LAGI 2025 FIJI

LAND ART GENERATOR
RENEWABLE ENERGY CAN BE BEAUTIFUL

LAGI 2025 Fiji Narrative

REUSE AS REIMAGINATION

1. Concept Narrative

As Earth grows more populous and humanity's demand for resources increases beyond its capacity to give, what once appeared limitless now seems finite. Forests, prairies, and oceans that were vast and unexplored are now logged, burned, and overfished. Our survival as our impact expands will depend on our ability to more efficiently and effectively use the resources that are all around us. Island communities have long offered perspectives into more harmonious, less resource intensive ways of living. In these geographies, the land never seemed infinite. Driven by the constraints of having less, these communities have invented countless ways of doing much with little.

Our LAGI 2025 Fiji submission focuses on showcasing the inventive mindset these communities embody. Where we saw opportunities to create flashy designs that would be expensive and impractical, our vision instead incorporates simple, pragmatic and affordable real-world technologies that have been tested and implemented across the globe. Our submission emphasizes the reuse of components, such as second-life PV solar panels, to demonstrate the inventiveness of people in communities like Marou Village in deriving value from materials and technologies that other cultures discard.

Our system design incorporates multiple sources of energy generation with appropriately-sized energy storage in such a way that offers other benefits to the community, such as storage of water for dry seasons and a shaded space below the solar array for the villagers to use the land for agriculture or recreation. The system design incorporates three major aspects: generation, storage, and usage.

Most of the electricity is generated by a 75kw solar photovoltaic array built within the boundaries of the site outlined in the project materials. This solar array is built from solar panels that have been previously used in the United States and are refurbished for a second life generating electricity for Marou Village.

Energy storage is handled by two technologies - pumped hydroelectric and chemical batteries. As over half of Fiji's electricity is currently generated from hydroelectricity, we felt that a small hydro system would be a great way to leverage knowledge in a technology many Fijians may already be familiar with. The needs of both water and energy storage can be met by a pumped hydroelectric system that sends water to an upper reservoir during periods of excess solar generation and drains that water to a lower reservoir to create electricity when the sun is not shining. This system revitalizes old infrastructure already in place on the island and will also be used to store water for the region's dry season. These reservoirs send water through a filtration system to supply the village. Energy storage capacity is supplemented by lithium-iron-phosphate (LFP) batteries, whose modularity enables easy expansion of the system if necessary.

Together, the energy generation and energy storage power the most important component of the system: the energy usage. The Marou villagers indicated a need for many different power electronics: from device charging and lighting to cold storage, irrigation and cooking. Our system design powers all of these applications, incorporating specific features as necessary to enable their use at lower energy consumption. For instance, water can be heated directly from the sun using solar thermal technology, while cold storage units can be built using local materials and set in cellars to reduce the temperature gradient. In this way, our system showcases efficient technologies that allow the villagers to power the experiences they want while minimizing the need for additional power generation. This approach keeps the system more affordable and smaller, enabling a simpler installation.

2. Technical Narrative

Our design incorporates several primary technologies for energy generation and storage. Solar photovoltaic was chosen as the primary form of electricity generation for its applicability to the geography, affordability, easy shipment and robustness. The primary form of energy storage is pumped hydroelectric, chosen for its simplicity and its ability to also store water for the community. This system has the secondary benefit of generating additional electricity during the rainy season when rainfall and stream runoff collects in the upper reservoir. The secondary form of energy storage is lithium-iron-phosphate (LFP) batteries, chosen for their user-friendly design, affordability at small sizes, and modularity.

The 75 kW solar system generates 136 MWh of energy annually. The solar system is constructed of four hundred 300 watt solar panels which were first used in the United States and refurbished for reuse in Fiji. Although these solar panels are warrantied by their manufacturers to retain at least 80% of their capacity for 30 years, they are commonly replaced when they are less than ten years old and cannot be easily reused in the United States due to economic constraints. These previously used panels are more affordable, enabling development of more total solar capacity with the same amount of funding. These panels can also be more easily transported from boats and carried on foot to the installation site because they are smaller and lighter than modern designs. Second-life panels are ideal for the Marou Village project because they can affordably generate the required electricity for multiple future decades and also showcase the inventiveness of the community in repurposing materials that another culture discarded.

Much of the energy generation is used instantaneously to meet demand. Energy not used in real-time is stored either in water pumped to the upper reservoir of the hydroelectric system or in batteries. Excess energy can also be used for more energy-intensive products such as fresh water generation via methods like atmospheric water generation and solar desalination. Water usage by the village and the natural evaporation of water from the reservoirs during the dry season will determine the amount of water that must be generated via these processes and, correspondingly, the amount of energy expended to do so.

Water is primarily captured and stored by the pumped hydroelectric system, which utilizes a lower and upper water reservoir as well as a mechanism to distribute water between them. The system captures and stores approximately two million liters of water annually to be distributed to the town throughout the dry season. The primary holding point for the water, the upper reservoir, is rebuilt from the compromised dam indicated in the site maps. Its three thousand cubic meter volume is sufficiently large to supply water to the town throughout the dry season and to store water from the lower reservoir that is pumped uphill during periods of excess solar generation midday. Water from the upper reservoir flows through a distribution pipeline and a turbine. Once in the lower reservoir, the water is either stored until it is returned uphill or flowed through another distribution pipeline where it is filtered and supplied to the village.

The lower reservoir fills throughout the night as water is drained from the upper reservoir to generate electricity for the village. At 1,500 cubic meters, the lower reservoir is about half the volume of a competition swimming pool. The reservoir drains and fills by one thousand cubic meters daily. As the water flows across the 45 meter difference in elevation between the lower and upper reservoirs, it spins a pump, providing roughly 100 kWh to be used each night by the village. Additional energy storage can be added in the form of LFP batteries as necessary to meet growth in energy demand.

3. Prototyping and Pilot Implementation Statement

Our team has extensive experience with prototyping and building small-scale solar and battery storage systems in Washington State. We have a background in creating affordable solar installations for nonprofit organizations and farms. These installations utilize secondhand solar components which are collected from companies that generate solar waste.

Our typical mode of operation for these installations starts by understanding the needs of the organization: what they wish to power, how they currently generate that power, and what electrical needs or demands can be most effectively met with solar. Once we understand the needs of our customers and their budget, we learn more about the constraints of the application: most importantly, the solar resource of the location and the degree of alignment between generation and the customer's demand for electricity. We understand that there are certain energy uses that are better suited to solar power and others that are less so. This pragmatic, user focused approach ensures that our installations will improve the lives of our customers and lead them to develop a positive mindset towards renewables.

We would utilize a similar approach with Marou Village to ensure that our installation is tailor-fit to their needs. We would start by communicating with the villagers to supplement information provided in the LAGI 2025 materials. Remote communication could include a translator from our local Fijian community to ensure correct translation of information. Our questions would aim to understand opportunities for reducing the energy consumption of applications proposed by the village. For example, confining hot water usage to the afternoons and evenings would enable heating of water directly with sunlight rather than inefficiently doing so with solar photovoltaic. Emphasizing the most efficient use of the available energy will reduce costs in the project. This would allow our team to power more applications with the same funding and to improve the lives of more villagers.

We will first build and test components of the energy system here in Washington. We can source representative materials locally and build scale models that resemble the geometry and construction methods of the Fijian system. If budget and time constraints allow, we will visit Marou Village before construction of the prototype to get a firsthand look at the site and the energy uses. We will then return with materials to construct a prototype. We will conclude the prototyping process by engaging with the village and taking note of their interactions with the system. This may inform design changes that would be made to ensure the full-scale implementation most effectively meets their needs.

Installation of the full-scale design will present an opportunity to involve members of the community in building the system. Since components of the full-scale design are made with locally-sourced materials, obtaining and building with those materials will represent a further chance to involve villagers and Fijian organizations in creating the installation.

4. Operations and Maintenance Statement

An ideal system offers fully automated operations and no maintenance. Our technologies were selected in part for their operational robustness and minimal requirement for oversight. The maintenance that is necessary to keep these systems functional during operation must be simple and easily trained to the villagers. Thus, operations and maintenance represent an opportunity to involve villagers in the activity of the system beyond its outputs.

One of the simple but important functions that the villagers will be responsible for is maintenance of the solar array. Solar maintenance will consist of tracking electricity output and visual inspection of the array at regularly scheduled intervals (and as necessary after inclement weather) to ensure that the panels are clean and clear of debris. The design of the array enables visual inspection of the solar panels from ground level. Solar panels are highly robust power equipment because of their lack of moving parts; however, panels may require replacement over time if they are damaged by flying debris from inclement weather. The installation will store additional panels in the village so that these panels can be readily replaced as necessary.

Since Fiji derives approximately 60% of its electricity from hydroelectric power, we felt that operational familiarity was a compelling reason to choose pumped hydroelectric technology for the energy storage system. Fijian professionals can provide hydroelectricity operations and maintenance skills and train these skills to the villagers. Local expertise will be valuable in operating the system, fixing its components as necessary, or expanding it if the demand for power in the village grows. Leveraging professional expertise by utilizing technologies that are commonplace in the country will help ensure future functionality of the system because its maintenance and repair will not depend on foreign knowledge and resources. Furthermore, experience that villagers gain through their involvement with the village system may provide them with valuable skills and knowledge that they could use in the hydroelectricity workforce elsewhere within Fiji. In summary, the technologies that we selected to power Marou Village either require very little operational and maintenance oversight or they utilize skills and resources which are readily available within Fiji.

5. Environmental Impact Assessment

The technologies we selected to power Marou Village will not create significant negative impacts upon the local environment surrounding the village. The main sources of environmental impact will be the solar panels and the pumped hydroelectric system. Once installed, solar panels usually affect their nearby environment by two factors: increased heat during the day and decreased sunlight beneath the panels. Very large (greater than 1 MW) solar arrays can increase local temperatures in the same way that asphalt roads do - their dark colors absorb more sunlight than some natural landscapes. We anticipate the local temperature increase around the Marou Village solar array will be negligible because the array is relatively small and convection from the ocean breeze will keep the panels and the nearby area cool. We similarly anticipate minimal habitat displacement due to increased shading because of the small footprint of the solar array.

The pumped hydroelectric system will positively impact the local environment by creating a buffer for stormwater, reducing the erosion that occurs after heavy rainstorms. Additional pipes or spillway channels could be installed to direct extra water to the ocean to minimize erosion from reservoir overflow during the rainy season. The main negative impact we foresee from this system is the creation of additional habitat for insects and rodents. These reservoirs are shaped to minimize surface area to reduce the amount of natural habitat loss required to build them. This design also reduces the amount of surface area that would be an attractive breeding ground for insects and other pests. Pumps in the reservoirs will circulate water to further impede insect breeding and the growth of algae or other plant life. The reservoirs are located away from the village to keep these pests away from villagers. Overall, we anticipate minimal negative environmental impacts due to the Marou Village installation. We will implement these additional design elements to further reduce adverse effects on villagers or local habitats.

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