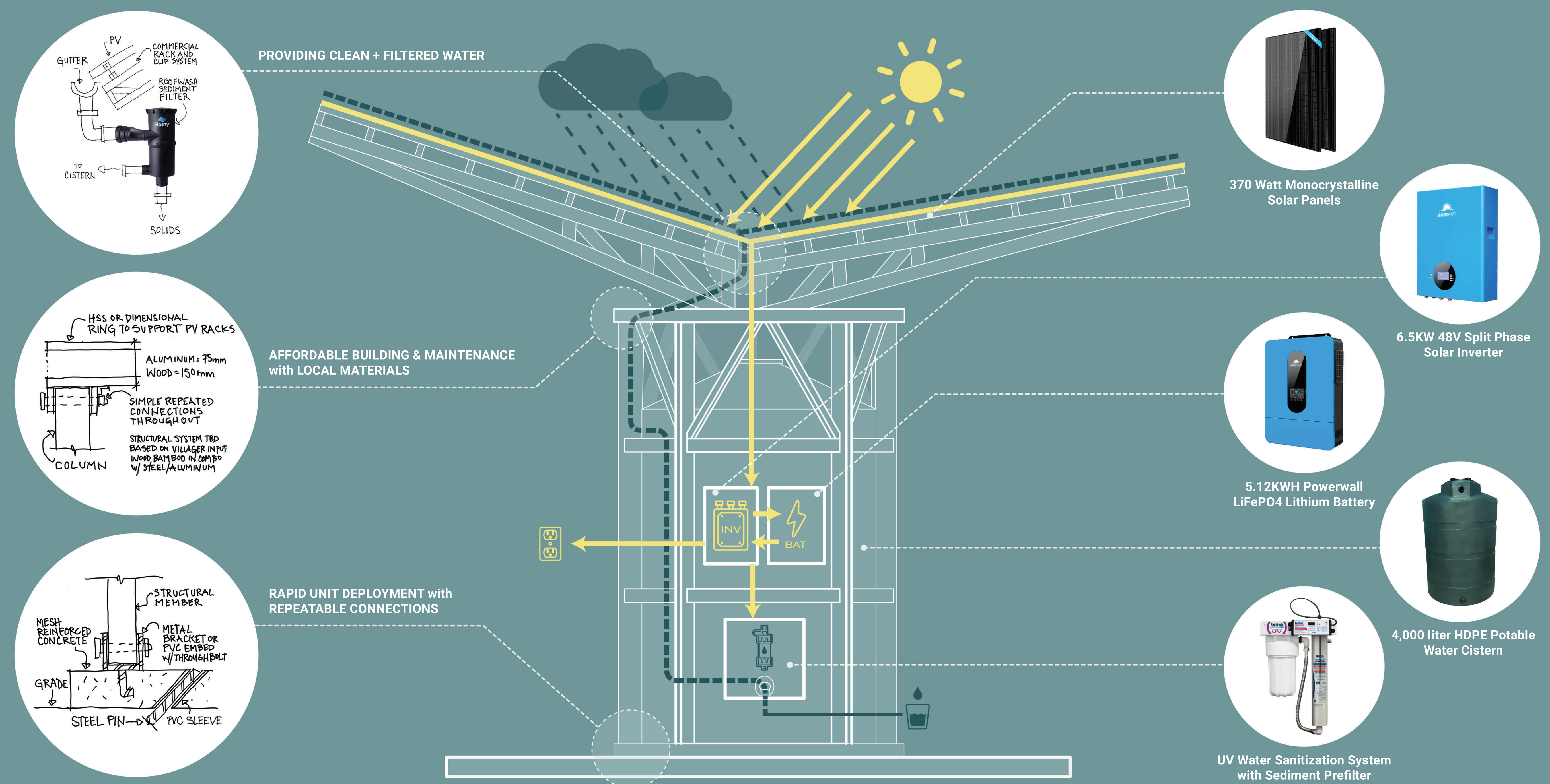
UNIT PERFORMANCE, ASSEMBLY, & OFF-SHELF KIT-OF-PARTS

The design is centered around a kit of parts packaged as a single, reconfigurable "unit" that delivers fresh water and power. This unit can stand alone or be configured into custom arrays. PV panels are attached to butterfly roofs sloped to direct rainwater into an integrated cylindrical catchment cistern. Standard off-the-shelf, turn-key products were chosen for easy sourcing, pricing, and maintenance. The exact components specified are examples and can be swapped out for similar products based on regional availability.

Each individual unit is designed to be constructed through a set of off-the-shelf building materials and technologies, which include pre-existing cisterns, PV modules and racking, batteries, UV filtration units, and dimensional lumber structural members. Each unit can be delivered and constructed as a packaged kit-of-parts, requiring minimal to no larger-scale machinery to construct. Final design of the prototype will rely on the knowledge and experience of local building techniques including structural timber framing and bamboo screen assembly from community experts in construction. Technical expertise from the design team will build on this local knowledge in a collaborative process with the Marou community. Once the first pilot prototype is built, the community can add subsequent units in the concentric array over time, as funding for the project and demand for its performative systems expands.



ELECTRICITY PRODUCTION ESTIMATES USING SPEC PANEL AND COMPARING OPTIMIZED PV FARM BASELINE TO SITED PROJECT DESIGN ITERATIONS (CLIMATE FILE: Yasawa-i-Rara, 16.70°S, 177.58°E)

1. SAMPLE PANEL USED FOR TESTS

SUNGOLD 370W Mono PERC (UL 61730)		
efficiency	20%	
peak output	370W	
area = l (1.6) x w (1.13)	1.80	m^2
height	35	mm
weight	19	kg

2. PROJECT PANEL TAKEOFF

1 "tree" (full module) =	28.8	sm
16 panels	296	kg
Full design (19 "trees") =	547	sm
304 panels	5,624	kg

3. SINGLE PANEL TESTS

Facing	°	kWh/yr	%
N	10	658	99.1%
	20	664	100.0%
	30	653	98.3%
S	10	605	91.1%
	20	560	84.3%
E	10	622	93.7%
	20	598	90.1%
W	10	642	96.7%
	20	635	95.6%
flat	0	636	95.8%

4. SHADING STUDIES AND ARRAY MODULE TESTS

Description	kWh/yr		COMPARE		
	No shade	Shade	S/NS %	NS %	S %
North 17°	2,893	2,858	98.8%	100%	100%
North 3°	2,806	2,793	99.5%	97%	98%
Butterfly N17°, S3°	2,813	2,796	99.4%	97%	98%
Butterfly NS3°	2,771	2,761	99.6%	96%	97%
Butterfly EW 3°	2,771	2,761	99.6%	96%	97%
Butterfly NS17°	2,694	2,678	99.4%	93%	94%
Butterfly EW17°	2,702	2,684	99.3%	93%	94%
Flat	2,770	2,761	99.7%	96%	97%
Shade from topo considered, tall trees may further shade					

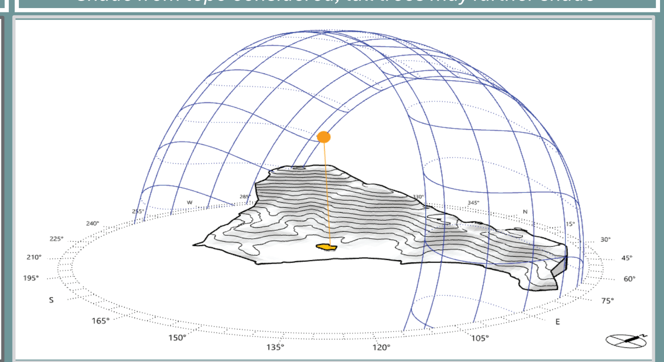
5. FULL INSTALLATION ITERATION TESTS

Array Description	Facing	SA (m^2)	kWh/yr		Compare
			total	/sm	%
Baseline PV farm	North 17°	517	189,117	365.80	100%
SunWell Design baseline design	varies	517	178,095	344.48	94.2%
SunWell baseline flattened	N/A (0°)	517	182,281	352.57	96.4%
SunWell custom angle iteration	**varies**	517	**183,238**	**354.56**	**96.9%**

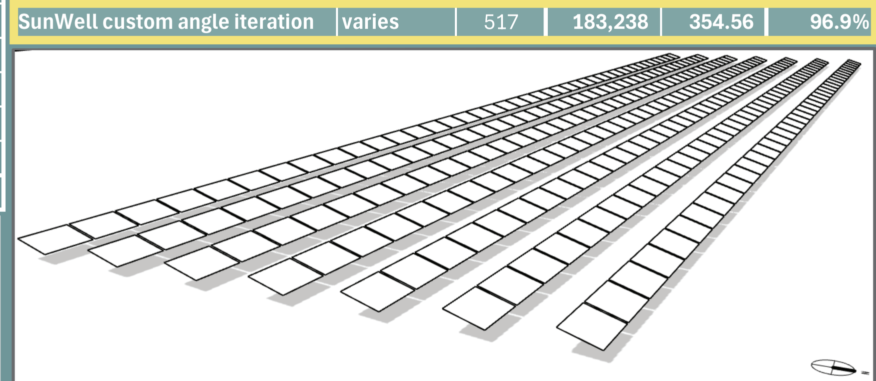
6. NYC COMPARE (rotate 180°, base 35°)

kWh/yr		Compare	
total	/sm	% FUJI	% Max
162,425	314.17	86%	100%
138,954	268.77	73%	86%
137,573	266.10	73%	85%
140,707	272.27	74%	87%

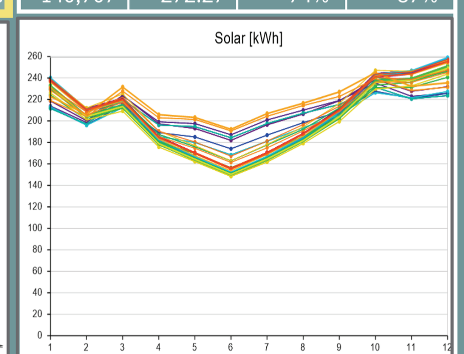
370W high-efficiency panels



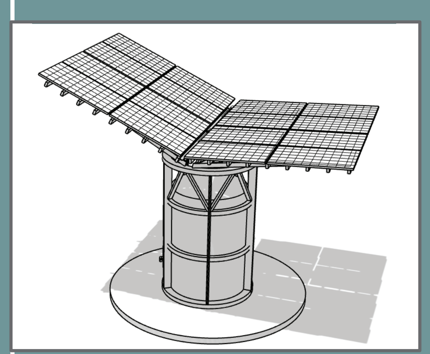
shading tests show terrain has little effect on solar insolation on site



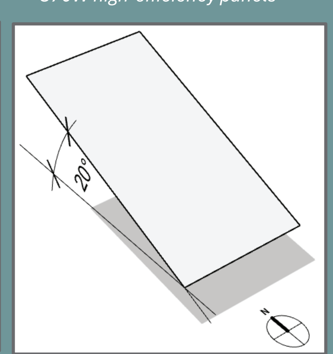
baseline PV farm with optimized orientation (17°N) produces 365 kWH/m^2 /yr



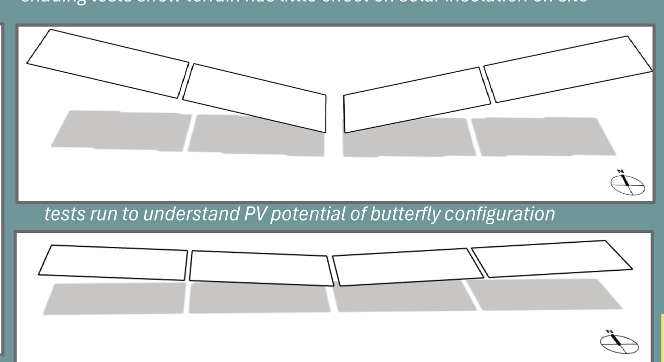
SunWell design on Fiji site: proximity to equator = more consistent PV production at varied solar angles



1 "tree" module can have up to 16 panels

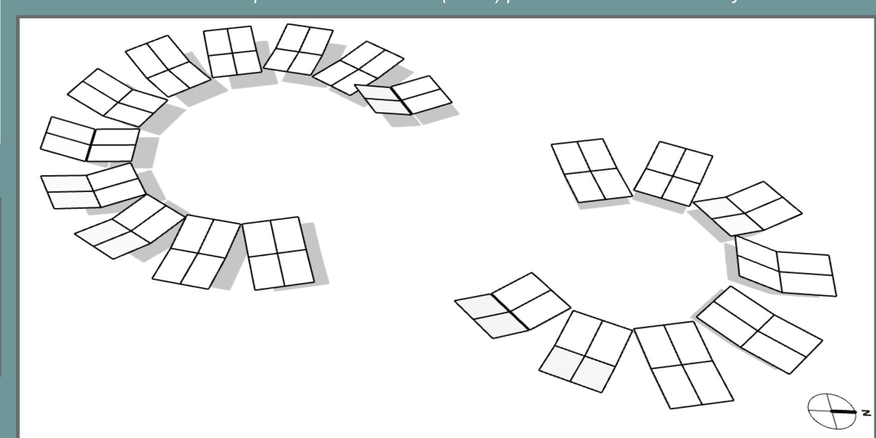


optimized production @ 17-20 °N

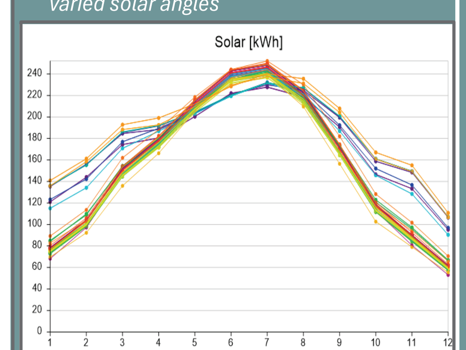


tests run to understand PV potential of butterfly configuration

above: 17 °EW =93%of max; below: 3 °EW = 96% of max



custom angle design = 97% PV production of optimized farm



SunWell design sited in NYC: approach would not work at higher/ lower latititudes

7. PROJECT DESIGN PV PRODUCTION			
	name plate capacity	*112*	*kW*
	projected on-site production based on detailed simulations	*183,000*	*kWh/yr*

8. PROJECT RAINCATCHMENT MODELER

9. CISTERN SPECS

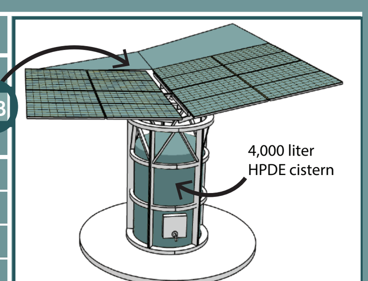
diameter	1.63	m
height	2.03	m
fill %	0.9	%
Volume	4.22	m^3
	4,215	l
actual fill	***3,794***	l

11. PROJECT TOTALS

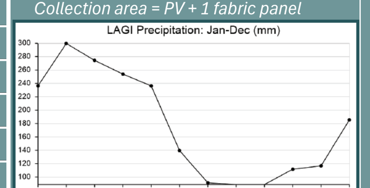
Monthly		
min	64,186	l
max	216,398	
Annual		
1 "tree"	***80,691***	l
PROJECT DESIGN	***1,533,124***	

10. MONTHLY COLLECTION

collection area (m^2)			38
Mon	mm	m^3	liters
Jan	236	9	8,976
Feb	300	11	11,389
Mar	274	10	10,424
Apr	254	10	9,652
May	236	9	8,976
Jun	140	5	5,309
Jul	91	3	3,475
Aug	89	3	3,378
Sep	89	3	3,378
Oct	112	4	4,247
Nov	117	4	4,440
Dec	185	7	7,046



Collection area = PV + 1 fabric panel



monthly values taken from climate file: FJI_WE_Yasawa-i-Rara.916600_TMYx

PERFORMANCE INFORMATION *See chart for related graphics, specs and simulation outputs*

1. **SAMPLE PANEL:** A commercially available turn-key PV production kit was chosen that includes a combined charge controller/inverter and batteries. This allows for the most realistic simulation of performance on-site and quick/reliable pricing estimation.
2. **PANEL TAKE-OFF:** Core "tree" module produces electricity and collects water. Each "tree" is customizable to meet particular installation goals. For maximum PV production, a tree would be outfitted with 16 panels. The competition design includes 19 such "trees" for a production area of 547 m2.
3. **SINGLE PANEL TESTS:** Single panel simulations were run to determine the relative production for different orientations. Optimal at project latitude is a north facing panel angled 17-20° which produces about 660 kWh/yr. In simulations with panels facing N,S,E,W and angled 10 and 20 degrees, performance ranged between 84 - 97% of optimal with flat panels at 96%.
4. **SHADING STUDIES AND ARRAY MODULE TESTS:** Module PV arrays are configured as butterfly roofs to direct rainwater to an integrated cistern. Testing of varied angle combinations showed a wide range with acceptable production: between 92 and 97% of optimal. This is enabled by high year round solar position on site due to low latitude. In addition, shade studies determined that the island topography only minimally shades the site with a resulting reduction in PV production of 2% or less over a simulated flat (unshaded) site at the same location.
5. **FULL INSTALLATION ITERATION TESTS:** A series of simulations were run comparing an optimized PV farm (spec panels facing north and angled 17°) to Team design iterations. An initial design configured without considering efficiency produced 94% of the PV farm output. Modules are designed to allow for custom angles on each side of the butterfly, so in the final design arrays were customized to produce 97% of the optimal. This illustrates that the "tree" module can be adjusted so that any desired grouping can produce close to the maximum PV output.
6. **NYC COMPARISON:** Tests of the competition design set on an open site at 40°N latitude were run. The optimized PV farm faced S with panels inclined 35°. The project design was rotated and optimized for the higher latitude, but iteration produced only 85 – 87% of optimal for NYC. This illustrates how the design is well-tuned to the competition project site.
7. **PV PRODUCTION OF THE PROJECT DESIGN:** As configured, the project design has a 112kW name plate capacity, well above the 75kW project required minimum. Based on detailed simulations, the modeled panel configuration had 517m2 for a yearly production of 183,000 kWh/yr or 355kWh/m2/yr. Using an estimate for a typical household on the island using ±3,000kWh/yr, each "tree" could power about 3 households, several cars, or 30,000 liters of community freezer space.
8. **MODELER:** A simple Excel modeler was created to calculate Raincatchment volume. The tool can be used when planning specific installations of the design module.
9. **CISTERN SPECS:** Inputs allow for adjustment of cistern sizing, collection area, and "fill percentage" which adjusts external cistern dimensions for wall thickness and internal "headroom".
10. **MONTHLY COLLECTION:** Values are taken from the indicated climate file and thus are averages representative of a typical year. The "panel collection area" is the surface area of a typical butterfly roof and single attached fabric section that spans between "tree" modules.
11. **PROJECT TOTALS:** 80kl/yr will pass through each module cistern for an annual project collection potential of 1.5 million liters. Based on the season and amount of direct access to cistern fill, there will be varying amounts of overflow available. Two potential uses could be drip irrigation and/or feeding aquaponic tanks. PV power from the same "tree" could power a DC pump to aerate aquaponic systems.