Republic of Mauritius

Technology Needs Assessment for an enhanced climate change adaptation and reduction of greenhouse gases emissions in the Republic of Mauritius

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Republic of Mauritius

Summary for Policy Makers

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

(July 2012)

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Introduction

It is a well-established fact that climate change is real and is one of the major challenges to humankind. It is going to affect our development process and put a risk to our hard-won development gains. It is also recognized that developing countries, in particular the Least Developed Countries (LDCs) and the **Small Islands Developing State (SIDS)**, are the **most vulnerable and least resilient to the impacts of climate change and climate variability**.

In line with Article 4(5) of the **United Nations Framework Convention on Climate Change (UNFCCC)**, developed country Parties to the convention are required to take all practicable steps to **promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies (ESTs) and know-how to developing country Parties**, to deal with the impacts of climate change.

With a view to implement this provision in the convention, the **Poznan Strategic Programme on Technology Transfer** was endorsed at the 14th Conference of Parties to the UNFCCC held in Poland in 2008 and was capitalized with USD 50 million under the administration of the Global Environment Fund (GEF) to help **to facilitate the transfer of, and access to** ESTs. In this regard, the global Technology Needs Assessment (TNA) project is being implemented by the United Nations Environment Programme with the technical assistance of the **UNEP Risoe Centre (URC)** based in Copenhagen, Denmark, and **Energie, Environnement et Developpement (ENDA)**, Dakar, Senegal covering the African region.

The project has been devised for 36 countries, out of which Mauritius is the only Small Island Developing State (SIDS) whereby the project is being **executed by the Ministry of Environment and Sustainable Development**.

Objectives

The TNA project has **three immediate objectives**:

1. To **identify and prioritize** through country-driven participatory processes, **technologies** that can contribute to **mitigation and adaptation** goals of the participant countries, while meeting their national sustainable development goals and priorities;
2. To **identify the barriers** that hinder the acquisition, deployment, and diffusion of the prioritized technologies for mitigation and adaptation; and
3. To develop Technology Action Plans (TAP) that **specify activities and enabling frameworks to overcome the barriers** and facilitate the transfer, adoption, and diffusion of selected technologies in the participant countries.

The **ultimate objective** of the TNA project is **to capacitate countries to leverage international funding to implement technology transfer to tackle climate change adaptation and mitigation**.

Stakeholder Process

The project is hinged on a fully inclusive multi-stakeholder participatory approach to address the multi- and cross-sectoral nature of climate change complexities.

In that context, a **National TNA Committee** and four **sectoral sub-committees** have been set up to manage the **technical aspects of the project**, while a **high-level TNA Steering Committee** has been institutionalized to endorse and **support the integration of recommendations formulated into national development policies, strategies and action plans.**

An integrated approach has been adopted in the execution of the TNA project, combining both top-down and bottom-up approaches. The key stakeholders, armed with the experience and proven local knowledge, have been given a central role in the project. 16 Sub-Committee sessions have thus been held from February 2011 to June 2012.

This open and participative process, with the **active participation from 28 institutions** (NGOs, Academia, Research Organizations, Private and Public sector), has ensured stakeholders' ownership and buy-in into the project.

Identification and Selection of Priority Sectors

The initial list of sectors which was identified to be considered within the realm of the TNA project comprised of water, agriculture, fisheries, coastal zone and ecosystems services, tourism, infrastructure, health, energy industries, transport, waste, industrial processes and land-use sectors.

Given the specific vulnerabilities of Mauritius to the impacts of climate change as a SIDS, the National TNA Committee considered that the TNA project should place more focus on adaptation to climate change.

Based on extended literature review of climate change impacts and national development priorities, and broad stakeholder consultations (bilateral and plenary meetings), and given the funding and time constraints, the National TNA Committee identified **four priority sectors** for Mauritius. **Water, Agriculture and Coastal Zones** (including coastal ecosystems and tourism) sectors were selected as priority climate change **adaptation sectors**, while **Energy Industries** was retained as the only **mitigation sector** for Mauritius given that it accounts for approximately 60% of all national greenhouse gas emissions.

The **priority sectors were validated** by **all project stakeholders** at an Inception Workshop held in September 2011. One sub-working group was set up for each priority sector (i.e. 4 in total) and the institutional composition of the working groups was recommended by the project stakeholders.

Identification and Selection of Technologies

The technology identification process was initiated at the Inception Workshop whereby a long list of 128 technologies were reviewed and trimmed down to a shortlist of around 7 to 9 technologies per sector, to be further examined at the sub-working group level.

As recommended by UNEP RISOE Centre, a rigorous **Multi-Criteria Analysis (MCA)** methodology was applied in the TNA project **to rank and prioritize** short-listed technologies. MCA is considered as the **most appropriate method as it combines both monetary and non-monetary criteria and indicators to evaluate options that have sustainable development dividends**. A generic framework called **MCA4Climate was adopted while tailoring its application to the local context**.

The technology prioritization process involved scoring, weighting and sensitivity analysis steps by the stakeholders, under the lead of key ministries concerned and guided by the local experts. The breakdown of sectoral sub-committee meetings comprised of 7 sessions for the Water Sector, 5 for the Agriculture Sector, 2 for the Coastal Zone Sector and 2 sessions for the Energy Industries Sector.

After ranking and prioritizing the technologies using MCA, three to four technologies have been retained for developing the Technology Action Plan (TAP).

Results of Technology Prioritisation

SECTOR	TECHNOLOGIES SHORTLISTED	TECHNOLOGIES RETAINED FOR TAP
WATER	• Reuse Treated wastewater • Rehabilitation Feeder Canals • Desalination • Stormwater Harvesting • Rainwater Harvesting • Water Fixtures & Fittings • Sensitisation Programme • Hydrological Models • Telemetry Systems	• Desalination • Rainwater harvesting • Hydrological models
AGRICULTURE	• Up-scaling of locally proven IPM technologies for control of pest of economic importance • Micro irrigation (gravity fed drip & mini and micro sprinkler irrigation) • Decentralised rapid pest and disease diagnosis service (plant clinic) • Reforestation of the water catchment area of the main Reservoirs of Mauritius • Reinforce breeding and conservation programme for crop adapted to change in climate • Education and awareness raising among farming community to promote adaptation to climate change • Low cost postharvest technology (crates and	• Up-scaling of locally proven Integrated Pest Management technologies • Micro irrigation (gravity fed drip & mini and micro sprinkler irrigation) • Decentralised rapid pest and disease diagnosis service (plant clinic)

	evaporative cooling chambers) • Improving Agro-meteorology Information network for forecasting and Early Warning System • Index based weather disaster subsidized agricultural insurance scheme for food crop	
COASTAL ZONE	• Setbacks (including minimum elevation requirements) • Relocation • Shore and beach management (e.g. controlled access, onshore grading, vegetation enhancement, dune enhancement etc...) • Beach nourishment • Groynes • Artificial headlands • Detached breakwaters • Shoreline armouring (e.g. revetments and sea walls)	Depending on site specificities, a combination of technologies listed below could be considered • Restoring coastal vegetation • Wetland protection • Dune restoration • Rock revetment
ENERGY INDUSTRIES	• Wind (utility scale) • Photovoltaic (> 1MW) • Energy Efficiency in Boilers (heat recovery) • HE compressors (industrial) • Small-scale hydro (>50 kW) • Energy Efficient Building Design (Façade insulation) • EE HVAC (industrial)	• Wind (utility scale) • Photo-Voltaic (greater than 1 Megawatt) • Energy Efficiency in Boilers (heat recovery)

Capacity Building

The global TNA project provides for a series of regional and in-country workshops to train coordinators, consultants and local stakeholders on the tools and methodologies to be employed.

A first regional workshop, organised and facilitated by UNEP RISOE Centre and ENDA Alteer, was held in Kenya from 28-30 July 2011 and replicated in Mauritius on 27-28 September 2011. Participants from the relevant departments of the Ministry of Energy and Public Utilities, Ministry of AgroIndustry and Food Security, Ministry of Fisheries, Ministry of Environment and Sustainable Development, as well as local consultants were exposed to tailor-made training on methodologies regarding technology prioritisation and stakeholder engagement.

Further capacity building was also undertaken during the Inception workshop held on 21-22 September 2011. A training course was also provided to all local stakeholders on the theory and application of Multi-Criteria Analysis in January 2012 that provided the basis for technology prioritisation by the technical working groups. Calculators were developed indigenously to help members of the technical working groups to apply MCA to prioritise technologies and these calculators have also been shared with stakeholders.

A second regional workshop was also held from 13 to 17 February 2011 in Zambia to empower local consultants and coordinators on the second phase of the project, *viz.* Barrier Analysis, Enabling Environment and Development of Technology Actions Plans.

Moreover, all along the project implementation, the scoping studies, reports and tools developed in the TNA project have been made available to all local stakeholders. It is firmly believed that the tools and methodologies could be applied to other climate and non-climate related projects.

While stakeholders contributed their expertise and experience within the local context, the project reciprocated by empowering them with the capacity building described earlier. This **win-win situation** has been maintained to ensure continuous constructive contribution and level of interest of local stakeholders with a view to serve the project objectives. The stakeholders, in turn, benefited from the highly interactive and **learning-by-doing approach** adopted in the TNA project, and they have fully embraced the learning opportunities offered by the project.

Way Forward

As part of the second and final phase of the TNA project, **Technology Action Plans (TAPs) will be carried out for selected prioritized technologies involving detailed analysis of the main barriers that hamper their uptake and/or diffusion**. The TAP will also develop means to overcome these barriers, as well as detailing the enabling conditions that are needed to promote these technologies.

Finally**, in line with the ultimate objective of the TNA, concept notes will be developed for leveraging funding to support the implementation of TAPs**.

The TNA project is expected to be completed by the end of June 2013.

Republic of Mauritius

TNA REPORT II
BARRIER ANALYSIS AND ENABLING FRAMEWORK – ADAPTATION (Agriculture, Water and Coastal Zone)

(March 2013)

Supported by:

Executive Summary

This report on Barrier Analysis and Enabling Framework covers adaptation technologies for three sectors, namely: (1) agriculture, (2) water, and (3) Coastal Zone. For each sector, the report covers the following:

- Setting up preliminary target of technology transfer and diffusion of each of the adaptation technology
- Identifying and prioritizing the barriers using the following barrier analysis tools: bilateral meetings, brainstorming, informal interview of documents, market mapping linking all the market actors and the Logical Problem Analysis involving barrier decomposition and root causes analysis
- Investigating, assessing and categorising the possible measures to address the barriers for the transfer and diffusion of each technology and eventually
- Identifying the enabling environment and support services to enhance the uptake of the technologies.

The Mauritian agriculture is dominated by sugar cane but based on the vulnerability analysis this study focused on the food crop and forestry sectors. In view of likely impact of climate change on the sectors, adaptation technologies were selected and prioritised to ensure that they are effectively transferred to improve resilience. In the development of TNA three prioritized adaptation technologies that best suit needs of small scale farmers were retained. They included (1) up-scaling of proven IPM technologies to reduce pest damage likely to amplify with increase in pest population due to temperature rise, (2) micro-irrigation in order to optimise use of water which is likely to become scarce in the future while enhancing food production and (3) decentralized pest and disease diagnosis to enable farmers to make informed timely decision concerning pest and disease control as well as reduce unnecessary pesticide application and minimize risk of crop failure. Technology Action Plan (TAP) was developed for 2 of the technologies namely: up-scaling of proven IPM technologies focusing on all food crop growers and micro-irrigation focusing of small scale growers of horticultural crops in the drought prone areas of the island.

The main barriers identified were limited research and development capacity, inadequate training and awareness, limited demonstration and technical support, weak inter institutional collaboration, lack of policies promoting climate change adaptation policies, gap between R&D and market chain. A range of measures and enabling environment required to overcome the barriers were identified including policy, economic incentives, research and institution support and public awareness.

The water sector in Mauritius is characterised by high rainfall, 2500mm on average, with the higher elevation regions receiving up to 4000mm rainfall annually; high surface runoff, 60% losses to the sea, increasing high intensity rainfall events which produce large volumes of surface runoff, variability in annual rainfall recorded over time; an increase in the minimum and maximum temperature and an increasing water demand with time. A number of measures will need to be implemented in order to address water security, and the Technology Needs Assessment study undertaken with the collaboration of stakeholders, has shortlisted three particular technologies which are considered as being key to help the country adapt to the negative impacts of climate change.

The TNA for the water sector retained three technologies, namely; Rainwater Harvesting at Residential level (RWH), Hydrological Models (HM) and the Desalination Technology in the hotel sector (Desal). These adaptation technologies reflect the priority for the country to climate change adaptation. The country is already recording flood type rainfall events which give rise to high surface runoff. In addition, the country falls under the category of the water stressed country, as per the IHDP classification, hence the need to both improve the water resource management practices and the need for alternative water sources.

The rainwater technology is firstly aimed at reducing the volume of rainwater which is lost as surface runoff and secondly is also aimed at educating the general public on sustainable use of water resources. The general public in Mauritius use potable water for secondary uses and are not aware of the cost and energy implications of water treatment and distribution processes that go into producing potable water. About 14% of the total water consumed per household goes into cleaning and gardening, hence the need to promote rainwater harvesting at residential level. Rainwater harvesting technology will contribute towards capturing the excess surface runoff which is lost to the sea and also to a more optimal use of treated potable water.

About 17 hotels located along the coastal zone have already embarked onto the desalination technology. The practice is desalination of brackish water, which is relatively less saline, with conductivity values of less than 30,000 mg/l. The desalination technology in use is the reverse osmosis process. The Government is encouraging hotels located along the coast to implement the desalination technology, in order to alleviate the pressure on water demand. By implementing a desalination plant, the hotels also have the guaranteed of satisfying the water demand of their customers. The Desalination process is relatively highly energy intensive and hence costly. During long dry periods the hotels buy water from the Central Water Authority at the rate of Rs. 30. per m^3, and based on this rate the cost of implementing such a plant becomes relatively a good option. However during the wet period, the cost of water is around Rs. 5 per m^3 and this makes the water produced from desalination plants a poor option. As per the prevailing environmental legislation EPA (2002), all coastal hotels need to look into the possibility of desalination technology. Following the recent long dry period, the Government is encouraging the hotel sector to set up desalination plants. The major concern of the water authorities is that the practice is about the desalination of brackish water rather than sea water.

Modelling and forecasting is an important working tool for effective decision making in the water sector. The use of hydrological models will help decision makers take more informed decisions on water management during long dry periods and to improve water management following climate change situations.

All the three retained technologies are highly crucial for adaptation to climate change; they address effective water management issues, sustainable use of water resources and alternative source of water, which are key issues to adaptation to climate change. Components of each prioritized technology have been analysed in terms of technical requirement, transfer and diffusion requirement, and current status of accessibility and readiness for implementation. From there Technology Action Plans have been prepared for two of the three technologies.

The TNA for the Coastal Zone sector has retained four technologies, namely; Restoration of coastal vegetation, Wetland protection, Dune restoration and Rock revetment. Mauritius with its varied coastline ranging from sandy beaches to rocky shores and cliff is very much affected by coastal erosion. The causes of erosion as identified by several studies including the Study on Coastal Erosion in 2003 were from the direct interaction of the sea with the shoreline, mainly during extreme events such as cyclones and storm surges. The extent of erosion is however exacerbated in certain places because of the negative anthropogenic impacts on the health of lagoons, beaches and dunes.

Three of the four technologies retained, Restoration of coastal vegetation, Dune restoration and Rock revetment are applicable directly on the shoreline and would provide direct benefits to the location where they are applied. In contrast, wetland protection would act indirectly in mitigating the erosion impacts on an adjacent coast. Wetlands, through their hydrological services they provide, contribute to improve the water quality of the lagoon around Mauritius and thus a healthy marine environment which in turn would contribute to the stability of the shoreline. The soft technologies, such as dune restoration and restoration of coastal vegetation, are used in conjunction. Both financial and non-financial barriers have been discussed for the combination of different coastal adaptation technologies, and unlike the other two sectors, a site-specific approach has been adopted. This is because the use of any coastal technology is critically dependent on the extent of erosion, near-shore dynamics, type and extent of human pressures, like coastal developments, and access and use of coastal sites, and topographical constraints, among others.

Republic of Mauritius

TNA REPORT II

BARRIER ANALYSIS AND ENABLING FRAMEWORK – MITIGATION (Energy Industries)

(March 2013)

Supported by:

Executive Summary

This report has discussed in details the barriers that prevent the promotion and diffusion of two mitigation technologies, namely (1) utility-scale wind energy, and (2) industrial and commercial waste heat recovery using boiler economizer. Both economic and financial barriers and non-financial barriers have been discussed. It has been observed that the economic and financial barriers are the most dominant in both cases. A proposition has been made that all barriers translate into risks from an investor's perspective, which would then increase the expected financial return on an investment in RE or EE technology. Detailed benefit-cost analysis has been carried out in both cases, and the analysis shows that the measures proposed to overcome barriers yield net sustainable development dividends when social (job creation), economic (reduction in energy bill) and environmental (reduction in GHG emissions) benefits are accounted using an incremental approach. The enabling environment and key stakeholders have been identified using the market mapping technique.

Republic of Mauritius

TNA REPORT III
TECHNOLOGY ACTION PLAN – ADAPTATION
(Water, Agriculture and Coastal Zone)

(March 2013)

Supported by:

Executive Summary

This report is the third in a series of reports that have been generated under the TNA project. It provides action plans for prioritized adaptation technologies in three sectors, namely: (1) water; (2) agriculture, and (3) coastal zone for Mauritius. Several parts of the Technology Action Plan (TAP) are derived from reports RI – TNA report and RII – Barrier Analysis and Enabling Framework for adaptation to climate change that have been generated under the TNA project. Consequently, TAP has to be used in concurrence with RI and RII for further details and references.

Mauritius has been grouped under the category of water stress countries, based on its current exploitable potential of the total rainwater recorded. The demand for water in all sectors is increasing with time, putting more and more stress on the water sector. The island has been recording heavy intensity long duration rainfall over the recent years and these rainfall events give rise to high surface runoff, and consequently high loses to the sea. The water sector is under increasing pressure, with increase in demand in all sectors and the negative impacts of climate change. In addition to increasing its exploitable potential from the current 33% total rainfall and to reduce the high loses in the form of surface runoff to the sea (about 60%), the country has to adopt measures in order to ensure sustainable development and optimal use of water resources.

Rainwater harvesting is one of the adaptation technology which has been identified through stakeholder participation approach, and this technology targeted the residential sector. The main constraints that have so far hinder the promotion of RWH is the low cost of potable water, the availability of potable water (99.6% population having access to piped water supply) and the availability of plentiful of good quality water in the recent past. With increasing demand and impacts of climate change, the scenario is changing. The country has been witnessing extreme events which have impacted upon its water security. Flood type rainfall events are common and these give rise to high surface runoff, and long dry periods further reduce the recharge potential to groundwater. Implementation of the rainwater harvesting technology will serve two purposes, one of making optimal use of domestic water by using rainwater for secondary purposes and the second one as an artificial recharge system for groundwater. Among the measures that have to be considered to ensure successful implementation of RWH is first appropriate legislation, institutional support and financial incentives. Legislation is needed to ensure that the consumer is protected against bad quality products and institutional support is needed in order to monitor the concerns and benefits of implementing RWH at residential level. In addition, aggressive sensitisation campaigns are needed to make the general public aware of water security issues and the need for each and every one to contribute towards achieving sustainable development and consumption of water resources. Since RWH is a simple technology with significant benefits, the proposed measures in terms of legislation, institutional support and sensitisation campaigns should be considered within the first five years, though a span of at least 10 years will be needed to get the maximum number of housing units adopt the RWH technology.

The second technology that was retained was the Desalination Technology and this time the target group was the hotel sector. Currently some 17 hotels have implemented the reverse osmosis desalination technology in order to address water security during dry periods. A Governmental policy has been promulgated since August 2012 so as to encourage hotels located along the coastal areas to implement desalination plant. The Desalination Technology is gaining wider acceptance over time owing to major development in the energy implications associated with this technology. This technology provides for an

alternative source of water, for Mauritius depends heavily on rainwater to cater for water demand. Climate change is increasing the variability of rainfall patterns and hence, increasing the vulnerability of the water sector in Mauritius. An alternative source of water is much needed in Mauritius, as the island is isolated and cannot consider importing water from nearby countries. The main barriers to the successful implementation of the desalination technology are the high initial cost, the operational cost, the maintenance cost, the lack of skilled technical staff, the environmental impacts associated with brine disposal and the lack of a consolidated legislation for ensuring safe desalination practices in the country. In order to address water security though an alternative source of water supply, there will first be a need for a consolidated legislation that will address safe exploitation of brackish water or sea water, safe disposal of brine effluents and minimise the long term impacts of disposal of brine in the aquifers. There is also a need to encourage local training institutions to train skilled technicians who will ensure sound and safe operation of the desalination plants. In addition to legislation and training, institutional support in terms of logistics and financial support are also a major factor. Given that the Government has recently promulgated a policy for desalination technology in coastal hotel, the promotion of desalination technology has already started. Hence it is expected that there is an urgent need to promulgate the legislation and to train skilled technical staff and these are needed over the next 5 years. In the longer time, over the next 10 years, more and more hotels would be adopting the desalination plant.

The third technology that was identified by the stakeholders is the Hydrological models, and this was targeted at the local water institution for a more effective water management approach. The use of hydrological models for a more informed decision is commonly used in many countries. The complexity of a hydrological model is related to the accuracy of the analysis and also of the complexity of the data collection. In Mauritius, hydrological model has not been very successful so far, because of the lack of local training and research centres dedicated in the use of hydrological models. The initial capacity cost, including training, capacity and logistics, are viewed as being a very high initial costs and the benefits are long term and often intangible, being associated with comfort and well-being. Hydrological model also requires highly skilled technical staff to understand how the model works and to critically make use of the results of the analyses for decision making. In order to promote the use of hydrological models, there is firstly a need to set up a dedicated unit at the offices of the concerned water authority, provide regular training to the technical staff, train trainers from local research and training centres to ensure transfer of know-how, and to cater for capacity building over a period of 2 years. There are a large number of hydrological models which are available on the market and the promotion of this technology would not take a long time, though the reliance of this working tool will take longer as this depends on the time taken by the highly skilled technical staff to master the use of this technology. The appropriate legislation, especially in terms of digital data security and sharing may take a longer time, more than 5 years. Overall it is possible within the first five years, to reap both the tangible and intangible benefits of hydrological model.

Agriculture being highly vulnerable to climate change was prioritised as one of the sector for adaptation for the Technology Need Assessment. The TNA study however focused only on foodcrop and livestock subsectors rather than the entire agricultural sector to ensure that adaptation technologies of interest can be translated and implemented in the most effective manner. Thus, firstly, the target subsectors were identified based on their vulnerability to climate change and contributions to the country's economic development and food security and the immediate need in terms of technology development and transfer. The criteria used in the prioritization of adaptation technologies were 1) the technical potential of the technology, 2) contribution of the technology to improve climate change resilience and sustainable development, 3) cost and ease of implementing the technology and 4) contribution of the technology to national development strategy and policy. Based on stakeholders' consultation and multi-criteria analysis, the adaptation technologies identified, prioritised and retained for the Technology Action Plan (TAP) were:(1) Up-scaling of proven IPM technologies in order to reduce risk of damage from pests and diseases likely to increase with rising temperature as well as to reduce excessive use of synthetic pesticides while improving productivity and minimising environmental and health impacts and (2) micro-irrigation to reduce risk of crop failure or loss while improving water use efficiency and. The TAP process involved: (1) setting up preliminary targets for technology transfer and diffusion of each technology option, (2) identifying barriers, (3) investigating possible solutions to address the barriers for the transfer and diffusion of technology, (4) and eventually developing a technology action plan for each technology option by considering legislation and regulation, financial incentives, institutional arrangement, infrastructure, R&D support, and human resource development.

During the TNA process, it was noted that many of these technologies were cross-cutting and could be applied across agricultural sub-sectors. Lack of financial support and knowledge/expert were identified as the fundamental barrier for technology development and implementation in Mauritius. The following major common barriers for the sector were identified (1) economic, (2) technology capacity, (3) policy and regulation and (4) infrastructure and analysed.

The common barriers of technology implementation that cut across the adaptation technologies and the 3 highly-impacted sectors: agriculture, water and coastal zone sector were identified and the possible cross-sectoral capability development actions were analysed. The common measures and possible synergies between technologies and across sectors were also identified and analysed.

Subsequently, the Technology Action Plans (TAPs) for each technology were developed. In this process, barriers to the transfer and diffusion of the two prioritized technologies were identified. The TAPs were established and divided into 3 phases, namely short-term (<0-5 years), medium term (5- 10 years) and long term (10-20 years). Food security being a national priority and climate likely to impact on agricultural productivity, emphasis is to identify actions to support small-scale farmers to cope with water stress and increasing pest and diseases pressure while promoting sustainable production systems. Actions to address most of the common barriers require policy enforcement or supporting mechanism such as policy enhancing 1) research collaboration, 2) R&D budget and 3) MOU with developed countries on technology transfer or research collaboration.

The TNA for the Coastal Zone sector has retained four technologies, namely; Restoration of coastal vegetation, Wetland protection, Dune restoration and Rock revetment. Mauritius with its varied coastline ranging from sandy beaches to rocky shores and cliff is very much affected by coastal erosion. The causes of erosion as identified by several studies including the Study on Coastal Erosion in 2003, were from the direct interaction of the sea with the shoreline, mainly during extreme events such as cyclones and storm surges. The extent of erosion is however exacerbated in certain places because of the negative anthropogenic impacts on the health of lagoons, beaches and dunes.

The coastal zone of Mauritius is important not only for providing income through tourism and fisheries but also protecting the island from the natural forces of the ocean. The viability of the major economic activity and protective functions are wholly dependent on the vitality, aesthetics and ecological functioning of the coastal ecosystems.

Three of the four technologies retained, Restoration of coastal vegetation, Dune restoration and Rock revetment are applicable directly on the shoreline and would provide direct benefits to the location where they are applied. In contrast, wetland protection would act indirectly in mitigating the erosion impacts on an adjacent coast. Wetlands, through their hydrological services they provide, contribute to improve the water quality of the lagoon around Mauritius and thus a healthy marine environment which in turn would contribute to the stability of the shoreline.

This present report provides an insight of the various strategies, national policies and action plans that have been developed over time and supports the sustainable development of the coastal zone in the Mauritius.

The various barriers to the diffusion of each technology have first been identified and then analysed in view of putting forward the most appropriate plan of action for each technology. It has been found that one common aspect leading to the barrier in the implementation of the technology has been the high costs involve and thus the need to make provision for appropriate financial incentives in certain cases. The legislation and regulations should also be reviewed and improved so as to support the actions and it was observed that lack of information and awareness in the use and benefit of the technology has also contributed to the implementation of these in Mauritius.

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TNA REPORT III
TECHNOLOGY ACTION PLAN
(Energy Industries)

(March 2013)

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Executive Summary

This Technology Action Plan (TAP) Report is the synthesis of the two reports, namely: (1) Technology Needs Assessment (TNA) Report; and (2) Barrier Analysis and Enabling Framework Report that have been developed under the TNA project for Mauritius. It is the product of broad multi-stakeholder collaborative action. The leaning-by-doing methodology has been used throughout the duration of the TNA project, whereby training on the tools and methodologies developed in the project were provided to all stakeholders. These methodologies and tools can be used for developing Nationally Appropriate Mitigation Actions (NAMAs) for Mauritius using an evidence-based approach.

This report has presented an overview of the power sector of Mauritius, along with its associated GHG emission levels and trends, broken down per sector. In 2010, energy industries accounted to 60% of total emissions, the highest contributor before transport with 24.8%. The National Energy Strategy targets for the electricity mix to 2025 places the use of renewable fuel sources at 25% of the total, notably with the share of wind power increasing from 0% in 2010 to 8% in 2025. Energy Efficiency (EE) target for the stationary combustion of fossil fuels (e.g. boilers in commercial and industrial settings) does not exist. In this report, one Renewable Energy Technology (RET) and one EE measure have been prioritized for climate change mitigation, namely utility scale wind energy and energy efficient boilers, respectively.

The TNA project has not discussed the wind farms or installation of economizers as stand-alone projects. Instead, it has considered the cumulative installed wind energy capacity to 2025, and that of economizers to 2020, which is analogous to the programmatic approach for scaling-up emission reductions. This programmatic approach is aligned with the development of sectoral Nationally Appropriate Mitigation Actions (NAMAs) for Mauritius. The Technology Action Plan (TAP) has also discussed the use of performance-based emission reduction finance instrument for accessing multilateral and bilateral sources of funding, along with domestic funding to support the implementation of measures. Hence, the action plans for the energy industries may be used for attracting funding for supported NAMAs.

Barriers for technology diffusion are for the most part financial: (1) wind technology investment is capital intensive, can be financially un-viable depending on tariffs for the sale of electricity, (2) initial investment in boiler economizers is high. In the case of boiler economizer, the non-financial barriers have been valued. This report therefore proposes the following measures and enabling framework for overcoming barriers and generating attractive investment opportunities:

Wind Technology	**Energy Efficient Boilers**
Measures	
A cost-reflective dynamic Feed-in Tariff (FiT) as a financial support scheme, supported by a wind-energy resource map that permits to determine the electricity generation capacity of wind-farms at	Support the uptake of economizers through the provision of energy audits, a rebate scheme on capital investment, and training of energy

different locations.	managers.
Enabling framework	
Guaranteed access to the grid supported by a Utility Regulatory Authority (URA), business permit facilitation, provision of financial and banking services	Provision of financial and banking services, EE promotion services, consulting services.

The TAP for utility-scale wind energy is summarised below. The penetration of wind technology is aligned with the Long-Term Energy Strategy 2009-2025 with a total installed wind capacity equal to 100MW in 2023. The provision of financial incentive in the form of a Feed-in-Tariff (FiT) is recognized as a policy instrument for de-risking investment in renewable energy technologies. The benefit-cost ratio is a high 4.84 showing the net worth of investing in the financial incentive. The benefits of wind technology have been taken as: (1) CO_2 emission reductions; (2) jobs created; and (3) savings on national energy bill. The cumulated emission reduction to 2025 has been calculated as 1,640,856 tCO_2. The table identifies the main stakeholders, time frame for implementation of action plan, selected indicators of success and the main risks associated with the implementation of the action plan.

Barrier Category	**Barriers**	**Potential measures, cost and capitalization**	**Concerned Institutions**	**Time Frame**
Economic & Financial (wind technology is financially not viable)	High Cost Capital Inappropriate financial incentives	Provide financial incentive in the form of cost-reflective FiT for de-risking investment in wind energy technology. Cost of action: Rs 937,695,079 (NPV) Benefit –cost ratio: CBR = 4.84 Sources of funding: • Public financing through carbon tax on fossil fuels; • Multi-lateral or bilateral funds for implementing FiT as a supported NAMA	Ministry of Finance and Economic Development; CEB, Ministry of Energy and Public Utilities; Ministry of Environment and Sustainable Development. The roles and functions of these institutions are discussed in Annex 2.	0-13 years
Indicators of success (selected): - Installed capacity (MW) - % penetration of wind in the national grid - Wind electricity generated annually (MWh/yr) - Grid emission factor - Annual emission reduction by wind (tCO_2/yr) - Number of jobs created - Monetary value of fossil fuel import substitution (Rs/yr) - Annual value of financial incentive disbursed for each project (Rs/yr)				

Barrier Category	Barriers	Potential measures, cost and capitalization	Concerned Institutions	Time Frame
Risks associated with action plan: Regulatory risk: The setting up of the URA may be further delayed that would slow down the penetration of wind energy due to lack of transparency in the setting of electricity tariffs and contract negotiations; Financial risk: The FiT scheme is predicated upon the availability of substantial amount of funding, and funding on a regular and timely basis. This is important in the context that guaranteed access to the grid will be granted for 15 years; Wind potential risk: There is a risk that wind energy potential assessment is not completed or delayed in its implementation that would jeopardize site selection for wind farms; Social risk: Mauritius is a small island and there is a high likelihood that suitable wind farm sites may be close to communities, environmentally sensitive areas, have detrimental impacts on bird life; be seen to be aesthetically unpleasant, among others. Wide-scale communication campaigns will be necessary and communities must be engaged at the early stage of wind project development; Technical risk: There is a low risk that the technologies adopted by promoters do not respond well in the cyclonic conditions that may prevail over Mauritius periodically; and Operational risk: The penetration of wind energy is predicated upon the increase in base load power production in the network. The targets set for the penetration of wind energy to 2025 is therefore dependent upon the timely commissioning of other power generation units detailed in the Long-Term Energy Strategy 2009-2025.				

The action plan for economizer seeks to retrofit a total of 115 economizers on boilers burning either diesel (61) or LPG (54) between 2013 and 2020. The annual CO_2 emission reduction in the Mauritian context has been calculated at 54.2 tCO_2 and 18.3 tCO_2 for retrofitted boilers running on diesel and LPG, respectively. The main financial measure seeks to provide a 20% rebate on the capital cost of an economizer. The net Present Value (NOV) of the three measures proposed here is Rs 33,190,975, which also takes into account the cost of operation and maintenance (O&M). The benefits consist of: (1) CO_2 emission reductions; (2) jobs created; and (3) energy saved. Depending on the choice of parameters, the benefit-cost ratio varies between 2.42 and 10.12. The various elements of the action plan for boiler economizer are summarised in the table below.

Barriers Category	Barriers	Potential measures, cost and sources of funding	Concerned Institutions	Time Frame
Economic & Financial	High Cost Capital	Government to provide financial incentives in the form of a rebate scheme on capital investment	Ministry of Finance and Economic Development; Ministry of Industry.	0-7 years
	Inappropriate financial incentives and disincentives			
Market Failures/	Low awareness of the technology	Energy audit for each boiler for retrofitting	Ministry of Industry,	0-7 years

Barriers Category	Barriers	Potential measures, cost and sources of funding	Concerned Institutions	Time Frame
Imperfection	Lack of consulting services	an economizer by a professional auditor, as incentive for associated capital investment	Commerce and EEMO.	
Social, cultural and behavioural	Traditions and habits	Promote EE interventions through training of energy managers (1 person per enterprise)	EEMO and/or the Ministry of Industry, Commerce.	0-7 years
	Lack of trained energy managers			
		<u>Cost of measures</u>: Rs 33,190,975 (NPV) <u>Benefit-cost ratio</u>: CBR = 2.42 – 10.12 <u>Sources of funding</u>: • Public financing through carbon tax on fossil fuels; • GEF-UNDP-EEMO project for the removal of barriers to promote EE in industry; • Multi-lateral or bilateral funds for implementing rebate scheme as a supported NAMA		

Indicators of success (selected):

- Number of economizers installed (with full specification)
- Quantity of fuel saved annually for by each economizer (tonne fuel / year)
- Annual emission reduction by each economizer (tCO_2/yr)
- Number of jobs created
- Monetary value of energy saved (Rs/year)
- Annual value of financial incentive disbursed for each project (Rs/yr)

Barriers Category	Barriers	Potential measures, cost and sources of funding	Concerned Institutions	Time Frame
- Number of energy managers trained (number per year) - Number of audits carried out				
Risks associated with action plan: Financial risk: The action plan is predicated upon the availability of substantial amount of funding on a regular and timely basis. There is a low risk that sufficient funding may not be available; Operational risk: There is a low-to-medium risk that the technologies adopted by promoters are not operated and maintained adequately leading to premature failure and reduced confidence in technology; and Human capacity risk: Since qualified energy auditors and energy managers are in short supply in Mauritius, there may be a high turn-over of such skilled staff once they have been trained;				