Tonga Renewable Energy Road Map

Achieving 50% of electricity generation from Renewable Energy (RE) sources by 2020.

OVERVIEW

- **TPL Core Purpose**
- **Tonga's renewable energy penetration**
- **Where do we want to be**
- **How do we get there**
- **Green Climate Fund Proposal : TREP**

TPL CORE PURPOSE

Safe, Reliable, Sustainable and Affordable Power Service to the people of Tonga

TPL MISSION

- *To deliver the nation's core purpose via our strategies and Business Plan*
- *To be financially sustainable*

'*every public enterprises and subsidiary to operate as a successful business and, to this end, to be as profitable and efficient as comparable businesses that are not state owned'*

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TONGA CORE PURPOSE

Reduce Tonga's vulnerability to oil price shocks, and achieve an increase in quality access to modern energy services in an affordable and environmentally sustainable manner

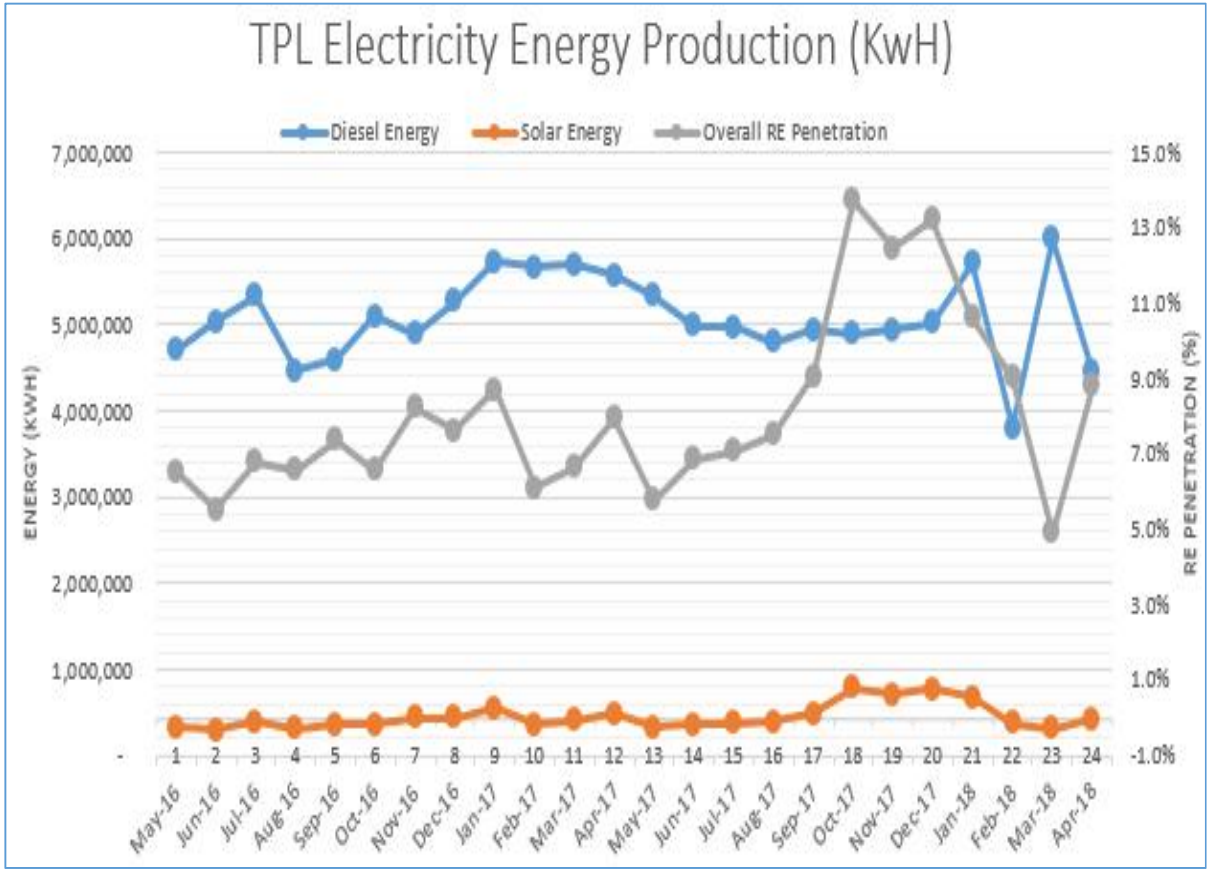
50% RENEWABLE BY 2020 & 70% RENEWABLE BY 2030

Key Energy Outcomes:

- National security of supply of energy
- Economic development- competitive energy pricing
- Standard of Living- energy price, quality, services
- Low carbon energy system

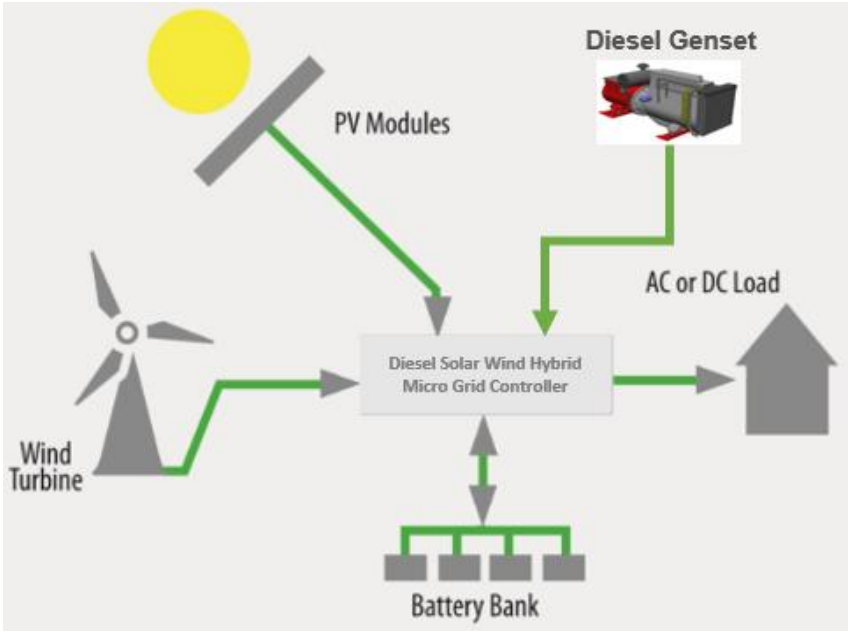
Tonga's Renewable Energy Penetration

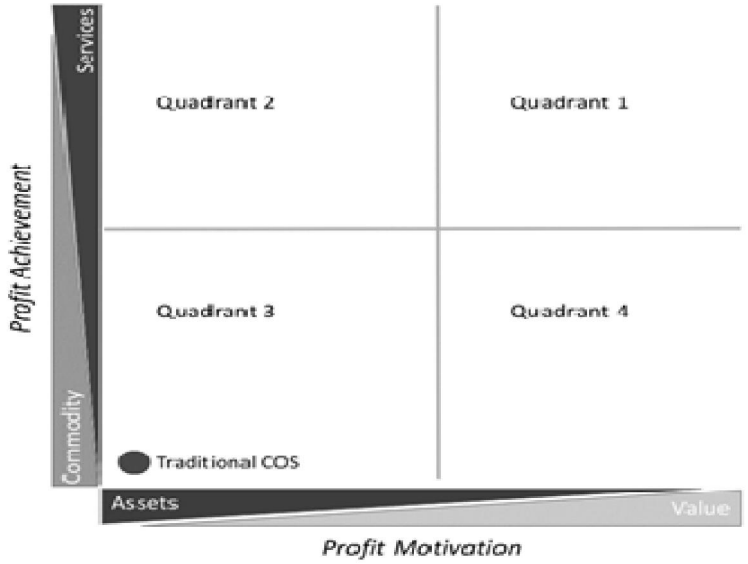
- Consistently between 7% and 11%.
- Best month achieved is 14%-16%.
- Diesel Generation RE absorption limit reached (4.3MW)
- 17.7 MW of Diesel Capacity Installed.
- 6.2 MW of RE Installed On-grid (Solar PV, Wind, IPP)
- 1.8 MW / 1.6 MWh Total BESS Installed



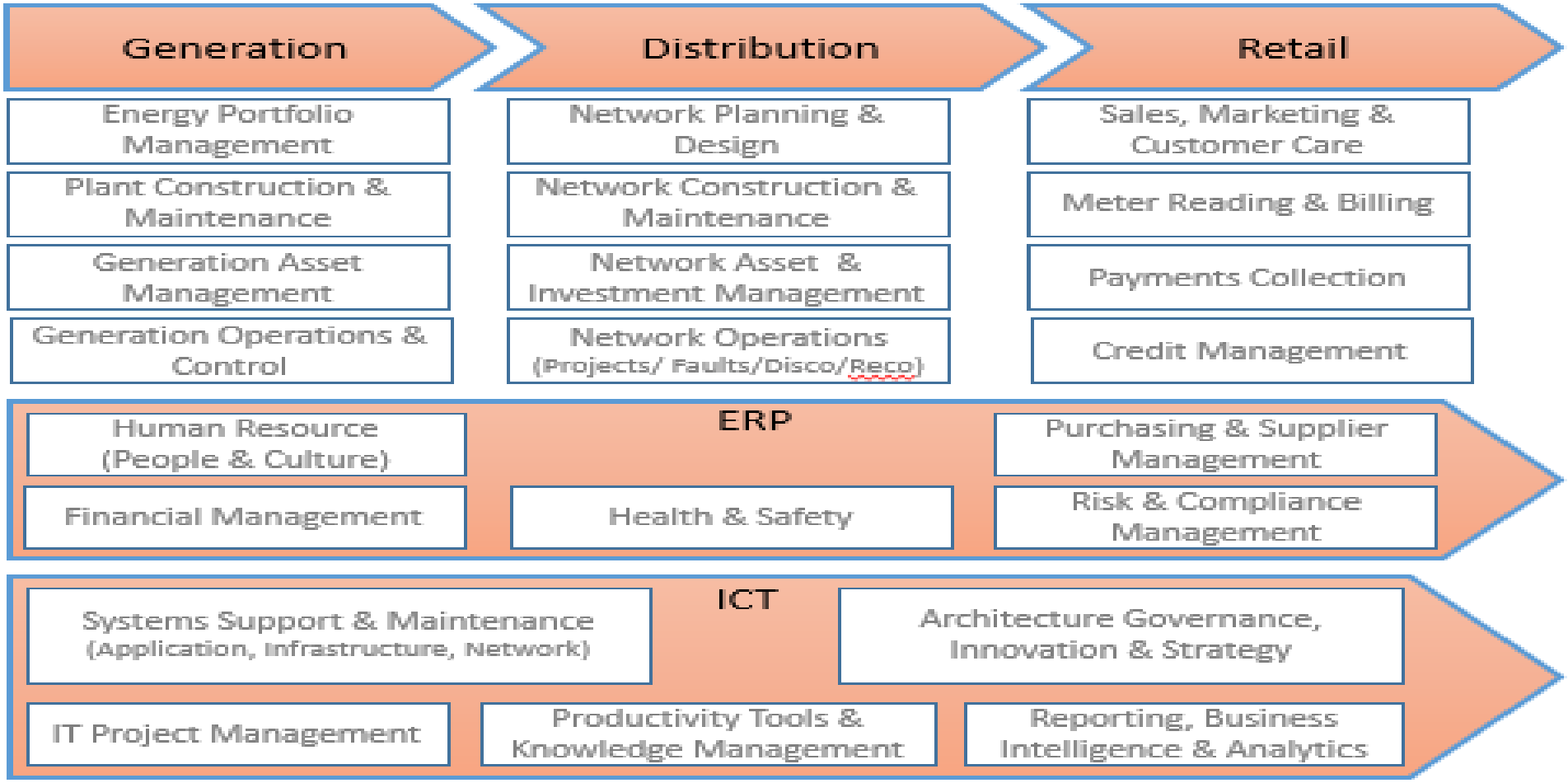
Where do we want to be?

- **Specifically** – 17.5 MW of RE and 10MW/20MWh Energy Storage added to the Tongatapu system.
- **Measure** – 50% or more of electricity generation from RE.
- **Achievable** – Through significant donor and private sector investment and a dedicated implementation team.
- **Relative** – Socio-economic benefits through tariff stability due to less impact of oil price shocks.
- **Time Bound** – before the end of 2020.





How do we get there?



TONGA RENEWABLE ENERGY ROAD MAP (TREP)

		Base case		Variant	
Components		**RE Capacity**	**BESS Capacity**	**RE Capacity**	**BESS Capacity**
TPL Tongatapu					
1	Fahefa solar PV plant	(2 MW)	0.7 MW/0.35 MWh	**(2 MW)**	**-**
	Matafonua solar PV plant	(2 MW)	0.7 MW/0.35 MWh	**(2 MW)**	**-**
2	Niutoua wind farm	(3.8 MW)	1.8 MW/0.9 MWh	**(3.8 MW)**	**-**
3	2 units of BESS	-	4.6 MW / 2.3 MWh		**5.1 MW / 2.5 MWh**
		-	2.3 MW / 16.0 MWh		**5.0 MW / 17.4MWh**

INDICATIVE FINANCING PLAN

Source	Net Amount ($ million)	%
Green Climate Fund (Grant)[a]	29.90	56.2
Asian Development Bank (Grant)	12.20	23.0
Government of Australia (Grant)[b]	2.50	4.7
Tonga Power Limited[c]	3.00	5.6
Government of Tonga[d]	5.60	10.5
Total	53.20	100.0

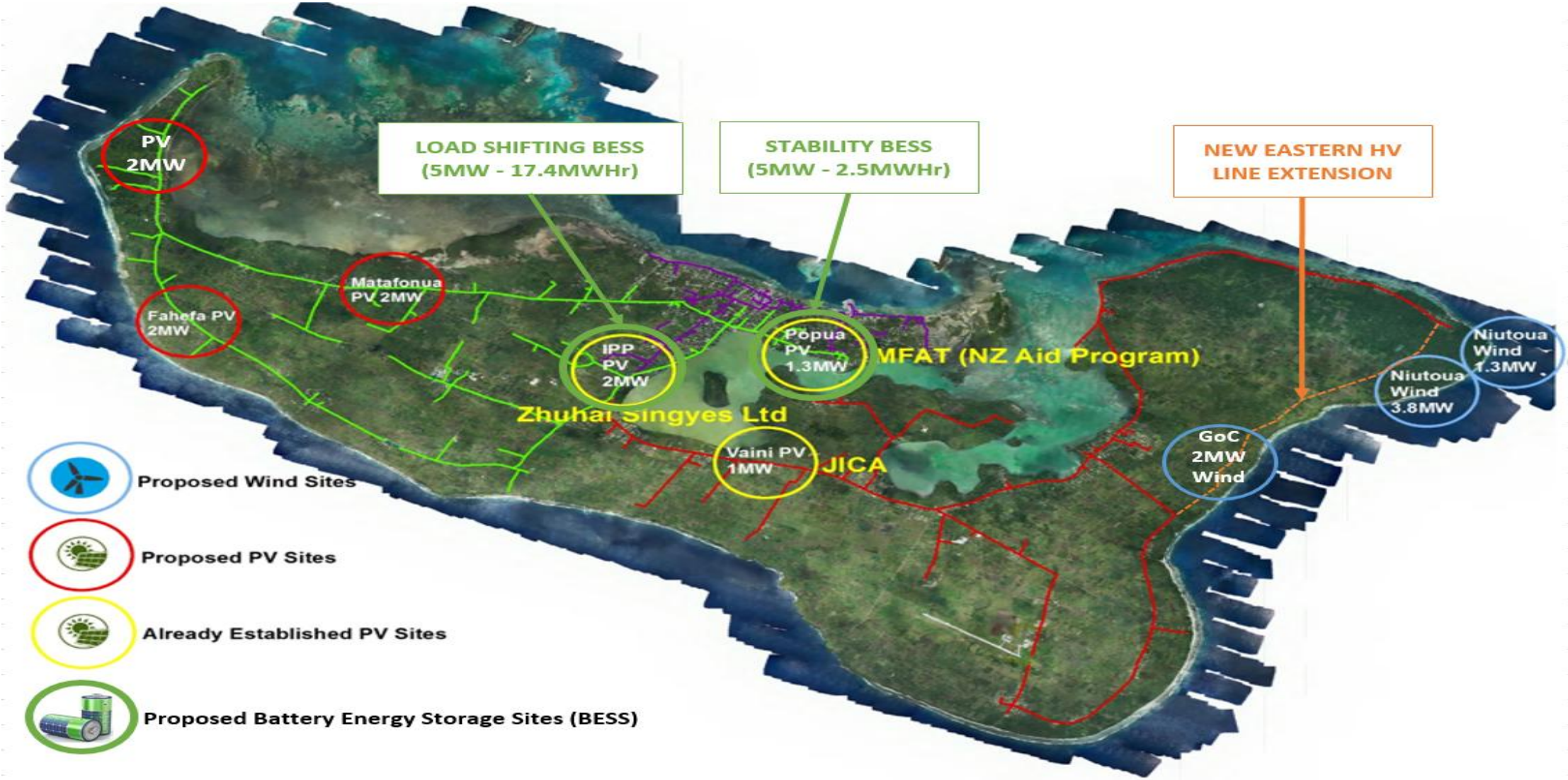
Anticipated Impact of Each Phase to Renewable Energy Penetration

		TPL Grid				Non TPL-Grid		
	Phase	**Tongatapu**	**'Eua**	**Vava'u**	**Ha'apai**	**Outer Islands**	**Total**	**%**
	Grand Total Consumption (kWh)	**54,215,438**	**1,791,133**	**6,148,000**	**1,553,085**	**2,292,344**	**66,000,000**	**100%**
	Conventional (kWh)	23,549,038	978,333	5,000,000	699,435	252,297	30,479,103	46%
Phase 1	OIREP RE+ BESS (kWh)	-	301,800	-	837,650	747,596	1,887,046	3%
	Existing RE + BESS (kWh)	4,000,000	-	710,000	16,000	550,946	5,276,946	8%
Phase 2	Ongoing and Upcoming RE +BESS (kWh)	10,840,000	-	-	-	15,885	10,855,885	16%
Phase 3	TREP RE + BESS including IPPs (kWh)	15,826,400	511,000	438,000	-	725,620	17,501,020	27%
Total	**Total RE + BESS (kWh)**	**30,666,400**	**812,800**	**1,148,000**	**853,650**	**2,040,047**	**35,520,897**	-
	RE Penetration (%) per Island	57%	45%	19%	55%	89%	54%	

TONGA RENEWABLE ENERGY ROAD MAP (TREP)

OBJECTIVES	ARUP	ENTURA	LOCATION
Economic optimum level of RE (LCOE)	58%	54% (GCF Submission)	TBU
Level of RE (Combination of Solar & Wind	20.1MW	17.5MW	TBU
Short Term Grid Integration Storage (BESS)	5MW/2.5MWHr	5MW/2.5MWHr	Popua Power Station
Long Term Load Shifting Storage (BESS)	5MW/17.5MWHr	5MW/17.4MWHr	Matatoa
Network Modelling & Upgrade (Operating Parameters)	RE Grid Absorption – Switching – Protection	Control System (Microgrid Control) – Eastern Ring Feeder – Generation Settings – Synchronous Condenser at the Power Station (reactive power support to allow maximum power output from RE)	TBU

RENEWABLE ENERGY ROAD MAP



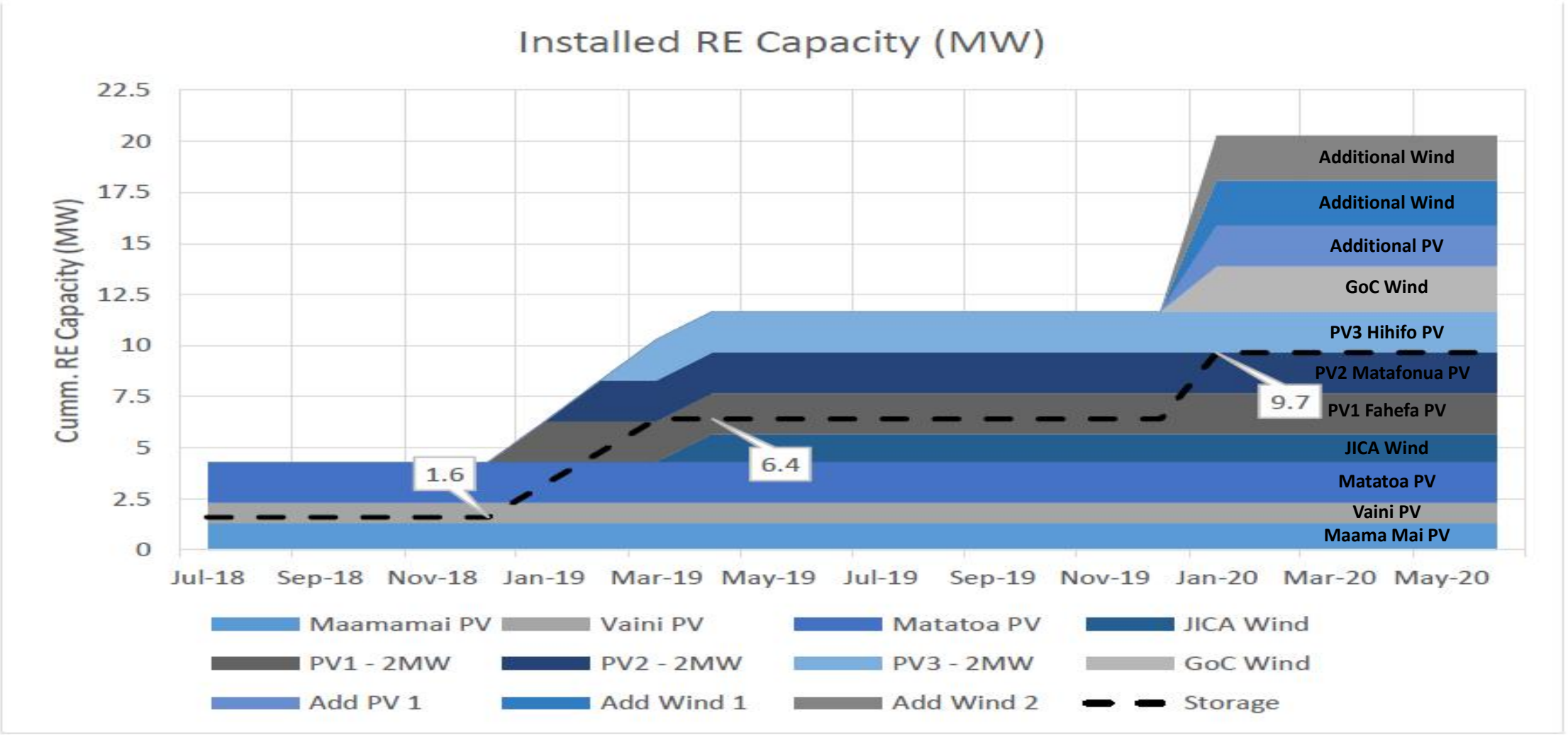
RENEWABLE ENERGY ROAD MAP

	Plant	Capacity (AC)	Installed	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Existing	6x Caterpillar (CAT-1750kVA-50Hz-CP_C)	9.6	2004													Phase out
	2x MAK 2.88 6CM32	5.6	2014													Maintain
	Solar PV (Maama Mai)	1.3	2014													25 year (Refurb 2039)
	Solar PV (Vaini)	1	2015													25 year (Refurb 2040)
	Solar PV (Villa)	2	2017													25 year (Refurb 2042)
	Solar PV (distributed rooftop)	0.5	2015-													Ongoing
Under construction	Wind (JICA - Niutoua)	1.37														20 year (refurb 2038)
Proposed	BESS (TREP)		2019		TREP Subproject 3											25 year (replace cells 2031)
Proposed - dependent on BESS	Solar PV (TREP - Matafonua)	2	2019		TREP Subproject 1											25 year (refurb 2046)
	Solar PV (TREP - Fahefa)	2	2019		TREP Subproject 1											25 year (refurb 2046)
	Wind (TREP - Niutoua)	3.8	2020		TREP Subproject 2											20 year (refurb 2040)
	Wind (GoC)	2	2020													20 year (refurb 2040)
	Solar PV (Future)	2	2020													25 year (refurb 2047)
	Solar PV (Future)	2	2020													25 year (refurb 2047)
	Wind (2020->2030)	5.3	2021													
	Solar PV (2020->2030)	See ->	See ->								4	4	4	4	4	4 +2MW/year for growth
Totals	Cumulative Wind							1.3	1.3	7.1	12.4	12.4	12.4	12.4	12.4	
	Cumulative Solar PV			1.3	2.8	2.8	4.8	4.8	8.8	12.8	16.8	20.8	24.8	28.8	32.8	+2MW/year for growth

Past, present and proposed generation for Tongatapu

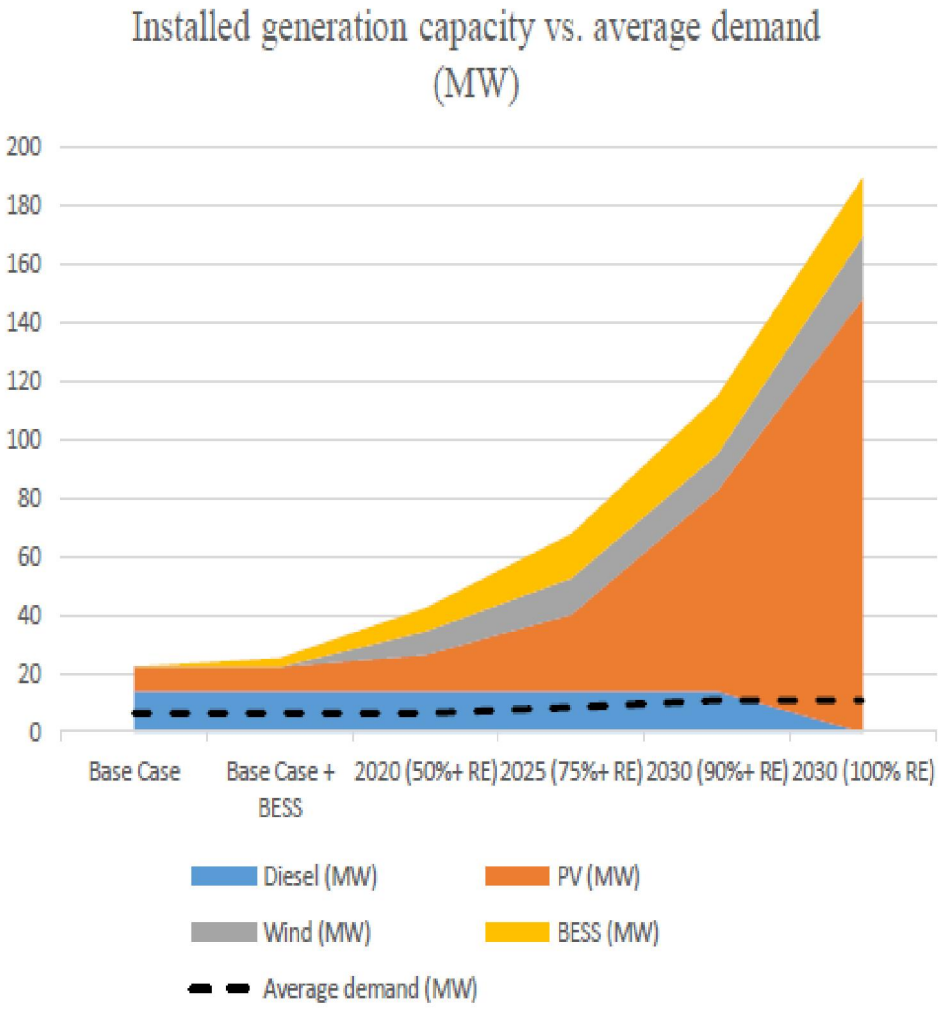
RENEWABLE ENERGY ROAD MAP

Figure 5 RE and BESS installation timeline (Scenario 1 - third 2MW PV plant commissioned in 2019)

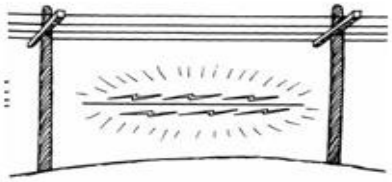


System configuration results

	Demand models						
	Unit	Base Case	Base Case + BESS	2020 (>50% RE)	2025 (>75% RE)	2030 (>90% RE)	2030 (100% RE)
Diesel Generation	MW	14	14	14	14	14	-
PV #1 Grant	MW	2.3	2.3	2.3	2.3	2.3	2.3
PV #2 $0.15/kWh	MW	2	2	2	2	2	2
PV #3 $0.12/kWh	MW	4	4	4	4	4	4
Additional PV @ $0.12/kWh	MW	-	-	4	18	60	140
Wind Farm #1 JICA Grant	MW	-	-	1.4	1.4	1.4	1.4
Wind Farm #2 GoC Grant	MW	-	-	2.2	2.2	2.2	2.2
Additional wind @ $0.15/kWh	MW	-	-	4.4	8.8	8.8	17.6
ESS - Peak Power	MW	-	3	8	15	20	20
ESS - Energy Capacity	MWh	-	8.4	26.3	73.5	147	273
Average demand	MW	6.56	6.56	6.56	8.36	10.72	10.72

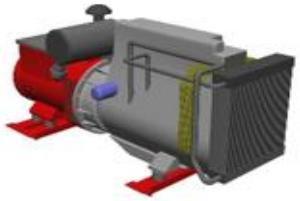


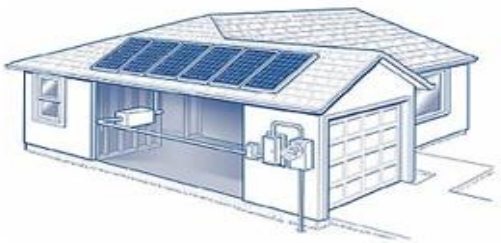
- Hybrid System Plan to reach 50% Renewable Penetration by 2020









SAFE, RELIABLE, SUSTAINABLE, AFFORDABLE Electricity for the people of Tonga

TC GITA POWER RESTORATION - TONGATAPU & EUA