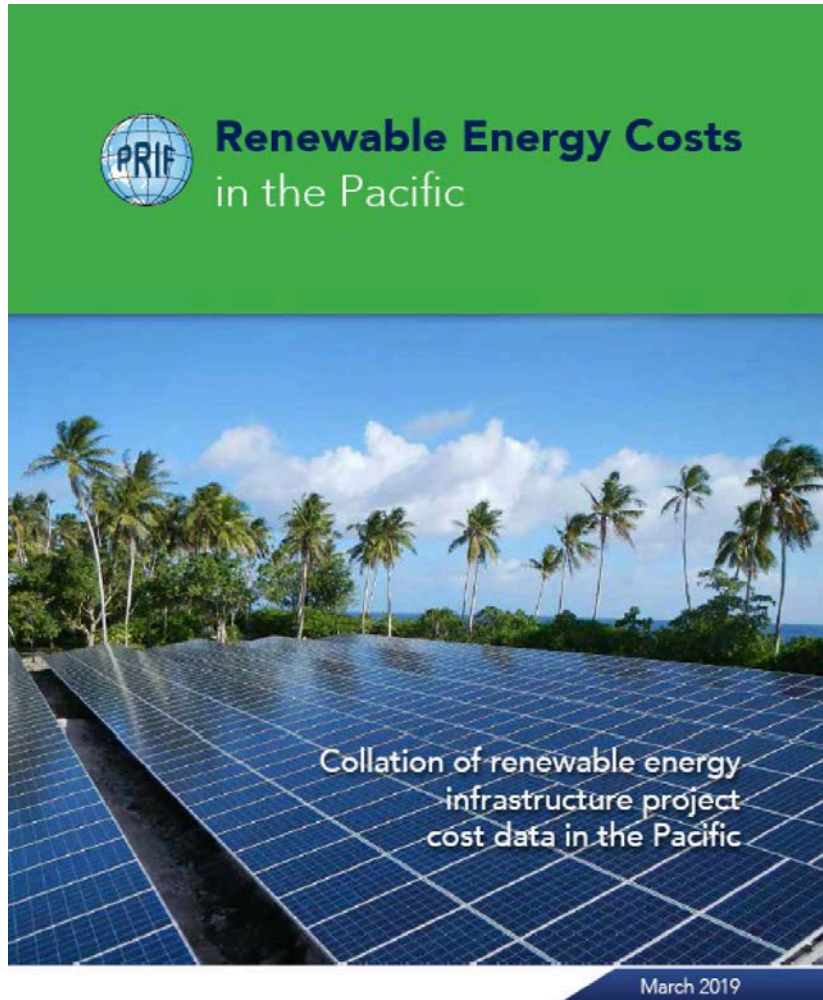




Pacific Region Infrastructure Facility / Clean Energy Solutions Center Webinar



Joe Wyder

ITP
Renewables
Consulting | Engineering | Implementation

20 May 2019





Pacific Island Countries' Electricity Sector Overview

	Geography	Population	Electricity Access	Generation GWh pa	RE Target	RE Target by Year
Cook Islands	14 islands	15,200	99%	31.8	100%	2020
Fiji	320 islands, 106 inhabited	888,400	87%	900	100%	2030
FSM	607 islands	105,300	65%	72	> 30%	2020
Kiribati	32 widely scattered atolls	120,100	>65%	23	23 - 40%	2025
Marshall Islands	34 islands, mostly atolls	55,500	87%	101	20%	2020
Nauru	single island	11,000	100%	31.7	50%	2020
Niue	single island	1,520	99%	3.3	80%	2025
Palau	596 islands, 12 inhabited	17,900	98%	89.3	45%	2025
PNG	Over 600 islands	8,558,800	12%	217.3	100%	2030
Samoa	10 islands	196,700	100%	140	100%	2025
Solomon Islands	~1000 islands, 350 inhabited	682,500	23%	78	79%	2030
Tokelau	3 atolls	1,400	100%	1.2	100%	long-term
Tonga	176 islands, 36 inhabited	100,300	89%	55.4	50%	2020
Tuvalu	9 atolls	10,200	98%	5.2	100%	2020
Vanuatu	>80 islands, 65 inhabited	304,500	33%	66.3	100%	2030



Rooftop Photovoltaics (PV)



Rooftop PV avoids land access issues, clearing, earthworks and fencing.



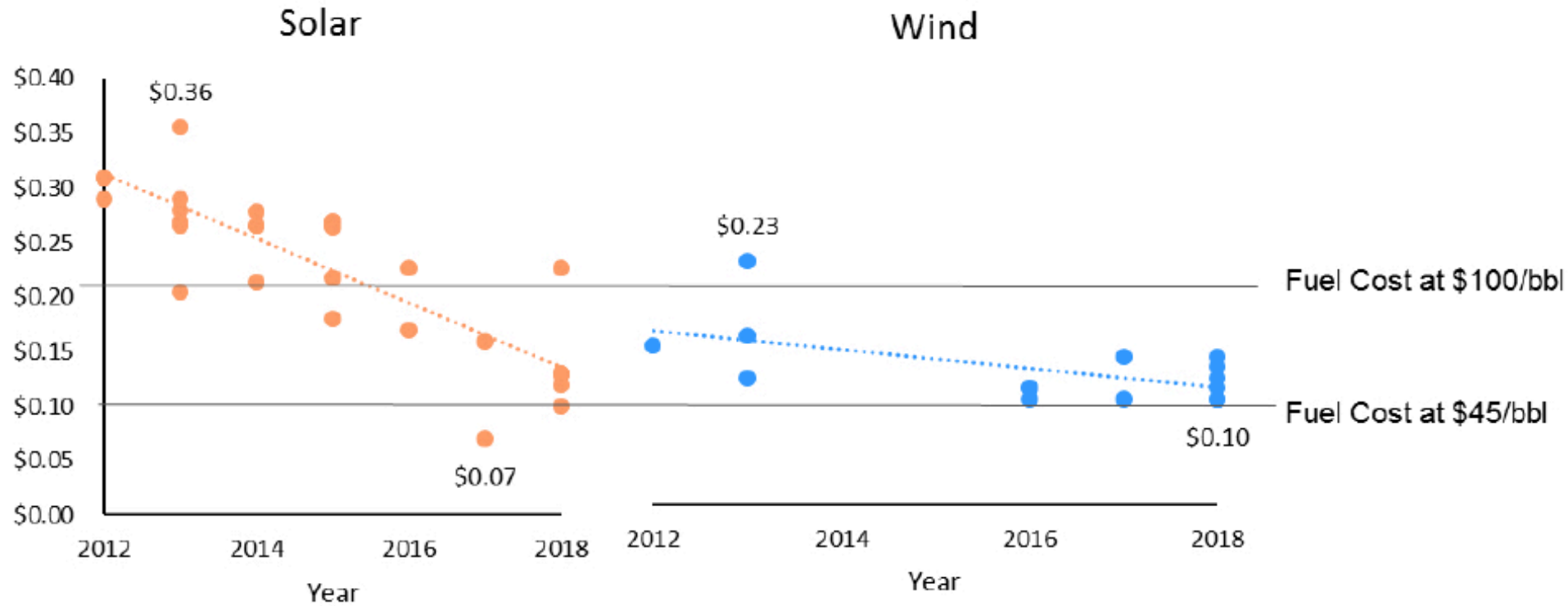


Caribbean USD/kWh



\$100/bbl = \$0.63/litre

\$45/bbl = \$0.28/litre



from Castalia presentation to the Caribbean Renewable Energy Forum, Oct 2017



Real Oil Prices

US\$/bbl

140

120

100

80

60

40

20

0

1970

1975

1980

1985

1990

1995

2000

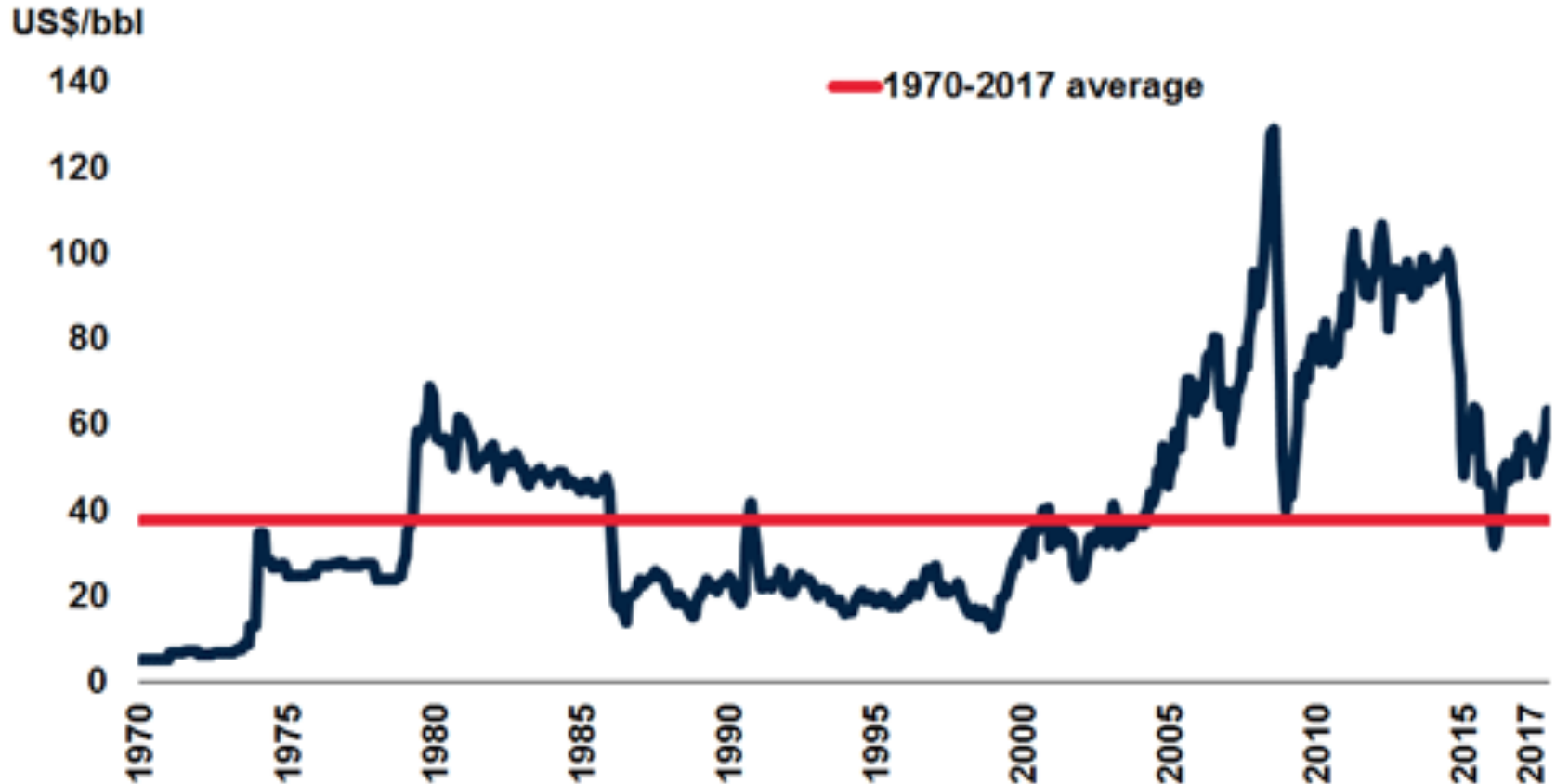
2005

2010

2015

2017

— 1970-2017 average



From World Bank website

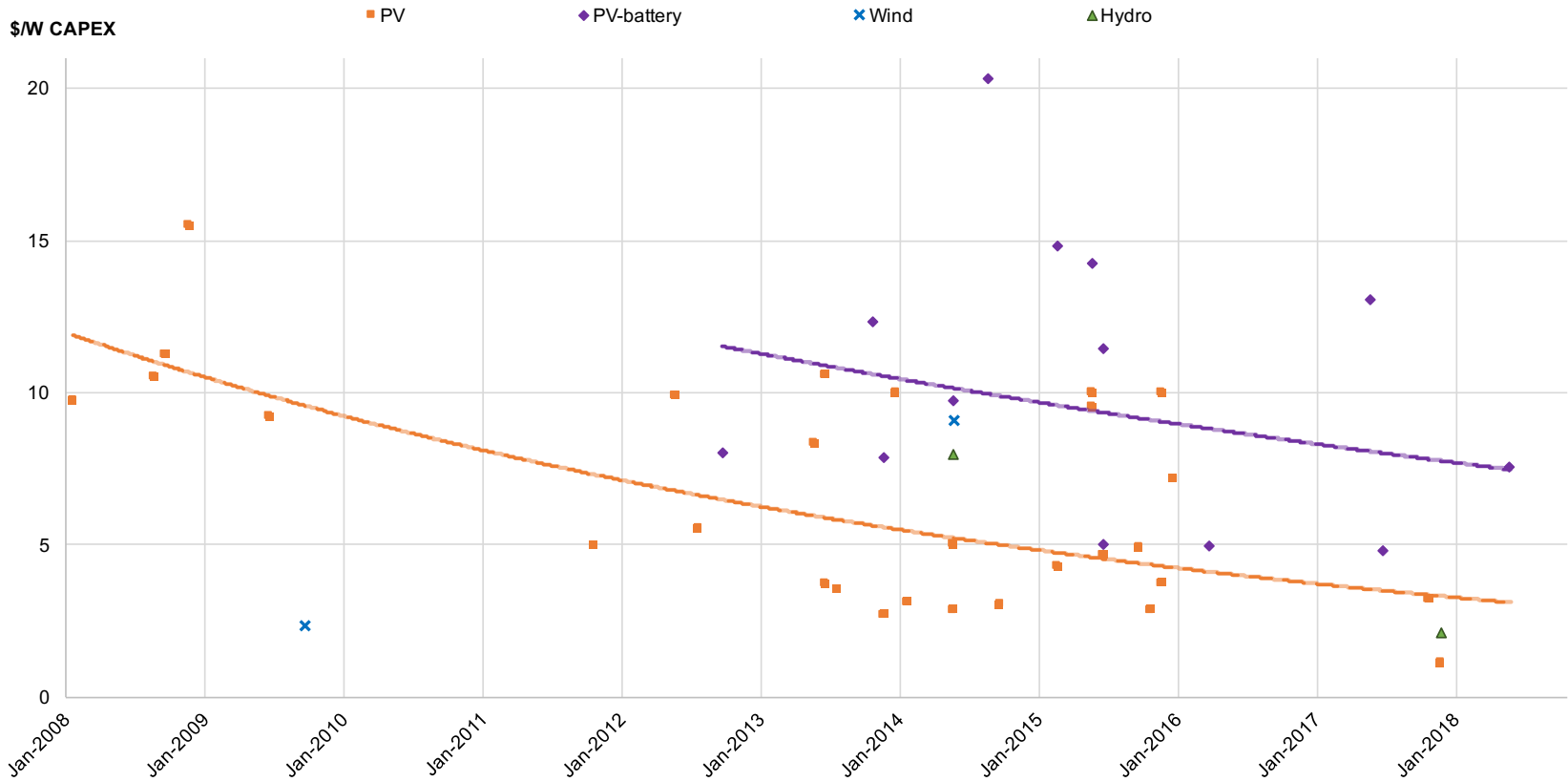


Annex A: RE Projects List

Cook Islands						
Project Name & details	PV kWp DC	Wind kW AC	Hydro kW AC	Cost USD \$,000	Key Dates (if known)	Notes
NZ Aid solar	96.0			\$340	NI, before Aug 2013	3 systems.
Solar PV Mini Grid - Mitiaro, Atiu, Mauke and Mangaia	1,364.0			\$3,900	approved June 2014	Website says PEC Fund Grant \$3,914,229.
Te Mana O Te Ra Solar Farm - Airport solar (Rarotonga Airport West)	960.0			\$3,000	approved 2014, completed 2015	Switched on 15 Oct 2014, built by Infratec/ Solar City. Dec 2015 report on MFAT website says NZ funding was for 900 kW _p and NZD \$3.5m.
Outer Islands Northern Group Solar	850.5			\$17,281	tender 10 Dec 2013, USD convert rate 10 Dec 2013 completed 2015	\$20.5m NZD six atolls (Manihiki, Rakahanga, Penrhyn, Pukapuka, Nassau, and Palmerston), 8 systems, opening ceremony for Penrhyn and Manihiki 19 May 2015, PowerSmart, Dec 2015 report on MFAT website says 6 mini-grids and NZD \$19.5m and completed 2015, IRENA spreadsheet says NZD \$25.554m before tax for 8 systems with 8,021 kWh of batteries.
Solar PV Projects - CI: RESP Mangaia, Mauke, Mitiaro, Aitutaki, Atiu and Rarotonga	3,000.0			\$17,020	approved Nov 2014	Up to 6 PV projects includes battery plus network upgrades.
BESS - CI: RESP Battery (3 MW, 12 MWh) to facilitate 6 MW PV	potential 6,000			\$12,000	approved 2016	Battery may be across 3 sites and PV 5 sites, includes networks and capacity building, weblink says \$12m GCF grant is additional funding.
CI RESP: Additional funding				\$13,710	approved 2016	This row and above two may be components of the one project.

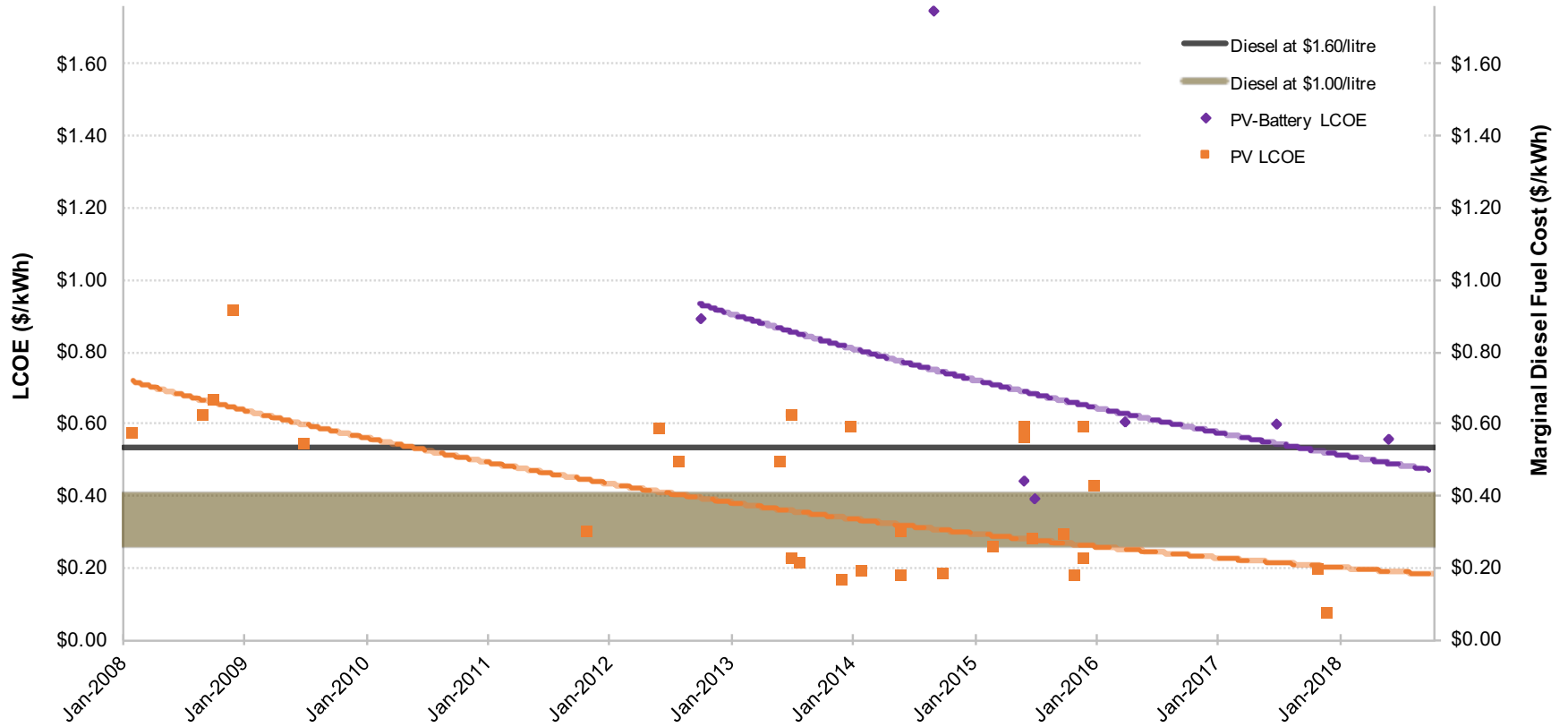


CAPEX \$/W Pacific Projects





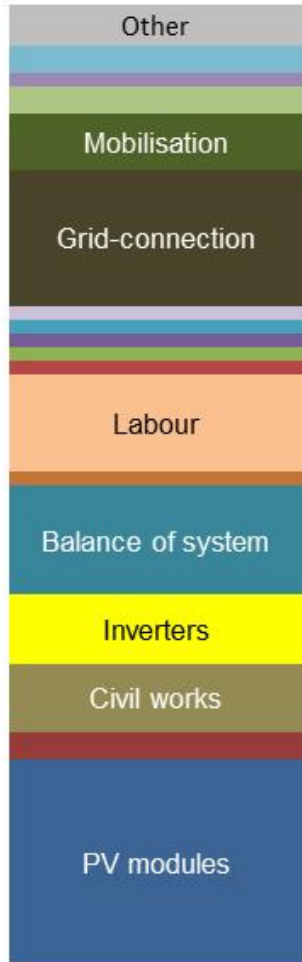
Pacific \$/kWh





ARENA Regional Australia Renewables

RAR program Data Spec



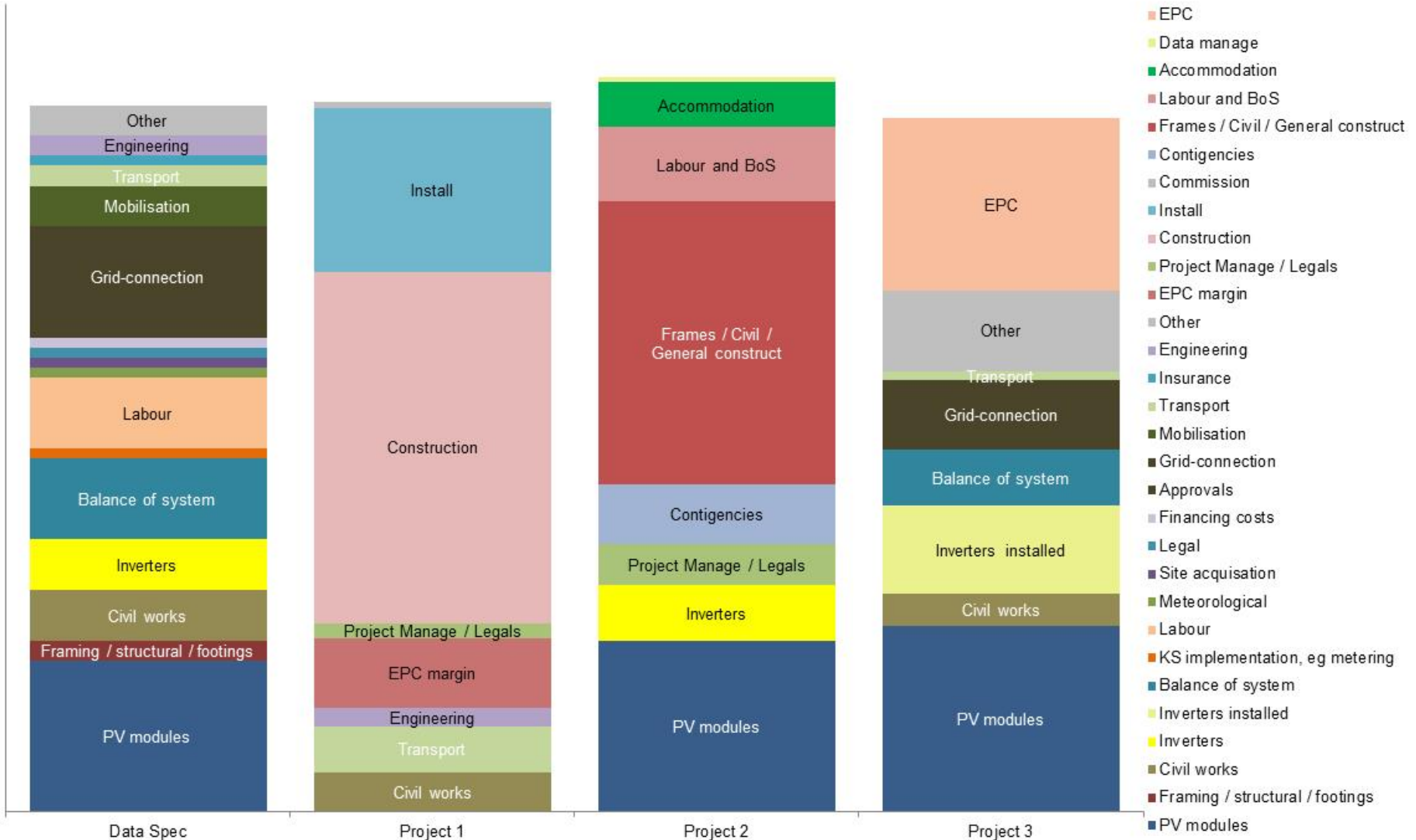
- Other
- Engineering
- Insurance
- Transport
- Mobilisation
- Grid-connection
- Approvals
- Financing costs
- Legal
- Site acquisition
- Meteorological
- Labour
- KS implementation, eg metering
- Balance of system
- Inverters
- Civil works
- Framing / structural / footings
- PV modules



Data Spec



Different CAPEX categories





Pacific RE Cost Template



www.itpau.com.au/publications



www.itpau.com.au

Renewable Generation - Components and Dates	Project Overview	Component Notes	Other Project Notes	Publish Notes
Country				Blank = Confidential
Project Name				
Location			other notes on remoteness and access	
Commissioning date		day-month-year		
Owner		If relevant - PPA tariff and currency		
Capacity		kW DC PV with X MWh of batteries		
Total Project Cost		USD March 2018		
PV Total new capacity kWp DC		PV system		
PV module model No.		PV modules, includes spares		
PV type		mono, poly or thin-film		
Tracking		fixed, single or dual-axis tracking		
Mounting		roof, ground, floating or carpark shade		
Footing		concrete or piled		
No. of PV inverters				
Inverter model No.			Inverter manufacturer	
Total PV inverter capacity kW AC				
Actual annual generation kWh		First year's generation, can document other years in column E		
Wind total new capacity kW		Wind turbine(s)		
Wind turbine model No.			Wind turbine manufacturer	
Rated wind speed				
No. of new wind turbines				
Wind turbine hub height m		above sea level specify here if above ground level		
Actual annual generation kWh				
Hydro total new capacity kW		Hydro turbine(s)		
Hydro turbine model No.			Hydro turbine manufacturer	
No. of new turbines				
Head m				
Actual annual generation kWh				
Storage		Storage type, eg lead-acid or li-ion		
Storage model No.				
Rated power kW				
Total storage capacity kWh				
Total usable capacity kWh				
Load management		Load management type		In case Project Cost includes other components, eg dump load.
Load management Identifier			Load manage manufacturer	
Total kW increase				
Total kW decrease				
New genset(s) total capacity kVA		New genset(s)		In case Project Cost includes new gensets.
New genset model No.			New gensets manufacturer	
No. of new gensets				
Total annual generation kWh			Document measurement point, eg powerhouse or metered load	
Total annual fuel consumption before litres pa				
Total annual fuel consumption after litres pa				
Other components		Other components - provide details		
Weather monitoring			Where data is reported	
Control systems				
Networks km			Line Voltage	
Transformer specs				
Other (specify)				
Tender close date				
Contract signing date				
Other date info		Exchange rate date in tender		
Any other key info				Increase row height, if notes are extensive



Batteries



	Flooded Lead Acid	Gel Lead Acid	Lithium-ion
Size litres/kWh	12 to 14	12 to 16	4 to 10
Approximate weight kg/kWh	35	25	7
Maintenance	High	Medium	Low
Cost	Low	Low-Medium	Medium-High
Roundtrip efficiency	80%	80%	90 to 95%
Cycle life	1,200 at 50% DoD	1,800 at 50% DoD	3,000 at 80% DoD
Typical Depth of Discharge	50%	50%	80% to 90%
Capacity by discharge rate	100% at 20 hour rate 80% at 4 hour rate 60% at 1 hour rate	100% at 20 hour rate 80% at 4 hour rate 60% at 1 hour rate	100% at 20 hour rate 99% at 4 hour rate 92% at 1 hour rate



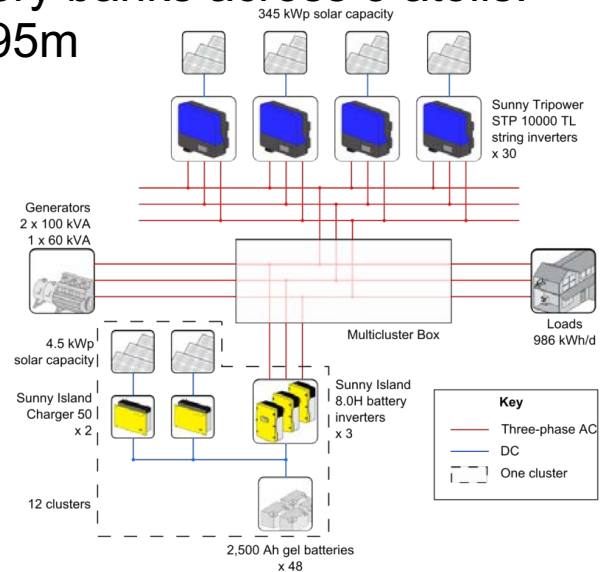
Tokelau

927.4 kW_{DC} of PV with 8,064 kWh (C10) of battery banks across 3 atolls.
Two contracts (Jan 2012) NZD \$7.475m + ~\$0.95m



Commissioned
Oct 2012

USD **\$8/W**
(March 2018)

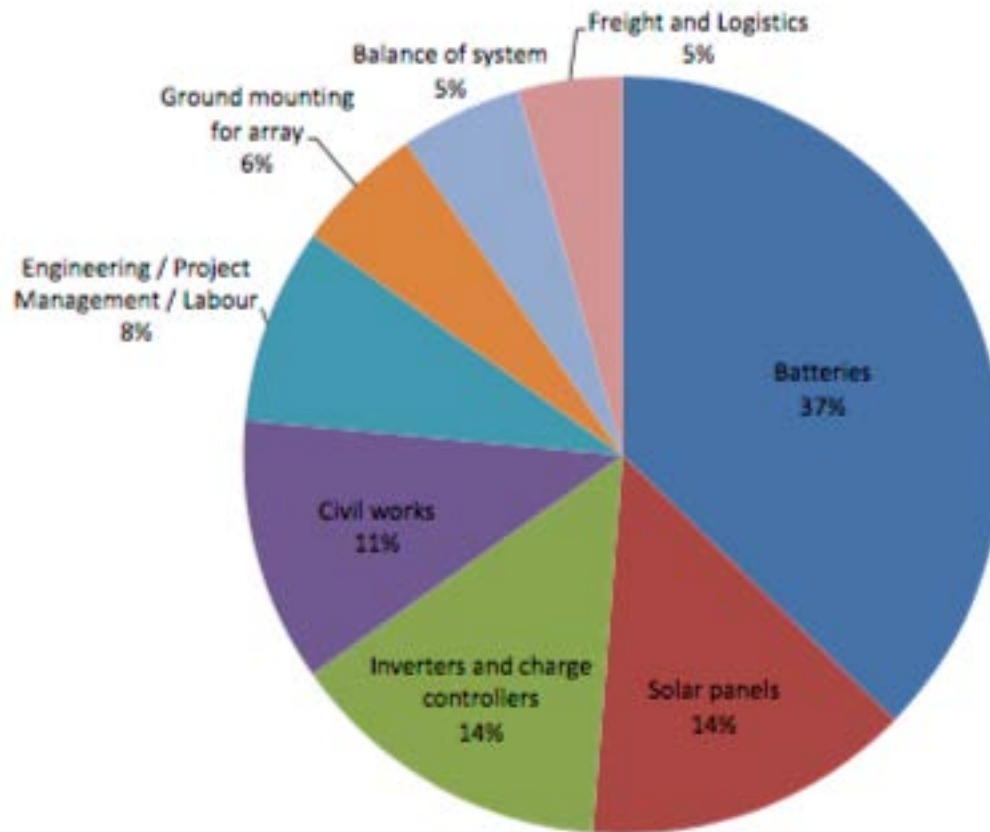




Batteries



Tokelau Battery – design DoD 30%, maximum DoD 50%



From Tokelau Renewable Energy Project Case Study, March 2013



Key cost findings (March 2018 USD)



Total system costs

- PV system costs fallen to $\$3/W_{DC}$
- PV-battery system costs fallen to about $\$5$ to $\$8/W_{DC}$

Component costs

- PV modules less than $\$1/W_{DC}$ and can be as low as $\$0.50/W_{DC}$
- PV frames $\$0.20$ to $\$0.85/W_{DC}$
- PV inverters $\$0.15$ to $\$0.40/W_{DC}$
- Civil costs $\$0.05$ to $\$0.90/W_{DC}$, with two outliers
- Transport costs $\$0.09$ to $\$3.19/W_{DC}$
- Batteries $\$200$ to $\$750/kWh$



Conclusions



Solar PV generation costs have declined significantly over the last decade.

PV fuel-savers provide economic benefits for most diesel mini-grids.

PV-battery systems can provide economic benefits where diesel prices are high.

RE project costs in the Pacific are higher than other island locations due to a variety of factors including

- Remoteness
- Smaller size of projects
- Lack of local contracting capacity
- High cost of locally sourced goods and the need to import some materials
- Contractors using high risk premiums

Civils and earthworks showed a wide range of costs. It may be worthwhile examining options to prepare sites before tendering for solar farms.



Further work



Use a standard template for consistent data collection and publication.

Consider altering tenders and contracts so that cost breakdown data can be published.

Need for documenting PV kW_{DC} and kW_{AC} plus key battery specifications in detail.

Improved details in tender docs to reduce risk premiums.

Future work to consider OPEX estimates, so that lifecycle costs can be estimated.





ITP
Renewables
Consulting | Engineering | Implementation

IT Power Australia

Trading as **ITP Renewables**

Services:

- engineering consultancy
- project management
- international aid and development
- energy markets and advisory.

Involved in renewable energy projects of all scales.

Head office in Canberra with offices in NSW, Victoria, SA, WA and New Zealand.

Battery Lab at CIT commissioned March 2016:

www.batterytestcentre.com.au

ITP provides independent energy advice





Cost template is available at: www.itpau.com.au/publications

Joe Wyder
Projects Manager



Ph (61-2) 6257 3511

joe.wyder@itpau.com.au

Level 1, 19-23 Moore St, Turner ACT 2612

PO Box 6127, O'Connor ACT 2602
info@itpau.com.au

itpau.com.au



IT Power (Australia)