ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

A TECHNO-ECONOMIC EVALUATION OF DOMESTIC ROOFTOP GRID-CONNECT PV (GCPV) SYSTEMS IN FIJI

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Background

- The Fiji Department of Energy in collaboration with the Energy Fiji Ltd. (EFL) and the Public Service Commission (PSC) has set up GCPV pilot projects for research purposes.
- These systems are either 1.2kW and 2.4kW and are installed in 60 government quarters in the two main islands.
- The total installed capacity is 110kW and the cost of installation was FJD 655,841 (total). All systems have a smart meter which records export and import of electricity.

Objective

This study aims to assess the techno-economic performance of three (3) of these pilot GCPV sites in the western part of Fiji.

- The three sites chosen have 2.4kW systems with similar installation designs. The study looks at the the energy produced from the GCPV systems and also analyses the economic parameters to determine the viability of the GCPV systems in Fiji.

Introduction

- Fiji is highly dependent on imported fuels and this situation is likely to remain in the near future unless extensive sustainable energy based interventions are undertaken.
- With high fuel import bills there is an urgent need to invest in RETs for clean and sustainable energy to drive economic growth.
- At present 50% of electricity being produced is supplied through hydropower however, there is a need for incorporation of solar, biomass, wind and other renewable energy resources to supplement the hydropower and diesel generators for electricity production.

Cont.

- On-grid PV systems are slowly becoming popular in Fiji as they have many advantages such as they are a clean technology and can be easily implemented anywhere in Fiji due to the abundance of solar energy throughout the year.
- Many private firms have opted for the grid PV systems under a new model proposed by a local solar company (Sunergise). In this model, the system is given on lease to a customer and at the end of the contract period the customer has options of terminating or continuing with the lease or even purchasing the systems.

Methodology

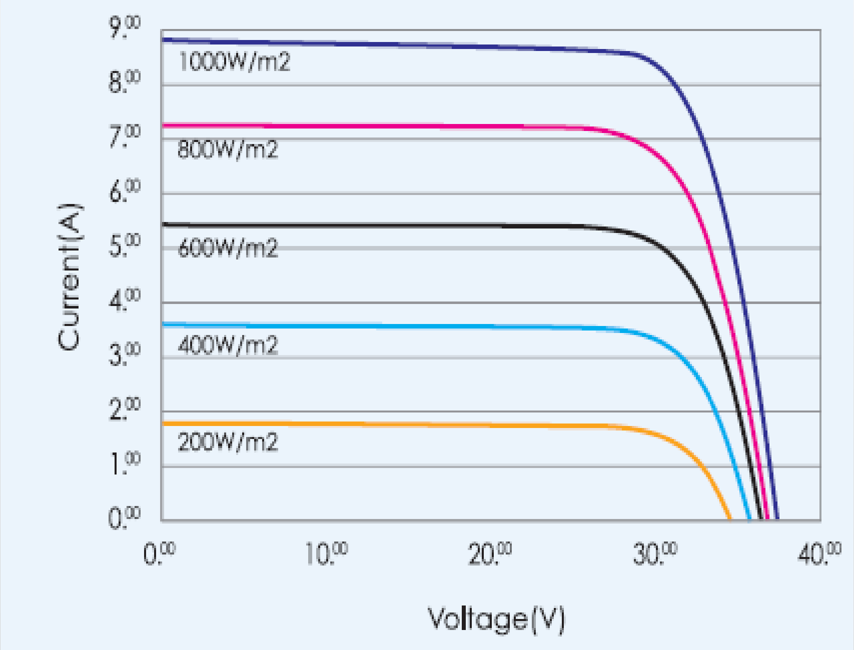
- The primary source of data for this research has been the sunny portal database which is the online software monitoring the 60 GCPV sites. These systems also have a smart meter which tracks the amount of electricity imported and exported.
- Once the energy production parameters are obtained, the three systems are economically evaluated by calculating the Net Present Value (NPV), payback period and the levelized cost of energy (LoC) for their feasibility.

System Components

2.4 KW SYSTEM COMPONENTS		
Component	**BRAND**	**QTY**
240 Watts TSM-240PC05.18 Solar Photovoltaic Module	Trina Solar	10
Solar Module Roof Mounting Frame/Structure and interconnection hardware – Anodized Aluminum Rails	Hopergy (5 panel flat mount)	1
1.3 kW Grid Connect Inverter with LCD Screen (SB1300TL-10)	SMA	1
Miniature Circuit Breakers Single Pole 240 V/ 10 Amps	CLIPSAL	2
Double Pole Non Polarized DC Circuit Breaker 500 VDC / 16 Amps	Noark (88068 KFD25)	1
DC Isolator (1500 VDC / IP67)	Kraus + Naimer	1
DC Surge Arrestors 3 Pole 1000 VDC	Noark (82743)	1
AC Surge Arrestors 2 Pole 275 VAC	Noark (82116)	1
IP65 Weatherproof Enclosure 8 pole 1000 VDC	IP65 PV Power	1
Data Logging System	SMA Web Connect Data Module	1
IP65 Weatherproof Enclosure 4 pole	CLIPSAL IP65	1
Earthing Kit	Hopergy	1
Signage (AS/NZS 5033 & AS 4777)	As per standards	1 set
Energy meter – Single Phase kWh meter	Regis	1

Solar Panel

The brand of the panel utilized for the project is Trina Solar/TSM-250PC05A. The panels are roof mounted at an inclination of 18^0 and an Azimuth angle of 180^0. The total number of PV modules in the 2.4kW system is ten (10).



ELECTRICAL DATA @ NOCT	TSM-250 PC/PA05A
Maximum Power (W)	183
Maximum Power Voltage (V)	27.7
Maximum Power Current (A)	6.62
Open Circuit Voltage (V)	34.8
Short Circuit Current (A)	7.20

ELECTRICAL DATA @ STC	TSM-250 PC/PA05A
Peak Power Watts-P_{MAX} (Wp)	250
Power Output Tolerance-P_{MAX} (%)	0/+3
Maximum Power Voltage-V_{MP} (V)	30.5
Maximum Power Current-I_{MPP} (A)	8.20
Open Circuit Voltage-V_{OC} (V)	37.8
Short Circuit Current-I_{SC} (A)	8.90
Module Efficiency η_m (%)	15.3

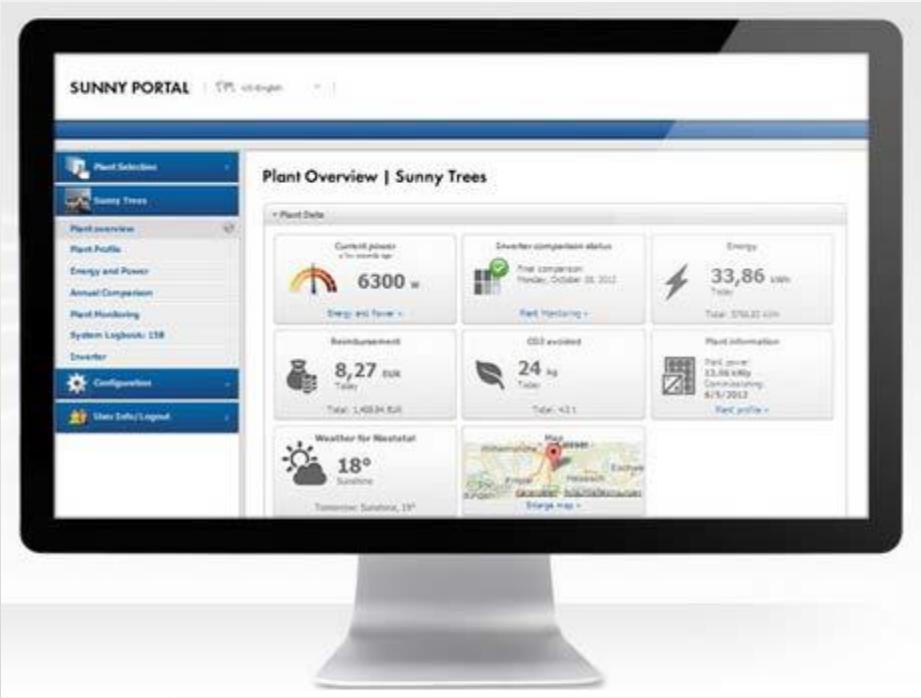
Inverter

The inverter utilized in the system is the ‘SMA Sunny Boy 2500HF’ which converts the direct current of a PV array into grid-compliant alternating current and feeds this into the power distribution grid.

Input	SB 2500
Max DC power (PDC, max)	2,700 W
Max DC voltage (UDC, max)	600 V
PV voltage range, MPPT (UPV, max)	224-600 V
Max input current (IPV, max)	12 A
DC voltage ripple (Upp)	< 10%
Max number of strings (parallel)	3
Thermally monitored varistors	Yes
Ground fault monitoring	Yes
Reverse polarity protection	Short circuit diode
Output	
Max AC power (PAC, max)	2,500 W
Nominal AC power (PAC, nom)	2,300 W
THD of grid current	< 4%
Default AC voltage (UAC, nom)	220 - 240 V
AC frequency (FAC)	49.8 - 50.2 Hz
Short circuit proof	Yes, current regulation
Connection to utility	AC plug
Max Efficiency	94.1 %

Monitoring

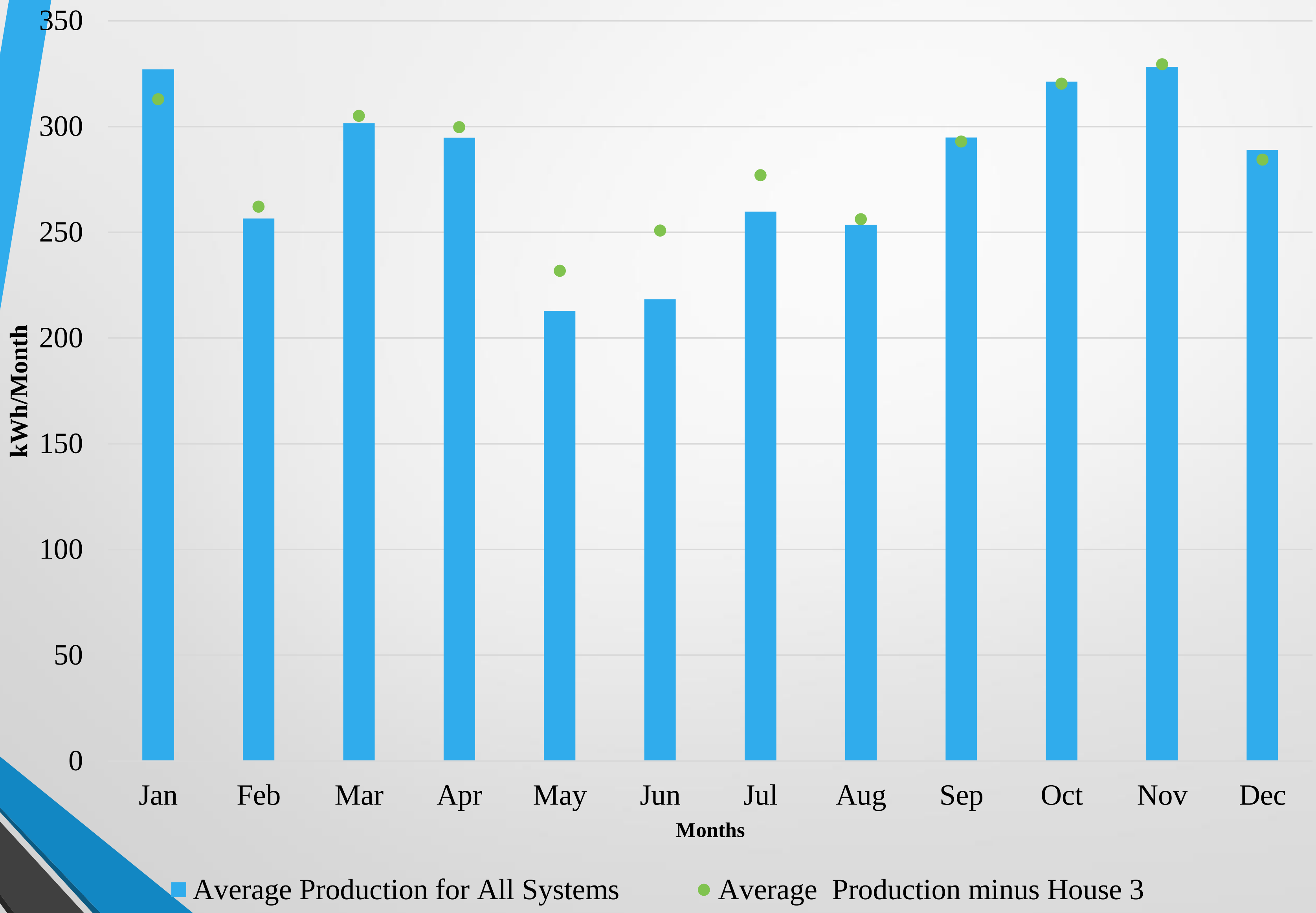
The monitoring of the 60 systems is done through the SMA web connect data module which is used to interface the inverter with SMA's online monitoring tool 'Sunny Portal'. Key information such as Annual energy yield (kWh/year) and functionality report can be obtained from the system



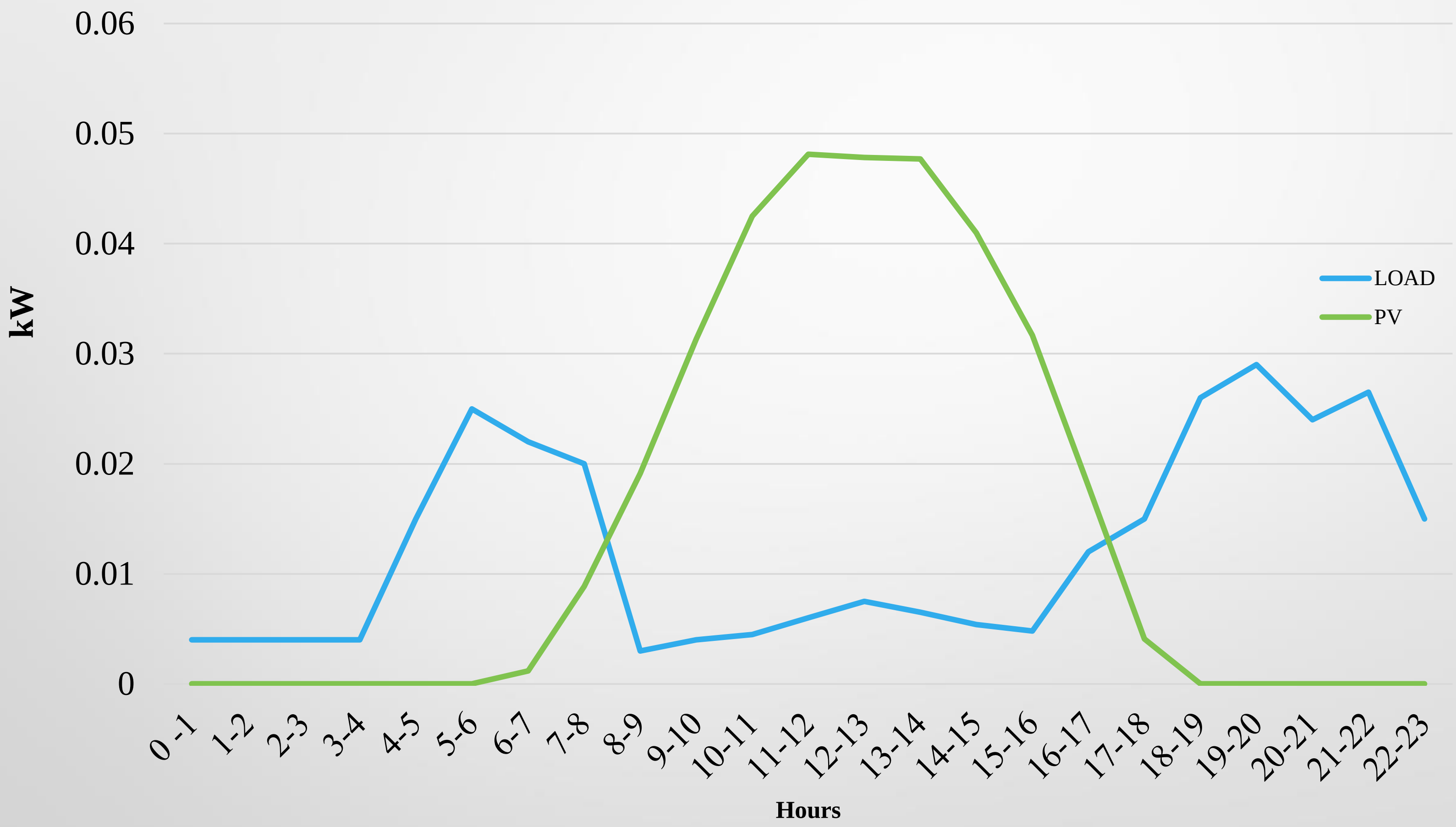
Smart Meter

To track import and export data, the system has been outfitted with ACE2000 type 292 Single Phase Electricity Meter. The meter itself is the property of FEA.

Average Monthly PV Production



Load Vs Demand Curve



Economic Analysis

The following parameters were used to evaluate the feasibility of the three installed GCPV systems [6].

- (a) Net present value (NPV)
- (b) Internal rate of return (IRR)
- (c) Cost of Electricity ($/kWh)
- (d) Dynamic pay-back period

Cont.

	NPV ($)	IRR (%)	DPB (Years)	PV Annual (kWh)	$/kWh
House 1	1977.757	10%	10	3428.43	0.2056
House 2	1977.631	10%	10	3416.75	0.2057
House 3	1976.521	9%	10.04	3227.40	0.2070

Discussion

- A positive NPV value was obtained stating that the project profitable. The internal rate of return is 10% whereas the dynamic payback period is 10 years which is half of the life of the project. The lower IRR is mainly due to the lower FiT of $0.15/kWh being provided to domestic GCPV customers in Fiji.
- For domestic customers much of the demand is during the night and day time witnesses fairly lower demand as such, majority of the electricity generated by the PV is sold to the grid and the customer buys back the electricity during the night at $0.341/kWh.
- If Fiji regulator decides to implement net-metering in the future GCPV projects will become much more attractive. The average cost of electricity over its lifetime is $0.20/kWh which is considerably less than the tariff charged by the utility.
- Fiji is currently deliberating on the payment mechanisms for domestic GCPV systems (FiT or net-metering). Net-metering will give a better return to the home owners.
- However, the technical and regulatory mechanisms are not in place.
- The FDoE in conjunction with EFL and FCCC is working on developing a policy framework.

Conclusion

- This study concluded that the domestic GCPV systems are viable in Fiji. Even though currently there are no government incentives for the installation of GCPV systems, the Fijian government does provide import duty exemptions for renewable energy materials being imported.
- The findings show that even with FiT being half the retail tariff, the systems are profitable. Creating awareness among the homeowners and businesses will be useful in expanding this programme.

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Thank You