such as agriculture, livestock rearing, fishing, and cultural tourism—demand an energy approach tailored to both daily needs and economic aspirations. Food drying, crop processing, and refrigeration for market-bound produce are examples of productive uses that could be supported by decentralised solar or hydro systems.

Central to this approach is inclusive, community-driven planning that engages customary leaders (notably through the nakamals), church groups, women's networks, youth associations, and ward area councils. Establishing local energy committees across the island will ensure that the distinct priorities of Tanna's diverse communities shape energy decisions. Traditional governance mechanisms, such as nakamal-based consensus processes, should be formally recognised within the planning framework. This participatory model supports procedural energy justice through transparency, accountability, and legitimacy rooted in local norms.

Tanna's energy mix should be varied and location-specific. In West Tanna, the existing diesel-solar hybrid grid already powers Lenakel and the surrounding villages. The Imaki hydropower mini-grid in South Tanna serves as an example of a community-operated renewable energy system. Across the rest of the island, solar home systems have filled basic needs, while new Pay-As-You-Go (PAYG) models in North Tanna are helping improve affordability and system ownership.

The Lenakel grid itself provides a crucial strategic anchor for broader energy planning on the island. While full island-wide grid extension is not economically viable given the rugged terrain and dispersed settlements, targeted grid expansion holds real potential. High-density zones, especially in Central Tanna, where settlements cluster near road networks, could benefit from higher-load electricity suitable for agro-processing, markets, refrigeration, and schools. Moreover, the grid could serve as a technical and operational hub—supporting technician training, spare parts logistics, and data monitoring in partnership with the Department of Energy and vocational institutions. Interoperability standards should be developed to allow for seamless integration between grid and off-grid systems, ensuring that mini-grids and SHSs can align with the central network when appropriate.

Given Tanna's remoteness, supply chain and spare parts strategies are essential to long-term viability. Lenakel should serve as a central warehouse and distribution hub for tools, parts, and replacement units, supported by satellite stores in key villages. Area Council offices, spread geographically across the island, offer a practical network for feeding this distribution. Mapping existing energy assets will help prevent the abandonment of still-functioning systems and allow for coordinated maintenance planning. Engaging local retailers in the supply chain will further bolster resilience and promote local economic activity.

Deployment should prioritise longevity and decentralised governance. Previous projects have failed when they did not account for ash fall, difficult terrain, or lack of local maintenance capacity. Training programs and community maintenance plans, such as those being piloted through ActionAid and the Women TokTok Tugeta Network, offer a scalable model.

Implementation Principles

Four pillars are crucial for effective implementation in Tanna: inclusivity, resilience, sustainability, and efficiency. Women and youth should be engaged not only as beneficiaries but as technicians, trainers, and decision-makers. Existing kastom and church leadership should be incorporated into planning processes, using local gathering spaces like the Nakamal as venues for engagement.

Resilience must be engineered into all systems—solar panels should be mounted to resist cyclone winds and ash, batteries and electrical components must be protected from moisture and debris, and hydropower systems must be designed to cope with fluctuating river flows.

Sustainability will require well-financed service models. While donor funding and national subsidies (like those provided through VREP) are crucial, long-term viability hinges on building systems that communities can maintain and eventually own. Maintenance plans, spare parts supply chains, and user education must be part of the deployment process from the outset.

Monitoring & Evaluation

Energy monitoring in Tanna must move beyond connection counts and track indicators that reflect local wellbeing. Does electricity facilitate the provision of cold-chain services at clinics? Are children able to study at night? Do women have access to lighting for weaving or community organising? Do mini-grids remain operational during cyclone season?

Data collection should be community-based, facilitated by trained local actors who can feed observations back to implementers and government. System performance logs, satisfaction surveys, and gender-sensitive metrics will help ensure services evolve to meet actual needs.

Lifecycle monitoring is increasingly important as early VREP-era SHSs begin to degrade. Disposal and recycling programs, such as those being trialled through partnerships with UNSW and the Department of Energy, should be scaled up. Battery recovery and solar e-waste management must be included in the national energy strategy.

Conclusion

Tanna Island offers a powerful illustration of both the complexity and promise of whole-of-island energy planning. The island's geography, culture, and vulnerability necessitate modular, inclusive, and ground-up design of energy solutions. The rapid rise in solar adoption, innovative hydropower systems, and community-led energy initiatives provides a strong foundation. By scaling successful models, aligning with traditional governance structures, and investing in climate-resilient infrastructure—including strategic grid expansion from Lenakel and robust supply chain management—Tanna can continue to build a future where every household has access to reliable, sustainable, and contextually appropriate energy.

MALAITA ISLAND

7.1 GEOGRAPHICAL AND ECONOMIC LANDSCAPE

Malaita is the second largest island province in the Solomon Islands after Guadalcanal, covering 4,225 km² over a 190km length and spanning 10 to 40 km wide.[169] The Maramasike Passage, a thin, winding river mangrove system, separates Northern Malaita from Southern Malaita. The island is thin and elongated, with a high mountainous spine that runs through its length. These central mountain ranges are of volcanic origin and are commonly 1,000 metres high.[169]

The coastal areas are either rocky, sandy beaches or mangrove swamps. Coastal plains are thin and few, and the beach descends quickly into the forest.[170] Lagoons are common, mostly concentrated in North Malaita and around the Maramasike Passage. Lau Lagoon and Langalanga Lagoon are famous for their artificial islands built from coral rock on reefs by the Lau and Langalanga peoples.[171]

Inland, the landscape is forested, with rocky ridges, sharp plateaus, and valleys.[145] The Malaitan hydrology system consists of thousands of streams, rivulets, and several smaller rivers that traverse the thin coastal plain and mountainous spine.[172] Meandering mangrove systems and lagoons dominate the coastal hydrology. Malaita is Solomon Islands' most populous province, with 173,347 people, 24% of the total population of the Solomon Islands, and an annual growth rate of 1.3%.[2] The population density is 41 people per square kilometre. Most people live in rural villages, with only 3.9% of people living in cities. The capital city is Auki on Malaita's north-west coast, with a population of 7,020.[2]

The temperature on Malaita remains relatively stable throughout the year, with daytime temperatures ranging from 25-30 degrees Celsius. Rainfall is consistently heavy, with 3,750 mm a year on the western coast, whereas the east can receive up to 7,500 mm.[169] Cyclone season begins in December and lasts until February, during which the winds blow from the north-west. Cyclones cause landslides, floods, and, occasionally, famine when crops and homes are stripped by catastrophic winds.[169] Malaita is vulnerable to the effects of climate change, with most farmers in north Malaita confirming a rise in average temperatures, an increase in rainfall, and a greater frequency of cyclones, which require changing crop types in certain seasons.[173] As sea levels rise, those who live on artificial islands and in low-lying coastal communities are already at risk of becoming displaced in their own country, forced to move to villages further inland.[171]

Malaita – Snapshot Overview	
Population	173,347
Households	32,332
Highest elevation	1,303m
Land area	4,225km²
Population density	41 people per km²

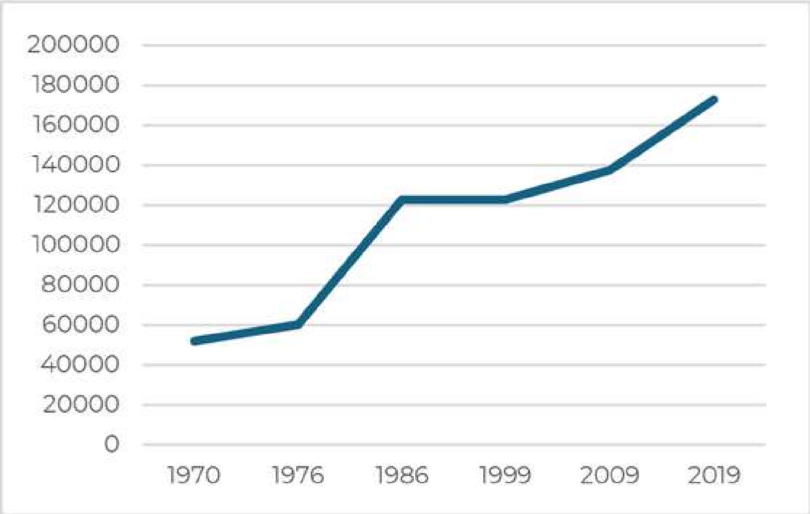


FIGURE 21 – MALAITA POPULATION GROWTH (CENSUS DATA)

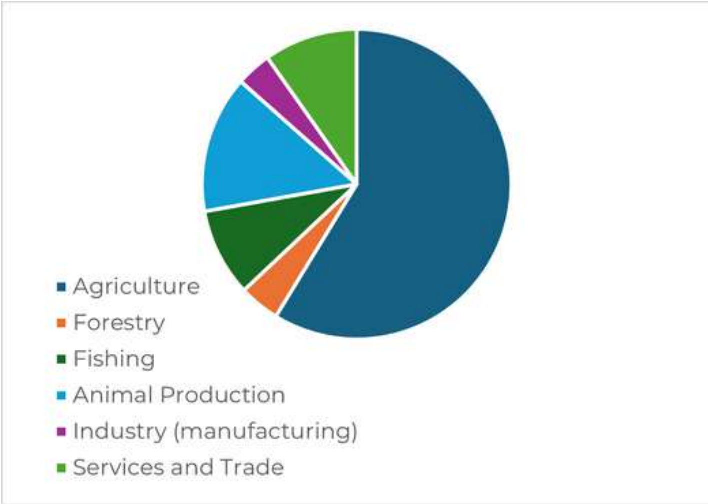


FIGURE 22 – SOURCE OF INCOME ON MALAITA (CENSUS DATA

Photo by Leocadio Sebastian

7.2 LIVELIHOODS

Subsistence activities are crucial to Malaitan livelihoods, with the 2019 census showing that of Malaita's 172,740 people, only 58,324, or 33.7%, are employed.[2] According to the 2019 census, farming and livestock are the most important forms of subsistence living, followed by fishing. Swidden is the main agricultural technique, and root vegetables like yams and taro dominate subsistence farming crop types.[170] Fishing is small-scale and non-motorised and is undertaken in the coastal mangroves, lagoons, and highland rivers. The most common techniques are the collection of shells and crabs, spearfishing, and hook-and-line fishing from canoes.[170] However, fishing is not as highly represented as a livelihood as one may think, with the 2019 census showing that 59% of households don't fish at all.[2]

Malaita is not excluded from recent trends that show an increasing reliance on store-bought foods by Pacific Islanders.[173] This speaks to a general access to cash in communities and a shift from healthy traditional diets that revolve around fresh animal proteins and tuber vegetables to unhealthy Westernised diets (processed foods high in salt, sugar, and saturated fats). On the other hand, store-bought foods supplement subsistence livelihoods that rely on natural resources (fishing, gardening, hunting/gathering), which experience fluctuating levels of consistency throughout the year, particularly at the lean agricultural period, which occurs at the end of the northwestern winds season in March.[174]

Subsistence activities present opportunities for Malaitans to participate in the cash economy. Nearly 82% of the island workforce is employed within the agriculture, forestry, and fisheries industries.[2] The most common form of income is the sale of crops, which is done in local marketplaces and the larger markets in the capital city of Auki. The most common cash crops are betel nut and coconuts, with pigs and poultry the most common form of livestock.

The education sector employs a marginal amount of Malaita's population, at 2,765 people, whereas government agencies and NGOs employ 8,781, but only 2,672 of these workers are women.[2]

Shell money is an important cultural and economic currency in the coastal north of Malaita. The practice of making shell money originated in Langalanga Lagoon an estimated 17 generations ago.[175] It remains an important part of daily life and a crucial livelihood, with one study finding it the second most common livelihood after fishing in Langalanga Lagoon.[176] Shells are polished and stacked on strings of ten to make one currency unit called *tafulia'e*, which is then used to make small purchases like rice and other groceries and is ceremoniously exchanged at weddings.[177] Shell money festivals, storefronts, and crafting classes have enabled Langalanga folk to participate in the tourism economy. This is an important cash flow for those who live on artificial islands and who may have limited space to grow their own food.[177]

The logging industry offers short-term work for rural Malaitans, as well as royalty payments for landowners. Malaysian companies dominate the logging sector, and they often use expatriate personnel to fill leadership and trained labour roles.[178] As such, the only work available for the local populace is minimum wage, physically demanding, untrained, and typically lasts less than a year. Logging companies enter agreements with local landowners to clear customary land, offering 5%–10% of the export value of each shipment of logs.[178] However, disputes between landowners and companies about late or missing payments are common.[178]

Logging is not highly represented as an island employer, employing just 2,005 in 2019.[2] However, the industry is notable due to its significant environmental and social consequences and their effects on other livelihoods. The creation of log ponds pollutes and damages mangroves, impacting fishing livelihoods, and deforestation disrupts farming, hunting, and gathering livelihoods and depletes the wood supply for building and maintaining homes.[178] The logging industry also introduces an increased risk of sexual violence and exploitation for women and girls, as it brings an influx of foreign men and alcohol for a short time. In 2023, the Malaita Alliance for Rural Advancement (MARA) introduced a forestry ordinance that incurred high fees for logging companies. As a result, logging has reportedly waned significantly since the beginning of 2024, with only eight logging operations reported in March 2024, compared to a previous recording of twenty-one operations in a single year.[179] Unfortunately, the cause of this waning is likely also due to a drastic depletion of forests in Malaita.

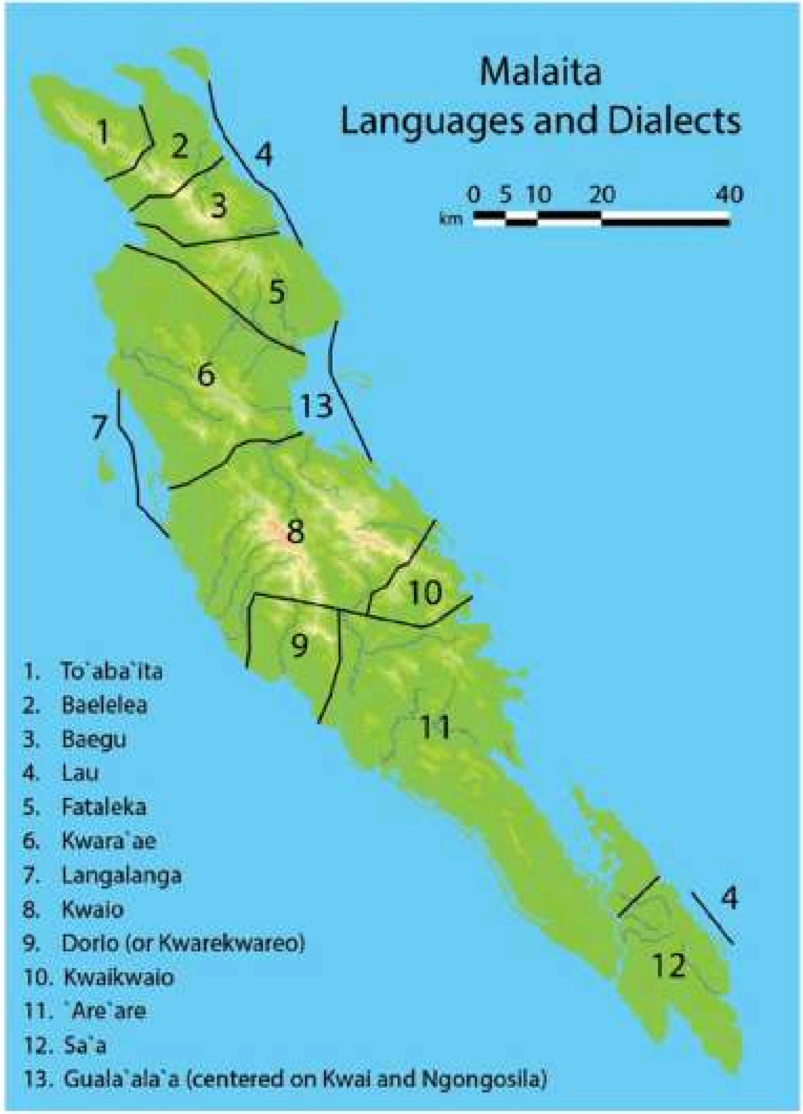
7.3 SOCIAL AND CULTURAL GEOGRAPHIES

There are 13 languages in Malaita, with numerous dialects within each zone (see figure 23).[169] The diversity of languages is striking; those from Small Malaita could not understand someone from Langalanga, and language learners note how the dialects within zones are indistinguishable from each other.[170] Malaitans commonly distinguish themselves into two main groups: the *to`aitolo*, the inland people, and the *to`aiasi*, the coastal and lagoon peoples.[169] Before British colonisation, inland villages were far more populous than coastal communities. From the 1870s, exploitative 'blackbirding' labour recruitment practices were prolific in Malaita, causing the displacement of people from their communities, which disrupted traditional social organisation significantly.[169,170] In the wake of this immense social restructuring, Christian mission villages and labour trade along Malaita's coast engendered a substantial migration of inland people over the course of the 20th century.[169]

The Church of Melanesia (49,710), South Sea Evangelical Church (48,512), and Roman Catholics (41,390) make up 80.8% of all religions in Malaita.[2] Christianity has come to influence social organisation significantly since its introduction to Malaita in the late 19th century, with church leaders being the most recognised community leaders by Malaitan locals in 2019.[180] Communities are generally small, with leaders commonly responsible for groups of up to 200 people.[169] A small number of groups, like the Kwaio in central Malaita, have never adopted Christianity and continue to worship ancestors.[169]

Christianity exists in confluence with traditional social customs in rural Malaita. Tribal chiefs are the second most recognised leaders by Malaitans, and are responsible for managing community conflicts, orchestrating trade with neighbouring groups, and overseeing traditional ceremonies like weddings and funerals.[180] Rural communities are organised around kinship ties to extended family through a deep respect for ancestors and a tradition of inheritance of ancestral lands.[170] Kinship connections are significant; Malaitans have a culture of sharing remittances and resources and maintaining political allegiance to those who are their kin.[181]

FIGURE 23 – MAP OF MALAITA LANGUAGE ZONES, SOURCED FROM MOORE 2017



Descent group territories are up to 120 hectares, and for sea people, this includes fishing areas and artificial islands.[169] Malaitans inherit customary land predominantly through patrilineal connections, although sometimes women can make a case for inheritance to the tribal chief. Traditional gender norms are still observed in daily life; there is a predominance of women's spaces and men's spaces in homes and communities, as well as a separation of women's and men's work.[169] Women leaders are common and garner significant respect in communities; they are recognised at the same level as male tribal chiefs by men but receive a higher level of recognition by women. [180]

Malaitans rank MPs far lower than tribal chiefs and church leaders in terms of leadership recognition.[180] MPs represent opportunities for infrastructural development in villages and are most commonly engaged with when village leaders galvanise the community and lobby the MP to grant development funding.181 When it comes to voting, kinship customs are at play, with most Malaitans voting for the MP that belongs to their kinship group. [181] NGO activity varies across Malaita, with 50% of Malaitans noticing NGO presence in the central region, versus just 15% in the outer islands. [180] There are some instances of distrust and hostility between locals and NGO project teams when customary land rights, local leaders, and traditional institutions are overlooked.[182]

7.4 PHYSICAL INFRASTRUCTURE AND TRANSPORTATION

Malaita has a limited road network that consists of one major road in the north from Auki to Lau Lagoon, another through the central mountains to Atori on the east coast, and a third down the west coast to Su'u.[169] These roads are mostly unsealed and in disrepair. Road securing initiatives seem to be targeted at the capital city, Auki, and other constituencies in the north. Southern Malaita is missing a reliable road system and relies upon coastal shipping for the importation of goods or walking tracks for movement to other parts of the province.[169] In some cases, there have been reports of farmers carrying their goods on their backs for long distances to reach markets and sick people dying en route to Malu'u, Auki, or Honiara for care.[181] Reflecting the state of Malaitan roads, few households own a car or motorbike (567 cars, 169 motorbikes out of 32,332 households), with canoes being far more common (owned by nearly 36% of households).[2]

Recent international political events have been influential to physical infrastructure development in Malaita, when in 2023, the People's Republic of China (PRC) pledged US $20 million to the province through the Rural Sustainable Development Program (RSDP), a partnership with the SIG's Ministry of Rural Development.[183] This comes after the Solomon Island's controversial decision to switch diplomatic ties from Taiwan to China in 2019, and after Malaita's Premier, Daniel Suidani dissented from the government's consensus to vow never to allow the PRC or Chinese companies to operate in Malaita.[184] Suidani was ousted from power in December 2023, and shortly after, the PRC moved to assert its presence in Malaita by announcing its commitment to rural infrastructural development aid through the RSDP. One of the RSDP's first projects is the tar-sealing of 9.5 km worth of roads in the Auki township, Malaita's capital city on the northwest coast.[183] The SIG is in conversation with the PRC to fund another road sealing project covering a 40 km stretch in East Malaita, and the Australian government is funding 20 kms' worth of roads from Auki to Bina Harbour.[183]

Malaitan households commonly consist of wooden walls and floors and 'traditional roofing', which is made of sago palm leaves woven together.[2, 170] Coastal homes are often on wooden stilts. Around half of households get their water from a public or outdoor tap, and the other half of households collect rainwater or gather water from springs.[2] Sanitation is a salient issue in Malaita, with 13,824 households defecating openly and 9,889 households defecating in an open pit or latrine.[2]

State funding for infrastructure in rural communities is delivered primarily through the Constituency Development Fund process, where constituent MPs are granted significant amounts of cash to put towards projects of their choosing.[46] This system has been critiqued for skewing development towards individual transactions and superficial election promises over longer-term development that would benefit the community collectively.[181] Because of this, the degree to which constituents receive this funding in the form of infrastructure varies from region to region. Tribal chiefs and church leaders, as community spokespeople, often broker developments by lobbying the local MP.[181]

Malaita has two hospitals in Kilu'ufi and Atoifi, three Area health centres; Afio, Malu'u, Nafinua and 85 rural health clinics.[185] There are health facilities in almost all of Malaita's 33 wards. However, some of these facilities are deteriorated, and there is a critical lack of medical staff in the province.185 As of 2023, Malaita has 113 childhood education centres, 93 primary schools, 67 community high schools, 2 provincial secondary schools and 4 rural training centres.[186] The development of a national university campus has been approved for Aligegeo near Auki, which will reduce the need for students to travel to Honiara to attend university.[187]

FIGURE 24: MAP OF MALAITA ISLAND, SHOWING KEY INFRASTRUCTURE.

In the Solomon Islands, energy policy is guided by the *National Energy Policy Framework* (2016), which is structured around six pillars: access, efficiency, renewable energy, petroleum management, institutional arrangements, and capacity building. The policy supports the expansion of mini-grids and solar home systems, as well as improvements to electricity generation and transmission infrastructure. It sets out goals to achieve full electricity access in urban areas and 60% access in rural areas by 2030, with a renewable energy contribution of approximately 50% to the national energy mix. In addition, the framework prioritises energy data collection, regulatory reform, and greater private sector involvement. The development of hydropower plays a central role in the country's renewable energy strategy.

Solar home systems (SHS) are the most prominent source of electricity for Malaitans, with more than 94% of households having access to one working system, according to the most recent census[2] This is a considerable increase from 8.7% of households using the technology in 2009 (see Figure 25). The majority of these SHS consist of simple 5 W panels connected to 12 V, 4.5 or 7 Amp-hours batteries without a charge controller or inverter.[46] Malaitans may obtain SHSs as gifts from MPs via the Constituency Development Fund, but this process depends on individual MPs and the stage of the election cycle.[46] The Japan International Cooperation Agency introduced a program in 2014 to supply households with 120 W SHS; however, they required an upfront contribution of SBD 2000, which excluded some households. Another barrier to participation was the long, wordy application forms, which were deemed untrustworthy by some. This is in the context of feelings of distrust towards international organisations due to negative past experiences of infrastructure projects.[46]

Most people gain access to SHSs through 'remittance networks'—a culture of giving and receiving among kin that is central to Malaitan lifeworlds.[46] To obtain SHSs through remittance networks, Malaitans typically receive cash from family members and then travel by ferry to Honiara to purchase an SHS at a technology store. Often, the SHS is damaged on the rough journey home via unsealed roads and crowded boats. However, if the system is in working order, once it is installed, the culture of sharing persists, and Malaitans will share electricity with neighbours, friends, and family, even if it disrupts their personal use. In this way, SHSs become integrated into Malaitan social life and reproduce social norms.

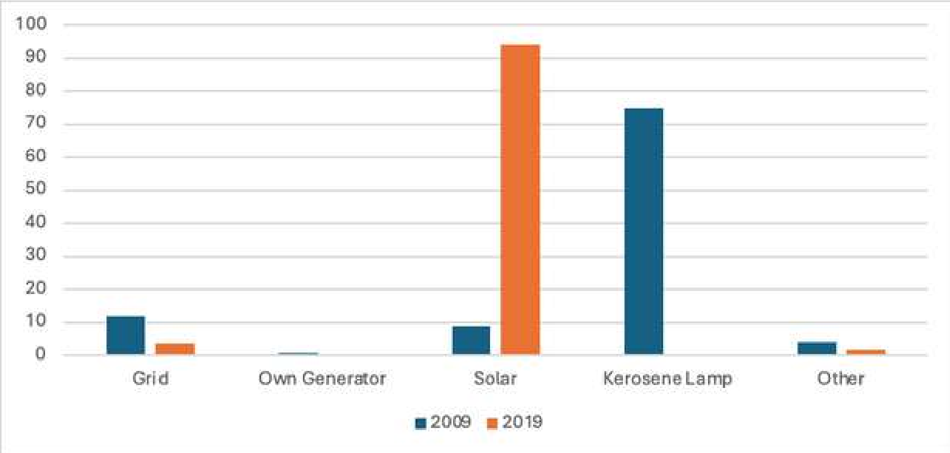


FIGURE 25 – MAIN SOURCE OF LIGHTING ON MALAITA: 2009 AND 2019 CENSUSES

Only 3% of Malaitans have access to the electricity grid, and these households are clustered around the diesel-generated power station in Auki.[46] The power station in Auki is the largest in Malaita, but it still only supplies electricity to a small number of customers—274 residential customers and 335 commercial customers in 2014.[188] The power station relies upon imported fossil fuels (equivalent to 6% of the gross domestic product and about 20% of total imports), which contributes to some of the highest electricity tariffs in the world (over $0.75 per kilowatt-hour [kWh]).[189]

There are five micro hydropower stations in Malaita—all less than 50 kW—in Malu'u, Masupa, Manawai, Rae'ao, and Nariao'a (see Figure 26), of which three are in disrepair.[190] The Asian Development Bank's (ABD) Fiu River Hydropower Project of 2013 would have constructed a 750 kW hydropower station on the Fiu River in northwest Malaita, which would have connected to the Auki Power Station to bolster its electricity capacity sustainably.[191] However, the project was officially cancelled in 2021 after long delays.[192]

The Asia Development Bank (ABD) is an important international donor of renewable energy infrastructure in Malaita. At COP29, the ADB and the Saudi Development Fund (SDF), in partnership with the SIG, committed $10 million each to the Solomon Islands Renewable Energy Development Project.[193] One of the project's aims is to establish a solar farm in Malaita. The agreement was announced in December 2024, and the details of the plan, such as the proposed site for this farm, are unclear. The ABD is also supporting the conversion of Malu'u's 180kW power station from diesel to solar; completion was expected in 2024, but construction appears to be ongoing.[190]

In 2023, the Hunanawa Community and Rokera Secondary School, both in Southern Malaita, received 36 kWp solar hybrid systems as part of the Stimulating Progress Towards Improved Rural Electrification in Solomon Islands (SPIRES) program, a partnership between the SIG's Ministry of Mines, Energy, and Rural Electrification and the UNDP.[194] Malaita's nascent diplomatic connections with the PRC could potentially facilitate further renewable energy projects, as detailed in the previous section.

Location	Year commissioned	Capacity (kW)	Operational
Diesel Generators			
Auki	Unknown	750	Yes
Malu'u	1984	180	Yes
Hydropower Systems			
Malu'u	1984	30	Yes
Maasupa	2010	30	Needs repair
Manawai	1995	30	Needs repair
Nariao'a	2004	25	Yes
Raea'o	2002	30	Needs repair
Solar Hybrid Systems			
Hunanawa	2023	36	Yes
Rokera	2023	36	Yes

FIGURE 26 : GRID-ELECTRICITY INFRASTRUCTURES IN MALAITA.

7.6 RENEWABLE ENERGY RESOURCES

Malaita is highly suited to solar power infrastructure, with solar irradiation levels being in the higher global range at 4.0kWh per square metre per day.[195] There is an excellent uptake of off-grid SHSs by Malaita's largely rural population, but grid-connected electricity is clustered in urban centres. Grid connection is complicated by Malaita's topography and geography, with small villages separated by long distances over sometimes very dense forest, mountainous terrain, and poor road infrastructure.[189] There are also high costs associated with connecting new customers, which further complicates levels of grid connection.[170]

Malaita's abundant waterways, hilly terrain, and high rainfall (3000mm p/a) make it a promising recipient of hydropower projects.[189] Run-off river plants with contour canals and steep penstock pipes are the most cost-effective hydropower designs for Malaita's hydrological landscape. Feasibility and financial reports demonstrate that levelised energy production costs are below US $0.10 per kWh, with a Financial Internal Rate of Return in the 40% range.[189]

However, there are some risks to hydropower systems. Most of the rivers in the Solomon Islands flow through porous limestone bedrock, which makes the installation of reservoirs difficult and increases the risk of sinkholes.[172] There appear to be social barriers to renewable energy infrastructural development, with "land disputes" between traditional owners and companies being cited as the reason for the cancellation of the Fiu River hydropower project.[172]

These tensions highlight a grave need for culturally grounded, inclusive, cooperative, respectful engagement with local communities. Finally, hydropower systems are threatened by the increase in extreme weather events associated with climate change, as smaller systems are vulnerable to damage during floods and cyclones.[172] Thus far, Malaitan hydropower projects have been dominated by mini and micro-hydropower systems (<100kWh), which are suitable for small rural communities with low rates of electricity consumption.

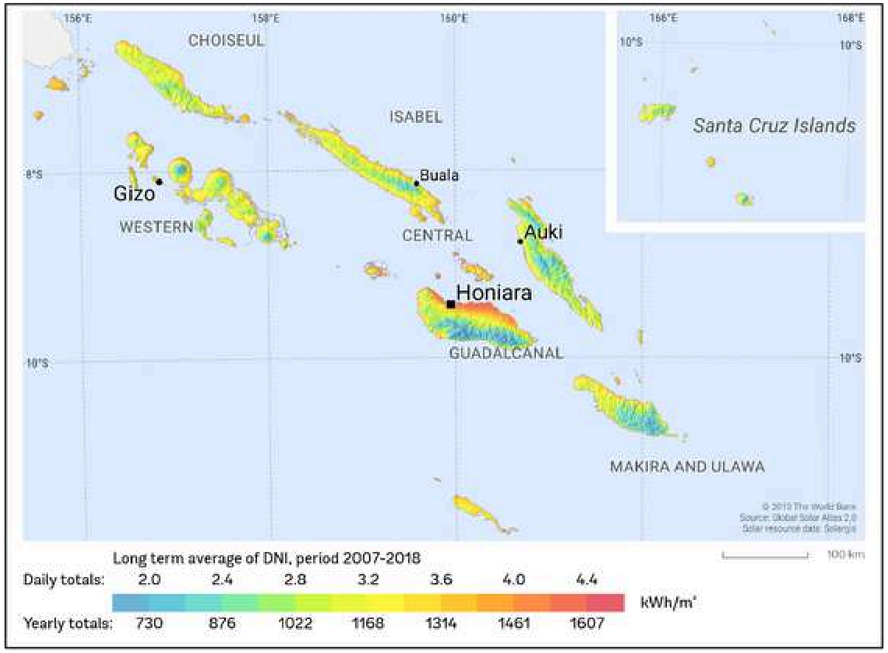


FIGURE 27 – SOLAR IRRADITION IN THE SOLOMOIN ISLAND. SOURCED FROM GLOBAL SOLAR ATLAS.

With regards to biofuel, there is some potential for coconut oil to assist in Malaita's transition from diesel. In 2014, the ABD funded a research project that substituted coconut oil for diesel at the Auki power generator. The study found that the use of the oil is feasible when blended at 10%, 20% and 60% for a 340 kW unit.[196] Coconut oil substitution depends upon the consistency and sustainability of coconut supply, and a feasibility project that deals with the projected coconut consumption required long-term for electricity generation is needed.[190]

There is limited data on the capacity for wind power in Malaita, and there are no operating wind farms on the island. One source suggests that Malaita has a low capacity for wind power, revealing in a 23-year average data set that 89% of the time, the wind speed is less than 13km/h.[195] Wind speeds also vary seasonally, with winds being calmer in the wet season than in the dry season. Another source claims that recent preliminary feasibility studies have been conducted by the Secretariat of the Pacific Community (SPC) and the International Renewable Energy Agency (IRENA), which have identified sites with high wind energy potential in Malaita. However, this study could not locate the official reports.[190]

Photo by Leocadio Sebastian

7.7 WHOLE OF ISLAND ENERGY PLANNING APPROACH

Foundational Principles

Effective energy planning for Malaita must begin with contextual integration. The island's topography—marked by steep volcanic ranges, limited road access, and dispersed rural settlements—makes centralised grid roll-out infeasible at scale. Current energy access is largely through solar home systems (SHSs), with 94% of households using basic solar kits. Only 3% of households are connected to the Auki diesel grid, underscoring the limited reach of formal infrastructure. This distribution pattern reflects both geographical barriers and sociopolitical dynamics, including the strong role of kinship networks and informal systems of reciprocity.

Energy justice is a key principle: distributional equity must consider the deep rurality of southern and eastern Malaita; procedural equity means recognising tribal chiefs, church leaders, and women's networks as legitimate governance actors; and recognition justice requires engagement with diverse linguistic, cultural, and religious groups across the island. Gender inclusion must be deliberate, especially as women are often responsible for household energy management but underrepresented in technical training and governance roles.

Planning must complement national and regional policies such as the *Solomon Islands National Energy Policy* and donor-led programs (e.g., ADB, UNDP, JICA). At the same time, it should address long-standing grievances about unequal infrastructure development and localised tensions between traditional landowners and state or donor actors. This includes formal recognition of traditional governance systems—such as kastom consensus mechanisms—as valid components of planning and implementation frameworks.

Core Components

A whole-of-island energy strategy for Malaita should be anchored in community-led assessment. Participatory mapping of energy needs should build on local knowledge, integrating insights from shell money artisans in Langalanga Lagoon, farmers in the mountainous hinterlands, and lagoon dwellers on artificial islands. The existing division between to'aitolo (inland people) and to'aiasi (coastal people) offers a cultural lens through which to structure planning processes. Public institutions—schools, health centres, churches, and local marketplaces—can serve as anchor points for future decentralised systems.

A just energy transition must begin with inclusive, culturally grounded engagement. Chiefs, church groups, women's associations, youth networks, and ward development committees all play vital roles in governance and decision-making. Establishing local energy committees—anchored in existing social structures—ensures planning reflects diverse voices, including those of women, youth, and marginalised groups.

The technology mix must be tailored. In highly dispersed inland areas, robust SHSs and micro-hydro systems are appropriate. Coastal and peri-urban centres like Auki and Malu'u may benefit from mini-grids powered by solar or hydropower. Existing micro-hydro plants, such as those in Malu'u and Nariao'a, offer starting points for rehabilitation and expansion. The integration of productive uses of energy (e.g., refrigeration for fishers, coconut processing, lighting for market vendors) is essential for economic development. E-mobility options, particularly solar-charged boats and outboard engines for lagoon communities could be piloted to reduce reliance on imported fuel.

Deployment must be grounded in flexible governance models. Community energy committees can formalise maintenance plans and fee structures. Traditional consensus-based decision-making should be respected, especially when navigating sensitive issues like land access. Customary leaders and church authorities can help bridge the trust gap between communities and external implementers.
The existing Auki grid, while limited in reach, can play a strategic role. Grid extension should focus on high-density areas along navigable road corridors, where agro-processing, clinics, and educational institutions could benefit from reliable electricity. Interoperability standards should be introduced so that mini-grids and SHSs can eventually integrate with the central grid. Auki should also serve as a logistical and technical hub, supporting technician training, system monitoring, spare parts distribution, and system maintenance through a regional facility tied to vocational schools and the Ministry of Mines, Energy and Rural Electrification (MMERE).

Implementation Principles

Inclusivity is key to success. Local women's groups, youth collectives, and church congregations should be involved at every stage—from needs assessments to system maintenance. Local ownership can be supported through training initiatives that target both men and women, building on successful models like the SPIRES hybrid solar installations. Practical training hubs should be based in Auki and key regional centres such as Malu'u and Afio, offering community-based programs and certification pathways.

Resilience must be designed into infrastructure. Systems must be cyclone-proofed, and hydropower schemes must account for climate risks like flooding and drought. Energy planning should also include water and sanitation co-benefits, especially in communities where solar is already being used for water pumping. In salinity-prone areas or outer islets, small-scale solar desalination units may be piloted to support water security.

Efficiency means building on existing assets and reducing duplication. Mapping exercises should identify which SHSs, mini-grids, and micro-hydro units are still operational, which can be repaired, and which require replacement. Past failures—such as the cancellation of the Fiu River hydropower project due to land disputes—highlight the importance of early, respectful engagement with landowners.

Sustainability requires robust financial models. Malaita should seek funding from national government budgets, climate adaptation funds, and development partners. Tariff models must balance cost recovery with affordability, especially for vulnerable households. Public-private partnerships and PAYG solar schemes can drive innovation and access. Community savings schemes or energy cooperatives could help fund system maintenance and eventual upgrades.

A supply chain and spare parts strategy is also vital. Auki should serve as a central warehouse and distribution hub, with satellite stores in Malu'u, Afio, and East Malaita. Local Councils can assist with geographically dispersed distribution, while partnerships with local retailers can stimulate economic activity and ensure parts are available when needed. Mapping existing systems will also prevent abandonment of functioning infrastructure and enable integrated maintenance planning.

Monitoring & Evaluation

Monitoring must go beyond counting connections. Are students able to study at night? Are health clinics keeping vaccines cold? Are SHSs still functional after five years? Indicators should include gender-sensitive metrics, service reliability, and community satisfaction.

Feedback loops are essential. Trained community monitors should collect usage and performance data, feeding this into adaptive management processes. Lifecycle tracking is particularly important for SHSs distributed via remittance networks or constituency funds. Disposal and recycling systems for old batteries and solar panels must be introduced as part of a national e-waste strategy. Smart metres and community-based data review processes can help sustain performance and transparency.

Conclusion

Malaita's whole-of-island energy strategy must blend pragmatism with cultural insight. From solar-powered shell money workshops to micro-hydro systems in mountainous villages, the future of energy lies in decentralised, resilient, and community-governed systems. Strategic grid expansion from Auki, rehabilitated hydropower assets, supply chain planning, integration with water security, and engagement with traditional leadership all provide avenues for sustainable progress. By embedding energy justice, participatory governance, and economic empowerment into each intervention, Malaita can move towards a future of equitable, climate-resilient energy access.

VIWA ISLAND

8.1 GEOGRAPHIC AND ECONOMIC LANDSCAPE

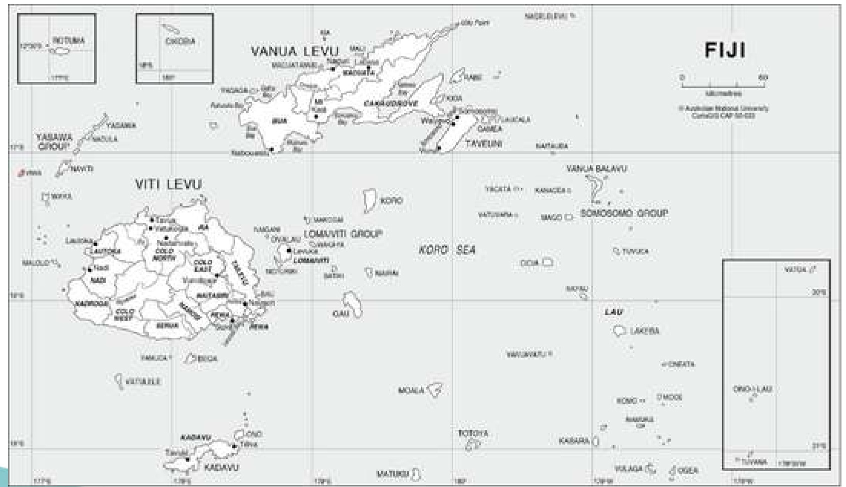
Viwa Island, covering approximately 4.6 km^2, lies about 75 km northwest of Fiji's main island, Viti Levu. A coral limestone atoll, it forms part of the Yasawa Islands—an island group renowned for fishing—within Fiji's Ba Province. Viwa hosts a well-known resort, although since the COVID-19 pandemic, it has remained closed due to a dispute between the community and the new owners of the resort. Viwa is the westernmost and most geographically isolated island in the Yasawa group, located around 25 km from its nearest neighbour.

Viwa Island is home to three *iTaukei* (Indigenous Fijian) coastal villages—Naibalebale, Najia, and Yakani—with a combined population of 251, according to the 2017 census.[26] While Najia and Yakani are located close together in the island's north, Naibalebale lies on the southern side and hosts Viwa's primary school and health clinic. Despite the island's small size and low elevation, there are no roads connecting the villages. Travel between the north and south is limited to footpaths through dense tropical vegetation—a 30 to 45-minute walk—or by community-owned boats, which are dependent on tidal conditions for access to shore.[199]

Viwa Island has no airstrip, and regular transport to and from the island is limited to small community-owned fibreglass boats or a public ferry that operates just once a month between Viwa and Lautoka, a major economic centre on western Viti Levu. Due to the high cost of fuel for the three-hour journey, trips to the mainland are usually made only once a week—primarily to sell fish at the Lautoka markets and to restock fuel, household supplies, groceries, and essential goods for the island's two village stores. These stores, located in Naibalebale and Naija, sell basic items such as tea, flour, rice, sugar, gas, and kerosene, with prices capped and periodically reviewed by the Fijian Competition and Consumer Commission to ensure affordability in both urban and rural areas.[199]

Most residents of Viwa rely on subsistence livelihoods and, for some families, remittances, with only a small number employed at the primary school in Naibalebale or in government-supported community leadership roles. Until its closure in 2019, the resort on the island's southern side, near Naibalebale, provided an important source of income and employment for the villages, and created market opportunities for selling handicrafts to tourists and supplying produce—such as fish—to the resort. Its shutdown not only resulted in job losses but also affected other benefits the resort brought to the community. However, it has remained closed since COVID-19 due to financial difficulties, including several million FJD in unpaid land lease fees owed by new owners to the Naibalebale community. The site is now overgrown with jungle.

FIGURE 28. MAP OF THE REPUBLIC OF FIJI, WITH THE NAMES OF ITS 14 PROVINCES AND HIGHLIGHTING THE VIWA CASE-STUDY ISLAND



8.2 LIVELIHOODS

Most households on Viwa rely on agriculture and fishing to support subsistence needs and participate in small-scale market economies. Fish are sold at the Lautoka markets, with each fishing boat typically catching two bundles per day (12–15 kg per bundle), which sell for 40 to 50 FJD each. Women from the village also collect crabs from Tiliwa—a nearby atoll—and sell them for 10 to 15 FJD per bundle. Lobsters, harvested seasonally, can fetch up to 70 FJD per kilogram, while giant clams, gathered from surrounding reefs, are sold for 50 to 100 FJD each. However, overharvesting has made giant clams increasingly scarce, prompting proposals to establish a marine protected area.

FIGURE 29. MAP OF VIWA AND ITS THREE ITAUKEI VILLAGES

Income from these marine resources goes directly to the harvesting families, who pay boat captains for transport to the mainland. Additional income sources include traditional crafts—such as mats, fans, brooms, and tanoas—as well as agricultural products like fresh chilli. Occasionally, government programmes such as the Ministry of Forestry's timber-buying schemes offer short-term financial support. Some residents also work on the mainland or migrate abroad to countries like Australia and New Zealand, sending remittances back to their families.

8.3 SOCIAL AND CULTURAL GEOGRAPHIES

In Fiji, an Indigenous village is known as a *koro*. Viwa Island's three koros—Naibalebale, Najia, and Yakani—together form the broader Indigenous identity of the island, referred to in Fijian as the *vanua*.[201] For the *iTaukei* (Indigenous Fijians), both vanua and koro are foundational to cultural identity, connecting individuals to generations of traditional knowledge, customary practices, livelihood systems, and totemic relationships with time, nature, and place.

These deep interconnections are reflected in the Fijian lunar calendar, Vula Vakaviti, which aligns sociocultural values with ecological rhythms. The calendar is structured around the yam cultivation cycle—yam being a revered crop in Fijian culture—and closely tracks seasonal events such as fish spawning, turtle nesting, and bird migration. These natural phenomena not only signal the months of the year but also guide the livelihood practices of the vanua.[201, 202]

For example, February (*Vula i Sevu*) marks the beginning of the harvest season, when yams are gathered and storage sheds are built in the fields. It also coincides with the abundance of breadfruit (*uto*), taro (*dalo*), cassava (*tavioka*), and oranges. In contrast, June (*Vula i Werewere*) brings cooler weather, signalling the time for weeding, the planting of first yams, and the seasonal peak of coconut crabs (uga vule), which are rich and ready for harvest.

While post-colonial influences and tourism-driven urbanisation have weakened the connection to traditional practices in many parts of urban Fiji,[202,203] rural and remote koros—such as those on Viwa Island—continue to maintain strong ties to their vanua. This connection is sustained through deeply rooted kinship and clan networks, known as mataqali, which are composed of extended families spanning generations. Each mataqali holds distinct responsibilities and knowledge systems related to the stewardship of land and marine resources, as well as the protection of the cultural and social wellbeing of the vanua.[204,205]

The various mataqali within a vanua are united under a common leader from the chiefly Turaga clan, known as the Ratu. This traditional structure is also formally recognised within Fiji's national governance system, where the vanua becomes a Tikina—an official sub-district—represented in provincial councils under the Ministry of iTaukei Affairs. Each Tikina is served by a Mata-ni-Tikina (MTK), who acts as the district's liaison and handles formal matters on behalf of the Ratu.

In the case of Viwa Island, the MTK represents the three villages—Naibalebale, Najia, and Yakani—as the Viwa sub-district in the Ba Provincial Council, which meets several times a year. At the village (koro) level, local leadership is provided by a Turaga-ni-Koro, a headman elected or appointed by the villagers to oversee day-to-day affairs and coordinate community activities.

As in many other Pacific Island nations, Christianity was introduced to Fiji in the 19th century by Methodist missionaries. It spread rapidly among iTaukei communities following the 1854 conversion of Seru Epenisa Cakobau, a paramount chief who later became King of Fiji. The Christian church (lotu) quickly became entwined with the vanua system of Indigenous governance. Rather than functioning purely as an external colonial imposition, the church was reinterpreted through local structures, evolving as a continuation of the traditional chiefly hierarchy.[206]

Christianity was not simply layered onto existing customs but was absorbed into them, taking on meanings and roles shaped by Fijian spatial and cultural frameworks.[199] This integration is seen in the way religious practices blend with traditional ceremonies—such as the sevusevu, a kava ritual performed to welcome visitors—which remain inseparable from the Vaka i Taukei, or Fijian way of life. Today, the vast majority of iTaukei are Methodist, although Roman Catholic, Assemblies of God, and Seventh-Day Adventist churches also have strong followings.

Fieldwork in Naija, one of Viwa's three koros, found that it is home to three clans (mataqali), with the remaining clans of the vanua residing in Yakani and Naibalebale. Naija's administrative and practical affairs are overseen through weekly elders' meetings. Daily village life is shaped by gendered yet complementary roles: men typically engage in communal subsistence tasks such as fishing, farming, and construction, while women are responsible for household management, including craft-making, mat weaving, food preservation, and small-scale fishing.[202] While women often lead decision-making within the household, public leadership roles in the community are largely held by men, who tend to speak more in village-wide Talanoa sessions.[199]

Naija is also represented in island-wide governance committees—including those managing new technologies such as solar home systems and mobile payment platforms—which include female members. Children up to around 13 or 14 years of age attend primary school in Naibalebale, commuting daily either by boat or, if the skipper is unavailable, by a 30–45-minute walk through forested trails. In their free time, children typically accompany elders, observing and participating in traditional livelihood activities, gaining skills and knowledge passed down through generations.[202]

As Viwa lacks a high school, most adolescents attend boarding schools on Viti Levu. This outmigration is reflected in census data, with only five individuals aged 15–19 recorded on Viwa in 2017.[199] While many young people return to their vanua after high school, an increasing number move to the main island for university or employment. Some men also migrate overseas, sending remittances home to support their families.[207,208] When visiting, younger members of the vanua often express a strong preference for "village life" over urban lifestyles in places like Suva, Nadi, or Lautoka. However, many also report feeling pressured to adapt to the rapid cultural and economic changes occurring across Fiji.[209] In response, some have made the conscious decision to remain in their villages, actively working to preserve the Indigenous vanua-based way of life.

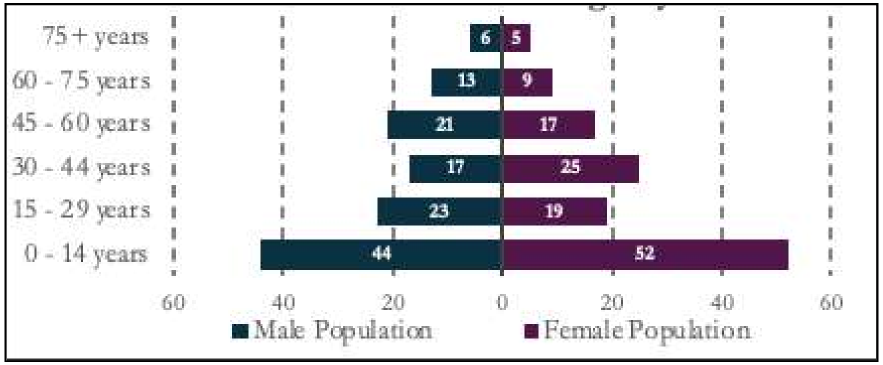


FIGURE 30 – STATISTICAL SNAPSHOT OF VIWA ISLAND.

Viwa – Snapshot Overview	
Population	251
Naibalebale	185
Najia	61
Yakani	5
Households	61
Highest Elevation	23m
Land Area	4.59km^2
Population density	54.7 per km^2

8.4 PHYSICAL INFRASTRUCTURE AND TRANSPORTATION

Naija has a total of 28 residential household structures, with five being unoccupied for the majority of the year since their owners live outside of the island for work. Most of the households in Naija are constructed with more modern rural construction methods, which include concrete flooring, wooden-panel frames, s and iron-metal roof sheets. Naija has only a few traditionally built homes and structures remaining, which are called bure and are comparatively sturdier than their modern counterparts against tropical cyclone winds. Bures are constructed from local materials and take 1-2 months and 10-15 males to construct. However, the construction of bures decreased across Fijian villages in the 1970s-80s as a result of limited local resources and labourers available and the labour-intensive maintenance requirements to replace core components roughly every 7 years.[210] Four homes have also recently been significantly damaged during cyclones, one of which was a bure. Most villagers consulted in Naija have stated that they would prefer to live in a bure due to its resilience in cyclones, its greater comfort for sleeping (soft flooring), and its lower cost (locally-sourced materials). The village also has one church, a kindergarten (built with the support of the New Zealand government), a small community store, a communal TV room and a community hall. Any plans to work on or build new infrastructure in the village need to first consult with the Turaga-ni-koro, who then discuss the issue with villagers at regular village meetings.[17] In most cases in iTaukei communities, home builders only pay the transport costs of materials and serve food and kava to the local labourers (other villagers) for payment. In some villages, if costs are unaffordable, villagers can take a loan from a committee that handles village funds.[210]

Naija, along with Viwa Island as a whole, relies solely on rainwater collection to meet drinking, cooking, washing, and sanitary needs. Naija has several concrete tanks of varying sizes, installed by JICA over 50 years ago, along with newer plastic tanks, with most houses having two tanks: one for drinking and cooking and one for washing and sanitary needs. The households have guttering allowing rainwater to collect in the tanks and PVC plumbing feeding water to their household sinks and taps. Dirty water from cooking and washing is usually led into locally built drains commonly made with shells that feed directly into the soil. In addition to this, to prevent water shortages, many households have other rainwater collection mechanisms where waste-water is used to manually flush toilets and to water plants. Waste-water from toilets is led to buried septic tanks that have no access points. When a septic tank is at capacity, the toilet is abandoned, and a new one is built.

The community also has a well, which is not used by households due to briny water, but is planned to be used for livestock in the future. Naija also has two 25kW diesel-powered desalination plants, which were donated by an aid agency in 2013; however, they are seen to be inoperable due to damage caused by Cyclone Winston in 2016. Village leaders note that the equipment was installed without adequate training for the village, and while a replacement pump has been delivered by another aid agency, it has yet to be installed. The village also has a community wood-fired oven, which was built and installed by UNSW in 2024, to be used for the preparation of communal meals, including for unmarried men. Waste management in Naija is primarily done through burning and burying of rubbish. Each household is given a specific area to burn any flammable waste they produce. Larger items and non-flammable items are brought to the community tip located on the border of the village in the forest.

There is one district public school on Viwa, located on Naibalebal,e which children from Naija attend. The school has 42 students from kindergarten to year 8 with five teachers who are, in most cases, not from the island and are allocated to the school by the Ministry of Education. The teachers live in dedicated housing quarters located in the school precinct and receive a salary of approximately 20,000 to 25,000 FJD along with additional relocation allowances of around 2,000-3,000 FJD.210 Viwa also has government government-administered health-care nursing station located next to the school in Naibalebale and serves as the primary centre for healthcare for the three villages. There is one nurse who is paid a monthly salary by the Ministry of Health (MoE) of approximately 22,500 FJD. There are no dedicated boats available for the transport of emergency patients to the main island; however, the MoE funds a helicopter service which can be called by the district Medical Officer who is located on Naviti for Viwa. In Viwa, emergency helicopter transportation has been used for 8 cases in 2021, 3 cases in 2022 and 2 cases in 2023.

As mentioned, regular transportation to and from Viwa Island is limited to local fibreglass boats or via a public ferry service, which costs 47.40 FJD (one-way) and runs only once a month. To get from Lautoka to Viwa, it takes approximately 3 hours and 160L of fuel with a 40HP engine on a 23-foot fibreglass boat. A return trip costs approximately 600 FJD in fuel costs, requiring 6 cans of fuel (25L each), which have to be fed into the main tank via a siphon.[199] There are six operational fibreglass boats on Viwa, of which two are in Naija. A trip to Lautoka can be organised through one of the boat captains, and villagers typically pay 50 FJD (one-way) as well as an additional 10 FJD for each bundle or sack of goods they bring on the boat. The boats are also used daily and shared by villagers to transport children to school in Naibalebale and for fishing, which occurs twice a day for around 2 to 3 hours each trip and consumes around 20L of fuel. Travel around Viwa during low tide can be challenging due to the extensive reef and rocks surrounding the atoll. As a result, consulted Naija locals are prioritising building a jetty to facilitate easier disembarking at the village. Other infrastructure aspirations on Viwa include building a seawall to protect households from storm surges and rising water levels, installing a cellular tower to improve connectivity, and building a small airstrip to encourage tourism, which is currently under consideration by Investment Fiji.

8.5 CURRENT ENERGY GEOGRAPHY

Fiji's energy plans are guided by the *National Energy Policy* (2013–2020) and the *Low Emission Development Strategy* (LEDS) 2018–2050. The National Energy Policy is organised around four themes: energy access, energy efficiency, renewable energy, and governance. It aims to ensure universal access to affordable, modern energy services and sets a national target of achieving 100% renewable electricity generation by 2036. The national energy policy supports investment in a diverse mix of technologies, including large-scale hydropower, biomass, wind, and solar, while also promoting rural electrification through solar home systems and mini-grids. The LEDS builds on these foundations by setting out long-term decarbonisation pathways for the energy sector, including a 30% reduction in greenhouse gas emissions by 2030 compared to 2013 levels. Both policies place a strong emphasis on strengthening regulatory frameworks, improving data systems for energy planning, and encouraging investment through public-private partnerships.

Access to basic household energy services in Fiji's outer islands, such as Viwa, has been supported by the Fijian Department of Energy, which has been installing solar home systems (SHS) through the Rural Electrification Program, including replacing older centralised diesel generators. Since 2009, around 450 communities have benefited from the program, with over 13,500 households being recipients of various models of SHSs. For Fiji, the SHS Program has been a core mechanism of the government's National Development Plan, which has aimed to ensure access to basic energy services for all Fijians.[211] Naija received 26 solar home systems (SHS), which were installed in households by the Department of Energy in 2013 through a contracted RESCO provider. Under the SHS Program, there was no cost of installation; however, a small refundable deposit was required at the time of installation in Viwa (deposits were later revoked in 2016), and a monthly payment of 18 FJD was required from households for repairs and maintenance.[212] All households at the time received an SHS with systems also installed for the village store, community hall and church. The system configuration consists of two 150W solar panels (300W total), one 200Ah sealed-lead-acid battery, one 300W DC-AC inverter, and a charge controller. Along with the SHS, the DoE provided 5 lightbulbs, which have been integrated into the households with switches installed on the walls, as well as two 3-pin power supply ports to power AC appliances.

These systems in Naija have been able to power basic low-power AC appliances along with the lights, phone chargers, radios, and small fans common in most households. Two households were previously able to use a television, and one household had a small washing machine; however, these appliances are no longer operable due to the declining energy services provided by the SHS over time—especially when operating larger appliances.[213]

During a 2024 study in Naija, 12 of the 22 SHSs that were examined were non-operative, with a further six systems seeing significant declines in energy production, leaving the households with lighting available for only a few hours a day. As a result, households have resorted to purchasing significantly smaller pico-solar products, which enable simple task lighting. Those unable to afford pico-solar revert to traditional fuels such as kerosene lamps and candles for lighting.

The vast majority of households are not able to afford the repairs or replacements required to upkeep the SHS systems. This task was initially supposed to be provided under the SHS program, where RESCOs would service systems periodically; however, recent studies have found that repairs were rarely provided to communities, and the RESCO maintenance service was discontinued in 2017.[13] Viwa did establish a solar committee, which was responsible for collecting the monthly 18 FJD payment from households (which many had stopped paying due to the lack of maintenance support) and being a point of contact for any system issues, which were usually unable to be resolved. More affluent villagers, such as the chief (Ratu) and priest (Bete), were able to arrange their own repairs and, as such, continue to use the systems and have even upgraded them with more batteries and larger inverters. Some other villagers either attempt repairs themselves or get 'home-technicians' to try to fix battery ageing and low power issues. This includes bypassing the charge controller, which was evident on multiple systems in Viwa. Such systems were often found to have been significantly bloated, with even one report of a battery exploding in 2018. Figure 31 displays the overall difference in energy access tiers that were provided across the 11 years of operation of the systems in Naija. Although all households were at Tier 2 or Tier 3 directly after the systems were installed, a lack of battery replacement and maintenance led to the complete failure of many systems, with households reverting to pico solar systems. Other systems had reduced daily hours of lighting and the ability to use other appliances.

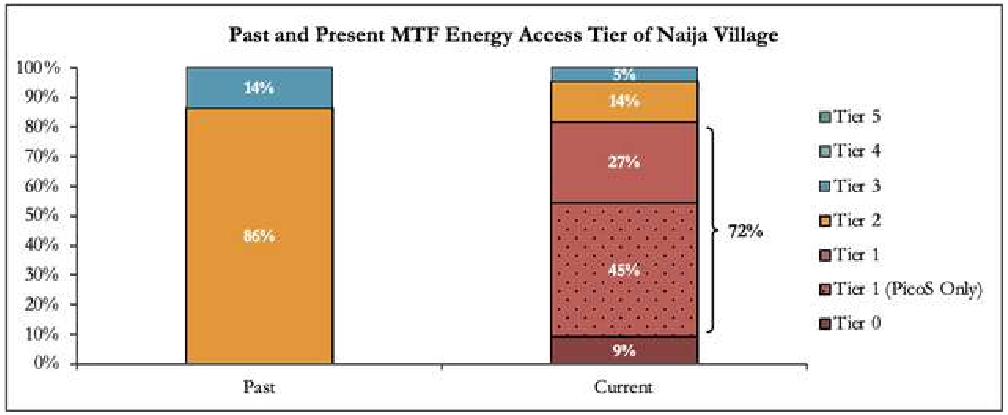


FIGURE 31. PAST AND PRESENT MULTI-TIER FRAMEWORK ENERGY ACCESS TIERS FOR 22 HOUSEHOLDS IN NAIJA STUDIED

Naija's experience with the SHS Program is not unique. Unfortunately, it reflects the current energy environment for the majority of similar iTaukei communities and even Indo-Fijian settlements found in rural areas on Viti Levu and Vanua Levu.[13,213-215] A new government policy drafted in 2022 seeks to repair all deployed SHSs and hand over their ownership from the government to households due to the failures of the RESCO model. Such an approach risks further exacerbating energy challenges in communities that are unable to afford adequate system repairs, with many resorting to noncompliant and unsafe repairs.[213]

In addition to household energy infrastructure, Viwa has several community-level energy services, though many are inoperative. A solar freezer, installed by UNSW in 2019, is currently inoperable even though it only requires minor maintenance. This is a particularly valuable asset for the Naija community, as it enables fishers to store fish, crab, and lobsters for transport and sale in Lautoka markets, generating a crucial source of income. Beyond its practical function, the freezer has fostered the development of a small-scale micro-economy that directly benefits villagers. Storage of fish costs 1 FJD per bundle (12–15kg), while smaller items can be stored at no cost. The Turaga-ni-Koro oversees payments, with profits given to the chief, who has established a community fund under his name to use the freezer's profits to cover various village expenses. Recently, this fund was used to replace the freezer's inverter for 300 FJD, demonstrating its role and greater potential in maintaining essential community infrastructure.

An older solar system that once powered a now-obsolete radio telecommunications system sits unused. After leaving it inoperable but intact for many years, the community has finally repurposed the batteries for their SHS in recent years. A 650W petrol generator, which was previously used by the village, is now broken. Viwa's primary school has multiple solar home systems (SHSs) installed across its dormitories, teacher quarters, and classrooms, ranging from 500W to 800W, though none are currently operational. A larger 1,360W AusAID-installed solar system, which once powered classrooms and other school facilities, is also non-functional. The school does have two operational 5kW petrol generators, but these are rarely used due to the high cost of fuel. The island's nursing station has a solar-powered vaccine freezer, which, according to consultations, remains fully functional.

Viwa's experiences with energy technologies present a mixed reality. While the solar freezer has provided tangible economic and social benefits, much of the island's energy infrastructure has fallen into disrepair, forming a 'solar graveyard' of non-functional systems. This highlights the critical need for long-term maintenance strategies and sustainability considerations from aid donors to ensure that energy projects deliver lasting benefits rather than becoming short-lived interventions.

8.6 RENEWABLE ENERGY RESOURCES

There are two main potential renewable energy resources for electricity available for Viwa Island: solar and wind. The World Bank Group, through its Global Solar Atlas (GSA) program has mapped out the photovoltaic power potential across Fiji, mapping the PV power producing potential of a 1kW solar PV power plant based on data between 1999 and 2018. The potential for Viwa Island was calculated at around 4.4 kWh/kWp per day (around 1650 kWh/kWp per year), one of the highest levels in Fiji (see Figure 32). [25] Evidently, according to the above profile, off-grid solar already has widespread use and adoption on Viwa Island; however, there are some fundamental challenges with the repair and maintenance of off-grid solar systems and energy projects in general.

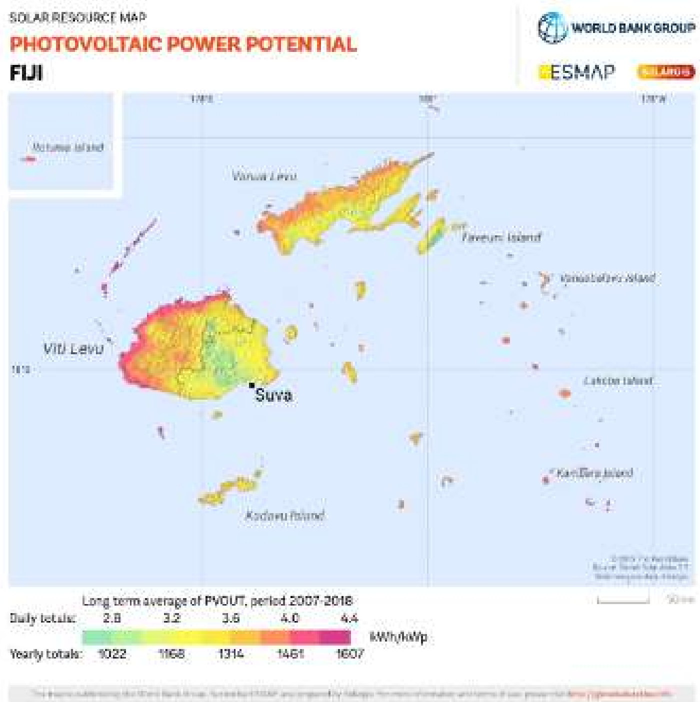


FIGURE 32 – SOLAR POTENTIAL MAP OF FIJI

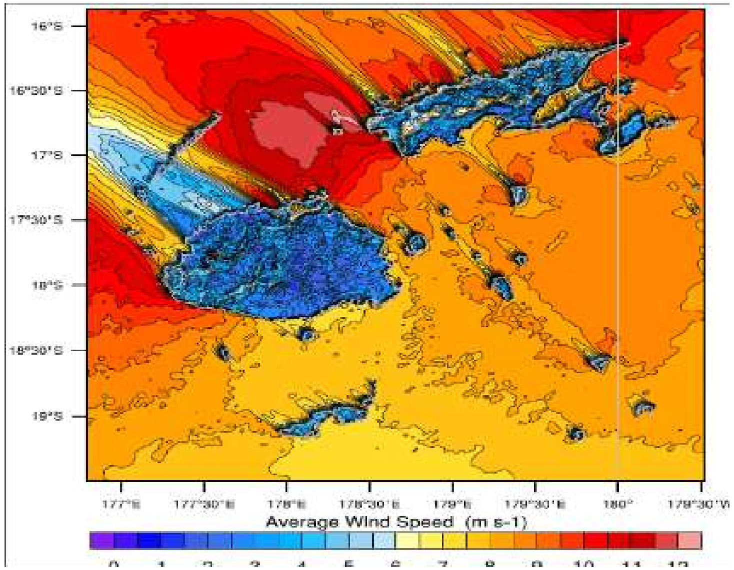


FIGURE 33 – NATIONAL WIND POWER MAP OF FIJI

There have been numerous recent studies examining the potential of wind power in Fiji, at a national level and at specific sites.[216,217,217-222] The overall consensus is that wind has relatively high potential as a renewable energy resource. Currently, Fiji has only one wind farm, a 10 MW in the Butoni hills of Sigatoka. The wind farm consists of 37×275kW Vergnet wind turbines that are connected to the grid.[223] A national-level wind map of Fiji indicates that there is some wind potential for Viwa Island, with the map suggesting its wind potential to be between 6 and 8 metres per second. While there are no location-focused recent studies of wind power potential on Viwa, there was one study conducted back in 1980 to measure the wind power in the village of Naija.[224] The study indicated that wind speeds were relatively limited (ranging between 0.6 to 2.25 metres per second); however, it did observe that the place of measurement was on the leeward side of the island, and other areas of the island might have better potential. The reason that Naija was selected as a study site is that it was actually the site of a wind turbine—a temporarily installed 5 kW Australian-made Dunlite turbine was installed at the time of study, and was producing around 4.5 hours of lighting each night for the 9 households in the village. How long the windmill remained there is unclear, but the study did conclude it had been placed in a poor location.[224]

8.7 WHOLE-OF-ISLAND APPROACH TO ENERGY ACCESS.

Foundational Principles

Viwa Island's remoteness, small population, and strong vanua-based governance structure offer both unique challenges and opportunities for whole-of-island energy planning. With only 251 people across three iTaukei villages (Naibalebale, Najia, and Yakani), the energy needs and development trajectories of Viwa are deeply entwined with customary institutions, seasonal livelihoods, and ecological rhythms. Contextual integration means acknowledging that energy must support a largely subsistence economy reliant on fishing, craft-making, and remittances, and be compatible with transport realities defined by a once-monthly ferry and limited boat access.

Energy justice is critical for Viwa, especially in addressing the uneven distribution of energy access. Many households rely on deteriorated solar home systems (SHSs), while others have reverted to kerosene and candles. Procedural justice requires respecting local governance protocols rooted in the vanua and involving mataqali, church leaders, and women's networks in planning processes. Recognition justice means acknowledging the Vula Vakaviti calendar and traditional livelihood cycles, which can guide demand patterns and system use. Gender inclusion is vital, particularly in maintenance and financial planning, given women's central role in household energy management.

Viwa's energy plan must also complement Fiji's national development goals and the strategic shift away from diesel dependency. Lessons from failed RESCO models and donor-driven installations highlight the importance of integrating maintenance, ownership, and training into every phase of energy delivery.

Core Components

A community-led assessment must be the starting point. Viwa's villages have already formed local governance structures for solar systems and mobile payments. This can be deepened through participatory methods, such as Talanoa, to identify current needs and align energy systems with social institutions like churches, schools, health centres, and women's weaving collectives. Mapping current infrastructure, including defunct SHSs and unused diesel or solar assets, is crucial to avoid redundancy and to guide repair or replacement strategies.

Technology solutions must be modest but resilient. Most households require reliable lighting, device charging, and occasional refrigeration. Enhanced SHS configurations with lithium batteries, modular inverters, and improved charge controllers could lift households from energy tier 1 to tier 2 or 3. For productive uses, the existing solar freezer presents a model: it enables fish storage and small-scale commerce while being community-managed. Scaling this through shared-use microgrids or battery banks should be explored. The feasibility of wind power remains uncertain given mixed historical data, but site-specific assessments may reveal viable locations beyond Naija. A centralised grid is not viable, but small hybrid systems could support public institutions. Boat-based e-mobility, including solar-charged outboards, should be piloted to reduce fuel costs and support inter-village transport.

Deployment and governance must centre the vanua. Formal recognition of mataqali roles, the Turaga-ni-Koro, and church-led development planning should guide implementation. Community training in system maintenance is essential to avoid the solar graveyard effect witnessed with past installations. Empowering youth and women through technical training can also counteract rural-urban drift and build energy stewardship.

Financing must blend government, donor, and local resources. Viwa can access support through national climate adaptation funds, development partner grants, and Ministry of Infrastructure programs. However, tariffs or repayment models must be affordable and equitable, given Viwa's low-cash economy. Community savings schemes, freezer-based microfinancing, and household contributions in-kind (e.g., food or services) could support maintenance. Ownership of systems should remain community-based, with mechanisms for accountability and pooled savings.

Implementation Principles

Inclusivity should be non-negotiable. Women's groups, youth leaders, and traditional elders must be present in all decision-making spaces, not just as advisors but as co-leaders. Traditional practices such as sevusevu and nakamal-style consensus should underpin planning sessions.

Resilience must address both cyclone exposure and technological failure. Systems should be cyclone-proofed and housed in durable bures where possible. Rainwater harvesting and sanitation improvements can be co-integrated into energy deployments, especially given the reliance on septic systems and tanked water. Consideration of the reactivation of desalination units with solar power should be prioritised.

Efficiency requires coordinated asset tracking. Many systems on Viwa remain unused or underperforming due to a lack of minor repairs. A full island-wide audit should inform deployment sequencing, which could avoid duplication and leverage potential for scale across multiple community facilities. The solar freezer demonstrates how a single well-managed asset can transform village economics. Additional shared systems could build on this.

Sustainability hinges on training, local ownership, and supply chains. A spare parts hub in Naibalebale, supported by satellite stores in Najia and Yakani, can ensure continuity. Village stores can carry basic solar components, stimulating the local economy. A support agreement with mainland-based technicians or NGOs could provide backup troubleshooting, especially for high-value equipment.

Monitoring & Evaluation

Community-led monitoring must track functionality, usage hours, and satisfaction. Smart metres may be infeasible, but household logs, freezer payment records, and women's committee reports can serve as alternative data sources. Indicators should capture not just system performance but well-being metrics: Are students studying longer? Are incomes improving? Are women spending less on kerosene?

Feedback loops must be institutionalised. Monthly village meetings, already common practice, can incorporate an energy review session. The solar committee can track repairs, finances, and complaints, with escalation to the Ba Provincial Council via the Mata-ni-Tikina. Lifecycle tracking must be introduced for batteries and panels to avoid safety risks and inform replacement cycles.

Conclusion

Viwa Island illustrates both the pitfalls and promise of decentralised energy in remote Pacific contexts. A whole-of-island strategy here must start with cultural and ecological embeddedness, using the vanua system not only as a governance scaffold but as a planning lens. Strengthening existing SHSs, repairing shared assets like the solar freezer, and exploring modular expansions offer near-term gains. Longer-term success will depend on embedding maintenance pathways, equitable financing, and inclusive governance. If done well, Viwa can transition from a solar graveyard to a model of resilient, community-owned energy.

UMAN ISLAND

9.1 GEOGRAPHIC AND ECONOMIC LANDSCAPE

Uman Island is located within Chuuk Lagoon, one of the four states of the Federated States of Micronesia (FSM). Geographically, Chuuk Lagoon lies roughly in the centre of the FSM's span across the western Pacific Ocean. It is one of the largest atolls in the world, encircled by 224 km of coral reef and dotted with 290 islets, including fifteen larger volcanic islands within the lagoon itself. [60]

Chuuk Lagoon is broadly divided into two regions: Faichuuk (the western islands) and Namoneas (the eastern islands). Uman Island lies in the southern part of the Namoneas region.

Although Chuuk Lagoon is more than 700 km west of FSM's capital, Palikir (on Pohnpei Island), it is home to around half of the nation's population—estimated at 50,000 people.[225] Despite this large population, Chuuk State remains significantly less developed than other parts of the country. The administrative and population centre is Weno Island, which has around 14,113 residents—approximately 29% of Chuuk Lagoon's population.

Uman Island itself is a small volcanic island located about 15 km south of Weno. According to the most recent census (2010), the island had a population of 2,554 people across 369 households, mostly concentrated along the southern and eastern coasts. This reflects a decline from the 2000 census, which recorded 2,847 people in 378 households. The island has a total of ten villages, with Nepononong, on the central east coast, serving as the municipal capital.

Uman covers an area of 4.7 km². It features dense forest and a central mountain peak, while its coastline—especially the northern edge—is lined with mangrove forests and sandy shores. Environmental hazards such as typhoons (Cyclone), coastal erosion, or sea level rise present major challenges for Uman and other parts of Micronesia.[226]

Uman - Overview	
Population	2,554
Households	369
Villages	10
Land area	4.7km2
Population Density	543 people per km2

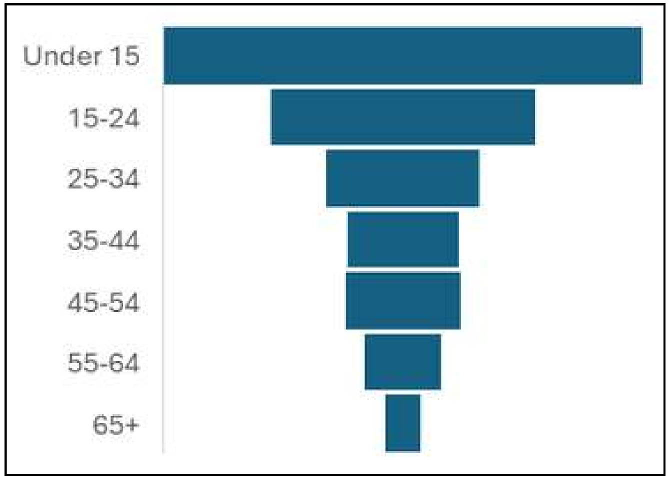


FIGURE 34: UMAN AGE PYRAMID

9.2 LIVELIHOODS

In Chuuk State, including Uman Island, the majority of households rely on subsistence farming, cultivating staples such as breadfruit, wet taro, coconut, bananas, cassava, and sweet potato primarily for local consumption. These activities typically take place in small-scale swidden gardens near villages.[227] Fishing is essential—both for home consumption and minor market activity. Both men and women participate: men typically catch fish and lobsters, while women collect crabs and other shellfish in intertidal zones.[228] While specific data on Uman is limited, remittances from family members living elsewhere (such as Weno, Guam, or the US) are widely understood to be an important income supplement across outer islands in Chuuk State. [229]

Chuukese communities historically engage in traditional crafts such as weaving mats and baskets, basketry, canoe carving, woodworking, and shell or pandanus-based handicrafts—these are sold or bartered locally. A small number of islanders work in formal public roles, including education, health care, and local government; there are, however, no specific numbers for Chuuk for most of these. A somewhat dated survey indicated that there were around 6-7 health workers on Uman Island.[230]

The primary source of cash-based economic income in Chuuk Lagoon comes from dive-based tourism, as there are several Japanese World War II shipwrecks within the atoll. The Japanese navy held large fleets of ships within the lagoon until the United States Navy sank many ships in a large battle that lasted several days. Most of these economic benefits, however, are concentrated on the largest island of Weno, where most of the tourist services and physical infrastructure are located. The tourism sector has also been declining in recent years, with air arrivals halving from 40,000 to 20,000 since 2012. Of those air arrivals, only 28% of foreign tourists visit Chuuk. The National Tourism Policy attributes the decline of foreign visitors to a lack of funding and government support of tourism, as well as substandard infrastructure. The decline in FSM's tourism runs counter to broader trends within the Pacific, which have generally been increasing within the same period. [231]

Chuuk has five hotels located on Weno and two live-aboard boats, which all cater exclusively to the dive market.[231] Jobs are also scarce within the tourist sector, with only 800 individuals across FSM employed within the tourism sector. There is no developed tourism infrastructure on Uman Island; however, it is surrounded by several shipwrecks and is likely an occasional destination for dive tourists.

Photo by micronedia drone videos

9.3 SOCIAL AND CULTURAL GEOGRAPHIES

The islands in Chuuk Lagoon were first settled by humans 2,000 years ago by people who migrated in canoes from elsewhere in the Pacific. The social structure and religions of the inhabitants of various islands within Chuuk Lagoon were fragmented and localised. Chuuk Lagoon was one of the last island groups in the Pacific to be influenced by Christian missionaries or a sustained Western presence. The first missionary settlement was established in the 1870s by American Protestants. Germany took possession of the island group in 1899 and established the first Catholic mission in 1912. Today, 55% of the population identify as Roman Catholic, and 44% identify as Congregational Protestant.[232]

After World War Two, the United States governed Chuuk State until the FSM signed a Compact of Free Association with the United States in 1986. This compact authorised the United States to maintain a military presence within FSM and gave the Chuukese people the right to migrate to the United States. Although this provides citizens of Micronesia with educational and employment opportunities, it also causes outmigration. The population of FSM has declined at an average rate of 0.2% per year since 2000. Higher wages in neighbouring countries, such as Guam, also attract migrants from the FSM who often never return permanently.[231]

Roles within the community are gendered, with men performing duties such as fishing, farming, climbing, and handicrafts, while women do the majority of the cooking and basket weaving.

In Chuukese communities that revolve around cash income, where subsistence lifestyles are less common, there are high rates of obesity and diabetes. Traditional foods have been replaced with imported goods like rice, bread, canned meat, and sodas with high sugar content. Within FSM, the obesity rate is 40% and diabetes rate is 25%, and the leading cause of death is heart disease. [231]

Photo by Chew Lin

9.4 PHYSICAL INFRASTRUCTURE AND TRANSPORTATION

Uman has a dirt pedestrian track connecting the villages along its coast, which is only suitable for two-wheeled vehicles or walking due to its poor condition.[234] Within the lagoon, travelling from Wemo to Uman, or any other island, will take approximately two hours on a passenger ferry. To travel to Chuuk Lagoon from the capital island, Pohnpei, there are five return flights per week, operated by United Airlines, which take 90 minutes and cost US $300. A cheaper alternative to inter-island travel within FSM is to board with one of two large vessels, which costs about $28 per trip or $150 for a private cabin. Travelling via boat is predominantly for government businesses, education, visiting friends and family, or medical purposes. Tourists travelling on these vessels is possible and welcomed, but less common.[231]

Getting to and from FSM internationally is also difficult for both residents and international visitors. United Airlines holds a monopoly over air travel, and the high cost of airfares makes travelling prohibitive. For example, a return flight from Guam to Chuuk costs $700.[231]

FSM prohibits foreign ownership of land, and most privately held land is passed down within families and existing clan structures. This can lead to conflicting land title claims and complicate investments in infrastructure development projects, as negotiations generally involve many parties with conflicting interests. [231]

There are three elementary (primary) schools on Uman Island: Panitiw Elementary School in the north, Uman Elementary School in the centre of the east coast, and Kuchu in the south. There are, in theory, five health dispensaries spread across Uman Island, providing basic health care. The current state of these is unclear. The last assessment, conducted in 2005, had found that two were not functional, one was locked, and one was being operated out of a health assistant's home. The most functional was the Innuk Dispensary located in the centre of the island, which had a water tank (supplied by UNICEF) and a generator for electricity. [230]

FIGURE 35- MAP OF UMAN ISLAND AND ITS INFRASTRUCTURE

9.5 CURRENT ENERGY GEOGRAPHY

In the Federated States of Micronesia (FSM), the energy strategy is set out in the *National Energy Policy* (2012) and a series of State Energy Action Plans. These provide a unified framework across FSM's four states—Yap, Chuuk, Pohnpei, and Kosrae—focusing on five main areas: access, affordability, efficiency, renewable energy, and environmental sustainability. The strategy highlights the importance of decentralised energy solutions adapted to each state's unique geographic and resource conditions, including solar PV, biomass, and wind energy. Each state has developed its own action plan to guide implementation, with specific targets for renewable energy uptake, public sector energy efficiency, and improved fuel management. The policy also promotes the development of energy institutions and encourages active participation from the private sector.

Individual states within FSM are largely devolved from the central government and have autonomy over the management of public utilities. Each state is served by its own state-owned power utility that generates, distributes, and supplies its own electricity. Although this decentralised model can be beneficial for tackling local complexities and challenges, the structure can also constrain design, procurement, and training for staff, which then incurs additional costs and complicates implementation.[230]

In 2018, the FSM adopted an energy development master plan for the FSM.[42] Each state has received an individual plan to provide electricity access to almost every household by 2023. The master plan's goal for Chuuk Lagoon was for the state to achieve 100% electrification, with 30% of that produced with renewable energy sources, by 2023. The plan included upgrades to the existing grid on Weno, along with the construction of 14 mini-grids on the other islands within the lagoon. Energy generation for the islands Tonoas, Fefan and Uman would come from a singular mini-grid that spans across the three islands via a medium-voltage overhead network, plus a low-voltage underground network running around the perimeter of each island. This would also require two submarine cables connecting the islands. The minigrid would generate energy through a mixture of diesel and solar, with additional solar battery storage. So far, only the mini-grid on Tonoas has been installed.

In FSM, approximately two-thirds of the population lacks access to reliable electricity sources; Chuuk State has the lowest rates of access in the country. This access is uneven, with the four main islands across Micronesia having around 97% access, with outer islands lacking grid electricity access. The barriers to energy development are predominantly related to the cost of fuel for petrol and diesel generators and the relative remoteness, geographic distances, and decentralised governance structures between states. The total cost of fossil fuel imports in 2022 exceeded $50 million, which is about 12.5% of the nation's GDP.[235] There is a significant urban-rural disparity in electricity access, as the eastern states of Pohnpei and Kosrae have as high as 94% access to electricity. The state of Chuuk has the lowest access to electricity in the country at approximately 30%, and within Chuuk, this access is highly concentrated on the island of Weno, which is the only municipality that has fully electrified its 2,200 households.[236] Energy development in Uman and other outer islands lags behind other parts of the country and remains reliant on fossil fuels.

The current status of off-grid electricity access on Uman Island remains unclear. The most recent available census data from 2010 estimated that about 8.9% of households used solar power for lighting, 4.9% relied on generators, and 3.5% used battery lamps, while the majority—82.7%—still depended on kerosene lamps.[237] Although around 28% of households reported owning a generator, only a small fraction (4.9%) actually used them for lighting.[237] The previous census from 2000 did not record lighting sources, but it noted that 1.3% of households used solar for their electricity needs, suggesting that solar uptake had increased over the decade.[238] It is almost certain that off-grid solar use has continued to grow on the island, while kerosene use has declined, mirroring trends across other Pacific islands. A proposed project in 2012 recommended distributing 500 solar lanterns throughout Uman and installing a 6 kW standalone solar system at the Uman Elementary School,[239] although it is unclear whether this project was ever implemented. There are, however, as seen via Google Satellite, a considerable array of solar modules on the roof of the school.

More recently, Uman Island is a target island for the Access and Renewable Increase for Sustainable Energy (ARISE), a project administered by the Government of the Federated States of Micronesia with financing from the World Bank. Officially launched in May 2025, the project aims to expand electricity access across Micronesia. Electricity access for households in ARISE is to be provided via solar-powered mini-grids and standalone solar home systems, as well as focusing on providing off-grid electricity access, including power for lighting, refrigeration, electronic devices, and healthcare equipment for schools, health clinics, and community centers.[240] Bids for the electrification of Uman, financed under ARISE, will be issued in the first quarter of 2026.

In terms of off-grid solar options, on Uman (as well as the islands of Fefen, Etten, and Piis Panaeu), energy service affordability models were developed through stakeholder consultations with each household, taking into account their monthly income. Based on these discussions, four service packages were designed:

- **Package 1 – Basic lighting and charging: 3 LED lights and two mobile phone charging points (275 Wh/day) at a cost of USD 4–8/month.**
- **Package 2 – Enhanced household services: 4 LED lights, two mobile phone charging points, one electric fan, and one LED TV (750 Wh/day) at a cost of USD 10–23/month.**
- **Package 3 – Appliance-ready household: 5–7 LED lights, three mobile phone charging points, one electric fan, one LED TV, one freezer, and one rice cooker (2,220 Wh/day) at a cost of USD 34–66/month.**
- **Package 4 – Comprehensive household and small business: 5–7 LED lights, four mobile phone charging points, one electric fan, one LED TV, one refrigerator, one rice cooker, and one power tool (3,850 Wh/day) at a cost of USD 59–116/month.**

When asked about their preferred package based purely on needs and aspirations, households expressed interest as follows: 17% in Package 1, 5% in Package 2, 32% in Package 3, and 46% in Package 4. However, when affordability constraints—such as household income and remittance levels—were factored in, the allocation shifted to 17% for Package 1, 22% for Package 2, 38% for Package 3, and 22% for Package 4.

9.6 RENEWABLE ENERGY RESOURCES

The main renewable energy resources available on Uman Island for electricity production are solar and wind. The island is too small to offer any potential for hydro or biomass sourced power.

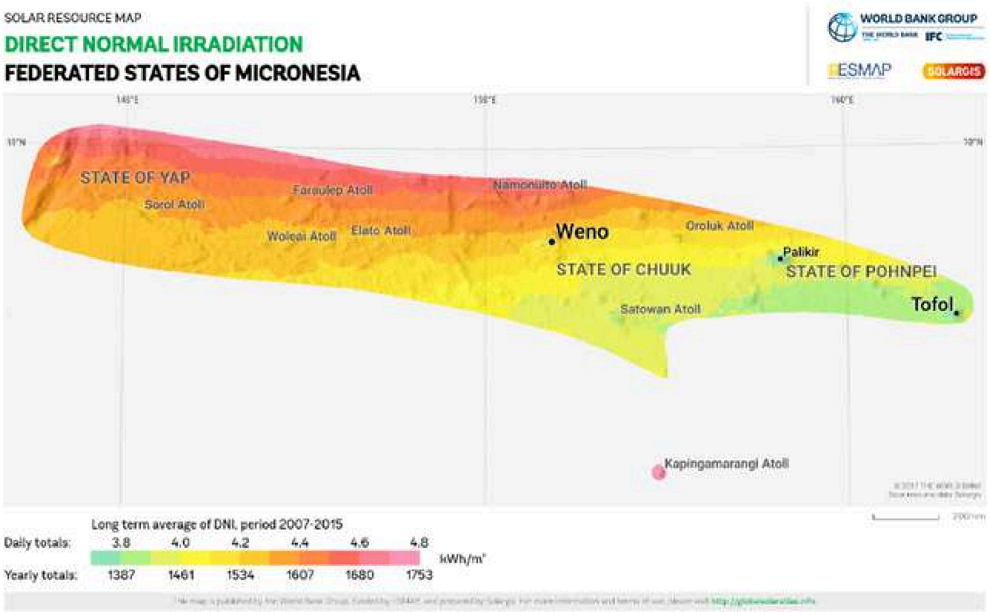


FIGURE 36 – SOLAR POTENTIAL MICRONESIA

The World Bank Group, through its Global Solar Atlas (GSA) program, has mapped out the photovoltaic power potential across Micronesia, mapping the PV power-producing potential of a 1 kW solar PV power plant based on data between 1999 and 2018. The potential for Uman Island (which is just south of Weno on the map) was calculated at around 4.2 kWh/kWp per day (around 1534 kWh/kWp per year) (see Figure 36). This indicates a strong potential for solar PV applications.

A recent study assessing wind energy potential was conducted on nearby Weno Island. The study measured a wind energy density of 157.08 W/m² and concluded that wind conditions in Chuuk State are generally poor. However, small-scale wind power generation is still feasible—particularly using turbines such as the Aeolos-H 20 kW model. The study recommended that any wind system be part of a hybrid setup, ideally combined with solar power for improved reliability and performance.[240] In Chuuk State, hybrid renewable energy systems that combine solar PV, wind generation, battery energy storage systems (BESS), and smart control technologies are being piloted on the islands of Edot and Satowan. These integrated systems aim to maximise renewable generation while ensuring a reliable supply, even during periods of low sunlight or wind. Smart controls can dynamically balance generation and storage, reducing reliance on diesel and improving

9.7 WHOLE-OF-ISLAND APPROACH TO ENERGY ACCESS.

Foundational Principles

Uman Island's energy future must be understood in the context of its geographic isolation within Chuuk Lagoon, its limited economic base (i.e., subsistence farming, limited cash economy), and a highly devolved national governance framework. The island is home to roughly 2,500 people across ten villages, and it relies heavily on subsistence livelihoods, remittances, and localised social governance structures. Contextual integration requires aligning energy development with the realities of Uman's household economy, land tenure complexity, and fragmented transport systems. Any plan must be responsive to the limited ferry and boat access, high fuel costs, and the impracticality of heavy infrastructure projects.

Energy justice is central to addressing Uman's low electricity access rate. Recognition justice involves valuing customary land systems, traditional resource use, and local knowledge when planning energy initiatives. This can be operationalised through formal community consultations, negotiated land use agreements, and conflict-resolution mechanisms that respect local governance structures and cultural protocols. Procedural justice requires genuine inclusion of Uman's diverse village communities, elders, and women's groups in decision-making. Gender inclusion is essential: women are central to household energy management and must have a voice in system design, tariff models, and maintenance training.

Complementarity must underpin all system design. Integration with existing public assets—including schools, health clinics, and community halls—is critical, as is coordination with ongoing donor initiatives such as the World Bank's ARISE project. Viable energy solutions must bridge standalone household needs with broader community resilience.

Core Components

A community-led assessment must drive Uman's energy strategy. Given the island's ten villages and variation in terrain, a village-by-village mapping of energy assets, infrastructure conditions, and social priorities is necessary. This should include consultations in Neponong (the municipal centre), coastal settlements, and upland communities. The approach should engage traditional leaders, church networks, and women's groups to ensure representation of local voices and social hierarchies. Any work on improving electricity access should be coordinated with other infrastructure upgrades (water, transport, communication) and economic development initiatives to maximise impact.

Tailored technology mixes are essential. Given the mountainous terrain and scattered settlements, a centralised grid is neither feasible nor cost-effective. The proposed mini-grid network connecting Uman, Tonoas, and Fefan through a hybrid diesel-solar system and submarine cables is promising but may only benefit a fraction of Uman's residents. For most villages, especially those inland or at the fringes, decentralised solar home systems and village-scale mini-grids will be more appropriate.

Where feasible, deployment should link into strategic hubs. Schools and clinics can anchor larger solar arrays with battery storage, offering reliable energy for essential services like refrigeration, lighting, and communication. Lessons from past failures (e.g., abandoned systems and lack of maintenance pathways) must guide new deployments. The ARISE project provides a strong platform but must avoid the pitfalls of the earlier SHS initiatives by embedding maintenance, training, and clear ownership models. Local technician training and establishing clear maintenance protocols with accountability are critical for sustainability.

Uman should also serve as a testbed for grid-off-grid integration and interoperability. As the Weno-Uman-Tonoas mini-grid is explored, technical standards should ensure compatibility with off-grid systems, allowing future linkage or shared maintenance support.

Implementation Principles

Inclusivity is critical. Energy planning must go beyond consultations and establish island-wide energy committees that include representation from each village. Customary processes—including community consensus and elder-led discussions—should be embedded into planning stages. Engagement with youth is equally important, offering pathways to technical training and slowing urban migration.

Resilience must address both environmental and institutional risks. Systems should be cyclone-rated and account for the island's exposure to salt spray, flooding, and logistical delays in receiving spare parts. Institutional resilience requires a clear delineation of responsibility between FSM's national energy authorities, Chuuk Public Utility Corporation, and community-based governance.

Efficiency requires coordinated asset mapping and supply chain strategies. A central parts hub located in Neponong could stock replacement batteries, controllers, and cables, supported by smaller depots in Panitiw and Kuchu. Community stores can be leveraged to maintain a stock of commonly needed solar components. Energy mapping should avoid duplication, track system lifespans, and allow for coordinated servicing.

Sustainability hinges on ownership and training. Households must be trained in the safe use and care of systems, while local technicians should be supported to offer repair services. Partnerships with vocational institutions on Weno and integration with the Department of Energy's training programs can provide capacity-building. Financing models should consider affordability, potentially using community savings schemes or donor-backed subsidies to cover repair costs. Avoiding a repeat of the RESCO failures seen elsewhere in the region is essential.

Monitoring & Evaluation

Monitoring frameworks must be community-based. Basic reporting mechanisms—such as logbooks, village-level audits, and health clinic records—can track energy use, outages, and repairs. These should feed into municipal reporting and be shared with Chuuk State energy authorities and ARISE project implementers. Where possible, digital tools (mobile apps, SMS reporting) should be used to improve timeliness and accuracy.

Key indicators should include system functionality, lighting availability, school and clinic service hours, and household satisfaction. Broader metrics, such as improved student attendance and income diversification from productive uses (e.g., refrigeration, small retail), should also be tracked.

Feedback loops can be built into village meetings, with quarterly reviews of energy system performance and repair needs. Escalation pathways to the Department of Energy and Chuuk Public Utility Corporation should be clearly defined.

Conclusion

Uman Island offers a case of both acute energy poverty and strategic opportunity. With the support of donors and a well-defined government policy framework, Uman Island stands ready to achieve significant improvements in energy access. But success will require an approach that is not just technical but social and ecological—rooted in the island's geography, governance structures, and economic realities. A whole-of-island plan for Uman must build from the community up, connecting households to services, linking off-grid systems to central hubs, and embedding resilience and maintenance throughout. If implemented thoughtfully, Uman could become a model for equitable, inclusive energy development in the Federated States of Micronesia.

CONCLUSIONS AND RECOMMENDATIONS

10.1 BRIDGING THE LAST NAUTICAL MILE: FINANCING, TECHNOLOGY, AND WHOLE-OF-ISLAND PLANNING

The Pacific Island Countries (PICs) face a unique and urgent challenge in achieving universal energy access. Unlike the "last mile" dilemmas common in continental contexts, the "last nautical mile" in the Pacific is defined by vast oceanic distances, dispersed populations, and logistical complexities that make conventional grid expansion economically and technically unfeasible. This framing demonstrates the importance of tailored, context-sensitive energy solutions that go beyond infrastructure and address the social, cultural, and ecological realities of island life.

To bridge this last nautical mile, PICs must embrace a diversified portfolio of energy technologies. Solar PV—both household-scale and community-scale—has emerged as the most widely adopted and viable solution, supported by falling costs and donor-backed programs. However, the sustainability of these systems hinges on robust maintenance, repair, and end-of-life management strategies. Other technologies, such as micro-hydro, wind, and biomass, require careful matching of their deployment to local geographies and capacities.

Financing remains a critical enabler. While donor-funded programs have catalysed initial access, long-term sustainability requires blended finance models, catalytic funding, and locally appropriate tariff structures. Community-owned models, RESCOs, and PAYG systems each offer distinct advantages and limitations. The success of any financing strategy depends on its ability to balance affordability, equity, and operational viability—especially in remote and economically constrained settings.

Central to this transformation is the adoption of a whole-of-island approach. This planning paradigm shifts the focus from fragmented, project-based interventions to integrated, place-based strategies that align energy systems with local economies, infrastructure, and development goals. It calls for participatory planning rooted in cultural deliberation methods such as Talanoa and Talanga and embeds principles of energy justice—distributional, procedural, and recognition—into every stage of design and implementation.

By grounding energy planning in the lived realities of island communities, the whole-of-island approach offers a pathway to resilient, inclusive, and future-fit energy systems. It ensures that electricity access is not just expanded, but made meaningful—supporting livelihoods, enhancing wellbeing, and empowering communities across the Pacific.

10.2 INSIGHTS FROM THE CASE STUDIES: WEAVING ISLAND REALITIES INTO ENERGY FUTURES

The six case studies presented in this report—Abaiang, Arno, Tanna, Malaita, Viwa, and Uman—offer more than just snapshots of energy access in remote Pacific communities. They reveal the layered, lived realities of energy transitions in places where geography, culture, and infrastructure intersect in complex and often fragile ways.

One of the most striking patterns is the fragility of energy systems once the initial installation phase ends. Across the islands, solar home systems (SHSs) have been widely deployed, often with donor support and government facilitation. In Abaiang, for instance, solar adoption reached over 90% of households by 2015—a remarkable achievement on paper. Yet, many of these systems now lie dormant, their batteries degraded, their panels damaged, and their wiring corroded by salt and time. Viwa Island tells a similar story. Once the recipient of a full suite of SHSs under Fiji's RESCO program, most of its households now rely on low-tier solar lanterns, candles or kerosene. The systems, once symbols of progress, have become a kind of solar graveyard—a testament to the consequences of neglecting maintenance, repair, and long-term planning, including for financial viability.

Yet, even in these breakdowns, there are stories of adaptation. In Viwa, a single solar freezer—installed by a university project and maintained by the community through a community micro-enterprise model—has become a vital piece of infrastructure. It enables fishers to store their catch for sale on the mainland, supports a small local economy, and is managed through a community fund overseen by the village head. This freezer, modest in scale, embodies a different model of energy access: one rooted in local ownership, productive use, and social accountability.

This theme of community governance recurs across the case studies. In Tanna, kastom governance and traditional leadership structures deeply influence energy planning. The Imaki mini-grid, for example, was not just a technical intervention—it was a social project, negotiated through nakamal meetings and embedded in local norms. Kinship networks often acquire and share energy systems in Malaita, with remittances from relatives abroad funding the purchase of SHSs. These systems serve not only as tools but also as gifts, obligations, and symbols of care. In Uman, where formal infrastructure is sparse, village-level governance and church networks play a central role in managing energy access and advocating for inclusion in national programs.

Where energy systems have been most successful, they have supported not just households but livelihoods. In Arno, the fisheries sector—anchored by ice-making facilities and aquaculture—relies on stable electricity to function. The proposed REGAIN mini-grid aims to strengthen this link, powering not just homes but economic infrastructure. In Tanna, solar-powered water systems and food drying technologies support agriculture and food security. In Malaita, energy access enables shell money production, market vending, and small-scale retail. These examples remind us that energy is not an end in itself—it is a means to sustain life, generate income, and build resilience.

But resilience is not just economic. It is also environmental. The Pacific is on the frontlines of climate change, and energy systems must be designed to withstand its impacts. In Arno, solar systems have been damaged by cyclones and saltwater intrusion. In Tanna, volcanic ash corrodes panels and clogs filters. In Uman, salt spray and flooding threaten even the most basic infrastructure. These are not abstract risks—they are daily realities. Energy planning must therefore be climate-aware, incorporating cyclone-proof designs, modular systems, and redundancy into every deployment.

Financing remains a persistent challenge. While donor programs have enabled widespread access, they often fail to support long-term sustainability. In Malaita, informal financing through remittances has filled the gap, but this model is uneven and vulnerable to economic shocks. In Tanna, PAYG pilots offer promise but require digital infrastructure and consumer protections. In Viwa, a community fund tied to the solar freezer offers a glimpse of what locally grounded financing might look like—small, transparent, and accountable.

What ties all these threads together is the need for a whole-of-island approach. Energy cannot be planned in isolation from transport, water, health, or education. On Viwa, the lack of a jetty complicates fuel delivery and school attendance. On Tanna, the Lenakel grid serves as a hub for technician training and spare parts distribution. On Abaiang, solar systems are linked to water pumps and health clinics. Whole-of-island planning means seeing energy not as a standalone sector but as a connective tissue—binding together the systems that sustain life on remote islands.

In the end, the case studies do not offer a single model or blueprint. Instead, they offer a mosaic of insights—each shaped by place, culture, and history. They show that energy transitions in the Pacific are not just technical challenges but social, cultural, and ecological ones. And they remind us that the last nautical mile is not just a distance to be crossed—it is a space to be understood, respected, and co-created with the communities who live there.

Island	Population	Main Energy Mode	Key Challenge	Promising Innovation
Abaiang (Kiribati)	~5,800	SHSs (92% coverage)	Maintenance gaps, solar e-waste	Gender-inclusive training, pilot mini-grid
Arno (Marshall Is.)	~1,100	SHSs, diesel backup	Cyclone damage, infrastructure fragility	REGAIN mini-grid for tourism & fisheries
Tanna (Vanuatu)	~40,600	Grid, SHSs, micro-hydro	Terrain, cultural complexity, ash fall	Community-led PayGo solar, geothermal studies
Malaita (Solomons)	~173,000	SHSs (94% coverage); Grid and Mini-grids	Dispersed settlements, system quality	Remittance-based solar sharing, micro-hydro
Viwa (Fiji)	~250	SHSs (many defunct)	Lack of maintenance, donor fragmentation	Community solar freezer, whole-of-island planning
Uman (Micronesia)	~2,500	Solar Lamps and SHS (likely)	Governance fragmentation, low access	ARISE mini-grid, school-based solar installations

TABLE 9 – OVERVIEW OF CASE STUDIES

10.3 RECOMMENDATIONS

The concept of the "last nautical mile" offers a compelling frame to shift energy planning from national metrics to lived island realities. It draws attention to the local nuances of access, justice, resilience, and maintenance that often determine whether a solar system becomes transformative—or ends up on the scrap heap.

Whole-of-island energy planning provides a pragmatic yet visionary pathway forward. It moves beyond piecemeal installations to an approach that coordinates across institutions, technologies, and communities. Whole-of-island planning integrates social structures, climate adaptation needs, local livelihood patterns, and governance systems into coherent strategies for energy development. The case studies from Uman, Viwa, Malaita, Tanna, Arno, and Abaiang demonstrate both the pitfalls of fragmented interventions and the transformative potential of coordinated, culturally grounded approaches.

To operationalise this shift across the Pacific, the following recommendations are proposed.

1. Planning & Demonstration

Develop a Whole-of-Island Energy Planning Toolkit

Create a regionally endorsed guide that provides step-by-step instructions for developing whole-of-island energy plans. Include tools for participatory community assessments, culturally grounded engagement (e.g., Talanoa, Talanga), governance models, technology selection, and lifecycle planning. Ensure alignment with national energy policies and SDG7 targets while allowing for local adaptation, while also aligning with different government agencies (e.g. school and health clinic systems).

Fund Demonstration Projects

Support 4–6 pilot projects across diverse island types (e.g., atoll, volcanic, outer-island) to showcase the full whole-of-island planning cycle. These should include deep community engagement, co-design processes, infrastructure rollout, and monitoring. Pilots should be multi-donor and multi-agency to foster collaboration and learning.

2. Data & Knowledge Platforms

Establish Island-Level Energy Data Platforms

Create open-access, regularly updated databases for each inhabited island, potentially managed by the Pacific Community (SPC). These platforms should include maps, infrastructure audits, census data, energy project history, and socio-economic indicators. A visual dashboard should support planning, coordination, and transparency across government department, donors, and civil society.

Create a Regional Mini-Grid Registry

Conduct a comprehensive review of mini-grid projects across PICs, capturing governance models, technical performance, financial viability, and community satisfaction. Use findings to inform future investments, avoid duplication, and develop region-wide interoperability standards.

3. Technology Standards & Local Capacity

Standardise and Rate Solar Products

Develop Pacific-specific standards for off-grid solar products (e.g., SHSs, lanterns) that prioritise repairability, spare parts availability, and cyclone resistance. Publish a ranked list of products (including appliances) most suitable for Pacific conditions to guide procurement and reduce solar e-waste. This should include considerations of energy efficiency as well as longevity (e.g. corrosion resistance) and potentially repairability.

Embed Solar Repair in Education

Introduce basic DC solar repair and maintenance into secondary school curricula. Equip schools with tools and sample systems to promote hands-on learning and transform solar repair into a common, community-based skill—especially critical in remote areas where over 90% of households rely on solar for lighting and charging.

Develop Renewable Energy Integration Guidelines

Create region-specific technical and socio-economic guidelines for integrating solar, wind, and micro-hydro into existing grid and off-grid systems. Include standards for resilience to extreme weather, land access, and compatibility with local infrastructure.

Establish a Regional Maintenance & Training Hub

Set up a central hub (e.g., in Fiji) to support repair and maintenance of renewable energy systems. The hub should offer technical training, spare parts, and repair services, and serve as a knowledge-sharing centre for best practices in island contexts.

4. Financing & Affordability

Diversify Financing Models

Blend donor funding, catalytic capital, and national financing mechanisms (e.g., FREF, NGEF) to support both household and community-scale systems. Include concessional loans, grants, and blended finance tailored to island contexts.

Support Inclusive Market Models

Expand ethical PAYG solar, RESCOs, and community-owned models. Address affordability, asset ownership, and long-term maintenance, including via training for community governance of solar micro-enterprises and, as needed, ongoing financial support. Ensure safeguards to prevent financial stress on low-income households and promote gender and disability inclusion.

Establish a Regional Energy Financing Facility

Create a Pacific-wide facility to pool resources and offer tailored financial products for island energy projects. Coordinate with SPC and regional donors to streamline access to capital and technical support.

Embed Financial Resilience in Project Design

Ensure all energy projects include lifecycle cost planning, maintenance budgets, and contingency funds. Promote financial literacy and transparent cost recovery mechanisms at the community level.

5. Governance & Regional Coordination

Institutionalise "Last Nautical Mile" Forums

Create an annual workshop aligned with the Pacific Power Association Conference to spotlight remote energy access challenges and share whole-of-island best practices. Rotate hosting among countries to ensure regional ownership and inclusion.

Engagement more with the Global Association for the Off-Grid Solar Energy Industry (GOGLA).

Efforts should be made to reach out to GOGLA to ensure that PICs are featured more prominently in future GOGLA publications and that PICs are strongly represented at future GOGLA events and expos.

6. E-Mobility & Transport

Promote E-Mobility for Atolls

Support electric bikes, scooters, and small marine transport tailored to atoll geographies. Integrate charging infrastructure with renewable energy systems to reduce fuel dependency and improve transport equity.

7. Solar E-Waste Management

Strengthen Lifecycle Tracking & Recycling

Develop regionally coordinated systems to track solar system lifespans and manage e-waste, especially batteries and panels. Promote repairability and reuse, and support recycling programs linked to vocational training centres. Embed circular economy principles and safe disposal protocols to mitigate environmental and health risks.

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