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Renewable energy exploitation in the small island developing state of Mauritius: Current practice and future potential

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ABSTRACT

Mauritius is highly reliant on fossil fuels for meeting its increasing energy demands. However, a lot of effort has been made over the years to shift towards renewable energies. This study investigated the current status of renewable energy exploitation in Mauritius while also considering other potential energy sources to further increase the contribution of renewable energy in the energy mix of the island. Among the different renewable energies studied, sugarcane bagasse combustion for electricity generation remains the main contributor followed by hydroelectricity. Considering solar and wind energy, several attempts have been made to promote the use of these two renewable energy sources but their contributions are still very low. However, solar energy, in the form of solar water heaters and photovoltaic panels, is being increasingly tapped while wind energy exploitation is also expected to further increase in the future. Furthermore, this study reviewed the huge potential of renewable energies from the ocean such as wave energy and ocean thermal energy conversion systems. Geothermal energy, often claimed as a promising renewable energy resource for Mauritius, was found to be unfeasible for the island. Another renewable energy resource, of huge potential, that is not fully explored on the island is bio-energy from biomass and waste materials, having an energy potential of 12 PJ/year. From the different sources of bio-energy investigated, sugarcane trash has the highest energy potential followed by the organic fractions of municipal solid wastes and animal manures. Finally, this study reviewed the different policies and legal and institutional frameworks governing energy in Mauritius while also addressing the several challenges for promotion of renewable energy on the island. For Mauritius to be energy sustainable, all the diverse renewable energy resources will need to be exploited such that the island has an energy-secured situation, far from the uncertainties surrounding fossil fuels.

1. Introduction

Global energy supply has been continuously dominated by fossil fuels over the years with 81.0% of the world's energy supply being met through fossils in 2014 [1]. Due to increasing population, higher standards of living, higher economic development and industrialisation, the world's energy requirement is anticipated to further increase [2,3]. Considering the negative ecological impacts of fossil fuels as well as the soaring and highly volatile prices of the fuel due to depletion of the reserves and political instabilities, heavy dependence on fossils poses major energy insecurity risks for any economy [4]. This issue of energy insecurity is of even greater concern for small island developing states (SIDS) which are highly vulnerable to the unstable prices of fossil fuels and this considerably impacts on these developing economies [5].

One such SIDS is Mauritius, located to the east of Madagascar in the Indian Ocean, with a surface area of 1865 km² and a population of 1,220,530 in 2015 [6]. In 2015, the total primary energy requirement

(TPER) for Mauritius was 64,087 TJ, representing an increase of 2.85% over the previous year [7]. As with many SIDS, Mauritius is highly reliant on fossil fuels for meeting its TPER, with 83.6% of its energy demand being met through fossil fuels in 2015 [7]. Considering that the TPER in Mauritius has been continuously increasing over the years, as depicted in Fig. 1, and is anticipated to further escalate in the future, Mauritius is condemned to shift towards renewable energy options for its energy requirements due to the energy insecurity issues posed by high dependency on fossil fuels. This shift has already been adopted by many countries worldwide while many developing economies are now following the trend as evidenced by the numerous studies performed on renewable energy in developing countries like Algeria [8], Bangladesh [9,10], Brazil [11], Cameroon [12–14], China [15], India [16], Indonesia [17], Iran [18], Kenya [19], Malaysia [20,21], Nigeria [13,22], Oman [23] and Pakistan [24,25] over the past few years.

As for Mauritius, the shift towards renewable energy has taken a negative trend from 2011 to 2014 with a gradual decrease in the share

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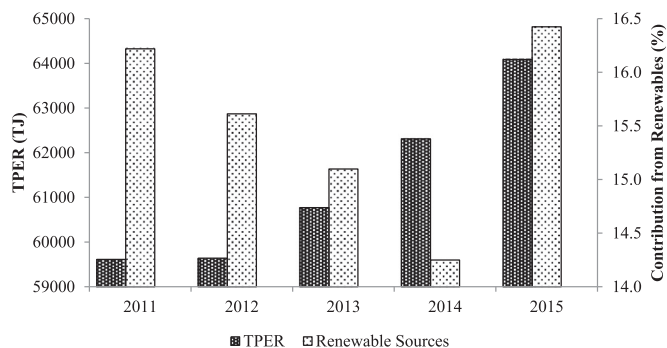


Fig. 1. Trends in energy requirement for Mauritius and contribution from renewable energies (Adapted from Ref. [26] with permission from Elsevier and compiled based on data from Refs. [7,27]).

of renewable energy as observed in Fig. 1. However, in 2015, the contribution of renewable energy in the energy mix increased by 15.7% as compared to the previous year [7]. Nonetheless, the dependency on fossil fuels (83.6%) is still very high and unexplored sources of renewable energy will need to be investigated so as to further increase the share of renewables in Mauritius. According to the long-term energy strategy for Mauritius, it is forecasted that 35% of electricity production will be met through renewable energies by 2025 [28] while this value currently stands at less than 23% [7]. Consequently, the aim of this study was to investigate the current status of renewable energy exploitation in Mauritius while also proposing future potentials in an attempt to reach the target of 35% by 2025. The study also summarises the frameworks (institutional and legal) that have been set-up to promote and facilitate renewable energy in Mauritius while also discussing the current barriers to renewable energy exploitation on the island.

2. Mauritius energy profile

The energy mix in Mauritius is currently dominated by fossil fuels with 83.6% of the TPER being met through coal and petroleum products in 2015 with the remaining 16.4% being covered through renewable energies in the form of sugarcane bagasse, hydropower, fuelwood, photovoltaics (PV) and landfill gas to energy, as shown in Fig. 2 [7].

Coal and petroleum products like kerosene and fuel oil are mainly combusted to produce electricity while gasoline, diesel and aviation fuel are used primarily in the transport sector. Liquefied petroleum gas (LPG) is widely used in household as cooking gas or in the commercial sector while most renewable energy sources are used for production of

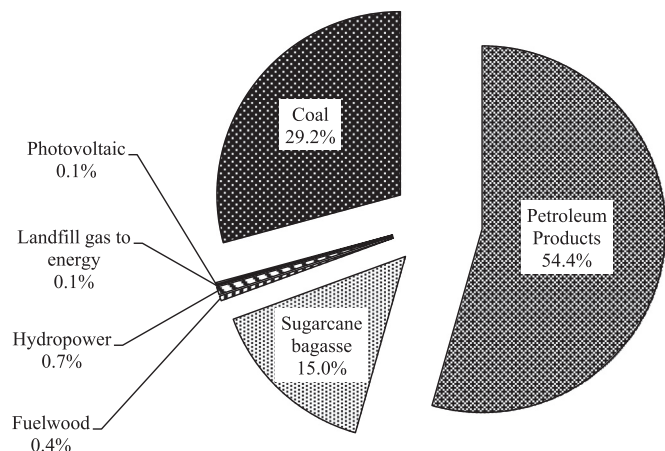


Fig. 2. Contributions of fossil fuels and renewable energy sources in the TPER for Mauritius in 2015 (Compiled based on data from Ref. [7]).

Table 1
Current and targeted contribution of renewable sources for total electricity generation in Mauritius.

	Current contribution (%) [7]	Targeted contribution (long-term energy strategy) (%) [28]		
Year	2015	2015	2020	2025
Bagasse	17.2	13	14	17
Hydropower	4.1	3	3	2
Solar PV	0.9	1	1	2
Waste to energy	0.7	5	4	4
Wind energy	0	2	6	8
Geothermal energy	0	0	0	2
Total	22.9	24	28	35

electricity with the exception of fuelwood which is also used for cooking purposes in some households. Besides the transport sector and the production of electricity, the manufacturing sector also consumes a considerable amount of energy in the form of coal, diesel, fuel oil and LPG.

2.1. Electricity generation in Mauritius

The “transmission, distribution and sale of electricity” is governed by the Central Electricity Board (CEB) in Mauritius [29]. Besides the distribution of electricity, the CEB also produces approximately 40% of total electricity in Mauritius and the remaining 60% is produced by independent power producers who subsequently sell the electricity to the CEB [29]. In 2015, 77.1% of total electricity generation in Mauritius was supplied through combustion of coal (40.0%), fuel and diesel oil (37.0%) and kerosene (0.1%) [7] with the remaining being supplied through renewable energies as summarised in Table 1.

Compared with the targeted values for the year 2015 from the long-term energy strategy 2009–2025, the actual values for 2015 differ for each of the renewable energy sources. All the targets set with respect to solar energy, wind energy and waste-to-energy (WTE) (forecasted for year 2015) are lower than the actual values for 2015. Based on these data, Mauritius is still lagging with respect to the 2015 forecasts in the long-term energy strategy. At the current rate, the targets of 2020 and 2025 will not be attained. As such, the following sections investigate the current status of renewable energies namely hydropower, solar, wind, wave, geothermal and bio-energy in Mauritius while also assessing the future potentials of these renewable energy sources in an attempt to achieve the targets of 2020 and 2025.

3. Renewable energy in Mauritius

Renewable energy sources that have been widely exploited in Mauritius include hydropower and sugarcane bagasse while solar and wind energy are now becoming a reality with potential sources viz. WTE, wave energy and ocean thermal energy conversion (OTEC) systems still not fully exploited.

3.1. Hydropower

Hydroelectric power is one of the oldest tapped renewable energy sources in Mauritius, with hydroelectricity first being produced in 1899 [30,31]. Currently, there are ten large and small hydroelectric power plants in Mauritius with a total installed capacity of 60.74 MW [27,32], located in different parts of the island as shown in Fig. 3. Some of them are conventional types with dam storage facilities while the remaining ones are operated as run-of-the-river types, as summarised in Table 2. There also exist two privately-owned micro-scale hydropower plants of capacities 200 kW (Riche en Eau) and 100 kW (Bois Cherie) that sell their electricity to the CEB while a further one 100 kW power plant

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