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A Comparative Study of Renewable Energy and Electricity Access Policies and Regulatory Frameworks in the Indian Ocean Islands

The Case of Mauritius, Seychelles, Madagascar and Comoros

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Key messages

This study aims to provide a comparative analysis of energy policy, market design and regulatory practices in the Indian Ocean Islands: Mauritius, Seychelles, Madagascar and Comoros. Based on this analysis, the study draws implications for the transition towards sustainable energy system future of the islands where universal access to electricity is ensured. It maps the roles, responsibilities and instruments of various stakeholders, and studies the top-down and bottom-up renewable energy and electrification initiatives in the islands.

The key messages of the report are presented in what follows.

1 Islands' peculiarities

Island energy systems are peculiar and therefore they require institutions, energy policies, market designs and regulations that are reasonable and proportionate.

How are the islands in the Indian Ocean accounting their peculiarities in their institutions, energy policy, regulation and market design?

2 Renewable Energy

Renewables present an opportunity for clean energy transition – policy instruments and regulatory measures should be geared towards attracting renewable energy investments, and their efficient integration into the power system.

How are the islands in the Indian Ocean promoting and integrating renewables to their power system?

3 Electricity access

Renewables present an opportunity to accelerate mass electrification. This requires synergy between renewable energy and electrification policies and regulatory interventions.

How are the islands in the Indian Ocean efficiently transitioning to a cleaner energy system while ensuring universal access to electricity?

4 Regulatory adequacy

Regulatory governance and decisions need to be context specific and should focus on the delivery of the intended policy objectives.

Do the islands in the Indian Ocean have regulatory systems that are geared towards improving the energy sector performance and realize energy policy objectives?

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1. Introduction

Energy systems in islands present inherent characteristics including small size[1], remoteness and vulnerability to natural disaster. This leads to high electricity prices, heavy dependence on imported fuel and limited private sector participation in energy [1]–[3]. In recent years, the development in renewable energy technologies has presented an opportunity to counter these challenges and improve the affordability and sustainability of the energy systems as well as ensure energy independence by harnessing the renewable energy potential of islands [4]–[6]. This calls for specific political action and tailor-made policies, regulatory approaches and power sector market design.

Under these premises, the transition to clean energy systems in islands has been slowly gaining increasing attention in the global energy and climate change agenda. In this regard, IRENA's small island developing states (SIDS) lighthouse initiative and the Global Renewable Energy Network (GREIN)[2]; the Alliance of Small Island States (AOSIS)[3]; the "pact of Island"[4] in Europe and other island initiatives in the Indian Ocean, Caribbean, Atlantic and Pacific are providing a regional approach to deal with their common energy challenges. Yet islands still require more support to help access their systems at large and in the development of appropriate measures to prepare them for a sustainable future.

This study focuses on the case of the Indian Ocean island states: Mauritius, Seychelles, Madagascar and Comoros. Although most islands in the Indian Ocean region have high renewable energy resources potential, the uptake of this has been constrained by various factors. These include, the limited hosting capacity of the grid, available land area, economies of scale as well as lack of political will, technical expertise, and appropriate policy and regulatory frameworks. Moreover, the challenge is dual for those islands that still must deal with the provision of electricity access to their population.

1.1. Objective, scope and significance of the study

The objective of this study is to provide a comparative analysis of energy policy, market design and regulatory practices in the Indian Ocean Islands. Based on this analysis, the study aims to identify implications for the transition to a sustainable energy system for the islands, where universal access to electricity is ensured. It maps the roles, responsibilities and instruments of various stakeholders, and studies the top-down and bottom-up renewable energy initiatives in the islands. Furthermore, it presents best practices that have been implemented by the islands and discuss their replicability locally and globally.

An exploratory research approach has been applied, and various data sources have been utilised, including the country report prepared by participants in FSR blended training from the islands. We have also consulted international reports and energy databases including those from IRENA, the African Energy Commission (AFREC) and the World Bank. This was supplemented by one-on-one interviews and roundtable discussions on renewable energy and electrification with energy practitioners from the

[1] An anomaly among the Indian Ocean islands is Madagascar, which is roughly the size of mainland France with the population of Australia.
[2] https://islands.irena.org/ and also see [48]
[3] https://sidsdock.org
[4] http://www.smartislandsinitiative.eu/en/history.php

islands. Moreover, a survey was conducted to gather data regarding the regulatory governance system of the islands (see Annex I).

Currently, Seychelles is revisiting its legal and regulatory frameworks; Madagascar is in the process of implementing new and amended regulations; Mauritius is in the process of operationalizing the newly set up regulatory body, whereas Comoros has yet to establish a new regulatory entity. Amidst these changes, this study can serve as a reference to initiate and support policy dialogues that are being undertaken under the leadership of the Indian Ocean Commission; and it can help identify specific topics that require further in-depth investigation. Moreover, the study contributes to the body of knowledge organised by IRENA through its SIDS lighthouse initiative (see Annex II).

The report is geared towards decision makers that are planning, designing or implementing policy or regulatory tools to integrate renewables and provide electrification for all. This includes national policymakers, energy regulatory authorities, energy utilities, rural electrification agencies and development organisations.

1.2. Structure of the study

The remaining part of the report is structured around five sections.

Section 2 provides an overview of the islands that are selected for the case study.

Section 3 presents the energy situation and policy directions in the islands by highlighting the issues of electricity access and the development of renewable energy, and policy instruments that are in place to realise the renewable and electrification targets.

Section 4 discusses the institutional and power sector setting in the islands, mapping the institutions that are supporting the power sector and the market design issues, including private sector participation, restructuring and competition.

Section 5 presents a comparative analysis of the regulatory system of the islands by evaluating the regulatory governance system and regulatory content which refers to the regulatory decisions introduced on various issues such as tariffs.

Finally, section 6 concludes and puts forward recommendations.

2. Overview of case study islands

The Indian Ocean islands belong to the East African region, and they cooperate through the Indian Ocean Commission that aims to create a platform for experience sharing and cooperation among member islands to realise a sustainable energy system in the region.

The selected case study islands - Mauritius, Seychelles, Madagascar and Comoros - represent a spectrum of size, demography and economic development, and power sector context (see Table 1).

Table 1: Summary characteristics of the case study islands (2016)

	Mauritius	***Seychelles***	***Madagascar***	***Comoros***
Land area (km^2)	2040	460	587,295	2235
GDP (Billion USD)	12.16	1.42	9.99	0.62
GDP per capita (USD)	9812	15075	416	768
Population (Million)	1.356	0.095	24.9	0.808
Urban population (%)	39.4	54.4	36.4	28.5
Urbanization rate (%)	0.07	1.02	4.47	2.71
Population growth rate (%)	0.59	0.77	2.5	2.7
Population below poverty line (%)[5]	0.2	0.9	78.1	21.3
Ease of doing business ranking	25	95	162	158
Installed capacity (MW)	810.2	104	680	32.27
Peak demand (MW)	476	65.1	342	17.84
Annual electricity production (GWh)	3042	377.6	1651	54
Average rate ($/kWh)	0.19	0.33	0.17	0.21
Renewable energy share (%)	21.8	2	45	9
Population without electricity access	0	946	19.2 million	188 thousand

2.1. Mauritius

The Republic of Mauritius is located in the south-west of the Indian Ocean. It consists of the islands of Mauritius, Rodrigues, Agalega, Tromelin, Cargados Carajos and the Chagos Archipelago, including Diego Garcia and any other island comprised in the State of Mauritius. The two main islands are the Island of Mauritius (1,865 km^2) and the Island of Rodrigues (104 km^2). It has a population of about 1.36 million in 2016 with approximately 95% of the population living in Mauritius and the rest in Rodrigues. Urban population (% of total) in Mauritius was reported at 39.55 % in 2016.

According to the new World Bank ranking of country economic development, Mauritius belongs in the group of the upper-middle-income countries [7]. It has a GDP of 12.16 billion USD with a per capita GDP of 9,812 USD in 2016.

The worldwide governance indicators data (see Figure 1) shows that Mauritius is one of the countries with good governance system in the world. It has a percentile rank of 82 in political stability, 78 in governance effectiveness, 80 in regulatory quality, 76 in the rule of law and 62 in terms of corruption. This makes the country top performing in most indicators.

[5] Data from World poverty clock data hub (2018). [Online] Available at https://worldpoverty.io

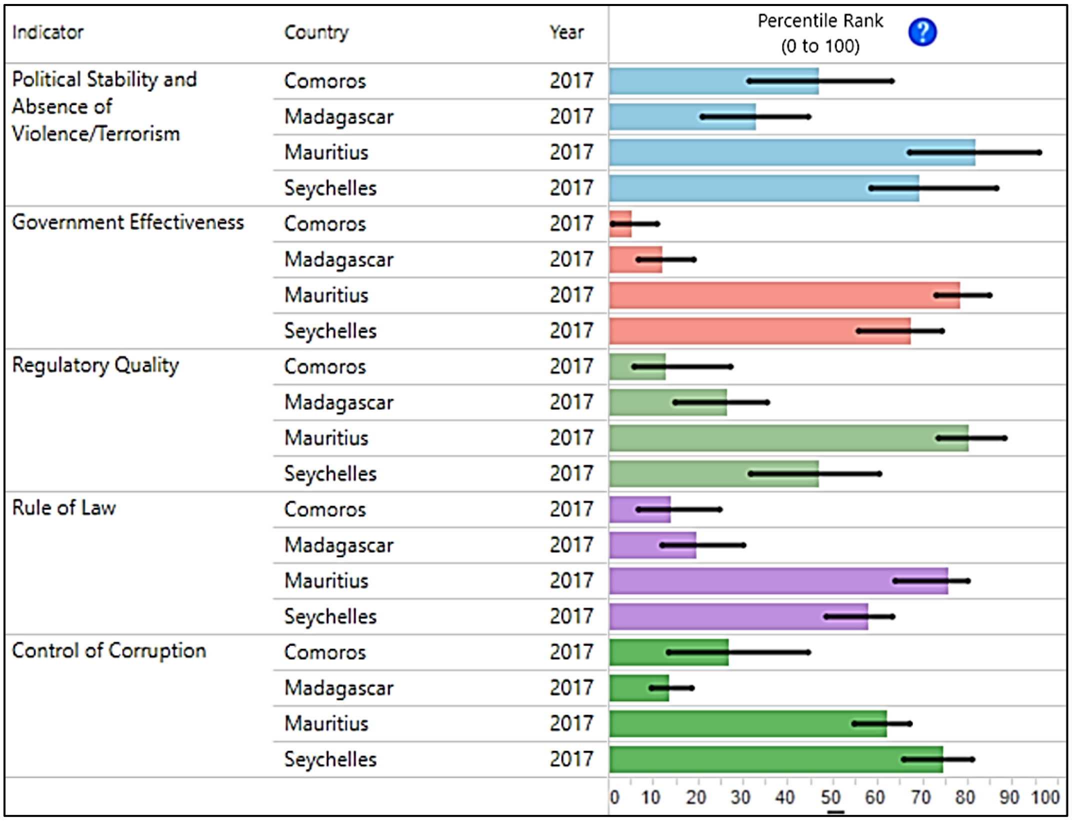

Figure 1: Worldwide governance indicator ranking
Source: World Bank energy database

The power sector has an installed capacity of 810.2 MW and peak demand of 476 MW with an annual electricity production of 3,042 GWh. The main energy source for electricity generation in 2016 was coal (41.6%), followed by diesel and fuel (36.5%) and renewable sources (21.8%). Bagasse is the largest renewable energy source (16.3%), followed by hydro (3.3%) and rest includes wind (0.6%), landfill gas (0.6%) and photovoltaic (1%) [8]. Mauritius has an average electricity price of 0.19 $/kWh which makes it one of the lowest in the region after Madagascar [9]. The country has achieved 100% electricity access.

Mauritius heavily depends on imported petroleum products to meet its energy requirements. The country does not have oil, natural gas or coal reserves. Its renewable energy sources include biomass, hydro, solar and wind energy. Biomass energy mainly comes from bagasse as a by-product of the sugar industry. It has exhausted its hydropower potential with an installed capacity of 60.74 MW. Furthermore, Mauritius has a good solar regime with a potential average annual solar radiation value of some 6 kWh/m^2/day. The wind regime is very good in some areas, with an annual average speed of 8.1 m/s at 30 meters above ground level.[6]

2.2. Seychelles

Seychelles is an island republic comprising approximately 115 islands, very few of which have a resident population. It has a population of 94,677 of which more than four-fifths live on the island of Mahé. Seychelles has a mixed, developing economy that is heavily dependent upon the service sector in general

[6] Ministry of Energy and public utilities of Mauritius

and the tourism industry. It belongs in the group of the high-income countries with a GDP of 1.42 billion USD and per capita GDP of 15,075 USD in 2016.

The worldwide governance indicators data (see *Figure 1*) shows that Seychelles is one of the countries with a relatively good governance system in the world; it has a percentile rank of 70 in political stability, 67 in governance effectiveness, 42 in regulatory quality, 58 in the rule of law and 75 in terms of corruption. This makes the country second top performing in all indicators in the region except for corruption, in which it is better than Mauritius.

The power sector has an installed capacity of 104 MW and peak demand of 65.1 MW with an annual electricity production of 377.6 GWh in 2015 [10]. Around 98% of electricity is generated from imported fuel oil and gas oil. The rest comes from renewable energy, mainly, wind and solar PV with an installed capacity of 8 MW and 1.627 MW, respectively. It has an average electricity price of 0.33 $/kWh which makes it the most expensive in the region. The country has provided electricity to 99% of its population.

As a tropical country, Seychelles receives large amounts of sunshine - an average of 6.9 hours of sunshine per day, and an average irradiance of 5.8 kWh/m^2/day [11]. The potential for electricity generation from wind energy is present in the islands, with some sites having been identified as having average wind speeds of 6.9-7.5 m/s at 80 meters. No extensive studies have been conducted to assess the potential for biomass. No geothermal source has been identified onshore and the potential on offshore has not been assessed yet. Moreover, Seychelles does not have any installed hydropower capacity, nor does the potential exist for hydroelectric power generation, due to the erratic nature of the water resources and topography.

2.3. Madagascar

The Republic of Madagascar is the fourth largest island in the world, with a land area of 587,295 km^2 and a population of around 25 million in 2016. The island state is one of the least developed countries; 78% of the population live below the poverty line, and it has a GDP of 10 billion USD with GDP per capita of 416 USD in 2016. The economy is based on agriculture, which accounts for more than one-fourth of GDP and employs roughly 80% of the population.

The worldwide governance indicators data (see *Figure 1*) shows that Madagascar one of the poorest performing countries in terms of governance system, which is a significant barrier to economic development. It has a percentile rank of 35 in political stability, 12 in governance effectiveness, 26 in regulatory quality, 20 in the rule of law and 13 in terms of corruption.

The power sector has an installed capacity of 680 MW and peak demand of 342 MW with an annual electricity production of 1,651 GWh. Around 54% of electricity is largely generated from imported fuel oil and coal with approximately 46% production from hydro. It has an average electricity price of 0.17 $/kWh, the lowest in the region. There are more than 19 million people in the population without access to electricity.

The Island has great natural potential for renewable energy, such as solar, wind, biomass and hydropower, much of which remains untapped. It has average horizontal insolation of 5.5 kWh/m^2/day, across most of the land area. Conditions in the north and south have been identified as favourable to wind energy, exhibiting average wind speeds of 7.5 to 8.1 m/s at 50 meters. Other locations in the east and west have average wind speeds of 5.5 to 6.0 m/s at 50 meters. It also has a high potential for biomass, geothermal (in excess of 350 MW) and hydro potential of around 7,800 MW.

2.4. Comoros

The Union of Comoros is an independent state comprising the four main volcanic islands of the Comorian archipelago Ngazidja (Grande Comore) 1.148 km^2, Mwali (Mohéli) 290 km^2, Ndzuwani (Anjouan) 424 km^2, and several minor islands. A fourth main volcanic island of the Comorian archipelago, Mayotte (Maoré) 308 km^2, is geographically part of the Comoros islands, but it is an overseas department of France. In total, Comoros has a population of 808,000 in 2016.

Comoros is one of the least developed countries, where 21.3% of the population live below the poverty line. It has a GDP of 0.62 billion USD with GDP per capita of 768 USD in 2016. The economy is based on tourism, fishery, and the export of ylang -yang essential oils, vanilla and spices. It has high diaspora remittances, which contribute to over 20% of the GDP.

The worldwide governance indicators data (see *Figure 1*) shows that Comoros is one of the poorest performing countries in terms of governance system which is a significant barrier to economic development. It has a percentile rank of 47 in political stability, 5 in governance effectiveness, 13 in regulatory quality, 14 in the rule of law and 27 in terms of corruption.

The power sector has an installed capacity of 32.27 MW and peak demand of 17.84 MW with an annual electricity production of 54 GWh. More than 90% of electricity is generated from imported fuel oil. Renewable energy share stands at 9%. It has an average electricity price of 0.21 $/kWh, one of the expensive ones in the region. Comoros has approximately 188,000 of its population without access to electricity.

Comoros has a great natural potential for renewable energy, such as geothermal, solar, wind, biomass, and hydropower. Geologically, Comoros has an estimated geothermal potential of 70.5 GWh/year, sufficient to meet its energy demands. It also has high hydropower potential, but detailed assessment is required. Solar may be a viable option for the Comoros Islands given the fact that, on average, the country is exposed to 9 to 10 hours per day of sunlight (2880 hours/year) at an average of 6.1 kWp/m^2. In 1985, two wind turbines were installed in Ngazidja to drive groundwater pumps, but neither has provided the amounts of water initially estimated [12]. A wind generator requires average annual wind speeds of at least 3 m/s, and data in the country has shown that the island winds do not always reach this speed. Oilseed plants such as coconut, sesame, peanut and jatropha grow in Comoros. No in-depth studies have been conducted on these oilseeds, except for dried coconuts, which are transformed into oil for local consumption.

3. Energy situation and policy

The energy situation and the corresponding policies vary from country to country. On the one hand, the developed world is mainly dealing with the transition to a clean energy system. On the other hand, the developing world also has to find ways to provide access to the over two[7] billion people who still do not have access to electricity, while satisfying the growing demand from those who do [13], [14]. In this regard, member states of the IOC represent both worlds; some are dealing only with energy transition while others are facing the additional challenge of providing first-time access to their population.

In what follows, we first present where the countries stand in terms of providing electricity access and transitioning to clean energy system. Then we identify the policy directions and the instruments that have been introduced by each of them to increase the electricity access and the renewable energy share in their respective energy mix.

3.1. Electricity access

The islands in the Indian Ocean have different levels of access to electricity. Some have achieved 100% electrification while others are still struggling to provide access. However, this evaluation depends on the definition of access to electricity which can have a direct implication on the electrification policy of the islands.

3.1.1. Definition of access to electricity

Measuring access to electricity is challenging due to the absence of a universally accepted definition and the difficulty to precisely measure any definition. It is often measured by binary metrics or as a continuum of service levels from Tier 1 (4 hours of electricity) to Tier 5 (23 hours) where access is simply defined as the availability of an electricity connection at home or the use of electricity for lighting or an electric pole in a village [15]. These measures fail to capture the multifaceted and multi-tier nature of electricity access such as adequate quality, reliability, affordability, safety and availability for use when needed.

There have been attempts to develop a more comprehensive measure, the most prominent of which is the Multi-tier matrix developed by the World Bank (see Annex III) for measuring access for different applications (household access, access for productive engagements and community facilities), in terms of supply and service levels [16]. However, measuring access using the multi-tier matrix is not an easy task, and so far the methodology has only been piloted in countries including Malawi, DRC Uganda, Ethiopia and India across 10,000 households [17].

Island states in the Indian Ocean region are also among the many countries that have not yet started measuring energy access in a way that recognises its multifaceted nature. The only data that is available today is based on the shallow definition of access. Accordingly, Mauritius and Seychelles are considered fully electrified systems. In contrast, Comoros and Madagascar have a significant number of their population still expecting first time and reliable electricity access. According to the 2017 IEA energy access outlook, in 2016, 77% or 19 million Malagasy do not have access, with 52% and 7% access rates respectively in urban and rural areas [13]. The official rates are even lower; around 85% of Malagasy do

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[7] The world population without access is considered to be more than 2 billion - one billion doesn't have first time access and another one billion have chronically inadequate or unreliable service [49].

not have access, and only 5% of the rural population has access [18], [19]. Note that this only includes grid-connected access, off-grid access is not accounted for due to lack of data.

The progress made in terms of providing electricity access shows that Comoros had a steep growth in terms of electrifying the country: While less than 20% of its population had access to electricity in 1990, in 2016 this figure had expanded to 80%. Furthermore, based on our interviews, at the time of writing this report close to 90% of the population is believed to have access to electricity. However, this only shows the population that has network coverage, which combines the part of the population that is already connected to the grid which is around 65% and the part that is under the grid, and that can be easily connected through grid extensions.

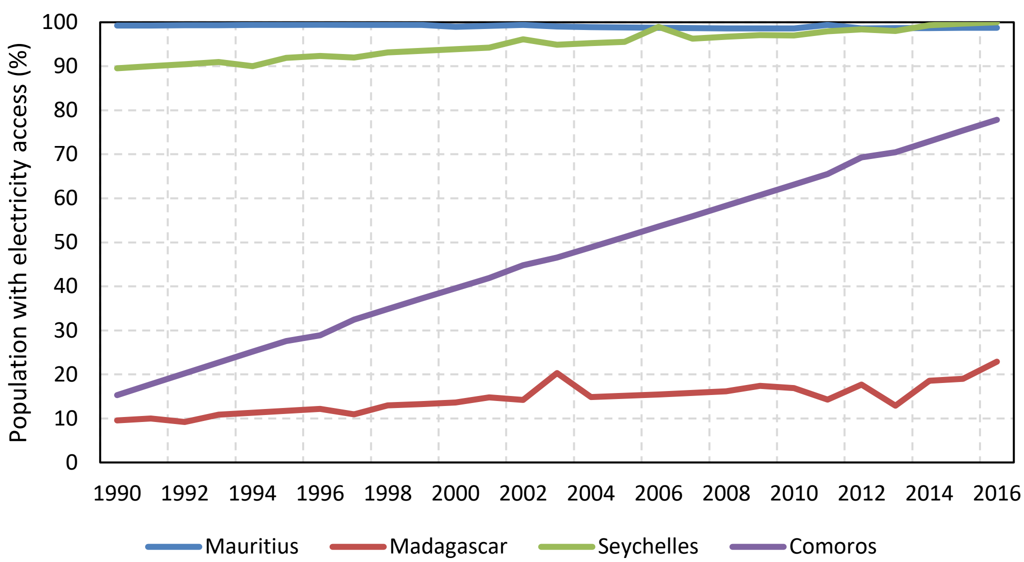

Figure 2: Electricity Access (1990 – 2016)
Source: Based on World Bank energy database (2018)

Comoros presents a good example of the limitation of the definition of access. This can be demonstrated by looking at the electricity consumption per capita in the region. As shown in *Figure 3*, the electricity consumption of an individual in Madagascar or Comoros is about 3% that of an individual in Mauritius or 2% of one in Seychelles. The fact that there is high electricity consumption in Mauritius and Seychelles is a rough indicator of the reliability of the electricity supply and use of electricity that goes beyond lighting. In contrast, Comoros has achieved around 90% electricity access, yet it still has a very low electricity consumption. This is mainly due to the low reliability of the electricity supply which hinders the productive use of electricity. According to the 2014 sector assessment of world bank, [20], the electricity supply is only available for approximately 6 hours a day in most of Grande Comore, while users located in the country's capital (Moroni) and immediate surroundings are supplied over much longer periods (most of the day) - although this supply is not reliable. Some parts of the island are supplied only a few hours a week.

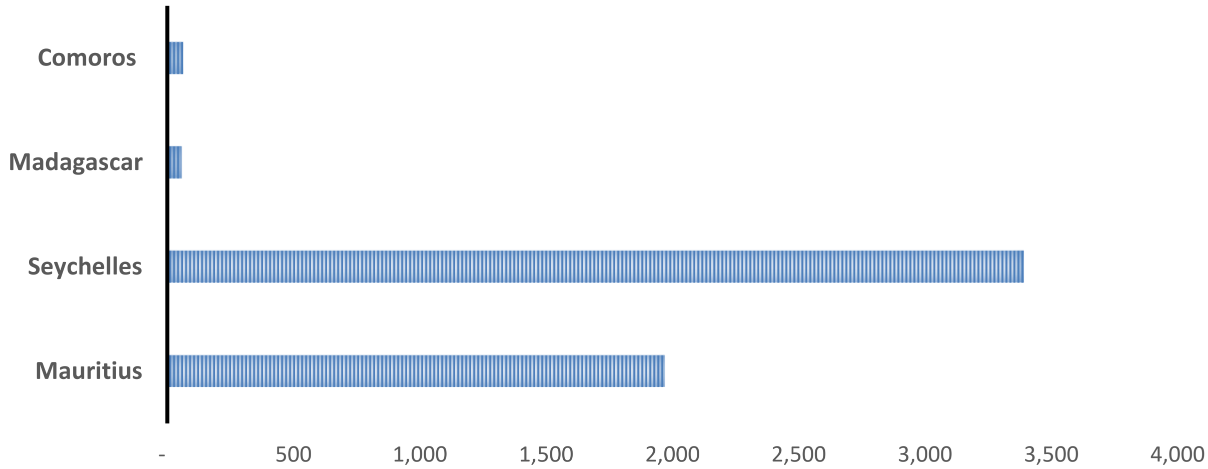

Figure 3: Electricity consumption in kWh per capita
Source: Based on AFREC database & CIA fact book

A majority of the population in Madagascar and Comoros still depends on biomass, mainly fuelwood, for cooking. Note, however, that activating the demand for electricity and ensuring reliability could take some time. For example, the kWh electricity consumption per capita of Mauritius grew from 670 kWh per capita in 1990 to 1,971 kWh per capita in 2016.

3.1.2. Electrification policy

The definition of access and the inconsistencies in measuring electricity access are barriers to setting the right policy targets and device the right instruments. Currently, Madagascar and Comoros have set electrification targets. According to the new energy policy of Madagascar, which stipulates the energy policy for 2015 -2030, the country will have 70% electricity access by 2030 [21]. Similarly, the national energy sector strategy of Comoros, first introduced in 2012 and later updated in 2017, sets a target of 100% electrification by 2033.

To achieve these targets, in Madagascar, the National Strategy of Electrification (NSE) is currently under development as a continuation of the National Energy Policy ("Nouvelle Politique de l'Energie", NPE) introduced in 2015. The NPE considers a pathway in which 70% of the electrification will be through grid extension, 20% through mini-grids and 10% will be served via individual solutions [22], [23].

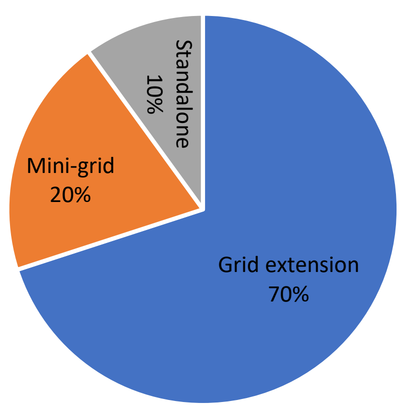

Figure 4: Pathway to achieve 70% electrification in Madagascar by 2030

Furthermore, it specifies that the hydro will represent 75% of the centralized grid access while diesel, wind and solar make up 15%, 5% and 5%, respectively. In the case of microgrids, 10% of the population will receive access to electricity through hydro based power plants, 4% through biogas technologies, 5% diesel and 1% solar PV. The 10% that will be served using standalone systems will be provided through decentralised solar home systems and solar lamps, equally shared. The breakdown in terms of technology is shown in Table 2.

Table 2: Technology mix for achieving 70% electrification by 2030 as outlined in the NPE

TECHNOLOGY	SHARE OF ELECTRIFIED POPULATION (%)	SHARE OF TOTAL POPULATION (%)
CENTRALIZED GRID	**70**	**49**
MINI-GRID	**20**	**14**
HYDRO	10	7
BIOGAS	4	2.8
DIESEL	5	3.5
SOLAR PV	1	0.7
STAND-ALONE	**10**	**7**
SOLAR HOME SYSTEM	5	3.5
SOLAR LAMPS	5	3.5

There are programs that aim to expedite electrification, but there is no strong institutional and financial support around these programs. The first decentralised rural electrification program was introduced in 2008 to improve the rate of access to electricity in rural areas by prioritising the development of renewable energy sources. The second program is a national fund for electricity, which was created in 2002 with the aim of funding rural electrification efforts. The rural electrification agency (ADER) has used it to subsidise rural operators' equipment to improve the affordability of electricity. The fund ran out years ago, but it now received new funding and has been rebranded as the National Fund for Sustainable Energy in 2018.

Comoros has invested in providing network coverage, but reliable access is still a big challenge in terms of both increasing the generation adequacy and extending the grid to connect more customers. Currently, there is an electrification target of 100% by 2033, but the contribution of off-grid mini-grid development and standalone systems is not clearly defined. Yet, the small population that needs first time access (approx. 187,200 of the 800,000 population) and the high population density (275 per km^2) in country makes electrification relatively easier, compared to Madagascar which has over 19 million people to supply with electricity who are widely spread (42 people per km^2) and a population that is growing at 2.7% per year.

An important aspect that requires further streamlining and coordination is the proper assessment of demand which is key for electrification planning and its execution. Currently, in Madagascar, the task is carried out by ADER and an indicative regional master plans for rural electrification has been developed and updated. Moreover, a study has recently been carried out defining strategies on how to achieve the NPE in Madagascar. The coordination of the regional master plans of ADER for rural electrification and the plans of JIRAMA for grid expansion is key. Failure to do so can distort the optimal mix of different modes of electrification and lead to inefficient planning and investment, especially if proper forecasting is not undertaken. Many electrification solutions risk being obsolete if they are designed to satisfy the current needs of the society without anticipating the evolution and economic development of the target community. Therefore, islands must adopt suitable assessment tools and develop the expertise to collect, manage and maintain energy data to get a clear indication of the capacity requirement and to plan for it.

3.2. Renewable energy development

Renewable energy technologies are attracting the attention of policymakers for advancing multiple objectives such as boosting national energy security and economic growth, creating jobs, developing new industries, reducing emissions and pollution, and providing affordable and reliable energy for citizens [24].

The growing share of renewables in the energy mix, particularly variable renewable energy technologies like solar and wind, is changing the energy landscape. As a result, market and regulatory environments are being adjusted and many countries are introducing mechanisms designed to accelerate investment, innovation and the use of smart, efficient, resilient and environmentally sound technology options [25].

Over 50 thousand islands around the world are also embracing renewable energy as an alternative energy supply. This transition to a cleaner energy system is not only driven by the climate change agenda. Renewables are considered an attractive alternative to deal with the high cost[8] and uncertainty of electricity generation in Islands [2], [5], [6]. Most islands, particularly small islands, generate their electricity based on fossil fuels which create serious economic and financial difficulties. The increased cost of the electricity supply is caused by the high cost of fuel transportation resulting from the distance of supply sources and by the absence of endogenous energy sources [1], [26].

Similarly, the islands in the Indian Ocean are highly dependent on fossil fuel, and renewables are starting to play their role in transitioning the energy system in these islands. For instance, Seychelles has been entirely dependent on imported fuel until around 1.354 MW solar PV systems, and 6 MW of wind power were added to the energy mix, representing 2.1% of the energy production, which reduced the fuel oil import by around 2 million liters in 2016.

In what follows we will examine where the islands are regarding renewable energy share, renewable energy policies, and instruments to promote and integrate renewables into the system.

3.2.1. Renewables in the power generation mix

The share of renewables in the power generation mix of the Indian Ocean Islands is shown in *Figure 5*. So far, electricity production from non-hydro renewables is quite limited. Including hydro, renewables in Madagascar represent around 40% of electricity generation in 2016, while it is 21.8% in Mauritius, 5% in Comoros and 2% in Seychelles.

[8] For example, the oil price could go as high as three to four times than the mainland [6]

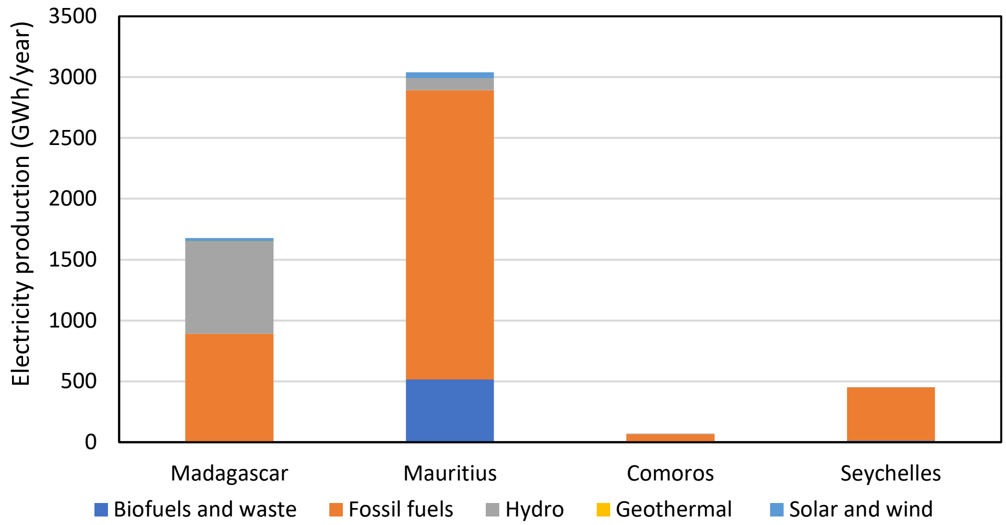

Figure 5: Electricity generation mix in 2016
Source: AFREC energy database, Mauritius Energy Digest, ORE, Seychelles National Energy Report

In the uptake of renewables, one of the key challenges is the accurate assessment of the resource potential of the various renewable energy sources to optimize the energy mix. The adoption of renewables and choice of technology also faces some roadblocks. These include lack of scale advantage to make renewables competitive, the limited hosting capacity of the grid, limited available land area, and environmental restrictions that are often linked to the visual impact of renewable technologies like wind farms.

3.2.2. Renewable energy promotion

The challenges and opportunities, and the corresponding renewable energy policies, depending on the specific context of the country. In more mature renewable energy markets, policymakers are mainly dealing with integrating the rising share of distributed and intermittent renewable energy into the power system designed for centralised conventional generation technologies. By contrast, in countries with limited access to modern energy services, policymakers are trying to design policies that maximise the potential of renewable energy to satisfy their growing demand and provide electricity to those who do not have it.

Although there is extensive experience with policies that promote the development of the renewable energy market, practice shows that there is no universally accepted policy prescription for promoting renewable energy. Countries are typically unique, and the most suitable policy instruments in one country may not be appropriate for another. Moreover, it is more useful to consider a portfolio approach or policy toolkit rather than relying on a single policy instrument. This portfolio can be made of up the following policies:

1. **Regulations and standards**: direct support including removal of non-economic barriers and increasing demand for renewable energy (e.g., renewable energy mandates for new buildings, net metering, etc.)

2. **Quantity instruments**: specific targets or absolute quantity of renewable energy production are defined through market-based instruments such as renewable portfolio standards[9] (RPS) and renewable energy credits[10] (RECs).
3. **Price instruments**: by establishing favourable price regimes for renewable energy relative to other sources of power generation, cost and pricing-related barriers can be reduced. They can be implemented in the form of fiscal incentives (e.g., tax credits, grants and subsidies) and feed-in tariffs.
4. **Government procurement**: government as a large consumer leads by example and creates a demand for renewable energy by purchasing and procuring its electricity consumption from renewable sources. This can have a significant effect in helping the renewable energy market to mature and build capacity.
5. **Auctions (also called tendering/reverse auctions or tender):** a renewable energy supply procurement mechanism which is competitively solicited from sellers, offering bids at the lowest price that they would be willing to accept. Both price and non-price factors can be applied to evaluate the bids. Auctions can also be applied to determine the tariff rate for Feed in Tariff policy.

Many countries are moving away from rather centrally fixed price-based mechanisms like the feed-in policies, which were the foundational elements of many renewable support programs. There is a trend to a more competitive system, such as renewable energy tenders [24]. In this regard, Mauritius and Seychelles[11] have some experience.

All four countries in the region have introduced an explicit target for renewable energy share in their energy generation mix[12]. The renewable energy targets in each country are given in Table 3. As can be seen, Mauritius aims for 35% renewables by 2025, Madagascar 85% by 2030, Seychelles 15% by 2030 and Comoros 55% by 2033 [12], [21], [27], [28].

Table 3: Renewable energy targets of the islands

Country	**Renewable energy Target**	**Progress**	**Gap**	**Target Year**
Mauritius	35%	22%	13%	2025
Madagascar	85 %	40%	45%	2030
Seychelles	15%	2%	13%	2030
Comoros	55 %	9%	46%	2033

To realise these targets, various policy instruments have been introduced, as shown in Table 4. In this regard, Mauritius and Seychelles have a diverse portfolio of policy instruments to promote renewables. In contrast, Madagascar and Comoros have so far introduced only one instrument, i.e., tax incentives. New instruments are expected including Net metering and Priority connection of RE production in

[9] A Renewable Portfolio Standard (RPS) is a law that requires utilities to generate a given percentage of electricity from renewable energy sources by a certain date. A large penalty can be imposed if the utility fails to comply with these goals in their power generation portfolio.
[10] One renewable energy credit represents the generation of one unit of electricity from an eligible source of renewable energy. Each REC denotes the renewable generation source, location, year of generation came online, date the RECs were generated, and other characteristics.
[11] There is an ongoing 4MW floating PV Project which will use auctioning to determine the rate for the IPP/PPA. [Available online] http://www.sec.sc/index.php/15-latest-news/80-tender-4mw-floating-pv-ipp-in-seychelles
[12] Targets are given in terms of electricity generated, not installed capacity.

Madagascar and Government procurement in Comoros. None of the countries have introduced any mandatory requirements for generators, energy suppliers and consumers to increase their portfolio of renewables through RPS or RECs.

Table 4: Programs and policy instruments to promote Renewable Energy

	Policy instruments/programs	Year	Target RE capacity addition (MW)	Status
Madagascar	Tax incentives	2015	Undefined	In force
	Priority for connection of RE production	Expected	-	-
	Net metering	Expected	-	-
Mauritius	Maurice Ile Durable (MID)	2009	Undefined	Ended 2015
	Feed-in Tariff/premiums	2010	3 MW	Ended 2012
	Net Metering Phase 1	2015	5 MW	In force
	Home solar project	2016	10 MW	In force
	Energy scheme for SMEs	2018	4 MW	In force
	Auctions	2015	Undefined	In force
Seychelles	The Small and Medium Enterprise loan scheme	2014	Undefined	In force
	Energy Efficiency and RE programme (SEEREP)	2014	Undefined (Targets 8800 out of the 25000 households)	In force
	PV rebate scheme	2010	1.3 MW (Target surpassed, around 3 MW mobilized)	In force
	Tax Incentive	2010	Undefined	In force
	Net metering	2013	Undefined	In force
	Auctions	2018	Undefined	In force
Comoros	Tax incentives	2012	Undefined	In force
	Government procurement	Expected	Undefined	-

One special feature of the instruments in Mauritius is that the additional renewable energy capacity that will be mobilized through each instrument is explicitly set while it remains undefined in the other countries. Setting such explicit targets helps monitor the effectiveness of the policies.

Details of each policy instrument of the islands are presented in what follows.

A. Madagascar

In Madagascar, the Tax Code of 2015 includes provisions that provide an incentive for renewable energy investment [29]. Accordingly, renewable energy investors can benefit from a reduction in their corporate income tax which is equivalent to 50% of the investment undertaken. In addition, they can benefit from VAT exemptions on the purchase of production equipment, and investment in equipment can be depreciated at an accelerated rate of 30% of the net value.

Moreover, article 13 of the new electricity code includes provisions that require transmission and distribution grid operators as well as mini-grids to give priority to the connection request of renewable energy producers, to the extent that is technically possible. The article also includes the possibility of applying net metering for auto-producers of renewable energy.

B. Mauritius

In Mauritius, various schemes have been introduced including subsidy, feed-in tariff and net metering.

Maurice Ile Durable

The first instrument was called 'Maurice Ile Durable (MID)'. It was introduced in 2009 and ended in 2015. It aimed to finance necessary renewable as well as efficiency projects by establishing the so-called MID fund which was collected through a carbon tax on fossil fuel.

Feed-in Tariff

In 2010, Mauritius introduced the Feed-in tariff (FiT) scheme for investments in a small-scale distributed generation (SSDG) by private producers. The goal was to mobilise 2 MW of power which was later increased to 3 MW[13]. Through this scheme, owners of small-scale solar PV, wind and hydropower installations are eligible to sell any surplus of generated electricity back to the grid in exchange for FiT payment. This is granted for a period of 15 years. Note that the application to this scheme was closed in 2012, as the 3 MW target was achieved.

The feed-in tariffs for electricity by the Central Electricity Board (CEB) are given in Table 5. However, to benefit from these tariffs any producer must have a self-consumption of at least one-third of the total energy amount produced by its installation. Where appropriate, the prices will be 15% lower than the figures shown in Table 5.

Table 5: FIT for small-scale distributed generators

Tariff for 15 years	**Wind ($/kWh)**[14]	**Hydro ($/kWh)**	**PV ($/kWh)**
Micro (up to 2.5 kW)	0.693 (20 Rs)	0.520 (15 Rs)	0.866 (25 Rs)
Mini (2.5 – 10 kW)	0.520 (15 Rs)	0.520 (15 Rs)	0.693 (20 Rs)
Medium (10 – 50 kW)	0.346 (10 Rs)	0.346 (10 Rs)	0.520 (15 Rs)

In addition, the CEB has also decided to extend the SSDG project to new categories of subscribers that include public, educational, charitable and religious institutions for a total capacity of 2 MW. The feed-in tariff that will be applicable to these categories of subscribers for the energy exported to the grid will be equivalent to the marginal cost of production of the CEB.

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[13] The second phase of the SSDG project also concerns residential, commercial and residential customers for an additional power of 1 MW, distributed as follows:

- 100kW for Rodrigues Island, from photovoltaic energy only and open to residential (50kW), commercial and industrial (50kW) subscribers;
- 900kW for Mauritius Island, from photovoltaic, wind or hydroelectric sources

To be able to satisfy pending requests (540kW) after the first phase of the project, only a total power of 360kW will be allocated for Mauritius and will only concern residential subscribers.

[14] Exchange rate of May 2012 applied.

Net metering for SSDG [15]

Net metering for SSDG in Mauritius was introduced as part of a pilot project where the utility integrated 5 MW of new renewable energy based SSDG in the Mauritian grid and 200 kW in Rodrigues. The scheme aims to provide an opportunity for small power producers to produce electricity using photovoltaic and wind technologies. In a spirit of democratizing the grid access, to an extent it is economically feasible, the scheme enables around 2000 small customers to interconnect their renewable energy installations into the grid without investing for energy storage or a backup service. This way, the customers can offset the quantity of energy produced and exported to the grid with their imported energy from the grid. Application into the scheme closed in 2016.

Home solar project[16]

The CEB home solar project aims to install 10,000 photovoltaic kits on the roofs of homes owned by customers in the "Social Rate 110A" category. These photovoltaic kits will be connected to the electricity grid and will enable vulnerable customers to receive 50 kWh of free electricity monthly for 20 years. The project will be implemented in several phases over a period of five years. The first phase, which concerns the deployment of the first batch of 2,000 Photovoltaic kits of 1 KW each for a total of 2 MW, is currently in progress.

The 10,000 photovoltaic kits will be installed in all regions of Mauritius as well as in Rodrigues. Otherwise, and in accordance with the stated objective, priority will be given to customers enrolled in the social register of Mauritius in each region.

The project was inaugurated on 18 May 2018, and it is to be deployed by the subsidiary of CEB called CEB (Green Energy) Company Limited (CGE), which was incorporated on October 11, 2016. It aims to promote the development of RE particularly solar energy for generation of electricity. Currently, CGE is involved in the promotion and development of renewable energy with the construction and operation of a Solar Photovoltaic Farm and deployment of Solar Photovoltaic Kits grid-tie, roof-mounted for CEB customers in the social category 110 A and Small and Medium Enterprises in Tariff 215 category.[17]

CEB green energy scheme for SMEs[18]

In 2017/18, CEB announced another pilot project that aims to integrate around 4 MW of new SSDG using solar photovoltaic technology, of which 142 kW will be integrated into Rodrigues. The scheme is applicable to SMEs in the Tariff 215 Category, and the principle of net-billing discount is applied. The investment is covered by the subsidiary of CEB, CEB (Green Energy) Company Limited. Through this scheme, around 2000 rooftop PV kits of 2 kWp capacity will be integrated into the grid. The customers will benefit from the project a reduction in its monthly electricity bill, which will net off partly or fully, as applicable, the electricity payments over a period of 20 years. The customers do not bear the project's financial and operational risks.

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[15] http://ceb.intnet.mu/sme2018/project.asp

[16] http://ceb.intnet.mu/communique/2017-09-15%20Home%20Solar%20Project.pdf

[17] http://ceb.intnet.mu/greenenergy/home.asp

[18] http://ceb.intnet.mu/sme2018/project.asp

C. Seychelles

The 100% imported fossil fuel reliance of **Seychelles** was called into question during the 2008 oil price surge which showed that dependence on one type of fuel is risky and can shake the economy. Being a small island developing state (SIDS), Seychelles does not have much influence on the development of oil prices; however, it can decrease its dependence on oil. With this in mind, Seychelles has since diversified into wind and solar energy and is looking at other ways to generate electricity from renewable energy sources.

In 2010, Seychelles introduced the GOS-UNDP-GEF[19] grid-connected rooftop PV project, due for 2014. The project aims to increase the use of grid-connected photovoltaic systems as a sustainable means of generating electricity in selected islands of Seychelles which have limited land space to install large PV units, an inherent limitation of most islands.

In the same year, a new financial incentive was introduced to promote renewable energy. Moreover, the 2012 Energy Act opened the market for the sale of solar photovoltaic systems in Seychelles, and to date, there are at least 6 suppliers/installers in Seychelles offering a range of panels and inverters.

Tax incentives

This was introduced through amendment 3 of the 2010 regulations of the Goods and Services Tax Act of 2001 (Regulation 163F) which states that "*Goods imported to be used in the process of conservation, generation or production of renewable or environmentally friendly energy sources, as endorsed by the Seychelles Energy Commission are exempt from Goods and Services Tax*". Moreover, a similar exemption for renewable energy technologies is offered in the 2010 "Promotion of Environment-Friendly Energy Regulations" under the Trades Tax Act.

The Seychelles Energy-Efficiency and Renewable Energy Programme (SEEREP)

The SEEREP made available a loan facility from commercial banks and the Seychelles Credit union which is open to all households, initially around SCR 100,000 (approx. USD 7,400) per household and recently revised to 150,000 SCR (approx. USD 11,100). The loan is used exclusively for purchase and installation of renewable energy systems, energy efficient appliances and energy saving devices. The loan duration is for a period of 1-5 years with 5% interest rate per year. The contribution of the beneficiary shall not exceed 2.5% of the loan amount and normal loan processing fees will be waived under this scheme. The programme targeted 8800 out of the 25000 households to have adopted either renewable energy or energy efficiency technologies or both. There was no target in terms of total renewable energy that will be mobilized or energy efficiency to be gained through this programme.

Rebate scheme for Rooftop Photovoltaic Systems

The project includes a rebate scheme, established by the GOS-UNDP-GEF PV project, where GOS and GEF provide 50% of the rebate fund shared equally. The rebate is given to applicants after they have installed their solar photovoltaic (PV) system. The residential sector can get 25%[20] of their cost of purchase and installation of solar PV systems up to 3kWp based on a 2.8 USD per watt installed cost of a solar PV system reimbursed. For commercial premises, the rebate payment is made on 15% of the total amount based on a calculated 3.2 USD per watt basis up to a maximum 15kWp PV system size. The Development Bank of

[19] A project by Government of Seychelles (GOS), Global Environmental Facility (GEF) and United Nations Development Programme (UNDP)

[20] This started with 35%.

Seychelles (DBS) will disburse the rebate payment for successful applicants. As of January 2018, 93 applicants have benefited from the scheme and the SEC has approved another 13 applicants for the rebate. There is still SCR 9,180,498.90 left in this scheme to be disbursed [30].

The Small and Medium Enterprise (SME) loan scheme

This scheme is aimed at encouraging businesses and entrepreneurship in various sectors excluding retails and wholesale. It covers loans up to SCR 3 million (approx. USD 220,000) for new business loan applications, with an annual turnover of no more than SCR 5 million (approx. USD 370000). Like SEEREP loan, this facility is also available for purchase and installation of solar PV systems but aimed at commercial establishments.

The scheme consists of a two-tier interest rate structure in which the government provides some element of interest subsidy and the client is charged 5% interest on the first SCR 1 million, 7% on the next SCR 2 million and interest rate is negotiated between the bank and the client for any additional amounts above SCR 3 million.

It has a grace period of up to 6 months during which the client and the bank can negotiate to pay either interest only or capitalise on interest. Accordingly, the repayment period could be 7 years or higher. The personal contribution of the client shall not exceed 2.5% of the loan amount or 20% for real estate development or construction projects.

Net-metering scheme

A net-metering program was established in 2013 to promote the use of renewable energy in both residential and commercial sectors. Energy produced from solar PV system is offset against the energy consumed from the grid. For consumption exceeding what is produced by solar PV, the consumer pays PUC the net consumption at the prevailing tariff rate. However, if the solar PV system has a surplus which is fed into the grid, then PUC pays the customer for every unit in excess at a rate of 88% of the prevailing fuel-marginal cost. The difference (12%) accounts for grid loss during energy transfer from the customer's installation to the other parts of the grid.

The scheme includes a cap of 50% of energy consumption for only commercial customers above 10kW. That is, the installations should meet only 50% of their energy consumption. In contrast, commercial customers with less than 10kW installation can install a PV system to cover 100% of their electricity consumption.

D. Comoros

The only instrument that is currently in force in Comoros is tax incentives for renewable energy equipment. The decree introduced in 2012 by the vice-presidents of Comoros states that import of equipment and materials for the development of renewable energy can be imported free of customs duties and taxes including the single administrative fee [31]. The list includes solar panels, charge regulator, invertors, battery, wind turbine, hot water production kit and digester for biogas production.

Moreover, government procurement of renewable energy is expected to be introduced with the intention of kick-starting the renewable energy market in Comoros.

3.2.3. Renewable energy grid integration

Promoting and adding renewable energy, particularly wind and solar, to the system is not as straightforward as adding conventional generators with controllable electricity generation output [32]. These variable renewable energy technologies have four characteristics that require specific measures to integrate them into existing power systems: 1) temporal availability of resources which creates variability in generation output; 2) uncertainty due to changes in resource availability; 3) location-specific properties of resources; and 4) low marginal costs as the resources are freely available.

The impact of variable renewable energy sources in islands is particularly challenging than in the mainland because islands systems are often operated on an N-2 reliability criterion (example, Seychelles), instead of N-1. This requires a higher cost of integrating intermittent generation into the system.

The islands of the Indian Ocean have introduced various policy instruments to promote renewables and increase their share in the energy mix, particularly Mauritius and Seychelles. Both these islands have also undertaken a study to assess the variable renewable energy hosting capacity of their grids. Accordingly, the current grid of Seychelles can host a maximum of 8% variable renewable energy and that of Mauritian power grid can host up to 30%. Traditionally, improving the hosting capacity of the grid requires reinforcing the grid. Alternatively, smartening the grid and implementing various demand response measures can increase the hosting capacity of the existing grid. In this regard, inspiration could be taken from the Orkney Isles in Scotland, which managed to integrate additional renewables by smartening the distribution system using Active Network Management System instead of a costly upgrade of the power grid [33]. Seychelles is moving toward this direction where 33kV lines with SCADA network are in the pipeline to help smarten the network; old meters are in the process of being replaced by smarter meters; and the utility is considering storage technologies to make the system more flexible and hence accommodate more renewables.

Moreover, the development of decentralized energy systems should be considered in the integration of renewables. This can affect both the countries that have not yet achieved 100% electrification and those that have 100% electricity access. In the context of countries that lack electricity access, the issue is how to deal with the long-term implication of off-grid energy systems such as renewable energy powered mini-grids which are considered an alternative mode of electrification. For example, what happens when the national grid arrives? This is one of the risks investors in off-grid systems face and regulation should be clear on how this is to be dealt with, assuring investors. Moreover, grid compatibility standards could be developed considering that these grids could be connected eventually. This calls for not only clear regulatory frameworks but also network codes and technical standards to avoid any inefficient investment.

In the context of countries that have achieved full electrification, the issue is related to the implication of the interaction between renewable energy policy and electricity tariffs on the adoption of distributed renewable energy; especially rooftop PV and storage. The implication can be that there will be a massive adoption of distributed generation which can have an impact on the grid and/or leading to grid defection. Currently, grid defection is not yet evident in the islands, but the evolution of technology cost combined with the high cost of electricity can push consumers with the means to disconnect from the grid [34].

4. Institutional and power sector setting

The political will and commitment to improve the performance of the energy sector, the realization of renewable and electrification objectives heavily depends on (a) the strength of the institutions that provide direction and oversight on the sector; and (b) the design of a power sector that provides an level playing field for private and public actors to operate efficiently and effectively.

In this section, we first present the institutional setting of the islands, followed by a discussion of the design and structure of the power market.

4.1. Institutional setting

The roles of various institutions involved in the energy system governance include:

- *setting policy frameworks* which among other things includes setting the long-term vision of the government for the energy system of each country;
- *regulation* which involves providing regulatory oversight and introducing various regulatory schemes that govern the various regulated players in the sector;
- *promoting (rural) electrification* in countries where part of the population does not yet have access to electricity;
- *promoting renewable energy* which involves managing the renewable energy initiatives introduced to realise a clean energy system; and
- other specialised offices responsible for issues such as energy efficiency.

Based on this classification, Table 6 presents the dedicated institutions that are responsible for each of these tasks, which are discussed in what follows. The organisation of these institutions is indicative of the emphasis given to some issues such as rural electrification in Madagascar and renewable energy in Mauritius. Note here that there is no dedicated office responsible for any of the functions does not necessarily mean that the function is not undertaken, rather it is often handled by other government offices. For example, in Seychelles, the promotion of renewable energy and energy efficiency is undertaken by either SEC, MEECC or PUC and in some cases jointly.

Table 6: Government offices responsible for energy system governance in the Indian Ocean Islands

	Madagascar	**Mauritius**	**Seychelles**	**Comoros**
Setting a policy framework	Ministry of water, energy and hydrocarbons (MEEH)	Ministry of energy and public utilities (MEPU)	Ministry for Energy, Environment and Climate Change (MEECC)	Ministry for water, energy, agriculture, environment, crafts and fishing
Regulation	Office of electricity regulation (ORE)	Utility Regulatory Authority (URA)	Seychelles Energy Commission (SEC)	No dedicated office
Rural Electrification	Rural Electrification Development Agency (ADER)	No dedicated office	No dedicated office	No dedicated office
Renewable energy	No dedicated office	Mauritius renewable energy agency (MARENA)	No dedicated office. Shared responsibility of MEECC, SEC and PUC	No dedicated office
Energy efficiency	No dedicated office	Energy Efficiency management office (EEMO)	No dedicated office. Shared responsibility of MEECC, SEC and PUC	No dedicated office

4.1.1. Setting a policy framework

In terms of setting the policy framework of the energy sector in the Indian Ocean Islands, there is usually one ministry that sits at the apex of the pyramidal form of the sector governance. Accordingly, in the *Malagasy* power sector, the Ministry in charge of energy (MEH) defines the energy policy and strategy, and grants licenses. In *Mauritius*, Ministry of Energy and Public Utilities (MEPU), as the policy-maker, is the highest body that sets the policy framework for the country's electricity sector. In the specific precinct of renewable energy, the Ministry is assigned to set the planning, strategies and programmes for the expansion and usage of renewable energy sources and with making proposals for appropriate legislation and regulations that would advance such activities. Similarly, in *Comoros*, the energy sector is overseen by the minister responsible for water, energy, agriculture, environment, crafts and fishing. Within the department, the Branch of Water and Energy is responsible for the administration of national enterprises responsible for water, electricity and hydrocarbons.

The exception, in this case, is *Seychelles* in which two ministries play a key role in governing the energy sector. The Ministry for Energy, Environment and Climate Change (MEECC) is responsible for the formulation of energy policies, strategies and action plans. The Ministry of Finance (MOF), along with MEECC, plays a role in the operation of the Public Utilities Corporation (PUC). MEECC is the parent ministry of PUC whereas MOF supports PUC mainly with providing an additional fund for capital projects. In addition, the MOF involved in the tariff setting of PUC by approving the petroleum fuel prices set by the Seychelles Petroleum Company (SEYPEC).

4.1.2. Sector regulatory oversight

Regulatory oversight in the islands is provided by a separate body, which is considered as an independent regulator, or by the ministry, which is responsible for setting policy frameworks. In this regard, ***Madagascar*** was one of the first islands to have a regulatory body, namely the *Office de Régulation de l'électricité* (ORE). It was established in 1999 by law as a public administrative body responsible for the control of the electricity sector, with legal and financial autonomy. It is composed of the electricity council, which is the decision-making body, and the executive secretariat, composed of the administrative and technical body. As per the new regulation "Code de l'Electricité", promulgated on April 10, 2018, ORE will be rebranded and renamed as "Autorité de Régulation de l'Electricité" (ARELEC).

In ***Mauritius***, the Utility Regulatory Authority (URA) was set up in 2016 in accordance with URA act 2004 to regulate utility services, namely electricity, water and wastewater. The regulatory duties and responsibilities are to be fully transferred from CEB, which has been acting as the regulator, once the regulator is fully operational. The objective of the regulatory authority is to ensure the sustainability and viability of the utility services, protect the interest of both existing and future customers, promote efficiency in both operations and capital investments in respect of utility services, and promote competition to prevent unfair and anti-competitive practices. The URA is a multi-utility regulator, which makes it unique in the region. In the context of islands, which are small in size and have limited scale advantage, it is a relevant consideration to examine if a multi-utility regulator is more efficient than a single sector regulator.

The ***Seychelles*** Energy Commission (SEC) was initially set up in July 2009 for the oversight and planning of the Government's approach on energy issues and has been responsible for coordinating the implementation of the National Energy Policy. Later in 2012, a new energy act was enacted in which the SEC has retained the mandate to implement the National Energy Policy and gained the additional responsibility of acting as the electricity regulator of the country. The SEC is set to regulate electricity-related activities for adequate, reliable, cost-effective and affordable electricity while protecting and conserving the environment.

In ***Comoros***, there is no separate regulatory authority. No government department takes an active role in energy regulation, aside from the Ministry of Planning, which is responsible for regulating the activities of Comorian Hydrocarbon Company (SCH)[21]. MAMWE (*Gestion de l'Eau et de l'Electricité aux Comores*) regulates the energy industry on the islands of Grande Comore and Moheli and EDA (*Electricité d'Anjouan*) on the island of Anjouan. They determine tariffs, standards of service, and procedures for the maintenance and extension of the electricity network, for its operations.

The governance system and regulatory decisions are discussed in more details in chapter 5.

4.1.3. Promoting rural electrification

Only Madagascar has a special agency, the Agency for Rural Electrification (ADER), which is responsible for promoting the rational development of electrical installations in rural areas. In terms of planning, the ministry combines plans from the regulator who prepares an indicative plan, which is used to calculate tariffs; the utility, which has its own plan; ADER, which makes rural electrification plans; and the network operator. As per the new electricity code (Article 4), this includes national generation master plan and the development of electrical networks plan for a period of 15 years, reviewed bi-annually. This is not an issue in Mauritius and Seychelles; it could only be relevant in the case of Comoros where there is a rural population in need of access to electricity.

4.1.4. Promoting renewable energy

Mauritius is the only island that has a specialised office for renewable energy. The Government has established the Mauritius Renewable Energy Agency (MARENA) to perform coordination and investment promotion functions regarding renewables and renewable energy Independent Power Producers (IPPs). Even if there is dedicated office, it should be noted that SEC has the mandate to promote both renewable energy and energy efficiency, as per the Energy Act 2012. Yet it sometimes shares these responsibilities with the ministry and/or the utility.

4.1.5. Promoting energy efficiency

The Energy Efficiency Management Office (EEMO) in Mauritius is established by the Ministry (MEPU) under the assistance of the recently closed UNDP-implemented GEF-financed project, named 'Removal of Barriers to Energy Efficiency and Energy Conservation in Buildings'. The office has been set up under Section 4 of the Energy Efficiency Act 2011 with the objectives of, among others, to establish links with regional and international institutions and for promoting awareness on the efficient use of energy as a means to reduce carbon emissions and protect the environment. Key achievements of EEMO in the space included the development of national guidelines for energy efficiency, voluntary agreements with the private sector and national energy efficiency awareness campaigns.

4.2. Power sector setting

The wave of power sector reform in the developed world, which started in Chile and the United Kingdom, has also reached the developing world. The World Bank and other international financial institutions were

[21] SCH has exclusive monopoly to import and market petroleum products in Comoros.

the prominent advocates of reforms of the power sector in developing countries. The proposed reforms had four dimensions [35]. These are:

- *regulation* which involved the creation of an independent regulator;
- *restructuring* which involves steps towards full vertical and horizontal unbundling of the incumbent state-owned utility;
- *private sector participation* that aims to bring private management and capital into the sector; and
- *competition* which aims to liberalise the generation and retail side of the energy value chain.

There are many drivers of reforms in the power sector [26], [36]–[38]. These include:

- the poor performance of the state-owned vertically integrated utilities, in terms of high costs, inadequate expansion of access to electricity service for the population, and/or unreliable supply;
- the inability of the state sector to finance needed expenditures on new investment and/or maintenance;
- the need to remove subsidies to the sector in order to release resources for other pressing public expenditure needs; and
- the desire to raise immediate revenue for the government through the sale of assets from the sector.

The reforms are expected to improve the economic performance of the electricity sector [26], [36]. First, it can encourage a more efficient utilisation and allocation of resources in which electricity prices reflect the marginal cost of production to guarantee both the investment recovery and future capacity expansion. Second, the profit motive provides a stronger incentive for efficient use of inputs, lowering the cost combinations of inputs required to produce a given output and passing through the gains to consumers. Third, the sector can be made to cover its costs and be profitable. Then there will be an incentive for firms to invest, and they will have an incentive to seek out new markets that can be profitable, attracting new entrants. However, the results of the reform are mixed, none of the African countries has reached the full target model in the four dimensions of the reform [37], [38]. Empirical studies also indicate that the sequencing of the reform in terms of competition, privatisation and restructuring could matter [39].

Many islands have also gone through reform, mainly in large islands like Madagascar. However, small islands are considered to have inherent limitations because of the limited size of their power sector [26]. This limits the potential for investment revenue, and hence wholesale markets would inevitably lead to monopolistic or oligopolistic market structure [40]. This is also what we observe in the islands of the Indian Ocean.

In what follows, we discuss the current situation in the Indian Ocean islands by focusing on the three dimensions which are linked to the power market design and structure; namely, competition, privatisation and restructuring. Regulation is discussed in chapter 5.

4.2.1. Private participation

The power market in the islands involves some level of private sector participation, which depends on the segment of the value chain they are active in, their market share and involvement in other sector utility.

The participation of the private sector in the electricity production is shown in Figure 6. In Seychelles and Comoros, there are hardly any private producers while in Madagascar 47% and Mauritius 60% of the production comes from private producers. The 1% contribution in Seychelles is from the close to 3MW distributed PV systems owned by private producers and connected to the grid through the net-metering program. This does not include off-grid private producers like hotels, whose production data is not available. Similarly, data on state-owned off-grid production by the Island Development Company (IDC)[22] is also not available.

Some of the private producers in Madagascar and most of them in Mauritius produce under the IPP arrangement and sell their electricity to the state utility. However, IPPs represent 6.5% of the electricity production in Madagascar, and the remainder is accounted for by private suppliers in rural areas.

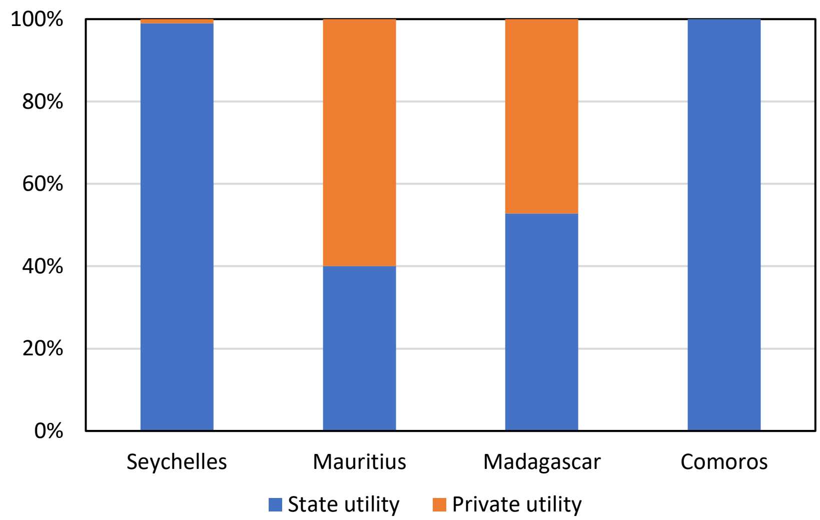

Figure 6: Share of electricity production by private and state utilities

All state utilities are vertically integrated; i.e., they are active in generation, transmission, distribution and the supply of electricity. This indicates that the market is far from being fully liberalised regardless of the contribution of private producers.

All state utilities in the Indian Ocean Islands are multi-utility in that they are active not only in electricity but also in other utility services mainly water and waste management. One of the justifications for the multi-utility approach is related to the relative size of the islands. In most cases, this arrangement is not challenged, except in Comoros where a new decree has been introduced to split the water and electricity activities and merge the two utilities (EDA and MAMWE) under one company called the National Electricity Company of Comoros (Société Nationale de l'Élecricité des Comores (SONELEC)) [41]. The water business will be operated by a newly established utility called Société Nationale d'Exploitation et de Distribution des Eaux (SONEDE) [42].

[22] IDCs are state owned off-grid energy companies that generate and supply electricity to the outer islands and any inner island under its management. There is no data on their share of production.

Box 1: Overview of state utilities in the Indian Ocean islands

Madagascar

Currently, JIRAMA, is the main utility in Madagascar, and caters to approximately 340,000 consumers dispatched in 114 locations. JIRAMA is the main utility mostly servicing urban areas, while there are more than 30 private companies operating in rural areas.

Mauritius

The Central Electricity Board (CEB), a parastatal body wholly owned by the Government, which is a generator and provider of power. Under the CEB Act, the CEB is

- statutorily in charge of the control and development of the electricity supplies in Mauritius.
- empowered to carry out development schemes with the goal of promoting, coordinating and improving the generation, transmission, distribution and sale of electricity for all purposes through Mauritius as required.
- entrusted with the responsibility for preparing the national integrated electricity plan (IEP).
- entitled to deliver electricity services at the minimum economic cost to the society to recover the cost of production, the repayment of loans and allocation of reserves.

Until the regulator is fully operational, CEB has been acting as the regulator.

Seychelles

The Public Utilities Corporation (PUC) is a parastatal body wholly owned by the Government of Seychelles. It was formed on 1st January 1986 following the merger of the Seychelles Water Authority and the Seychelles Electricity Corporation Ltd. It reports to the Ministry of Environment, Energy and Climate Change (MEECC) through its board and is regulated by the Public Utilities Act of 1st January 1986 and subsequent amendments. PUC is a vertically integrated utility company that has the responsibility on the three main islands of Seychelles (Mahé, Praslin and La Digue) for:

- the generation, transmission, distribution and sale of electrical energy;
- the treatment of raw water and supply of potable water;
- the treatment and safe disposal of waste water to the environment.

Other relevant activities of PUC include metering, billing, procuring equipment and materials, inventory control, inspectorate services, customer services, public relations, system planning and project management. Aside from its core activities, PUC is also playing a key role in assisting its customers to reduce their utility bills through adopting efficiency and conservation measures.

Comoros

The provision of electricity services has been split between two state-owned enterprises, MAMWE (Comoros Water and Electricity Management) - which provides services electricity supply in the islands of Grande Comore and Mohéli - and Electricity Anjouan (EDA) - which serves the island of Anjouan. MAMWE was founded in 2002, emerging an abortive privatization effort with the French company Vivendi. Both companies are vertically integrated, with responsibility for the production, transmission and distribution in their respective service areas.

The current organization of the energy sector is expected to change following the newly introduce decree (18-081/PR) on September 06, 2018. Accordingly, the water and electricity activities will be split, and the two utilities will be merged under one company called the National Electricity Company of Comoros (Société Nationale de l'Élecricité des Comores (SONELEC)).

4.2.2. Power sector restructuring

Restructuring or unbundling the power sector refers to the vertical break up of generation, transmission, distribution and retailing segments into different entities. It can enable multiple generators and distributors to compete. Monopolies can also be restructured by geographically dividing parts of the service into different competitive or non-competitive regions which is a suitable concept for multi-island states [26].

The power sector structure of the islands in the Indian Ocean presents diversity. As shown in Figure 7, Madagascar, Mauritius and Seychelles have a rather similar structure where there are a few IPPs selling their electricity production to the state utilities, JIRAMA in Madagascar, CEB in Mauritius and PUC in Seychelles. In addition, the systems have private suppliers or auto producers[23], which are connected to the distribution grid. In Comoros, two vertically integrated state-owned utilities manage two autonomous systems. There is no physical interconnection between the two systems today. Yet their respective generators get their petroleum supply through the national monopoly CHS, also owned by the state.

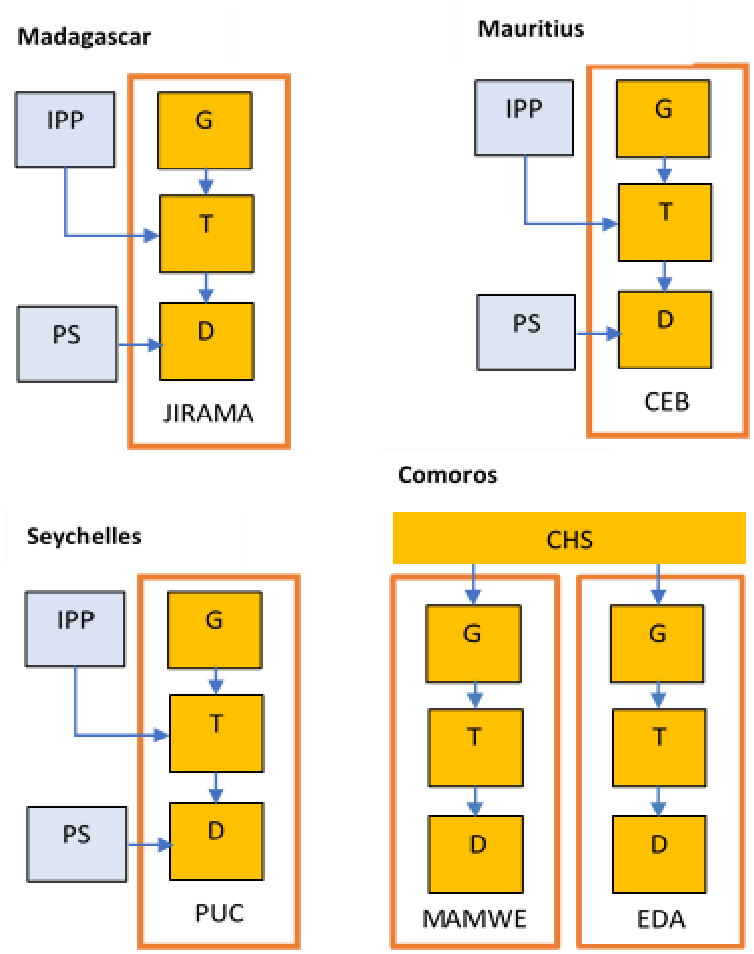

Figure 7: Structure of the electricity sector in Indian Ocean islands
Legend: Generation (G), Transmission (T), Distribution (D), Independent Power Producers (IPP), Private suppliers (PS)

[23] Auto producer undertakings generate electricity and/or heat, wholly or partly for their own use as an activity, which supports their primary activity.

Source: Own representation

Specifically, the relatively small power system in ***Madagascar*** has been for many years a centralised vertically integrated monopoly. The state-owned utility JIRAMA has been generating, transmitting, distributing and supplying electricity, albeit only in limited parts of the island. However, with the 98-032 act, the energy sector has been liberalised, but the participation of the private sector is limited to generation and is dispersed across the island. A small number of players sell their generation capacity to JIRAMA, and the rest are distributed generation.

For decades, the **Mauritian** electricity sector has operated on a model of centralised, state-owned power plants, typically where vertically integrated electricity monopolies have been separated into generation, transmission, and distribution activities. Of these, only generation has been privatised and competition induced by promoting independent power producers. Competitive markets require many buyers and sellers to function properly. On an island the size of Mauritius - and even more so in the case of Rodrigues - there are no economies of scale to be gained by such division. The Government, therefore, opted to corporatise CEB as a vertically integrated company and to retain CEB in Government ownership.

The power system in ***Seychelles***[24] was a centralised vertically integrated monopoly for many years. The state-owned Public Utilities Corporation (PUC), generated, transmitted, distributed and supplied electricity. However, with the Energy Act of 2012, the generation sector was liberalised so that the private sector could enter the market. While the generation sector has been opened, transmission, distribution and supply are still under the monopoly of PUC, resulting in a single buyer model. According to the Energy Act 2012, under the Single Buyer Model, only the production of electric power is opened to private operators, such as independent power producers, who carry out such production by constructing and operating power plants. In addition, auto-generation and co-generation plants are permitted. So far, there are only off-grid IPPs, mainly diesel generators. These include the Island Development Company (IDC), outer island resorts and large 5-star hotels on the main islands of Seychelles[25]. With the new infrastructure on the 33 kV lines being developed in Mahé, the generators in Mahé will have the chance to connect to the grid.

A consequence of this might be the issue of stranded assets. Yet there is less incentive to connect diesel generators to the grid as the fuel procurement price of the IPPs is the same as the utility. On-grid IPPs are expected soon.

The power system in ***Comoros*** is controlled by two centralised vertically integrated monopolies MAMWE and EDA, each operating two autonomous island systems (expected to change as per the new decree to merge the two entities). No information is available on the participation of IPPs, prosumers and private distribution grid operators.

4.2.3. Power sector competition

Short term competition in the market is hardly existent in the power sector of Indian Ocean islands. The current market structure is highly dominated by the incumbent state-owned vertically integrated utilities, in which private participation is limited as in the case of Madagascar and Mauritius, or insignificant as in

[24] Based on data from Ministry of Home Affairs Environment Transport and Energy (MHAETE).2011, 'Proposed Energy Bill and Annex '

[25] It was roughly estimated that the auto-producers produced a total of 74.96 GWh in 2010, based on their total fuel consumption.

Comoros and Seychelles. The typical market model is the single buyer model, which is applied in all islands except Comoros. Under the Single Buyer Model, all electricity produced is purchased by the main utility, and the prices payable for electric power is, therefore, regulated by a regulatory authority. The Single Buyer Model does not allow sufficient competition with respect to power generation[26]. No competition is allowed on the demand side of the market either, due to the fact that the main utility is the single buyer.

Introducing competition through wholesale markets in islands faces an inherent limitation, particularly for small islands [26]. It is argued that small islands will not have bulk electricity markets in the near future because electricity demand is not sufficient to be able to reduce electricity prices through competition in the market. It is also argued that countries with capacities below approximately 1GW would not attract a sufficient number of participants in generation and distribution to introduce sustained competition [36]. CEB is embarking on a corporatization process as a vertically integrated company and ownership is retained by the government. This has measure is in line with the peculiar feature of the islands and their limited potential economic benefit from competition. Yet, the largest island in the region, Madagascar, is considering retail competition as per the New Electricity Act on April 2018 with the aim of opening up the demand side of the market to competition.

[26] There is some form of competition for the market (e.g. renewable energy auctions), but not in the market.

5. Regulatory system

This section assesses the effectiveness of the regulatory system in realising the energy policy objectives in the Indian Ocean islands. In doing so, two dimensions of the regulatory system of the islands are evaluated (a) the regulatory governance and (b) regulatory substance. Regulatory governance refers to the institutional and legal design of the regulatory system and the framework under which decisions are made. The regulatory substance refers to the actual regulatory decisions made by the specified regulatory entity or other government entities [43].

Schematically, the various indicators of these two dimensions of the regulatory system that have been evaluated are depicted in Figure 8. This framework helps assess whether the specific elements of the regulatory system help or hinder the uptake of renewable energy and electricity access.

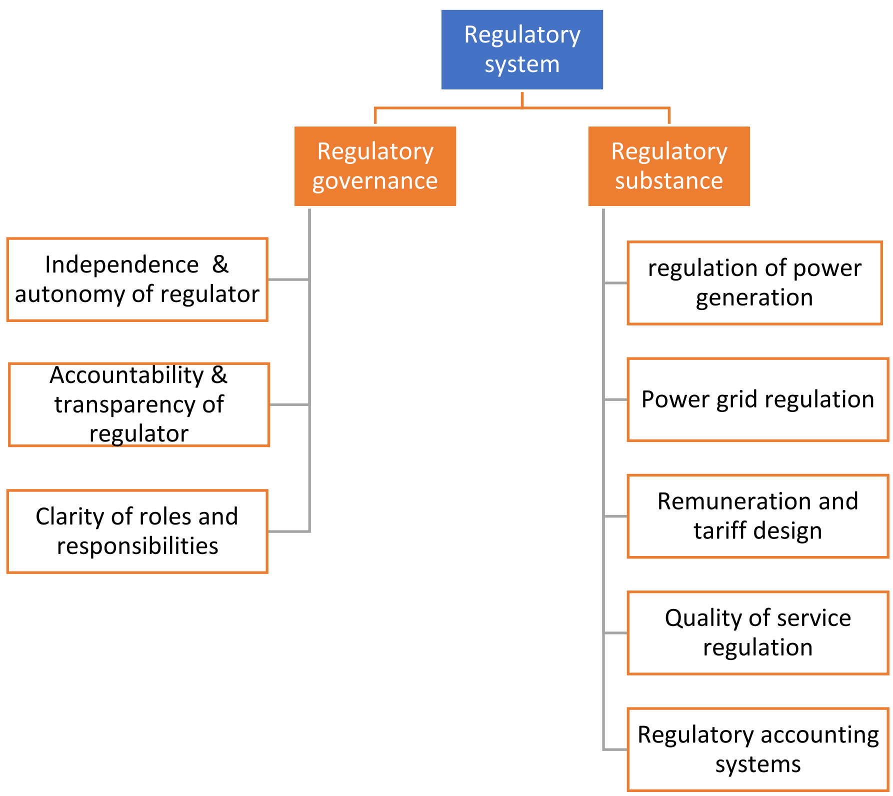

Figure 8: Dimensions of a regulatory system
Source: Adapted based on [43]

5.1. Regulatory governance system

To study the regulatory governance system in the region, we have conducted a survey which mainly focused on three aspects of the regulatory authority; namely, (1) independence and autonomy, (2) Accountability and transparency, and (3) clarity of roles and responsibilities of the regulator.

5.1.1. Regulatory independence

Regulators should be adequately insulated from short-term political pressure. They should not also require prior approval of other officials or agencies of the government to make decisions within the scope of their authorities. According to [44], there are five indicators against which we can assess a regulator's independence. These are:

- *legal protection* - regulator protected from dismissal without due cause;
- *institutional independence* – the regulatory institution is outside ministry;
- *managerial independence* – the regulator has control over professional staff;
- *financial independence* – the agency has earmarked, secure, adequate source of funding; and
- *decision-making independence* – no government entity other than a court or pre-assigned arbitrator can overrule the decision of the regulator.

A qualitative ranking of the independence of URA, ORE and SEC is shown in Table 7. Regarding legal protection, the head of the regulatory agency in Mauritius can be dismissed for a specific reason (e.g., if guilty of misconduct) by the president on the advice of the prime minister after consultation with the leader of the opposition. The appointment committee before dismissal also approves the cause. The process, in this case, provides better legal protection compared to the other two countries where the Malagasy prime minister and minister of energy have the power to dismiss the regulatory head, without the approval of the cause. Similarly, the president of Seychelles can remove the head of the SEC, without the approval of the causes.

Table 7: Regulatory independence of regulators in Indian Ocean islands

	Mauritius	**Madagascar**	**Seychelles**
Legal protection	Medium	low	Low
Institutional independence	High	High	Low
Managerial independence	High	High	High
Financial independence	High	High	Low
Decision making independence	High	Medium	Low

Source: FSR based on regulatory governance survey (2018)

The institutional independence of regulators in Mauritius and Madagascar is strong. In contrast, the Seychelles energy commission is still under the parent ministry of energy and climate change. Yet, it claims that it does not report or is not subjected to any direction from the ministry. All three regulators have managerial independence; i.e., they can freely make personnel decisions.

In terms of financial independence, the regulator in Mauritius gets its budget partly from the government and partly from regulated entities as a fee. This fund is legally earmarked for use only by the agency, and it is not subject to government reallocation. The regulatory budget in Madagascar comes only from payments by regulated entities, is legally set aside for use only by the regulator and is not subject to government reallocation. In contrast, the budget of the regulator in Seychelles comes only from the government budget, legally earmarked for use only by the regulator, and it is subject to government reallocation since the ministry of finance sets the ceiling. Hence, the Seychelles regulator has low financial independence.

Decision making independence is linked to how the regulator performs in terms of its independence in other areas. It also includes whether the government can easily reverse the regulator's decision. In this case, given Seychelles has low legal protection, institutional and financial independence; decisions can be easily adapted by the government. In Madagascar, the lack of sufficient legal protection for the management of the regulatory body can have an impact in the regulatory decision-making independence.

However, no legal protection cases have been witnessed in Madagascar yet. In Mauritius, the decision-making independence is rated high given the performance in other indicators.

5.1.2. Accountability and transparency

Regulators should be held accountable for their decisions. Among others ensuring accountability requires putting in place legally defined appealing process for regulatory decisions, reporting on the process or substance and reporting audit obligation. In Mauritius, a regulatory authorities appeal tribunal is established under the regulatory authorities appeal tribunal act of 2004[27]. Besides utility regulation, the tribunal also deals with appeals related to information and communication technology[28]. Similarly, Madagascar has a special administrative tribunal that handles appeals. In Seychelles, an investment appeal panel handles appeals. According to the Seychelles investment act 2010, the president appoints the members of the panel and they consist of a chairperson, representative of the attorney general, private sector and non-government consumer welfare organization.

In terms of maintaining transparency, all regulators have websites through which they make various regulatory frameworks and decisions available to the public. Both Madagascar and Mauritius have clear reporting process about decisions and processes, while Seychelles instead has a public hearing. The survey also indicates that the Malagasy regulator does not publish audited accounts. This is summarised in Table 8.

Table 8: Indicators of regulatory accountability and transparency in the Indian ocean islands

	Mauritius	**Madagascar**	**Seychelles**
Legally defined appealing process	Yes	Yes	Yes
Reporting decisions and processes (e.g., Annual report)	Yes	Yes	No
Website	Yes	Yes	Yes
Public hearing	Yes	No	Yes
Audited accounts published	Yes	No	Yes

5.1.3. Clarity of roles & relation with ministry and utility

Regulators in the Indian Ocean islands are involved in various decisions to a varying extent. As shown in *Figure 9*, the regulators in Mauritius and Madagascar undertake the decisions related to almost all issues except on investment decisions (neither in the ex-ante approval phase nor the ex-post prudence review), and merger/acquisition reviews. However, the Malagasy regulator is also involved in sector expansion plans while only the Seychelles energy commission is involved in merger and acquisition reviews[29].

ORE shares a few decisions only with the ministry; namely, decisions related to sector expansion plan, wholesale market structure, and anti-competitive. The office also shares decisions related to consumer complaints and service quality with the utility, JIRAMA. Moreover, the decision related to technical and safety standards is shared among regulator, ministry and the utility.

URA has exclusive autonomy to make decisions on a number of issues compared to ORE and SEC. Namely; it makes a decision on tariff structure, tariff level, service quality, consumer complaints, wholesale market

[27] URA act 2004, Article 28.

[28] Regulatory Authorities Appeal Tribunal Act 2004, Article 12.

[29] SEC acts as a referral Agency for other agencies and authorities. Merger and acquisition case were referred from Fair Trading Commission.

structure, and anti-competitive behaviour. The ministry and utility share some of the decision regarding sector expansion plans, providing ex-ante approval for investment plans/decisions, and technical and safety standards. Investment decisions related to ex-post prudence review are made only by the ministry.

Note here that the SEC is less involved in regulatory decisions than ORE and URA because it is not exercising most functions as per the Energy Act which provides the basis, but it lacks secondary legislation to define its responsibilities as a regulator. SEC notes that the Energy Act and the legislation governing the energy sector including the PUC act needs review because there are gaps that are preventing SEC to regulate the sector appropriately.

Figure 9: Roles of the regulator, utility and ministry
Source: FSR based on regulatory governance survey (2018)

5.2. Regulatory content

In this section, the regulatory content of selected topics is addressed. The selection has been based on the availability of information and the interest noticed from our engagement with stakeholders in the Indian Ocean islands. We focus on the following topics (1) regulation of power generation, including off-grid generation (2) power grid regulation, (3) remuneration and tariff design, and (4) other regulatory topics including quality of service and regulatory accounting system. In doing so, we refer to the key regulatory documents on each island and the inputs collected through our roundtable and one-on-one discussions.

5.2.1. Regulation of power generation

Power generation business is still not fully open for competition. Even if there are provisions that allow for private investment in power generation, vertically integrated state utilities still dominate the power sector landscape in the Indian Ocean islands.

In **Mauritius**, private participation in power generation has been formalised through policy directives such as the Bagasse Energy Development Program (BEDP), which gave rise to an amplified number of seasonal IPPs at sugar, estates scattered around Mauritius through the signing of power purchase agreements. Moreover, CEB has signed agreements with the private sector for power generation from renewables such as PV and wind through policy directives.

In **Seychelles**, the Energy Act 2012 opens the grid to independent power producers at standardised conditions, which is usually done via a power purchase agreement (PPA). Under this provision, only renewable energy PPA's have been contemplated so far.

In **Madagascar**, the 2017-020 Electricity Act states that generation and distribution are open to anyone, provided they apply for a license, which can fall under different legal regime - a concession, authorisation or declaration [45]. The generation limits (P) for different types of generation technology are given in Table 9.

Table 9: Regimes applicable under the new Malagasy Electricity act

Installation	Declaration	Authorization	Concession
Thermal		P≤ 500 kW	P > 500 kW
hydroelectricity	P≤ 500 kW	500 kW <P ≤ 5 MW	P > 5 MW
Wind	P≤ 250 kW	250 kW <P ≤ 5 MW	
Solar Thermal		P ≤ 5 MW	
Solar photovoltaic	P≤ 150 kW	150 kW ≤ P ≤ 5 MW	
biomass		P ≤ 5 MW	
Geothermal and marine origin		P ≤ 10 MW	
Waste		P ≤ 5 MW	

Source: New regulation - Madagascar

Concession applies for establishment and operation of installations with an installed capacity greater than 500 kW for thermal installations and 5 MW for hydroelectric installations. In addition, a declaration regime applies for generation investments that are below 500 kW (hydro), 250 kW (wind) and 150 kW (Solar PV). For the moment, wholesale electricity is sold exclusively by long-term contracting. Authorizations are delivered for 7 to 15 years, while Concession contracts run for 15 to 30 years, depending on the amount of investment.

Regulatory frameworks for auto production

In **Madagascar**, the establishment and operation of auto production facilities with an installed capacity of 500 kW or less for thermal, hydraulic and solar installations and less than or equal to 1 MW for biomass, geothermal and wind power installations or waste processing, are subject to *Declaration*. If it is greater than those limits, then it is placed under the *authorisation* regime, which is handled by the ministry in charge of energy. Moreover, the Auto producer may sell its surplus electricity under conditions set by the Electricity Regulatory Authority, provided that at least 60% of the electricity produced is consumed for its purposes. However, this has not yet exceeded 10%.

In **Mauritius**, the Electricity Act does not explicitly refer to auto producers. Nevertheless, there are projects that have been initiated by CEB in collaboration with the ministry; for example, the Small-Scale Distributed Generation project (SSDG) which was limited to mobilising investment in 3 MW and allowing consumers to inject back their surplus to the grid.

Auto producers[30] in **Seychelles** are governed by the provisional net metering arrangement with a buyback rate of 88% of fuel marginal cost for every surplus unit. Moreover, since PUC's 70% of revenue comes from the commercial sector and are the ones who want solar PV, there is a cap of 50% of energy consumption for commercial customers above 10 kW. In other words, installation capacity should meet only 50% of the consumer's energy consumption[31]. Commercial customers consuming less than 10 kW can install solar PV system to cover 100% of their electricity consumption. On the other hand, residential customers can produce 100% of their household energy needs from renewable energy.

5.2.2. Power grid regulation

Currently, there are initiatives to develop and implement grid codes[32] that govern the operation, planning and investment related to the power grid in the islands. In **Seychelles**, PUC and a consultant are developing grid codes, which will be subject to approval. SEC will oversee its implementation. In **Madagascar**, the new regulation states that a consortium of the ministry of energy, network operators as well as market players will be formed and called 'Group of Network Users', which will be coordinated by the regulator. The Malagasy grid code is expected to include but not be limited to the following aspects: (1) planning code that provides for the exchange of data for the preparation of development plans, (2) connection code, (3) access code, (4) operational and data exchange code, (5) collaborative code (among system operators), (6) count code, and (7) code of conduct for networks.

Even if there are currently no operational grid codes, there are some regulatory practices related to the power grid in the islands. In what follows, we assess the practices related to grid access, planning and investment as well as grid reliability.

[30] As per Energy Act 2012, auto-producers are licensees carrying out electricity generation to meet its electricity requirements.
[31] http://www.sec.sc/images/archives/miscellaneous/PUC-Press-Release-January-2013.
[32] Grid code is the technical code including requirements and rules for the connection, access and management of electricity.

Grid access

Given that the transmission grid is owned and operated by the vertically integrated state utilities, grid access is an important aspect that calls for regulatory oversight. In all four countries, effective unbundling of the regulated and competitive activities of the electricity sector is not in place. Yet **Madagascar** has a provision[33] that allows some categories of users or distributors and some generators to conclude direct supply agreement between them. In relation to this, the provision defines the conditions under which the relevant inter-connected network could be used to transit flows of electricity generated under these contracts. It fixes a royalty of transit, which is based on economic cost calculated considering the investment plan of transmission for a fifteen-year period, the losses on the network and the costs incurred by the licensee of transmission to ensure the dispatching function and to ensure the continuity and the quality of the service. This cost is adapted to five years period throughout concession at an average rate of benefit fixed by the regulatory body. However, for the moment, such a case has never been experienced in Madagascar.

In **Mauritius**, the Electricity Act of 2005 requires all electricity market participants to have a license for connecting to the grid. Applications should be made to the regulator (URA), although it is yet to start its operations.

Grid planning and investment

Grid planning and investment is part of the overall sector expansion planning exercise. As discussed in section 5.1.3, currently, there is no clarity on the role of the regulatory body when it comes to sector planning. Requesting regulatory approval for grid investments seems not to be a common practice. In the islands where the infrastructure is underdeveloped, they welcome any investment. Whereas in the rather developed systems like Mauritius and Seychelles, the vertically integrated state utilities self-regulate their investment plans.

Grid losses and reliability

The reliability of the grid in the Indian Ocean islands is a serious concern, particularly in Madagascar and Comoros where the existing grid is aging and lacks proper maintenance. In general, it is also worth mentioning that the vulnerability of the islands to natural disaster calls for a highly resilient grid and reliable energy system.

In terms of technical and non-technical transmission and distribution losses, as shown in Figure 10, around 33% and 40% of the electricity generated in Madagascar and Comoros is lost in the network, mainly in the distribution grid. In this case, the non-technical losses in Madagascar account for 20%, which are mainly driven by a meager bill collection rate at around 60% [46]. To solve this, JIRAMA has started implementing a new commercial management system to improve billing and collection performance, and it is rehabilitating some of the overloaded transmission lines.

International reference values for well-performing power systems suggest that technical losses can be kept to less than 10% and non-technical losses to zero. In this case, Mauritius has been successful in keeping its grid losses to less than 10% due to the measures were taken by the utility. Note that this was not as a response to the regulatory measure but the CEB's own initiative.

[33] Provision 16 and 58 of the 98-032 Act.

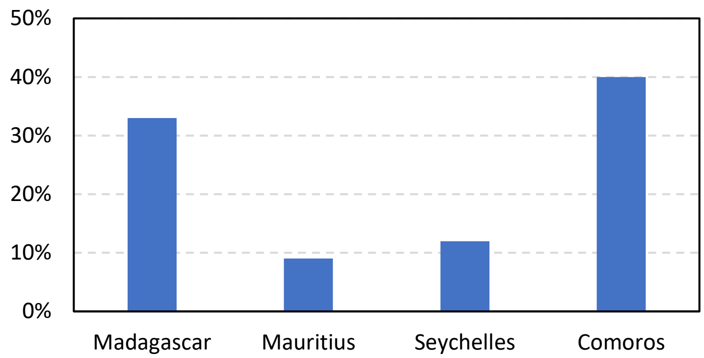

Figure 10: Power grid losses in the Indian Ocean islands

In contrast, Madagascar, which has had a regulatory regime for a long time does not have a mechanism that provides incentives for distribution companies to reduce grid losses. Such mechanisms are intended to be set up in the new Electricity Act. Only standardised tolerances (plus or minus *x*) are defined regarding the voltage at the end of the network and for the frequency.

5.2.3. Remuneration and tariff design

All islands apply cost of service regulation. Yet most of the utilities face serious financial deficit because they fail to recover their costs. There are no strong incentives for the utilities to improve efficiency or maintain the quality of service. As shown in Figure 11, the quasi-fiscal deficit of the utilities in the Indian Ocean islands is significant where Madagascar, Mauritius and Comoros have a deficit of $229 million, $51 million and $23 million, which represents 2.2%, 0.4% and 4.1% of their GDP respectively [9]. This is a bottleneck especially for countries which require a huge investment in expanding their grid and improving their generation adequacy to satisfy the growing demand and ensure universal access to electricity. The exception, in this case, is Seychelles where the utility fully recovers its costs and even makes a surplus of $4 million. To deal with the financial deficit of the utility, Madagascar is expected to change its regulation from cost of service regulation to a revenue cap regime where the regulator sets the annual allowed revenue of the utility. Moreover, the change will involve revising the current tariff structure and level based on the new tariff study.

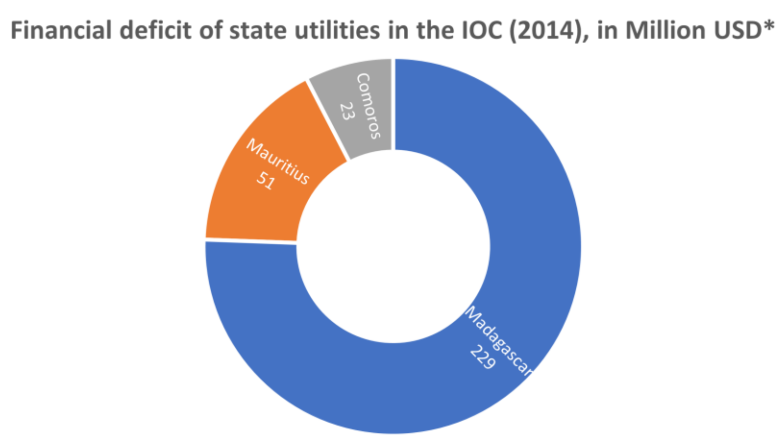

Figure 11: Financial deficit of state utilities in the Indian Ocean islands
Source: Based on [9]

Tariff levels

Comparing the electricity supply cost, Comoros is the costliest in producing electricity at $0.61 per kWh, and it has set its average tariff at $0.21 per kWh but is recovering only $0.12 per kWh. Madagascar and Seychelles have a relatively similar level of total electricity cost. However, Madagascar has set a tariff ($0.17 per kWh) that is not cost-reflective, and yet it recovers less than the tariff level ($0.09 per kWh). Seychelles fully recovers its cost, even with slightly higher tariff than the total cost. In contrast, Mauritius has the lowest cost of electricity supply, and it recovers $0.19 of the total $0.21 per kWh cost of electricity. The comparison is presented in Figure 12.

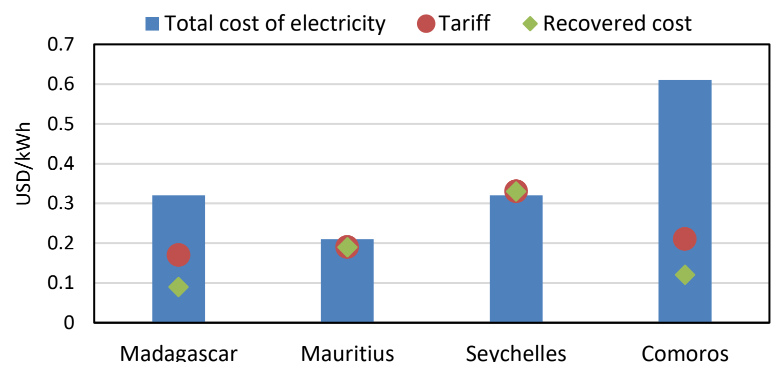

Figure 12: Total cost of electricity supply, tariff and cost recovered in the Indian Ocean islands (2016)
Source: based on data from [9]

The high tariff level in Comoros is a barrier for most households and small businesses to connect to the grid. The combination of high prices and unreliable supply of electricity could make a business case for more renewable energy investment by end users. Similarly, in Madagascar, the high upfront connection fee is a considered as one of the barriers to connect new users to the grid (around $165, equivalent to four times the average monthly household income), even if JIRAMA provides highly subsidized tariff for low consumption users [46].

Tariff design

All islands have several tariff categories that often go beyond the classification based on type consumers. As can be seen in Table 10, they all have categories within each consumer group depending on usage and the voltage level to which the consumer is connected. Madagascar is the only exception that has a locational tariff. That is, the tariff structure differs in three zones: Zone 1 for customers powered by hydro, Zone 2 for cities where heavy fuel oil production predominates, and Zone 3 for customers where gasoline production is the majority. However, none of the islands differentiated based on the quality of service.

Table 10: Tariff categories

	Type of consumer (e.g., domestic, commercial, industrial)	**Usage characteristics (e.g., load factor, usage)**	**Quality of service (e.g., firm or interruptible)**	**Voltage level**	**Location**
Mauritius	Yes	Yes	No	Yes	No
Madagascar	Yes	Yes	No	Yes	yes
Seychelles	Yes	Yes	No	Yes	No

Additionally, Madagascar and Mauritius have social tariffs. In Mauritius, it applies only to those households under the welfare system. In the case of Madagascar, this applies to anyone who has a monthly consumption up to 25 kWh. In Seychelles, all consumers with monthly consumption below 300 kWh are considered to be cross-subsidized, paying a tariff lower than the cost of production. Those that still have difficulty paying their bills can seek assistance from the Agency for Social Protection (ASP). Currently, a tariff re-balancing exercise being undertaken by the government of Seychelles with the aim of establishing a cost-reflective tariff and remove the cross-subsidization in the current tariff structure. As part of this exercise, consumers who have difficulty in paying their bills will benefit from PV democratization project funded by the Government of India. Through this project, the consumers will receive a 3kW PV system to offset their consumption instead of giving them money to pay their bills.

The design of the electricity tariffs includes energy (per kWh), demand/capacity (per kW or kVA) and/or fixed charge (per period). In this regard, Mauritius, Madagascar and Seychelles have tariffs that incorporate these three components for their residential, commercial and industrial consumers. The exceptions are the tariff for residential consumers in Mauritius who do not see capacity charges and all consumers of Seychelles, which do not include fixed charges. This is summarised in Table 11.

Table 11: Electricity tariff components

	Mauritius			**Madagascar**			**Seychelles**		
	Energy	Demand (kW/ kVA)	Fixed	Energy	Demand (kW/kVA)	Fixed	Energy	Demand (kW/ kVA)	Fixed
Residential	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Commercial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Industrial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Looking further into how the tariffs are structured, we can observe that residential tariffs are designed based on increasing block rates in all islands. Commercial tariffs in Mauritius are flat rates per consumer group while a combination of increasing block rates for energy charges and flat rates for demand charges are applied in Madagascar[34] and Seychelles. Industrial tariffs are rather sophisticated in Mauritius and Madagascar. Where a mix of flat, decreasing block, day and night tariff and peak pricing are applied in Mauritius, and a day and night tariff with peak pricing and flat rates for demand charges are applied in Madagascar. Seychelles has a similar structure for consumer groups under residential, commercial and industrial consumers; i.e., the differences among the tariff categories are mainly in terms of the tariff levels. This is summarised in Table 12.

Table 12: Tariff structure

	Mauritius	**Madagascar**	**Seychelles**
Residential	Increasing block rate, with a minimum charge and security deposit	Zonal pricing with increasing block rate for energy charges and a flat rate for demand charges	Increasing block rate for energy charges and a flat rate for demand charges
Commercial	Flat rate per consumer group	Zonal pricing with increasing block rate for energy charges and a flat rate for demand charges	Increasing block rate for energy charges and a flat rate for demand charges

[34] These are only tariffs applied by the state-owned company only. Each private operator in each mini-grid has his regulated tariffs based each on his business plan.

Industrial	Flat rate, decreasing block rate, day and night tariff, and peak pricing (Depending on the customer group)	Zonal pricing with day and night tariff, peak pricing, and flat rates for demand charges	Increasing block rate for energy charges and a flat rate for demand charges

5.2.4. Quality of service regulation

Quality of service in the electricity supply generally includes commercial relationship between a supplier and a user, continuity of supply and voltage quality. In this regard, **Madagascar** has a provision in which the 98-032 Act indicates that "continuity of service" is required from each operator, but without specific details, targets and standards. There are no penalties or credits applied to the distribution company if it does not meet or exceed the prescribed quality standards. The regulatory body surveys the quality of service, but there is no explicit regulation exploring it in depth. The upcoming grid code could incorporate such aspects, with a distinction between on-grid and off-grid electricity supply. Currently, the regulator is assessing the quality of service using EU standards and norms, since the existing standard dates back to the 1960s.

In **Mauritius**, the electricity act of 2005 includes provisions to prepare for regulations to set rules for the quality of services [47]. However, the act is yet to be proclaimed. Similarly, in **Seychelles**, there are provisions in the Energy Act 2012 to prepare for regulations to set rules for quality of services. For ensuring the quality of service, there are no rules or regulations. Note also that the PUC Act in electricity regulations 64 (2) states that PUC cannot be penalised or sued in any situation; hence, there are no repercussions for poor quality of service[35]. This could change when reviewing the Energy Act.

5.2.5. Regulatory accounting system

A good regulatory accounting system is an important source of reliable information for regulators to fulfill their duties adequately. In this regard, we see a discrepancy in the islands. The utilities in Mauritius, Comoros and Seychelles are self-regulating to a varying extent. This has been the case in Mauritius, which now has a new regulator to oversee activities of the utility. In Comoros, this is still the case. While in Seychelles, SEC has not yet started exercising its full regulatory functions.

Even in those islands where there are regulators, the regulatory accounting system is far from existence. In Madagascar, the regulator does not asses the economic and technical efficiency of the utility. Similarly, in Seychelles, SEC receives periodic information and data from the utility company. However, it does not have a comprehensive accounting system for all the data information to account for the cost breakdown, and as a result, the economic and technical efficiency of the utility is not being assessed. Furthermore, here is no reference value to use as an indicator to help in the improvement of the quality of service delivered by the utility company especially on the distribution level.

[35] Article 64(2) of electricity regulations of 1960 states: "*Neither the Government nor the corporation shall be responsible for any cessation or deficiency of the supply of electricity and will not be liable for any loss or damage direct or consequential due to or arising from such cessation or deficiency resulting from any cause within the consumer's premises or from strike, lock-out, war, act of God, legislative action or embargo, or from breakdown or stoppage of machinery, or from interruption of supply from whatever cause, and whether or not such cause be attributed to the act or omission of any employee or agent of the corporation*."

6. Conclusions and recommendations

Renewable energy presents an opportunity for islands to gain energy independence and provide access to clean and affordable electricity. However, the success of the islands in harnessing their respective renewable energy potential is challenged by the general political-economic context of the islands; the effectiveness and clarity of roles and responsibilities of various institutions in the sector; the performance of dominant incumbent utilities and private participation; coherence of policy and regulatory interventions; and the adequacy of the regulatory system. We conclude by presenting how these dimensions are at play in the island nations studied above.

First, the case islands present diversity in their social-economic and political context. On the one hand, Mauritius and Seychelles are high-performance countries in terms of both economic development and the effectiveness and stability of the governance system. Both have a power sector that is performing well, and their key challenges are promotion and integration of more renewables into their system. On the other hand, Madagascar and Comoros are low-income countries with a weak governance system. Their utilities are facing a chronic financial deficit. This coupled with the ineffective governance system poses a major barrier to harness their renewable energy potential and provide access to clean and affordable electricity to their population.

Second, institutions governing the energy sector lack clarity in roles and responsibilities in overseeing and implementing the electrification and renewable energy targets. This could lead to ineffectiveness, duplication of effort and market distortions. In this case, Mauritius is unique in setting up specialised agencies focused on renewable energy (i.e., MARENA) and energy efficiency (i.e., EEMO) which shows the priority the island has given to these issues. However, establishing multiple institutions overlooking similar operation may not be the most efficient and effective approach. For example, MARENA is established to coordinate and promote renewables by IPPs in a context where there is a proactive utility (i.e., CEB) which has been initiating and implementing various renewable energy promotion measures, activating the market through various schemes such as the feed-in tariffs and net metering. The newly established regulator could also assume some of the regulatory functions related to renewable investment. In this context, the role and effectiveness of institutions such as MARENA may require revisiting.

Similarly, in Madagascar, the rural electrification agency (ADER) has been entrusted with the promotion of rural electrification, which has not been effective in improving the situation. There are no policy instruments in place that aim to accelerate electrification and ADER has limited financial resources and human skills to lead this effort. Moreover, the regulatory body appears to focus on regulations that pertain to grid-connected systems (covering only 15% of the population) and not having clarity on regulation for off-grid electrification, which by default is seen as the responsibility of ADER. As mini-grid developments and standalone systems become viable technologies for rural electrification, the role of ADER should also be revisited.

Third, state-owned incumbent utilities had an indispensable role in ensuring universal access to electricity in Mauritius and Seychelles, which are the two islands with full electrification. The participation of the private sector in Mauritius is one of the success stories where independent power producers, contributing close to 60% of the electricity production, created a conducive environment for generation investment. This set up can give the utility to focus its efforts on expanding and maintaining the power grid and taking proactive measures to prepare the system to accommodate more renewables with an intermittent production pattern.

Madagascar has also opened its electricity generation business, and this led to more than 50% production by private players. However, this is only for the 15% of the population, and the huge challenge remains in attracting private investment in both on-grid and off-grid electricity production, distribution and supply. Realising these calls for major reform in the state-owned utility and ensuring the political and governance system of the country is stable and effective. The remaining two islands, Seychelles and Comoros, do not have significant private participation in energy. Seychelles has a provision that allows IPPs in which only a few off-grid IPPs are currently present.

Furthermore, the design of the power market in islands needs to consider their inherent limitation of size. The dominant market model in the islands is the single buyer model, which is functional in Mauritius and Madagascar, where grid-connected IPPs are active. Comoros, in this case, has two geographically separated utilities. The limitation that comes with the size of the islands is often given as justification to delay the restructuring of the power sector utilities which still are multi-utilities. Yet Madagascar is considering unbundling its poorly performing utility JIRAMA, while Comoros has recently introduced new decrees to split the water and electricity business activities and merge the two utilities (EDA and MAMWE). However, the effectiveness of these measures is yet to be determined, calling for further research.

Fourth, the coherence of renewable and electrification policies and regulatory frameworks, and how these are synergised with the development plan of the island, requires due consideration. This is particularly important for Madagascar and Comoros, which have the dual energy challenge of transitioning to a clean energy system and ensuring universal electricity access. Achieving renewable energy targets do not guarantee the realisation of universal electricity access. The priority can imply how scarce funding of the government and development partners is allocated. If increasing the share of renewables is prioritised, islands may channel investments and incentives only to the grid-connected system, while fewer resources are directed towards increasing grid connection. Therefore, setting the right policy blend is vital to avoid risks of leaving part of the population unelectrified.

Furthermore, electricity alone cannot kick-start local growth, although it is a stepping-stone towards improving the living standard of societies. Hence, it is crucial to embed electrification in the national and local development plans that include other necessary infrastructures such as water, transport, health, and education. This can help improve the low connection rates and weak productive utilisation of electricity that are currently evident on these islands, as well as boost the local economy.

Fifth, the regulatory system in the case islands triggers debates in terms of the regulatory governance system and the various regulatory decisions. Notably, the need for an independent regulatory body is quite debatable across the islands. The state utilities in Mauritius, Seychelles and Comoros, are considered self-regulating because the regulatory body has just been established as in Mauritius, or the regulator performs a limited set of regulatory tasks as in Seychelles, or there is no regulatory body as in the case of Comoros. Among these, except for Comoros, the sector performance has been positive at least in terms of ensuring access to reliable electricity. On the contrary, Madagascar was one of the first to set up an independent regulator, which is by far close to the standard model of an independent regulator, and it has good regulatory frameworks in place. However, it has not been effective in improving the performance of the utility and accelerating access to electricity. Ultimately, what matters is that regulation should not only focus on the development of rules but also on its delivery.

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Annexes

Annex I Survey on regulatory governance system

Questionnaires on Infrastructure Regulatory Systems[36]

Please answer **Yes**, **No**, **N/A** (not applicable), or **D/K** (don't know), or note a checkmark and add explanation where appropriate.

General Regulatory Issues

1. Name of country: Choose an item.
2. What government body has the primary legal responsibility for economic regulation (e.g., tariff setting, quality of service, consumer protection, investment, promotion of competition) of the sector?
   Click or tap here to enter text.

   Is the body:

   a) An independent/autonomous regulatory agency? Yes ☐ No ☐ N/A ☐ D/K ☐
   b) A regulatory agency within ministry? Yes ☐ No ☐ N/A ☐ D/K ☐
   c) An independent advisory agency reporting to minister? Yes ☐ No ☐ N/A ☐ D/K ☐
   d) The minister/ministry? Yes ☐ No ☐ N/A ☐ D/K ☐
   e) Other? Yes ☐ No ☐ N/A ☐ D/K ☐

   If Yes, specify:Click or tap here to enter text.

   In what year was the regulatory agency established? Year: Click or tap here to enter text.

3. Does the agency/ministry derive its legal authority to carry out economic regulation from -

   a) Constitution? Yes ☐ No ☐ N/A ☐ D/K ☐
   b) Law or statute? Yes ☐ No ☐ N/A ☐ D/K ☐
   c) Government decree? Yes ☐ No ☐ N/A ☐ D/K ☐
   d) Contract? Yes ☐ No ☐ N/A☐ D/K ☐
   e) Combination of the above? (if Yes, explain) Yes ☐ No ☐ N/A ☐ D/K ☐
   f) None of the above? (if Yes, explain) Yes ☐ No ☐ N/A ☐ D/K ☐

   In what year was the law or decree, etc., enacted? Year: Click or tap here to enter text.

   In what year was the law or decree, etc., last amended? Year: Click or tap here to enter text.

   Is there a electricity sector law separates from any regulatory law? Yes ☐ No ☐ N/A ☐ D/K ☐
   If, so, in what year was the sector law enacted? Yes ☐ No ☐ N/A ☐ D/K ☐

4. Indicate what percentage of the regulatory agency's budget comes from the following sources:
5. Government budget Choose an item.

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[36] This questionnaire is adapted based on the proposal by
Brown, A. C., Stern, J., Tenenbaum, B., & Gencer, D. (2006). *Handbook for Evaluating Infrastructure Regulatory Systems.* Washington, DC: World Bank

6. Identified payment by regulated entities (e.g., license fees) Choose an item.
7. Identified payment by consumers (e.g., specific fees or taxes) Choose an item.
8. Other (explain) Choose an item.

For what year do these percentages apply? Year: Click or tap here to enter text.

How are these percentages obtained?

a) From a published source? (If Yes, name the source) Yes ☐ No ☐ N/A ☐ D/K ☐
b) Estimated? (If Yes, indicate source of estimate) Yes ☐ No ☐ N/A ☐ D/K ☐

Are regulatory funds legally earmarked for use only by the agency, or are they subject to government reallocation? Yes ☐ No ☒ N/A ☐ D/K ☒

9. Is the regulatory agency headed by
a) A single person (e.g., director general/president)? Yes ☐ No ☐ N/A ☐ D/K ☐
b) Multimember body (e.g., 3–5 regulatory commissioners)? Yes ☐ No ☐ N/A ☐ D/K ☐
c) Other? Click or tap here to enter text.

10. Who is legally responsible for appointing the head(s) of the regulatory agency? (mark one or more in the case of shared legal responsibilities)
a) President/head of state Yes ☐ No ☐ N/A ☐ D/K ☐
b) Cabinet Yes ☐ No ☐ N/A ☐ D/K ☐
c) Prime minister Yes ☐ No ☐ N/A ☐ D/K ☐
d) Departmental minister Yes ☐ No ☐ N/A ☐ D/K ☐
e) Legislature Yes ☐ No ☐ N/A ☐ D/K ☐
f) Other (explain): Click or tap here to enter text.

Under the law, are these appointments subject to approval by

a) Legislature? Yes ☐ No ☐ N/A ☐ D/K ☐
b) Other body (explain): Click or tap here to enter text.

11. Under the law, are regulatory agency head(s) appointed for
a) Fixed terms? (if Yes, specify length of term) Yes ☐ No ☐ N/A ☐ D/K ☐
b) Indefinite periods? Yes ☐ No ☐ N/A ☐ D/K ☐

If the head is appointed for indefinite period, specify at whose discretion the appointment is ended Click or tap here to enter text.

If terms are fixed, are they the same term as the period between elections? Same ☐ Different ☐

Are regulatory agency head(s) limited in the number of terms they are permitted to serve? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, specify the maximum number of terms. Click or tap here to enter text.

For regulatory agencies with 3, 5, or more commissioners, indicate whether their terms of office are

Staggered and overlapping Yes ☐ No ☐ N/A ☐ D/K ☐
Common, so that they all begin and end together Yes ☐ No ☐ N/A ☐ D/K ☐

12. Under the law, are regulatory agency head(s) subject to dismissal (within terms if terms are fixed)? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes:
a) For any reason? Yes ☐ No ☐ N/A ☐ D/K ☐
b) For specific causes only? Yes ☐ No ☐ N/A ☐ D/K ☐

If only for specific causes, list main types of specific cause: Click or tap here to enter text.

Under the law, indicate who has the power to remove regulatory agency head(s): Click or tap here to enter text.

If removal can be made only for specific causes, under the law, do the causes have to be proved before the agency head(s) can be removed? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, is an independent investigation required? Yes ☐ No ☐ N/A ☐ D/K ☐
If Yes, identify who is identified in the law to carry out the investigation: Click or tap here to enter text.

13. For fixed-term regulatory appointments, how many times in the past 5 years have agency head or regulatory commissioners served less than a complete term? Click or tap here to enter text.

For non–fixed-term appointments, how many times in the past 5 years have agency head or regulatory commissioners served less than 5 years? Click or tap here to enter text.

For fixed-term appointees who have served less than full terms, were removals voluntary or involuntary under the law? (include compulsory retirement as involuntary, but specify separately) Voluntary ☐ Involuntary ☐N/A ☐ D/K ☐

For fixed-term appointees, can terms and conditions of employment be changed midterm under the law? Yes ☐ No ☐ N/A ☐ D/K ☐

(if Yes, explain): Click or tap here to enter text.

14. Under the law, how are the pay scales of regulatory staff in the agency established (excluding directors/commissioners, etc.)?
a) According to civil service pay scales/rules Yes ☐ No ☐ N/A ☐ D/K ☐
b) Regulatory agency discretion Yes ☐ No ☐ N/A ☐ D/K☐
c) Other (explain):

Under the law, is the regulatory agency free to make its own personnel decisions (e.g., hire, fire, promote, discipline)? Yes ☐ No ☐ N/A ☐ D/K ☐

15. How many staff are employed in electricity regulation (independent agency/ministry)? Click or tap here to enter text.

How many of the staff are professional (e.g., lawyers, economists, accountants, engineers)? Click or tap here to enter text.

How many of the staff are support staff (e.g., secretaries, administrative personnel, drivers)? Click or tap here to enter text.

What percentage of the staff is

a) Permanent? Choose an item.
b) Temporary? Choose an item.
c) On fixed contract? Choose an item.
d) Seconded from ministry? Choose an item.
e) Seconded from regulated companies? Choose an item.

Is there an organization chart for the agency? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, please attach a copy.

If No, list main departments/branches of agency with staff numbers in each, if available: Click or tap here to enter text.

16. If there is an independent regulatory agency (i.e., Yes to Question 2[a]), does it regulate only the power sector? Yes ☐ No ☐ N/A ☐ D/K ☐

If No, what other sectors does it regulate? (mark all that apply)

a) Natural gas Yes ☐ No ☐ N/A ☐ D/K ☐
b) Telecommunications Yes ☐ No ☐ N/A ☐ D/K ☐
c) Transport (e.g., highway, rail, bus) Yes ☐ No ☐ N/A ☐ D/K ☐
d) Water Yes ☐ No ☐ N/A ☐ D/K ☐
e) Sewerage Yes ☐ No ☐ N/A ☐ D/K ☐
f) Petroleum products (e.g., gasoline/petrol, kerosene) Yes ☐ No ☐ N/A ☐ D/K ☐
g) District heating Yes ☐ No ☐ N/A ☐ D/K ☐
h) Other (identify): Click or tap here to enter text.

What percentage of staff effort is dedicated to the power sector? Choose an item.

If the regulatory agency has responsibility for more than one sector, do agency staff have multisector responsibilities? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, is this

☐ For all staff?
☐ For a few high-level professionals only (e.g., chief legal adviser, chief economist)?
☒ Other (explain): Click or tap here to enter text.

17. Who (subject to appeal) has the legal responsibility for making decisions on the following issues?

Decision	**Regulatory agency**	**Ministry**	**Company/enterprise (identify who)**	**Other (identify who, if it exists)**
Tariff structure	☐	☐	☐	☐
Tariff level	☐	☐	☐	☐
Service quality	☐	☐	☐	☐
Consumer complaints	☐	☐	☐	☐

Sector expansion plans	☐	☐	☐	☐
Investment plans/decisions (ex-ante approval)	☐	☐	☐	☐
Investment decisions (e.g., ex post prudence review)	☐	☐	☐	☐
Wholesale market structure	☐	☐	☐	☐
Anti-competitive behavior	☐	☐	☐	☐
Merger/acquisition reviews	☐	☐	☐	☐
Technical and safety standards	☐	☐	☒	☐

18. Is there a legally defined process for appealing regulatory decisions? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, indicate by whom appeals are considered:

General law courts Yes ☐ No ☐ N/A ☐ D/K ☐
Specifically designated court (identify) Yes ☐ No ☐ N/A ☐ D/K ☐
Ministry/government Yes ☐ No ☐ N/A ☐ D/K ☐ Special
administrative tribunal Yes ☐ No ☐ N/A ☐ D/K ☐

Combination of above (e.g., to courts and government) (explain): Click or tap here to enter text.
Other (explain): Click or tap here to enter text.

Under the law, can parties appeal on all matters, including the substance of decisions, or are they limited (e.g., only to questions of law and regulatory process)? Can appeal ☐ Limited ☐

If appeals are limited, explain limitations on appeals: Click or tap here to enter text.

Under the law, are there limits on who may seek appeals (e.g., regulated companies, consumer agency)? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, identify or explain: Click or tap here to enter text.

19. Does the regulatory agency publish an annual report on its activities? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, how many annual reports have been published in the past 5 years? Click or tap here to enter text.

Does the regulatory agency publish audited accounts? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, how many times have audited accounts been published in the past 5 years? Click or tap here to enter text.

Who audits the accounts?

a) International accounting firm Yes ☐ No ☐ N/A ☐ D/K ☐
b) Local accounting firm Yes ☐ No ☐ N/A ☐ D/K ☐
c) Internal audit facility Yes ☐ No ☐ N/A ☐ D/K ☐
d) Government audit office Yes ☐ No ☐ N/A ☐ D/K ☐
e) Other (explain): Click or tap here to enter text.

Does the regulatory agency have a Web site? Yes ☐ No ☐ N/A ☐ D/K ☐

Does the regulatory agency publicly answer questions from the legislature (e.g., from a parliamentary committee)? Yes ☐ No ☐ N/A ☐ D/K ☐

20. Have there been any serious disputes or controversies involving the electricity regulatory agency or the regulatory system within the past 3 years? Yes ☐ No ☐ N/A ☐ D/K ☐

a) If Yes, have they involved disputes between the regulatory agency (including ministry regulator) and regulated companies? Yes ☐ No ☐ N/A ☐ D/K ☐

b) between the regulatory agency and the government/ministry? Yes ☐ No ☐ N/A ☐ D/K ☐

c) with others? (specify) Click or tap here to enter text.

If Yes to (a), (b), or (c), give a brief description, and provide documentary references, if available: Click or tap here to enter text.

21. Have there been any major changes in the past 3–5 years in the responsibilities of the regulatory agency? Yes ☐ No ☐ N/A ☐ D/K ☐

If Yes, have they been

a) Increases in responsibilities? Yes ☐ No ☐ N/A ☐ D/K ☐

b) Decreases in responsibilities? Yes ☐ No ☐ N/A ☐ D/K ☐

c) Other (specify): Click or tap here to enter text.

Give a brief description of changes, and list documentary sources for documentary changes, if available:Click or tap here to enter text.

Annex II IRENA SIDS Quick Scan – regulatory indicators

Element 1: Institutional Framework

=> RE policy direction

		Madagascar	Mauritius	Seychelles	Comoros
1.1.	Is there government leadership and political support for a renewable energy transition?	Yes	Yes	Yes	Yes
1.2.	Is there a recent national energy policy that clearly promotes renewable energy?	Yes	Yes	Yes	Yes
1.3.	Are there official renewable energy targets defined in legislation? For which sectors (total energy, electricity generation, transport, etc.)?	Yes (electricity generation)	Yes (electricity generation)	Yes (electricity generation)	Yes (electricity generation)
1.4.	Is there an official energy roadmap or detailed plan for renewable energy deployment including clear definition of roles and responsibilities?	Yes, roles & responsibilities?	Yes, Clear roles & responsibilities?	Yes, Clear roles & responsibilities?	Unknown
1.5.	Have quality standards for renewable energy technologies been officially adopted?	Unknown	Unknown	Unknown	No

=> Regulatory governance, Investment incentives and tariffs

		Madagascar	Mauritius	Seychelles	Comoros
1.6.	Is there an independent energy regulator to oversee the electricity sector?	Yes	Yes	Yes	No
1.7.	Is there grid access and attractive rates of return allowing for independent power producers (IPPs) and residential or commercial customers to invest in renewable energy?	Yes	Yes	Unknown	No
1.8.	Does the electricity price (not the retail tariff) take into account the variation in generation costs from different generation technologies at different times of the day and year?	Yes Time variation only for industrial users	Yes Time variation only for industrial users	No	No
1.9.	Does the current tariff structure allow for savings in generation cost from renewable energy to be passed on to customers, and how? Was there a dedicated tariff study to assess this?	No?	Yes? Solar Home Scheme?	No	No
1.10	Are there incentives (financial or not) dedicated to facilitating renewable energy investment?	Yes	Yes	Yes	No

1.11.	Are there subsidies in place for fossil fuels (including for electricity from fossil fuels)?[37][38]	No	Unknown	Unknown	Unknown
1.12.	Are there clearly defined procedures to develop renewable energy projects? If yes, what is the average time and cost for permitting?	No	No	No	No

Element 2: Knowledge Base

Renewable resource assessment

		Madagascar	Mauritius	Seychelles	Comoros
2.1.	Are renewable resource assessments available (hydro, geothermal, wind, solar, biomass, ocean)?	Partial	Partial	Partial	Partial
2.2.	Are energy balances available and updated at least yearly?	Yes	Yes	Yes	Yes
2.3.	Are regularly updated data available on the reliability and performance of current generation and grid assets (including distributed, off-grid and renewable energy generation)?	No	Unknown	Unknown	No
2.4.	Is a forecast of demand growth available and updated at least yearly (national, per island, per sector, etc.)?	Unknown	Unknown	Unknown	Unknown
2.5.	Are relevant data easily accessible and shared among key agencies and renewable energy stakeholders?	Unknown	Unknown	Unknown	Unknown
2.6.	Is there in-country experience with design, installation, procurement or use of renewable energy technologies? Which technologies, and who has the experience?	Hydro	Solar, Wind	Solar	Hydro
2.7.	Has the potential for energy efficiency improvement been assessed for both the supply and demand sides (e. g., through benchmarking)?	No	Unknown	Unknown	No
2.8.	Has the potential for non-electric renewable energy been assessed (e. g., for cooling, heating, cooking, manufacturing, desalination, transport, etc.)?	Unknown	Unknown	Unknown	Unknown

[37] http://documents.worldbank.org/curated/en/194781525420767595/pdf/125947-BRI-PUBLIC-P153084-ESMAPCountryBriefMadagascarPApr.pdf
[38] http://climatepolicydatabase.org/index.php/Country:Mauritius

Element 3: Planning

		Madagascar	Mauritius	Seychelles	Comoros
3.1.	Is there a dedicated office with responsibility for a comprehensive energy planning process that incorporates renewable energy?	No	Yes	No	No
3.2.	Is there a list of renewable energy projects (completed, ongoing, planned and potential), and an understanding of how much they contribute to meeting official renewable energy targets?	No	Unknown	Unknown	Unknown
3.3.	Are there any land use restrictions that could limit renewable energy deployment?	Unknown	Yes	Yes	Yes
3.4.	Have grid integration studies been done to allow more variable renewable energy in the power sector?	No	Yes	Yes	No

Annex III Multi-tier Matrix for measuring household electricity supply

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
1. Peak Capacity	Power capacity ratings[28] (in W or daily Wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	OR Services		Lighting of 1,000 lmhr/ day	Electrical lighting, air circulation, television, and phone charging are possible			
2. Availability (Duration)	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration <2 hrs
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Afford-ability					Cost of a standard consumption package of 365 kWh/year < 5% of household income		
6. Legality						Bill is paid to the utility, pre-paid card seller, or authorized representative	
7. Health & Safety						Absence of past accidents and perception of high risk in the future	

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