Efaté Energy Road Map 2018-2030

Power Sector Development Pathway to Achieving the Vanuatu Renewable Energy Objectives

PCREEE | Wednesday September 26 2018 |

UNELCO in Efaté today … in brief

Installed grid-connected capacity in Efaté
(Sept. 2018)




Wind	Solar	Coconut oil	Diesel
3.6 MW	2.4 MWc	*Up to* 8 MW	*Up to* 20 MW

ÉFATÉ

Electricity
And Water

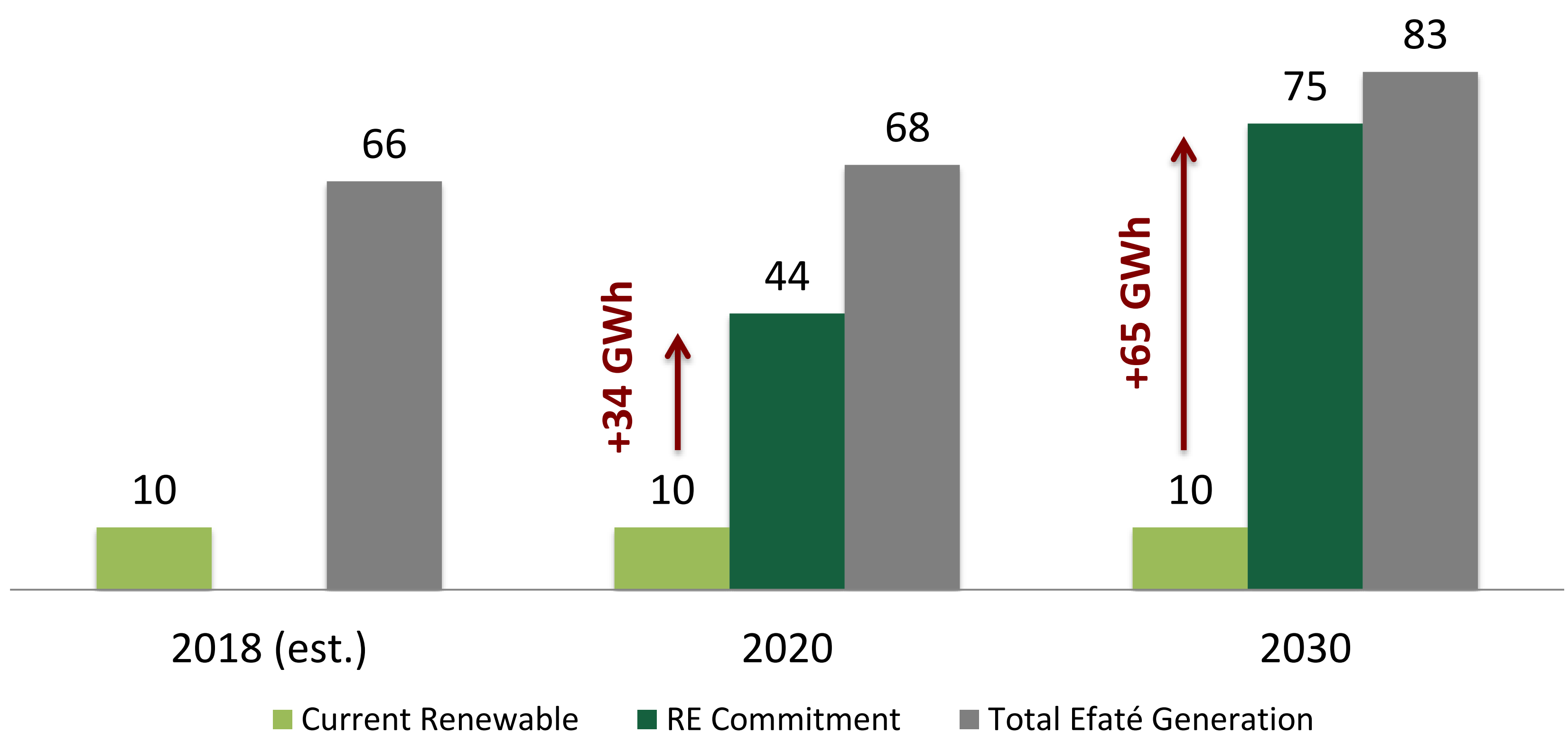
Customers: 16 000

Peak elec demand
12 MW

Generation: 66 GWh

The Vanuatu renewable energy (RE) commitments imply a 34 GWh increase in RE by 2020 and a 65 GWh total increase by 2030...

Currently deployed renewable gen., projected demand, and NERM/Paris Agreement commitments (Efaté; 2018, 2020*, 2030*; GWh/year)



… achieving these objectives will require a mix of renewable technologies; there are a handful of renewable ressources available in Efaté and a certain number of criteria to consider when determining the target energy mix ...

Commercially/Technically viable Efaté Renewable Resources

Confirmed (with high potential)

Bio-fuels – sufficient local production to theoretically produce 2x Efaté's elec. needs

Wind – Approx 1 860 h per year

PV Solar – Approx 1 380 h per year

Possible (but limited in scope)

Biomass/Incineration

Speculative/Unconfirmed exploitability

Geothermal – 4 to 6 MW

Strategic planning and renewable energy mix integration criteria

Pre-requisite: Availability of resource in Efaté (and in commercially viable range)

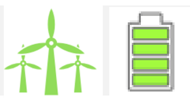
Technical

- Technical maturity
- Dispatchability/Intermittency

Economic

- Flexibility/Option value
- Overall Value for Vanuatu ("V4V")
- Cost competitiveness

… all renewable technologies have their pros and cons, and the answer to meeting the renewable challenge will not be an "either/or" but rather an evolving "energy mix" in which intermittent energy will naturally have a place.

	TECHNICAL			ECONOMIC		
	Resource availability	Tech. Maturity	Dispat-chable	Option value	V4V	Cost Compe-titivness
	●	●	●	●	●	◑
	●	●	○	◔	◑	◕
	●	◕	◑	◑	◑	◔
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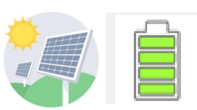
	●	◕	◑	◑	◔	◔
	◔	◕	●	◑	●	◑
	?	◑	◕	○	◔	?

One technically and financially coherent scenario to reach 90% by 2030 could be the following RE energy mix …

	CAPACITY			HOURS		Power Gen. 2030
	Existing		Additions			
	2.4 MWp	+	7.4 MWp	x 1 380 h	=	**13.5 GWh**
	3.6 MW	+	5.1 MWp	x 1 860 h	=	**16.2 GWh**
	0.0 MW	+	0.5 MW	x 6 000 h	=	**3.0 GWh**
	8.0 MW	+	0.0 MW	x 5 288 h	=	**42.3 GWh**
TOTAL	**10.0 GWh**	→				**75.0 GWh**

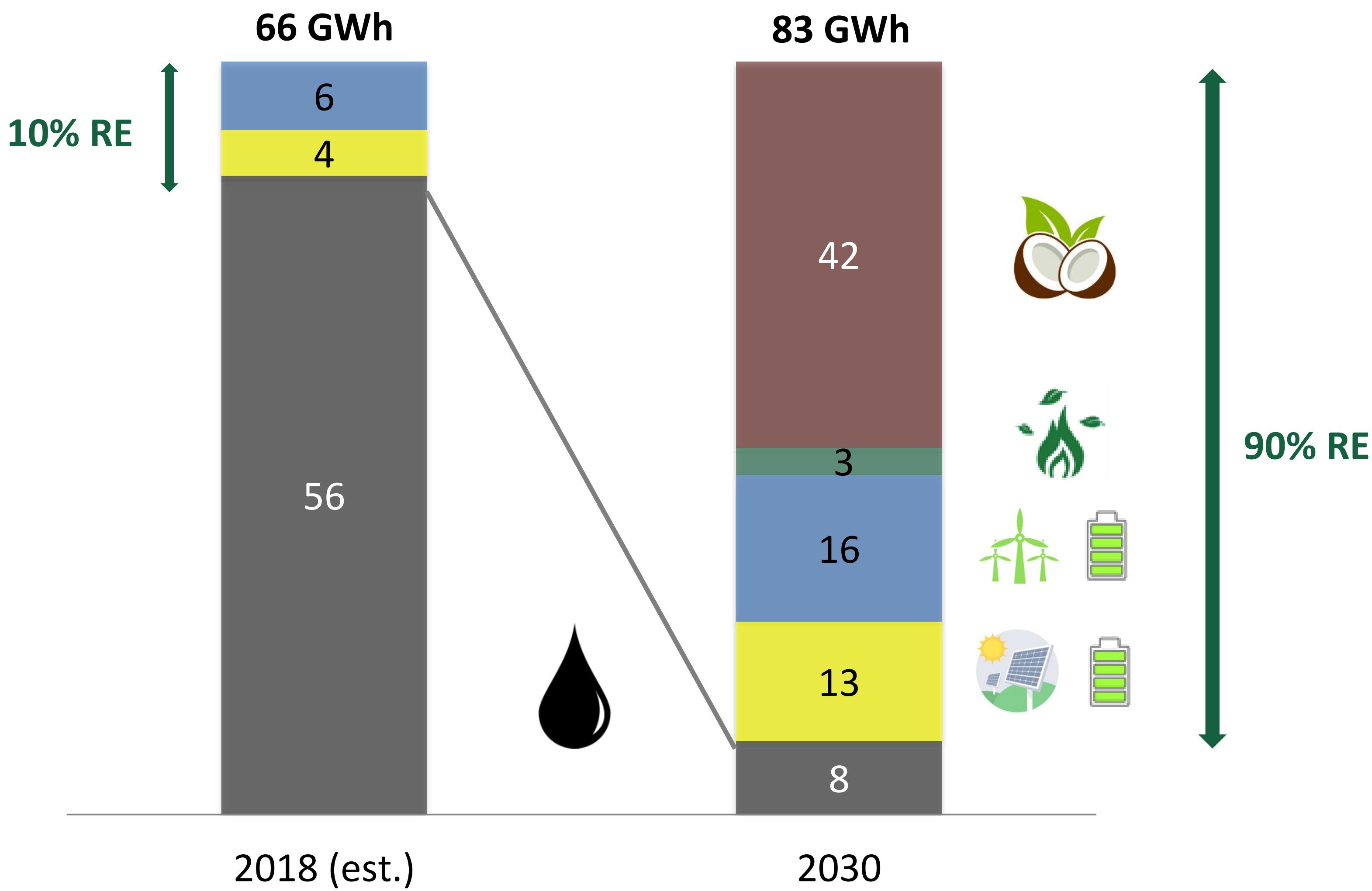
… the investment requirements would be significant and substancial donations will be paramount to achieving the objective without making the customer tariff unaffordable …

	Capacity/Power added	"One-time" INVESTMENT	Recurrent FUEL + O&M
	**7.4 MWp**	1 365 M	50 M/year
	**5.1 MW**	1 480 M	75 M/year
	**6.3 MWh**	650 M	12 M/year
	**0.5 MW**	150 M	45 M/year
	**14 Million liters per year**	0 M	1 385 M/year
TOTAL		**3 645 M**	**1 565 M/year**

Avoided fossil fuel (per year)

- **17 M liters**
- **45 120 tons of CO_2**
- **1 650 M Vatus**

... the resulting energy mix in 2030



In summary

In this scenario:

- Vanuatu would not only **meet its international climate commitment**, ensure **quasi-energy independence**, **reduce electricity cost volatility**, but also **sustainably re-inject 1.4 Billion Vatus per year into the local economy** (with a very high multiplier effect)

- **Development agencies would need to fund approximately 35 M USD in capex** for the PV Solar, Wind and Buffering/Storage

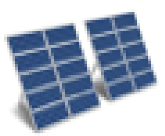
- **UNELCO would ensure the coordination of the implementation, the long-term O&M** of all the assets funded by the development agencies

- Total **coprah oil expenses would be sensibly similar to current oil expenditure, keeping the customer tariff similar to the one today**.

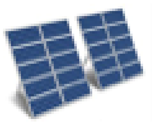
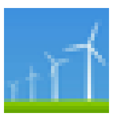
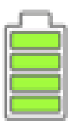
- **If development agencies help fund developments along the coprah oil value chain**, and UNELCO can therefore purchase coprah oil below the price of fossil fuels from aided producers, **the customer tariff could even decrease.**

APPENDIX

One technically and financially coherent scenario to reach 65% by 2020 could be the following RE energy mix …

	CAPACITY			HOURS		Power Gen. 2020
	Existing		Additions			
	2.4 MWp	+	5.7 MWp	x 1 380 h	=	**10.6 GWh**
	3.6 MW	+	3.6 MWp	x 1 860 h	=	**13.4 GWh**
	0.0 MW	+	0.5 MW	x 6 000 h	=	**3.0 GWh**
	8.0 MW	+	0.0 MW	x 2 175 h	=	**17.0 GWh**
TOTAL	**10.0 GWh**	→				**44.0 GWh**

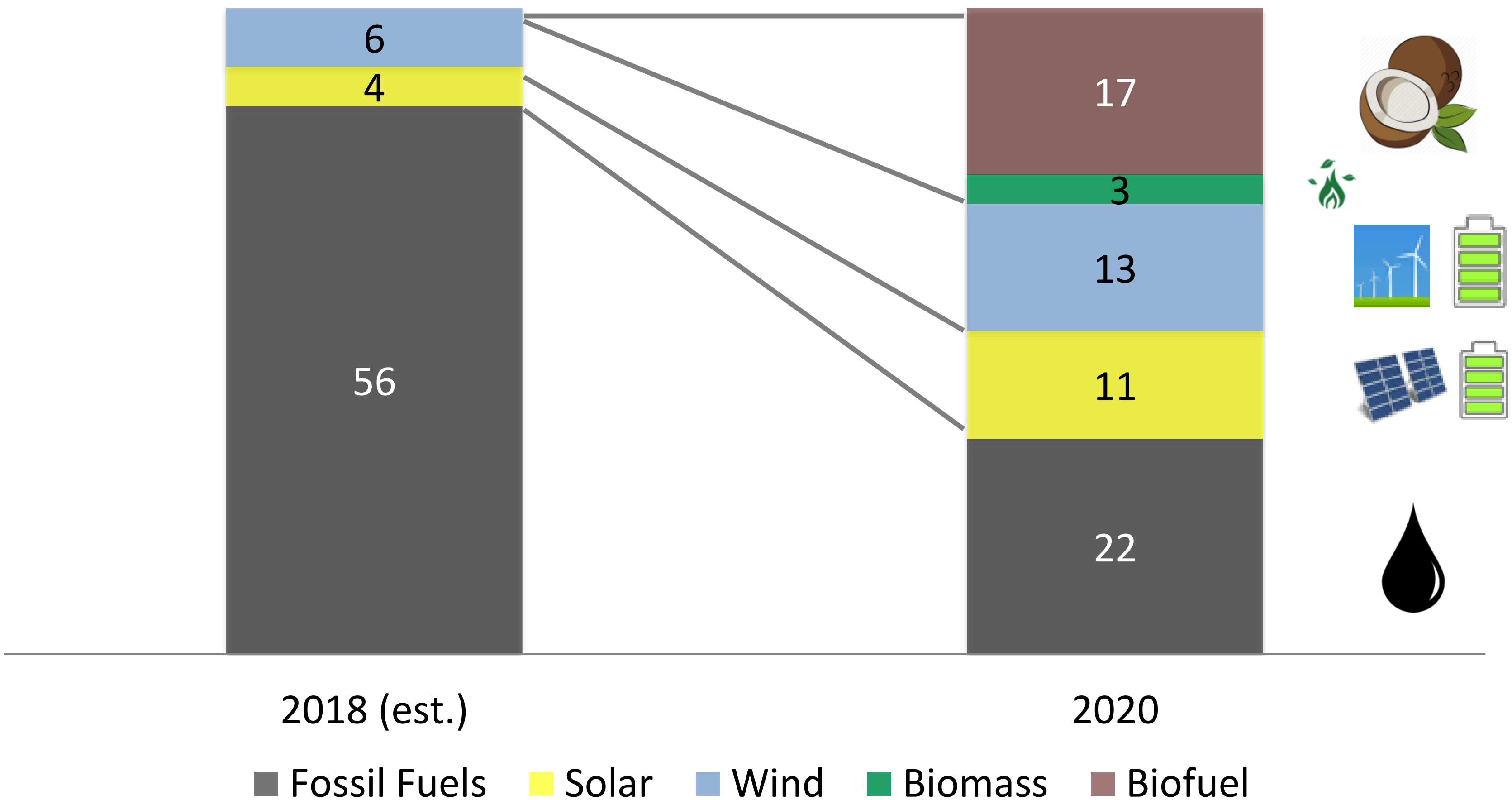
… the investment requirements would be significant and significant donations will be paramount to achieving the objective without making the customer tariff unaffordable ...

	Capacity/Power added	**"One-time" INVESTMENT**	**Recurrent FUEL + O&M**
	**5.7 MWp**	1 050 M	40 M/year
	**3.6 MW**	1 045 M	55 M/year
	**4.5 MWh**	465 M	10 M/year
	**0.5 MW**	150 M	45 M/year
	**5 Million liters per year**	0 M	490 M/year
TOTAL		**2 710 M**	**640 M/year**

Avoided fossil fuel (per year)

8.8 M Liters
23 600 tons CO_2
865 M Vatus/year

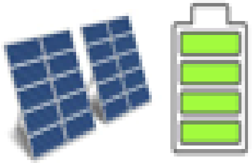
The NDC commitments imply an approx. 34 GWh increase in RE by 2020 and approx. 65 GWh increase in RE by 2030...



Notes:
* Projections of demand, hence commitment were established based on the assumption of a 2% p.a. growth of consumption

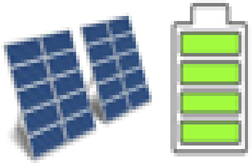
... the question now is how "best" to achieve the objective ...

Key local technical and economic parameters of PV Solar Generation (1/2)



ECONOMIC	
PV solar	
• Overnight investment	185 M Vatus / MWp
• Operations and Maintenance	7 M Vatus / MWp / year
Battery stabilisation	
• Overnight investment	100 M Vatus / MWh
• Operations and Maintenance	2 M Vatus / MW / year
TECHNICAL	
PV Solar	
• Local generation nominal capacity in year 1	1 400 hours / year
• Average efficiency over lifetime of PV farm	90%
• Lifetime of PV solar farm	20-25 years
• Average generation per MWc	1 260 000 kWh / year / MWp
Battery stabilisation	
• Requirement to “Firm” intermittent generation	0.85 MW useful storage capacity/MWp PV Solar
• Depth of discharge	80%
• Round-trip efficiency	98%
• Lifespan	10 years
• Nominal storage capacity required to “Firm”	1 MW nominal storage capacity/MWp PV Solar
• Nominal storage capacity in MWh	0.5 MWh / MWp PV Solar

Key local technical and economic parameters of PV Solar Generation (2/2)

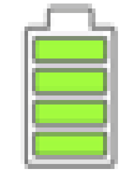


For 1 MWp of firmed PV Solar

PV Solar investment	22.2 M Vatus/year
+ Operations and Maintenance	7.0 M Vatus/year
+ Stabilisation investment	8.5 M Vatus/year
+ Operations and Maintenance	2.0 M Vatus /year
= TOTAL annual cost	**39.7 M Vatus/year**

Total annual cost	39.7 M Vatus/year
/ Average generation	1.26 M kWh/year
= Estimated cost per kWh generated	**31.5 Vatus/kWh**

Key local technical and economic parameters of cyclone resistant wind generation (1/2)

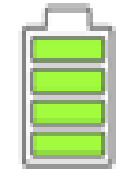
ECONOMIC

Wind	
• Overnight investment	290 M Vatus / MW
• Operations and Maintenance	14.5 M Vatus / MW / year
Battery stabilisation	
• Overnight investment	100 M Vatus / MWh
• Operations and Maintenance	2 M Vatus / MW / year

TECHNICAL

PV Solar	
• Local generation nominal capacity in year 1	1 800 hours / year
• Lifetime of PV solar farm	20 years
• Average generation per MWc	1 800 000 kWh / year / MWp
Battery stabilisation	
• Requirement to “Firm” intermittent generation wind	0.85 MW useful storage capacity/MW of
• Depth of discharge	80%
• Round-trip efficiency	98%
• Lifespan	10 years
• Nominal storage capacity required to “Firm”	1 MW nominal storage capacity/MW of wind

Key local technical and economic parameters of cyclone resistant wind generation (2/2)



For 1 MWp of firmed Wind

Wind turbine investment	34.8 M Vatus/year
+ Operations and Maintenance	14.5 M Vatus/year
+ Stabilisation investment	8.5 M Vatus/year
+ Operations and Maintenance	2.0 M Vatus /year

= TOTAL annual cost	**59.8 M Vatus/year**

Total annual cost	59.8 M Vatus/year
/Average generation	1.8 M kWh/year

= Estimated cost per kWh generated	**33.2 Vatus/kWh**

Key local technical and economic parameters of Biofuel generation (1/2)

ECONOMIC

Bio-oil/fuel - Variable costs

• Low	23.5 Vatus/KWh generated
• Medium	29.4 Vatus/KWh generated
• High	35.3 Vatus/kWh generated

Fixed costs

• Investment + Operations + Maintenance	3.75 Vatus/kWh generated

TECHNICAL

Bio-fuel per GWh generated	294 000 liters/GWh generate

Key local technical and economic parameters of Biofuel generation (2/2)

For 1 GWh of biofuel generation

	LOW	MEDIUM	HIGH
Variable fuel cost (M Vt/GWh)	23.5	29.4	35.3
Non fuel generation costs (M Vt/GWh)	3.8	3.8	3.8
= TOTAL annual cost (M Vt/GWh)	**27.3**	**33.2**	**39.6**
Total annual cost (M Vt/GWh)	27.3	33.2	39.6
Generation (M kWh)	1.0	1.0	1.0
= Unit cost (Vatus/kWh)	**27.3**	**33.2**	**39.6**