Symbiotic Infrastructures: A Woven Network of Biology and Technology for Sustainable Water and Energy Systems

Location: Marou Village, Yasawa Islands, Fiji

CONCEPT NARRATIVE

Marou Village faces acute threats from climate change, including rising sea levels, freshwater scarcity, and energy insecurity. Symbiotic Infrastructures proposes a holistic response by weaving biological and technological systems into a single, community-centered landscape that provides clean water, renewable energy, and ecological restoration.

At the heart of the proposal is a closed-loop infrastructure integrating aquaponics, hydro-turbines, rainwater harvesting, activated carbon water filtration, and renewable energy systems. Community engagement is central: rather than isolating complex technologies, the design places them in transparent, interactive settings where residents and visitors can observe, learn, and contribute. Walkways double as stormwater conveyance channels, while piezoelectric flooring generates light and aids wayfinding. The Power Petal System, inspired by native flora, rotates toward the sun to collect solar energy and rainwater, while micro-turbines embedded in their stems generate additional hydropower.

Biological systems, including native fish breeding, algae cultivation, and mangrove restoration, complement technological components. Coconut trees provide both flood mitigation and materials for carbon filtration, uniting ecological stewardship with functional design.

The visitor experience moves beyond observation to participation. From the aquaponics outdoor classroom to the piezoelectric playground, every element promotes learning, resilience, and cultural continuity. Materials-including volcanic rock, woven palms, and repurposed coconut shells-reflect local traditions while reducing embodied carbon.

This design transforms infrastructure into a shared community asset, reinforcing the social, ecological, and cultural identity of Marou Village while providing critical water and energy resources.

TECHNICAL NARRATIVE

The proposal integrates multiple renewable energy and water systems tailored to the climate and resource availability of Fiji. Key technologies include a stormwater dam equipped with a hydro-turbine, which captures and stores 20,000 gallons of stormwater annually while also generating electricity. The Power Petal System tracks the sun to collect

solar energy and harvest rainwater, while micro-turbines within the stems harness gravitational energy as the water descends. Piezoelectric walkways contribute to energy production by generating electricity through foot traffic. An aquaponics system employs native fish and vegetation to perform the initial stages of water filtration, while also supporting local food production. To complete the water purification process, coconut shells are transformed into activated carbon for tertiary water treatment. The system maximizes renewable resource inputs while minimizing dependence on external utilities, ensuring resilience and sustainability. Annually, the installation is expected to generate approximately 25 to 30 megawatt-hours of energy and produce up to 18,000 gallons of clean water.

PROTOTYPING AND PILOT IMPLEMENTATION STATEMENT

Prototyping will commence with small-scale models of the stormwater dam, aquaponics system, and Power Petal. The team will collaborate with university research facilities and, where necessary, local manufacturers to ensure that materials and methods align with the cultural and environmental context. The coconut-to-carbon filtration process will be piloted using coconuts sourced locally. A small kiln will be developed to convert coconut shells into carbon, followed by steam activation. Community workshops will play a central role in introducing residents to the filtration system and training them in its maintenance. Once prototypes are successfully validated, the full-scale installation will be implemented in modular phases, beginning with critical systems that address water and flood management. Throughout the process, the design will incorporate educational elements to promote transparency and foster local stewardship.

OPERATIONS AND MAINTENANCE STATEMENT

The design emphasizes long-term community autonomy and ease of maintenance. All systems utilize locally available materials and technologies that can be repaired without specialized tools. Community members will manage daily operations, including monitoring water quality, overseeing aquaponics cultivation, and maintaining solar and hydro systems. Training programs will be established in partnership with local schools and community organizations to build capacity. The infrastructure is designed for modularity, allowing components such as water storage and filtration units to be updated or replaced as needed. Routine maintenance will include daily inspections of water quality and aquaponics, weekly checks on hydro-turbine and piezoelectric systems, and quarterly reviews of the activated carbon production process.

ENVIRONMENTAL IMPACT ASSESSMENT

The project is designed to generate positive ecological impacts while minimizing potential environmental risks. Native vegetation will be planted around stormwater infrastructure to reduce erosion and enhance local biodiversity. The aquaponics system will support the restoration of native fish species, while algae and coral cultivation will contribute to marine ecosystem health. Sustainable sourcing practices will govern all materials used, particularly for structural elements and filtration media. Energy systems and water management practices are carefully designed to avoid disruption of sensitive habitats. Community

involvement in stewardship will help ensure that the ecological balance is maintained over time, reinforcing both environmental and social resilience.