

**For Components 1 and 3 under the project  
Nationally Appropriate Mitigation Actions  
(NAMAs) for Low Carbon Island  
Development Strategy for the Republic of  
Mauritius  
(NAMA Project)**

**Baseline Analysis of Mitigation Actions**

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**A sectoral perspective**

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# Table of Contents

<b>TABLE OF CONTENTS.....</b>	<b>1</b>
<b>LIST OF ACRONYMS .....</b>	<b>3</b>
<b>1.0 INTRODUCTION.....</b>	<b>5</b>
<b>2.0 ENERGY .....</b>	<b>6</b>
2.1. ENERGY INDUSTRIES .....	6
2.1.1. <i>Electricity generation</i> .....	6
2.1.2. <i>Electricity DSM</i> .....	9
2.2. LAND TRANSPORT .....	21
<b>3.0 WASTE MANAGEMENT .....</b>	<b>32</b>
3.1. SOLID WASTE MANAGEMENT.....	32
3.2. WASTEWATER MANAGEMENT.....	34
<b>4.0 AGRICULTURE, FORESTRY AND OTHER LAND USE .....</b>	<b>37</b>
4.1. AGRICULTURE.....	37
4.1.1. <i>Non-sugar sector</i> .....	37
4.1.2. <i>Sugar sector</i> .....	39
4.2. FORESTRY AND OTHER LAND USE (FOLU).....	40
4.2.1. <i>Increased tree cover over the island</i> .....	40
<b>5.0 IPPU .....</b>	<b>41</b>
<b>ANNEX 1 – SUPPLEMENTARY INFORMATION ON MIGRATION ACTIONS IN LAND TRANSPORT.....</b>	<b>44</b>
<b>ANNEX 2 – TECHNOLOGICAL OPTIONS FOR MITIGATION IN RAC INDUSTRY. ....</b>	<b>47</b>
<b>ANNEX 3 – REVIEW OF IMPLEMENTATION OF FORESTRY ACTIVITIES IN THE STRATEGIC PLAN 2016 – 2020 .</b>	<b>53</b>

## Summary of Figures

Figure 1. Evolution of solid waste generation and management under the BAU scenario.....	32
Figure 2. Technological options for solid waste management: 2020 - 2030.....	33
Figure 3. Roadmap for the solid waste sector: 2020 - 2030.....	34
Figure 4. Projected emissions in the RAC sub-sector in Mauritius: 2010 - 2050.....	42
Figure 5. Mitigation potential in RAC industry to 2050.....	42
Figure 6. Proposed phase out plan for HCFCs to 2030.....	43

## Summary of Tables

Table 1. Historical share (GWh) of renewable energies in electricity generation in Mauritius, 1990 – 2019.....	7
Table 2. Renewable electricity generation in Mauritius (GWh), 2011 - 2019.....	7
Table 3. Optimum renewable energy mix in 2025.....	8
Table 4. Optimum renewable energy mix in 2030.....	8
Table 5. DSM measures proposed in the EEMO action plan 2017-2022.....	11
Table 6. Proposals from the NLTA and vetted by the MLTLR.....	23
Table 7. Projected number of registered vehicles to 2030.....	29
Table 8. Status of ongoing WMA projects.....	34
Table 9. Forthcoming projects (2020 – 2024).....	35
Table 10. Future WMA projects (2025 – 2035).....	36

## List of Acronyms

AAP	Africa Adaptation Programme
ASI	Avoid-Shift-Improve
CC	Climate Change
CCD	Climate Change Division
CCM	Climate Change Mitigation
CEB	Central Electricity Board
CTCN	Climate Technology Centre and Network
DSM	Demand Side Management
EEMO	Energy Efficiency Management Office
ERP	Electronic Road Pricing
FAREI	Food and Agricultural Research and Extension Institute
FOLU	Forestry and Other Land Use
FS	Forestry Services
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWh	GigaWatt hour
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HOV	High Occupancy Vehicle
IPPU	Industrial Processes and Product Use
IPNS	Integrated Plant Nutrition System
ktCO <sub>2</sub> e	Kilo tonne of carbon dioxide equivalent
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MARENA	Mauritius Renewable Energy Agency
MCIA	Mauritius Cane Industry Authority
MEL	Metro Express Limited
MEPU	Ministry of Energy and Public Utilities
MESWMCC	Ministry of Environment, Solid Waste Management and Climate Change
MLTLR	Ministry of Land Transport and Light Rail
MNICD	Ministry of National Infrastructure and Community Development
MSIRI	Mauritius Sugarcane Industry Research Institute
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
NLTA	National Land Transport Authority
PA	Paris Agreement
RAC	Refrigeration and Air Conditioning
SWMD	Solid Waste Management Division
TDM	Travel Demand Management
TNA	Technology Needs Assessment
TNC	Third National Communication
TMRSU	Traffic Management and Road Safety Unit
TWG	Technical Working Group
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

WMA	Wastewater Management Authority
WtE	Waste-to-Energy

## 1.0 INTRODUCTION

Component 1 of the NAMA project seeks to ‘strengthen national capacity to identify, prioritize and develop mitigation actions to meet NDC targets’. In order to achieve this, it has four outputs of which the second – i.e. Output 1.2 – is ‘to develop NDC Implementation Strategy and identify potential sources of funding’. Output 1.2 would entail two activities:

- ✓ Activity 1.2.1 - Review NDC, NDC action plan, and other relevant climate change and sectoral strategies and plans with focus on mitigation actions to develop a revised NDC action plans including specific instruments and emission scenario; and
- ✓ Activity 1.2.2 – Development of implementation strategy for identified mitigation actions to meet the NDC goals

This report relates to Activity 1.2.1 and presents the results of the baseline analysis of sectoral mitigation actions with a programmatic approach. It complements the results of the MRV Baseline Analysis<sup>1</sup> that also did a preliminary assessment of the existence of sectoral mitigation policies, strategies and action plans. The results show that sectoral mitigation policies, strategies and action plans were scattered. There is a general lack of strategic planning that focuses on climate change mitigation, and which would cover at least the 2030 time horizon. Some of the main observations are:

- Except for the supply side in the electricity and industrial processes and product use (IPPU) sectors, none of the other emissions sectors have official low-carbon strategies or strategic plans that can be used to develop mitigation scenarios. Mitigation scenarios based on technology evolution has been carried out to 2050 for refrigeration and air conditioning (RAC) sub-sector of IPPU;
- In the case of demand side management, there is an Energy Efficiency Masterplan that covers the period 2016-2030 and it is accompanied by an Action Plan with year-on-year total energy savings. The energy savings cannot be attributed to individual mitigation actions;
- In the case of solid waste management, data are available and technological options have been proposed for developing mitigation scenarios to 2030;
- There are interventions proposed in the Strategic Plan 2016-2020 for the Non-Sugar Sector<sup>2</sup> that could be carried forward and developed as mitigation actions, but more visibility is needed regarding the process of updating the strategy.

The lack of strategic planning is also addressed by the NAMA project through Output 1.1 ‘Strengthen institutional arrangements to coordinate development and implementation of NDC through development of process and procedures as well as clear institutional responsibilities’. This output is secured through the recently developed Climate Change Act 2020, formalizing the institutional arrangements for climate change, and for which process, procedure and guidelines and stakeholder engagement plan for the relevant institutions are also being developed through the NAMA project. This output is covered through separate reports.

The above preliminary findings are supplemented by a more detailed analysis of sectoral mitigation actions. The results reported here emanate from inputs received from either sectoral Technical Working Groups (TWGs) or from sectoral policies. They are presented by emission sector. Although the baseline analysis investigates mitigation actions of the recent past, these actions are not the main

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<sup>1</sup> PNK Deenapanray and FA Canu. 2021. MRV Baseline Analysis. Ministry of Environment, Solid Waste Management and Climate Change, Port Louis.

<sup>2</sup> Ministry of Agro-Industry and Food Security, 2016. *Strategic Plan 2016-2020 for the Non-Sugar Sector*. MAIFS, Port Louis.

focus of the baseline analysis. This is because historical mitigation actions are sunk and hence do not pass the test of additionality for increasing the mitigation ambition of Mauritius. Hence, past mitigation actions are discussed in as far as they provide a baseline for forward-looking, more ambitious mitigation contribution. The baseline analysis also seeks to analyze if the existing mitigation actions are aligned with actions proposed in the existing NDC.

## 2.0 ENERGY

This section covers the largest emitting sector in Mauritius, and it includes (i) the energy industries, and (ii) land transport. Together, these two sub-sectors represented 62% (or 3,581.89 ktCO<sub>2e</sub>) of total national greenhouse gas (GHG) emissions in 2019.<sup>3</sup>

### 2.1. Energy Industries

Mitigation actions in the energy industries have been further subdivided into (i) electricity supply and (ii) electricity demand side management (DSM).

#### 2.1.1. Electricity generation

In 2019, a total of 3,236.6 GWh of electricity was produced in Mauritius and Rodrigues, with the latter comprising only 44.1 GWh.<sup>4</sup> In Rodrigues, generation from wind and PV was 2.5 GWh (5.7%), with the remaining 41.6 GWh (94.3%) generated from the combustion of heavy fuel oil. The remaining discussion will center on Mauritius that remains by far the larger emitter of GHGs.

In Mauritius, there is a relatively higher share of renewable electricity generation. Of the 3,192.5 GWh generated in 2019, 250.2 GWh was generated from hydro (98.6 GWh), wind (12.9 GWh), photovoltaic (118.8 GWh) and landfill gas (19.9 GWh). A further 439.6 GWh of electricity was generated from the combustion of bagasse that is a renewable biomass. Hence, around 21.6% of total electricity generated in Mauritius was from renewable energy sources. Except for hydropower that is generated by the Central Electricity Board (CEB), the other forms of renewable electricity were generated by independent power producers (IPPs).

Since renewable electricity generation is of primary interest for low-carbon development, a historical perspective (1990 – 2019)<sup>5</sup> of the contributions and evolution of different renewable electricity sources are discussed. **Table 1** shows the evolution of different renewable energy sources in the electricity mix of Mauritius. Over the period 1990 – 2019, the generation of renewable electricity has increased in absolute terms by a factor of ~2.9. However, the percentage share of renewable energies has decreased revealing that thermal

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<sup>3</sup> Statistics Mauritius, 2020. Environment Statistics – 2019, Ministry of Finance and Economic Development, Mauritius.

<sup>4</sup> Statistics Mauritius, 2020, Energy and Water Statistics – 2019, Ministry of Finance and Economic Development, Mauritius.

<sup>5</sup> The data is drawn from the Historical Series 1990 – 2019 available at: [https://statsmauritius.govmu.org/Pages/Statistics/By\\_Subject/Energy\\_Water/Energy\\_Water.aspx](https://statsmauritius.govmu.org/Pages/Statistics/By_Subject/Energy_Water/Energy_Water.aspx) - accessed 14 May 2021. In particular, the data contained in Table 8 – Electricity generation by source of energy, 1990 – 2019 were used.

generation from fossil fuels sources has outstripped gains in renewable energy generation. Another pertinent observation is the gradual decrease in electricity generation from bagasse from its peak of 509.8 GWh in 2015. Electricity generated from bagasse and from wind/PV is qualitatively different since the former generates baseload and the latter is variable. This qualitative difference implies that gains in the latter form (variable) cannot directly substitute for losses in the former (baseload).

**Table 1.** Historical share (GWh) of renewable energies in electricity generation in Mauritius, 1990 – 2019.

Source	1990	1995	2000	2005	2010	2015	2019
Hydro	84.9	135.1	95.7	114.9	100.7	121.9	98.6
Bagasse	157.8	177.5	430.5	452.9	474.1	509.8	439.6
LFG	-	-	-	-	-	20.4	19.8
Wind/PV <sup>6</sup>	0.2	-	-	-	2.5	25.7	140.9
<i>Sub-total RE</i>	<i>242.9</i>	<i>312.6</i>	<i>526.2</i>	<i>567.8</i>	<i>577.3</i>	<i>677.8</i>	<i>698.9</i>
Total generated	775.6	1,153.6	1,757.9	2,242.1	2,656.6	2,956.0	3,192.5
<b>RE (%)</b>	<b>31.3</b>	<b>27.1</b>	<b>29.9</b>	<b>25.3</b>	<b>21.7</b>	<b>22.9</b>	<b>21.9</b>

Source: Historical Series 1990 – 2019, Statistics Mauritius

For a better understanding of potential trajectories for mitigation actions to 2030 and beyond, **Table 2** shows granular, year-on-year changes in different forms of renewable energy sources in electricity generation. Hydropower generation has reached its practicable potential at 61 MW operational capacity and generation varies according to changes in precipitation and availability of water resources. The recovery of landfill gas (LFG) for electricity generation started in 2011 with a 3.3 MW thermal generator, and the current system has reached its capacity as from 2000. A recent study has noted that the existing LFG capacity is not always fully utilized, and that there was potential for 67 GWh to be generated in 2019, and thereafter decreasing exponentially.<sup>7</sup> A wind farm of 9.3 MW installed capacity at Plaine des Roches became operational in 2016.<sup>8</sup> The largest gain has been from photovoltaic (PV) through a combination of rooftop systems (residential and commercial) and utility-scale applications. In 2018, there were 8.5 MW residential rooftop PV systems in operation, while commercial rooftop systems totaled 3.27 MW. Utility scale PV systems had an installed capacity of 62.7 MW.<sup>9</sup>

**Table 2.** Renewable electricity generation in Mauritius (GWh), 2011 - 2019.

Source	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hydro	100.7	56.5	74.1	94.8	90.8	121.9	99.5	89.8	124.5	98.6
Bagasse	474.1	486.5	470.5	472.8	456.2	509.8	497.0	463.2	437.1	439.6
LFG	-	3.1	17.8	20.0	21.3	20.4	18.7	16.9	22.6	19.8
Wind	-	-	-	-	-	-	14.5	11.9	12.6	12.9
PV	-	-	0.9	2.7	24.5	25.7	30.0	38.9	49.1	128.0
<b>Total</b>	<b>574.8</b>	<b>546.1</b>	<b>563.3</b>	<b>590.3</b>	<b>592.8</b>	<b>677.8</b>	<b>659.7</b>	<b>620.7</b>	<b>645.9</b>	<b>698.9</b>

<sup>6</sup> The Historical Series does not provide decomposed data for electricity generated from wind and solar PV.

<sup>7</sup> B. Purmessur and D. Surroop, 2019. Power generation using landfill gas generated from new cell at the existing landfill. *Journal of Environmental Chemical Engineering* 7; <https://doi.org/10.1016/j.jece.2019.103060>.

<sup>8</sup> <https://www.qair.energy/en/realisations/mauritius/plainedesroches/> - accessed 14 May 2021.

<sup>9</sup> Republic of Mauritius, 2019. *Renewable Energy Roadmap 2030 for the Electricity Sector*, Ministry of Energy and Public Utilities, Port Louis.



Source: *Digest of Energy and Water Statistics 2019, Statistics Mauritius*

The Ministry of Energy and Public Utilities (MEPU) has developed a Renewable Energy Roadmap 2030 for the Electricity Sector<sup>10</sup> with the support of the Central Electricity Board (CEB). The Roadmap proposes different levels of renewable energy targets as shown in **Table 3** and **Table 4** for 2025 and 2030, respectively.

**Table 3.** Optimum renewable energy mix in 2025.

Renewable energy source	Installed Capacity (MW)	Energy Generation (GWh)	% Share in Electricity Mix
(i) On-shore wind	38.8	66	1.9
(ii) Solar Energy - Residential	46.2	68	2.0
(iii) Solar Energy - Commercial	46.6	69.8	2.1
(iv) Solar Energy - Utility	139.4	202.9	6.1
(v) Biomass - Bagasse	164.2	464	13.9
(vi) Biomass – Cane trash		44	1.3
(vii) Landfill Gas	3.0	23	0.7
(viii) WtE, MSW Generation	20.0	140	4.2
(ix) Hydro	61	93	2.8
<b>Total</b>	<b>519.2</b>	<b>1170.7</b>	<b>35.0%</b>

Source: *Renewable Energy Roadmap 2030 for the Electricity Sector.*

**Table 4.** Optimum renewable energy mix in 2030.

Renewable energy source	Power (MW)	Energy Generation (GWh)	% Share in Electricity Mix
On-shore wind	50.6	86	2.3
Solar Energy - Residential	88.4	128.8	3.4
Solar Energy - Commercial	88.8	130.6	3.5
Solar Energy - Utility	180.3	256.7	6.8
Biomass - Bagasse	164.2	464	12.3
Biomass – Cane trash		68	1.8
Landfill Gas	3	23	0.6
Waste to Energy	20	140	3.7
Off-shore wind	22	90	2.4
Wave	20	30	0.8
Hydro	61	93	2.5
<b>Total</b>	<b>698.3</b>	<b>1510.0</b>	<b>40%</b>

Source: *Renewable Energy Roadmap 2030 for the Electricity Sector.*

The generation of renewable electricity in 2020, 2025 and 2030 would take place against a projected electricity demand of 3,097 GWh, 3,345 GWh and 3,775 GWh, respectively. The

<sup>10</sup> Republic of Mauritius, 2019. *Renewable Energy Roadmap 2030 for the Electricity Sector*, Ministry of Energy and Public Utilities, Port Louis; At the time of finalizing the MRV Baseline Analysis, the Renewable Energy Roadmap 2030 was being updated.

demand forecast provided in the RE Roadmap has to be qualified from several perspectives:<sup>11</sup>

- The baseline electricity demand does not take into account any energy efficiency gains arising from the implementation of the action plan of the Energy Efficiency Management Office (EEMO), which is discussed in the next section;<sup>12</sup>
- The baseline electricity demand does not take into account increased demand from the uptake of electric vehicles;<sup>13</sup>
- The waste-to-energy planned by 2025 is unlikely to materialize given Government's commitment to pursue solid waste management under the ambit of industrial ecology and the development of a circular economy; and
- The analysis was carried out before the COVID-19 pandemic, and, therefore, it does not take into account any contraction of the national economy in 2020 onwards.

The MEPU, MARENA and CEB are currently undertaking an exercise to update the RE Roadmap 2030 to account for some of the above shortcomings. However, the updated Roadmap will still maintain the 35% and 40% RE targets in 2025 and 2030, respectively. The MEPU has made it clear that Government was seriously looking at the use of liquefied natural gas (LNG) in power generation and that Phase 2 of a feasibility study was being carried out.<sup>14</sup>

### 2.1.2. Electricity DSM

There is an Energy Efficiency Masterplan<sup>15</sup> that covers the period 2016-2030 and it is accompanied by an Action Plan with year-on-year total energy savings. The economy-wide energy savings were used in the Third National Communication (TNC)<sup>16</sup> for developing mitigation scenarios in the power sector. If achieved, the efficiency measures would produce 734 ktCO<sub>2e</sub> of emissions reductions – a factor ~1.5 larger than all supply side emissions reductions combined. There is, however, few policy issues related to the DSM efficiency gains proposed in the Energy Efficiency Masterplan, namely: (i) the energy (and hence emissions) savings cannot be attributed to individual actions that would make it difficult to track and report on mitigation actions; and for a related reason (ii) the baseline electricity demand used in developing the RE Roadmap does not capture the DSM efficiency gain.

Faced with the above constraints, the Energy Efficiency Management Office (EEMO) has used the Masterplan to develop an action plan covering the period 2017-2022 as shown in

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<sup>11</sup> Based on discussions with the CEB during meeting organised under the aegis of MEPU on 15 February 2021.

<sup>12</sup> Natural or background sector-wide energy efficiency is taken into account in CEB's modeling.

<sup>13</sup> EVConsult and Ecosys Ltd, 2020. *A 10 Year Electric Vehicle Integration Roadmap for Mauritius*.

<sup>14</sup> As reported during the stakeholder dialogues held under the Climate Promise Initiative on 19 February 2021. It is expected that the electrification of road transport will also be reviewed in the updated document.

<sup>15</sup> Maxwell Stamp, 2016. *Energy Efficiency / Demand Side Management Master Plan and Action Plan 2016 – 2030*, Energy Efficiency Management Office, Port Louis, Mauritius.

<sup>16</sup> Republic of Mauritius. 2016. *Third National Communication*. Ministry of Environment, Sustainable Development, and Disaster and Beach Management, Port Louis.

**Table 5.** There are a few observations that can be made regarding the Action Plan 2017-2022:

1. The DSM measures proposed straddle several (sub)sectors, such as buildings and land transport, which are under the oversight or mandate of other institutions such as the Ministry of National Infrastructure and Community Development (MNICD), and the Ministry of Land Transport and Light Rail, MLTLR (and their respective technical arms), respectively. Hence, there is a need to reallocate the measures to other institutions / working groups as far as mitigation analyses are concerned;
2. Several of the proposed DSM measures will not directly result in GHG emission reductions and cannot be used for mitigation analyses;
3. For measures related to energy efficiency standards for electrical appliances / equipment, it is possible to develop mitigation scenarios. However, a preliminary step would be to identify the equipment / appliances, and to develop pathways for their uptake to 2030. At present, EEMO does not have a baseline for developing these technology diffusion pathways; and
4. The timeline for the purposes of the NAMA project is very short. Hence, there is a need to update the Action Plan to cover interventions to at least 2030.

**Table 5.** DSM measures proposed in the EEMO action plan 2017-2022.

Description	Action required	Time frame	Implementing agency	Barriers
Accelerate the development and implementation of EE projects through the establishment of an EE Financing Scheme to promote and enhance commercial financing for EE projects in SMEs and other companies. The EE Financing Scheme will provide partial credit guarantees for EE investments and subsidise interest of loans for EE investments and energy audits.	Development of the EE financing scheme	2018 - 2019 NOT COVERED	MEPU, EEMO	MOFEPD not cooperative for the creation of separate fund
	(i) Setting up of Managing Committee as the managing and decision making body of the Financing Scheme.			
	(ii) Setting up of Advisory Committee to provide assistance to the Managing Committee.			
Awareness raising and provision of tailored technical information on EE technologies, opportunities, costs, suppliers and energy audits by an EE Information Centre to energy users in order to empower them to make informed decisions about energy efficiency and thereby reduce their operational costs. The EE Information Centre shall serve all sectors. and shall also provide all necessary training/awareness raising sessions to: (i) energy users (ii) energy auditors (iii) energy managers (iv) the public.	(1) Setting up of the EE Information Centre as a unit of the EEMO.	2018 onwards	EEMO	Lack of human resources and logistics
	(2) Collect and manage appropriate data and information which would be of interest to energy users and installers			
	(3) Dissemination of the information through the most appropriate means			

Development of an Energy Information System that will operate as: (i) a central point for providing data to the models for decision support in energy policy and planning, (ii) a mechanism for the monitoring of the energy sector and the implementation of the strategies, policies and action plans through the provision of statistics and indicators, (iii) a central information point for providing energy information services to all interested parties nationally and internationally (national stakeholders, donors, investors, public etc.).	Appropriate surveys to secure necessary data  (i) for the Energy Observatory;  (ii) to run existing models	2017 onwards	EEMO  MEPU (Planning Cell)	No baseline has been defined. Modelling is not being carried out at the level of the Ministry.
1. Implementation of energy efficiency measures in building envelope (i) New buildings	(1) Development and enforcement of a standard for LED lamps	2018	MSB, MoIC&CP, EEMO	Standard already developed & enforcement yet to start
(ii) Retrofits	(2) To set more stringent limits for energy efficiency in the Building Code.	2017-2018	MPI,EEMO	Adoption of the Energy Efficiency Building Code is not high on the priority list of the Ministry of National Infrastructure and Community Development
	(3) Enforcement of Building Code through appropriate regulations under the Building Control Act	2017	MPI	
2. Financial incentives for retrofits (appliance and building envelope) for targeted groups	Development and implementation of financial incentives	2018	MPI & LT	
Establishment of energy performance contracting in energy service companies as a mechanism to increase private business activities and growth in the EE sector	(1) Development of regulatory framework for energy performance contracting.	2018 - 2019	EEMO	Policy makers are not convinced of the concept of Energy Performance Contracting

	(2) Design of contract templates to be used by ESCOs	2019 - 2020	EEMO	
	(3) Trainings/awareness raising of engineering companies, private sectors consumers, financial institutions and public sector on the concept of Energy Performance Contracting (EPC) and Energy Service Companies (ESCOs)	2019 - 2020	EEMO	
Building capacity of local installers (building envelope and systems) in the use of appropriate technologies for efficient use of energy in buildings. - MITD Project Econoler/Enerxis	(1) Development of a framework for the installation and maintenance of air conditioners	2017	EEMO MITD	Under Consultation phase for implementation
	(2) Development of appropriate training courses for air conditioner installers and for other installers (for example insulation, solar water heaters)	2018-2019	MITD	MITD has recruited Econoler/Enerxis to include green jobs courses in their programmes
	(3) Conduct training courses and certification of installers	2019-2020	MITD	MITD has a constraint with regard to the demand for green jobs courses.
Educate students about EE and cultivate a culture of conservation and sustainable development.	Design educational courses for secondary and primary schools.	2017 - 2018	EEMO Ministry of Education MIE	No pedagogical capacity at the EEMO. Curriculum development timelines have to be followed.
Enhancing the technical capacity of the EEMO through cooperation with foreign established institutions in the field of energy efficiency	Drafting and signing Memorandum of Understanding (MOU)	2017 - 2019	MEPU / EEMO	None of the MOUs proposed have materialised

1. Mandatory affixing of energy labels in showrooms for household electrical appliances which are put on display for sale  (I) refrigerators, electric ovens and dish washers	Regulations made under the Energy Efficiency Act 2011.	As from 2017  (i) enforcement as from July 2017	EEMO / MSB	Regulations made in January 2017 for energy labelling of refrigerators, electric ovens and dishwashers. Regulations to be enforced as from July 2017.  Testing facilities being set up at MSB for refrigerators and electric ovens.
(ii) air conditioners and washing machines	Schedule in Regulations made under the Energy Efficiency Act 2011 to be amended in 2018	(ii) enforcement as from January 2022	EEMO / MSB	No testing facilities for air conditioners and washing machines.
(iii) lamps and tumble dryers	Schedule in Regulations made under the Energy Efficiency Act 2011 to be amended in 2020	(iii) enforcement as from January 2024	EEMO / MSB	Labelling of tumble dryers projected for 2022. Labelling of lamps put in abeyance.
Implementation of Minimum Energy Performance Standards (MEPS) as a measure to prevent entry into the country of energy inefficient appliances	Regulations to be made under the Energy Efficiency Act 2011	2023 onwards	EEMO	Energy inefficient appliances are, since 2013, subjected to an additional levy of 25% at Customs. Testing facilities are not available and the mechanism for enforcement not defined.
Implementation of a programme to incentivise the residential sector to install solar water heaters and replace electrical or LPG fired ones	(1) Development of standard for energy efficient solar water heaters	2017 - 2018	MARENA, MSB	MARENA has prepared Regulations on Standards for Renewable Energy Technologies. Initially, PV and wind turbines have been included in the first phase. Standards for solar water heaters have not yet been included.

	(2) Continuation of the existing solar water heater scheme by providing subsidy to the initial cost of solar water heaters for the residential sector	2018 - 2019	MOESD	Four SWH schemes already implemented.
	(3) Development and implementation of financial incentives / framework to promote shift to solar water heaters.	2019 - 2020		
	(4) Mandatory provision of solar water heater in all new houses	2021	MPI through the Building Code	Provision already made in Building Code for SWH in buildings > 500 sqm. - Energy Efficiency Building Code has not been adopted.
Reduce the energy consumption of the large companies mainly in the industrial sector and, at a second phase, in the services sector by engaging in long-term voluntary agreements.	(1) Study to identify the energy technologies, the energy consumption and the potential and EE opportunities in targeted facilities.	2017 - 2018	EEMO	Amendments have been made in the regulations to cover the private sector as from 01 January 2021. The implementation will depend on the execution of the GEF-6 project.
	(2) Develop a prototype of voluntary agreements to be used in: (i) Industries and (ii) Service sector.	2018 - 2019	EEMO	
	(3) Setting up of management structure for the voluntary agreement program.	2018 - 2019	MEPU	
	(4) Implementation of the voluntary agreement program.	2019 - 2020	MEPU	



Reducing demands during peak hours through: 1. Self-generation of electricity in hotels and service sector buildings	Carry out a study to assess the technicalities and feasibility (including financial) of hotels and service sector buildings to use standby generator to lower consumption during system peak hours.	2017 - 2018	CEB	Request for funds to carry out the study was not considered.
	Formulate and implement financial incentives for the use of standby generator in Hotels and service businesses to lower consumption during system peak hours.	2018 - 2019		This will depend on the findings of the study.
2. The use of Building Energy Management Systems (BEMS) in hotels and service sector buildings	Carry out a study to assess the technicalities and feasibility (including financial) of hotels and service sector buildings to use BEMS to lower consumption during system peak hours.	2019 -2020	EEMO	Request for funds to carry out the study was not considered. Also no standard set for the implementation of BEMS
	Formulate and implement financial incentives for the use of BEMS in Hotels and service businesses to lower consumption during system peak hours.	2020-2021	EEMO	This will depend on the findings of the study.
Introduce energy managers in all public buildings; train existing technical staff as energy managers on monitoring and managing energy in buildings and developing energy management plans	(1) Identifying the number of energy managers based on operational needs, existing staffing, the surface area and use of the public buildings	2018-2019	EEMO	Provision of funds and policy makers have to be convinced. Lack of baseline to quantify savings associated with this measure.
	(2) Training of EEMO as trainer in energy management	2018-2019		

	(3) Training of energy managers	2019-2020	EEMO	
Implementation of a programme to eliminate energy-inefficient lamps, reconfigure lighting patterns as appropriate, and address issues such as under and over-lighting in street and public area lighting	(1) Development of a standard and a design guideline for street and public area lighting	2017	EEMO	Completed
	(2) Implementation of a programme to eliminate energy-inefficient lamps in street and public area lighting	2018 - 2022	EEMO CEB Ministry of Local Authority Beach Authority	Included in Government Programme 2020-2024 to promote use of LED technology
Efficient energy use for water pumping at the CWA, WMA and IA	(1) Study on the efficiency of water pumping system at the CWA, WMA and IA.	2017-2018	EEMO	Mandatory energy audits being carried out at 12 CWA pumping sites.
	(2) Implementation of a programme to replace energy inefficient water pumps at the CWA, WMA and IA.	2019 - 2023	CWA WMA IA	
Improving the Energy Use Intensity (EUI) of primary, secondary and tertiary educational institutions	(1) Energy audits in all educational institutions	2017 onwards	EEMO	Scope for energy savings in educational institutions is limited.
	(2) Implementation of recommendations of energy audits	2018 onwards	Min of Edu MPI Tertiary Institutions	
	(3) Awareness raising on the judicious use of energy	2017 onwards	EEMO	Talks and competitions ongoing

Improving the Energy Use Intensity (EUI) of public sector buildings	(1) Enforcement of regulations for mandatory energy audits in public buildings	2017 onwards	EEMO	Started in 2017 and as from 2019 mandatory energy audits have started in parastatal bodies and local authorities.
	(2) Energy audits in public and local authority buildings	2017 onwards	EEMO (energy consumption < 15 TOE) Public Institutions (energy ≥ 15 TOE)	Started in 2017 and still ongoing
	(3) Implementation of recommendations of energy audits	2018 onwards	Public bodies	Lack of funds and time lag for implementation of projects
	(4) Awareness raising on the judicious use of energy	2017 onwards	EEMO	Need to develop awareness raising materials
1. Provision of financial and tax incentives to  (i) facilitate the purchase of electric vehicles and construction of vehicle recharging points	(1) Development of a financing scheme for electric vehicles	2018 - 2019	MPI & LT	Roadmap for electric vehicles have been developed by MEPU.
	(2) Development of a standard for recharging points	2018 - 2019	MSB	
	(3) Setting up of public charging points	2019 onwards	MPI & LT	
	(4) Development of a tariff and EV charging framework to minimise impact on CEB grid	2018 - 2019	MEPU EEMO CEB URA	
(ii) replace old energy-intensive vehicles with new, state-of-the-art ones and to promote energy efficient vehicles	(1) Study to determine the growth of the number of vehicles until 2030 and the foreseen penetration of electric and hybrid (including plug-in hybrid) vehicles	2017	MPI & LT NTA	Addressed in the roadmap for electric vehicles

	(2) Study to determine the cost effectiveness and the impact on CO2 emissions of subsidising the replacement of inefficient vehicles by more efficient ones	2017	MPI & LT NTA	Study done under GFEI
	(3) Development and implementation of a financing scheme for replacement of existing vehicles by electric and hybrid ones	2018	MPI&LT NTA	Carbon rebate incentives could not be implemented
2. Energy Efficiency Labelling of vehicles	(1) Develop/ Adopt standard for energy efficiency labelling of vehicles.	2018	MSB	Pending
	(2) Enforce energy efficiency labelling of vehicles	2019	MOESD	
3 Energy Efficiency labelling of tyres	(1) Develop/ Adopt standard for energy efficiency labelling of tyres.	2018	MSB	Pending
	(2) Enforce energy efficiency labelling of tyres	2019	MOESD	
	Setting of energy efficiency thresholds for common appliances, equipment and vehicles procured in the public service	2017-2018	EEMO PPO	Pending
Ensuring only energy efficient buildings are rented in the public service	Setting out of energy efficiency parameters to be met by buildings to be rented to public bodies	2017-2018	EEMO PPO	Pending

Use of mobile applications as a means to promote energy saving and energy efficiency	Development of mobile applications (i) for reporting of faults that lead to wastage of energy	2017-2018	EEMO CIB	Initially planned under CIB cluster Government Apps project, but not implemented due government-endorsed CSU programme.
	(ii) for making full use of data obtained from smart meters	2017-2018	EEMO CEB CIB	To be implemented under the CEB smart grid project
	(iii) to provide information on energy efficiency of appliances	2018-2019	EEMO CIB	Implemented under National Open Data Portal

*Source: Energy Efficiency Management Office.*

## 2.2. Land Transport

The land transport sector contributes significantly to the emission of global greenhouse gases (GHGs) resulting in a rise in global temperature and climate change. A troubling aspect of emissions from the land transport sector is that they are increasing rapidly. In Mauritius, with the ongoing increase in population, rising incomes, and availability of cheaper vehicles, the level of GHGs concentration in the atmosphere will continue to increase in the coming decades unless strict measures are put in place to contain the transport demand. There is currently no policy, strategy and action plan for land transport that can be used to develop low-carbon scenarios.<sup>17</sup> The technical working group (TWG) members have provided inputs related to the development of mitigation scenarios and these are summarized in the tables below depending on emanating institutions.

**Table 6** lists the suggestions made by the National Land Transport Authority (NTLA), as well as comments made by the Consultant (NAMA Project) and the views of the Ministry of Land Transport and Light Rail (MLTLR). Two actions (Park-and-Ride and Light Rail extension) are implemented by the Metro Express Ltd (MEL) and are discussed separately. Regarding the electrification of land transport (mainly cars), the MEPU has conducted a feasibility study to 2030 as discussed earlier. Further, the NTLA has projected the increase of registered vehicles to 2030. These projections are shown in **Table 7**. There is a misleading assumption on the part of the NTLA that these data can be used directly to develop mitigation scenarios. This situation is not dissimilar to the expectations of the EEMO regarding the Action Plan 2017-2022 shown in **Table 5**. There is now a need to disaggregate the total number of projected registered vehicles by types of vehicles (e.g. private cars, dual purpose vehicles, buses, lorries, two-wheelers etc ...) and by type of fuel used (e.g. diesel, gasoline, hybrid, electric, LPG etc ...).

The land transport sector has made two further sets of propositions for identifying mitigation actions through MEL and the Traffic Management and Road Safety Unit (TMRSU). The proposed list of mitigation measures proposed by MEL is:

- Power Generation from Renewable Energy (Solar, Wind)
- Acquisition of Electric Vehicles with Regenerative Braking
- Modal Shift to Public Transport
- Fiscal Instruments to Reduce Vehicular Growth and to Promote Acquisition of Environmental-Friendly Vehicles
- Travel Demand Management
- Road Maintenance
- Congestion Mitigation and Traffic Flow Smoothing Techniques
- Hydrogen Fuel Cell Vehicles

More details about proposed actions in land transport are given in Annex 1.

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<sup>17</sup> PNK Deenapanray and FA Canu. 2021. *MRV Baseline Analysis*. Ministry of Environment, Solid Waste Management and Climate Change, Port Louis.

The general approach in addressing the GHG emissions from the land transport sector is formulated based on the basic understanding on the factors that influence the emissions of GHGs from the land transport itself. The most appropriate approach to address the GHG emissions from land transport would be to utilize the Avoid-Shift-Improve (ASI) approach which is universally accepted as the approach to achieve a more sustainable transport system. Based on the ASI approach the report on Baseline Analysis for Mitigation Actions in the Land Transport sector has identified three focus areas in which strategies and action plans can be developed to address the GHG emissions. The Avoid strategy relates to the efficiency of the land use-transport system and means that the trip may not necessarily be made and can be avoided without jeopardizing the fulfilment of the purpose of the trip. In this case, a motorized trip can be avoided. As for the Shift strategy which relates to trip/travel efficiency implies that a person will choose a less carbon-intensive mode of transport such as bus, light rail and cycling instead of the regular private car. Finally, the Improve strategy refers to the improvements that can be made on the vehicle technology and fuel efficiency as well as improvement to the traffic control for more optimal traffic flow which will result in better energy savings and higher emission reduction. The TMRSU will ultimately be called upon to align its actions, as an enabler and supporter, with the ASI approach.

The strategic orientation favours reducing amount of travel, the impact of travel and the need to travel by car by a series of methods including mode shift to walk, cycle, and use of public transport and flexitime approach. This is an important focus area in terms of GHG emissions reduction not only in terms of carbon reduction per capita for the mode but also the multiple effects on possible congestion reduction as well. Finally, given the continuously increasing trend of the vehicle fleet, mitigation measures are needed for the country to fulfil its commitment to reduce GHG emissions. For this, political will and support (technical and financial) will be needed to ensure successful implementation of these proposals.

**Table 6.** Proposals from the NLTA and vetted by the MLTLR.

Components	NLTA's Proposal	NLTA Remarks	NAMA Project Remarks	Ministry's Remarks
<p><b>Land Transport Mitigation Policies and Strategies</b></p>	<p>Provide better incentives for the purchase of environmentally friendly vehicles e.g hybrid cars.</p>	<p>- Road Traffic Act (Regulation on incentives for non-conventional vehicles - Road Traffic (Construction and Use of Vehicles) Amendment 2 - Regulations 2018 GN198/2002) and Budgetary measures                      '- use same instruments and make more attractive -                      Hybrid Cars &amp; electric vehicles already benefitting of concessionary rates as regards Excise Duty. In fact electric cars up to 189kw benefit from 0% Excise Duty. Besides, hybrid vehicles/electric vehicles are entitled to 50 % rebate on Registration Duty as compared with conventional Diesel/petrol propelled vehicles. As for Motor Vehicle Licence, the rate is 50% lower than the corresponding amount of conventional Diesel/Petrol propelled vehicles.</p>	<p>- This can be used to develop scenarios for the penetration of hybrid and electric vehicles, but need to know what is the funding levels and timeframe                      '- It would be good to assess the effectiveness of existing incentives on penetration of hybrid/electric vehicles (data/number of vehicles)</p>	<p>Agreeable.                      1. Consultant may submit recommendations as to the effectiveness of the prevailing fiscal regime and as to whether same need to be reviewed to incentivise switch to greener vehicles including any development of any potential schemes for charging infrastructure.                      2. In that regard, Consultant may wish to liaise with the Ministry of Finance.                      3. NLTA may share statistics as regards disaggregated data on electric/hybrid vehicles registered on a yearly basis.                      4. Legal framework could be reviewed to provide, for example, that Public Service Vehicles to be propelled by cleaner energies by a set date.                      5. In addition, a study has been carried out by the Ministry of Energy and Public Utilities on electric vehicles.</p>



	<p>Fitness tests, including emission tests, should be done more frequently, preferably after 3 or 5 years rather than after 7 years.</p>	<p>- find research papers correlating performance standards uptake with GHG ER - No research has been carried and to validate correlation between fitness tests and emissions.</p>	<p>- will this have an impact on reducing emissions? If yes, how do we quantify this? -Cannot confirm as no empirical evidence available</p>	<p>Not Agreed.</p> <p>1. It is not being envisaged, at this stage to review the frequency of vehicle examinations.</p> <p>2. Consultant may wish to consult Acting CVE, NLTA or the Director of the Mechanical Engineering Division of the Ministry of National Infrastructure to assess whether there are merits to review the frequency of fitness examination with a view to reducing emissions.</p> <p>However, the NLTA and Police de L'Environnement, as enforcement agencies shall see to it that vehicles with emissions above prescribed levels are taken to task.</p>
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	<p>Regulations for labelling of motor cars should be developed to provide information on the fuel consumption and CO2 emission of cars and not only on the make of the vehicle.</p>	<p>- find research papers correlating performance standards uptake with GHG ER</p>	<p>- since vehicles are imported, is there already a labelling/performance standard that we can already use? Same as for electrical appliances that are typically already labelled by the manufacturer</p>	<ol style="list-style-type: none"> <li>1. The proposal can be considered. However, in view of the different models and makes of motor vehicles imported in Mauritius, the development of a labelling system and the mechanism thereof could take time and would be a long term project.</li> <li>2. The Consultant may wish to liaise with the Ministry of Commerce, Ministry of Energy and Public Utilities and the MSB in that regard.</li> <li>3. The Consultant may also advise if the labelling system needs to be linked to a negative taxation to correlate excise duty with the fuel consumption/emission of vehicles.</li> </ol>
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	<p>Introduction of the Park and Ride Service accompanied with safe parking facilities at strategic points; comfortable buses with appropriate fares and timely departure.</p>	<p>- Check if connected and included in modal shift for Light Rail  -A study could be carried out by TMRSU</p>	<p>- We can also model this but need to know many parameters: (1) number of cars that will participate; (2) number of passengers per car; (3) frequency of use; (4) details of alternative transport  '- we can use these parameters to estimate passenger-km of vehicles avoided and translate into equivalent of alternative modal shift transportation  -Already being looked into by MEL in the context of the operations of the light rail</p>	<p>Agreed. Consultant may liaise with MEL in relation to the Park and Ride concept and for obtaining statistics.  2. As regards first and last mile connectivity to the light rail stations, Ministry, NLTA and MEL is working on same.  3. NLTA may brief Consultant on the feeder bus concept including routes on which these buses were operating along with the applicable fares.</p>
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<p><b>Mitigation projects that can be modeled</b></p>	<p>Bus modernisation Programme - Under this programme, bus operators are granted a subsidy of MUR 1 Million (USD 28,600) per bus on acquisition of a semi-low floor bus to be used for public transport.</p>	<p>Govt Policy decision - age to replace bus 16 years to 21 years. By June 2025, 182 buses need replacement by SLF under bus modernisation scheme. If 18 years is considered for bus replacement - 577 needs to be replaced. Total number of buses _ RSL Public Buses - 1962</p>	<p>- can have energy savings if semi-low floor buses have better fuel efficiency than baseline technology. If this is the case, then we can develop a scenario if we know the fleet replacement rate. '- I have heard (unqualified sources) that the semi-low floor buses are more energy intensive than baseline technologies. Is it possible to draw a fleet replacement scenario beyond 2025 to include a combination of low-floor buses / electric buses up to 2030 and beyond?</p>	<p>1. Agreed. The BMS may be reviewed periodically to capture new types of buses and to promote buses running with clean energy. However, the decision to renew fleet rests with the bus operator including engine specifications of the buses. 2. NLTA may share as to the bus replacement scenario beyond 2025. 3. Consultant may recommend on guiding principles regarding procurement of semi low floor buses with lower energy consumption and with enhanced performance. -RTC to share details</p>
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Electric buses	2 existing electric buses are being operated- A grant from friendly country being looked into. UNDP is considering the grant of 1 electric bus and charging system on a pilot basis.	<p>- Great. We can run this scenario. Can we have the data from RHT in terms of kWh used for 1 passenger-km?</p> <p>'- Regarding NTC, can we know on average the types of buses that will be replaced and on which routes so that we can estimate passenger-km avoided using diesel?</p> <p>'- How will the buses be charged? Grid electricity or renewable energies.</p> <p>'- GEF PIF Electric buses + initial version of GCF project with transport component</p>	<p>1. Agreed. However, the feasibility and autonomy of electric buses should be assessed as well as the grid capacity. The running of electric buses should also take into account storage capacity of batteries as well as charging requirements in addition to defining the energy mix ratio of fossil fuels to renewable clean sources of energy.</p> <p>2. Consultant may liaise with RHT and NTC as regards requested data.</p>
Light Rail	2nd phase of Metro Express Curepipe to Rose Hill on going	<p>- we had modelled this in the TNC. Is it possible to have data in terms of what modal shift will the light rail entail (e.g. shift from private cars to light rail or a combination of bus ridership and private cars to light rail)?</p> <p>'- check if modal shift already includes Park-and-Ride feature</p>	<p>Agreed. The push for mass transport system should be encouraged specifically at peak hours.</p> <p>Consultant may liaise with MEL for additional information while NLTA may share on the disaggregated on ridership on the corridor.</p>

Source: National Land Transport Authority.

**Table 7.** Projected number of registered vehicles to 2030.

Year	Annual % increase	Vehicles registered	
2010	-	384,115	Registered vehicles
2011	4.4	400,919	
2012	5.2	421,926	
2013	5.1	443,495	
2014	4.9	465,052	
2015	4.5	486,144	
2016	4.4	507,676	
2017	4.8	531,797	
2018	4.6	556,001	
2019	4.4	580,629	
2020	3.3	600,053	
2021	3.2	619,477	
2022	3.1	638,901	
2023	3.0	658,325	
2024	3.0	677,749	
2025	2.9	697,173	
2026	2.8	716,597	
2027	2.7	736,021	
2028	2.6	755,445	
2029	2.6	774,869	
2030	2.5	794,293	

Source: NLTA.

The proposed list of mitigation measures proposed by TMRSU is:

The Government Programme 2020-2024 includes:

- At section 49. Provide for a National Cycling Policy Framework will be developed to encourage cycling for leisure and recreation as well as for transport and tourism. Dedicated cycle lanes will be included as a component of road infrastructure development plans.
- At section 134. The existing road signalling systems in our major cities will be reviewed to increase traffic fluidity.

The following demand and supply management measures with a view to reduce traffic congestion and simultaneously improve air quality as it is a known fact that the transport sector is a fast-growing sector in terms of GHG emissions in Mauritius:

- 1. Active Transportation:** “Build it and they will come” is as true of cycle paths as of roads, as long as they provide a continuous connection between places that people want

to travel between, without dangerous intersections or road crossings. Promotion of active transport modes for commuters accessing LRT stations as well as those making short trips would reduce the use of private cars, hence reduce GHG emissions.

The TMRSU is favourable to providing cycling infrastructure around the island that will encourage micromobility. Such infrastructure would satisfy the various cycling needs (commuting, recreational, or home-school). But, there are some design principles that would have to be considered and these include:

- Safety (actual and perceived crash risks)
- Coherence (easy to navigate and of consistent quality)
- Directness (minimize detours and detours)
- Comfort (smooth, well maintained, gentle gradients)
- Attractiveness (lighting, personal security)

The Ministry of Land Transport and Light Rail, through the TMRSU, has recruited a consultant in July 2019 to:

1. develop a comprehensive strategy for developing bicycle infrastructure in Mauritius with consideration for future land use planning, road development and the LRV project;
2. develop bicycle standards and a blueprint for planning design and development;
3. review and suggest changes to current laws, regulations and policies; and
4. submit detailed cycling network plan for four specific town/villages of the Republic of Mauritius, namely Flacq, Rose Hill, Grand Bay and Vacoas.

The consultant will complete the assignment by July 2021. Their findings and deliverables will provide clarity to TMRSU and other stakeholders in the planning and designing of cycle networks island wide. There are plans to implement, in the first instance, the proposed cycling network for Rose Hill. The costs for the relative infrastructural works have been estimated to be around Rs 50M.

2. **Intelligent Transport System [ITS]:** The use of ITS would be appropriate in towns and major villages to assist in improving the traffic flow and achieve a more appropriate traffic speed and reduce GHG emissions. For example, the use of adaptive traffic control systems can be very effective in maximising road capacity by varying the timing of traffic lights to match demand in real time.

There are a number of different adaptive traffic control systems in operation around the world. Each of the systems endeavors to minimize delays and stops to vehicles, therefore reducing travel times. Some of the state-of-the-art adaptive control algorithms that are operational and implemented in real-life systems are Sydney Coordinated Adaptive Traffic system [SCATS], Split Cycle Offset Optimisation Technique [SCOOT] and InSync.

TMRSU has been trialling a scheme in Port Louis to optimise the timings of a group of traffic lights with actual demand, and is also seeking to collaborate with the UoM to experiment an adaptive traffic control system in our local road network. TMRSU's future plans include recruiting a consultant to recommend the most appropriate adaptive traffic

control system that could be cost effectively implemented island wide. The estimated cost for this consultancy service is Rs 30M.

- 3. Road Pricing:** Setting up of an Electronic Road Pricing (ERP) system through a cordon control system, operated during the morning peak hours. The ERP can be implemented for Port Louis in the first instance and extended to other congested regions over the island. Congestion pricing is indeed the most powerful tool at the hands of policy makers to reduce unnecessary driving, promote environmentally sound transportation and finance improvements to the existing transportation infrastructure.
- 4. Park and Ride Scheme:** Implementation of Park and Ride Schemes in Ebene, St Pierre, La Vigie, Quatre Bornes, Vacoas, Riche Terre (Jinfei area), Montebello and Coromandel and relocate existing long-stay/commuter parkings in Port Louis towards its periphery in order to free capacity for short-stay parking.
- 5. Create High Occupancy Vehicle [HOV] Lanes and Provision for an uninterrupted flow facility on Motorway M2 from Calebasses to Port Louis:** HOV lanes can be reserved for the exclusive use of certain vehicles, including carpools and buses and will relieve traffic congestion and reduce emissions. The provision of an uninterrupted flow facility on M2 will contribute to a reduction in delay and queue length and ultimately reduce traffic congestion and emissions.
- 6. Carpooling Policy:** Carpooling service is helpful in reducing traffic congestion, energy consumption and environmental problems. Carpooling is indeed the concept whereby vehicles are available within a community or locality for individuals to hire on a club basis, or a carpool is a system in which several people share rides to work, school or other destinations.
- 7. Parking Policy:** Reduction in public parking/raising the cost of parking may reduce traffic congestion and emissions.
- 8. Flexitime:** It has been advocated as a measure to mitigate traffic congestion during the morning and afternoon peak hours.
- 9. Teleworking:** It is one of the most popular TDM [Travel Demand Management] strategies for reducing motor vehicle travel.

Some of the propositions made by the NLTA, MEL and TMRSU are common. It is pointed out that the institutions (probably except TMRSU) do not have the technical expertise to carry out modeling of travel demand for most of the proposed measures.

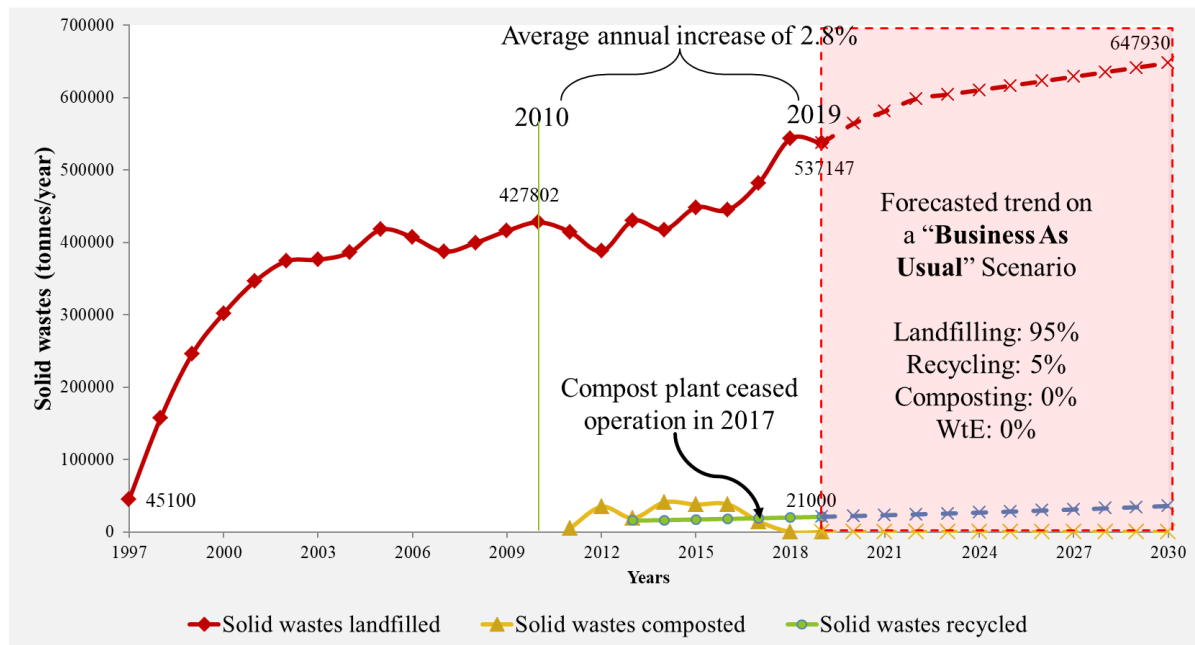


### 3.0 WASTE MANAGEMENT

This sector contributed 23% (or 1,323.12 ktCO<sub>2e</sub>) of total GHG emissions in 2019.<sup>18</sup> The mitigation actions are differentiated by type of waste, namely (i) solid waste; and (ii) wastewater effluents.

#### 3.1. Solid Waste Management

A Strategic Plan has been developed as part of Phase 1 of a Consultancy study funded by the Agence Française de Développement (AFD). As part of Phase 2 of the consultancy study, the consultants are commissioning a feasibility study on the setting-up of composting plants and sorting units in the North and West of Mauritius and this feasibility study is expected to be completed by April 2021. Under the business-as-usual scenario (**Figure 1**), the quantity of solid waste is expected to reach 647,930 tonnes/year in 2030. The bulk of this waste – i.e. 95% - would be destined for landfilling, and with the rest being recycled.



**Figure 1.** Evolution of solid waste generation and management under the BAU scenario.

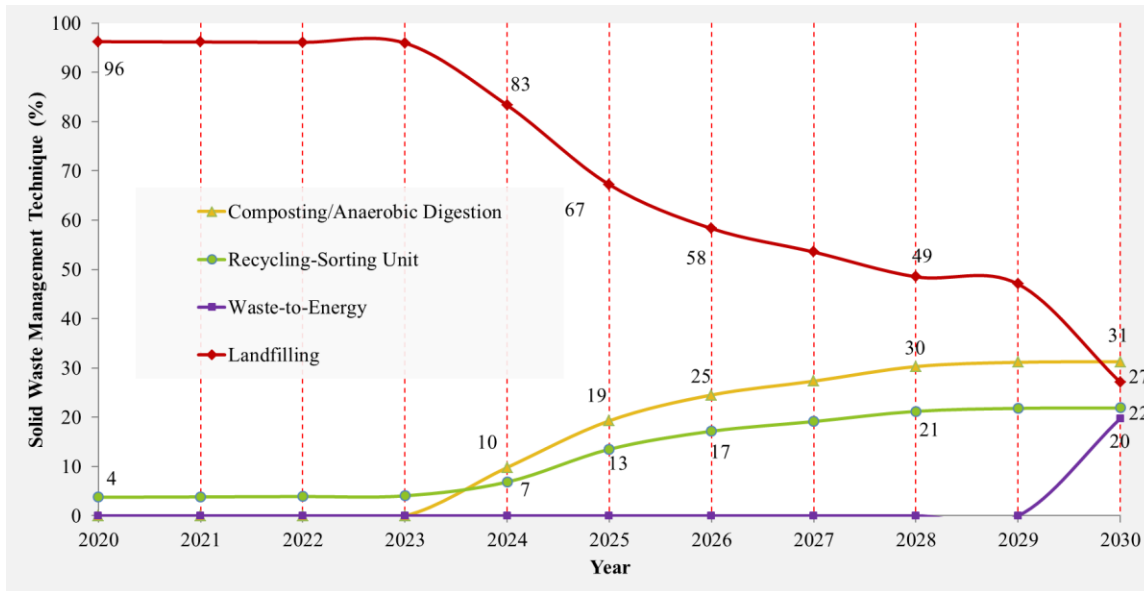
Source: Mr A. Beerachee. 2020. *Solid Waste Management. Solid Waste Management Division, MESWMCC.*

In order to bring about a more sustainable management of solid waste, including addressing the pressing issue of scarcity of land for landfilling of solid waste,<sup>19</sup> the Solid Waste Management Division (SWMD) has proposed four technological options for solid waste

<sup>18</sup> Statistics Mauritius, 2020. However, the figures of GHG emissions from the solid waste sector published by Statistics Mauritius are overestimated. As per calculations done in the context of the BUR, it is estimated that GHG emissions from the solid waste sector is approximately 420 ktCO<sub>2e</sub> (~21 ktCH<sub>4</sub>).

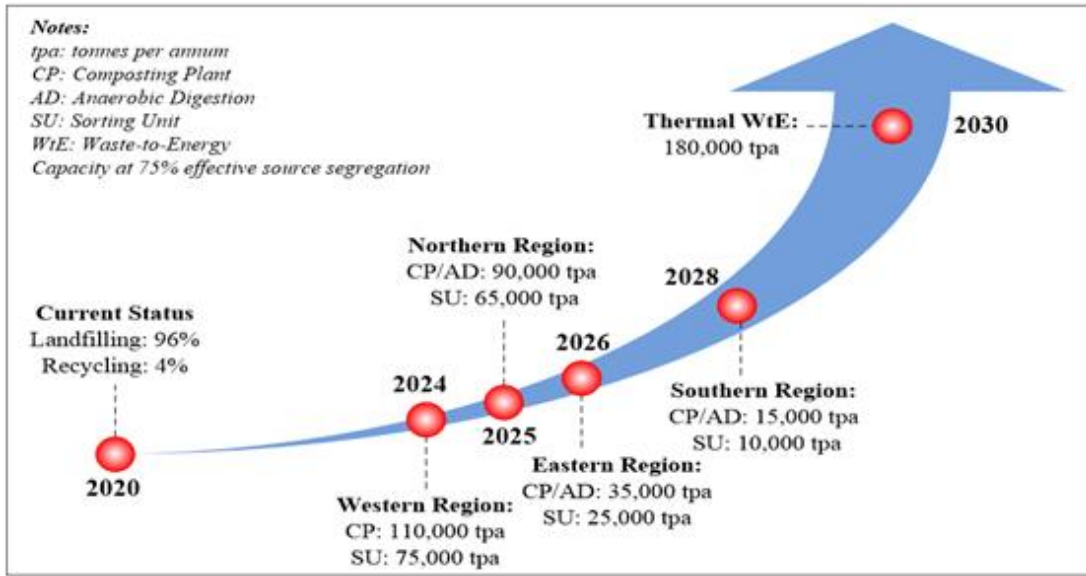
<sup>19</sup> Neehaul, N., Jeetah, P. and Deenapanray, P.N.K., 2020. Energy recovery from municipal solid waste in Mauritius: Opportunities and challenges, *Environmental Development*, 33, 100489.

management between 2020 and 2030 during the process of formulating the National Environment Policy (**Figure 2**).<sup>20</sup> These technological options can be used to develop mitigation scenarios to 2030. Thermal waste-to-energy (WtE) will only be envisaged in the long-term if the need arises and subject to the outcome of a proper feasibility study and the setting-up of all legal and institutional frameworks. More discussions are needed to chart viable solid waste management pathways after 2030. The roadmap to the pathways shown in **Figure 2** is illustrated in **Figure 3**.



**Figure 2.** Technological options for solid waste management: 2020 - 2030.  
*Source: Mr A. Beerachee. 2020. Solid Waste Management. Solid Waste Management Division, MESWMCC.*

<sup>20</sup> Presentation made by Mr B. Beerachee, Ag. Director, SWMD on 17 December 2020 as part of the national dialogue on the formulation of the National Environment Policy.



**Figure 3.** Roadmap for the solid waste sector: 2020 - 2030.

Source: Mr A. Beerachee. 2020. Solid Waste Management. Solid Waste Management Division, MESWMCC.

### 3.2. Wastewater Management

The Wastewater Management Authority (WMA) has provided a list of ongoing projects (Table 8), as well as the timelines for different phases (Table 9 and Table 10) of the sewer network extension.

**Table 8.** Status of ongoing WMA projects.

Source: WMA.

Rehabilitation projects are currently being/ will soon be implemented at J. Nehru Phase 2 at St Paul, Residence Atlee in Curepipe, Raoul Rivet Street in Port Louis, Allée Père Laval at Ste Croix and Residence Malherbes in Curepipe.

**Table 9.** Forthcoming projects (2020 – 2024).

<b>Project Name</b>	<b>Status</b>	<b>Projected no. of House Connections</b>	<b>Completion Date</b>
<b>Project Name</b>	<b>Status</b>	<b>Projected no. of House Connections</b>	<b>Scheduled Completion date (Works)</b>
Grand Baie Sewerage Project – Phase 1B	Surveys and Trial Pits ongoing	4500	March 2023
Pailles Guibies Sewerage Project – Phase 2	Surveys and Trial Pits ongoing	3100	January 2023
Valentina Project	Works ongoing	75	October 2020
<b>Total</b>		<b>7675</b>	
Contract WW 334W - Camp Rouillard Project	Evaluation stage at CPB Expected award end February 2020	175	Expected January 2022
Contract WW369W – Morcellement Goolamally Project	Bids document finalisation and send to CPB early March 2020	200	Expected May 2022
Contract WW410C :Consultancy Lot 1: Bain des Dames	Terms of Reference being finalised shortly	310	Expected December 2023
Consultancy Lot 2: Caro Lalo, Vallee des Pretres		200	Expected December 2023
Contract WW443W and 15 subsequent similar Contracts from the PWSP- Lot 1A South	Survey works ongoing for first phase	2900	To be implemented in phases, period 2020-2024 = 2900
	Survey works ongoing for first phase	2900	To be implemented in phases, period 2025-2028 = 2900
Camp Cavale Robinson	Inception Stage	1800	Expected : 2024

Project Name	Status	Projected no. of House Connections	Completion Date
<b>Total</b>		<b>8,485</b>	

Source: WMA.

**Table 10.** Future WMA projects (2025 – 2035).

Project Name	Status	Projected No. of House Connections	Tentative Start Date
Wooton	Inception	240	To be decided
Pointe aux Sables	Inception	3000	To be decided
<b>Total</b>		<b>3240</b>	

Source: WMA.

Additional information that have been provided by the WMA are:

**1. House Connection Works under the House Connection Framework Agreement Contract (Ongoing)**

The house connections are carried out as and when applications are received at the WMA. These connections are applicable for premises within the sewered areas of Mauritius. The average number of connections per year is around 500.

**2. Sewer Extension Works And Sewer Maintenance Works under Framework Agreement Contract (Ongoing)**

Under this Contract, small extension of the sewer networks are carried out in sewered areas. The threshold per works order is MUR 1 million.

**3. Contract WW427W - Construction of rising main and associated works for ENT Hospital at Vacoas (Ongoing)**

Connection of the newly constructed ENT hospital to the sewer network.

**4. Contract WW432W – Sewer Extension Works (Evaluation Stage)**

- a. Construction of 345m of sewer line with provisions for house connections at Riverside Phoenix
- b. Construction of 205m of sewer line at Odette Ernest Street, Quatre Bornes
- c. Construction of 720m of sewer line for the connection of swimming pool Closel, Vacoas
- d. Construction of 235m of internal reticulation for the connection of Meenakshee Amen Temple

## 4.0 AGRICULTURE, FORESTRY AND OTHER LAND USE

Agriculture is the smallest emitting sector in Mauritius accounting for only 2% (or 116.37 ktCO<sub>2e</sub>) in 2019. Forestry (and Other Land Use) represents a carbon sink that totaled 370.9 ktCO<sub>2e</sub> in 2019.<sup>21</sup> Carbon sequestration in agricultural soil represents a good potential of C sink, and this should be highlighted in the introductory note for the AFOLU sector. It is pointed out that most of the mitigation actions being developed and promoted in the agricultural sector involve and rely heavily on farmers' behavioural change.

### 4.1. Agriculture

#### 4.1.1. Non-sugar sector

The agriculture sub-sector relates primarily to the non-sugar sector and it is subdivided into food crops and livestock management. The measures that have been proposed to date are detailed below.

Climate change has been adversely affecting crop and livestock production, prices, incomes and ultimately the livelihoods of the farming community. In this regard a number of policies, plans and actions have been enumerated in several documents for the agricultural sector, namely:

- 'Mainstreaming Climate Change Adaptation in the Development Process in the Agriculture Sector of the Republic of Mauritius in the context of the Africa Adaptation Programme (AAP) (2012)
- Technology Need Assessment (TNA) report (August 2013)
- National Climate Change Adaptation Policy Framework (2012)
- The most recent agricultural policy documents that addresses climate change issues in Mauritius is the **Strategic Plan 2016 - 2020 for the Food Crop, Livestock and Forestry Sectors** and the **Mauritius INDC (2015)**. They recognize that agriculture is highly vulnerable to climate extremes and climate variability, which give rise to disasters and results in lower agricultural productivity, crop loss or crop failure, and highlighted the urgency to implement adaptation and mitigation strategies for climate change.

The policy document (Strategic Plan 2016-2020) proposes the following measures as part of an adaptation/mitigation strategy in the agricultural sector:

- Screening of crop varieties adapted to changing climatic conditions;
- Developing protected cultivation systems;

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<sup>21</sup> Statistics Mauritius, 2020.

- Adopting rain-water harvest systems and using water-saving technologies for irrigation;
- Promoting Integrated Pest and Disease Management;
- Optimising use of chemical fertilisers;
- Introducing and promoting soil conservation methods;
- Promoting mixed cropping and agro-ecological farming;
- Implementing an agricultural insurance scheme;
- Mainstreaming Climate Change in Research and Extension;
- Fertilisation using an Integrated Plant Nutrient System;
- Composting and waste management

Although the strategic plan detailed an implementation plan of projects that cover the period 2016 – 2020, and that it is currently under review, the broad strategies related to climate change adaptation and mitigation will span over a longer time period, well beyond 2030.

A list of strategies/projects resulting in reductions in GHG emissions in the agriculture sector, and that would also most probably feature in the Ministry's forthcoming Strategic Plan, relates to Organic farming, Sustainable Land Management, Integrated Plant Nutrient Management System, Agroforestry and Water saving technologies for irrigation in order to reduce GHG emission from the agricultural crop sector, namely:

- Use of renewable energy sources for agricultural activities, such as solar panels to power water pumps, solar dryers and Gravity fed drip irrigation systems.
- Development and promotion of Organic Farming and related agro ecological and natural systems of crop production, which prohibit or decrease chemical fertiliser use, as well as increase C stock in the soil solum.
- Develop and promoting the concept of Integrated Plant Nutrition System (IPNS), which uses less chemical fertilizers and in an optimal way, and therefore reduce GHG emissions.
- Develop composting technologies, including vermicomposting, and promote organic waste recycling at farm and household level.
- Development of Agroforestry Systems, which has a great potential for Carbon sequestration.
- Crop diversification on marginal and abandoned sugar cane plantation, having co-benefit potential of Carbon sequestration such as *macadamia* plantation and expansion of area under tea.

In the livestock sector the following strategies/projects will be pursued:

- i. Developing a Standard for treated manure (Switch Africa Green Project);
- ii. Evaluation of different methods of sanitization of cattle and poultry (layers) manure, including dissemination and demonstration of manure sanitization (Switch Africa Green Project);
- iii. Promoting Climate Smart agriculture concept among small livestock holders in the Republic of Mauritius (Global Climate Change Alliance);

- iv. Develop a GHG emission model from livestock waste for Mauritius and to establish baseline of current emission (Switch Green Africa Project);
- v. Evaluate biogas potential from livestock wastes and the setting up of a pilot biogas demonstration plant;
- vi. Pelletizing of raw cattle manure (NEF/DeSIRA).

Projects (i) and (ii) are being implemented, and it is now confirmed that project (iv) will not be implemented. Data have been provided to develop mitigation actions up to 2030 based on the above projects, including modeling GHG emissions from livestock for Mauritius.

#### 4.1.2. Sugar sector

The past decade has witnessed a major transformation of the Mauritian sugar industry into a cane cluster following a consequent drop in sugar prices in the guaranteed preferential access to the European Union (EU). Measures taken by the Government and industry have prompted the industry to re-engineer itself and to maintain its competitiveness. Despite the profound reforms implemented, new challenges have arisen, among which the fluctuating sugar price on the European market and climate change.

A study was commissioned by the Ministry of Agro Industry and Food Security on ‘The Economic, Social and Environmental Impact on Mauritius of Abolition of Internal Quotas of Sugar on the EU Market’<sup>22</sup> in 2015. Based on these findings ‘The Research and Development plan 2016-2020 for a resilient Mauritian cane industry’<sup>23</sup> was elaborated with the aim of contributing to the long-term sustainability for a resilient Mauritian cane industry and capitalizing on the multi-faceted potential of the sugar cane plant to deliver a multitude of components, either naturally or industrially with limited impact on the environment. The Plan aimed at bringing improvements in breeding, cane growing and milling to contribute to industry diversification and profitability taking into account major global challenges such as climate change, emerging diseases and pests, costly energy supply and water scarcity.

The following measures were part of an adaptation/mitigation strategy in the sugarcane sector:

- a) Screening of sugarcane varieties for non-irrigated regions and adapted to changing climatic conditions;
- b) Selection of varieties with high biomass and enhanced fibre content for bioenergy production;
- c) Agronomic potential of sugarcane biomass for energy production;
- d) Selection of varieties resistant to pests and diseases;
- e) Optimising efficient use of chemical fertilisers and adoption of integrated nutrient management;
- f) Redefining the different climatic zones of the island.

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<sup>22</sup> LMC International, 2015. The Economic, Social and Environmental Impact on Mauritius of Abolition of Internal Quotas of Sugar in EU Market. Ministry of Agro Industry and Food Security. Port Louis.

<sup>23</sup> MSIRI, 2016. Research and Development Plan 2016-2020 for a resilient Mauritian Cane Industry, Mauritius Sugar Industry Research Institute, Réduit.



Of the above, recommendations (c), (d) and (e) can be used for developing mitigation actions in the post-2020 period.

## **4.2. Forestry and Other Land Use (FOLU)**

Actions in the FOLU sub-sector were framed by the Strategic Plan 2016-2020 mentioned earlier. The baseline analysis has been carried out by reviewing progress made against the five objectives for forestry. This mitigation action related to the offsetting of GHGs through increased tree cover is discussed in the next section, while progress related to the remaining 4 objectives of the forestry sector is covered in Annex 3.

### **4.2.1. Increased tree cover over the island**

During the period January 2016 – March 2020, approximately **400 000** plants have been planted or issued under the national tree planting campaign to Schools, socio-cultural organisations, NGOs and public. Other private initiatives for planting trees have not been accounted. The planting sites identified for planting included: State lands (approx. 30 ha), Mountain Reserves (2.5 ha), river reserves (6.5 ha), roadside of Motorway M1 and M2 (approx. 37 600 plants over 22 km) and other roadsides, government compounds, schools, botanical garden (SSRBG), Socio-cultural compounds and NGOs' compounds.

A small decrease in the total area under forest cover (approximately 20 ha) was noted since the start of the implementation of the strategic plan in 2016. However, the overall stocking density of the state forest lands has been increased in some forest land, mostly due to the replanting of bare lands and filling of gaps within forest areas. From January 2016 to August 2019, more than 200 000 seedlings (subset of 400 000 plants mentioned above) have been planted in bare lands/gaps within the forest areas, water catchment areas, steep slopes and other Environmentally Sensitive Areas. In the long run, this will increase the overall forest productivity.

A mini forest over an extent of approximately 2 ha was created at Bel Air. The site which was previously in an abandoned/neglect state was cleared and replanted with some 2744 native plants. The site was inaugurated in 2018 for the celebration of the International Day of Forests. The two bee reserves zones that were created with meliferous trees during the financial year 2016-2017 an extent of 20 ha at Bras D'Eau and 5 ha at PG les Salines) were maintained. Around 8111 meliferous trees were planted between January 2015 to August 2019.

Approximately 6.5 ha of River Banks have been weeded and replanted with native species (including approximately 5 ha along Takamaka River Bank and 1.5 ha at Grand River North West). As an incentive to protect and restore native forests, an additional 7000 native plants were also issued free charge to private land owners to plant in their Mountain and River Reserves.

Due to acute lack of labor force, the annual target of 100 000 to 160 000 trees planted was not met in 2019 and will also not likely be achieved in 2020. To meet the higher requirement for plants, the production capacity of the Forestry Service Nurseries had to be increased. Two

nurseries were upgraded. For example, new overhead sprinkler systems were purchased and new shade houses were erected. However due to the decrease in labor force, the plant production decreased from approximately 350 000 plants in 2016 to 210 000 plants in 2019. The forecasted plant production for 2020 is less than 150 000 plants.

## 5.0 IPPU

The IPPU sector in Mauritius is mainly dominated by the emissions of refrigerants used in the refrigeration and air conditioning (RAC) sub-sector. Although there was only 48.77 ktCO<sub>2e</sub> (or 0.8% of total) emissions reported in 2019,<sup>24</sup> the updated national inventory in the first Biennial Update Report<sup>25</sup> notes an increase in RAC emissions by a factor ~6 that would make it about three times as large an emitting sector as agriculture.

The updated national inventory for the IPPU has shown that products used as substitutes for Ozone Depleting Substances (ODS) accounted for around 91% (282.1 ktCO<sub>2e</sub>) of total emissions (311.18 ktCO<sub>2e</sub>) in the sector in 2016. Also, the trend was a rising share over time, which is also due to the decline in emissions from other activities such as lime, and iron and steel production.<sup>26</sup> Hence, focus of mitigation analyses will be on the refrigeration and air conditioning (RAC) sub-sector that will cover both stationary and mobile uses of refrigerants.

Another study has made projections in GHG emissions from the RAC sub-sector to 2050, and the results are shown in **Figure 4**.<sup>27</sup> Based on current trends and a predicted increasingly hotter climate in Mauritius, the GHG will more than double by 2050 to over 7 MtCO<sub>2e</sub>. It needs to be noted that the Business As Usual (BAU) GHG emission scenario is based on an energy mix which continues to rely on fossil fuels to power the RAC appliances<sup>28</sup>. This data includes CO<sub>2</sub> emissions that are emitted from the combustion of fossil fuels to power the refrigeration and air conditioning equipment and appliances, and not just emissions related to refrigerants. The direct emissions from refrigerants in the CTCN study was 260 ktCO<sub>2e</sub> in 2015, which is close to the value of 269.03 ktCO<sub>2e</sub> reported in the biennial update report (BUR).

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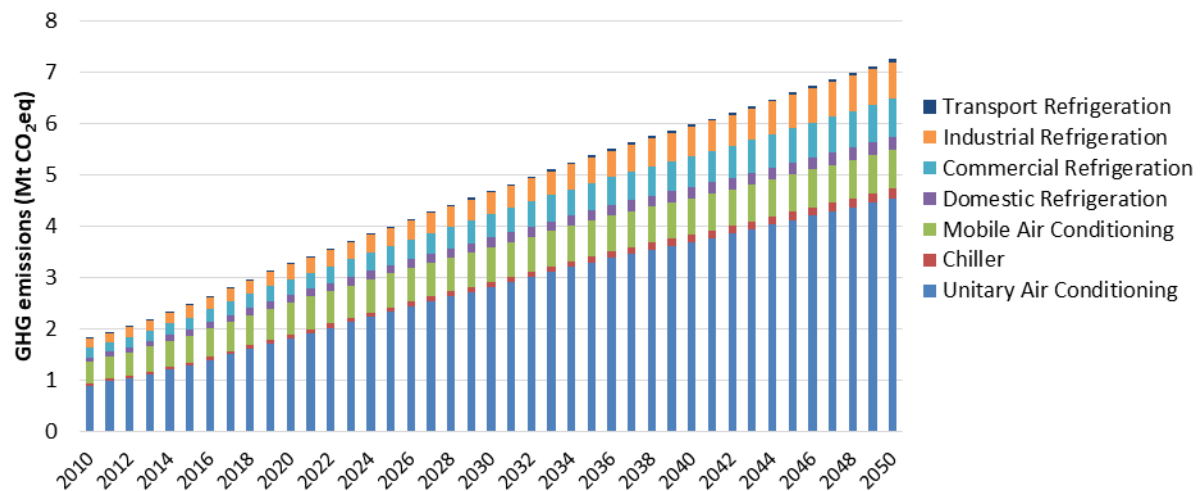
<sup>24</sup> Statistics Mauritius, 2020.

<sup>25</sup> Based on discussions with the CCD, MESWMCC.

<sup>26</sup> Based on information shared – i.e. extract of data on IPPU in NIR – by the CCD, MESWMCC, 11 February 2021.

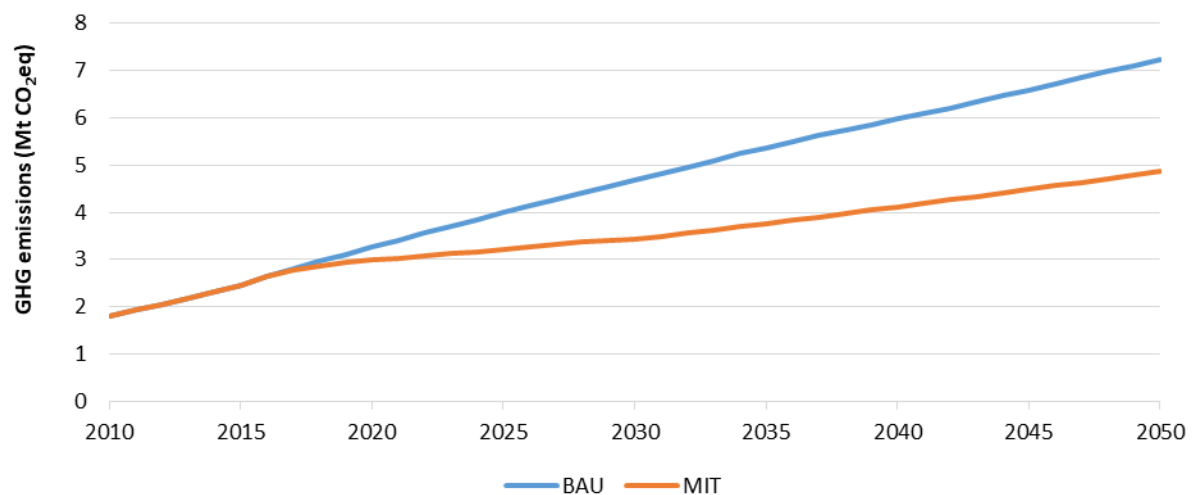
<sup>27</sup> In the IPPU sector, regarding projections of GHG emissions till 2050 from Refrigeration and Air Conditioning sub sector, the demarcation between actual emissions and potential emissions should be taken into account. Potential emissions assume that all emissions from activities occur during the current year whereas actual emissions include delays in emissions or banks due to the cumulative difference between the amount of chemical consumed in an application and that which has already been released.

<sup>28</sup> See also Government of Mauritius (2010) Mauritius Second National Communication' table 4.3



**Figure 4.** Projected emissions in the RAC sub-sector in Mauritius: 2010 - 2050.  
*Source: CTCN (n.d.). Green Cooling Africa Initiative Interim Report II – Refrigeration and Air Conditioning Greenhouse Gas Inventory and Technology Gap Analysis Draft Report for Mauritius.*

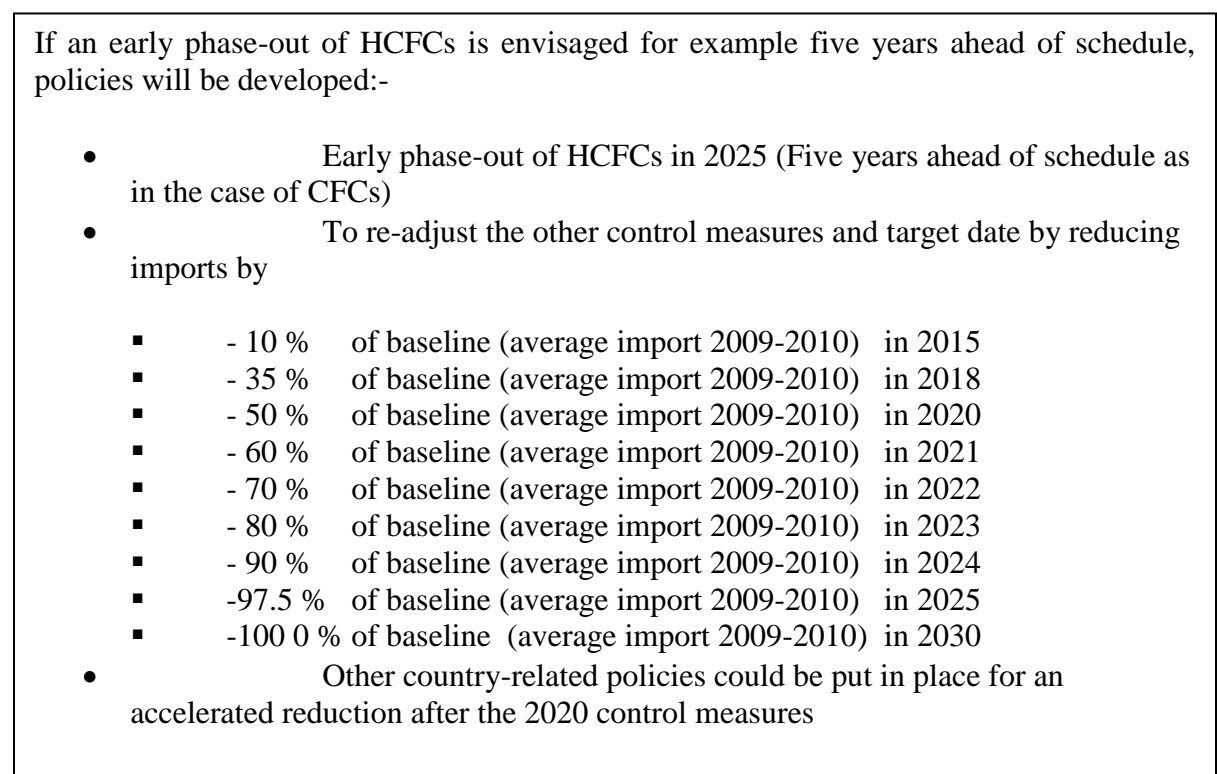
A mitigation scenario (MIT) have been provided for the RAC sub-sector based on a combination of less contaminating refrigerants and higher energy efficiency technology options (**Figure 5**).



**Figure 5.** Mitigation potential in RAC industry to 2050.  
*Source: CTCN (n.d.). Green Cooling Africa Initiative Interim Report II – Refrigeration and Air Conditioning Greenhouse Gas Inventory and Technology Gap Analysis Draft Report for Mauritius.*

Underlying the low-carbon scenario analysis is that in nearly all sub-sectors there are technology alternative RAC systems available, operating without hydrofluorocarbons (HFCs) and with zero or very low global warming potential (GWP) refrigerants (e.g. R717, R290, R600a etc...). Also, With the Kigali Amendment, also Developing Countries (A5 countries under the Montreal Protocol) have to gradually phase down HFCs. Annex 2 lists the technological options used to develop the mitigation scenario shown in **Figure 5**.

In alignment with the need to protect both the ozone layer and climate systems, Mauritius has developed a hydrochlorofluorocarbon (HCFC) phase out plan.<sup>29</sup> The targets that can be used to mitigation analyses are shown in **Figure 6**.



**Figure 6.** Proposed phase out plan for HCFCs to 2030.  
*Source: HCFC Management Plan 2011-2025.*

<sup>29</sup> Republic of Mauritius (n.d.) HCFC Management Plan 2011-2025 (document shared by the CCD, MESWMCC on 6 February 2021).

## **Annex 1 – Supplementary information on migration actions in land transport**

The Ministry fully supports initiatives to reduce the level of Greenhouse gas emissions which may be realized through the decarbonization of the land transport sector. A number of measures have, in fact, been taken to address noxious gas emissions by Government while other projects are in the pipeline.

Ongoing projects and long-term ventures are detailed below:

### **Metro Express Project**

Reduction in greenhouse gas emissions is being achieved through the implementation of the light rail transit system which intends to provide a reliable, convenient, fast and safe alternative to private car use. In turn, this would lead to fewer vehicles at peak hours on our main arteries resulting in less traffic congestion and by extension, reduced gas emissions.

As a mass transit system, the operation of the light rail prompted a modal shift both from bus transport and from private vehicle users, thereby lowering gas emissions. With the extension of the alignment to Quatre Bornes and ultimately to Curepipe, it is expected that more private car users would switch to the light rail and foreseeably, the positive environmental impacts would be more noticeable.

In the wake of the Metro Express, a Bus Reengineering Strategy is being worked out by the Ministry along with the NLTA and MEL to reorganize the transport system so that there is enhanced synergy between the light rail and the buses in the context of the first and last mile connectivity to the light rail. The aim is to encourage and foster public transport in lieu of private vehicle use.

Being a capital-intensive project, extension of the light rail beyond Curepipe, would rest with Government in view of the high financial implications, especially in the present Covid-19 context.

### **Bus Modernisation Scheme**

Since its inception in September 2014 and up to Mid-September 2020, 374 buses have been replaced through the Bus Modernisation Scheme. In that endeavour, the Ministry is pushing for the rejuvenation of the public transport system through the Bus Modernisation Scheme wherein subsidies varying between Rs0.7m and Rs1.3m per bus are allocated to bus operators to incentivize replacement of their fleet by a semilow floor/low floor bus. The Scheme also provides for VAT Exemption.

The aim is to rid public transport of the ageing fleet of highly polluting buses. With the provision of subsidies, the rate of fleet replacement is accelerated and the benefits are manifold in as much that

- (i) old buses which are known to have higher level of emissions as well as less frequent maintenance, are gradually being replaced;
- (ii) the attractiveness of the public transport system is being enhanced as new buses equipped with latest amenities such as Wifi are being put to use;
- (iii) easier access to persons with disabilities, elderly and pregnant women, who, otherwise would have had to resort to private car use;
- (iv) the replacement of the ageing fleet prevents commuters from switching to other means of transport;
- (v) reduced noise pollution; and
- (vi) enhanced comfort and more OSH friendly for bus drivers as engines of semi-low floor buses are located at the rear of the vehicle.

The BMS is an ongoing scheme and a specific budget is allocated to the NLTA to ease the upfront financial investment of bus owners for replacing their ageing fleet.

### **Electric Vehicles**

Owners of electric or hybrid vehicles benefit from rebated excise rates and registration duty upon purchase of such type of vehicles. On the other hand, owners of such vehicle pay only 50% of the Road Tax applicable to conventional vehicles when calling at the NLTA for payment or renewal of their Motor Vehicle Licences. The above fiscal measures seek to incentivize the acquisition and operation of such vehicles in Mauritius. This BMS also caters for electric/hybrid buses and, in fact, a higher level of subsidy is provided for such types of buses.

The Ministry is also, with the assistance of international organization and friendly countries exploring the possibility for electric buses along with their charging infrastructure, to be granted to Mauritius as a donation or at a preferential rate.

In that respect, discussions are underway with the United Nations Development Programme (UNDP) under the Global Environment Facility for assistance to be extended to Mauritius in connection with the operation of electric buses. The Project is expected to be implemented over a 5-year period, that is, from 2021 to 2025 and the Project Preparation Phase has already started. A budget amounting to UDS3,229,998 has been sanctioned by the GEF accordingly. In that respect, an Information gathering exercise is ongoing and a Consultant, namely Eco-Forge (India) has been appointed by the UNDP to carry out a Feasibility Study to advise as to how electric buses and their charging stations could best fit Mauritius having regard to the specificities of the Mauritian topography.

### **Cycling Network**

A study has been commissioned by the TMRSU with a view to promoting cycling as a non-motorized mode of commute and for advising on the development of a cycling network at selected locations.

### **Euro Standards (Budget Measure 2017/2018)**

With a view to reducing emissions of two-wheelers, the Ministry is envisaging to restrict the importation of motorcycles/autocycles only to those vehicles complying with the EURO

Standard or its equivalent. This would ensure that two wheelers plying on our roads are in line with environmental norms and to ensure that no-substandard motorcycles/autocycles are introduced on the local market. In turn, this would gradually replace the fleet of two wheelers by vehicles emitting lesser levels of pollutants as is the case for motorcycles/autocycles fitted with 2-stroke engines.

In view of the intricacies and implications of implementing such a decision, a Technical Committee comprising stakeholders from the NLTA, TMRSU, MRA, MSB and the Mechanical Engineering Division, amongst others, has been established to make recommendations on the above proposal including the legal framework thereto.

## Annex 2 – Technological options for mitigation in RAC industry.<sup>30</sup>

### Unitary AC systems

With the high ambient temperature conditions of Mauritius, hydrocarbons can be used widely for most unitary air-conditioning systems, particular portable and ductless split systems. Portable units utilising R290 are widely available and window units using R290 are in production in Asia. Split air-conditioning systems using R290 are in production in India and China. China has completed the conversion of 18 production lines from R22 to R290 as part of their HCFC Phase-out Management Plan (HPMP). Efforts are underway to better assess the risks and to establish standards and best practices of using hydrocarbons in larger charge systems. According to technical experts from HEAT, R290 can be safely handled for cooling capacities up to 10 kW.

With R290 portable and split systems, typically energy efficiency improvements of 10 to 20 per cent over the currently installed technologies can be achieved in Mauritius, mainly with R410 as refrigerant.

For ducted and multi-split systems, the use of hydrocarbons requires the use of ducted systems, either with air or water as heat exchange carrier inside the buildings. With appropriate design options, also with these indirect systems, energy efficiency improvements can be achieved in the range of 0-10%, compared to currently installed systems with R410 or R404A and R407C for ducted air conditioning systems.

**Table 1: Current and Best Practice RAC appliances (Source: HEAT analysis)**

		Current technology	Best practice technology	Potential market penetration for alternative systems			Product Examples
				Current	2020	2030	
Self-contained air conditioners	Refrigerant	R410A	R290	< 5%	50%	60%	Midea MPPC-11 CRN7-QB6G1
	Equipment energy efficiency	2.9	>3.2				
Spilt air conditioners	Refrigerant	R410A	R290	< 5%	50%	70%	Midea MSAECU-18HRFN7-QRD0GW /
	Equipment energy efficiency	2.9	>3.7				

<sup>30</sup> CTCN (n.d.). Green Cooling Africa Initiative Interim Report II – Refrigeration and Air Conditioning Greenhouse Gas Inventory and Technology Gap Analysis Draft Report for Mauritius.



							Godrej GSC FG 6 BOG
Ducted air conditioning systems	Refrigerant	R410A, R404A, R407C	R290 (+liquid secondary)	< 5%	40%	80%	N/A
	Equipment energy efficiency	3	>3.5				
Multi-splits	Refrigerant	R410A	R290 (+liquid secondary)	< 5%	30%	70%	N/A
	Equipment energy efficiency	3.5	>3.5				

### Chillers – AC and Refrigeration

Stationary air-condition and refrigeration chiller systems are used for residential, commercial and industrial cooling applications. Generally, chillers are located in a machinery room or outside, making it easier to deal with safety issues related to toxicity and flammability of low-GWP refrigerants.

For the hot ambient conditions, both R717 and hydrocarbon (R290 and R1270) refrigerants are very energy efficient with often superior energy efficiency properties compared with HFC chiller systems.

Particular, driven through the requirements of the European F-Gas Directive, there is an increasing number of manufacturers mainly in Europe but also in other regions to manufacture R290 chillers. In Europe, HC chillers are manufactured and safely operated over many years, even for large systems with up to 1 MW. R717 chillers are manufactured, installed and operated worldwide since decades, mainly for large scale industrial refrigeration systems. With the F-Gas directive, in Europe, R717 chillers are now also increasingly used for AC purposes. In combination with screw compressors, very high energy efficiencies can be achieved with both R290 and R717 chiller systems, particular in high ambient temperature environments.

A comparison of the current and best practice technology has been shown in Table 20. The current RAC chillers in Mauritius mainly operate with HFC R134a and R410A, which has a high GWP. With the adaptation of an alternative technology using hydrocarbon refrigerant R290 and R717, energy efficiency improvements in the range of 10-20 % are possible.

As R717 is toxic and hydrocarbons are flammable, particular consideration and technical skills are required for the installation, operation and maintenance of the systems.

Due to technical skill requirements, R717 systems are mainly used for applications with a cooling capacity over 500 kW. For large system, R717 systems are very cost competitive, both with regard to upfront and operating costs. Hydrocarbon chiller systems are suitable for systems from 10 – 500 kW.

**Table 2: Current and Best Practice RAC chillers (Source: HEAT analysis)**

		Current technology	Best practice technology	Potential market penetration for alternative systems			Product Examples
				Current	2020	2030	
Air conditioning chillers	Refrigerant	R134a, R410A	R290 R717	< 5%	30%	70%	Eco Chill Stratos S-Type and V-Type
	Equipment energy efficiency	3-4	>4				
Process chillers	Refrigerant	no data	R717	< 5%	40%	60%	There are many R717 chiller available worldwide
	Equipment energy efficiency	no data	>4				
Centralised systems for supermarkets	Refrigerant	R134a	R290 + liquid. sec. for MT and CO <sub>2</sub> cascade for LT	< 5%	20%	80%	N/A
	Equipment energy efficiency	1.95	>3				

### Refrigeration – Domestic and Commercial Standalone Systems and Commercial condensing units

With the drive to lower F-gases, particularly, under the European F-Gas Directive, alternative refrigerants are increasingly used for RAC appliances for commercial refrigeration in Europe.

For stand-alone equipment (bottle coolers, ice coolers and display cases up to 3.75m) mainly RAC appliances with hydrocarbons as a refrigerant have reached significant market shares. Commercial refrigeration systems in supermarkets can also be up-scaled, linking multiple standalone units, which reject their condensation heat into a water circuit. Condensing units using hydrocarbon refrigerants are also available. Currently, the updated draft of the IEC standard 60335-2-89 suggest to allow increased charge size from 150g to 500g hydrocarbons, which will allow a wider use of hydrocarbons.

The use of R600a and R290 instead of the currently available R134a and R410a is estimated to result in energy efficiency gains of over 10%.

**Table 3: Current and Best Practice Standalone and condensing Units (Source: HEAT analysis)**

		Current technology	Best practice technology	Potential market penetration for alternative systems			Product Examples
				Current	2020	2030	
Domestic refrigeration	Refrigerant	R600a, R134a	R600a	N/A	95%	95%	many fridges with Energy rating A+++
	Equipment energy efficiency	>300 kWh/year	139 kWh/year				
Stand-alone equipment	Refrigerant	R134a	R290	<5%	85%	85%	AHT, Athen XL ECO
	Equipment energy efficiency	3.3	>3.5				
Condensing units	Refrigerant	R410A	R290 (+liquid secondary)	none	40%	60%	TBC
	Equipment energy efficiency	3.2	>3.5				

### Refrigeration – Transport refrigeration systems

The leading manufacturer of transport refrigeration systems, Transfrig, is currently field testing a prototype with R290. The prototype testing of the units has been highly successful with energy efficiency improvements of 20-30% against HFC systems. It can be expected that the units will be commercially available, also potentially to Mauritius, by 2018. The technology would be highly relevant to Mauritius, giving its climatic conditions and the good performance of hydrocarbons in higher and high ambient environments. The technology would allow Mauritius to avoid direct emissions from the transport refrigeration sector and also to save fuels for powering the systems.

**Table 4: Current and Best Practice transport refrigeration units (Source: HEAT analysis)**

	Current technology	Best practice technology	Potential market penetration for alternative systems		
			Current	2020	2030

Refrigerated trucks/trailers	Refrigerant	R407C	R290	none	40%	80%
	Equipment energy efficiency	no data	no data			

A change from the current R407C to an alternate low GWP R290 in the transport refrigeration sector is forecasted to have a significant improved market potential of 80% by the end of 2030.

**Mobile AC**

MAC systems can be categorized into two types; these are as follows:

- › Mobile air-conditioning (MAC) systems used in passenger vehicles.
- › Transport air-conditioning systems used in other vehicles (e.g., trucks, trains, airplanes and buses).

Current installed mobile air-conditioning systems in Mauritius use R134a. Alternative systems with HFO-1234yf and R744 have been developed in Europe, where refrigerants are required to have a GWP less than 150, according to EU law.

Hydrocarbons are not yet considered a viable refrigerant option by car manufacturers due to flammability concerns. Still, hydrocarbons can be an option for electric vehicles with hermitically sealed refrigerant systems. For large vehicles, R744 MAC systems are available for buses and trains for example in in Germany.

The most energy efficient and environmentally sound solution for passenger MAC cars would be hermetically sealed refrigerant systems for electric cars. However, such a scenario could be premature for the Mauritian economy considering that electric cars still carry a high premium for the time being.

**Table 5: Current and Best Practice Mobile AC Units (Source: HEAT analysis)**

		Current technology	Best practice technology	Potential market penetration for alternative systems		
				Current	2020	2030
Car air conditioning	Refrigerant	R134a	R744 HC for hermitically sealed refrigerant systems.	<5%	30%	60%
	Equipment energy efficiency	no data	no data			
Large vehicle	Refrigerant	R134a	R744	none	5%	15%

air conditioning	Equipment energy efficiency	no data	no data			
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## **Annex 3 – Review of implementation of forestry activities in the Strategic Plan 2016 – 2020**

This annex provides a summary of the review of Objectives 2 to 5 of forestry activities in the Strategic Plan 2016 – 2020.

### **Objective 2: Review of the existing laws, legislation and policies to increase tree and forest protection.**

Several gaps have been identified in the current forest legislations (i.e. the Forest and Reserves act of 1983, Amended 2003). The main gap being control of felling of trees on private lands. Under the FAO project TCP MAR 3602 ‘Support to Forest Code Revision and Institutional Reform in Mauritius’ a revised **Forests and Reserves Bill** was submitted to the Ministry of Agro-Industry and Food Security. The proposal still needs to be approved and endorsed by the Ministry of Agro-Industry and Food Security and passed through the Parliament.

The new Forests and Reserves bill provides for a better management and protection of the forestry sector in Mauritius. It reflects the objectives under the National Forest Policy of 2006 and has been developed following an analysis of all the laws relating directly or indirectly to the forestry sector in Mauritius. It was also drafted by taking into consideration all the feedback received from stakeholders under the project.

The Shooting & Fishing Lease Act (1966), provides legal provisions to shoot and go in pursuit of game and to fish, hunt or fowl on State lands. **The Shooting and Fishing lease act has been amended to include ecotourism in 2017** (09 May 2017) and **amendment of schedule regulation for Shooting and Fishing Leases in 2018** (10 March 2018).

Almost no progress has been made toward the development of a national forest action program (NFAP). It was proposed that the NFAP be prepared after the new Forests and Reserves bill has been enacted.

For the development of Agroforestry, Mauritius has obtained technical assistance from the FAO under the Technical Cooperation Programme (TCP) project “Enhancing rural livelihoods and agriculture productivity through agroforestry development in Mauritius”. The project has a 2-year duration (June 2019-May 2021). The project aims to enhance the livelihoods of people through identifying, testing and adopting good agroforestry options in underutilized/abandoned agricultural land and promoting agroforestry enterprises. One of the key expected output of the project is to develop a National Action Plan for the upscaling of agroforestry on underutilised/abandoned agricultural land;

### **Objective 3: The sustainable development, management and protection of environmentally sensitive areas such as watersheds and steep slopes**

**And**

### **Objective 4: Enhance biodiversity and ecosystem services.**

The strategic document outlined various strategic actions for the protection and restoration of different types of Environmentally Sensitive Areas (ESA) such as wetlands, watershed, steep slopes and native forests. A number of decisions and initiatives have been taken and mechanisms established at the national levels to facilitate the protection and restoration of ESAs in the country.

The Protected Area Network Expansion Strategy (PANES) 2017-2026 was launched in May 2017. The project is co funded by GEF through UNDP. It makes provision for the expansion of the protected areas in Mauritius from 4.4% to 16% or more through the inclusion of land with high biodiversity and ecosystem value with the Protected Area Network (PAN). A thorough conservation mapping exercise was conducted to provide spatial guidance for the expansion. The PANES 2017-2026 also contains an in- depth review of the legal framework related to biodiversity conservation, outlines the institutional framework required for the implementation of the PANES and proposes the basis for biodiversity stewardship agreements for the incorporation of private land in the PAN.

The initial weeding of 81.75 ha (including 70.25 ha weeded under the PAN project) of mainland native forest areas under the jurisdiction of the Forestry was carried out. These include: Mt Brisée (24.26 ha), Nature Reserve Cabinet (9.74 ha), Nature Reserve Gouly Pere (9.13 ha), Nature Reserve Les Mares (3.45 ha), Nature Reserve Bois Sec (2.45 ha), State Land Mon Vert (30.32 ha), Nature Reserve Le Pouce (2.2 ha). Maintenance weeding carried out over an average of extent of 57 ha of Native Forests annually. On average some 26% of the total plants (400 000 plants) planted or issued under the national tree planting campaign comprised of native species.

A National Strategic Action Plan for the Conservation and sustainable use of Crop Wild Relatives (2016-2025) which aims to protect and restore the crop wild relatives (CWR) ecosystems for their conservation and sustainable used has been prepared and submitted to the Ministry of Agro Industry and Food Security for endorsement.

More than 1,000 native plants have been reintroduced at Nature Reserve Gouly Pere, Nature Reserve Cabinet and State Land Monvert.

The Republic of Mauritius became an official partner of the Queen's Commonwealth Canopy (QCC) on 15 November 2016. The Forestry Service was mandated by the Ministry of Agro-Industry & Food Security to endorse 5 projects under the umbrella of the Queen's Commonwealth Canopy. The project will include rehabilitation of 650 ha in 5 biodiversity rich areas (Black River Gorges national parks, Le Pouce Nature Reserves, Ilot Gabriel Nature Reserves, Vallée D'Osterlog Endemic garden, and Sir Seewoosagar Ramgoolam Botanical Garden).

For the restoration of Ilot Gabriel, the weeding programme was initiated on the South Eastern and on the North Western side of the islet where the weeds have started to gain access but have not yet established. The following weeds were targeted for manual removal: *Opuntia ficus indica*, *Lantana camara* and *Wikstroemia indica* and *Cassytha filiformis*. After these patches have been cleared of invasive weeds, the highly invaded area up to the center of the

island was targeted for weeding. Transects of 150m x 5 m were sequentially weeded. The weeding exercise was carried out over approximately 24 ha. The maintenance weeding of the previously weeded site is ongoing. To increase the presence of Forest Enforcement Officers on the island, a basic field station was constructed in 2017. The Field Station was extended and upgraded in 2019. In addition to the weeding, endemic plants (*Pandanus vandermeeschii* and *latania loddigesii*) seedlings were transplanted to new location on the islet. 70 % and 40% success rate were observed for *Pandanus vandermeeschii* and *latania loddigesii* transplants respectively. Since 2015 at least 12 new invasive alien species (not previously recorded) were found on the island. This is attributed to the high turnover of visitors on the island. To increase the presence of forest enforcement officers on the island and to facilitate restoration activities a basic field station of 5m x 5m was constructed in 2017. The field station is wooden structure (roof made with iron sheet). A wooden enclosure was erected around the facility. Due to severe coastal erosion, the field station was relocated, extended and upgrade in 2019.

As part of an ESA study, the country is reviewing updating the list and boundaries of ESAs across the country. Around 40 % of the ESAs have already been surveyed and demarcated. With regards to the implementation of the restocking programme in water catchment area, steep slopes and other ESAs, preference is being given to native species because of their resilience and lower water consumption rates and other environmental and ecological benefits. Approximately 20 ha of bare lands and gaps within ESAs have replanted since January 2016. In addition, approximately 6.5 ha of River Banks have been weeded and replanted with native species (including approximately 5 ha along Takamaka River Bank and 1.5 ha at Grand River North West). The Forestry Service also provide incentives (e.g. free issue of plants) for the restoration of Mountain and River Reserves.

#### **Objective 5: Awareness on importance of trees and forests**

The main difficulty with the any sensitization and awareness is to induce a change in behaviour and not restrict the campaign to information sharing only. In this perspective, experiential learning approach during the sensitization and awareness campaign was favoured. For instance, during specifically organised guided tours to Nature walks, the public were given the opportunity to plant native trees; Endemic gardens were created in schools with the participation of students; NGOs, youth clubs, and student participated in roadside and avenue planting; etc.

The communication and outreach strategy have also evolved from the more traditional dissemination of information through reports and articles to a more proactive engagement with the media, stakeholders and the public. Under the Sensitisation and Awareness Campaign of the Forestry Service the following activities were carried out:

- Talks/ presentation on the importance of forests, including forest biodiversity, are given by Forest Officers in schools. About 20 schools and 10 Social Welfare Centres/Community Centers were targeted annually.
- Guided tours are offered to students and private institutions at the three Nature Walks under the jurisdiction of the Forestry Service (Mon Vert at Forest Side, Powder Mills at Pamplémousses and Sophie at Plaine Sophie). Between January 2015 and



- December 2019, 342 guided tours have been carried out. The Nature walks receive on average 30 300 visitors annually.
- At least two small exhibitions on forests were carried out annually.
  - Students and visitors were given opportunity for experiential learning (e.g. weeding and planting activities). Between January 2015 and December 2019, approximately 2000 plants have been planted by students and other visitors.
  - Creation of endemic gardens in schools/ and or free issue of plants to schools (on demand).
  - To raise awareness on importance of trees and encourage people to plant trees, plants were issued free of charge (to Government institution, NGOs, Parastatal bodies, schools, socio-cultural organisations) under the national tree planting campaign (from January 2015 to December 2020 more than 120 000 plants have been issued free of Charge).
  - The international Day of Forests was celebrated in Mauritius in 2016,2017,2018. Each year, the event was attended by students, representatives of various governmental organisations NGOs, and local inhabitants. Information dissemination materials (pamphlets, posters, video clips, intervention on TV and Radio) were specifically prepared to marks these events. For experiential learning, tree planting events, creation of endemic gardens, free issue of endemic plants were also organised.

### **Cross-Cutting for the five objectives**

#### **A. Capacity development**

Training of staff at all levels is a cross cutting component of the strategic plan that influences the implementation of all the strategic objectives. During the preparation of the strategic plan the main areas of competency identified for strengthening included: (i) management of forest plantations and protected areas, (ii) monitoring and enforcement, (iii) public awareness and education and (iv) nature-based tourism development (v) arboriculture and green Landscaping (vi) data management and information sharing.

Progress has been made in terms of capacity development initiatives that cut across the various strategic objectives and outcome areas. For example, the Government sponsored 40 forest officers (20 already graduated + 20 ongoing) for a Diploma Course in Forestry at the University of Mauritius. The course has been specifically designed to meet the demand of the Forestry Service.

Short training programs were also run to strengthen capacity of Officers of the Forestry Service, National parks and Conservation Service, representatives of NGOs and private forest owners in diverse themes related to such forestry, endangered species management, habitat restoration, invasive alien species management, wildlife photography, sensitization and awareness, etc. These training programs were run under the Protected Area Network Project (GEF funded).

Under the FAO project TCP MAR 3602 (August 2016 to March 2019) ‘Support to Forest Code Revision and Institutional Reform in Mauritius’, a Training of Trainers session was carried out between 29<sup>th</sup> July to 3<sup>rd</sup> August 2018. It targeted 20 beneficiaries from public and private institutions involved in the policy implementation. The training was focused on the following thematic areas: (i) Standard operating procedures (ii) forest policy development and evaluation (iii) environment economic valuation, (iv) research methodologies and survey

techniques (v) formulation of awareness raising programmes. In addition to the above, Forest Officers also participated in several international workshops on topics related to forestry.

## **B. Research**

Apart from a few research projects by students on ecology and conservation and propagation of native species, very little progress has been made towards implementation of the research components. The collaboration with academics and NGOs has not significantly improved since inception of the project implementation and research areas for the project has not been prioritised.

## **C. Constraints for implementation of the strategic plans**

- In spite of key progress towards the achievement of certain goals, the implementation process faced several constraints. The main constraints are outlined below:
- *Inadequate human resources* – Acute shortage of staff at the Forestry Service.
- *Low participation of Private land owners* - Inability to stimulate sufficient private land owners to embark on forest restoration and protection activities. Due to limited land area, increase in population and rising value of land, private forest owners are more inclined to convert their forests lands to more profitable land uses such as housing, business development and deer ranching. Lack of sufficient incentive to encourage private forest owners to protect and restore forest land
- *Poor coordination process and knowledge management system* - The coordination process for implementation, monitoring and evaluation of the activities was not fully institutionalized and sustained. For example, some stakeholders are unclear on their roles in the plan implementation and monitoring. In addition, there was inadequate information sharing amongst institutions and stakeholders. There was no centralized database for baseline data and monitoring of the implementation process. An improved Knowledge management system was essential to leverage know-how across various institutions and to improve decision making, partnerships, increase transparency and overall results.
- *Fragmented institutional arrangements* - There was significant fragmentation in the responsibilities among various ministries and institutions in the implementation of the strategic plan including. E.g. Restoration of Native Forests is being carried out by the Forestry Service and National Parks and Conservation Service (both under the aegis of the MAIFS); there was much confusion regarding the management of Road side plantations, which were managed by the Road Development Authority, Forestry Service and Department of Environment (all three are under the aegis of different Ministries).
- *Lack of local Expertise* - Some strategic actions have not been implemented due to a lack of local expertise. E.g. Development of a Rehabilitation model for biodiversity conservation in watershed areas;
- *Lack of Base line data* - There is significant baseline knowledge gaps regarding forests on private lands. Many wetlands have not been documented.
- *Inadequate financial resources* – The activities outlined in the strategic plan was largely funded by the Government. Due to inability to mobilize additional funds

some of the strategic actions were not implemented. For example, one of activities proposed to mobilise funds (Setting up of a reforestation fund) was not implemented.

- *Capacities building gaps* - Some of the capacity building gaps that have been identified for technical and scientific areas and in core activity areas were not implemented. E.g. Training in Landscaping and arboriculture.