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# Mauritius

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| | |
|---|---|
| cc | Cubic centimetres |
| CEB | Central Electricity Board |
| CIT | Company income tax |
| $CO_2$ | Carbon dioxide |
| EIA | US Energy Information Administration |
| ET | Environmental taxes |
| ETS | Emissions trading scheme |
| GDP | Gross domestic product |
| GFR | Green fiscal reform |
| GHG | Greenhouse gas |
| GJ | Gigajoule |
| GPS | Global positioning system |
| GWh | Gigawatt-hour |
| HBS | Household Budget Survey |
| IMF | International Monetary Fund |
| IUCN | International Union for Conservation of Nature |
| ktoe | kiloton of oil equivalent |
| kVA | kilo-volt-ampere |
| kWh | Kilowatt-hour |
| LPG | Liquefied petroleum gas |
| MER | Market exchange rate |
| MID | Maurice Ile Durable |
| $Mm^3$ | Million cubic metres |
| MUR | Mauritian rupee |
| MW | Megawatt |
| OECD | Organisation for Economic Co-operation and Development |
| PIT | Personal income tax |
| PPP | Purchasing power parity |
| PV | Photovoltaics |
| REFiT | Renewable Energy Feed-in Tariff |
| REIPPP | Renewable Energy Independent Power Producer Procurement |
| RES | Renewable energy source |
| SADC | Southern African Development Community |
| SCC | Social cost of carbon |
| SIPP | Small independent private producer |
| UBP | Unit-based pricing |
| UNECE | United Nations Economic Commission for Europe |
| UNEP | United Nations Environment Programme |
| VAT | Value added tax |

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Ministry of Foreign Affairs of the Netherlands

# EXECUTIVE SUMMARY

Mauritius has embraced the objective of a green economy development path. A number of fiscal instruments for environmental protection and incentives for green investment are already in place. The Government and the Maurice Ile Durable (MID) Commission have also pioneered a number of environmental policy initiatives. The overall fiscal system is functioning well and revenues from environmentally-related taxes have been increasing. However, there remains potential to rationalize the system as a whole, to create further fiscal space in order to sustain green economic development.

This study identifies areas with potential for improvement through the rationalization of current fiscal measures and the mobilization of further resources for innovation and investment. It sets out options for the reform of tax instruments applied to fuels used in electricity generation and transport, and identifies reforms to pricing policies pertaining to waste collection and domestic water. The study identifies a number of fiscal policy reform options in the medium to long term, including the following:

- **Turn the MID levy into a carbon tax by formulating it in direct relation to the carbon emissions of petroleum products.** In the first phase (2016-2018), the MID levy could be raised to MUR 0.60 per kg (US$0.016 per kg); in the second phase (2019-2024), a fuel-specific carbon tax could be introduced at a rate equal to 50 per cent of the level that would fully internalize externalities; and in the third phase (2025 onwards), a fully corrective carbon tax could come into effect. This reform would increase electricity prices by 2.09 per cent in the first phase, by 9.66 per cent in the second phase, and by 25.69 per cent in the third phase. Electricity consumption is expected to decrease by 0.3 per cent, 1.18 per cent, and 3.14 per cent, respectively, in the three phases. Total tax revenues from such a reform would progressively increase from about MUR 97 million (equivalent to approximately US$2.68 million) per year between 2016 and 2018, to MUR 361 million (roughly US$9.99 million) per year between 2019 and 2024, and MUR 943 million (just over US$26 million) per year from 2025 onwards. Thus, the reform would mobilize substantial resources, particularly in the long run, which could be used to finance green economy investments and other priorities.

- **Reform the current system of transport fuel taxes to a fuel specific, environmentally efficient excise duty**. The net effect of the reform (including the carbon tax and re-modulated excise duties) would be a reduction of 3.9 per cent on the final price of gasoline and an increase of 8.1 per cent on the final price of diesel, resulting in a reduction in revenues of 7.3 per cent from gasoline and an increase in revenues of 21.8 per cent from diesel. This would rebalance the relative taxation of the two main transport fuels in the country on environmental grounds. The additional revenue from such a reform would be about MUR 282 million (US$7.8 million) per year, which represents a non-trivial increase in fiscal space. This reform is substantially neutral from the distributive point of view as it leaves the progressive pattern of expenditures for fuels unchanged, while leading to a progressive reduction in environmental impacts, stimulating fuel switching and technological change.

- **Use carbon tax revenues for green investments.** The fiscal space generated though the carbon tax could be directed to support a renewed feed-in tariff scheme. With a feed-in tariff of MUR 13 (US$0.36) per kWh, the scheme would induce 0.99 MW per year of new installed capacity in 2016-2018, 1.69 MW in 2019-2024, and 3.23 MW from 2025 onwards. This would lead to an increase in the share of total installed capacity from renewable sources to 4.89 per cent in 2030.

- **Other fiscal options**. Further incentives for clean energy could be considered, such as a partial tax deduction of investment costs in renewable technologies. In the waste sector, unit-based

pricing for solid waste management based on the "pay-as-you-throw" principle could be adopted in the medium term. In the water sector, domestic water tariffs could be increased to reflect the full cost of water use. Water tariffs could be based on household income and would result in a decrease in water consumption by 18.58 per cent, an increase in revenue of 12.38 per cent, and an increase in the recovery of operational costs from 65 per cent to 74 per cent.

© Affendi Shahidan – Solar panels on a roof.

# 1 INTRODUCTION

In the last 30 years, Mauritius has developed from a low-income to a middle-income economy, through rapid growth in the agriculture, manufacturing, tourism and financial services sectors. Although its successful development strategy has raised the standard of living and achieved important socio-economic results, the cost has been borne by the country's environment. Statistics show a decline in total fish catch, and a general increase in the number of threatened species, in freshwater abstraction, in per capita domestic water consumption and in solid waste generated. The total primary energy requirement is also rising and is increasingly satisfied by imported fossil fuels. As a result, both total and per capita carbon dioxide ($CO_2$) emissions are also steadily increasing, rising from 1.6 tons of $CO_2$ emissions per capita in 1995 to 3 tons of $CO_2$ emissions per capita in 2013 (Table 1). However, Mauritius is not a major contributor to world greenhouse gas (GHG) emissions given its small size.

Mauritius has a relatively high ratio of energy use to gross domestic product (GDP), which has important macroeconomic risks as the country is almost completely dependent on imports to satisfy its energy requirements. Only a small, and decreasing, percentage of its energy sources originates locally and comes from renewable sources (excluding bagasse, which is still relevant in electricity generation).[1] Fuel imports are a serious risk for the balance of payments and for the whole economy as they are equivalent to almost one third of total exports (Table 2). Should the price of oil increase more than expected, imports would increase the energy bill and in turn impact on the cost of exports, thereby impinging negatively on the competitiveness of the economy.

**TABLE 1.** SELECTED ENVIRONMENTAL INDICATORS, 1995, 2004, 2010 AND 2013

| Indicator | Unit | 1995 | 2004 | 2010 | 2013 |
|---|---|---|---|---|---|
| Forest area (% of total land area) | % | 30.6 | 23.8 | 25.3 | 25.3 |
| Threatened animal species (IUCN Red List) | number | … | 60 | 65 | 89 |
| Total fish catch | tons | 16 029.0 | 9 431.0 | 7 502 | 5 125 |
| Daily per capita solid waste disposed at landfill | kg | … | 0.86 | … | 0.97 |
| Annual freshwater abstraction | $Mm^3$ | 650.0 | 662.0 | 695.0 | 608.0 |
| Daily per capita domestic water consumption | litres | 154.8 | 160.0 | 160.0 | 165.0 |
| Total primary energy requirement | ktoe | … | 1 255.8 | 1 430.7 | 1 454.8 |
| Primary energy requirement from renewable sources | % | … | 22.0 | 20.0 | 15.1 |
| Total carbon dioxide emissions | tons | 1 738.4 | 2 795.7 | 3 583.2 | 3 836.8 |
| Per capita carbon dioxide emissions | tons | 1.6 | 2.3 | 2.8 | 3.0 |

… = data unavailable.
Source: Statistics Mauritius, 2010; 2013.

**TABLE 2.** TOTAL EXPORTS VERSUS OIL IMPORTS, 2010-2013 (IN MILLION US$)

| | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|
| Exports of goods (free on board) | 2 259 | 2 645 | 2 664 | 2 782 |
| Imports of oil | -842 | -1 120 | -1 177 | -1 191 |

Source: IMF, 2013.

Green fiscal reform (GFR), which entails the use of fiscal instruments to stimulate environmentally-friendly behaviour and the effective reinvestment of tax revenues to support the green economy, can help to address environmental challenges and foster sustainable growth. Although the trend in revenues from environmentally-related taxes has been increasing in Mauritius, the potential to create further fiscal space exists, rationalizing the system as a whole and increasing its possibility to sustain green economic development.

Aware of the challenges faced, the Government of Mauritius is actively promoting the development of an action plan for sustainable development. The fiscal policy assessment and proposed reform options set out in this report aim to provide analytical and quantitative information to support this plan. This report provides a thorough review of the existing tax system, with a focus on environmental challenges and the revenue-generating capacity of current instruments. It formulates a set of options for the reform of tax instruments applied to fuels used in electricity generation and transport. The reform entails re-modulating the taxes to internalize environmental externalities. It then simulates the impact of reinvesting the revenues from these reformed taxes in a renewable energy incentive scheme.

The report also develops options to reform pricing policies pertaining to waste collection and domestic water, which together with fuels for transportation and the generation of electricity cover the most significant environment-related sectors in Mauritius.[2] For each option identified in the report, the impact on revenue collections and distribution is carefully explored.

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# 2 OVERVIEW OF THE TAX SYSTEM IN MAURITIUS

Revenues from taxes represent 19 per cent of GDP in Mauritius.[3] This percentage has been relatively stable over recent years and is comparatively moderate (in comparison with 25.5 per cent in South Africa, 20.8 per cent in Mozambique, 26.7 per cent in Botswana, while the OECD average is 30.1 per cent[4]). Thus, taking into account the level of GDP in Mauritius, there is some room for the expansion of tax revenues to create additional fiscal space, which can be directed to fund investments with a high social and environmental rate of return.

The moderate overall tax burden derives from the application of the same flat tax rate – 15 per cent – on three broad-based taxes: personal income tax (PIT), company income tax (CIT) and value added tax (VAT). While the 15 per cent VAT rate is similar to VAT rates applied in most countries, 15 per cent income tax rates for individuals and companies is remarkably low, particularly for PIT. Mauritius has one of the most C-efficient[5] VATs in the world and VAT is the single largest contributor to tax revenues in Mauritius.

The flat rate on PIT is quite low by international standards and raises very low revenues. However, because of large exemptions granted to low income groups, the PIT in Mauritius is highly progressive and fares well when compared to other countries as the richest segments of the population bear most of the tax burden. The Kakwani index[6] for Mauritius is high and close to that observed for Colombia and the United States (David and Petri, 2013). The 15 per cent CIT doubles the volume of collections.

All in all, the country's tax system seems to be well structured and implemented. While relatively low tax rates suggest the potential for an expansion of revenue, any tax changes must be carefully designed to avoid losses in efficiency and in the equity of the existing system.

## 2.1 ENVIRONMENTAL TAXATION IN MAURITIUS

The share of environmental taxes (ET) in Mauritius has been increasing over time. In the 2009 fiscal year, the weight of ET on total revenues was slightly higher than 11 per cent (Parry, 2011) and decreased to 7 per cent in 2013 (UNEP, 2014). These figures, however, encompass a broad definition of environmental tax, similar to that adopted by Eurostat.[7] The latter focuses on tax bases that have particular environmental relevance, and thus considers all taxes levied on these tax bases as environmental – independent of their capacity to influence behaviour and hence pursue improvements in environmental quality. For statistical purposes, the tax base can be seen as the only objective basis for identifying environmental taxes. However, when analysing green economy policies, it is crucial to consider the specific capacity of fiscal instruments to generate incentives to reduce environmental impact (which makes them instruments for environmental protection), as distinct from their revenue-generating potential. Both are important ingredients in green economy reforms and thus relevant for this analysis.

The ET structure in Mauritius, discussed in detail in UNEP (2014: §3.1.1), appears in Table 3, with added detail pertaining to the areas under focus in this study. Motor vehicle taxes and fuel taxes account for the main share of revenues from ET, with relatively minor revenues from other ET. The Maurice Ile Durable (MID) levy, a tax on fossil fuels introduced in 2008, de facto imposes a burden on $CO_2$ emissions, but it is not related to the carbon content of fuels or to valuations of externalities from carbon emissions and therefore does not impose a uniform level of taxation on $CO_2$ emissions.

Motor vehicle duties and road taxes are a substantial part of total revenues from ET (Figures 1a and 1b), but most of these taxes are not designed to influence behaviour. Taxes on vehicle ownership discourage driving to a lesser extent than taxes on use (mileage driven) and, in general, unless

**TABLE 3.** CURRENT STRUCTURE AND SCALE OF ENVIRONMENTAL FISCAL INSTRUMENTS

| Instrument | Description |
|---|---|
| **VAT** | Irrigation water is zero rated. Electricity supplied by the Central Authority Board and water supplied by the Water Authority Board are zero rated. These zero rates are not in line with international standards. Normal rates apply to fuels, as in prevailing international practice. |
| **Excises on transport fuels** | The level of excises on gasoline is in line with international practice; the excise on diesel is low compared to gasoline and compared to international standards. |
| **Excises on energy fuels** | Coal, liquefied petroleum gas (LPG) and fuel oil are not subjected to excise duties. A subsidy is in place to sustain the diffusion of LPG for household purposes (Mauritian rupees (MUR) 640 million in 2013, US$17.72 million).[8] The supply of electricity, petroleum products, LPG and other goods is subsidized for Rodrigues Island. |
| **MID levy** | The MID levy of MUR 0.3 per litre (US$0.008) on most fossil fuels de facto imposes a burden on $CO_2$ emissions, although it is not related to the carbon content of fuels. |
| **$CO_2$ levy/rebate** | There is a $CO_2$ levy/rebate on the purchase of cars producing more than 150 grams of $CO_2$ per kilometre driven. |
| **Emission taxes** | There do not appear to be emission taxes. |
| **Water tariffs** | Water tariffs are low. The average water charge per $m^3$ in Mauritius is US$0.23 (the OECD average is US$1.09). The water affordability index (the share of average net disposable income spent on water and sanitation bills) for Mauritius is 0.8 per cent (for developed countries it is approximately 1.1 per cent, for developing countries approximately 2.5 per cent). Water abstraction is free for agriculture. Water capture (dams and reservoirs) is fully financed by the Government through consolidated funds. The cost of providing water is not recovered through prices. |
| **Environmental protection fee** | This fee is intended for revenue generation (not to reduce environmental impacts). It amounts to MUR 50 per unit for mobile phones, batteries for motor vehicles and pneumatic tyres. The tariff structure for hotels, guest houses and tourist residences is 0.85 per cent on turnover; for stone-crushing plants and the manufacture or processing of aggregates, concrete blocks and precast units, it is 0.75 per cent on turnover. |
| **Electricity tariffs** | Electricity tariffs are set with the aim of cost recovery (which is not fully achieved). Differential rates are charged among user types to create resources for cross-subsidies, which apply to households, sugar factories and irrigation. The commercial sector pays the highest rates, followed by the industrial sector, which pays differential day, peak and night rates. |
| **Personal income tax** | No deductions are allowed for expenses of environmental interest. |
| **Corporate tax** | A Corporate Social Responsibility levy of 2 per cent on corporate profits exists. Currently, all Corporate Social Responsibility projects are targeted at social rather than environmental outcomes. |
| **Road tax** | The annual per-vehicle charge is between MUR 3,500 (US$96.92) and MUR 13,000 (US$360), depending on engine size. A tax is also levied on fuels at the rate of MUR 1.85 (US$0.051) per litre of gasoline and MUR 1.75 (US$0.048) per litre of diesel. |

Source: Authors' elaboration.

sufficiently high to reduce car sales, such taxes do not encourage a shift towards cleaner modes of transport.

Within the main prevailing ET, namely fuel and motor vehicle taxes, there are opportunities to rebalance and better target fiscal instruments to support environmental objectives (the correction of externalities) and help create additional fiscal space for green investments. The following sections develop and outline detailed proposals for reforming environmental fiscal instruments on fossil fuels.

**FIGURE 1A. ENVIRONMENT-RELATED TAX REVENUES, 2013** (IN MILLION MUR)

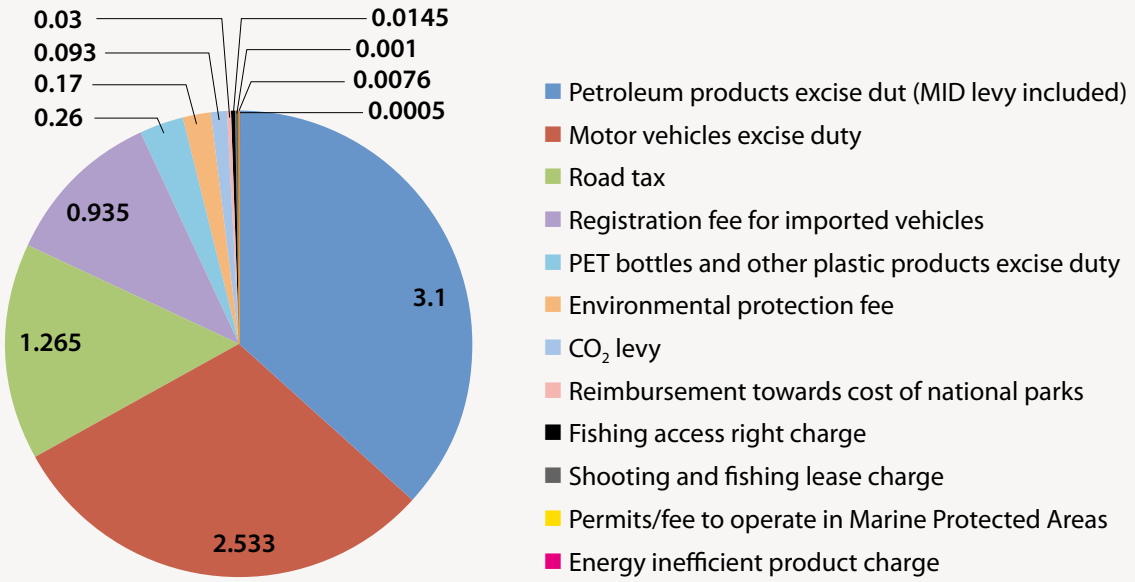
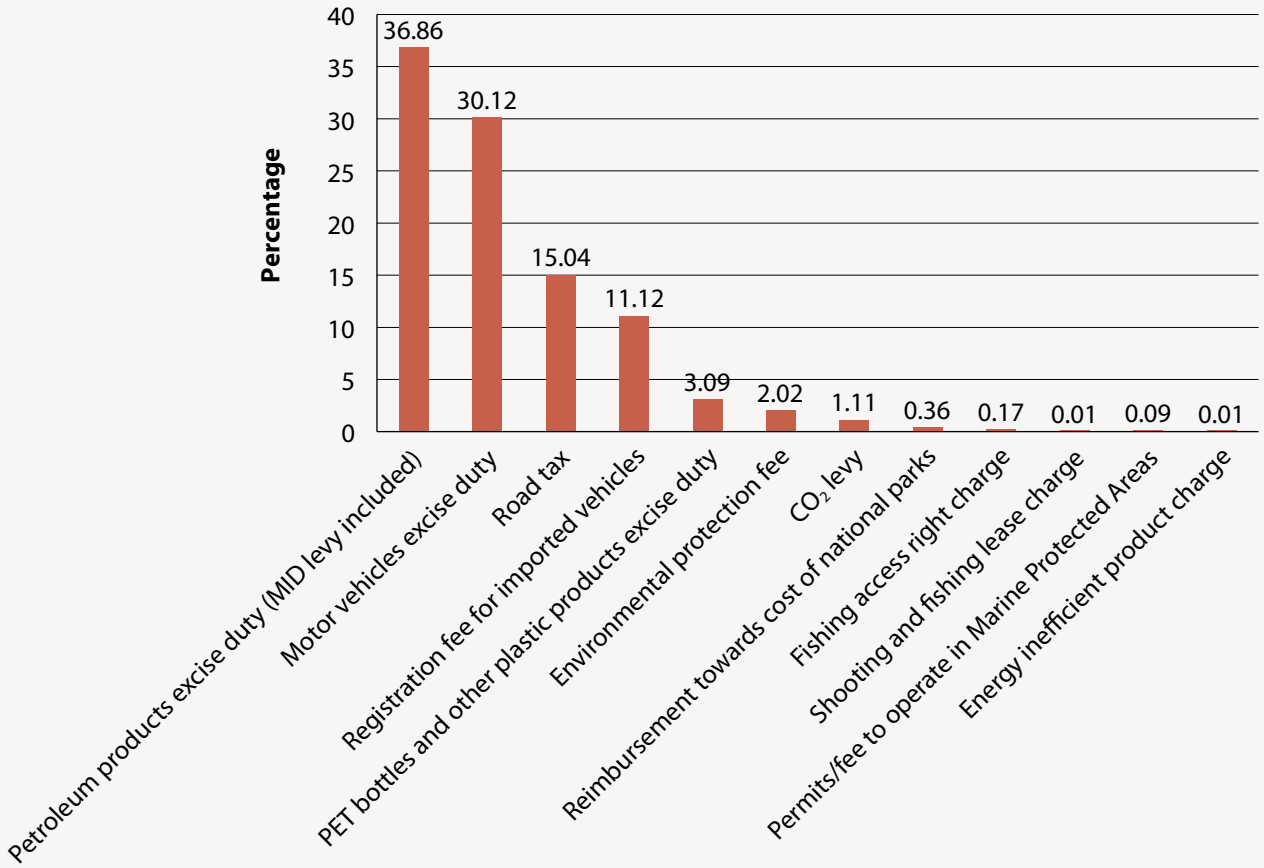



**FIGURE 1B. ENVIRONMENT-RELATED TAX REVENUES, 2013** (IN PERCENTAGE)




Source: Republic of Mauritius, Ministry of Finance and Economic Development, 2012: Appendix A: Revenue, and authors' elaborations.

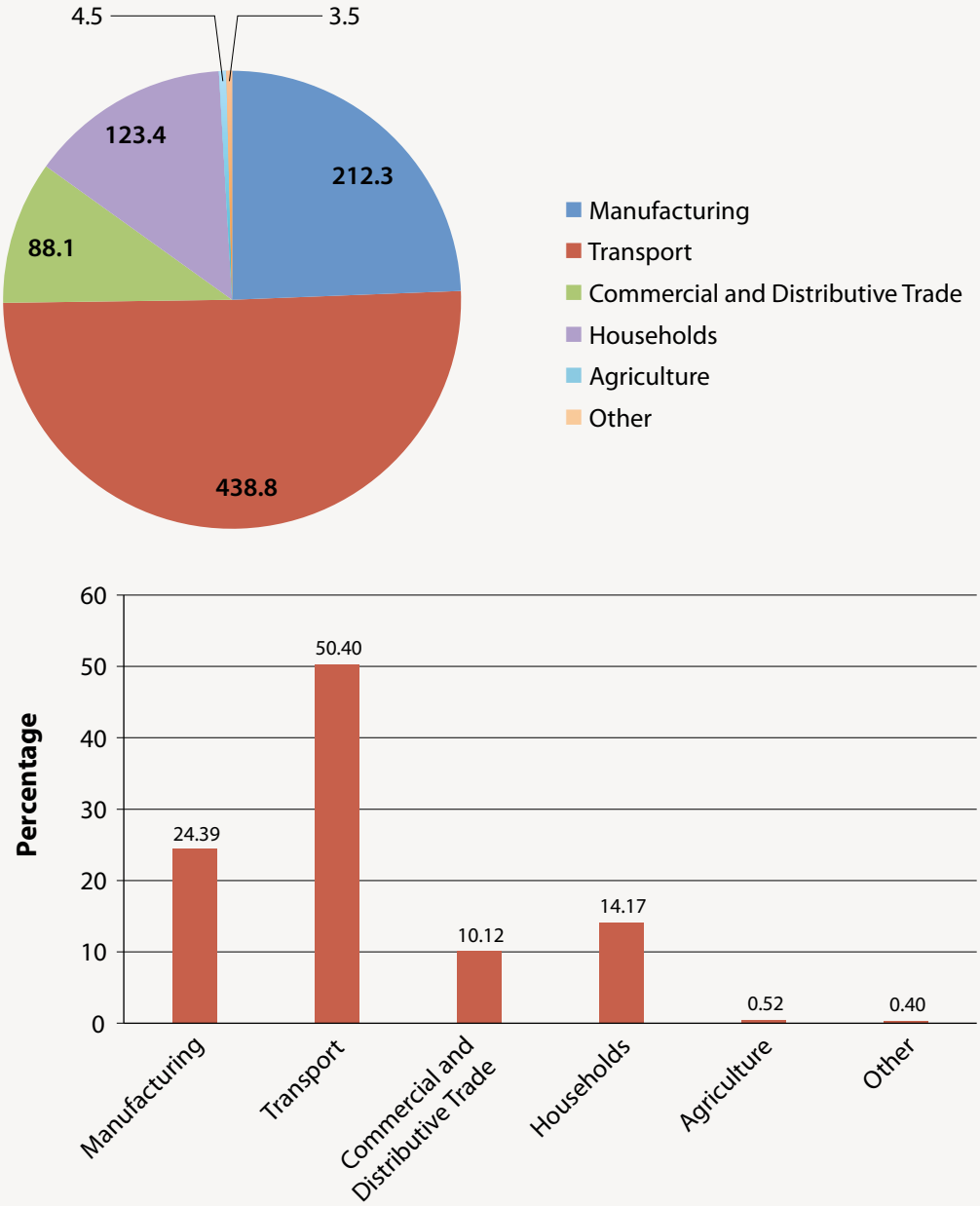
### 2.1.1 Fossil fuels

The energy sector is strongly dependent on fossil fuels, which represent 85 per cent of the country's primary energy requirements (Republic of Mauritius, Ministry of Environment and Sustainable Development, 2013). In particular, coal and petroleum products are used in electricity generation and to supply the two main energy-intensive sectors: transportation and manufacturing (Figure 2, Figure 3 and Table 4).

Bagasse[9] represents approximately one fifth of the inputs used for the generation of electricity in Mauritius. It is used, jointly with coal, in power plants owned by independent power producers, mostly sugar cane planters that sell their electricity to the Central Electricity Board on the basis of an administered price.

The use of bagasse in the generation of electricity is considered part of a general strategy to reduce the power sector's pollution content, and $CO_2$ emissions

**FIGURE 2. FINAL ENERGY CONSUMPTION BY SECTOR, 2013** (KILOTON OF OIL EQUIVALENT AND PERCENTAGE)



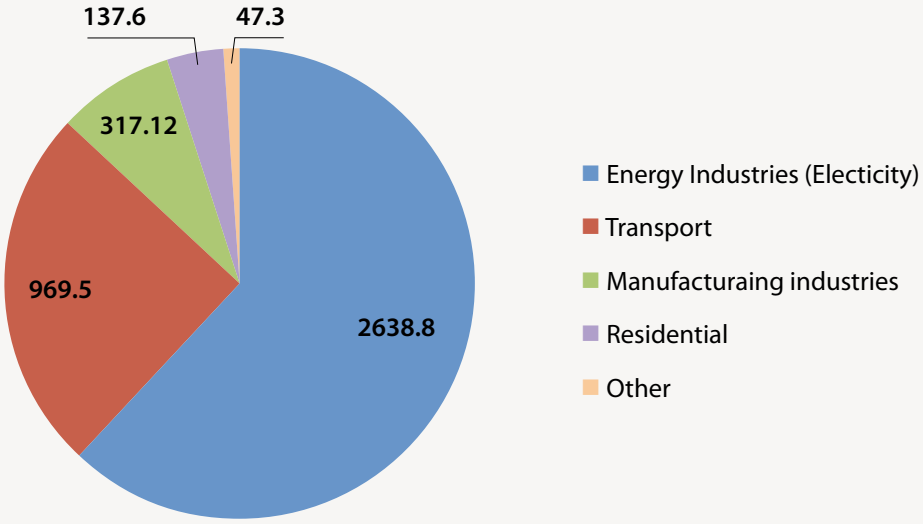

Note: Other includes agriculture and trade.
Source: Statistics Mauritius, 2014a.

**TABLE 4.** FINAL ENERGY CONSUMPTION BY FUEL AND SECTOR, 2013

| Sector | | | 2013 | | |
|---|---|---|---|---|---|
| | | | Ton (except electricity in GWh) | ktoe | % |
| **1.** | **Manufacturing** | | | **212.3** | **24.4** |
| | 1.1 excluding bagasse | | | 179.5 | 20.6 |
| | | Fuel oil | 39 182 | 37.6 | 4.3 |
| | | Diesel oil | 35 443 | 35.8 | 4.1 |
| | | LPG | 5 353 | 5.8 | 0.7 |
| | | Coal | 27 507 | 17.1 | 2.0 |
| | | Fuel wood | 1 385 | 0.5 | 0.1 |
| | | Electricity(GWh) | 962.6 | 82.8 | 9.5 |
| | 1.2 including bagasse | | 204 565 | 32.7 | 3.8 |
| **2.** | **Transport** | | | **438.8** | **50.4** |
| | Land | | | 310.1 | 35.6 |
| | | Gasoline | 128 928 | 139.2 | 16.0 |
| | | LPG | 4 068 | 4.4 | 0.5 |
| | | Diesel oil | 164 802 | 166.5 | 19.1 |
| | Air | | | 120.7 | 13.9 |
| | | Aviation fuel | 116 093 | 120.7 | 13.9 |
| | Sea | | | 8.0 | 0.9 |
| | | Gasoline | 3 170 | 3.4 | 0.4 |
| | | Diesel oil | 1 142 | 1.2 | 0.1 |
| | | Fuel oil | 3 525 | 3.4 | 0.4 |
| **3..** | **Commercial and distributive trade** | | | **88.1** | **10.1** |
| | | LPG | 13 285 | 14.3 | 1.6 |
| | | Charcoal | 483 | 0.4 | 0.0 |
| | | Electricity(GWh) | 853.2 | 73.4 | 8.4 |
| **4.** | **Households** | | | **123.4** | **14.2** |
| | | Kerosene | 202 | 0.2 | 0.0 |
| | | LPG | 46 360 | 50.1 | 5.8 |
| | | Fuel wood | 15 466 | 5.9 | 0.7 |
| | | Charcoal | 111 | 0.1 | 0.0 |
| | | Electricity (GWh) | 781.0 | 67.1 | 7.7 |
| **5.** | **Agriculture** | | | **4.5** | **0.5** |
| | | Diesel oil | 2 320 | 2.3 | 0.3 |
| | | Electricity(GWh) | 25.4 | 2.2 | 0.3 |
| **6.** | **Other (not elsewhere specified)** | | | **3.5** | **0.4** |
| | **TOTAL** | | | **870.6** | **100.0** |

Source: Statistics Mauritius, 2014a.

**FIGURE 3.** CARBON DIOXIDE EMISSIONS FROM THE ENERGY SECTOR, 2013
(FUEL COMBUSTION ACTIVITIES, TONS)




Note: Other includes agriculture and trade.
Source: Statistics Mauritius, 2014a.

in particular (Ramjeawon, 2008). The use of bagasse in the energy sector also supports the strategic objective to boost the declining competitiveness of sugar cane production. There are, however, adverse environmental impacts of monoculture sugar cane production, including significant use of polluting substances, such as pesticides and fertilizers, and high water use (with the sector absorbing most of the water available in the country). The continued use of bagasse in electricity generation should therefore be complemented by efforts to use more sustainable agricultural inputs and water efficiency measures in sugar cane farming.

The strong dependence on imported petroleum products and coal for energy and the continuously growing demand for primary energy call for policies to reduce energy consumption and increase electricity generation from renewable sources, as already considered in the Long-Term Energy Strategy 2009-2025 of Mauritius (Republic of Mauritius, Ministry of Environment and Sustainable Development, 2013).

The only fuel subsidy in place in Mauritius aims to sustain the diffusion of liquefied petroleum gas (LPG) for household purposes. The subsidy amounted to MUR 640 million in 2013 (US$17.72 million). The supply of electricity and petroleum products is subsidized for the autonomous outer island of Rodrigues at a cost in 2013 of about MUR 0.45 million or US$12,462, including LPG.[10]

Total fuel taxes, including fuel excises, the MID levy and other taxes, are one of the main sources of revenue from environmental taxation in Mauritius. If re-modulated, these taxes have the capacity to influence fuel consumption behaviour and thus support environmental policy objectives. In addition, the current taxation level is not based on the specific environmental impacts of different fuels. Unlike transport fuels, coal, LPG and fuel oil are not subjected to excise duties. The only fiscal burden on these fuels is the uniform MUR 0.30/litre (US$0.008) MID levy.

A multiplicity of distinct earmarked levies are in place, such as contributions to the Build Mauritius Fund,[11] subsidies on LPG, flour and rice, and subsidies for Rodrigues Island's transportation and storage (Table 5 provides the full list). While earmarking in some cases facilitates acceptance of such levies, it could lead to obfuscation, which may

impact negatively on policies. Earmarking implies separating funds to allocate them for specific uses. This undermines the continuous comparison at the margin, required by efficiency, between the benefits of the expenditure and the cost of funds. Earmarking should therefore be used sparingly and after careful evaluation, in cases where it appears solidly justified.[12]

### 2.1.2 Price determination and taxes on transportation fuels

Mauritius uses an administered system for the determination of fuel prices. The price is set by the Petroleum Pricing Committee by adding taxes and margins to the international price of the concerned fuel, which is taken as the reference price. Table 5 provides the detailed fuel price structure in the country. This system is prone to the subsidization of fuels if the reference price used in the formula is not automatically adjusted to fluctuations in the international price. In practice, the Petroleum Pricing Committee prevents excessive fluctuations in the retail price by lagging the adjustment of the reference price in the formula to the international price. According to International Monetary Fund (IMF) estimates, the resulting subsidy has in the past reached 0.1 per cent of GDP, although this is a gross subsidy, since net taxes are levied on fuels (IMF, 2014).

A number of taxes are levied on fuels for transportation, which includes taxes introduced to sustain specific policies. These earmarked taxes, after the re-modulation of January 2015, represent almost 40 per cent of total taxes on fuels for

**TABLE 5.** FUEL PRICE STRUCTURE

| | Gasoline | Diesel |
|---|---|---|
| Reference price – US$ per metric ton | 641.25 | 597.30 |
| Cost of insurance and freight – US$/litre | 0.5369 | 0.5547 |
| Exchange rate – MUR/US$[13] | 32.40 | 32.40 |
| | MUR/litre | |
| Cost of insurance and freight | 17.3956 | 17.9723 |
| Excise duty | 10.8000 | 3.3000 |
| Maurice Ile Durable levy | 0.3000 | 0.3000 |
| Contribution to the Road Development Authority | 1.8500 | 1.7500 |
| Contribution to Rodrigues Island's transportation and storage | 0.1600 | 0.1600 |
| Contribution to the Build Mauritius Fund | 4.0000 | 4.0000 |
| Contribution to the subsidy for LPG, flour and rice | 1.5000 | 1.5000 |
| Contribution to the State Trading Corporation's operational expenses* | 0.3500 | 0.4000 |
| Rounding of figures | 0.0069 | 0.0793 |
| **TRANSFER PRICE TO OIL COMPANIES** | **36.3625** | **29.4616** |
| Oil companies' operational expenses and wholesale margin | 1.8200 | 1.6700 |
| VAT (15%) | 5.9935 | 4.9304 |
| **WHOLESALE PRICE** | **44.1760** | **36.0620** |
| Retail margin (filling station's margin) | 1.7740 | 1.7380 |
| **RETAIL PRICE** (price at filling station, MUR) | **45.9500** | **37.8000** |
| **RETAIL PRICE** (price at filling station, US$) | **1.449** | **1.166** |

* The State Trading Corporation, defined as the "trading arm" of the Government of Mauritius, is responsible for imports of essential commodities, such as petroleum products, LPG, flour and rice. To support the administration of this institution, a specific levy of MUR 0.35/litre for gasoline and MUR 0.40/litre for diesel is imposed on fuels for transportation.
Source: State Trading Corporation, Government of Mauritius. Published on 16 January 2015. Available at: http://stc.intnet.mu/pps/pricestructure.html.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transportation. The total tax rate is the sum of levies listed in Table 6.

Despite a different level of development, the excises on gasoline in Mauritius are in line with prevailing tax rates in OECD countries (OECD, 2013). Current excises on diesel, on the other hand, although higher than those of other African countries, are lower than international standards – both compared with OECD (Parry 2011, Figure 4) and with European countries (European Commission, 2014). The minimum excise duty on diesel prescribed in Europe by the Energy Tax Directive (European Commission, 2003) is EUR 0.33/l (MUR 12.74/l),[14] against the current level in Mauritius of EUR 0.085/l (MUR 3.3/l). However, several additional earmarked levies raise the effective total tax on diesel to a level comparable with the minimum European level.[15]

Although the orientation on petroleum product pricing already positions Mauritius closer to high-income countries than to Southern African Development Community (SADC) countries or small island developing states, the differential between diesel and gasoline excises does not correctly reflect the relative environmental impact of the two fuels. The rationale for why diesel is currently taxed in Mauritius at a lower rate than gasoline is, presumably, the same as in most OECD countries (with the notable exception of the USA) and pertains to the prevailing use of diesel in commercial transport and the consequent concern about the impact of taxation on transport costs, and hence on competitiveness. The *diesel differential* in Mauritius, however, is much higher than the OECD average (in Europe for example, the above-mentioned Energy Tax Directive prescribes minimum rates of EUR 0.359 per litre of unleaded gasoline against the EUR 0.33 per litre of diesel).

### 2.1.3 Fuels for power generation

The Central Electricity Board (CEB), established in 1952 and owned by the Government of Mauritius, is the authority mandated to promote and coordinate the generation, transmission and distribution of electricity. The CEB produces electricity to meet 40 per cent of electricity demand from four thermal and eight hydroelectric plants. The remaining 60 per cent of electricity is produced by independent power

**TABLE 6. TAXES ON FUELS FOR TRANSPORTATION** (MUR/LITRE)

| Tax | Gasoline | Diesel |
|---|---|---|
| Excise duty | 10.80 | 3.30 |
| Maurice Ile Durable levy | 0.30 | 0.30 |
| Contribution to the Road Development Authority | 1.85 | 1.75 |
| Contribution to Rodrigues Island's transportation and storage | 0.16 | 0.16 |
| Contribution to the Build Mauritius Fund | 4.00 | 4.00 |
| Contribution to the subsidy for LPG, flour and rice | 1.50 | 1.50 |
| Contribution to the State Trading Corporation's operational expenses | 0.35 | 0.40 |
| Rounding of figures | 0.0069 | 0.0793 |
| Total excises | 19.029 | 11.4893 |
| VAT on excises (15%) | 2.8543 | 1.7233 |
| **TOTAL TAXES** (MUR) | **21.88** | **13.21** |
| **TOTAL TAXES** (US$) | **0.6059** | **0.3658** |

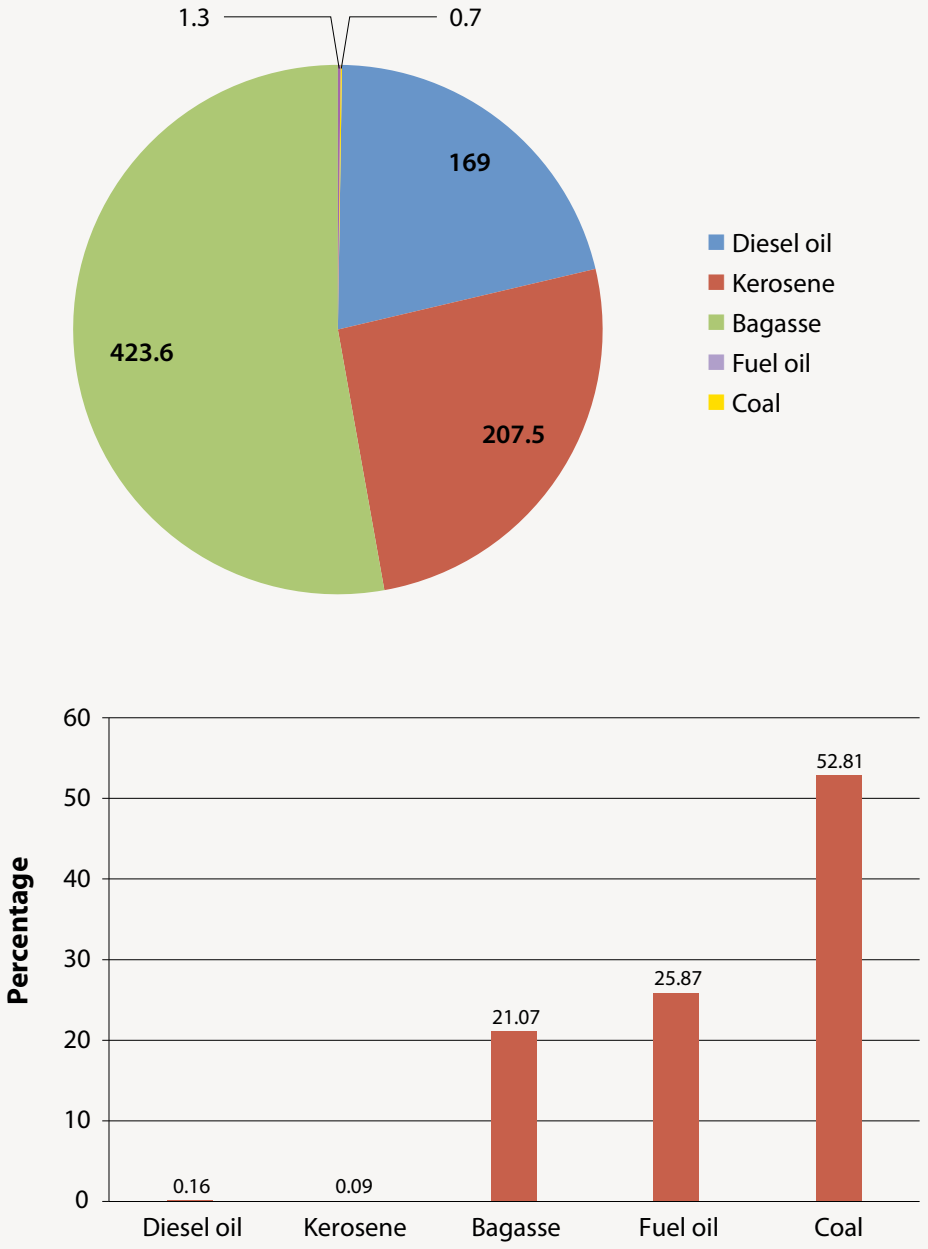
Source: State Trading Corporation, Government of Mauritius. Available at: http://stc.intnet.mu/pps/pricestructure.html.

© Mark Fisher – Waterfall in Mauritius.

producers. Thermal plants rely on cogeneration using bagasse and coal or fuel oil (Figure 4).

Despite the Government's stated objective, full cost recovery through electricity tariffs has not yet been achieved. In 2006, distribution losses and under-pricing were estimated to lead to a burden of 0.4 per cent of GDP for the CEB (IMF, 2013).[16] As already mentioned, coal, LPG and fuel oil are currently not subject to excise duties.

**FIGURE 4. FUEL INPUT FOR ELECTRICITY GENERATION, 2013** (KILOTON OF OIL EQUIVALENT AND PERCENTAGE)




Source: Statistics Mauritius, 2014a.

# 3 REFORMING FOSSIL FUEL TAXATION: A PROPOSAL

This report proposes the comprehensive reform of fossil fuel taxation, designed to link the fiscal burden on each fuel to its specific environmental impact. The proposed reform addresses the global impact of carbon emissions from both the energy and the transport sector, through a transition from the existing MID levy and other charges to a real carbon tax based on the carbon content of fuels, and imposed upstream as an excise on fuel prices. In addition, it revises fuel excises in the transport sector, to internalize the cost of local pollution, accidents, congestion and road damages.

The upstream carbon tax on fossil fuels proposed in this study seems to be a better option from an administrative point of view than downstream carbon taxes imposed at emission points. According to Calder (2015), the main advantages of an upstream carbon tax widely overcome the few disadvantages (i.e. the imperfect alignment with the *polluter pays principle*). The main administrative advantages are: (1) few and clearly identifiable taxpayers (refineries and imports by points of entry); (2) more comprehensive coverage than a tax on emissions, which in view of administrative costs generally exempts small emitters; (3) limited scope for tax avoidance, due to the close regulation of the fossil fuel industry; and (4) low administrative costs, due to the affinity of an upstream carbon tax to existing excises.

## 3.1 CARBON TAX DESIGN

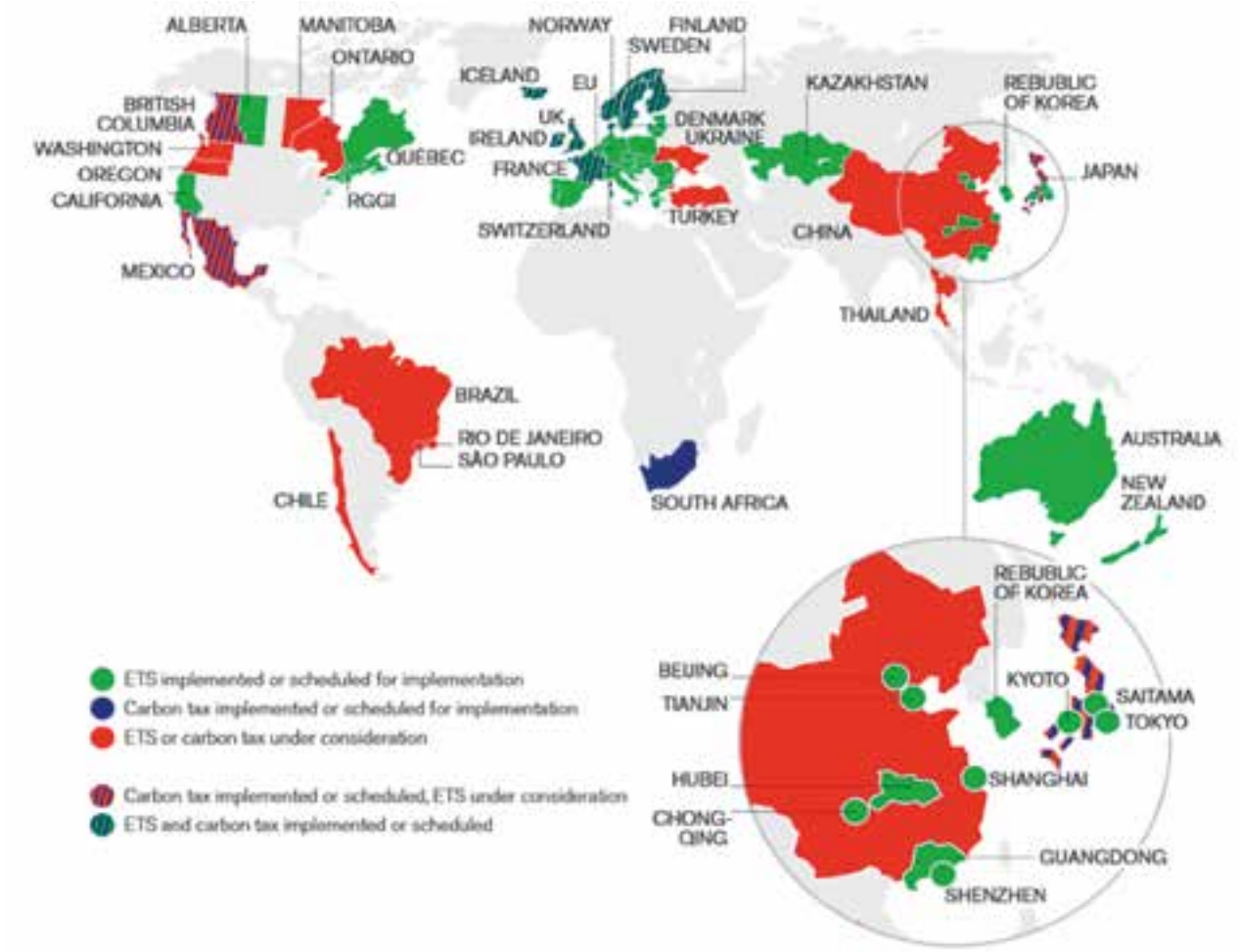
As mentioned, the current MID levy imposes a burden on $CO_2$ emissions that is neither related to the carbon content of fuels (and hence does not impose a uniform level of $CO_2$ taxation) nor to international valuations of the cost of carbon. While the introduction of the MID levy in 2008 represented a noteworthy policy choice, it is now an appropriate time to consider a re-modulation. The MID levy could be turned into a real carbon tax by formulating it in direct relation to carbon emissions by fuel, as highlighted by a comprehensive IMF study on environmental taxes in Mauritius (Parry, 2011). The rationale for re-modulating and transforming the MID levy into a fully-fledged carbon tax would be that of correctly internalizing the $CO_2$ externality of distinct fuels, thus conveying the correct price signal to the economy. An effective and predictable carbon price would play a substantial long-term role in assisting the transition to a low-carbon economy. It would set Mauritius in line with an increasing number of upper-middle-income countries that have chosen a green economy development path, and place it in a pioneering position, together with South Africa, on its continent (Figure 5).[17] An additional important reason to recommend carbon pricing in developing countries is the emission transfer via international trade that can be induced by climate policies confined to advanced, large emitting countries (Peters, Minx, Weber and Edenhofer, 2011). Equitable burden-sharing between developed and developing countries should be pursued, for example, by applying purchasing power parity (PPP) exchange rates in calculating the carbon tax, as discussed below, and through appropriate compensation mechanisms.

This study summarizes and endorses Parry's proposal (Parry, 2011). To provide additional quantitative support to its implementation, it:

- updates the estimates on the cost of carbon, following the revisions recently proposed by the IMF (IMF, 2014) and other international organizations
- calculates the pass-through of the carbon taxes on the electricity price
- calculates the distributive impact of the carbon tax on the population by income quintiles, based on the latest Household Budget Survey (HBS)
- calculates, from a fiscal perspective, the expected additional revenues

Finally, this study's quantitative results differ from those in Parry (2011) due to the fact that updated $CO_2$ coefficients provided by EIA (2013) were adopted.

**FIGURE 5.** SUMMARY MAP OF EXISTING, EMERGING AND POTENTIAL REGIONAL, NATIONAL AND SUBNATIONAL CARBON PRICING INSTRUMENTS




ETS = emissions trading scheme.
Source: World Bank, 2014: p.16.

The carbon tax would apply, as is the case of the current MID levy, to petroleum products used both in transport and in power generation, and would thus convey the signal to all sectors, businesses and households. It would raise the unit price of fossil fuels, expressed in mass or volume, to an amount equal to the monetary value of the $CO_2$ externality caused (the marginal social cost of carbon emissions, i.e. the marginal economic value of their environmental impact). Applying the tax to fuel inputs substantially reduces administrative costs with respect to a tax applied directly to measured $CO_2$ emissions. Carbon taxes based on $CO_2$ emissions per unit of generated energy (in gigajoules) have the advantage of being flexible with respect to technological change and variation over time of different fuels' energy conversion factors.

The calculation of an efficient carbon tax requires:

1. A monetary value for the externality caused by $CO_2$ emissions. While prevailing reviews of the social cost of carbon until a few years ago were set at around $21-$25 (the calculation of a carbon tax for Mauritius in Parry (2011) is based on these values), it is now evident that a near-term carbon price consistent with moderate climate change scenarios needs to be considerably higher.[18] The IMF's Fiscal Affairs Department, in its recent analysis on corrective tax estimates on energy prices, recommends a value for the $CO_2$ externality of US$35/ton (IMF, 2014).

2. Emission coefficients (kg of $CO_2$ per kg or litre of fuel burned). There is little variation in the

emission coefficients provided by different sources due to the fact that fossil fuels are not a natural resource of uniform quality. This study uses the emission coefficients by fuel provided by the US Energy Information Administration (EIA).[19]

3. The choice of the appropriate exchange rate to convert international monetary amounts into local currency units. Whether one uses a market exchange rate (MER) or a PPP exchange rate to convert the international value of the externality into local currency units makes a substantial difference. On the one hand, as Parry (2011) argues, using the PPP exchange rate goes in the direction of burden-sharing between richer and poorer countries. On the other, using MERs everywhere would go in the direction of establishing a uniform global carbon price. Both options have advantages and disadvantages. The PPP exchange rate is certainly useful in minimizing the bias in the actual burden posed on different local economies by a unique, standardized carbon price. Its calculation, however, is controversial because of the difficulties of finding equivalent baskets of goods to compare purchasing power across countries. In addition, the calculation of PPP relies on the strong assumption of the price of goods and services remaining constant across comparisons. One should also consider that the high economic growth rates of Mauritius tend to reduce the difference in price levels over time with respect to higher-income countries and, thus, in the medium and long term, the difference between PPP and MER.

The introduction of a carbon tax is, in any country, subject to heated political debate. The purpose of this part of the study is not to provide a prescription, but to offer quantitative informational support to a national policy process. To allow for a transparent evaluation of the consequences of the choice of the discount rate, Table 7 provides estimates of the re-modulated carbon tax using both options – the last six-month average of the MUR/US$ market exchange rate (30.27), and the MUR/US$ PPP exchange rate for 2013 from the World Bank World Development Indicators database (18.99).[20]

The calculations for this study result in a value for the $CO_2$ externality, in local currency units, of MUR 665 (in PPP), or of MUR 1,059 (using the market exchange rate). The resulting amounts for the fuel-specific carbon tax vary between MUR 1.7 and MUR 3.3 per kg or litre of fossil fuel, if a market exchange rate is used; and between MUR 1.09 and MUR 2.07 per kg or litre, if a PPP exchange rate is used. The implementation of a fully corrective carbon tax for all fossil fuels used in Mauritius is presented in Table 7.

Lower values for the tax rate on coal with respect to all other fuels except LPG are due to the tax being defined on $CO_2$ emissions per unit of fuel mass or volume, rather than per units of generated energy. Different fuels have different efficiencies in power generation: for instance, the generation of one gigajoule (GJ) of energy requires 34.12 kg of hard coal, but only 18.59 kg of LPG. Despite the low tax rate per kg applied on coal, due to the lower efficiency of coal in power generation, it is in reality the fuel with the highest carbon tax rate per unit of generated energy.

**TABLE 7. CALCULATION OF THE CARBON TAX** (KILOGRAM OR LITRE)

| | Coal (kg) | LPG (kg) | Gasoline (l) | Diesel (l) | Kerosene (l) | Fuel oil (l) | Aviation fuel (l) |
|---|---|---|---|---|---|---|---|
| $CO_2$ emission coefficient (kg/l or kg/kg) (EIA) | 2.31 | 1.64 | 2.35 | 2.68 | 2.58 | 3.12 | 2.53 |
| Fuel-specific $CO_2$ externality (US$/kg or l) | 0.08085 | 0.0574 | 0.08225 | 0.0938 | 0.0903 | 0.1092 | 0.08855 |
| Fuel-specific $CO_2$ externality (MUR/kg or l, MER) | 2.4473295 | 1.737498 | 2.4897075 | 2.839326 | 2.733381 | 3.305484 | 2.6804085 |
| Fuel-specific $CO_2$ externality (MUR/kg or l, PPP – World Bank WDI, 2013[22] | 1.53534 | 1.09000 | 1.56192 | 1.78120 | 1.71470 | 2.07370 | 1.68156 |

Note: Fuel oil is not listed in the EIA's carbon dioxide emission coefficients by fuel. The coefficient used here is what EIA classifies as residual heating fuel (businesses only).
Source: Authors' elaboration based on data in IMF, 2014.

These amounts represent, under different assumptions on the appropriate exchange rate, a full internalization of the social and environmental costs of carbon emissions, that is, of the present value of current and future damages from climate change, given current information.[21] Both are substantially above the token uniform levy of MUR 0.30 (US$0.008) currently in place. Both are also higher than the amount suggested in the study by Parry (2011), due to the updated social cost of carbon.

In what follows, the reform's projected impact on relative prices, the distribution of income and fiscal revenues is analysed. An economy-wide evaluation of potential competitive losses is not performed – such an exercise would be interesting to perform once updated input-output tables for the Mauritian economy become available. Existing empirical studies on current carbon and energy taxes seem to indicate, however, that the impact on competitiveness is not significant (see, for example, Zhang and Baranzini, 2004). In addition, the way in which the revenues are invested (for example incentives to renewable energy) can provide opportunities to at least partly offset the negative effects.

To not overburden the presentation of results, the calculation in this study is based on the highest tax level, the one calculated based on a MER (the recalculation of the impact with the PPP value, or any intermediate level, is straightforward).

## 3.2 IMPACT OF THE REFORM ON POWER GENERATION

Fuels used in power generation are currently subject, as described in section 2.1.1, only to the MID levy's MUR 0.30/kg (or per litre), equivalent to US$0.008. Therefore, the transition of the 'MID levy to carbon tax' will be the only policy change to be evaluated.

A re-modulation of the MID levy calculated so as to fully internalize the $CO_2$ externality of fuels used in power generation would bring about a substantial change in relative prices. Therefore, the present study does not propose to simultaneously also consider the internalization of damages due to local pollution from power generation. This does not mean that the reform will not produce a reduction in local pollution: the level of environmental tax on fossil fuels calculated as a full internalization of carbon costs will reduce fuel use and will thus also induce the abatement of local pollutant emissions, although not as much as required by the efficiency level.[23]

As the abrupt introduction of the full carbon tax would represent too large a shift in factor prices, this report suggests a gradual introduction, to enable the economy to adapt through technological and behavioural change. The introduction could be undertaken in three phases:[24]

1. Short term (2016-2018): raising the existing uniform MID levy to MUR 0.60/kg, equivalent to US$0.016/kg.

2. Medium term (2019-2024): introducing the fuel-specific carbon tax at a rate equal to 50 per cent of the level that would fully internalize the externality.

3. Long term (2025 onwards): introducing the fully efficient carbon tax.[25]

For policy evaluation purposes, the starting point in each phase is the electricity tariff. Given the current average end-user tariff of MUR 5.94 per kilowatt-hour (kWh) (US$0.164) (CEB, 2014), the proposed fiscal reform would result in an increase of MUR 0.1241 (US$0.003), MUR 0.5738 (US$0.016) and MUR 1.5257 (US$0.042) in the short, medium and long term, respectively. This would amount to a 2.09 per cent increase in the price of electricity in the first phase, 9.66 per cent in the second, and 25.69 per cent in the third (Table 8). This calculation includes 15 per cent VAT on top of the carbon tax. Subjected agents pass on the VAT through subsequent transactions, without being affected. The impact in real terms is on final users – households or businesses not subject to VAT.

These increases may seem substantial, and in some respect they certainly are, but they should be placed in context. Between January 2014 and January 2015, the crude oil Brent price decreased from US$107.78 to US$47.44, a reduction of more than 55 per cent. The introduction of a carbon tax at this time, even an ambitious one calculated using a MER and thus in line with a uniform global carbon price, would cause no shock to the productive system: it would only transform a small part of the benefits from the

**TABLE 8.** ELECTRICITY PRICES UNDER DIFFERENT CARBON TAXATION

| | | | | | Proposed re-modulation | | | Values of imports under three phases | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fuel** | **Current energy mix for power generation** (ton) | **Average Import Prices** (MUR/ton) | **Conversion from ton to kg/litre** | **Value of imports** (including current MID levy, MUR 0.30/kg) | **Doubled MID levy** (MUR/kg) | **50% of proposed carbon tax** (MUR/kg) | **Full carbon tax*** (MUR/kg) | **Doubled MID levy** (MUR/kg) | **50% of proposed carbon tax** (MUR/kg) | **Full carbon tax** (MUR/kg) |
| Fuel oil | 216 190 | 19 807 | 220 729 990 | 4 282 075 330 | 0.6 | 1.9007 | 3.8013 | 4 348 294 327 | 4 635 387 517 | 5 054 918 701 |
| Diesel oil | 1 269 | 30 389 | 1 480 923 | 38 563 641 | 0.6 | 1.6326 | 3.2652 | 39 007 918 | 40 537 137 | 42 954 911 |
| Kerosene | 645 | 31 008 | 803 670 | 20 000 160 | 0.6 | 1.5717 | 3.1434 | 20 241 261 | 21 022 182 | 22 285 306 |
| Coal | 683 207 | 2 993 | 683 207 000 | 2 044 838 551 | 0.6 | 1.4072 | 2.8144 | 2 249 800 651 | 2 801 295 222 | 3 762 713 994 |
| Bagasse | 1 056 146 | - | | | | | | | | |
| | | | | | | | | | | |
| **Total** | | | | **6 385 477 682** | | | | **6 657 344 157** | **7 498 242 059** | **8 882 872 911** |
| Percentage increase in cost of inputs | | | | | | | | 4.26 | 17.43 | 39.11 |
| Value of electricity sold (million MUR) | | | | | | | | | | 13 525.41 |
| Percentage of cost of inputs on value of electricity sold | | | Actual MID levy | | | | | Doubled MID levy | 50% adjustment | Total adjustment |
| | | | 47.21 | | | | | 49.20 | 54.10 | 63.00 |
| **Percentage variation in electricity price** | | | | | | | | **2.09** | **9.66** | **25.69** |

* VAT included.

Source: Authors' elaboration based on Statistics Mauritius, 2014a.

**TABLE 9.** FUELS FOR POWER GENERATION TAX REFORM: SUMMARY RESULTS BY PHASE

| | 1) Doubled MID levy | 2) 50% of proposed carbon tax | 3) Full carbon tax |
|---|---|---|---|
| Price* (MUR/kWh) | 5.94 | 5.94 | 5.94 |
| Tax adjustment for carbon emissions (MUR/kWh) | 0.1241 | 0.5738 | 1.5257 |
| New price (MUR/kWh) | 6.0641 | 6.5138 | 7.4657 |
| % increase in price | 2.09 | 9.66 | 25.69 |
| Elasticity to price | 0.15** | 0.15 | 0.15 |
| 2013 households' electricity consumption (kWh) | 780 960 000 | 780 960 000 | 780 960 000 |
| Estimated households' electricity consumption after reform (kWh) | 778 593 455 | 771 726 528 | 756 365 676 |
| Estimated tax collections after reform (MUR) | 96 613 413 | 361 322 361 | 943 263 635 |

* Average price of the current increasing-block electricity tariffs for domestic customers (see Annex 1, Table 32).
** Estimated in Bernstein and Griffin, 2006.
Source: Authors' elaboration.

current low oil prices into tax revenues. Even if the reductions in international oil prices in the last two years are conjectural and future increases can be expected, timing the introduction of environmental taxes in the low-price phase allows economies to adjust gradually and absorb the impact through technological and behavioural chance. The spot average international price of crude oil is forecast to return to its 2013 level no earlier than 2025 (World Bank, 2015), leaving ample time for the desired structural changes.

The price increase is partly absorbed by a reduction in consumption through the elasticity of demand to price, whose short-term value, 0.15, is derived from the literature (see Bernstein and Griffin, 2006).[26] Electricity consumption would, in fact, decrease by 0.3 per cent in the first phase, 1.18 per cent in the second, and 3.14 per cent in the third (see absolute values in Table 9). The associated reduction in carbon emissions depends on the marginal rate of technical substitution between fossil fuels in the country's energy mix employed for electricity production.

The total tax revenues implied by the proposed reform in the three phases would progressively increase from about MUR 97 million (equivalent to approximately US$2.68 million) per year from 2016 to 2018, to MUR 361 million (roughly US$9.99 million) per year from 2019 to 2024, and MUR 943 million (just over US$26 million) per year from 2025 onwards (Table 9). The mobilization of resources, particularly in the long run, would be substantial and could be used to finance green economy investments and other priorities.

## 3.3 IMPACT OF THE REFORM ON THE TRANSPORT SECTOR

Besides carbon externalities, the proposed rationalization of transport fuel taxation on environmental grounds also takes into account the local impacts of fossil fuel use. These impacts include local air pollution, traffic congestion, accidents and road damage. The proposed rationalization of the current system implies the removal of all other existing excises (the contributions to the Road Development Authority, to Rodrigues' transportation and storage, to the Build Mauritius Fund, to the subsidy for LPG, flour and rice, and to the operational expenses of the State Trading Corporation), which represent about 40 per cent of the current tax burden. This will help relieve the public and business sectors from an unnecessary administrative burden. This section therefore analyses the reform's overall impact.

The IMF (IMF, 2014) provides country-specific estimates of the monetary value of the local

externalities from fossil fuel use, which represent the efficient value for a corrective tax. The values for Mauritius are presented in Table 10.

The proposed reform of transport fuel taxation implies: (1) transition from the current MID levy (MUR 0.30/litre, equivalent to US$0.008) to the efficient carbon tax values of MUR 2.49/litre (US$0.069) for gasoline and MUR 2.84/litre (US$0.079) for diesel; and (2) the replacement of the existing excises and earmarked levies with a unique, fuel-specific, environmentally efficient excise.

The net effect of the overall reform on final transport fuel prices would be -3.9 per cent for gasoline and +8.1 per cent for diesel (Table 11). The reduction in

**TABLE 10.** COST OF LOCAL ENVIRONMENTAL IMPACT: TRANSPORT FUELS

| | Gasoline | | Diesel | |
|---|---|---|---|---|
| *Externalities* | US$/litre | MUR/litre | US$/litre | MUR/litre |
| Local air pollution | 0.012 | 0.36 | 0.078 | 3.374 |
| Congestion | 0.064 | 1.941 | 0.048 | 1.449 |
| Accidents | 0.418 | 12.667 | 0.239 | 7.237 |
| Road damages | * | * | 0.008 | 0.246 |
| **TOTAL** | **0.494** | **14.969** | **0.373** | **11.307** |

* Road damages are estimated only for heavy vehicles, fuelled with diesel.
Source: Authors' elaboration based on data in IMF, 2014.

**TABLE 11.** TRANSPORT FUEL TAX REFORM: SUMMARY RESULTS

| Global and local impact | | |
|---|---|---|
| | **Gasoline** | **Diesel** |
| Present tax and levies (MUR/litre)* | 21.88 | 13.21 |
| Price (MUR/litre)* | 45.95 | 37.80 |
| Tax adjustment for carbon and local emissions (MUR/litre) | -1.813 | 3.051 |
| Price after reform (MUR/litre) | 44.1 | 40.9 |
| % change in price | -3.9 | 8.1 |
| Short-term elasticity** | 0.26 | 0.13 |
| 2013 consumption (litres per year)*** | 177 671 810.0 | 193 656 648.0 |
| Consumption after reform (litres per year) | 179 494 463.7 | 191 624 636.5 |
| Short-term change in consumption | +1.02 | -1.04 |
| Estimated tax collections before reform (MUR) | 4 011 857 897.3 | 2 640 066 858.3 |
| Estimated tax collections after reform (MUR) | 3 717 269 315.2 | 3 215 720 476.3 |
| Additional collections (MUR) | -294 588 582.1 | 575 653 617.9 |
| % change in tax collections | -7.3 | 21.8 |

Sources: * Authors' elaboration based on data from the State Trading Corporation, Government of Mauritius, available at: http://stc.intnet.mu/pps/pricestructure.html; ** Dahl, 2012; *** Statistics Mauritius, 2013.

the retail price of gasoline contributes to reducing the large gap between gasoline and diesel taxation in the current system to the level justified on the grounds of relative environmental impact, and helps contain the overall impact of the re-modulation on consumers. The moderate overall dimension of the price impact makes it feasible to consider a straightforward introduction of the full efficient tax level.[27]

Assuming a short-term economy-wide elasticity of 0.26 for gasoline and 0.13 for diesel,[28] the short-term impact on consumption of the fiscal correction for all local and global damages would be +1.02 per cent in the case of gasoline and -1.04 per cent in the case of diesel. With an estimated long-term[29] price elasticity of 0.44 for gasoline (Sultan, 2010), the reduction in consumption would range from -11.2 per cent for gasoline to -7.8 per cent for diesel.

Contrary to the power generation sector, the transport sector, already subject to considerable taxation in Mauritius, would not see a substantial change in terms of fiscal burden. The proposed reform would rationalize and simplify the current system of fuel taxation and at the same time generate additional revenues, as the system adjusts and gradually reduces its carbon intensity. The impact on tax collections would result from the increased consumption of gasoline and the decreased consumption of diesel.

Taking into consideration the reaction of demand to the tax change, the simulated final outcome would be a reduction in revenues of -7.3 per cent from gasoline and an increase of 21.8 per cent from diesel. The additional revenue would be about MUR 281 million per year (US$7.8 million) (Table 11), which represents a non-trivial additional fiscal space (0.35 per cent of 2013 total fiscal revenues or 0.08 per cent of GDP, and about 4 per cent of the budget deficit).

## 3.4 DISTRIBUTIVE IMPACT OF THE FUEL TAX REFORM

The effect of the proposed reforms on the welfare of households has been simulated using a distributive impact analysis. With reference to proposed changes in taxes on power generation and transportation fuels, estimates of fuel and electricity price elasticities have been used to calculate the welfare effect of different tax policies based on second-order welfare effects (Banks, Blundell and Lewbel, 1996). Given the availability of the detailed 2012 HBS (Statistics Mauritius, 2015) and price information for Mauritius, the simulations could generate estimates based on quantity variations in response to own-price variations computed for different quintiles of the households' expenditure distribution.

### 3.4.1 Fuels for power generation

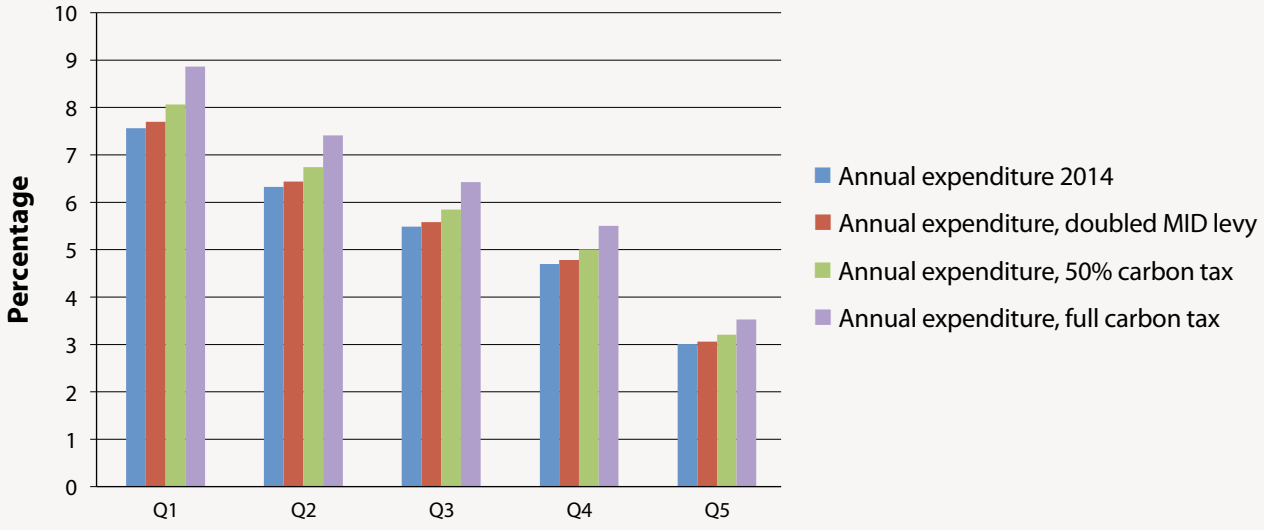
Consumption of electricity increases with expenditure, in a regressive pattern. Figure 6 shows the percentage share of household expenditure on electricity out of total expenditure. Households are ranked from left to right according to the level of total expenditure.

The regressive pattern of electricity consumption is coherent with that displayed, on average, by middle-income OECD countries (OECD, 2014) and suggests that the poorest households spend a higher share of total expenditure on electricity. Table 12 shows the per-household increase in expenditure deriving from the three phases of the reform scenario. Compensatory measures for the lowest quintiles could be considered, including income tax rebates, payroll tax rebates and increased resources to specific projects (Dinan, 2015).

Based on the change in price and electricity consumption (elasticity-adjusted) (Table 9), the direct impact of the tax reform on fiscal revenues can be estimated. The first phase of the implementation of the carbon tax (doubled MID levy) would raise MUR 96.6 million (US$2.67 million) of additional revenues, the second phase (50 per cent of the efficient carbon tax) would raise MUR 361.3 million (US$10 million), and the third phase (full carbon tax) would raise MUR 943.3 million (US$26.12 million).

The total impact should also include the indirect impact due to an increase in the price of all other goods and services as producers pass on higher fuel prices. An IMF study on the distributional impact of fuel subsidies calculates the indirect effect, for sub-Saharan countries, to be twice as large as the direct effect (Arze del Granado, Coady and Gillingham, 2010). The total impacts in that case would be MUR 0.29 billion in the first phase, MUR 1.08 billion in the second, and MUR 2.83 billion in the third

**FIGURE 6.** SHARE OF ELECTRICITY EXPENDITURE IN TOTAL HOUSEHOLD CONSUMPTION EXPENDITURE BY QUINTILE, 2014 (PERCENTAGE)




Source: Authors' elaboration based on the 2012 HBS (Statistics Mauritius, 2015).

**TABLE 12.** MEAN 2014 ANNUAL HOUSEHOLD ELECTRICITY EXPENDITURE BY QUINTILE AND ANNUAL EXPENDITURES AFTER TAX REFORM (IN MUR)

| Expenditure quintile | Mean annual household expenditure | Annual expenditure after tax (doubled MID levy) | Annual expenditure after tax (50% of carbon tax) | Annual expenditure after tax (full carbon tax) |
|---|---|---|---|---|
| 1 | 6 273.2 | 6 384.2 | 6 687.6 | 7 351.2 |
| 2 | 9 144.0 | 9 305.7 | 9 748.1 | 10 715.3 |
| 3 | 11 084.8 | 11 280.9 | 11 817.1 | 12 989.6 |
| 4 | 13 509.6 | 13 748.7 | 14 402.2 | 15 831.2 |
| 5 | 19 272.2 | 19 613.2 | 20 545.4 | 22 584.0 |
| **Average** | **11 856.00** | **12 065.8** | **12 693.5** | **13 893.4** |

Source: Authors' elaboration based on the 2012 HBS (Statistics Mauritius, 2015).

(equivalent to US$8 million, US$29.9 million and US$78.3 million, respectively).

### 3.4.2 Transport fuels

Expenditure on transport fuels varies markedly across quintiles. Poor households spend very little on transport fuels (on average MUR 850 per year, US$23.5), while the richest spend almost MUR 47,000 per year (US$1,301). Table 13 shows the direct impact on household expenditures (taking into account the short-term impact of elasticity) of the reform, which internalizes global and local externalities.

The column on the right shows the expenditure needed to maintain the level of consumption constant despite the tax re-modulation. The increase over current expenditure represents the direct impact of the reform on households.

Figure 7 shows the percentage expenditure on transport fuels by different quintiles, before and after the tax reform. Quintiles are based on households' expenditures and are ranked on the horizontal axis from the poorest (on the left) to the richest (on the right). The proposed transport fuel taxation reform does not significantly increase the burden on taxpayers. It is also substantially neutral from the

**TABLE 13.** MEAN 2014 ANNUAL HOUSEHOLD EXPENDITURE FOR TRANSPORT FUELS BY QUINTILE, BEFORE AND AFTER FUEL TAX REFORM (IN MUR)

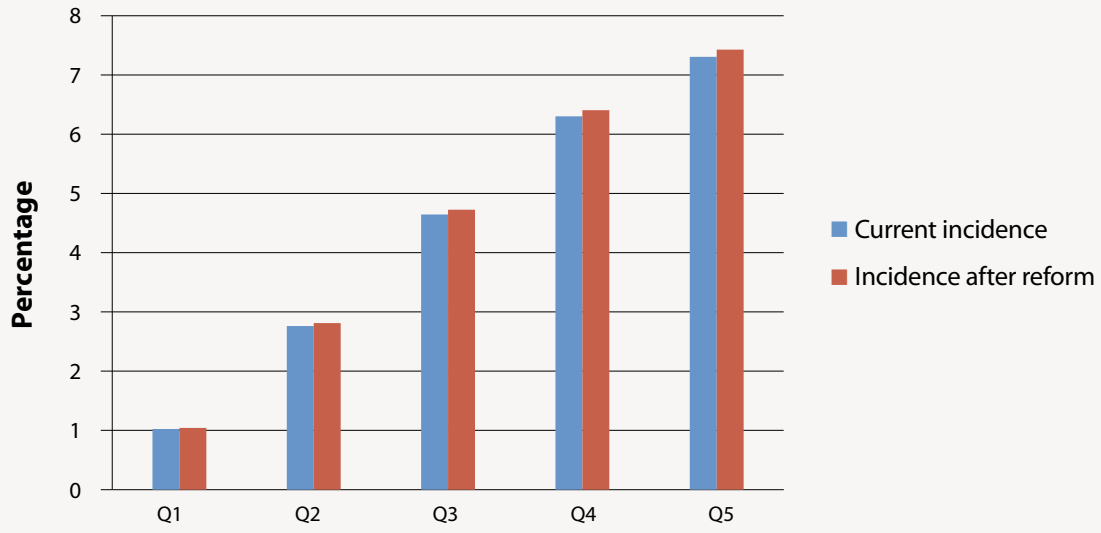
| Expenditure quintile | Mean annual household expenditure | Annual expenditure after reform (corrected by elasticity) |
|---|---|---|
| | Gasoline and diesel | Gasoline and diesel |
| 1 | 850.6 | 864.9 |
| 2 | 3 996.9 | 4 064.0 |
| 3 | 9 392.1 | 9 549.7 |
| 4 | 18 125.4 | 18 429.6 |
| 5 | 46 811.5 | 47 597.1 |
| **Average** | **15 832.7** | **16 098.4** |

Source: Authors' elaboration based on the 2012 HBS (Statistics Mauritius, 2015).

distributive point of view, leaving the progressive pattern of expenditures for fuels unchanged.

The direct impact of the new level of taxation on fiscal revenues would be approximately MUR -295 million for gasoline (US$8.17 million), and MUR 576 additional million for diesel (US$15.95 million). When indirect effects[30] are also taken into consideration, the estimated net total impact is MUR 843 million (US$23.35 million).

**FIGURE 7.** SHARE OF EXPENDITURE ON TRANSPORT FUELS IN TOTAL HOUSEHOLD CONSUMPTION EXPENDITURE BY QUINTILE, BEFORE AND AFTER REFORM (PERCENTAGE)




Source: Authors' elaborations based on the 2012 HBS (Statistics Mauritius, 2015).

# 4 USING CARBON TAXES TO PROMOTE RENEWABLE ENERGY SOURCES

Economic theory would suggest that revenues from green fiscal reforms go to the general budget and are used, for example, to lower the rates of broader taxes on labour and capital that distort economic activity and harm growth: they should be used for green investment only to the extent they generate welfare gains at least as large as those from alternative uses. Stated differently, one drawback of earmarking is that there is no actual relation between revenues raised from a corrective environmental tax and the efficient amount of spending on projects earmarked to green investments (Parry, Morris and Williams III, 2015).

There are, however, also arguments in favour of earmarking in GFRs that in some cases deserve to be considered. Dresner, Dunne, Clinch and Beuermann (2006) and Kallbekken and Aasen (2010) find that the incentive effect of environmental taxes is generally difficult to understand by the general public, who tend to consider taxes merely as a means of raising revenue. Spending revenues from environmental taxes on green economy projects would thus increase public acceptability, as shown in almost all studies on the issue (Schade and Schlag, 2003; Thalmann, 2004; Steg, Dreijerink and Abrahamse, 2006; Globescan and PIPA, 2007; Schuitema and Steg, 2008; Hsu, Walters and Purgas, 2008). The strategic nature of the GFR and the sensitivity around the fuel price issue make the destination of revenues from the carbon tax a case in which earmarking finds sound justification.

For these reasons, this study formulates a proposal that allows decision makers to quantitatively evaluate one hypothetical scenario of green economy investment financed through carbon tax revenues, namely the promotion of renewable energy sources. Alternative uses, not necessarily in the green economy, can obviously be considered for all or part of the revenues from the carbon tax. Within the energy sector, for example, one possibility would be to devote part of the increase in electricity tariffs from the carbon tax to reducing the gap between cost recovery and current revenues from electricity bills.

Using the revenues from the carbon tax designed in section 3 to finance a Renewable Energy Feed-in Tariff (REFiT) scheme is therefore one possibility that could be considered, since the resources the Government has so far been able to allocate to renewable energy source (RES) incentives are insufficient to reach the stated objectives for renewable energies.

Elsewhere in the world, and predominantly in Europe, RES incentives are often financed directly by consumers through a (equally earmarked) tax component added to the electricity bill. While this is in principle a viable alternative, in this fiscal policy reform, the price of electricity would already be affected by the carbon tax (the incidence of which is show in Table 9). Charging RES incentives on electricity bills would double the imposition of the $CO_2$ externality on consumers and raise issues of political feasibility and excessive socio-economic impacts. Such a situation occurs less in the European context, where a carbon tax is charged only in a few countries and at very low rates, while the EU Emissions Trading System has not yet imposed a serious binding constraint. On the other hand, if the Government were to finance RES incentives through electricity bills and drop the carbon tax, most of the incentive would be lost, in terms of fuel shift and technological change, as would the desired environmental impact of the fiscal measure (all the more so in contexts where consumers cannot choose the source from which the electricity they buy is generated).

The proposal to finance RES incentives through the proceeds of the carbon tax is in line with current practice in Mauritius, whose REFiT scheme is financed by the Maurice Ile Durable Fund, which collects revenues from the MID levy. Citizens particularly value this form of financing because it burdens households' budgets less directly than a tax included on the electricity bill (and considering that the elasticity of household demand for electricity is about half that for transport fuels). Moreover,

dedicating the carbon tax to financing renewable energy conveys the Government's real commitment to promoting the transition to a low-carbon economy.

## 4.1 RES INCENTIVES IN MAURITIUS: STATUS QUO

In 2008, the Government launched a number of policies within the broader Maurice Ile Durable project to reduce the country's energy dependence by promoting the dissemination of renewable energy. The MID strategy[31] identifies a national target of 35 per cent of energy produced through RES by 2025, with particular attention to solar and wind power. The renewable sources considered include bagasse, which, however, is used in thermal power stations as a complement to coal, and which in 2012 represented 14.16 per cent of the 15.24 per cent of the primary energy requirement satisfied by renewables (Republic of Mauritius, Ministry of Environment and Sustainable Development, 2013). Monitoring the actual progress towards a greener energy mix requires looking at the separate targets for RES sources other than bagasse (hydroelectric power, waste to energy, photovoltaics (PV), wind turbines, geothermal energy), which in the Government's Long-Term Energy Strategy 2009-2025 are set at 18 per cent in 2025 (Table 14).

Several policies aimed at greening the energy mix in Mauritius have been implemented in recent years, but some appear to be uncoordinated interventions whose target, impact and cost-effectiveness would deserve to be defined and investigated in further detail.

The first step of the MID strategy was the implementation of a rigorous grid code in 2009, which includes a listing of the technical features of new production stations. Subsequently, a REFiT was designed and developed. The incentive scheme, introduced in 2011 and meant to last for 15 years, focused on small independent private producers (SIPPs), with a maximum of 50 kW per installation and a cap for the overall installed capacity of 2 megawatts (MW) or MUR 200 million per year (US$5.54 million), whichever came first. The country's feed-in tariffs that apply to SIPPs for the energy transmitted to the CEB grid are shown in Table 15.

If a small generator consumes less electricity than that produced in a year, the surplus can be transmitted to the grid and the SIPP receives

**TABLE 14. GOVERNMENT TARGETS FOR RENEWABLE ENERGY, 2010, 2015, 2020 AND 2025** (PERCENTAGE)

| | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|
| Bagasse | 16 | 13 | 14 | 17 |
| Hydro | 4 | 3 | 3 | 2 |
| Waste to energy | 0 | 5 | 4 | 4 |
| Wind | 0 | 2 | 6 | 8 |
| Solar PV | 0 | 1 | 1 | 2 |
| Geothermal | 0 | 0 | 0 | 2 |
| **Total** | **20** | **24** | **28** | **35** |

Source: Republic of Mauritius, Ministry of Renewable Energy and Public Utilities, 2009.

**TABLE 15. CURRENT FEED-IN TARIFF[32]** (IN MUR/KWH)

| Feed-in tariff for 15 years | Wind MUR/kWh | Hydro MUR/kWh | PV MUR/kWh |
|---|---|---|---|
| Micro (up to 2.5 kW) | 20 | 15 | 25 |
| Mini (2.5+ to 10 kW) | 15 | 15 | 20 |
| Small (10+ to 50 kW) | 10 | 10 | 15 |

Source: Central Electricity Board: http://ceb.intnet.mu/grid_code/feedin.asp.

a payment for these quantities. If the annual production/consumption ratio is larger than three, the tariff for the following year changes to that applicable to greenfield installations (Table 16), on the assumption that the commercial purpose dominates that of household self-consumption. After the 15-year duration of the incentive scheme, the feed-in tariff will be set at the CEB's marginal electricity production cost.

The incentive scheme rapidly attracted domestic investors, mainly for solar PV and wind plants (the latter in particular on Rodrigues Island). After five months of operation, in May 2011, the programme was closed to new entrants because the cap of 2 MW had already been reached. The cap for new capacity was increased in 2012 to 3 MW and in 2013 to 5 MW. Two of the three additional MW of capacity were reserved to investments by commercial producers, to balance the households' almost complete absorption of first-phase incentives. Finally, the 50-kW limit for each investment was removed to also attract larger investors.[33]

The feed-in tariff is complemented by other fiscal incentives in the MID strategy:

- A solar water heater financing scheme (MUR 600 million over three years, equivalent to US$16.61 million), introduced in 2008, which succeeded in equipping 20 per cent of households with solar water heaters
- VAT exemption on PV panels. As mentioned, however, the VAT exemption is effective only for certain taxpayer categories, namely households and firms not subjected to VAT
- The Power Service Subsidy, which replaced the Energy Services Subsidy in 2013, with the purpose of financing the renewable energy provision.[34] MUR 33 million (US$0.93 million) was allocated to the Power Service Subsidy in 2013 and MUR 110 million (US$3 million) in 2014

The impact of these policies could be strengthened by introducing a partial *tax deduction for investments in renewable technologies* (e.g. solar and PV panel installation costs), replacing the current VAT exemption to extend the incentive to firms, and by considering a partial deduction for investment costs for solar water heaters.

Total incentives in recent years to encourage renewable energy have reached around MUR 500 million per year (US$13.84 million), representing 0.08 per cent of GDP. In 2012, the thermal (operating mainly with a mix of coal and bagasse) and hydro sectors together accounted for 99.4 per cent of the energy sources used to generate electricity (Table 17). During the REFiT scheme's three years of activity (2011-2013), the installed capacity of renewable sources saw timid growth, reaching 1 per cent of total installed capacity, partly due to public investments in offshore wind power installations. In general, the presence of a tight cap on eligible capacity, mainly due to scarce resources allocated to the incentive scheme, has limited its effectiveness. With the current trend, the MID strategy's objective of 18 per cent of primary energy requirements produced with RES (excluding bagasse) by 2025 appears vastly out of reach. The sustained growth of electricity consumption, on average over 4 per cent per year, provides further motivation for sustaining an increased share of renewable sources in the energy mix of the country. In the increasingly uncertain context of international fossil fuel prices, reducing energy dependence is an important objective in itself.

**TABLE 16. TARIFF FOR GREENFIELD INSTALLATIONS** (IN MUR/KWH)

| Greenfield tariff for 15 years | Wind MUR/kWh | Hydro MUR/kWh | PV MUR/kWh |
|---|---|---|---|
| Micro (up to 2.5 kW) | 17.00 | 12.75 | 21.25 |
| Mini (2.5+ to 10 kW) | 12.75 | 12.75 | 17.00 |
| Small (10+ to 50 kW) | 8.50 | 8.50 | 12.75 |

Source: Central Electricity Board: http://ceb.intnet.mu/grid_code/feedin.asp.

**TABLE 17. INSTALLED GENERATION CAPACITY, 2007-2012** (IN MW)

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Total hydro (CEB) | 59.44 | 59.44 | 59.44 | 59.79 | 59.80 | 59.69 |
| Total thermal (CEB) | 372.80 | 372.80 | 372.80 | 372.80 | 378.80 | 432.50 |
| Wind (small-scale distributed generation) | 0 | 0 | 0 | 0 | 0 | 0.01 |
| Photovoltaics (small-scale distributed generation) | 0 | 0 | 0 | 0 | 0 | 1.42 |
| Landfill gas | 0 | 0 | 0 | 0 | 2.00 | 2.20 |
| Total thermal purchases | 311.10 | 283.30 | 296.80 | 296.50 | 287.80 | 275.43 |
| **TOTAL** | **743.34** | **715.54** | **729.04** | **729.09** | **726.40** | **767.62** |
| Rodrigues | 10.00 | 10.00 | 10.53 | 11.10 | 11.10 | 13.68 |
| Wind | 0.20 | 0.20 | 0.73 | 1.30 | 1.30 | 1.28 |
| Thermal | 9.8 | 9.8 | 9.8 | 9.8 | 9.8 | 12.4 |

Source: provided upon request by Statistics Mauritius.

## 4.2 CARBON TAX TO FINANCE REFIT: A PROPOSAL

This section provides a quantitative analysis of the amount of new capacity that could be financed in a scenario in which total additional carbon tax revenues are devoted to RES incentives. To this end, a prototypical investment, such as the installation of a small-scale PV system, is considered. Using data on PV productivity as a function of solar radiation on the island of Mauritius, it is possible to estimate the total amount of kWh that could be produced in 15 years and thus sustained by the feed-in tariff. According to Bholah and Surroop (2012), a 2.5 kW PV system in Mauritius can generate up to 4,861.1 kWh of solar power in a year. Actual and theoretical PV power generation were shown to be almost identical and confirmed the country's

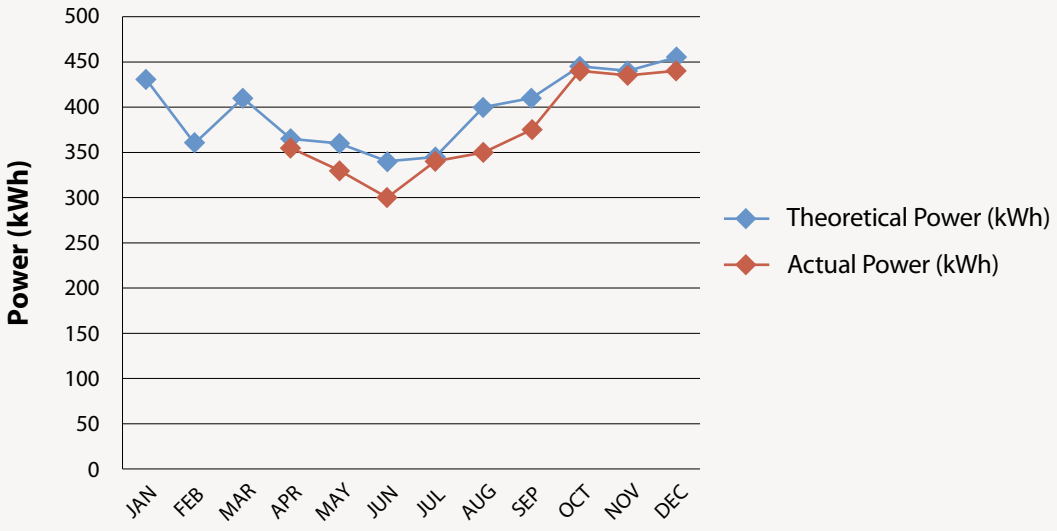
remarkable potential for electricity production from solar energy (Figure 8). The REFiT scheme requires that the incentive be transferred to the owner of the system for each kWh produced, for 15 years. It is assumed that in this period the plant will produce about 72,916 kWh.

The cost of financing through the REFiT scheme can thus be calculated for every new unit of installed energy. The simulation is conducted on the specific case of the PV technology for which certified information on productivity is available.

As shown in Table 15, the current tariff structure provides very high incentives, between MUR 15 (US$0.41) and MUR 25 per kWh (US$0.69), depending on the installation size. These starting values for the feed-in tariff currently applied in Mauritius were calculated based on the cost of household installations with a moderate return on investment of 6-8 per cent (Larsen et al., 2010). The costs of imports and the lack of local expertise in Mauritius, causing higher upfront costs, resulted in tariffs three to four times higher than in most African countries (Heinrich Böll Stiftung and the World Future Council, 2013).

With the incentive of MUR 25/kWh (US$0.69) now active in Mauritius for micro PV installations, and without considering the electricity not totally consumed by the producer and sold to the CEB, the total cost to finance this type of plant (typically 2.5 kW installation) would be MUR 1,822,912 (US$50,482), or MUR 729,165 per kW installed (US$20,192 per kW). This is an upper bound estimate of the cost for the Government to finance the REFiT, which can be used to calculate a lower bound estimate of what can be attained by investing the additional carbon tax revenues in the scheme. In the short term (2016-2018), the additional revenues that could be collected by the carbon tax would be about MUR 96.61 million (US$2.66 million) from electricity production and MUR 281.06 million (US$7.78 million) from transportation fuels, for a total of MUR 377.67 million per year (US$10.45 million per year). These resources could finance up to 0.52 MW of new installed capacity per year. In the medium term (2019-2024), with additional revenues equal to MUR 642.39 million (US$17.79 million), the REFiT could finance up to 0.88 MW. It could finance 1.68 MW per year in the long term (2025 onwards) (Table 18). The resulting total cumulative RES installed capacity in 2025 would be 13.51 MW, which represents 1.76 per cent of total installed capacity. The third carbon tax phase would strongly reinforce the incentive effect: in 2030 the cumulative installed capacity would reach 21.91 MW, equal to 2.86 per cent.

**FIGURE 8: ACTUAL AND THEORETICAL POWER FROM PV SYSTEM** (POWER/KWH)




Source: Bholah and Surroop, 2012: Figure 4, p. 49.

**TABLE 18. ADDITIONAL INSTALLED CAPACITY (MW) WITH REFIT AT MUR 25/KWH**

| | Years | Additional revenues (million MUR) | Additional capacity (MW/year) | Cumulative installed capacity (MW)* | Share of renewables (excluding bagasse) on total installed capacity (%) |
|---|---|---|---|---|---|
| Short term | 2016-2018 | 377.67 | 0.52 | 6.55 | 0.85 |
| Medium term | 2019-2024 | 642.39 | 0.88 | 11.83 | 1.54 |
| MID target | 2025 | 1 224.32 | 1.68 | 13.51 | 1.76 |
| Long term | 2025-2030 | 1 224.32 | 1.68 | 21.91 | 2.86 |

* Obtained as the sum of the current installed capacity (around 5 MW at time of writing) plus the additional capacity.
Source: Bholah and Surroop, 2012.

The current maximum tariff of MUR 25/kWh REFiT (US$0.69), however, is no longer justified by differences in upfront installation costs. Using an average value of MUR 13/kWh (US$0.36), close to that adopted by the Renewable Energy Independent Power Producer Procurement (REIPPP) South African programme (Heinrich Böll Stiftung and the World Future Council, 2013) for solar PV, for example, would result in much more effective incentives: the scheme would enable 0.99 MW per year of new installed capacity in 2016-2018, 1.69 MW in 2019-2024, and 3.23 MW from 2025 onwards. The share of total installed capacity satisfied by renewable sources would grow to 1.04 per cent in 2018, 2.78 per cent in 2025, and 4.89 per cent in 2030.

In addition, it is worth considering the transfer of resources currently absorbed by the Power Service Subsidy (whose specific target and impact are not clear) in the REFiT scheme. In this case, an additional new installed capacity of approximately 0.37 MW per year could be generated, raising the RES share in 2025 to 3.16 per cent, and the share in 2030 to 5.46 per cent.

These calculations are in terms of installed capacity, whereas the Government's 2025 objectives are formulated in terms of energy requirements satisfied by RES. The above cumulative installed capacity of small-scale PV plants would translate into 68.4 gigawatt-hours (GWh) per year of additional electricity produced in 2030, representing the total energy requirement of 0.4 per cent.

These remain very conservative estimates, since solar PV is the most costly among eligible RES technologies: the maximum tariffs of the REIPPP programme in South Africa are US$0.14 per kWh for onshore wind, US$0.13 for small hydro and biomass, and US$0.10 for landfill gas (Heinrich Böll Stiftung and the World Future Council, 2013). Since in the real world the incentive policy would be accessible to all technologies, not just to PV as in this report's simulation, the actual induced new capacity would be higher. Nonetheless, the 2025 18 per cent objective does not appear to be realistic with only the reinvestment of the resources generated in the next 10 years by the gradual introduction of the carbon tax.

Reaching the 2 per cent objective (in 2030 rather than 2025) for PV generation through RES incentive policies (Table 14) would require lowering the REFiT to MUR 2.45/kWh (US$0.067) – a level largely below the incentive required to induce new PV installations. The targets set for 2025 in the Long-Term Energy Strategy will also require large-scale direct public and/or private investments, in addition to incentive schemes geared to small-scale installations.[35] Since the carbon tax in 2025 would enter in its third phase, from then on the resources mobilized for reinvestment in RES would substantially increase: the full-scale carbon tax, reinvested in the RES incentive scheme, would enable 6.28 GWh new PV generation each year.

The assessment provided in this section is preliminary, aimed at highlighting that there is room to target fiscal instruments better in this crucial area. A detailed reform design should also: (1) project the renewable energy mix over the planning horizon, thus applying the proper REFiT to the (variable) share of energy produced by the different RES technologies over time; (2) consider in the calculations the differentiation of tariffs by plant size; and (3) introduce a decreasing tariff structure over time, to account for progress towards the maturity of technologies.

# 5 THE TAXATION OF MOTOR VEHICLES

Another channel to tackle the environmental impact of fossil fuels, and more generally of transportation, is the fiscal treatment of motor vehicles. The issue is explored comprehensively in Parry (2012); the main arguments are recalled and updated here.

In Mauritius, motor vehicles are currently subject to various excises and taxes on imports and ownership. The general tax base is the size of the engine.[36] In summary, the taxes levied are:

1. A one-off excise duty on the car price of 55 per cent for vehicles with engine capacity of less than 1,600 cubic centimetre (cc) and 100 per cent for vehicles with engine capacity of greater than 1,600 cc. Civil servants and agricultural users are exempt. This constitutes a large loophole, since these two categories use more than 25 per cent of vehicles.

2. A one-off registration fee for imported vehicles (from MUR 12,500 to MUR 150,000; from US$346 to US$4,153) depending on cc. This fee is paid again, with certain reductions, if the vehicle is subsequently resold.

3. A road tax comprised of an annual per-vehicle charge of between MUR 3,500 and MUR 13,000 (between US$96.92 and US$360), depending on engine size, also levied on fuels at the rate of MUR 1.85/litre for gasoline and MUR 1.75/litre for diesel (equivalent to US$0.051 and US$0.048, respectively).

4. According to a $CO_2$ levy/rebate programme, a $CO_2$ tax on the purchase of a vehicle producing more than 158 grams of $CO_2$ per kilometre driven.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wThe present system does not effectively address the externalities caused by automobile use – primarily congestion (whose marginal cost has been estimated by Parry (2012) at about MUR 2.1/km driven nationwide, and MUR 12/km for peak driving in Port Louis); air pollution (MUR 0.08/km in terms of local pollution and MUR 0.06/km in terms of global pollution); accidents and fatality risk (MUR 0.8/km). First, being related to vehicle ownership rather than use, the current framework does not trigger incentives to change behaviour and reduce automobile use. Second, it encourages the choice of more energy efficient cars only weakly, as engine size is a somewhat rough proxy for fuel economy. Third, it predominantly acts at the point of purchase, which helps maintain older, less efficient vehicles in circulation.

One important step in the direction of an effective fuel economy incentive system was taken in 2011 with the introduction of one of the first $CO_2$-based feebate systems in developing countries.[37] The rebate rates in Mauritius are reported in Table 19. Higher values of the tax/rebate rate introduce a stronger incentive to adopt efficient vehicles and encourage

**TABLE 19.** FEEBATE RATES

| | Fee/rebate rate | |
|---|---|---|
| $CO_2$ gram per km | Compliant with Reg. 101 | Not compliant with Reg. 101[38] |
| Up to 90 (in MUR) | 3 000 | 1 000 |
| From 91 to 150 (in MUR) | 1 000 | 350 |

Source: Republic of Mauritius, Ministry of Finance and Economic Development, 2011.


the shift from large to small vehicles. The tax rate can be modulated over time according to the evolution of the vehicle fleet and policy goals.

One of the main issues related to the feebate system is maintaining revenue neutrality. The system should prevent revenue losses by setting a threshold that declines over time as the average $CO_2$ emissions per km of the vehicle fleet decreases. Moreover, revenue neutrality can be ensured by implementing the feebate system within a wider scheme of taxation on vehicles in which excises and other taxes compensate revenue losses. Indeed, in November 2013, the first periodical review of the threshold lowered it from 158 g/km to 150 g/km. A second issue is related to the fact that the certification of vehicles' $CO_2$/km emissions involves measurement standards that differ according to the different economic areas from which the vehicles are imported.[39]

Feebates are in many circumstances an effective policy and an ideal complement to fuel price increases because consumers take conscious decisions not only when they drive their car but also when purchasing vehicles. In addition, manufacturers are encouraged to market vehicles under the pivot point to exploit the rebate. Fuel taxes remain more effective at reducing fuel use than feebates, as they decrease vehicle miles travelled, while feebates may increase vehicle miles travelled, albeit moderately, through the rebound effect) (Anderson, Fischer, Parry and Sallee, 2011). Feebate programmes can also help provide a long-term price signal to both auto manufacturers and consumers (Adamou, Clerides and Zachariadis, 2014).

Further reform options have been explored in detail by Parry (Parry, 2012), including graduated taxes on $CO_2$ emissions per km, and GPS-based mileage tolls able to charge vehicle owners for actual kilometres driven.

# 6 WASTE COLLECTION AND DISPOSAL SERVICE

Population growth as well as rapid economic growth in Mauritius over the last few decades have generated increasing consumption levels and mounting volumes of waste. The per capita production of waste has seen a stable and sustained increase in the country, from 0.88 kg of daily disposed waste in 2004 to 0.97 kg in 2013 (Table 20).

The waste collection and disposal service is the responsibility of the Ministry of Local Government and local authorities. In some areas, contractors are employed in the collection phase and in the transportation of waste to transfer stations[40] where it is compacted and sent to Mare Chicose, the first and only landfill on the island of Mauritius.

Until 1997, when the Mare Chicose landfill became operational, no collection and disposal services existed. Open-air, uncontrolled dumps were the only waste disposal method available.

The total amount of solid waste dumped in the Mare Chicose landfill increased from 381,114 tons in 2004 to 429,935 tons in 2013, showing an average yearly growth rate of 1.3 per cent. In recent years, the rate has grown to about 2 per cent, and the total amount of waste reached around 460,000 tons in 2015. The historical trend of the volume of landfilled solid waste is shown in Figure 9.

With a continuous increase in landfilled waste, the Mare Chicose landfill has required numerous expansions over the last two decades (doubling its surface from 1997) and today is filled close to capacity. Under these circumstances, the proper management of solid waste has become a crucial environmental issue.

A number of policies have been implemented within the current Solid Waste Management Strategy 2011-2015, with the overall objective of reducing, reusing and recycling waste. One of the most significant actions is the construction of a composting plant, in which up to 15 per cent of total waste generated is deposited. A substantial increase in composted quantities is expected in the future: up to 130,000 tons per year, equal to almost 30 per cent of total waste generated. The potential of compost heat and methane as a source of energy also contributes to the Government's objectives in terms of the share obtained from renewable sources. In addition, the Government has planned a series of projects in the medium term, including investments and the construction of facilities to recycle e-waste, tyres, compact fluorescent lights and other hazardous waste, and a project for two new plants, planned for mid-2017, using ultra-high-temperature gasification technology.

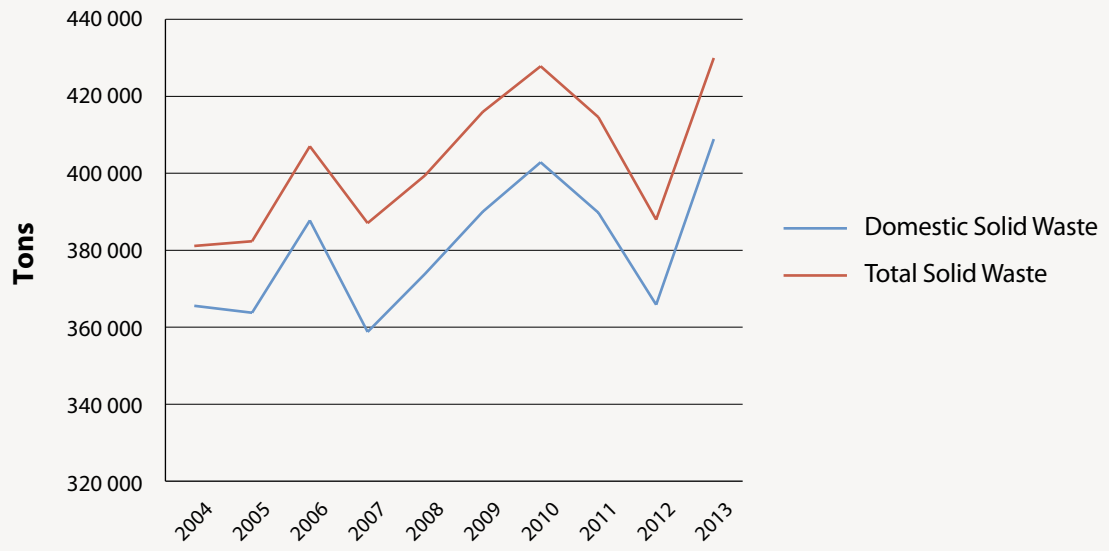
Furthermore, a levy on the distribution of plastic bags was introduced in July 2006. Despite its low initial rate (MUR 1, raised to MUR 2 in November 2010), the introduction of this levy reduced the use and circulation of plastic bags and associated plastic waste. In the few months following the introduction of the levy, the consumption of plastic bags in supermarkets decreased by 75-80 per cent (Republic of Mauritius, Ministry of Environment and Sustainable

**TABLE 20. WASTE PRODUCTION, DISPOSAL AND EMISSIONS, 2004-2013**

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| Daily per capita solid waste disposed at landfill (kg) | 0.88 | 0.88 | 0.93 | 0.88 | 0.91 | 0.94 | 0.97 | 0.94 | 0.87 | 0.97 |
| Daily per capita domestic solid waste disposed at landfill (kg) | 0.85 | 0.84 | 0.89 | 0.82 | 0.85 | 0.88 | 0.91 | 0.88 | 0.83 | 0.92 |
| Methane ($CH_4$) emissions (1 000 tons) | | | | | | | | | 35.92 | 39.94 |

Source: World Bank, 2012.

**FIGURE 9. TOTAL SOLID WASTE LANDFILLED AT MARE CHICOSE, 2004-2013** (TONS)




Source: Statistics Mauritius, 2014a.

Development and UNEP, 2013). The implementation of this measure, however, was much less effective in open markets and fairs, where insufficient monitoring and enforcement did not prevent the free distribution of plastic bags. International experience with this type of fiscal instrument confirms its ability to promote sustainable behaviour, and supports further policies aimed at fostering the reduction and reuse of waste. Such policies play a particularly important role in small island states such as Mauritius, where scale issues limit the scope for effective recycling.[41]

Presently, the cost of waste services weighs entirely on the general budget of local and national government, presumably financed in part by the Municipal rates imposed in urban centres.[42] Waste management at present absorbs 26 per cent of the Government's environmental expenditure (UNEP, 2014). No waste disposal fee is currently in place.

## 6.1 RECYCLING

Recycling of waste in Mauritius appears to be embryonic. There is virtually no waste segregation at the domestic level. Based on information from recycling companies (Mohee et al., 2009) and data from the Ministry of Local Government (Table 21), the country's recycling rate (recycled quantity/total amount of waste collected) for paper is approximately 1 per cent, over a maximum potential of 12 per cent. This means that approximately 10 per cent of wastepaper is recycled. The recycling rate for plastics is 0.3 per cent (maximum potential 9.6 per cent), such that approximately 3.4 per cent of plastics is recycled. The recycling rate for metal is 2.1 per cent (maximum potential 4.9 per cent), with approximately 43 per cent recycled. The recycling rate for glass is 0.3 per cent (maximum potential 1.8 per cent), with approximately 1.4 per cent recycled. The total recycling rate is 3.5 per cent.[43]

Although these are very low rates, it is generally recognized that recycling is costly in the context of small islands such as Mauritius (Sealey and Smith, 2014). On a small scale, labour costs and the difficulty to create a complete market for secondary materials, as well as the costs to remove secondary, not locally reused materials from the island, make very high rates for recycling prohibitive. Recycling remains feasible for those materials that do not require complex and costly treatment processes, and particularly for those that can be reused on

**TABLE 21. COMPOSITION OF SOLID WASTE LANDFILLED, 1998-2007** (TONS)

| Year | Amount of waste collected | Paper | Plastics | Glass | Metal | Organics | Electronics | Ceramics | Misc. |
|---|---|---|---|---|---|---|---|---|---|
| 1998 | 45 065 | 5 534 | 4 353 | 820 | 2 249 | 31 802 | 36 | 787 | 39 |
| 1999 | 157 489 | 19 340 | 22 820 | 2 866 | 7 859 | 111 660 | 126 | 787 | 137 |
| 2000 | 245 682 | 30 170 | 23 733 | 4 471 | 12 260 | 173 378 | 197 | 1 228 | 214 |
| 2001 | 302 045 | 37 091 | 29 178 | 5 497 | 15 072 | 213 153 | 242 | 1 510 | 263 |
| 2002 | 346 335 | 42 530 | 33 456 | 6 303 | 17 282 | 244 409 | 277 | 1 732 | 301 |
| 2003 | 374 186 | 45 950 | 36 146 | 6 810 | 18 672 | 264 063 | 299 | 1 871 | 326 |
| 2004 | 376 186 | 46 196 | 36 340 | 6 847 | 18 772 | 265 475 | 301 | 1 881 | 327 |
| 2005 | 385 991 | 47 400 | 37 287 | 7 025 | 19 261 | 272 394 | 309 | 1 930 | 336 |
| 2006 | 417 729 | 51 297 | 40 353 | 7 603 | 20 845 | 294 791 | 334 | 2 089 | 363 |
| 2007 | 394 118 | 48 398 | 38 072 | 7 173 | 19 666 | 278 129 | 315 | 1 971 | 343 |
| Total | 3 044 826 | 373 905 | 301 737 | 55 416 | 151 937 | 2 149 253 | 2 436 | 15 786 | 2 649 |
| Average percentage | | 12.2 | 9.90 | 1.8 | 4.9 | 70.58 | 0.08 | 0.5 | 0.08 |

Source: Mohee et al., 2009.

the island. Among landfilled materials, metals, glass, plastics and paper are eligible for recycling. Policies targeted at encouraging waste reduction and reuse, also through programmes aimed at generating a significant shift in attitude regarding waste production in the population, form part of effective management strategies that are crucial on small islands. A step in that direction would be the use of fiscal instruments, such as the plastic bag tax already mentioned. Deposit-refund systems are another effective tool which induce waste reduction, reuse and recycling. They also provide a potential source of income to poor households by encouraging the collection of unreturned material. In addition, pay-as-you-throw disposal fees are another crucial component of waste management strategies in green economies.

Appropriate infrastructure planning and coordination among authorities are essential for Mauritius, in particular with respect to waste generated in small quantities. For these waste flows, uncoordinated municipal investments in treatment facilities are unfeasible and inefficient from a financial point of view. Cooperation within a network of local authorities could enable them to reach the critical level of waste required for the feasibility of these facilities.

## 6.2 INTRODUCING A WASTE DISPOSAL FEE

As mentioned, Mauritius currently has no charge for waste disposal, thus there is no attempt at cost recovery nor is there any connection to the polluter pays principle. Actions aimed at a more sustainable waste management strategy could be strengthened by introducing a waste disposal fee.

The policy reform proposed in this report concentrates on domestic waste services, since domestic waste, which includes household and commercial activities, constitutes about 95 per cent of the country's current total solid waste landfilled (Table 22).

The proposed reform is based on the following overall strategy:

1. *Gradual full cost recovery*. A tariff system for waste collection and disposal should aim at achieving complete cost recovery for providing the service. In the short term, the Government may choose to partially satisfy the principle of cost recovery so as not to generate an abrupt increase in the burden on taxpayers.

**TABLE 22. WASTE PRODUCTION AND DISPOSAL BY SECTOR, 2004-2013** (TONS)

| Waste type | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013* |
|---|---|---|---|---|---|---|---|---|---|---|
| Domestic | 365 528 | 363 776 | 387 751 | 358 781 | 373 860 | 389 999 | 402 816 | 389 743 | 365 867 | 408 858 |
| Construction | 6 097 | 3 755 | 1 109 | 502 | 2 065 | 671 | 2 394 | 5 306 | 5 601 | 6 141 |
| Industrial (excluding textile) | 928 | 537 | 499 | 886 | 796 | 1 170 | 1 140 | 1 565 | 680 | 325 |
| Textile | 2 169 | 1 803 | 2 120 | 1 271 | 1 002 | 300 | 432 | 130 | 233 | 89 |
| Tuna/sludge | 189 | 5 913 | 8 056 | 13 077 | 12 148 | 9 126 | 10 949 | 10 402 | 7 370 | 6 963 |
| Poultry | 3 962 | 3 930 | 3 752 | 3 387 | 6 867 | 7 209 | 6 339 | 5 942 | 6 061 | 5 316 |
| Rubber tyres | 423 | 394 | 465 | 223 | 347 | 365 | 481 | 447 | 372 | 315 |
| Asbestos | 36 | 85 | 14 | 260 | 32 | 26 | 44 | 15 | 6 | 50 |
| Condemned goods | 1 770 | 2 114 | 3 265 | 2 036 | 2 361 | 1 164 | 1 388 | 848 | 1 573 | 1 588 |
| Difficult and hazardous waste | 12 | 40 | 8 | 4 | 5 | … | 42 | 13 | 7 | 17 |
| Paper waste | … | … | … | … | … | … | 6 | 67 | 7 | 30 |
| Other | … | … | … | 6 648 | 5 | 5 918 | 1 771 | 65 | 149 | 243 |
| TOTAL | 381 114 | 382 347 | 407 039 | 387 075 | 399 488 | 415 948 | 427 802 | 414 543 | 387 926 | 429 935 |

* Provisional.
… = data unavailable.
Source: Statistics Mauritius, 2014b.

2. *Progressivity.* This is achieved through a two-part tariff: a fixed component independent of household income (linked to the number of residents in the dwelling, or family size) plus a variable component correlated to dwellings' Municipal rates.

3. *Unit-based pricing*. In the medium to long term, the tariff system should be based on actual volumes of waste disposed of by each household or commercial agent, according to the pay-as-you-throw principle. Moreover, full cost recovery should be aimed for and the cost of new investments in disposal infrastructures should be taken into account in defining the rate of the waste collection service.

According to the Ministry of Environment and National Development Unit, the cost of waste collection and disposal increased from MUR 764 million in 2005 (US$21.2 million) to MUR 1,069 million in 2009 (US$29.6 million), or MUR 832 per capita (US$23.04) (Table 23). The increase in total costs was due to: (1) increased quantities of collected and disposed waste; (2) increased separation costs due to higher recycling rates;

**TABLE 23. COST OF WASTE COLLECTION AND DISPOSAL, 2005 AND 2009** (MILLION MUR)

| | 2005 | 2009 |
|---|---|---|
| Disposal cost (landfilling and cell construction cost) | 108 | 210 |
| Operation and transfer stations and transportation to Mare Chicose landfill | 127 | 166 |
| Scavenging contracts by Ministry of Local Government | 167 | 187 |
| Collection costs by local authorities | 362 | 506 |
| **TOTAL** | **764 (US$21.15 million)** | **1 069 (US$29.60 million)** |

Source: Republic of Mauritius, Ministry of Environment and National Development Unit, 2010.

and (3) increased transport costs, due both to scale and to fuel prices.

The increasing volume of waste production is correlated with increasing costs of collection and disposal. Table 24 shows projections for the country's landfilled waste, total costs and costs per capita. The cost of waste treatment per ton in 2009 was MUR 2,515 (US$69.65). This is expected to increase by about 48 per cent by 2020. These estimates are in line with those (US$40-US$90 per ton collected) provided by the World Bank (2012) for upper-middle-income countries (see Table 35 in Annex 2).

The initial projected costs shown in Table 24 are useful to define fees which approach cost recovery in the long term. Specifically, a starting point of MUR 500 per capita in 2015 (US$13.84) has been assumed, amounting to 46 per cent of total costs, as well as an increase in this share of about 10 per cent per year to achieve complete cost recovery in 2020 (Table 25).

**TABLE 24.** PROJECTED COST OF WASTE COLLECTION AND DISPOSAL, 2009-2020

| Year | Waste landfilled (tons)[a] | Cost of collection and disposal (MUR/ton)[b] | Inflation rate (%)[c] | Total cost of waste collection and disposal (million MUR) | Population (x1 000)[d] | Cost per capita/ year (MUR) |
|---|---|---|---|---|---|---|
| 2009 | 415 948 | 2 515 | – | 1 046.10 | 1 275 | 820.47 |
| 2010 | 427 802 | 2 588 | 2.93 | 1 107.15 | 1 281 | 864.28 |
| 2011 | 414 543 | 2 757 | 6.54 | 1 142.48 | 1 286 | 888.39 |
| 2012 | 387 926 | 2 862 | 3.85 | 1 111.02 | 1 291 | 860.58 |
| 2013 | 429 935 | 2 964 | 3.50 | 1 274.32 | 1 296 | 983.27 |
| 2014* | 438 534 | 3 112 | 5.00 | 1 338.84 | 1 300 | 1 029.88 |
| 2015* | 447 304 | 3 206 | 5.00 | 1 406.32 | 1 309.75 | 1 073.73 |
| 2016* | 456 250 | 3 301 | 5.00 | 1 477.79 | 1 319.57 | 1 119.90 |
| 2017* | 465 375 | 3 401 | 5.00 | 1 552.49 | 1 329.47 | 1 167.75 |
| 2018* | 474 683 | 3 503 | 5.00 | 1 631.01 | 1 339.44 | 1 217.68 |
| 2019* | 484 177 | 3 608 | 5.00 | 1 713.50 | 1 349.49 | 1 269.74 |
| 2020* | 493 860 | 3 715 | 5.00 | 1 800.12 | 1 359.60 | 1 324.00 |

* Authors' projections based on the following assumptions: a) waste landfilled grows at a 2 per cent rate from 2014 onwards; b) cost of collection and disposal increases at inflation rate as reported by World Bank; c) starting in 2014, a 5 per cent inflation rate is assumed as in the simulations provided by UNEP (2014) (Appendix 1); d) population growth is assumed stable at 0.75 per cent per year.
Sources: a) UNEP, 2014; b) World Bank, 2012; c) and d) World Bank data.

**TABLE 25.** FEE SCHEME FOR WASTE COLLECTION AND DISPOSAL SERVICE, 2015-2020

| Year | Projected cost per capita/year (MUR) | Flat fee per capita/year (MUR) | Cost recovery (%) |
|---|---|---|---|
| 2015 | 1 073.86 | 500.00 | 46.56 |
| 2016 | 1 119.80 | 671.50 | 60.00 |
| 2017 | 1 167.70 | 817.39 | 70.00 |
| 2018 | 1 217.66 | 974.12 | 80.00 |
| 2019 | 1 269.75 | 1 142.77 | 90.00 |
| 2020 | 1 324.07 | 1 324.07 | 100.00 |

Source: Authors' elaboration.

Waste disposal fees are generally proportional to the number of household components (a proxy of the amount of waste produced). According to the HBS (Statistics Mauritius, 2015), in 2012 the total average monthly expenditure was MUR 22,632 (US$626.75) and the average household size was 3.7 components. Using a flat per capita fee (i.e. equal for all) and assuming constant expenditure levels and family size, a cost of 0.68 per cent for the waste collection service on total yearly expenditure can be estimated for 2015 for the average household.

The flat per capita fee would represent, in 2015, a marginal share of total yearly expenditure, also for the bottom quintiles (2.2 per cent of total expenditure for households in the first quintile). In subsequent years, however, it would become an increasing burden for the poorest quintiles (up to 5.9 per cent in 2020), whereas it would stay a minor expenditure item for richer households (remaining less than 1 per cent) (Figure 10).

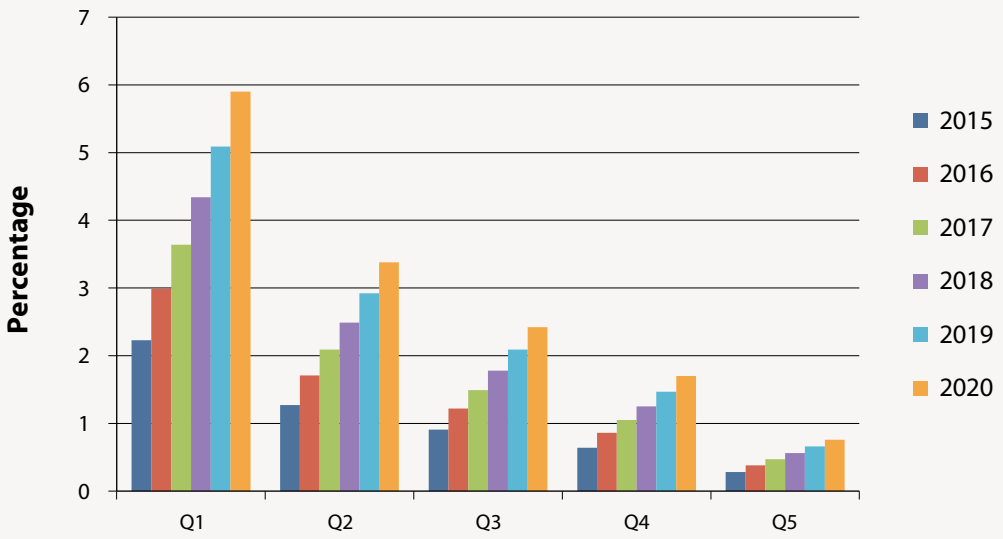
This report therefore suggests designing the waste disposal fee so as to limit the burden for poorest families. In particular, the fee could be modulated and linked to household wealth to give it a progressive profile. To do this, the fee on waste collection could be split into two components: (1) a fixed amount; and (2) a variable component depending on household wealth. By mirroring the progressive structure of the annual expenditure in Municipal rates,[44] it is possible to modulate the variable component so as to redistribute the burden according to household wealth.

Table 26 presents the calculation of the two-part fee. The fixed component is set equal to 50 per cent of the cost of waste disposal to be recovered in each year (according to the progression shown in Table 24) divided by the number of households in each quintile. The variable component has been derived by weighing the residual total cost to be recovered by the relative incidence of Municipal rates on the total expenditure of each quintile, that is by multiplying the weight of Municipal rates on households total expenditure by the per household cost of the waste management service.[45]

Figure 11a shows total expenditure for the waste disposal two-part fee by quintile, progressing towards cost recovery as in Table 25. Figure 11b does the same for the share of the waste collection fee on total expenditure. The maximum incidence, reached in 2020, on the poorest quintile is reduced to 4.25 per cent.

The introduction of fees for waste collection and disposal should increase awareness of the service's usefulness. In the basic form presented here,

**FIGURE 10: SHARE OF WASTE COLLECTION AND DISPOSAL FLAT FEE ON TOTAL EXPENDITURE BY QUINTILE WITH FULL COST RECOVERY, 2015-2020** (PERCENTAGE)




Source: Authors' elaboration.

**TABLE 26.** WASTE COLLECTION AND DISPOSAL TWO-PART FEE BY QUINTILE, 2015

| Quintile | Yearly expenditure in Municipal rates | Relative weight of Municipal rates | Number of households* | Fixed tariff per HH/year | Variable tax per HH/year | Total tariff rate | Share of waste tariff on total expenditure (%) |
|---|---|---|---|---|---|---|---|
| Q1 | 208.19 | 0.304 | 162 792 | 958.9 | 226.87 | 1 185.77 | 1.42 |
| Q2 | 278.63 | 0.407 | 84 329 | 958.9 | 303.64 | 1 262.54 | 0.87 |
| Q3 | 336.91 | 0.492 | 59 030 | 958.9 | 367.14 | 1 326.05 | 0.65 |
| Q4 | 473.83 | 0.692 | 37 765 | 958.9 | 516.34 | 1 475.25 | 0.51 |
| Q5 | 684.27 | 1.000 | 22 732 | 958.9 | 745.67 | 1 704.57 | 0.26 |

* The number of households by quintile is calculated using information on the distribution of households per income class provided by Statistics Mauritius, available at: http://statsmauritius.govmu.org/English/StatsbySubj/Documents/ei1035/hbs.pdf (Table 4).

Source: Authors' elaboration.

**FIGURE 11A:** WASTE COLLECTION AND DISPOSAL TWO-PART FEE BY QUINTILE, 2015-2020 (MUR/YEAR)

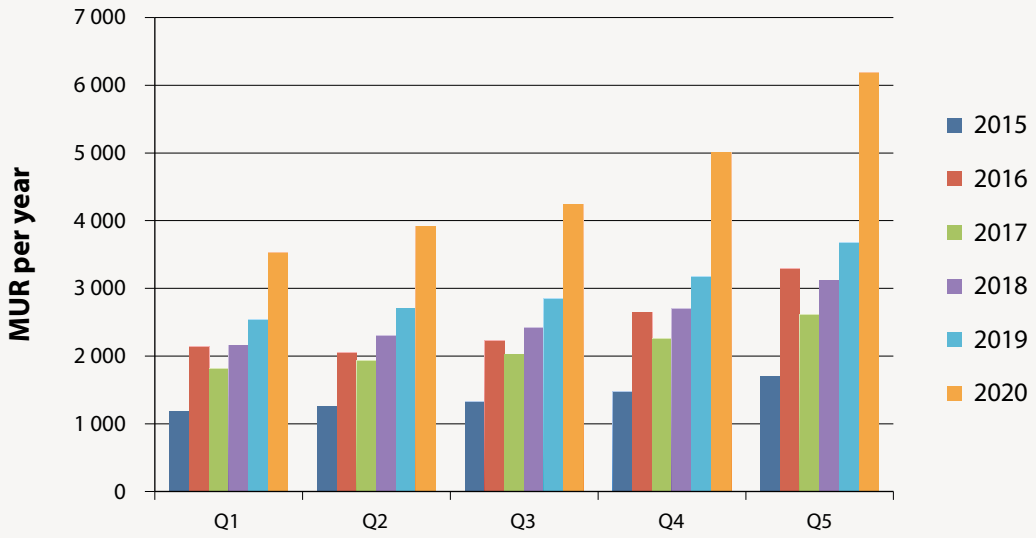
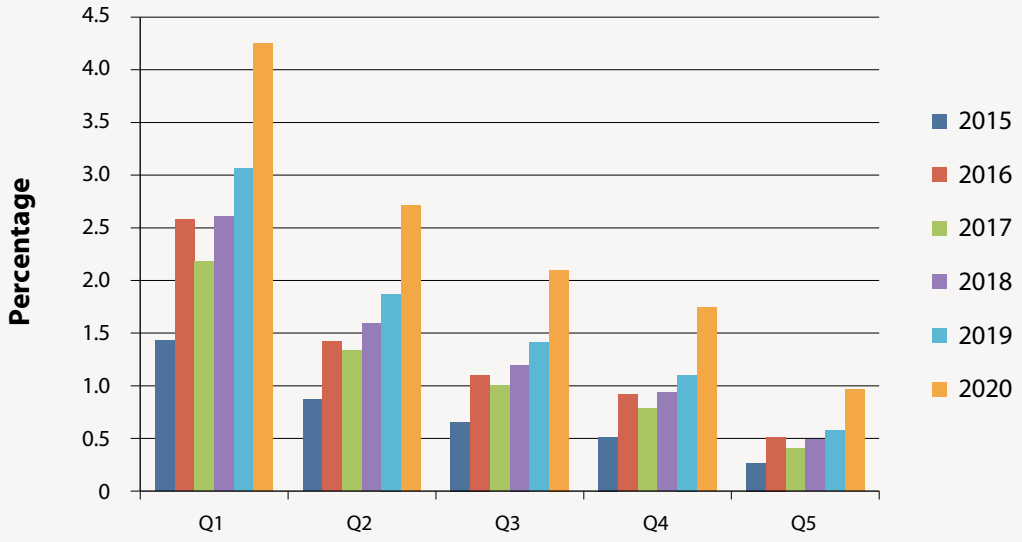



**FIGURE 11B:** WASTE COLLECTION AND DISPOSAL TWO-PART FEE AS A SHARE OF TOTAL EXPENDITURE BY QUINTILE, 2015-2020 (PERCENTAGE)




Source: Authors' elaboration.

however, the proposed reform would merely steer the system towards cost recovery. This frees resources that can be invested in green economy projects. However, the environmental objective of reducing waste production and promoting recycling and reuse requires that the variable component of the cost recovery tariff incorporate unit-based pricing (UBP) of waste collection, in order to implement the pay-as-you-throw principle.

The system would require households to pay for waste disposal services per unit of waste collected (like the pricing of other utilities, such as water or electricity) rather than through a fixed fee or a property tax. The use of UBP is widespread around the world (for example in the United States, most European countries, Japan, Korea, Thailand, Vietnam, China, Taiwan, and experimental trials in the Philippines). It can be designed as a weight-based or volume-based pricing system. Design options include:

- Pre-paid bags: households must dispose of their waste in standard sized bags sold by municipalities. Only official bags are collected.
- Pre-paid stickers: households must purchase official stickers corresponding to the volume of the waste container. Only containers displaying the official sticker are collected.
- Subscription systems: households subscribe to a given number of containers they will dispose of during a collection cycle. If customers are able to reduce waste production, they can modify the subscription to a lower number of containers and save money.
- Weight-based systems: the tariff is based on the weight of waste residents dispose of. The trucks collecting waste are equipped with scales that weigh the actual amount of waste each resident produced.
- Hybrid systems: a flat fee, ensuring a basic level of service, is combined with a fee per unit for each unit exceeding the basic level.

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Weight-based systems offer greater waste reduction incentive but, in general, are more expensive and complex to implement than volume-based systems (Canterbury, 1994).

In all cases, there is convergence among scholars that UBP creates a strong incentive to reduce household waste production.[46] However, situations in which this kind of pricing system encourages illegal disposal, burning or other forms of waste concealment cannot be excluded (Bel and Gradus (2014) offer a meta-analysis of numerous experiences). To prevent the risk of opportunistic behaviour and illegal disposal, UBP should be accompanied by appropriate monitoring and control as well as support policies for economically disadvantaged families, and information campaigns to raise awareness among the population on the effectiveness and fairness of the system.

# 7 WATER SUPPLY AND SANITATION

Water plays a critical role in the sustainability of the development of Mauritius. The country has per capita freshwater resources of approximately 1,028 cubic metres, compared to the average 5,705 cubic metres of sub-Saharan Africa. Groundwater is the main source, contributing 57 per cent of the potable water supply (Proag, 2006) and about 20 per cent of total freshwater abstractions (Statistics Mauritius, 2014a). Water resources are critical to sustaining the country's sugar, agriculture and refining industries but are increasingly subject to stress from economic activities, population growth and climate change.

Access to water services in Mauritius is almost universal, whereas 8.4 per cent of the population does not yet have access to improved sanitation services. The socio-economic costs imposed by non-universal access to good-quality water and sanitation services (estimated for Mauritius at US$6.56 million, or 0.1 per cent of GDP) are much lower than in other southern African countries (Table 27). However, serious concern for the future is raised by impending water scarcity. Water infrastructures are in need of significant investments. Network losses are estimated at 50 per cent, reflecting a very high level of inefficiency.[47]

Water tariffs in Mauritius are low. The average water charge per cubic metre is US$0.23 (against an average OECD price of US$1.09 per cubic metre; in South Africa, the average retail water tariff for a sample of cities was estimated in 2006 to be US$1.06 per cubic metre[48]). Infrastructure investments and maintenance costs, as well as water capture (dams and reservoirs), weigh on the general budget. Water abstraction is free for agriculture, which uses 68 per cent of available freshwater, despite contributing only 6 per cent to GDP. As a consequence of the current pricing strategy, the public utility responsible for water provision (the Central Water Authority) runs a substantial deficit.[49]

A straightforward calculation based on data from the 2012 HBS shows that the water affordability index (the share of average net disposable income spent on water and sanitation bills) for Mauritius is on average 0.8 per cent (1.04 per cent if total expenditure data are used in the estimate in place of net disposable income).[50] The average value for developed countries is approximately 1.1 per cent, whereas for developing countries it is approximately 2.5 per cent. An analysis of the incidence of water tariffs for different quintiles on total expenditure suggests that the incidence of water and wastewater bills increases up to 2.22 per cent for the lowest quintile within the population, whereas water and wastewater services only weigh 0.58 per cent on the total expenditure of the richest population quintile (Table 28). The current residential water tariff structure is illustrated in Table 29.

**TABLE 27. COMPARATIVE DIRECT AND INDIRECT COST OF LIMITED ACCESS TO GOOD-QUALITY WATER SUPPLY AND SANITATION IN SOUTHERN AFRICAN COUNTRIES**

| | Mauritius | | Zambia | | Malawi | | Namibia | |
|---|---|---|---|---|---|---|---|---|
| | Water | Sanitation | Water | Sanitation | Water | Sanitation | Water | Sanitation |
| Population without access to improved service | 8 000 | 109 290 | 4 959 000 | 6 186 430 | 3 528 000 | 6 239 480 | 241 000 | 1 393 030 |
| Estimated cost of limited access to good-quality water supply and sanitation per capita (US$) | 26.59 | 58.08 | 26.59 | 58.08 | 26.59 | 58.08 | 26.59 | 58.08 |
| Total losses (million US$) | 0.21 | 6.35 | 131.86 | 359.31 | 93.81 | 362.39 | 6.41 | 80.33 |
| Grand total losses (million US$) | 6.56 | | 491.17 | | 456.20 | | 86.73 | |
| % GDP | 0.10 | | 6.84 | | 16.64 | | 1.20 | |

Source: SADC, 2010, calculated from World Health Organization 2010 data.

**TABLE 28. INCIDENCE OF WATER AND WASTEWATER BILLS (WATER AFFORDABILITY INDEX) BY QUINTILE**

| Quintile | Monthly expenditure in water (MUR) | Total monthly expenditure (MUR) | Incidence (affordability index) (%) |
|---|---|---|---|
| Q1 | 153.99 | 6 913.24 | 2.22 |
| Q2 | 207.73 | 12 050.54 | 1.72 |
| Q3 | 238.03 | 16 842.36 | 1.41 |
| Q4 | 275.35 | 23 972.25 | 1.14 |
| Q5 | 310.89 | 53 384.95 | 0.58 |
| **Average** | **237.19** | **22 630.17** | **1.04** |

Source: Authors' elaboration based on the 2012 HBS (Statistics Mauritius, 2015).

**TABLE 29. CURRENT RESIDENTIAL WATER AND WASTEWATER TARIFF STRUCTURE**

| Water consumption | Fee (MUR/m³) | | | |
|---|---|---|---|---|
| < 10 m³ | MUR 45.00/month | | | |
| >10 m³ | **0-10 m³** | **11-20 m³** | **21-50 m³** | **Every additional m³** |
| | 6.00 | 8.00 | 17.00 | 32.00 |

Source: Central Water Authority official website: http://cwa.govmu.org/Pages/Services/Charges%20fees%20tariff/watertariff.aspx (accessed March 2015).

The status quo appears to offer ample room for reforming the residential water tariff scheme so as to mobilize resources to be invested in water infrastructure and to promote more efficient water use, while including design measures that guarantee water affordability for the poorest part of the population.

This section simulates a residential tariff reform proposal. The costs considered are the operational costs of water and wastewater provision, for Mauritius MUR 9.95 per cubic metre sold (US$0.275) (OECD, 2007). Full cost recovery would require collecting revenues sufficient to cover long-run marginal costs, which include investments, and are estimated for Africa at approximately US$1 (MUR 36.11) per cubic metre (OECD, 2007). This report, however, adopts a more realistic "sustainable cost recovery" approach (OECD, 2009), which involves covering the costs of service provision not solely on the basis of tariffs, but including a partial support of public budgets and, where available, official development assistance.

The price elasticity of water demand is assumed to decline with income levels. The elasticity values assigned to each quintile are anchored to the minimum (-0.26) and median value (-0.06) empirically estimated for Mauritius by Madhoo (2011).[51] The quantities consumed by tariff block are derived from the expenditure on water and wastewater bills reported in the 2012 HBS. The revenues (amount collectible) with the current tariff structure are from Statistics Mauritius (2014a).

The objective of the simulation is to identify a tariff structure that could: (1) increase revenues, to run the service on a financially sustainable basis and mobilize resources for investments in the infrastructure; (2) generate incentives to reduce water consumption; and (3) not increase incidence for the lowest quintile.

The trade-offs are evident: increasing the tariff reduces water consumption, but may also reduce total revenues if water demand declines (depending on the elasticity) enough to more than compensate the increase in per unit revenues. Increasing the share of recovered costs may conflict with keeping incidence low for the lowest quintile, even if the tariff for the first consumption block is kept low or zero: the average water consumption of households in the lowest income quintiles, according to the 2012 HBS, is about 21 cubic metres per month, thus is also fully affected by the second tariff block. The


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tariff structure presented here is constructed so as to balance these multiple objectives.

The proposal entails introducing a tariff structure differentiated by household income. The first six cubic metres are free of charge for the first expenditure quintile (which in Mauritius includes 44.4 per cent of the population), according to the principle of free basic water. They are sold at a slightly higher fee than in the current structure (MUR 8 rather than MUR 6 per cubic metre, i.e. US$0.22 rather than US$0.16) to all other population quintiles. The following blocks would be priced with a more steeply increasing tariff, designed with levels close to those implemented in the South African municipalities of Durban and Johannesburg, and detailed in Table 30.

A similar structure would result in a revenue increase of 12.38 per cent, attaining about 74 per cent of operational cost recovery. Residential water consumption would decrease by 18.58 per cent (Table 31). Incidence for the first quintile remains substantially stable (from 2.227 per cent to 2.224 per cent), whereas it increases for the median and top quintiles: for the second quintile, it increases from 1.72 to 2.76 per cent; for the third, from 1.41 to 2.74 per cent; for the fourth, from 1.14 to 2.48 per cent; and for the fifth, richest quintile, from 0.58 to 1.46 per cent. Overall, this results in a more equitable sharing of the costs of water and wastewater services, reflected in a substantially smoother incidence profile (Figure 12). The new average incidence of water charges (as before, calculated as a ratio of total expenditure rather than disposable income) would be 2.29 per cent.

Residential tariff design certainly affects the financial viability of water utilities and their investment capacity. It also contributes to shaping more efficient and environmentally-friendly water consumption habits. An overall national strategy for managing the water resources of Mauritius sustainably, however, would also have to consider revisions of the industrial tariff structure and, more importantly, tackle the sensitive issue of water use in the country's intensive monoculture sugar cane production. These are topics for ad hoc, specific studies that would have to investigate the percolation of the effects of reform through the whole economic system, for example by means of an input-output approach.

**TABLE 30. PROPOSED REFORMED RESIDENTIAL WATER TARIFF STRUCTURE** (MUR/M³)

| Quintile | 0-6 m³ | 7-10 m³ | 11-15 m³ | Every additional m³ |
|---|---|---|---|---|
| Q1 | 0 | 8 | 20 | 40 |
| Q2-Q5 | 8 | 8 | 20 | 40 |

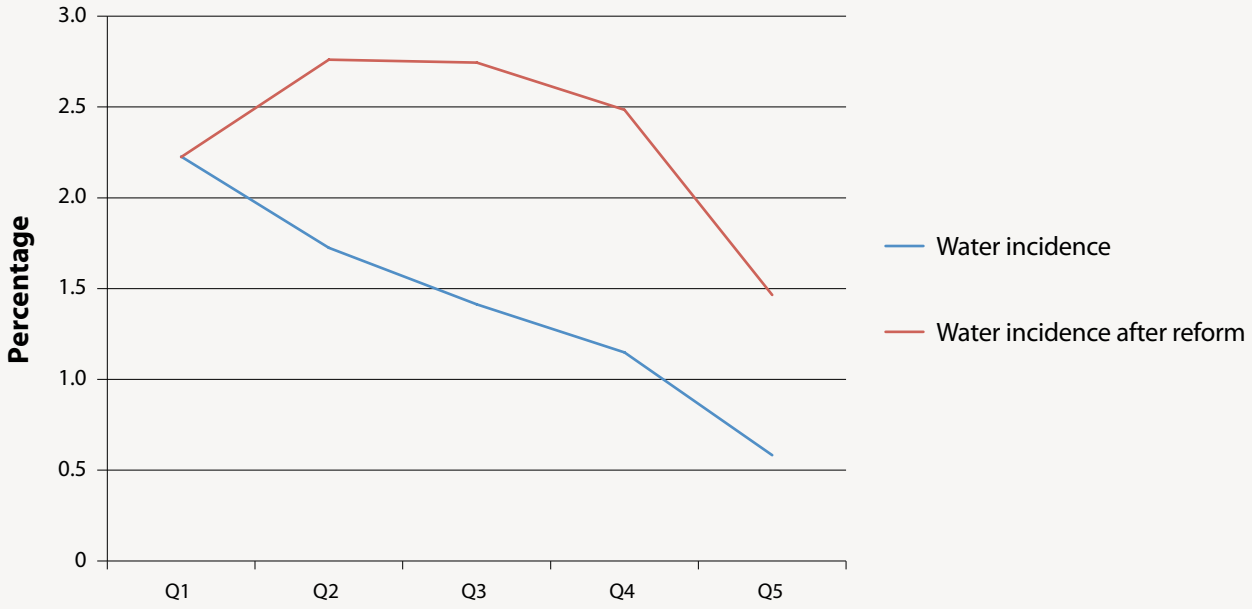
Source: Authors' elaboration.

**TABLE 31. IMPACT OF PROPOSED WATER TARIFF REFORM**

| | Current | After reform | % change |
|---|---|---|---|
| Water consumption (m³) | 88 272 824.42 | 71 867 741.55 | -18.58 |
| Revenues (MUR) | 689 711 226.00 | 783 070 294.20 | +13.54 |
| Recovered operational costs (%) | 65 | 74 | +9.00 |

Source: Authors' elaboration.

**FIGURE 12:** INCIDENCE OF WATER AND WASTEWATER EXPENDITURE BY QUINTILE WITH CURRENT AND PROPOSED TARIFF STRUCTURE (PERCENTAGE)




Source: Authors' elaboration.

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# 8 SUMMARY AND RECOMMENDATIONS

Mauritius has embraced the objective of a green economy development path. A number of fiscal instruments for environmental protection and incentives for green investment are already in place, and the Government and MID Commission have pioneered a number of environmental policy initiatives. The overall fiscal system is functioning well. There are virtually no subsidies to fossil fuels, with the exception of a subsidy to sustain the diffusion of LPG for household purposes (against which solar water heaters must compete, and which therefore should be reconsidered) and those targeted to support livelihoods on the small and remote Rodrigues Island. Instead, a light form of carbon taxation is already in place. Thanks also to this conducive local context, numerous studies by international organizations, research centres, consulting companies and academic departments have produced policy-oriented analyses in key areas of environmental concern.[52]

In this context, this study aims to identify the areas with potential for improvement through the rationalization of current measures and the mobilization of resources for innovation and investment. The underlying principle is that making effective use of fiscal instruments in the design and implementation of policies in the sectors of energy generation and use, transport, waste disposal, water supply and sanitation form the core of any green economy strategy. Reform proposals formulated in this report include:

1. **Turning the MID levy into a real carbon tax by levying it based on carbon emissions by fuel.** The proposed fiscal reform, to be introduced gradually through small predictable steps between 2016 and 2025, would result in a 2.09 per cent increase in the price of electricity in the first phase (2016-2018), 9.66 per cent in the second (2019-2024), and 25.69 per cent in the third (2025 onwards). Electricity consumption would decrease by 0.3 per cent in the first phase, 1.18 per cent in the second, and 3.14 per cent in the third. The total tax revenues would progressively increase from about MUR 97 million (equivalent to approximately US$2.68 million) per year from 2016 to 2018, to MUR 361 million (roughly US$9.99 million) per year from 2019 to 2024, and MUR 943 million (just over US$26 million) per year from 2025 onwards. This would mobilize substantial resources, particularly in the long run, which would be available to finance green economy investments.

2. **Re-modulating transport fuel excises to fully internalize negative global and local externalities of fossil fuel use**. The net effect on final transport fuel prices would be moderate, given the already considerable fiscal pressure on fossil fuels in Mauritius: -3.9 per cent for gasoline and +8.1 per cent for diesel. The short-term impact on consumption would be +1.02 per cent in the case of gasoline and -1.04 per cent in the case of diesel. This would rebalance the relative taxation of the two main transport fuels on environmental grounds. Considering the reaction of demand to the tax change, the final outcome would be a reduction in revenues of -7.3 per cent from gasoline and an increase of 21.8 per cent from diesel. The additional net revenues would be about MUR 282 million per year, which represent a non-trivial additional fiscal space. The proposed transport fuel tax reform does not significantly increase the burden on taxpayers. It is also substantially neutral from the distributive point of view, leaving the progressive pattern of expenditures for fuels unchanged. The internalization of environmental externalities in the price of fossil fuels would lead to a progressive reduction in environmental impacts, stimulate fuel switching and technological change.

3. **Directing revenues from the carbon tax to finance a renewed REFiT scheme**. With a feed-in tariff of MUR 13/kWh (US$0.36), the scheme would enable 0.99 MW per year of new installed capacity in 2016-2018, 1.69 MW in 2019-2024, and 3.23 MW from 2025 onwards. The share of total installed capacity satisfied by renewable sources would grow to 1.04 per cent in 2018, 2.78 per cent in 2025, and 4.89 per

cent in 2030. Fulfilling the objectives stated in the Long-Term Energy Strategy by 2025 would require large-scale direct public and/or private investments, in addition to incentive schemes geared to small-scale installations. When the proposed carbon tax enters its third phase in 2025, the resources mobilized for reinvestment in RES would increase substantially. The full-scale carbon tax, reinvested in the RES incentive scheme, would enable 6.28 GWh new PV generation each year.

4. **Considering the introduction of a partial tax deduction for investments in renewable technologies** (e.g. solar and PV panel installation costs), replacing the current VAT exemption to extend the incentive to firms; and considering a partial deduction for investment costs for solar water heaters.

5. **Introducing a tariff system for waste collection and disposal.** This aims to achieve cost recovery for service provision and is designed to mitigate the impact on less wealthy families. In the short term, a two-part fee (a fixed component linked to the number of residents in the dwelling plus a variable component correlated to dwellings' Municipal rates) achieves cost recovery and ensures progressivity. In the medium term, the fee should switch to unit-based pricing, i.e. a system based on actual volumes of waste disposed of by each household or commercial agent, according to the pay-as-you-throw principle. The distributive impact of introducing the two-part waste disposal fee able to achieve full cost recovery would not be prohibitive: for the average household the waste collection service would have an incidence on total yearly expenditure of 0.68 per cent. The maximum incidence, in 2020, on the poorest quintile would be 4.25 per cent. To complement waste tariffs, a deposit-refund system for the most valuable components (such as glass and metals) could be considered to encourage waste reduction, reuse and recycling.

6. **Redefining domestic water tariffs**. This would achieve sustainable cost recovery, reflect the true cost of water use, level the incidence of water charges across different income levels, and generate fiscal space for investments in the modernization of the water infrastructure network. Here the aim is not full cost recovery, but rather a partial recovery of operational costs. The objective of the simulation was to identify a tariff structure able to: (1) increase revenues, to run the service on a financially sustainable basis and mobilize resources for investments in the infrastructure; (2) generate incentives to reduce water consumption; and (3) not increase incidence for the lowest quintile. The proposed tariff structure would result in a revenue increase of 12.38 per cent, attaining about 74 per cent of operational cost recovery. Residential water consumption would decrease by 18.58 per cent. Incidence for the first quintile remains substantially stable (from 2.227 per cent to 2.224 per cent), whereas it increases for the median and top quintiles: for the second quintile, it increases from 1.72 to 2.76 per cent; for the third, from 1.41 to 2.74 per cent; for the fourth, from 1.14 to 2.48 per cent; and for the fifth, richest quintile, from 0.58 to 1.46 per cent. Overall, this results in a more equitable sharing of the costs of water and wastewater services, reflected in a substantially smoother incidence profile.

Among the issues not tackled in this report, priority should be given to the environmental impact of the agricultural sector. Regulation of water use for irrigation – a complex and delicate issue that would require an in-depth and participatory analysis – is of prime urgency. The introduction of a mineral fertilizer tax aimed at reducing the negative environmental impact by favouring substitution (also considering the large potential of sugar cane processing to provide natural fertilizers) could also be examined.

Areas to be explored further include reform in the design of RES incentives, which should: (1) project the renewable energy mix over the planning horizon, thus applying the proper REFiT to the share of energy produced by the different RES technologies over time; (2) consider the differentiation of tariffs by plant size in calculations; and (3) introduce a decreasing tariff structure over time, to account for progress in technology maturity.

# 9 ANNEXES

## ANNEX 1 ELECTRICITY TARIFFS

Different tariffs are charged on the basis of the type of customer. To promote a reduction in consumption and virtuous habits, an increasing-block scheme is in place for households (Table 32). The average price of the current increasing-block electricity tariff for domestic customers is MUR 5.94 /kWh.

Commercial and industrial sectors pay higher rates, which generate resources to subsidize other users, namely households and sugar factories (Table 33). The industrial sector is subject to on-peak and off-peak differentiated tariffs (Table 34).

**TABLE 32. CURRENT INCREASING-BLOCK ELECTRICITY TARIFFS FOR DOMESTIC CUSTOMERS** (MUR/KWH)

| | |
|---|---|
| Initial 25 kWh | 3.16 |
| Next 25 kWh | 4.38 |
| Next 25 kWh | 4.74 |
| Next 25 kWh | 5.45 |
| Next 100 kWh | 6.15 |
| Next 50 kWh | 7.02 |
| Next 50 kWh | 7.90 |
| All additional kWh | 8.77 |

Source: Central Electricity Board: http://ceb.intnet.mu [available under 'Tariffs'].

**TABLE 33. CURRENT INCREASING-BLOCK ELECTRICITY TARIFFS FOR COMMERCIAL CUSTOMERS**

| Tariff code | Charge/kWh (MUR) | Demand charge/kVA (MUR) | Minimum charge (MUR) |
|---|---|---|---|
| 15 | 10.01 | – | 196/month or part thereof per kW or fraction thereof of total connected load |
| 217 | 6.14 | 186/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 225 | 5.83 | 186/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 245 | 6.04 | – | 125/month or part thereof per kW or fraction thereof of total connected load |
| 250 | 3.50 | 160/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |

– Tariffs 15 and 245 are flat rate tariffs, for which there is no demand charge.
Source: Central Electricity Board: http://ceb.intnet.mu (accessed November 2014).

**TABLE 34.** CURRENT INCREASING-BLOCK ELECTRICITY TARIFFS FOR INDUSTRIAL CUSTOMERS

| Tariff code | Charge/kWh (MUR) | Demand charge/kVA (MUR) | Minimum charge (MUR) |
|---|---|---|---|
| 313 | 3.12 | 144/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 315 | 5.40 | – | 113/month or part thereof per kW or fraction thereof of total connected load |
| 317* | 2.86 1st 250 000 kWh<br>2.51 all additional kWh | 144/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 320* | 2.86 (day rate)<br>3.30 (peak rate)<br>2.26 (night rate) | 144/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 323 | 2.97 | 136/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 325* | 2.78 1st 250 000 kWh<br>2.44 all additional kWh | 136/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 330* | 2.78 (day rate)<br>3.30 (peak rate)<br>2.17 (night rate) | 136/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 340 | 4.04 (day rate)<br>3.19 (night rate) | 150/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |
| 350 | 3.83 (day rate)<br>3.08 (night rate) | 150/kVA of maximum demand, subject to a minimum of 20 kVA | A sum equal to the highest demand charge paid in the preceding six months |

– Tariff 315 is a flat rate tariff, for which there is no demand charge.
* Tariff no longer applicable to new customers.
Source: Central Electricity Board: http://ceb.intnet.mu (accessed November 2014).

# ANNEX 2 COST OF WASTE COLLECTION AND DISPOSAL

**TABLE 35.** ESTIMATED COST OF WASTE COLLECTION AND DISPOSAL BY COUNTRY INCOME LEVEL

| | Low-income countries | Lower-middle-income countries | Upper-middle-income countries | High-income countries |
|---|---|---|---|---|
| Income (gross national income, US$/capita) | <876 | 876-3 465 | 3 466-10 725 | >10 725 |
| Waste generation (tons/capita/year) | 0.22 | 0.29 | 0.42 | 0.78 |
| Collection efficiency (% collected) | 43 | 68 | 85 | 98 |
| **Cost of collection and disposal** (US$/ton) | | | | |
| Collection | 20-50 | 30-75 | 40-90 | 85-250 |
| Sanitary landfill | 10-30 | 15-40 | 25-65 | 40-100 |
| Open dumping | 2-8 | 3-10 | NA | NA |
| Composting | 5-30 | 10-40 | 20-75 | 35-90 |
| Waste-to-energy incineration | NA | 40-100 | 60-150 | 70-200 |
| Anaerobic digestion | NA | 20-80 | 50-100 | 65-150 |

NA = not applicable.
Source: World Bank, 2012: Annex E.

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# NOTES

1. The marked decline in primary energy requirement from renewable sources between 2010 and 2013 is due to the combined effect of an increase in energy supply from imported fuels (petroleum products and coal), which grew by 2.5 per cent, and a 1.4 per cent decrease in energy supply from locally available renewable sources (bagasse, hydroelectricity, landfill gas, fuelwood, wind power and photovoltaics) (Statistics Mauritius, 2014a).

2. The agricultural sector also raises serious environmental concerns; however a strategy for reform in this sector would require a separate, ad hoc analysis, which is beyond the scope of the current report.

3. World Bank, tax revenue (per cent of GDP); see http://data.worldbank.org/indicator/GC.TAX.TOTL.GD.ZS.

4. OECD Tax Policy Analysis; see http://www.oecd.org/ctp/tax-policy/table2totaltaxrevenueasofgdp1965-2012en.htm.

5. C-efficiency is the ratio of VAT revenue to aggregate consumption divided by the standard VAT rate (Ebrill, Keen, Bodin and Summers, 2001). C-efficiency is widely applied to provide an initial assessment of the effectiveness of VAT to raise revenues.

6. The Kakwani index measures the progressivity of tax systems. It is calculated as the difference between the index of distribution concentration according to the tax paid (or pseudo-Gini index), which varies between -1 and +1 depending on whether the tax weighs on the poorer or on the richer taxpayers, and the distribution concentration index according to gross income (i.e. calculated on the tax distribution after taxpayers have been ordered according to gross income), which varies between 0 and 1. A positive difference implies a progressive tax while a negative, or zero difference implies a regressive, or proportional tax. The larger the index, the more progressive the tax.

7. In line with the Regulation (EU) No 691/2011, Eurostat uses the following definition of environmental taxes: "A tax whose tax base is a physical unit (or a proxy of a physical unit) or something that has a proven, specific negative impact on the environment, and which is identified in the European System of National and Regional Accounts as a tax."(Eurostat, 2013: p. 9).

8. At the time this report was compiled (March 2015): US$1 = MUR 36.11.

9. Bagasse is the fibrous residue left after the extraction of juice from sugar cane or sorghum stalks.

10. According to the Ministry of Finance and Economic Development, National Budget; see the official website at http://mof.govmu.org/English/Pages/default.aspx (accessed February 2015).

11. The Build Mauritius Fund is a specific fund set up to help finance projects related to development schemes under the Build Mauritius Plan (at the end of 2013, MUR 4.3 billion (US$119 million) was allocated to the Build Mauritius Fund).

12. See also the discussion on financing renewable energy source incentives in section 4.

13. Exchange rate used by the State Trading Corporation.

14. At the time this report was compiled (March 2015): EUR 1 = MUR 38.60.

15. Even though most European countries levy taxes that are higher than the minimum (see excise duties: energy tax rates at http://ec.europa.eu/taxation_customs/taxation/excise_duties/energy_products/rates/index_en.htm, and the overview of EU countries' energy tax rates at http://ec.europa.eu/taxation_customs/business/excise-duties-alcohol-tobacco-energy/excise-duties-energy/excise-duties-energy-tax-rates_en).

16. Full cost recovery in public utility pricing, according to Foster and Yepes (2006), is feasible with negligible effects on affordability in countries in which households spend less than 5 per cent of their total income on them (as is the case in Mauritius). Affordability should be evaluated with care, however, in low-income countries. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/8421/wps3943.pdf?sequence=1.

17. South Africa plans to introduce a carbon tax of 120 South African Rands (US$11) on every metric ton of carbon emitted above a 60 per cent threshold from 2016, and raise the rate by 10 per cent a year for the following six years.

18. The social cost of carbon is the present value of the future stream of damages from one additional ton of carbon emissions emitted in a particular year (Newbold, Griffiths, Moore, Wolverton and Kopits, 2010).

19. Available at: www.eia.gov/environment/emissions/co2_vol_mass.cfm.

20. Available at: http://data.worldbank.org/indicator/PA.NUS.PRVT.PP.

21. "The social cost of carbon (SCC) is meant to be a comprehensive estimate of climate change damages and includes [but is not limited to] changes in net agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs". As also stressed in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, most likely it represents an underestimate of the damages: "The models used to develop SCC estimates, known as integrated assessment models, do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research." (US-EPA, official website, http://www.epa.gov/climatechange/EPAactivities/economics/scc.html).

22. Available at: http://data.worldbank.org/indicator/PA.NUS.PRVT.PP.

23. In addition, the emissions of local pollutants from thermal power plants in Mauritius have a relatively minor environmental impact because they are mainly located along the coast so most of the resulting pollution is blown offshore.

24. The timeline for the short (1-3 years), medium (5-10 years) and long term (10-20 years) is indicative and in line with that used in UNEP (2014), which in turn conformed to Ministry of Finance indications aimed at aligning with the country's policymaking and planning processes (annual budget, Blueprint 2020 and Special Planning Unit).

25. The rationale behind the three-step increases is that of building a gradual convergence path towards the implementation of the fully corrective carbon tax. The size and duration between subsequent steps are subject to considerations of political feasibility and can be re-modulated with some flexibility.

26. Some recent studies suggest that the demand for electricity in Mauritius, in particular in the long run, is inelastic (Khadaroo and Sultan, 2013). The assumption of the price elasticity of demand is therefore quite conservative in this report.

27. It is important not to confuse the environmental impact of a fossil fuel per km driven with that per litre. Last generation diesel and gasoline engines can be considered more or less equivalent: diesel engines produce less $CO_2$ per km driven, but more particulate; emissions of carbon monoxide, nitrogen oxides, hydrocarbons and other pollutants per km are more or less equivalent. Even though reported emissions per fuel type vary across sources, in terms of impact per km driven, on the whole diesel appears to contribute less than gasoline to global pollution, but more than gasoline to local pollution. However, diesel has a higher environmental impact per litre burned than gasoline, both in terms of $CO_2$ and of local pollutant. Since the tax rates are set per litre, the appropriate reference is the externality per litre of fuel use.

28. Estimated for countries in the income category of Mauritius by Dahl (2012).

29. "Long-term" refers to a timespan long enough to allow for technological change (specifically, the replacement of the current stock of vehicles with new stock with higher fuel efficiency, induced by the higher prices).

30. The indirect impact deriving from electricity being used as an input in the production of most other goods and services is assumed, again, to be twice the direct impact (Arze del Granado, Coady and Gillingham, 2010).

31. The Maurice Ile Durable (MID) strategy is the result of a project launched in February 2012 by the Government of Mauritius aimed at reviewing the institutional and legislative framework and formulating policy recommendations for sustainable development (see the Maurice Ile Durable Policy, Strategy and Action Plan, available at: http://mid.govmu.org/portal/sites/mid/file/full%20report%20midpolicy.pdf.

32. At the time of writing this report in March 2015.

33. The balanced distribution of PV production between household and commercial or industrial users is generally required for the grid to function correctly, to align production and consumption peaks.

34. The Power Service Subsidy appears to collect the contributions of several initiatives meant to encourage investment in and the use of renewable energy. It is implemented through the CEB, which provides loans to replace traditional lamps by more energy-saving lights or to finance investments in wind turbines, or provides solar panels directly; the Development Bank of Mauritius, which provides loans for the purchase of solar water heaters and facilitates the purchase of energy saving techniques/devices; and the Central Water Authority, which provides water storage facilities, such as water tanks (S. Sobhee, University of Mauritius, personal communication; official statistics on the revenues and uses of the Power Service Subsidy do not appear to be available).

35. A significant Clean Development Mechanism project, for example, has been carried out at the Mare Chicose landfill. The waste-to-gas project is estimated to reduce coal demand by 13,000 tons/year and increase the fraction of energy derived from renewable sources by 1 per cent (see Project 4359: Mare Chicose Landfill Gas Project at https://cdm.unfccc.int).

36. The system is described in detail in UNEP (2014).

37. A feebate is a taxation system that targets $CO_2$ emissions from vehicles by taxing high-emission vehicles (the "fee") and offers a rebate on low-emission vehicles (the "bate"). The system in Mauritius is based on the $CO_2$ emissions of vehicles and is calculated according to the following formula F = R x (C - T), where F is the amount of the levy or rebate, R is the rate of the $CO_2$ levy/rebate according to the level of C (the grams per km), and T is the threshold (or pivot point) in terms of $CO_2$/km emissions that determines whether F is a levy or a rebate. The threshold was initially fixed at 158 grams of $CO_2$ per km, which is the average $CO_2$ emission of new cars imported into Mauritius in 2010.

38. In the European Union, the energy used by cars is measured according to Regulation 101 of the United Nations Economic Commission for Europe (UNECE.) The regulation prescribes laboratory tests in a controlled environment to measure both energy consumed and emissions. Regulation 101 is widely used and recognized internationally (see the UNECE website for details: http://www.unece.org/trans/main/wp29/wp29regs101-120.html).

39. More specifically, European cars comply with UNECE Regulation 101, while Japanese cars do not, for example. This generates difficulties in guaranteeing inner consistency in the scheme's implementation. In the 2013 review of the scheme, rebates were differentiated for cases in which $CO_2$ emissions were not measured according to Regulation 101.

40. The transfer stations are La Brasserie, St Martin, Roche Bois, Poudre d'Or and La Laura.

41. A notable, well-documented case is Northern Ireland's carrier bag levy, introduced in 2013. A five-pence levy (equivalent to about MUR 2.6)

achieved a reduction of 71.8 per cent in the use of plastic bags in one year and generated net revenues of €4.17 million (more than MUR 230 million). Detailed annual statistics are available at: http://www.nidirect.gov.uk/carrier-bag-levy.

42. Municipal rates, commonly known also as local rates or general rates, are a tax levied by local governments, calculated as a percentage of the net annual value of the immovable property. The net annual value is the annual rate the property is expected to yield.

43. Statistics on waste management in Mauritius are poor and outdated. No figures on actual recycling rates appear to be available from Statistics Mauritius or official government documents. To calculate approximate recycling rates, 2012 data on treated waste from waste recycling plants in Mauritius were used (for plastics: Plaspak Group, Polypet Recyclers Ltd, Plastic Recycling Ltd; for paper: Dakri Paper & Products Ltd, AgriPak Ltd, Atics & Lagtex Co. Ltd; for metal: Runghen G. & Co., Samlo-Koyenco Co. Ltd, Scrap Supplies, Steal Scrap Co. Ltd, A. B. Soobratty & Co., the Pillay Group; and for glass: Glass Gallery) coupled with data from the Ministry of Local Government on quantities and the composition of solid waste landfilled (Table 21, 2007). The calculated rates are based on the assumption that no separated waste is exported for recycling.

44. See footnote 42.

45. The fee is designed for a five-year period, over which the distribution of households by quintile can be assumed to remain constant. In the longer term, the variable component must be adjusted, to guarantee full cost recovery, in order to account for changes in the distribution of income. Moreover, the tariff scheme should be revised periodically also to accommodate changes in waste disposal costs due to technological change, as would occur as a consequence of the construction of waste-to-energy plants.

46. Numerous country studies show that unit-based pricing is effective in reducing unsorted waste and in stimulating recycling. See, for example, Usui and Takeuchi (2014) on Japan; Dijkgraaf and Gradus (2004) on the Netherlands; and Reichenbach (2008) on several EU countries.

47. Detailed economic accounting for water resources in Mauritius can be found in the Economic Accounting of Water Use final report (SADC, 2010).

48. International Benchmarking Network for Water and Sanitation Utilities (IBNET): IBNET database search for South Africa country report.

49. An accurate portrait of water governance in Mauritius (tariff structure, Central Water Authority revenue breakdown, etc.) is provided in UNEP (2014).

50. To measure the affordability index for different expenditure quintiles, total expenditure instead of net disposable income was used.

51. Specifically, the values used for elasticity are -0.26 for Q1, -0.18 for Q2, -0.12 for Q3, -0.06 for Q4, and 0 for Q5.

52. The IMF elaborated a detailed proposal to reform fuel taxation (Parry, 2011); in 2007, an EC/UNDP/UNEP project supported the development of a 25-year comprehensive energy policy, including the Master Plan for Renewable Energy sources; the CEB and the Ministry of Public Utilities, in collaboration with a Danish consulting company (EA Energy Analyses), designed the current RES incentive system (Larsen at al., 2010); Cottrell, Fortier and Schlegelmilch (2015) looked into options for a transition from fossil fuel to renewable energy in a comparative study of subsidy reforms in African and Indian Ocean island states; the Southern African Development Community, in collaboration with the European Development Fund, developed economic accounting of water use in Mauritius (SADC, 2010); Madhoo (2004, 2007, 2011) analysed the water pricing policy of Mauritius; and FAO (2007) and CODWAP (Mohee, Rughoonundun and Peryagh, 2009) explored waste management opportunities. The UNDP Country Programme 2013-2016 lists, among others, the environmental and green economy initiatives planned in collaboration with international partners, available at: http://www.undp.org/content/dam/rba/docs/Programme%20Documents/Mauritius%20CPD%202013-2016%20%28en%29.pdf.

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