Submission to FCCC on the
Review of Electricity Tariff Rates
Sustainable Energy Industry Association of the Pacific Islands
SEIAPI, 12 October 2023

Introduction

This submission is from the *Sustainable Energy Industry Association of the Pacific Islands* (SEIAPI; https://www.seiapi.com/), which is registered in Fiji as an Industry Association. Our mission is to create an enabling environment for the growth of sustainable energy business entities and sustainable energy equipment and energy services in Fiji and the wider Pacific. SEIAPI has about a dozen members in Fiji representing the key companies which study, design, develop and install renewable energy systems, primarily solar photovoltaic (PV) systems. We work closely with development agencies, utilities, the Pacific Power Association (PPA) and others to develop technical guidelines on renewable energy (RE) and energy efficiency (EE), training programmes and facilities, and accreditation to build local capacity and improve the quality of sustainable energy systems.

There is very limited public information[1] on which to assess the 2023 submission of Energy Fiji Ltd (EFL) to the Fijian Competition and Consumer Commission (FCCC). We do not have access to EFL's assumptions regarding demand growth, its costs, sensitivities to changing economic conditions, inflation, and growth, etc. or the justification for requesting a substantive change to the structure of the tariff with a new fixed daily charge, additional to energy use and, for industry, demand charges. We provide the rationale and sources for our views and assumptions where possible so FCCC can independently check them. In some cases, where we lack sufficient recent data for a firm recommendation, we suggest where FCCC should obtain further justification from EFL or independent advice.

We note that FCCC's methodology[2] for tariff determination considers the costs of supply, encourages efficient electricity consumption, and tries to assure environmental sustainability. FCCC forecasts 'reasonable costs' of fuel, energy sales, peak demand, customer numbers, etc. FCCC also strives to ensure equitable returns for business and promotes the interests of consumers.[3] We also note that Fiji's Climate Act[4] imposes legal obligations on EFL as a Fiji-registered public company to: a) consider financial risks arising from climate change, b) assess its liability risk from the failure to address climate risks, c) report measures adopted to reduce exposure to these risks, and d) report its compliance with Paris Agreement long-term temperature goals. FCCC methodology does not of course include obligations within the Climate Act (which did not exist when the methodology was prepared in 2019) but the Act requires specific EFL actions that can affect its planning methodology and investment decisions, and is thus relevant to a tariff review. This submission addresses these and other

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[1] We have only the 'non confidential' version of EFL's submission to FCCC and a 'redacted' (i.e., incomplete & censored) executive summary of its 10-year plan for 2022-2031, EFL's 2022 annual report and several EFL public presentations made during 2022 & 2023.

[2] *Electricity Tariff Methodology Public Version 2* (FCCC, 2019). It is understood that the methodology includes a contingency for an *ad hoc* review in the event of extraordinary events such as natural disasters and unbudgeted fuel costs incurred by EFL due to unexpected increases in the global fuel price'.

[3] *FCCC Annual Report for 2018-2019*, apparently the most recent available.

[4] *Climate Change Act* (Act 43 of 2021) https://fijiclimatechangeportal.gov.fj/wp-content/uploads/2021/12/20210927_161640.pdf

issues. We apologise for some repetition in the text due to limited time to finalise and edit this submission.

Structure of the submission

Our submission covers the following *seven* areas, with a brief summary below of SEIAPI concerns and recommendations for each.

1. EFL's justification for a fixed plus variable charge is to blame the solar industry

   We acknowledge EFL concerns that Variable Renewable Energy (VRE) can be challenging to integrate into utility systems. EFL's submission states that it is being exploited by domestic rooftop solar developers but current installations and prospective growth do not destabilise the grid or increase EFL's O&M costs. Impacts thus far are negligible or even positive. Independent studies suggest that Viti Levu can absorb much higher VRE penetration.

   We strongly recommend that FCCC require EFL to justify its claim of exploitation by solar developers and reject EFL's assertion that roof-top solar undermines EFL and necessitates a structural change to the tariff. If FCCC accepts the need for a fixed daily charge plus energy charge, it should be structured to encourage, not penalise, those who invest in solar PV or other VRE.

2. EFL alleges that roof-top solar harms lower income consumers

   Recent studies show that a fixed plus variable charge tariff can help, or hurt low-income families, or be neutral, depending on the tariff design, assumptions and local conditions. If poorly designed, it can also discriminate against various consumer classes (domestic, commercial, industrial). The number, and expected growth, of roof-top solar systems in Fiji do not hurt lower-income consumers and may even be beneficial.

   We strongly recommend that FCCC independently assess the actual impact of roof-top solar on lower-income electricity customers currently and with likely roof-top solar expansion from 2023-2027.

3. EFL's proposed tariff has very different impacts for different customer classifications

   The percentage increase in charges for various consumer groups varies quite widely, but with no explanation or justification.

   EFL should be required to justify to FCCC the very different impacts on electricity costs proposed for different classes of consumers, and whether the distribution of impacts is equitable.

4. EFL has not justified an overall tariff increase of 32%

   EFL's charges are roughly double those of countries with a similar mix of diesel and hydro. There is insufficient information (sensitivities, assumed economic growth, inflation, investment need) for SEIAPI to assess the need for the large increase and no information on EFL's expectations for a fair return to shareholders. EFL claims the increase will allow implementation of its 10-year investment plan with over $4 billion required for new generation and T&D. This assumes low rainfall (low hydro output) whereas 'average' recent rainfall patterns would require only $2.3 billion. Independent climate assessments for Fiji do not clearly predict low future rainfall patterns so EFL's rainfall assumption is not justified as EFL's base case for tariff revisions.

FCCC should require EFL to justify its projected hydro output based on credible independent climate assessments, not use an apparent worst case as its baseline. If normal hydro output is more credible, FCCC should revise EFL's generation investment need and priorities, and adjust the tariff requirements accordingly.

5. EFL's 2022-2031 plan is inconsistent with national renewable energy policies and obligations, and seems likely to result in electricity supply costs that are higher than justified.

EFL's stated goal is 90% RE to the grid by 2025 and the government is committed to 100% grid-connected RE by 2030. EFL, majority government-owned on behalf of the people of Fiji, has an obligation to act in consistency with government policies. However, RE to the grid is expected to *decline*, with petroleum (EFL's highest cost generation and largest budget item) growing from 35% of generation (2022) to between 46-62% (2031), with 62% as the base-case for investment needs. Solar energy is the least costly investment for Fiji with an estimated cost per kWh less than half of EFL's current fuel cost per kWh.

FCCC should require EFL to justify a 10-year plan in which petroleum fuel use grows and RE declines, with solar contributing only 2.8% of generation by 2031. EFL has apparently not seriously considered lower-cost but more resilient investment, thus demanding a higher charge to consumers.

We recommend that any tariff increase should be contingent on amendment of the 10-year plan with credible assumptions and increased RE generation as a percentage of the total.

6. EFL planning for climate change risk and mitigation appear to be inadequate and may ignore legal obligations, which will be costly to later address

Under Fiji's Climate Act, EFL is *legally obligated* to consider climate change affects on its services, plan for climate resilience, assess the costs of not addressing climate change, and assess costs and benefits of opportunities. There is nothing in its 10-year plan or submission to FCCC to suggest that EFL has done this.

It is strongly recommended that FCCC obtain and assess EFL's climate risk mitigation plans and ascertain that it meets legal obligations. If not, any tariff increase should be contingent on development of a credible mitigation and climate adaptation plan which reduces climate risks and better serves the public.

7. The tariff methodology is unsuited for Fiji's current and expected future conditions and requires review and modification

FCCC's methodology provides incentives to EFL to over-invest in generation and to sell more electricity each year in order to increase profits. The methodology disincentivizes both solar energy systems (particularly distributed PV which is not EFL-owned) and investment in improving consumer energy efficiency. This is not be appropriate for a future in which distributed solar PV should be encouraged and the new draft building code has strong energy efficiency requirements.

It is strongly recommended that the methodology be reviewed and updated well before the next tariff review to decouple capital investment and sales from company profits and encourage EFL investment in sustainable renewable energy systems and improved demand side energy efficiency.

Detailed Comments

1. EFL's justification for a fixed plus variable charge is to blame the solar industry

We are sympathetic to EFL's concern that distributed solar PV systems might disrupt utility operations technically and financially. We reject, however, that Fiji's roof-top solar developers are somehow exploiting EFL directly requiring hugely costly upgrades. To the contrary, current and expected future roof-top PV penetration levels in Fiji have at most negligible impacts. In addition, investments in roof-top PV by companies and private households lower EFL's peak Viti Levu power demand[5] by about 10%,[6] thus reducing EFL's investment needs. We also reject the EFL assertion that widespread installation of solar systems will mean "the EFL power system can become redundant one day." This eventuality would require massive private investment in back-up battery systems to provide evening and nighttime supply but as EFL itself correctly observes[7] the vast majority of PV in Fiji has no storage, thus necessitating a grid supply.

EFL does need to upgrade its distribution system but this is a longstanding issue and is not attributable to roof-top solar: "Equipment is antiquated, leading to substantial reliability and efficiency issues. It mostly lacks modern smart-grid technologies (e.g., smart metering systems, automatic reclosers) and online smart-meter reporting."[8]

Systems without storage only reduce consumer demand on the grid during the daytime, EFL's peak period, which can be beneficial to EFL. All customers, corporate and private, who invest in roof-top solar systems are investors in the transition to fossil free generation, not exploiters, and should not be penalised by a tariff structure that ignores these investments, and risks less private local investment in PV in the future.

High levels of PV have had negative impact in some countries. However, "private power utilities often misdirect regulators and consumers, with counter-narratives to try to plausibly argue they are not fighting their own customers just to protect utility profits. They support policies that put caps on how much rooftop solar can be built or reduce the financial benefits of solar by coming up with new charges and modifications to rates which undermine roof-top solar."[9] We suspect that EFL may be misdirecting FCCC in this case.

The costs of integrating solar power into electricity networks have been debated for decades yet remain controversial and often misunderstood. However, a recent systematic review of the

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[5] We assume that 1 kW of solar PV lowers loads by 1 kW, with the effective load calculated through the 'Reconstituted Load Approach.' A recent Pacific Power Association presentation discusses how utilities can use this approach effectively as solar PV penetration grows: *Dealing with High Penetration Solar Generation impacts on Load Forecasting* (PPA Sept 2023) https://www.ppa.org.fj/wp-content/uploads/2023/10/PPA-2023-presentation-Itron.pdf Current roof top solar installations do not require grid infrastructure upgrades due to their low energy export and effectively act as a negative load. It can also be argued that those roof-top systems installed by SEIAPI members typically reduce the stress on the transmission line (by reducing the power transfer length) and thus help in reducing transmission losses.

[6] EFL's peak demand is about 180 MW. There are about 20 MW of roof-top solar PV in Fiji, mostly in sunny parts of the country. Assuming they produce 90% of rated peak output, EFL's peak drops by18/180 or 10%.

[7] From the EFL submission: "customers with roof top solar treat EFL as their natural backup 24/7. In the event of cloud cover, continuous raining, cyclone and at night when the sun is not shining and the rooftop solar is not generating, then they resort to national electricity grid for power supply." This effectively nullifies EFL's allegations.

[8] See *Annex 1: Fiji Country Private Sector Diagnostic: Electric Power,* excerpted from *Country Private Sector Diagnostic* (World Bank-IFC, May 2022) https://www.ifc.org/en/insights-reports/2022/cpsd-fiji

[9] Edited from *Some Rare, Real Talk From a Utility About Competition With Rooftop Solar* (21 Sept 2023) https://insideclimatenews.org/news/21092023/inside-clean-energy-utilities-rooftop-solar-competition-profits/

international evidence shows that costs are small at low penetrations of Variable Renewable Energy (VRE), as in Fiji, and can even be negative.[10] In Australia, for example, where about 35% of homes have roof-top solar, there has been no grid impact, a positive impact or a negative impact, depending on assumptions and the communities studied, but the study concludes that an *equitable* fixed plus variable tariff can be quite difficult to develop and needs careful consideration.

There can also be advantages in replacing existing diesel units in island grids with RE sources in terms of system reliability. Another recent study shows that by introducing RE systems to an island's grid, the reliability of the grid can increase by up to 50% and cable capacity usage drops by as much as 30%.[11]

EFL's submission suggests that high income households investing in solar systems disrupt the grid,[12] requiring substantial additional funds for maintenance. Household consumers[13] account for less than 27% of sales by revenue (*EFL Annual Report* 2022) and perhaps less by MWh of energy consumed. There are very few grid-connected household roof-top PV systems in Fiji.[14] These tend to be small (about 3-5 kWp) and their impact on the grid is insignificant. Even if we consider all private grid-connected roof-top PV systems (overwhelmingly commercial / industrial), these provided[15] only 3.1% of Viti Levu grid generation in 2022 and fed into the grid only 0.2% of the Viti Levu Integrated System (VLIS) generation. The International Renewable Energy Association (IRENA)[16] considers 40 MW of roof-top distributed PV plus 25 MW of utility-scale PV as 'conservative upper bounds for *initial* PV deployment in Viti Levu' which is far more than current installations.

In brief, EFL has provided no evidence that roof-top PV (domestic, commercial & industrial combined) has any significant effect on the stability of the Viti Levu grid (and its O&M costs), even with significant growth.[17]

We recommend *that FCCC independently assess assess EFL's dubious claim that rooftop solar necessities the proposed new tariff structure with a fixed daily charge. If the key justification for a fixed plus variable charge is the impact of grid-connected PV systems, we urge FCCC to*

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[10] *A systematic review of the costs and impacts of integrating variable renewables into power grids* (Nature Energy, 2021) https://www.nature.com/articles/s41560-020-00695-4

[11] *Grid Island Energy Transition Scenarios Assessment Through Network Reliability and Power Flow Analysis* (Front. Energy Res., 19 Feb 2021) https://www.frontiersin.org/articles/10.3389/fenrg.2020.584440/full. The study suggests that it would not be necessary to modify the grid cables when substituting the diesel generator.

[12] This is based on other countries which subsidise household roof-top solar, which is not the case in Fiji and (even if accurate) is irrelevant.

[13] EFL's domestic category includes private households plus places of worship, schools, other institutions and streetlights. Most are private households.

[14] We have sought details on numbers, size & location of all roof-top PV systems from EFL (which provides contracts for feed-in to the grid), and from FCCC. EFL declined to provide the information and FCCC has provided no information. Our estimates are based on limited available data from EFL and on installations known to SEIAPI members.

[15] SEIAPI estimate is based on a maximum of 20 MW roof-top PV generating 29,200 MWh in 2022 (assuming an average of 4 kWh/kWp). EFL (presentation, Nov 2022) shows 1525 MWh fed into the grid in 2021 from *all* roof-top solar (not just domestic), with an apparent significant drop in 2022 but we assume 1525 MWh for 2022 as well. VLIS generation is from *EFL Annual Report, 2022*.

[16] *Grid Integration Assessment: Viti Levu, Fiji* (IRENA, 2020). We had access to the summary report but not the full technical report.

[17] There is a good overview of risks, benefits, opportunities etc. of VRE at *Facilitation of High Penetration of Variable Renewable Energy in Pacific Island Country Utility Grids* (Pacific Power Association, Nov 2022) https://www.ppa.org.fj/presentations/ppa-2022-conference/

reject it. If FCCC agrees that this sort of structure is justified, we recommend that it be developed in a manner that does not penalise those private companies and individuals who have invested in solar systems. The tariff should encourage such investment. FCCC should approve a tariff structure and magnitude based on an equitable arrangement among consumer classifications, concern for low-income households and fair treatment of those who invest in Fiji's energy infrastructure including those who invest in commercial or home roof-top solar systems.

2. EFL alleges that roof-top solar particularly harms lower income consumers

EFL claims that in countries with PV incentives, only high-income people invest in solar. However, there is no such incentive in Fiji, unlike for solar water heating in the 1980s. It is claimed that, as higher-income individuals in Fiji continue to invest more in solar PV, there will be a reduced customer base which will require low-income people to cover EFL's high maintenance costs. As neither EFL nor FCCC have provided the information we requested on the numbers, sizes and locations of household and other rooftop PV systems, we do not have precise numbers of solar PV systems. However, commercial systems overwhelmingly dominate in terms of any feasible impact. We estimate that only 0.2%[18] of EFL's household customers have roof-top solar installations. If these grew at an unlikely high rate of 20% per year, in 5 years there would be only 1,000 household systems, only 5% of all current grid-connected households. This would not stress the grid or require a higher rate of grid investment and maintenance than what is already needed. The EFL customer base in five years will have grown far more than this.

EFL has provided no evidence that growth in household roof-top PV has had, or will have, a significant impact on grid investment and O&M costs. There seems to be no justification that low-income households would have to bear a high and unfair burden to meet these costs. Impacts on different consumer classifications, and technical impacts, can vary widely in different situations but tend to be benign with low grid penetration, as in Fiji now and over the four-year tariff period.[19]

***We recommend** that EFL be required to fully justify its allegations. We feel there is no justification in a change in the structure of the tariff which EFL claims is to remedy an alleged problem, and its impact on low-income consumers, that does not in fact exist.*

3 EFL's proposed tariff has very different impacts for different customer classifications

The table on the next page provides a rough indication of likely impacts on different categories of consumer of EFL's proposed formula. This ignores the reactive tariff and any discounts. Obviously different assumptions regarding representative loads and energy use within the categories could change the percentage increase. For example, a subsidised domestic customer consuming 50 units (kWh)/month would experience a 36% cost increase; at 100 kWh this would be 14%. The same percentages would apply to the VIP cost, but 15% higher.

We are not experts in establishing an equitable structure for electricity tariffs. However, we note that:

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[18] In 2022 (EFL *Annual Report*) EFL had 214,628 customers of whom 195,250 were domestic. Assuming that 95% of the latter are households, EFL has 185,490 household customers. If 400 of these have solar PV systems (which we believe is a high estimate) this is only 0.2% of households.

[19] *A systematic review of the costs and impacts of integrating variable renewables into power grids* (Nature Energy 2021) https://www.nature.com/articles/s41560-020-00695-4

"The existence of fixed and variable components of the price plays a significant role and a simple change of the electricity tariff may bring significant savings and shorten the payback time of PV investment (or the reverse). However, this is a complex issue and requires several other factors to be considered. The most important ones are the fixed component of the electricity price, household consumption diagram and the distribution system to which the household is connected. *The fixed component is dominant mostly in case of low consumption levels*"[20] (typical of most Fiji consumers) so the level of this component needs to be carefully considered.

Impact of Proposed EFL Tariff on Customers by Classification

Current & Proposed EFL Charges per Month VAT Excluded (discounts & subsidies ignored)										
Category	------ Current Charge ------			------------- Proposed Charge -------------				---- Assumptions ----		% change
	Energy	Demand	Total	Energy	Daily	Demand	Total	(one month = 30 days)		
	$/kWh	$/kW	$/month	$/kWh	$/day	$/kW	$/month	kWh/m	kW	
subsidised domestic	0.3401	0.00	$30.61	0.3123	0.25	0.00	$35.61	90	0	16%
domestic, church, etc	0.3401	0.00	$68.02	0.3223	0.65	0.00	$83.96	200	0	23%
commercial (≤ 14,999 kWh/m)	0.4099	0.00	$4,099.00	0.4842	3.00	0.00	$4,932.00	10,000	0	20%
commercial (> 14,999 kWh/m)	0.4295	0.00	$8,590.00	0.5805	3.00	0.00	$11,700.00	20,000	0	36%
industry 1 (75-500 kW)	0.2781	35.3300	$15,409.00	0.2888	450.00	36.4047	$29,444.94	30,000	200	91%
industry 2 (500-1000 kW)	0.3026	37.5700	$40,281.50	0.2334	2000.00	28.5094	$90,718.05	40,000	750	125%
industry 3 (>1000 kW)	0.3270	39.2400	$104,640.00	0.2265	4500.00	26.5368	$206,193.60	80,000	2,000	97%
reactive (PF<85%)	0.4295			0.5875						

Consumers who are, or are not, especially concerned with energy efficiency are not EFL classifications but EFL's submission asserts that a fixed daily charge plus variable charge mechanism promotes commercial sector energy efficiency by sending the correct market signals. A higher overall electricity cost might encourage efficiency in energy use but EFL provides no evidence that the structure of the tariff does so. EFL has never seriously promoted demand side (consumer) energy efficiency and can do so through provision of professional energy auditing services, not spurious claims.

***We recommend** that FCC carefully assess the likely percentage increase in electricity costs for typical consumers in each category, and assess whether the requested allocation is equitable. We request FCCC to carefully consider the effects of the requested allocation of total cost between the fixed daily charge and the energy charge.*

4. EFL has not justified an overall tariff increase of 32%

The World Bank[21] reports that Fiji has relatively low electricity tariffs compared to other Pacific Island Countries, but tariffs are *roughly double* those of countries with a similar generation mix. Also, Fiji has one of the highest connection costs in East Asia & the Pacific, almost double the regional average. This does not suggest efficient planning and the best use of financial resources.

EFL request an overall increase of about 32% (actually 32.5% or higher) over 4 years to implement its 2022-2031 10-year plan. There are several reasons to question this increase:

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[20] *Impact of the fixed and variable component of electricity price on the economic viability of a small-scale photovoltaic power plant* (April 2021 Journal of Electrical Engineering 72(2):140-147) https://www.researchgate.net/publication/351571655_Impact_of_the_fixed_and_variable_component_of_electricity_price_on_the_economic_viability_of_a_small-scale_photovoltaic_power_plant

[21] *Fiji Country Private Sector Diagnostic: Electric Power* (World Bank-IFC, May 2022), which is attached as Annex 1. Excerpted from https://www.ifc.org/en/insights-reports/2022/cpsd-fiji

a) There are two scenarios in the plan for Viti Levu. The one selected, EFL's base case for financial and growth forecast assumptions, assumes below average – but unspecified – future rainfall (and thus lower hydro output) with capital invest needs of F$4.3 billion. Of the total about $2b is for five hydropower projects averaging $400 million each. EFL assumes, reasonably, that the hydro finance must be assured soon, or project development will be deferred, and ultimately be more costly. However, the required $4.3b capital investment falls significantly to $2.3b if hydro output is assumed to be consistent with recent rainfall patterns. It may be prudent for EFL to assume low rainfall but Fiji climate change studies do not unambiguously support this assumption. As shown in Annex 1, from the climate knowledge portal of the World Bank, there has been no significant upward or downward trend in precipitation in Fiji from 1971-2020 but there has been a significant *increase* from 1991-2020.

   Projections of future climate change in Fiji and the implications for energy infrastructure vary widely depending on assumptions regarding global emissions reductions and the effects of the South Pacific Convergence Zone (SPCZ) that heavily influences Fiji's climate, effects dependent on SPCZ movement (north or south). It may be prudent for EFL to assume a worst-case scenario of low hydro output, at considerable potential cost to the consumer and the Fiji economy, but it is also prudent for FCCC to independently assess this assumption.[22]

b) If EFL is in fact correct about declining hydro output per installed MW, why has it not considered a significant investment in solar PV to counter this decline? With a 40-year history of hydro development, it is plausible that EFL has already developed the best hydro sites (those with lower costs per MWh) and may be developing those with higher costs per MWh, more erratic output as the climate changes, and higher risks. When hydro output drops (drought, low rainfall) solar output rises (sunny conditions) so the two to some extent can balance the deficiencies of the other and potentially provide opportunities for stored hydro (as hydro is used more sparingly when VRE supplies energy). Why does the 10-year plan assume such a small amount of presumably low-cost PV development compared to hydro?

c) EFL justifies the increase by arguing that it catches up to Fiji's inflation – the consumer price index (CPI) – since the last tariff revision. According to the EFL submission, "inflation … sets the benchmark for revision to [the] electricity tariff." EFL's inflation rate is not the same as Fiji's CPI. For example, imported fuel is EFL's single largest expense but is not linked to Fiji's CPI, nor are many of EFL's other expenses. Fuel and energy equipment for generation, transmission and distribution are globally priced.

d) EFL assumes a 4% annual increase in electricity generation. Its 10-year plan would have considered a range of assumptions about Fiji's economic growth, tourism, electric vehicle uptake, etc. There are presumably analyses which indicate the sensitivities of various assumptions but these are unavailable to the public to assess.

e) EFL claims the tariff increase is required to ensure a reasonable rate of return. The recent return of around 7% – EFL's Return on Shareholder Fund – is considered (by EFL?) to be on the lower side for energy companies limited by shares. EFL's return was higher from 2015-2020 and EFL does not state what return the requested tariff increase is expected to

[22] Future climate projections point to a worst-case scenario if the world follows a high emissions pathway up to 2040 and the SPCZ moves south, while best-case scenarios are dependent on the world maintaining a low emissions pathway until 2040.

provide, and what it considers to be reasonable. A Nov 2022 review[23] of tariffs in a number of countries concluded that a 'reasonable' profit considering the electricity market competition should be modest and limited to about 8% every year.

f) EFL does not know the actual generation of electricity by solar PV or other RE generation, just the amount fed to the EFL grid. It is not known whether EFL has considered behind-the-meter[24] generation and its growth in its investment plans and whether this is considered to be significant.

Considering the above discussion, ***it is recommended*** *that FCC consider carefully whether EFL is justified in obtaining a tariff increase of over 32% when this appears to be based on questionable assumptions, including worst case hydro output, yet emphasises further hydro development.*

5. EFL's 2022-2031 plan is inconsistent with national renewable energy policies and obligations, and seems likely to result in higher electricity supply costs

FCCC (Annual report 2018-2019) has written that "regulation is an important means for *accomplishing Government policy objectives* while driving market economies" but EFL is not achieving or even moving towards key energy sector government objectives. EFL's own goal is 90% RE to the grid by 2025[25] and the government is committed to 100% grid-connected RE by 2030. EFL, majority government-owned on behalf of the people of Fiji, has an obligation to act in consistency with these policies, yet future RE to the grid is expected to *decline*, with petroleum fuel (EFL's highest cost generation) growing from 35% of generation (2022) to between 46-62% (2031), with 62% as the base-case, despite a government policy[26] banning heavy fuel oil by 2030. Solar energy is the least costly investment for Fiji with an estimated cost per kWh under half of EFL's fuel cost per kWh alone,[27] and the trend for heavy fuel oil costs has been increasing over time.[28]

We recommend *that FCCC require EFL to explain and revise its 10-year plan in which petroleum fuel use grows, and possibly high-cost low-output hydro is prioritised, but low-cost solar contributes only 2.8% by 2031. EFL has apparently not seriously considered possibly*

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[23] *A Review of Electricity Tariffs and Enabling Solutions* (Nov 2022) https://www.researchgate.net/publication/365403523_A_Review_of_Electricity_Tariffs_and_Enabling_Solutions_for_Optimal_Energy_Management/link/637442542f4bca7fd0640419/download

[24] Behind the meter PV generation obviously is not measured by EFL – it is behind the meter – but it can be estimated reasonably accurately from selected systems (system software retains detailed records of energy flow from the inverter) and through independent estimates (e.g., the World Bank's Global Solar Atlas. (2022), *Global Photovoltaic Power Potential – Fiji* https://globalsolaratlas.info/download/fiji which is also included in the *Fiji Renewable Energy Integration Investment Plan* (Fiji Ministry of Finance, draft, Sept 2023) https://fijiclimatechangeportal.gov.fj/ppss/climate-investment-funds-cif-renewable-energy-integration-rei-investment-plan-ip/

[25] EFL 'aim to provide clean and affordable energy solutions to Fiji with at least 90% of the energy requirements through renewable sources by 2025". (EFL Annual Report, 2022

[26] *Fiji National Energy Policy* 2023-2030.

[27] The cost of solar PV to EFL's grid is not known but we estimate a levelised cost of energy of F$0.13/kWh including lifetime O&M costs. In 2022 FEA's *fuel costs alone* were F$0.32/kWh for all its petroleum fuelled generation (calculated from data in EFL's Annual Report, 2022) and thermal generation has far higher O&M costs than those of solar. To be comparable with diesel, some storage costs must be added but battery costs have fallen rapidly.

[28] EFL's generation from petroleum-based fuels is about 19% industrial Diesel Oil (IDO) and 81% Heavy Fuel Oil (HFO). See Annex 3 *Heavy Fuel Oil Price trends 2015 - 2023* https://www.benzinga.com/pressreleases/23/07/33348849/fuel-oil-price-trend-analysis-historical-chart-and-forecast-analysis

lower-cost more resilient investment, thus 'requiring' a higher charge to consumers. Any tariff increase should be contingent on amendment of the 10-year plan with credible assumptions.

6. EFL planning for climate change risk and mitigation appear to be inadequate and may ignore legal obligations, which will be costly to later address

"Despite The Government of Fiji's commitment to ensure resiliency, Fiji's energy infrastructure is vulnerable to climate- and disaster-related hazards, which affects energy reliability [and] hydropower generation is highly vulnerable to extreme drought. … These vulnerabilities subject Fijians to frequent and significant power outages during disaster. … There is no financial deterrent [for EFL] to limit power outages." (World Bank; See Annex 1)

It is understood that EFL plans investment in its transmission and distribution (T&D) systems in part to improve current reliability and redundancy, but also to allow high levels of energy feed-in from utility scale PV. If done with foresight, improved T&D can also accept quite high levels of VRE throughout the grid, in particular the circular grid system of Viti Levu.

EFL plans a short 132 kV transmission line in the NW of Viti Levu from Virar to Koronubu (EFL Annual Report, 2022). This would provide more resilience for proposed IPP solar PV and security for consumers in that part of Viti Levu but it seems that NE Viti Levu, and much of the south coast (including the large demand in the Suva area), would remain vulnerable to extended outages[29] when hurricanes or other disasters affect the current 132 kV lines (as has happened). Considering that Fiji's future climate is expected to be increasingly volatile and less predictable, EFL should consider the viability of mini-grids along the main Viti Levu circular grid (with distributed generation and storage), that could disconnect from the main grid during/after natural disasters. This can improve climate resilience in and near those areas.[30] There can be challenges with distributed RE generation and decentralised energy[31] distribution but these days various software provides greater visibility of the negative load supplied from behind-the-meter RE systems allowing real-time information about power changes, demand or surges and better grid resilience and quality of supply.

A new tariff is valid for four years but utility capital investment for generation and T&D infrastructure should have a design life of 30+ years. EFL investments within the next decade, *and within the 2023-2027 tariff period*, should be consistent with expected conditions in 2050 and well beyond. EFL does not appear to have designed for improved long-term resilience and security[32] anticipating likely climate conditions for that period. The logic of its 10-year plan investments (bias on hydro, little on transmission resilience) appears to be questionable and could be very costly to the general public, particularly with significantly increased reliance on high-cost diesel generation.

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[29] and/or increased reliance on expensive petroleum fuelled electricity

[30] "Mini-grids are highly suitable for remote load centers and offer an opportunity to accelerate electrification through diversification" from *Scaling Mini-Grid* (International Finance Corporation, 2022). IFC is supporting EFL to develop about 15 MW of solar PV to the grid. https://www.ifc.org/en/insights-reports/2022/brochure-smg

[31] *DERs to reach renewable energy targets* (Microgrid Knowledge Oct. 5, 2023) https://www.microgridknowledge.com/sponsored/article/33012603/comap-derms-smart-energy-management-solutions-supporting-ders-to-reach-renewable-energy-targets

[32] The *EFL Annual Report* (2022) refers to a risk management review and risk mitigation strategies but it is not known if this includes climate change or actions to mitigate climate risk.

Fiji's energy infrastructure is "vulnerable to flood damage, with 16–18% of grid and transformer assets … immediately vulnerable to a 1-in-5 year flood, and a further 18–20% with potential vulnerability to localised flooding."[33] 88% of planned new generation (EFL and IPPs) from 2022-2031 is hydro (Annex 1). "There is a lack of diversification in Fiji's energy matrix which leads *to an overreliance on hydro, which in turn makes the country's electricity infrastructure less resilient and more vulnerable to climate risks*, such as drought or floods."[34] A new report in a highly-respected journal concludes that even under a stringent mitigation scenario, coastal flood risk in small island developing states (SIDS) is projected to increase by more than an order of magnitude by the end of this century. By 2100, without adaptation, climate change would amplify present direct economic damages from coastal flooding by more than 14 times under high-emissions scenarios. Keeping global warming below 1.5°C could avoid almost half of unmitigated damage. "Our results underline that investments in adaptation and sustainable development in SIDS are urgently needed" [35] and EFL needs to address this in both its planning and actions.

Under Fiji's *Climate Act* (see Annex 4, excerpts), EFL is *legally obligated* to consider climate change effects on its services, plan for climate resilience, consider financial risks arising from climate change, consider liability risk from the failure to address the risks, adopt measures to reduce exposure to these risks, and compliance with Paris Agreement long-term temperature goals. EFL's 10-year plan, it's 2022 annual report, and its current request for a tariff revision, do not provide any assurance that this has been taken seriously. Under Fiji's *National Climate Finance Strategy* (Annex 5, excerpts) there are numerous planned investments in the electricity sector that EFL could, and should, have considered in its planning.

***It is strongly recommended** that FCCC obtain and assess EFL's climate risk mitigation plans and ascertain that they meet legal obligations. If not, any tariff increase should be contingent on development of a credible mitigation plan which reduces risks and better serves the public.*

7. The tariff methodology is unsuited for Fiji's current and expected future conditions and requires review and modification

"By paying utilities based on how many assets they build, and by charging customers based on how much electricity they sell, utilities have every incentive to build more stuff and sell more electricity. Unfortunately, this 'throughput incentive' runs counter to policy goals such as reducing electricity use and increasing access to alternative generation such as distributed PV systems. When faced with technologies and programs that can reduce their earnings, utilities' responses have often been predictable."[36] The paper quoted suggests a decoupling mechanism (Performance-Based Ratemaking[37]) to remove utility disincentives to support energy efficiency and solar energy."

[33] *Fiji Climate Risk Country Profile* (World Bank, 2021); https://climateknowledgeportal.worldbank.org/country-profiles

[34] *Climate Investment Funds Renewable Energy Integration Investment Plan for Fiji* (draft, Sept 2023) https://fijiclimatechangeportal.gov.fj/ppss/climate-investment-funds-cif-renewable-energy-integration-rei-investment-plan-ip/

[35] *Small Island Developing States under threat by rising seas even in a 1.5°C warming world* (Nature Sustainability, 9 Oct 2023) https://www.nature.com/articles/s41893-023-01230-5.pdf?pdf=button%20sticky

[36] *Utility Rate Design & Complementary Policies* (Solar Energy Industries Association) https://www.seia.org/initiatives/utility-rate-design-complementary-policies

[37] Well-designed performance-based mechanisms can eliminate the link between utility profits and utility sales, reward utilities for improving customer service and system reliability, encourage improved energy efficiency

FCCC's methodology may have been reasonable in the past when the utility (then FEA) was a state-owned enterprise but it no longer addresses Fiji's needs at a time when the utility (now a privatised EFL) seems to be more concerned with profits than national priorities. We also need a smooth, rapid transition away from increasing petroleum fuel use to a balanced[38] and resilient RE system, and this will require financial and other regulatory incentives for EFL.

Electricity rate designs "must be reformed to ensure a stable transition to less carbon-intensive sources and secure utilities' role in the future system. Updated designs must align rates with system-wide costs, encourage flexibility, and address customers' differing needs. Rate components (e.g. fixed daily fee) do not reflect their costs to the system. Accurately reflecting system-level cost breakdowns will motivate distributed generation, behind-the-meter storage, and other distributed energy resources (DERs) where they are economically efficient."[39]

This submission has discussed RE extensively but not energy efficiency. Fiji's new near-final draft building code[40] "focuses on sustainable building design and climate resilience and is a key component in fulfilling Fiji's commitment to creating a greener and more sustainable future" and has strong requirements for more energy-efficient building design. Roughly 40% of electricity use in Fiji is for buildings but demand side management (DSM) for improved energy efficiency has long received only lip service within EFL. Currently EFL has no legal requirement to assist customers reduce energy consumption for new or existing buildings. However, the 2023 *Fiji Renewable Energy Integration Investment Plan,*[41] Fiji's submission to the Climate Investment Fund (CIF) for sustainable energy financial support and technical assistance, notes that EFL will have to play *the lead role* for all DSM and demand response programmes in government's investment plans. Improved energy efficiency is also a goal in numerous Fiji government policy documents.

An earlier (2015) report[42] identified the need for an independent regulatory body in Fiji capable of evaluating the design and implementation of RE support mechanisms and programmes. It concludes that evaluation by the regulator (FCCC) should take into consideration their effectiveness, efficiency, equity and administrative impacts. Although dated, it still has some useful suggestions.

In 2018, FCCC regulated an off-grid (micro-grid) electricity tariff in Vio village, noting that the project aligned with government policy on renewable energy and with the Climate Action Plan (FCCC Annual Report, 2018-2019). Considering the high priority accorded by the government to 100% electrification of communities throughout Fiji,[43] regulation of electricity supply throughout Fiji should be an FCCC function, if it is not already.

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and maximum solar energy penetration, and sets specific energy efficiency and clean distributed generation targets, rewarding utilities for achieving those targets.

[38] Balanced between hydro and solar which complement each other (solar more productive in dry sunny conditions; hydro when rainy) but also balanced between larger EFL-owned RE to the grid and smaller distributed RE throughout the circular grid (Viti Levu) and small island girds (elsewhere).

[39] *Solving the rate puzzle: The future of electricity rate design* https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/solving-the-rate-puzzle-the-future-of-electricity-rate-design#/

[40] *Fiji National Building Code* (2nd draft, June 2023) https://www.mims.gov.fj/wp-content/uploads/2023/06/Fiji-National-Building-Code-Draft-2.pdf and *Fiji Home Building Manual* (2nd draft June 2023) https://www.mims.gov.fj/wp-content/uploads/2023/06/FHBM-Draft-2-for-Review.pdf

[41] Sept 2023 draft. We do not have access to the revised final draft submitted to CIF on 6 October

[42] *Proposals for Renewable Energy Support Mechanisms – Fiji* (IT Power Renewables; 2015), which should be available from the Fiji Dept of Energy

[43] *Climate Investment Funds Renewable Energy Integration Investment Plan for Fiji* (2023)

It is strongly recommended *that the FCCC methodology be reviewed and updated*[44] *well before the next tariff review to be consistent with Fiji's changing conditions and needs. This should provide financial incentives to EFL to embrace distributed renewable energy and improved DSM energy efficiency. It is also recommended*[45] *that an independent review be carried out of the terms and conditions of the feed-in tariff offered by EFL for power to the grid and that FCCC formally regulate charges for all off-grid mini-grid systems beyond the current EFL supply areas.*

Finally, a new tariff system should incentivise EFL to plan for the most robust energy system for a wide range of volatile and unknown but credible future conditions. It is no longer appropriate to design for the best system under past or current conditions; that is not the future we face.

Concluding remarks

Distributed renewable energy (DRE) along the grid, both for Viti Levu and less populated islands, is the logical future for a reliable, robust electricity supply which is resilient for a near future of unpredictable and variable climate, with the probability of stronger cyclones and floods along the coasts. As decisions and investments made today will determine our electricity future for decades, EFL's investments now must help prepare for such a future.

FCCC cannot dictate specific EFL investments but, in the interests of the nation and the consumer, should ensure a tariff structure that encourages, not penalises DRE. The tariff should acknowledge, and take into consideration, that resorts, many businesses and some households have invested quite significant amounts of money into solar PV, and thus reduce EFL's needs for investment in generation facilities. Under its tariff methodology, FCCC may not be able to include this investment, but it can, and should, ensure that these investments that help Fiji transition to a clean energy future are in some way reflected in the tariff determination.

SEIAPI feels that solar PV, whether roof-top or utility scale directly to the grid, contributes considerably to Fiji's energy sector goals and commitments. We acknowledge the challenge of distributed variable renewable energy and offer to work with EFL to better plan for its inevitability.

Annexes

Annex 1: Fiji Country Private Sector Diagnostic: Electric Power

Annex 2: Rainfall Precipitation Trends Fiji

Annex 3: Fuel Oil Price trends 2015 - 2023

Annex 4: Excerpt from Climate Change Act of 2021

Annex 5: Fiji's National Climate Finance Strategy (excerpts)

Annex 6: Resources

[44] The Ministry of Finance has reportedly (6 October) submitted its draft proposal for Climate Investment Fund (CIF) support. There is a range of technical assistance within the proposal, with an excellent opportunity for CIF to finance an independent review of the tariff structure.

[45] "An effective IPP framework and legislation to allow net metering and establish viable feed-in tariffs does not exist [in Fiji]. IPP tariffs are viewed by prospective investors as too low for an attractive return on investment, and private sector investment in renewable energy generation is *unsurprisingly low* despite Fiji's considerable potential and the incentives recently implemented by the Government of Fiji." (World Bank, Annex 1)

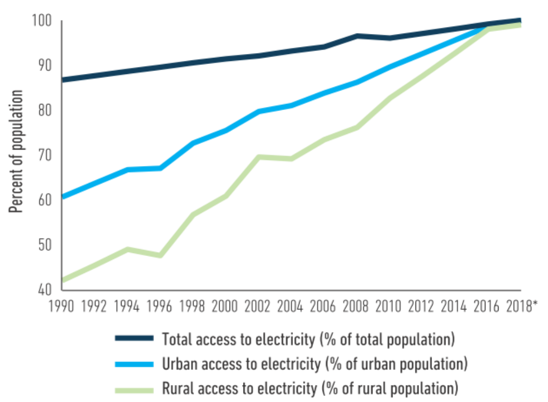
ANNEX 1: FIJI COUNTRY PRIVATE SECTOR DIAGNOSTIC: ELECTRIC POWER

Excerpt from *Country Private Sector Diagnostic* (World Bank-IFC, May 2022)

https://www.ifc.org/en/insights-reports/2022/cpsd-fiji

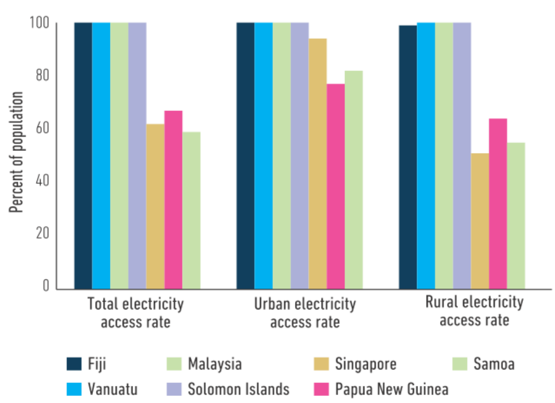
Fiji has made significant improvements in access to energy over the last few decades, but the reliability and efficiency of the country's energy supply are still deficient. Electrification rates have increased substantially for both urban and rural populations (figure 4.4), making Fiji's current access to energy rates one of the highest in the Pacific Islands and largely on par with that of aspirational peers (figure 4.5). The country's situation is thus significantly better than when electricity was reported as a major constraint to private sector development by more than 25 percent of firms in the 2009 World Bank Enterprise Survey. However, there is still considerable room for improvement in the reliability and efficiency of the country's energy supply. Suva residents experience almost five power outages per year, excluding *force majeure* events with which this number would be considerably higher. There is also no circular integrated transmission network around the country, and Fiji's networked energy sources are concentrated in its most populated islands (e.g., Viti Levu, Vanua Levu, Ovalau, Taveuni),[1] which suggests that outage events outside of these islands are likely more frequent. This severely constrains the growth of economic sectors that depend on a stable supply of electricity, such as outsourcing services and telehealth, which require it for data servers and other digital equipment, and pharmaceutical warehouses and agrilogistics services, which need it for cold chain distribution and storage. Service restoration when power outages occur is also substandard, and businesses generally report that they lack control over their energy supply in order to manage energy costs efficiently.

FIGURE 4.4: ACCESS TO ELECTRICITY, 1990–2018



Source: WBG—Sustainable energy for all indicators
* WB estimate

FIGURE 4.5: REGIONAL BENCHMARKING—ACCESS TO ELECTRICITY, 2018

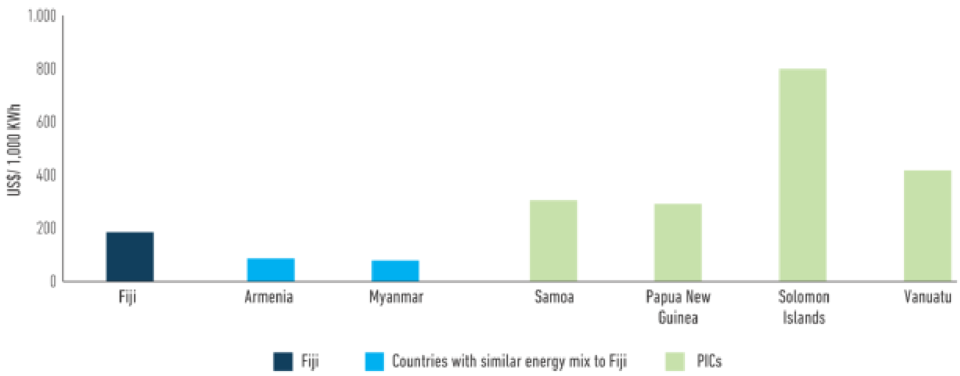


Source: WBG—World Development Indicators.

The cost of obtaining energy in Fiji is also still high. While Fiji has one of the lowest electricity tariffs in the PIC region, its rates are high relative to countries with a similar power mix (figure 4.6). Additionally, unlike maximum electricity retail prices set by the Fiji Commerce Commission for those connected to Energy Fiji Limited's (EFL's) grid, the price regulation for fossil fuels takes supply cost at a given location into consideration. Off-grid solutions reliant on petroleum-based fuels (e.g., diesel-based mini grids) in remote rural areas need to often use expensive fuels for own-generation. Preliminary assessment shows that Fiji has one of the highest connection costs in East Asia and Pacific and almost twice the regional average of F$595. The up-front cost, which is predominantly comprised of the installation materials needed for the electricity connection (e.g., service cables, meter) represents a considerable financial obstacle for many MSMEs and is even more onerous for firms located outside of Suva.

[1] Government of Fiji, World Bank, and Global Facility for Disaster Reduction and Recovery. 2017. "Fiji 2017: Climate Vulnerability Assessment—Making Fiji Climate Resilient."

FIGURE 4.6: REGIONAL BENCHMARKING—ELECTRICITY TARIFF FOR COMMERCIAL FIRMS WITH CONSUMPTION OF 1,000 KWH PER MONTH, 2019



Source: Pacific Power Association. Pacific Power Utilities. Benchmarking Report—2019 Fiscal Year; PSRC AM. Publication of Tariffs 2019; Myanmar Times, First power tariff hike in five years.

Problems with energy reliability, efficiency, and cost in Fiji are largely due to infrastructure deficiencies. Thermal generation is predominant in Fiji, and approximately 50 percent is diesel based. A cheaper option used in larger countries, such as gas fired generation, is not feasible due to the size of the electricity grid in Fiji.[2] Not surprisingly, this leads to significant higher generation costs than in other countries with similar energy mixes.[3] Additionally, while EFL[4] maintenance of infrastructure is excellent, its grid equipment is antiquated, leading to substantial reliability and efficiency issues. It mostly lacks modern smart-grid technologies (e.g., smart metering systems, automatic reclosers) and online smart-meter reporting: (1) precluding businesses from gaining insights into their consumption patterns and identifying saving opportunities; and (2) inhibiting EFL from running the grid closer to its full potential through collection of time of use data, prevention of short circuits, and implementation of outage management.

Despite The Government of Fiji's commitment to ensure resiliency,[5] Fiji's energy infrastructure is also vulnerable to climate- and disaster-related hazards, which affects energy reliability. Substations and transformers in Fiji are generally located near coastal areas, and a large proportion of distribution lines are still above ground and reliant on a single transmission line.[6] Similarly, thermal generation stations, which account for more than 42 percent of grid-based energy supply,[7] are often located on the coast. All these conditions expose Fiji's electricity grid to cyclones and floods. Meanwhile, hydropower generation stations, which are 53 percent of the country's grid-based energy supply are highly vulnerable to extreme drought (e.g., caused by El Niño), while solar and wind power stations can be negatively impacted by strong winds. Off-grid solutions (e.g., mini-hydro, diesel-based mini grids, solar home systems) are also similarly exposed.[8] These vulnerabilities subject Fijians to frequent and significant power outages during disasters, as in the case of recent extreme

[2] Fiji CPSD Private Sector Consultations. May 2021.

[3] This situation, in addition to the Nationally Determined Contribution (NDC) targets made by Fiji, have pushed the Government of Fiji to commit to having 100 percent of its electricity generation supplied by renewable energy sources by 2036.

[4] EFL, which is the new name of what was previously known as the Fiji Electricity Authority (FEA), is the government-owned statutory agency that is responsible for the generation, transmission, distribution, and retail of electricity in Fiji.

[5] Government of Fiji outlines electricity infrastructure resiliency as one of its priorities in Fiji's 2017 National Development Plan. It has also already taken several steps to improve resiliency. For example, EFL has increased the undergrounding of distribution and transmission lines, solar home units managed by the Department of Energy are designed so customers are able to remove panels and store them inside their house, and some wind farms are designed so turbines can be lowered when high winds pose a risk.

[6] Government of Fiji, World Bank, and Global Facility for Disaster Reduction and Recovery. 2017. "Fiji 2017: Climate Vulnerability Assessment—Making Fiji Climate Resilient."

[7] Energy Fiji Limited. Annual Report. 2019.

[8] Solar home systems and wind powered mini grids can be affected if they are not dismounted in time, and diesel generated mini grids can be impacted if they are located in exposed areas (e.g., near the coast).

weather events like TC Winston and TC Evan, which resulted in damages amounting to almost 1 percent of Fiji's GDP.

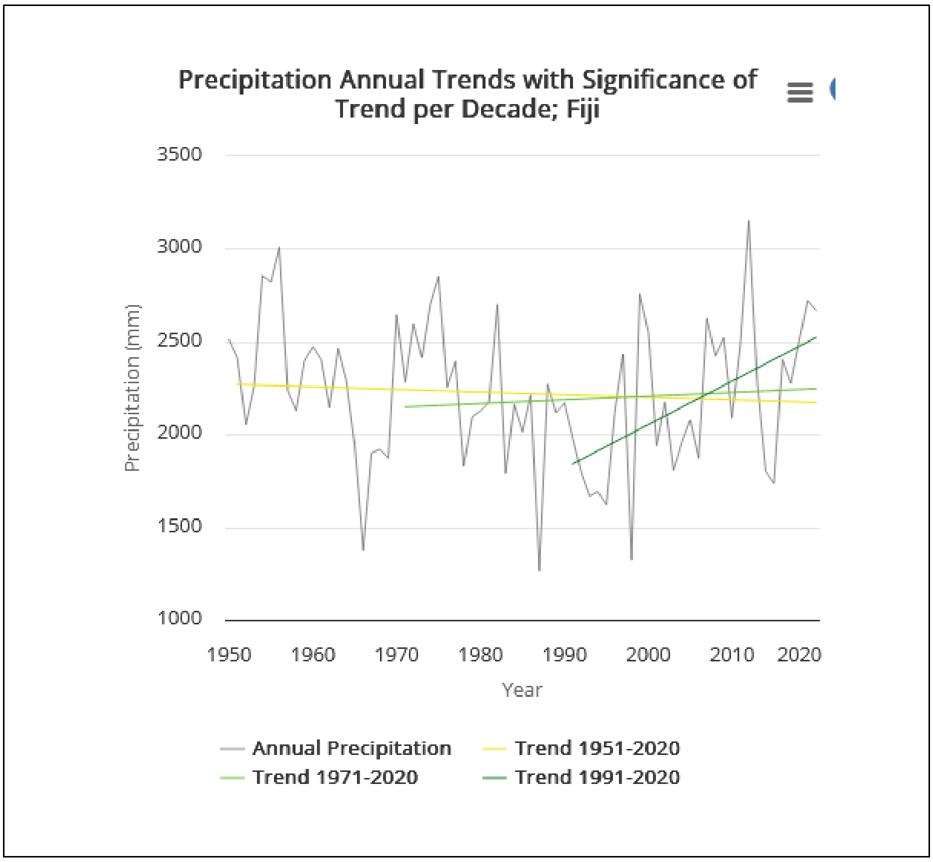
Institutional weaknesses contribute to the persistence of reliability, efficiency, and affordability issues. Fiji does not currently have an independent technical regulator to monitor EFL's reliability of supply, while economic regulation is undertaken by FCCC with mixed effectiveness.[9] This diverges from most of the countries in its region (e.g., PNG, Samoa, Vanuatu) and from its aspirational comparators (e.g., Malaysia, Singapore), and has led to a situation where no financial deterrent to limit power outages has been introduced in Fiji. More importantly, institutional weaknesses have contributed to the postponement of necessary investments to improve the reliability, efficiency, and cost of Fiji's energy infrastructure (e.g., additional transmission lines, underground distribution lines, increase of renewable energy power generation sources). While the Government of Fiji committed to these improvements in its five- and twenty-year National Development Plans published in 2017, the required investment is significant—an estimated F$2.4 billion in power generation, transmission, and distribution assets to increase renewable energy generation,[10] and appreciably more for other objectives. As such, it is unlikely to be financed by the public sector alone, and private sector investment is urgently needed.

Attracting private capital to the energy sector has proven difficult to date with the country's current regulatory framework. For example, while opportunities for independent power producers (IPPs) for distributed and renewable energy generation and for the supply and operation of mini grids could crowd in considerable amounts of private sector capital, this has yet to happen. IPP generation between 2010 and 2019 has increased by only 29,000 MWh, in comparison to a total increase in grid generation of 1.061 million MWh. This is largely because an effective IPP framework and legislation to allow net metering and establish viable feed-in tariffs does not exist. There is a gradual shift and appetite from EFL to work closely with agencies in attracting private participation for a solar IPP through a competitive bidding process. This needs to continue across different renewable energy spectrums to allow more private sector participation. Consequently, EFL often offers IPP tariffs that are viewed by prospective investors as too low for an attractive return on investment, and private sector investment in renewable energy generation is unsurprisingly low despite Fiji's considerable potential and the incentives recently implemented by the Government of Fiji.[11]

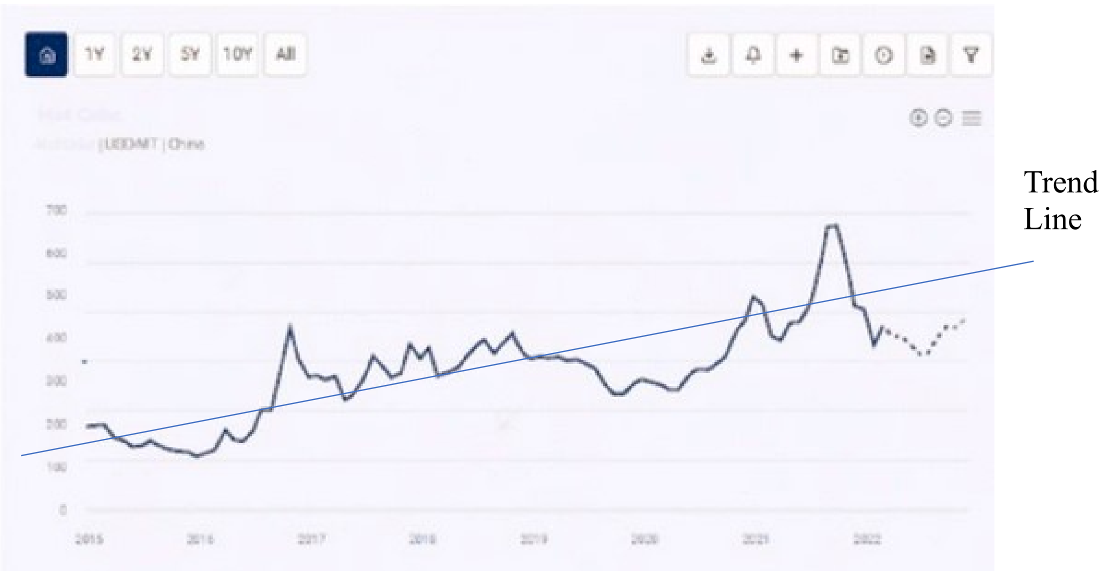
[9] Fiji's Department of Energy does not have the authority to monitor EFL.
[10] ADB and UN-ESCAP. 2019. Asia and the Pacific—Renewable Energy Status Report.
[11] For example, there is a five-year tax holiday available to taxpayers undertaking a new activity in renewable energy projects and power cogeneration

ANNEX 2: RAINFALL PRECIPITATION TRENDS - FIJI

There has been no significant trend in precipitation from 1971-2020 but there has been a significant *increase* from 1991-2020. Source: https://climateknowledgeportal.worldbank.org/country/fiji/trends-variability-historical



ANNEX 3: HEAVY FUEL OIL PRICES TRENDS 2015 - 2023



Source (Bengazi, 6 Oct 2023) : https://www.benzinga.com/pressreleases/23/07/33348849/fuel-oil-price-trend-analysis-historical-chart-and-forecast-analysis

ANNEX 4: EXCERPTS
CLIMATE CHANGE ACT 2021 (ACT NO. 43 OF 2021)

From fijiclimatechangeportal.gov.fj/wp-content/uploads/2021/12/20210927_161640.pdf

PART 15—PRIVATE SECTOR TRANSITION AND ENGAGEMENT

94.—(1) In exercising reasonable care and diligence under section 106(1) of the Companies Act 2015, directors or other officers of a company must consider and evaluate climate change risks and opportunities to the extent they are foreseeable and intersect with the interests of the company.

(2) For the purposes of this Part, climate change risks include—

(a) the physical risks associated with climate change, including both acute risks (for example extreme weather events) and chronic risks (for example rising temperatures, rising sea levels and changes in water availability, sourcing and quality) that may affect, for example, a company's premises and other assets, operations, supply chains, transport needs and employee safety;

(b) the transition risks associated with changes that may occur in the process of adjusting towards a low-carbon economy including policy and legal changes, technological changes, market changes and reputation risks associated with changing customer or community perceptions;

(c) the liability risk stemming from the failure to consider and address the physical risks and transition risks; and

(d) the economic and financial loss or impact arising from paragraphs (a), (b) and (c).

(3) For the purposes of subsection (1), climate change opportunities may include—

(a) reducing operating costs by improving efficiency across premises, operations and processes;

(b) saving on annual energy costs through shifting energy usage towards low emission energy sources;

(c) capitalising on shifting consumer and producer preferences by innovating and developing new low-emission products and services;

(d) opportunities in new markets or types of assets; and (e) enhancing climate resilience to climate change risks thus avoiding future economic costs.

96.—(1) All companies and managed investment schemes that are required to prepare financial statements and a directors' report under section 388 of the Companies Act 2015 must disclose, in their financial statements and directors' report—

(a) any material financial risks to the company or managed investment scheme arising from climate change risks and climate change opportunities;

(b) measures adopted by the company or managed investment scheme to reduce its exposure to these material financial risks;

(c) how consideration of climate change risks are integrated into investment policies, risk management policies and investment decision-making processes; and

(d) the climate change impacts of the activities of the company or managed investment scheme activities and of the use of goods and services it produces and the extent to which the company or managed investment scheme complies with the long-term temperature goal in Article 2 of the Paris Agreement.

ANNEX 5: FIJI NATIONALCLIMATE FINANCE STRATEGY (June 2022)
https://fijiclimatechangeportal.gov.fj/wp-content/uploads/2022/05/Fijis-National-Climate-Finance-Strategy.pdf

Edited excerpts relevant to EFL's investments and plans

Fiji's National Development Plan and its Climate Vulnerability Assessment call for prioritising investments, such as building additional transmission lines, adding new generation capacity, undergrounding distribution lines in targeted locations, and improving the uptake of rural mini-grids and solar home systems, that will decarbonise the sector and improve its resilience. A more robust enabling environment is needed to help the private sector invest in renewable energy options.

Fiji's climate finance priorities are: 1) Provide universal access to affordable, reliable, and sustainable energy services; 2) Increase the share of electricity generation from renewable energy sources; and 3) Improve energy efficiency in the electricity sector.

Priority 1 includes creation of a long-term resilience strategy for the electricity sector underpinned by a climate risk model that identifies which power systems and network components are most vulnerable to climate change, ensures that cost-effectiveness of measures can be properly evaluated, prioritises measures delivering the greatest net benefits, and is financeable through a variety of international and domestic sources.

Priority 2 includes increasing the resiliency of the power system by investigating more diversified and distributed generation options, including mini grids. A more distributed grid will localise any damage to the grid from extreme weather events and ensure that most people continue to have power during extreme weather events. It also includes diversifying RE generation to improve its resilience, including increasing generation from new hydro and solar facilities, expanding rural mini-grids and solar home systems, and completing feasibility studies for new biomass power plants.

Priority 3 includes investigating options for increasing electricity sector resilience by ascertaining the benefits of energy efficiency and other demand side management options. These could include alternative transmission routes, altered load capacities, and more energy efficient products. A programme for Capacity Building in Energy Efficiency in Industry provides technical assistance to conduct a national survey of the energy intensive equipment currently used by Fiji's domestic industries. This would include detailed energy audits for industry, and development of a certification system for energy auditors

ANNEX 6: RESOURCES

Climate Change Projections and Possible Impacts on Fiji Energy Sector

It is important that climate impacts are considered as EFL investments made today strongly determine our energy system and its resilience and costs, for 30 years, or more

Climate Change Act 2021. https://fijiclimatechangeportal.gov.fj/wp-content/uploads/2021/12/20210927_161640.pdf

Current and Future Climate for Fiji (CSIRO & SPREP Oct 2021) https://www.met.gov.fj/aifs_prods/Climate_Products/Fiji%20Country%20Report%20Final.pdf

Fiji - Climate Change Portal for Development Practitioners & Policy Makers (World Bank) https://climateknowledgeportal.worldbank.org/country/fiji/climate-data-projections

Fiji National Climate Finance Strategy (2022) https://fijiclimatechangeportal.gov.fj/wp-content/uploads/2022/05/Fijis-National-Climate-Finance-Strategy.pdf

Fiji - Climate Risk Country Profile (World Bank, 2021) https://climateknowledgeportal.worldbank.org/country-profiles

NextGen Projections for the Western Tropical Pacific: Current and Future Climate for Fiji (Technical Report Oct 2021 CSIRO & SPREP) https://www.met.gov.fj/aifs_prods/Climate_Products/Fiji%20Country%20Report%20Final.pdf

Small Island Developing States under threat by rising seas even in a 1.5°C warming world (Nature Sust, Oct 2023) https://www.nature.com/articles/s41893-023-01230-5.pdf?pdf=button%20sticky

Mini-Microgrids

DERs to reach renewable energy targets (Microgrid Knowledge Oct. 5, 2023) https://www.microgridknowledge.com/sponsored/article/33012603/comap-derms-smart-energy-management-solutions-supporting-ders-to-reach-renewable-energy-targets

Overcoming Barriers to Microgrid Development - A Review of Policies and Regulations Madhav Sharma & Anoop Singh May 2023 https://smartgrid.ieee.org/bulletins/may-2023/overcoming-barriers-to-microgrid-development-a-review-of-policies-and-regulations

Quality infrastructure for smart mini-grids (IRENA 2020) https://islands.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Dec/IRENA_Smart_mini-grids_outlook_2020.pdf?rev=c7f4225a301544e2bf914168ba78ad94&hash=1FC703ABF05B9C30DBA0DCDB7F900292

Scaling Mini-Grid (International Finance Corporation, 2022) Brief general non-technical summary https://www.ifc.org/en/insights-reports/2022/brochure-smg

Why the Next Microgrids Will Be Well Connected. Puerto Rico test could finally push microgrids into the mainstream (16 Sep 2023) https://spectrum.ieee.org/microgrid

Power Sector Planning for Renewable Energy in Fiji

Climate Investment Funds Renewable Energy Integration Investment Plan for Fiji (draft, Sept 2023; revised final draft of October 2023 should be available from Ministry of Finance) https://fijiclimatechangeportal.gov.fj/ppss/climate-investment-funds-cif-renewable-energy-integration-rei-investment-plan-ip/

Integrating Renewable Energy into the Grid

A Sure Path to Sustainable Solar - Solar Deployment Guidelines (ESMAP Sept 2019) Non technical overview https://www.esmap.org/a-sure-path-to-sustainable-solar_guidelines

A systematic review of the costs and impacts of integrating variable renewables into power grids (Nature Energy 2021) https://www.nature.com/articles/s41560-020-00695-4

Dealing with High Penetration Solar on Load Forecasting (PPA Sept 2023) https://www.ppa.org.fj/wp-content/uploads/2023/10/PPA-2023-presentation-Itron.pdf

EFL Renewable Energy Plan (PPA presentation, PPA, 24 Nov 2022) https://www.ppa.org.fj/wp-content/uploads/2023/01/ENERGY-FIJI-LIMITED-HASMUKH-PATEL-Environment-Stewardship-Fiji-Renewable-Energy-Plan-Support-Sustainability.pdf

EFL Fiji Renewable Energy Plan (EFL presentation 14 April 2023) Workshop on Consultation Meeting on Draft National Policy Framework on EV, Suva, Fiji

Facilitating High VRE Penetration in PICT Utility Grids (PPA 2022)
https://www.ppa.org.fj/presentations/ppa-2022-conference/

Grid Integration Assessment: Viti Levu Fiji (IRENA 2020) This is a summary. There is a full technical report which we could not access as it was confidential to the Fiji government. The director of Energy may be able to assist. https://www.irena.org/-/media/Irena/Files/Grid-Integration-for-Islands/IRENA_grid_study_Fiji_2020.pdf?rev=9c016a1ae1124da987234d26845e2b42

Grid Island Energy Transition Scenarios Assessment Through Network Reliability and Power Flow Analysis (Front. Energy Res., 19 Feb 2021) https://www.frontiersin.org/articles/10.3389/fenrg.2020.584440/full

How Smart Grids Can Support RE Communities On Small Islands (IEEE SmartGrid Apr 2022)
https://smartgrid.ieee.org/bulletins/april-2022/how-smart-grids-can-support-renewable-energy-communities-in-small-islands

Integrating Variable Renewable Energy to the Grid – Key Issues (NREL 2015)
https://www.nrel.gov/docs/fy15osti/63033.pdf

Proposals for Renewable Energy Support Mechanisms Fiji (ITP, 2015)
Should be available from Fiji Dept of Energy

Transforming Small Island Power Systems: Technical Planning Studies for the Integration of Variable Renewables (IRENA, 2018) Overview of technical issues for small island developing countries
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Transforming_SIDS_Power_2018.pdf?rev=0e459c72eed843899f4c8fdae1816f4d

Transitioning Island Energy Systems—Local Conditions, Development Phases, and Renewable Energy Integration (Energies, Sept 2019) Focus on small high-income European islands
https://www.researchgate.net/p ublication/335734174_Transitioning_Island_Energy_Systems-Local_Conditions_Development_Phases_and_Renewable_Energy_Integration/link/5d786d4a299bf1cb809821a0/download

World Bank ESMAP studies on Grid Connection of VRE. Technical in nature

Compensation Devices to Support Grid Integration of Variable Renewable Energy (ESMAP 2019)
https://www.esmap.org/compensation-devices-to-support-grid-integration-of-variabl

Grid Integration Requirements for Variable Renewable Energy (ESMAP WB 2019)
https://www.esmap.org/grid-integration-requirements-for-variable-renewable-energy

Studies for Grid Connection of VRE Generation Plants (ESMAP WB 2019)
https://www.esmap.org/studies-for-grid-connection-of-vre-generation-plants

Tariff Determination for Regulated Utilities

There have been a number of recent studies on the equity of tariff systems with high loads of PV & other VRE/DRE. Examples are listed not because they are currently relevant to Fiji (most are not) but there are likely to be useful studies by the time FCCC develops a new tariff in 2027. arxiv.org might be worth searching.

A Review of Electricity Tariffs and Enabling Solutions (Nov 2022)
https://www.researchgate.net/publication/365403523_A_Review_of_Electricity_Tariffs_and_Enabling_Solutions_for_Optimal_Energy_Management/link/637442542f4bca7fd0640419/download

A review of equity in electricity tariffs in the RE era (June 2022)
https://www.sciencedirect.com/science/article/pii/S1364032122002465#sec7

Balancing DSO interests and PV system economics with alternative tariffs (March 2023)
https://arxiv.org/abs/2303.04433

Does the short-term boost of renewable energies guarantee their stable long-term growth? Assessment of the dynamics of feed-in tariff policy (2019) Iran example so perhaps of limited use for Fiji.
https://arxiv.org/abs/1907.11224

Who should pay for frequency-containment ancillary services? Providing incentives to shape investment during the energy transition (Aug 2023) https://arxiv.org/abs/2308.10629

Electricity Tariff Design via Lens of Energy Justice (Omega, June 2023) Highly technical; discusses how Distributed Energy Resources can significantly affect the net social benefit in power systems. It is behind a paywall https://www.sciencedirect.com/science/article/abs/pii/S0305048322002286#sec0020 but free download of earlier (?) version at https://browse.arxiv.org/pdf/2110.10122.pdf

Fair Equitable & Efficient Tariffs in Presence of DER (MIT, 2018) https://ceepr.mit.edu/wp-content/uploads/2021/09/2018-012.pdf

Falling Short: A Global Survey of Electricity Tariff Design (World Bank, 2020) Most countries' tariff structures are ill-adapted to emerging technological disruption in the sector, https://openknowledge.worldbank.org/server/api/core/bitstreams/7e94ecb0-8d87-52c3-bc6f-4a9457a9dc05/content

Impact of the fixed and variable component of electricity price on the economic viability of a small-scale photovoltaic power plant (April 2021 Journal of Electrical Engineering 72(2):140-147) https://www.researchgate.net/publication/351571655_Impact_of_the_fixed_and_variable_component_of_electricity_price_on_the_economic_viability_of_a_small-scale_photovoltaic_power_plant

Optimal Retail Tariff Design with Prosumers: Pursuing Equity at the Expenses of Economic Efficiencies? Sept 2022) Technical academic paper assesses policies providing direct financial compensation to low-income households, but US approach may not be useful for Fiji https://arxiv.org/abs/2209.14505

Renewable Energy Feed-in Tariffs: Lessons Learned from the U.S. and Abroad (2009) Old paper but may be useful https://www.energy.gov/scep/slsc/articles/feed-tariffs-best-practices-and-application-us

Solving the rate puzzle: The future of electricity rate design (McKinsey 2019) https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/solving-the-rate-puzzle-the-future-of-electricity-rate-design#/

Some Rare, Real Talk From a Utility About Competition With Rooftop Solar (21 Sept 2023) https://insideclimatenews.org/news/21092023/inside-clean-energy-utilities-rooftop-solar-competition-profits/

Tariff Appraisal Study: Balancing Sustainability and Efficiency with Inclusive Access (Asian Development Bank, 2018) South Asian study but with "Lessons for Developing Member Countries on Socially Inclusive tariffs" https://www.adb.org/sites/default/files/publication/462676/swp-060-tariff-appraisal-study.pdf

Tariffs and DER (Anna Bruce, PPA, 2022) https://www.ppa.org.fj/wp-content/uploads/2022/12/PPA-29th-Annual-Conference-Utitlity-Board-Members-Workshop-6-Tariffs-and-DER_ABruce_Nov-2022.pdf

Utility Rate Design & Complementary Policies (Solar Energy Industries Association, undated) https://www.seia.org/initiatives/utility-rate-design-complementary-policies

Miscellaneous

Fiji Country Private Sector Diagnostic: Electric Power (World Bank / IFC, May 2022excerpted from https://www.ifc.org/en/insights-reports/2022/cpsd-fiji

Heavy Fuel Oil Price trends 2015 - 2023 https://www.benzinga.com/pressreleases/23/07/33348849/fuel-oil-price-trend-analysis-historical-chart-and-forecast-analysis

Levelized cost of electricity (version 14 Lazard Oct 2020) available from SEIAPI
Levelized cost of energy (version 16 Lazard April 2023) https://www.lazard.com/media/2ozoovyg/lazards-lcoeplus-april-2023.pdf was seen after this draft was completed.

Technological diffusion trends suggest a more equitable future for rooftop solar in the United States (Berkeley National Laboratory, 2023). forecasting methods suggest that clean energy technologies should be expected to become more equitably adopted over time https://iopscience.iop.org/article/10.1088/1748-9326/acb3e4

When international 'best practice' is not: Power sector reform in small island states (Dornan,2018) https://www.devpolicy.org/pdf/website/Dornan-Power.sector.reform.in.small.island.states.pdf