Government of the Cooperative Republic of Guyana

Technology Action Plan for Mitigation

January 2018

Supported by:

gef

UNEP DTU PARTNERSHIP

UN environment

Guyana Technology Action Plan for Mitigation

January 2018

This publication is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by UN Environment (UNEP) and the UNEP DTU Partnership (UDP) in collaboration with the Regional Centres (Libélula, Peru and Fondación Bariloche (FB), Argentina). The views expressed in this publication are those of the authors and do not necessarily reflect the views of UDP, UN Environment, Libélula, FB or the Government of Guyana. We regret any errors or omissions that may have been unwittingly made.

Acknowledgements

The Government of the Cooperative Republic of Guyana is extremely grateful for the contributions made by the National TNA Committee, local experts, stakeholders from the various sectors, the Consultant, Mr. Shyam Nokta, and the staff of the Office of Climate Change, Ministry of the Presidency in preparing Guyana's TNA mitigation reports and this technology action plan on mitigation and accompanying project idea notes.

We are also grateful for the support provided by the Global Environment Facility, United Nations Environment Programme – Technical University of Denmark (UNEP-DTU) Partnership, and the TNA Regional Offices for the Latin American and Caribbean Region Fundación Bariloche and Libélula.

Foreword

Hon Lt. Col. (Ret'd) Joseph Harmon, MSM, MP
Minister of State

The Government of the Cooperative Republic of Guyana is committed to the fight against global climate change. This commitment is demonstrated at the global level as exemplified in our Nationally Determined Contribution (NDC) under the Paris Agreement, and actions taken at the local level in the pursuit of a Green Economy.

As expressed in our NDC, Guyana's overarching contribution goal is to achieve a Green Economy *via* a low emission economic-development pathway. We intend to continue the transition of our economy to realize improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. This includes the pursuit of a resilient, low-carbon, socially-inclusive economy that provides a better quality of life for all within the ecological limits of our planet, particularly as it pertains to our common global climate.

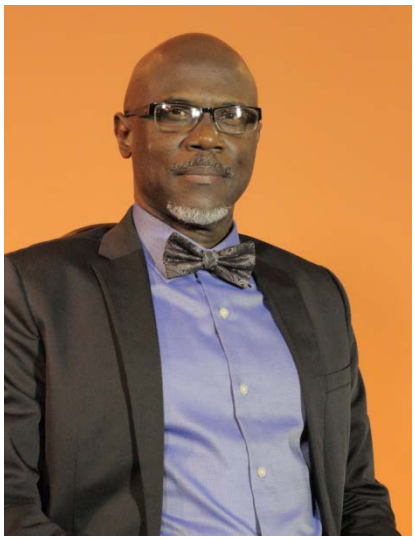
The Technology Needs Assessment (TNA) project has allowed Guyana to examine and prioritize our technology needs for key mitigations sectors (Forests -with a focus on Mining- and Energy) and key adaptation sectors (agriculture, coastal zone and low lying communities, and water), in accordance with commitments made in the NDC and within the framework of the Green State Development Strategy (GSDS).

The TNA process examined barriers to diffusion of the technologies and identified measures and actions to address the identified barriers in the technology action plans and project ideas presented in this report. The studies/analysis generated from the TNA project and resultant technology action plans provide valuable information in achieving our commitments towards emission reductions and to adaptation to climate change impacts.

As Minister responsible for climate change matters, it is my fervent hope that the technology action plans will form an integral part of our planning process for these key sectors and the project idea notes produced will help to initiate the request for funding in critical areas.

Joseph Harmon, MSM, MP
Minister of State
Ministry of the Presidency
Government of the Cooperative Republic of Guyana

Statement from the Chairman of the National TNA Committee



Rear Admiral (Ret'd) Gary A R Best, MSS
Presidential Advisor on the Environment
June 2015 –January 2018

According to the Intergovernmental Panel on Climate Change (IPCC), 'adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change'. Adaptation and mitigation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods and behavioural and lifestyle choices. Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation.' (IPCC 2014)

The Technology Needs Assessment (TNA) Project has allowed the Cooperative Republic of Guyana to prioritize adaptation and mitigation technologies suitable to local circumstances, taking into account Guyana's commitments under the Paris Agreement as expressed in the country's Nationally Determined Contributions.

The process of arriving at the Technology Action Plans for adaptation and mitigation and Project Idea Notes for the prioritized sectors has been an intense but rewarding one. This process included consultations with local experts and stakeholders who are in direct interface with the users of technologies, and other actors who hold responsibility for the diffusion of the technologies at various levels of government.

It is with great pleasure that I submit, on behalf of the Government of Guyana, the final Technology Action Plans and Project Idea Notes. As Chairman, I look forward to the development, enhancement and transfer of the identified technologies for integration into our national policies, strategies and plans.

Finally, I wish to thank the UNEP-DTU Partnership, the Global Environment Facility (GEF) and the members of the National TNA Committee for the execution of this project.

With every good wish,

Rear Admiral (rtd) Gary A R Best, MSS
Presidential Advisor on the Environment (June 2015-January2018)
Chairman, National Technology Needs Assessment Committee

Table of Contents

List of Tables

List of Abbreviations

AC	Alternating Current
BA&EF	Barrier Analysis and Enabling Framework
CI-G	Conservation International – Guyana
DC	Direct Current
DoE	Department of Environment
DTU	Technical University of Denmark
ERP	Emissions Reduction Programme
EPA	Environmental Protection Agency
GE	Green Economy
GEA	Guyana Energy Agency
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GGDMA	Guyana Gold and Diamond Miners Association
GGMC	Guyana Geology and Mines Commission
GHG	Greenhouse Gas(es)
GMSTC	Guyana Mining School and Training Centre Inc.
GO-INVEST	Guyana Office for Investment
GoG	Government of Guyana
GPL	Guyana Power and Light Company
GRA	Guyana Revenue Authority
GSDS	Green State Development Strategy
GTI	Government Technical Institute
HRDP	Human Resources Development Plan
HECI	Hinterland Electrification Company Inc.

IAST	Institute of Applied Sciences and Technology
IDB	Inter-American Development Bank
ICU	Institutional Capacity Upgrading
IFG	Improved Forest Governance
LCDS	Low Carbon Development Strategy
MCA	Multi-Criteria Analysis
MDG	Millennium Development Goal
MoB	Ministry of Business
MNR	Ministry of Natural Resources
MoF	Ministry of Finance
MoPI	Ministry of Public Infrastructure
MPFR	Mineral Policy and Fiscal Regime
MRVS	Monitoring, Reporting and Verification System
NDC	Nationally Determined Contributions
NDS	National Development Strategy
NFP	National Forest Policy
OCC	Office of Climate Change
PIN	Project Idea Note
PV	Photovoltaic
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus
RIL	Reduced Impact Logging
RPM	Revolutions per Minute
SNC	Second National Communication
SWG	Sectoral Working Group

TAP	Technology Action Plan
TNA	Technology Needs Assessment
TVET	Technical Vocational Education and Training
TWG	Technology Working Group
UAEP	Unserved Areas Electrification Programme
UNEP	UN Environment
UDP	UNEP DTU Partnership
UNDP	United Nations Development Programme
UNCBD	United Nations Convention of Biological Diversity
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wildlife Fund

Glossary of Terms[1]

Adaptation	Short for 'climate change adaptation', meaning adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects to moderate harm or exploit beneficial opportunities (IPCC, 2007). Adaptation is a process, not an outcome.
Adoption	The process by which a technology is selected for use by an individual, an organization or a society.
Barrier	A reason why a target is adversely affected, including any failed or missing countermeasures that could or should have prevented the undesired effect(s).
Diffusion	The process by which a technology is spread or disseminated through various channels over time in a society, the technology gradually being adopted by more and more members of it (people, institutions, companies, etc.).
Enabling environment	The set of resources and conditions within which the technology and the target beneficiaries operate. The resources and conditions that are generated by structures and institutions that are beyond the immediate control of the beneficiaries should support and improve the quality and efficacy of the transfer and diffusion of technologies.
Hardware	The tangible aspects of technology, such as equipment and machinery.
Measure	Any factor (financial or non-financial) that enables or motivates a particular course of action or behavioral change, or is a reason for preferring one choice over the alternatives. Often the word 'incentive' is used synonymously, sometimes with a slightly different interpretation. This guidebook does not distinguish between 'measure' and 'incentive'.[2]
Mitigation	Short for 'climate change mitigation', meaning an action to decrease the concentration of greenhouse gasses, either by reducing their sources or increasing their sinks.
Orgware	The institutional framework, or organizational aspects, involved in the diffusion and uptake of a technology.
Software	The intangible elements associated with the production and use of the technological hardware. This comprises know-how (e.g. manuals and skills) and experience and practices (e.g. agricultural, management, cooking and behavioral practices).
Stakeholder	A person, group, organization or system that affects or can be affected by an organization's actions.

[1] Extracted and adapted from ''Overcoming Barriers to the Transfer and Diffusion of Climate Technologies'' (Nygaard and Hansen, 2015).

[2] Other frequent and very similar phrases are 'policy tools' and 'policy instruments'.

Technology	A piece of equipment, technique, practical knowledge or skills for performing a particular activity. It is common to distinguish between three different elements of technology: the tangible aspects, such as equipment and products (hardware); the know-how, experience and practices (software) associated with the production and use of the hardware; and the institutional framework, or organization, involved in the transfer and diffusion of a new piece of equipment or product (orgware).
Technology transfer	Involves vertical technology transfer, which is understood as the movement of technologies from the R&D stage through to commercialization; and horizontal transfer, which involves the spatial relocation or diffusion of technologies across space.

Executive Summary

Guyana's Technology Needs Assessment (TNA) process commenced in 2015 through the Office of Climate Change (OCC) within the Ministry of the Presidency. The TNA process was implemented using a three-step approach which sought to:

1. Identify and prioritize, through a participatory process, technologies that can contribute to Guyana's mitigation and adaptation goals while meeting the country's national sustainable development goals and priorities;
2. Identify and analyze barriers hindering the acquisition, deployment and diffusion of the prioritized technologies; and
3. Develop Technology Action Plans (TAPs) specifying activities and enabling frameworks to overcome the barriers and facilitate the transfer, adoption and diffusion of selected (prioritized) technologies in Guyana.

During the first step in the TNA process, the forests and energy sectors were identified as the priority sectors for mitigation. Thereafter, the following shortlisted technology applications, identified through a participatory process using the multi-criteria analysis (MCA) tool, were selected by the Sector Working Groups:

1. Energy sector:

- Solar farms to service urban centers and supply the national grid;
- Large hydropower plants (over 5MW) to support national energy demands; and
- Standalone wind farms to service urban centers and supply the national grid.

2. Forests sector:

- Introduction of geological surveys and mineral mapping to improve exploration;
- Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.; and
- Deployment of efficient recovery systems in small and medium gold-mining operations were identified as the prioritized, ranked technologies for the forests sector.

In the second step of the TNA, the barriers hindering the acquisition, deployment and diffusion of the prioritized technologies were identified and analyzed. This step was undertaken with the Technology Working Groups (TWGs) for each of the shortlisted technologies and involved assessing the critical barriers and identifying appropriate measures to overcome them in order to create an enabling environment for the implementation of the technologies. The TWGs identified the **policy framework** as the most critical barrier to the promotion, transfer and diffusion of the technologies and recognized several critical issues which required actions within the overarching Policy Framework. The Table below summarizes the priority sector, shortlisted technology applications and critical cross-cutting measures based on the Barrier Analysis and Enabling Framework (BA&EF) process.

Sectors	Shortlisted technology applications	Critical measures
Energy	*Solar farms to service urban centers and supply the national grid*	Establish a robust policy framework
	Large hydropower plants (over 5MW) to support national energy demands	
	Stand-alone wind farms to service urban centers and supply the national grid	

Sectors	Shortlisted technology applications	Critical measures
Forests	*Introduction of geological surveys and mineral mapping to improve exploration*	Establish clear policy framework
	Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.	
	Deployment of efficient recovery systems in small and medium gold-mining operations	

This report and the Project Idea Notes (PINs) are the results of the third step and are the culmination of the results from steps 1 and 2. Step 3 delivers on a TAP for the critical measures and actions identified in the barrier analysis. In the TAP, the actions and activities have been determined based on identified measures for overcoming the barriers to support the successful transfer of the prioritized technologies.

The TAP and PINs were prepared based on the UN Environment (UNEP) and the UNEP Technical University of Denmark (DTU) Partnership (UDP) guidelines, 'Enhancing Implementation of Technology Needs Assessment – Guidance for Preparing a Technology Action Plan'. This guidance document outlines the specific approach and methodology to be used in preparing the TAP, which involves five (5) steps, as outlined below:

1. Step 1: Establishing the ambition of the TAP.
   This was completed during the first step of the TNA Project, where the priority sectors and technology applications were identified and defined.

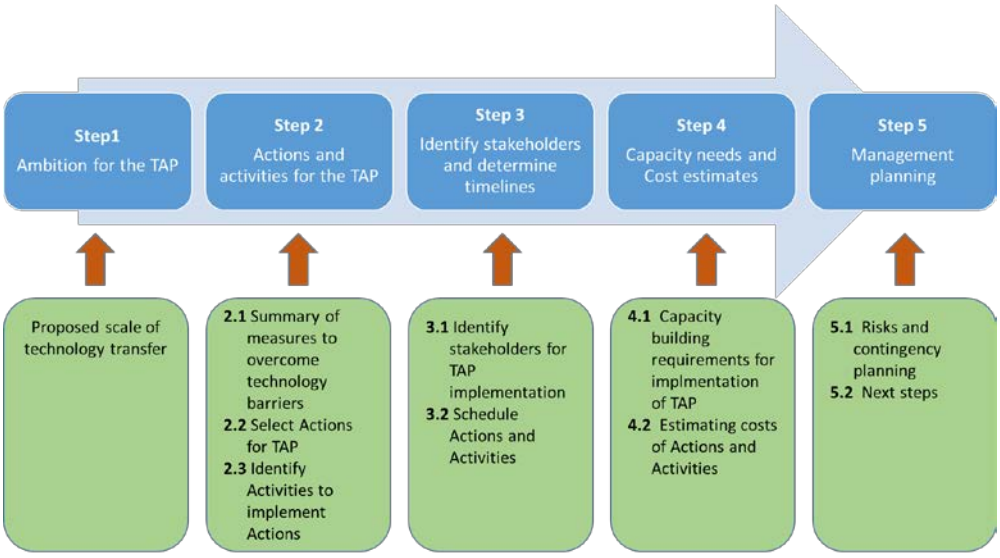
2. Step 2: Actions and Activities for the TAP. This step involved:
   (1) Summarizing the measures to overcome the critical technology barriers;
   (2) Selecting actions for the TAP; and
   (3) Identifying activities to implement the actions.

   Items (1) and (2) were completed as part of the second step of the TNA Project, the BA&EF Process. The Sectoral Working Groups (SWGs) served as the stakeholder mechanism to allow input into the TAP for both the energy and forests sectors. A briefing document was prepared summarizing the critical barriers and prioritized measures and outlining brief actions and activities developed in collaboration with lead sector agencies for review and input.

3. Step 3. Identifying stakeholders and determining timelines. This step involved:
(1) Identifying stakeholders for TAP implementation; and
(2) Scheduling actions and activities.

4. Step 4. Capacity needs and cost estimates. This step involved:
(1) Identifying capacity-building requirements for the implementation of the TAP; and
(2) Estimating the costs of actions and activities.

5. Step 5. Management planning. This step involves identification of risks and contingency planning and next steps. These five (5) steps are summarized in the figure below:



Energy sector

Solar farms to service urban centers and supply the national grid, *large-scale hydropower plants (over 5MW) to support national energy demands and stand-alone wind farms to service urban centers and supply the national grid* were prioritized and selected for further analysis in the barrier analysis phase. Here the TWG identified, through a prioritization process, the *lack of a robust policy[3] framework* as the most critical barrier hindering the acquisition, deployment and transfer of these technology applications. The TWG expressed the view that, in the absence of a comprehensive energy policy, there is no clear guidance on which critical elements are needed to promote and facilitate the transfer and diffusion of the technologies. This barrier was also linked to the institutional and human capacity barriers. The table below lists the specific critical barriers by technology applications and their corresponding identified measures that were further assessed during the TAP process.

Identified critical barriers	Identified measures
Solar farms to service urban centers and supply the national grid	
Absence of a robust policy and regulatory enabling framework	Establish a robust policy framework
Limited technical capacity	Conduct a ten-year forecasting study of projected investments and support skills requirements and implement capacity-building programmes with key stakeholders
	Sustained strategic public awareness and education campaign, including disseminating information on skill-set requirements
	Improved, robust, clear and updated policy and regulatory framework with local content requirements

[3] Policy was interpreted by the TWGs to mean a broad framework that includes policy direction and decision-making by the government to pursue and undertake specific actions. It included aspects such as policy statements outlining the vision, goals, objectives and targets of the sector or specific to the technology application; incentives to stimulate uptake of the technology; institutional requirements, including a human and technical resources plan to increase and build capacity; and a supporting Action Plan, Strategy and Legislation for implementation.

Identified critical barriers	Identified measures
Large hydropower plants (over 5MW) to support national energy demands	
Limited policy framework	Prepare a comprehensive updated energy policy that includes: 1. Preparation of a human resources development plan 2. Updated geological and hydrological studies 3. Regulations to support investment 4. Develop a mechanism to allow for a policy review every five to ten years
Stand-alone wind farms to service urban centers and supply the national grid	
Weak policy and regulatory framework	Preparation of a robust and clearly defined policy
	Improving capacity
	Development of an investment framework
	Identification of a focal point

During the discussions with the TWG in the barrier analysis process, stakeholders identified the most critical barriers and corresponding critical measures for Guyana in keeping with the country's sustainable development trajectory and its transformation to a Green Economy (GE). Stakeholders prioritized the selected technology applications, corresponding critical barriers and measures based on their mitigation potential, effectiveness and suitability in the context of Guyana's energy sector.

Thereafter, engagements were held with the lead sector institution, the Guyana Energy Agency (GEA), to discuss the TAP approach and the broad actions which emerged out of the barrier analysis process. These actions have been presented in the report (see **Section 2.2.3.2)** and were further categorized into three (3) critical areas, recognizing that some actions had already been implemented, for example, the GEA is the focal-point institution for energy, the draft Energy Policy has been crafted to be part of the broader policy development framework for the Green State Development Strategy (GSDS), and ongoing efforts to improve energy infrastructure are being undertaken by Guyana Power & Light (GPL) through its Demand and Expansion Programme and other support initiatives. As such, the following list of actions was put forward as part of the TAP process:

1. Implement a sustained public awareness and education programme.
2. Institute economic and financial incentives to promote investments.
3. Prepare a human resources development plan.

The SWG convened on June 16, 2017 to review the prioritized measures for overcoming the technology barriers in the energy sector, agree on the actions, and review and identify activities to implement them. The actions listed above were discussed by the SWG, and in addition, the Working Group reviewed a draft list of activities corresponding to each action. **Section 2.2.3.3** outlines in detail a list of the activities for each corresponding action.

The prioritization of actions for the preparation of project concept notes or PIN was done at two (2) levels and took into consideration cost, timing and the most critical action for the acquisition, deployment and transfer of the priority technologies. The first engagement was with the lead agency and thereafter with the SWG. In both cases, the preparation of a comprehensive human resources development plan emerged as a critical action. Through the SWG, stakeholders further identified the economic and financial incentives as the next priority action:

1. Institute economic and financial incentives to promote investments.
2. Prepare a human resources development plan.

Forests Sector

Introduction of geological surveys and mineral mapping to improve exploration, *reforestation of mined-out areas utilizing fast-growing species such as Acacia spp. and deployment of an efficient recovery system in small and medium gold-mining operations* were prioritized and selected for further analysis in the barrier analysis phase. Here the TWG identified, through a prioritization process, the *absence of a clear policy position and framework* as the most critical barrier hindering the deployment and transfer of technologies in the forests sector. Recognizing that the technology applications all relate to the mining sector and, in particular, to small- and medium-scale mining, the TWG was of the view that a policy position is critical in the absence of a comprehensive mining policy, since there is no clear guidance on the critical elements needed for the diffusion and transfer of the technologies. The table below lists the specific critical barriers by technology applications and their corresponding identified measures that were further assessed during the TAP process.

Identified critical barriers	Identified measures
Introduction of geological surveys and mineral mapping to improve exploration	
Limited human capacity, knowledge and awareness	Enhanced human capacity, education and awareness through targeted programmes
Limited policy framework to support geological surveys and mineral mapping to improve exploration	Clear policy to support exploration technologies and mineral mapping
Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.	
Lack of a clear policy framework to guide the reforestation of mined-out areas	Clear policy framework that includes the following areas: 1. Updating the mining and environmental regulations 2. Incentives 3. Enhanced monitoring and enforcement 4. Reconciling environmental protection and extraction activities
Deployment of efficient recovery system in small and medium gold-mining operations	
Absence of a clear policy position to support the Technical Assistance Programme	Clear policy for government to provide technical assistance to improve the recovery rates of small- and medium-scale operations
Lack of coordination and planning of initiatives	Enhanced coordination and planning of initiatives for improved recovery in the gold-mining sector

During the discussions with the TWGs that were part of the barrier analysis process, stakeholders identified the most critical barriers and corresponding critical measures for Guyana in keeping with the country's green development trajectory. Stakeholders prioritized the selected technology applications, corresponding critical barriers and measures based on their mitigation potential, effectiveness and suitability in the context of Guyana's forests sector. In keeping with the guidance provided by UN Environment-DTU for the TAP and the outcome of the BA&EF process, the overarching critical cross-cutting measures and proposed actions for the technology applications listed above were identified and presented in **Section 3.2.3.2**.

Consultations were held with the lead sector institution, the Ministry of Natural Resources (MNR), to discuss the TAP approach and the broad actions which emerged out of the barrier analysis process. The list of actions below, categorized into five (5) critical areas, was put forward as part of the TAP process:

1. Implement a sustained public awareness and education programme.
2. Institute economic and financial incentives to promote investments.
3. Updating mining and environmental regulations.
4. Improve human resources.
5. Improve the planning and coordination of initiatives.

The SWG for the forests sector convened on June 16, 2017 to review the prioritized measures for overcoming the technology barriers and agree on the actions, as well as review and identify activities corresponding to the above list for implementation. The SWG reviewed a draft list of activities corresponding to each action for adjustment. The revised list is presented in **Section 3.2.3.3**.

For the forests sector, the prioritization of actions for the preparation of project concept notes or Project Idea Notes was done at two (2) levels and took into consideration cost, timing, and the most critical actions for the acquisition, deployment and transfer of the priority technologies. The first consultation was with the lead agency, the MNR, and thereafter with the SWG. In both cases, the action to *'improve planning and coordination initiatives'* emerged as critical. Stakeholders felt that there is an urgency in having coordinated efforts not only for the efficient use of resources, but to also to allow streamlined planning. The action to institute economic incentives to promote investments was also selected as a priority action.

In summary, stakeholders identified the following priority actions for the preparation of project ideas:

1. Improve the planning and coordination of initiatives.
2. Institute economic incentives to promote investments.

1. Introduction

1.1 Overview of the TNA

Technology transfer is a critical component of the United Nations Framework Convention on Climate Change (UNFCCC). In 2001, as an outcome of the seventh Conference of Parties (COP7) meeting, developing countries were encouraged to conduct assessments of their country-specific technology needs in an effort to identify, evaluate and prioritize climate change mitigation and adaptation technologies.

The first generation of climate TNAs were conducted during the period from 2001 to 2007 with support from the Global Environment Facility (GEF) and were implemented by the United Nations Development Programme (UNDP) and United Nations Environment Programme (UNEP). Guyana is in the second phase or 'second generation' of countries participating in the TNA process, which covers the period from 2015 to 2017. This second phase is supported by GEF and implemented by the UDP.

Guyana commenced the TNA process in 2015 through the Office of Climate Change (OCC) within the Ministry of the Presidency. The TNA has been undertaken by means of a three-step approach, which sought to:

1. Identify and prioritize, through a participatory process, technologies that can contribute to Guyana's mitigation and adaptation goals while meeting the country's national sustainable development goals and priorities;
2. Identify and analyze barriers hindering the acquisition, deployment and diffusion of the prioritized technologies; and
3. Develop TAPs specifying activities and enabling frameworks to overcome the barriers and facilitate the transfer, adoption and diffusion of selected (prioritized) technologies in Guyana.

Step 1 involved the identification and prioritization of mitigation (and adaptation) technologies. The forests and energy sectors were identified as the priority sectors for mitigation, and the technology applications listed in Table 1 were determined and shortlisted through a participatory process using the MCA tool.

Table 1. Shortlisted Technology Applications for the Energy and Forests Sector

Sectors	Shortlisted technology applications
Energy	*Solar farms to service urban centers and supply the national grid*
	Large hydropower plants (over 5MW) to support national energy demands
	Stand-alone wind farms to service urban centers and supply the national grid
Forests	*Introduction of geological surveys and mineral mapping to improve exploration*
	Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.
	Deployment of efficient recovery systems in small and medium gold-mining operations

Step 2 of the TNA was the identification and analysis of barriers hindering the acquisition, deployment and diffusion of the prioritized technologies. This step was carried out with the TWGs for each of the shortlisted technologies and involved assessing the critical barriers and identifying appropriate measures to overcome them in order to create an enabling environment for implementation of the technologies.

Step 3, which is currently in process, will result in the preparation of a technology action plan for the critical measures and actions identified in the barrier analysis process. The TAP combines the results from steps 1 and 2 and also presents project concepts for financing. This report presents the outputs of step 3 of the TNA.

1.2 Outcome of the BA&EF process

A pervasive observation throughout the process of analyzing the barriers to the technologies is that many of the issues identified were shared among the selected technologies in both the energy and forests sectors. All of the TWGs identified the policy framework as the most critical barrier to the promotion, transfer and diffusion of the technologies, several issues being identified as critical and as requiring actions.

Table 2 outlines the priority sector, shortlisted technology applications and critical cross-cutting measures based on the BA&EF process.

Table 2. Priority Sectors, shortlisted Technology Applications, critical cross-cutting Measures

Sectors	Shortlisted technology applications	Critical measures
Energy	*Solar farms to service urban centers and supply the national grid*	Establish a robust policy framework
	Large hydropower plants (over 5MW) to support national energy demands	
	Stand-alone wind farms to service urban centers and supply the national grid	
Forests	*Introduction of geological surveys and mineral mapping to improve exploration*	Establish clear policy framework
	Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.	
	Deployment of efficient recovery systems in small and medium gold mining operations	

1.3 Approach and Methodology for the Technology Action Plan

The third step of the TNA process is the preparation of a TAP. In a TAP, actions and activities are identified (based on identified measures to overcome barriers) to support the successful transfer of the prioritized technologies.

The UDP provides specific guidelines for each step in the TNA process. The guidelines 'Enhancing Implementation of Technology Needs Assessment – Guidance for Preparing a Technology Action Plan', prepared in 2016 by the UNFCCC Secretariat and the UDP, was used in preparing the TAP. This guidance document outlines the specific approach and methodology to be adopted in preparing the TAP that involves the five steps outlined below:

Step 1. Establishing the ambition of the TAP. This was completed during step 1 of the TNA Project, where the priority sectors and technology applications were identified and defined.

Step 2. Actions and activities for the TAP. This step involved:

(1) Summarizing the measures to overcome the critical technology barriers;

(2) Selecting actions for the TAP; and
(3) Identifying activities to implement the actions.

Items (1) and (2) were completed as part of step 2 of the TNA Project, the BA&EF Process, and are outlined in Table 2. The SWGs served as the stakeholder mechanism to allow input into the TAP for both the energy and forests sectors. A briefing document was prepared summarizing the critical barriers and prioritized measures and outlining brief actions and activities developed in collaboration with lead sector agencies for review and input. The Energy SWG and Forests SWG convened on June 16, 2017 to review, identify and define the specific activities for the implementation of the actions (see Annex A for a list of the representatives who participated in the SWGs for both the energy and forests sectors).

Step 3. Identify stakeholders and determine timelines. This step involved:
(1) Identifying stakeholders for TAP implementation; and
(2) Scheduling actions and activities.

The SWGs convened on June 16, 2017 to (a) discuss the outcomes of steps 1 and 2; (b) elaborate actions into activities and establish timelines; and (c) discuss capacity needs, costs and management planning.

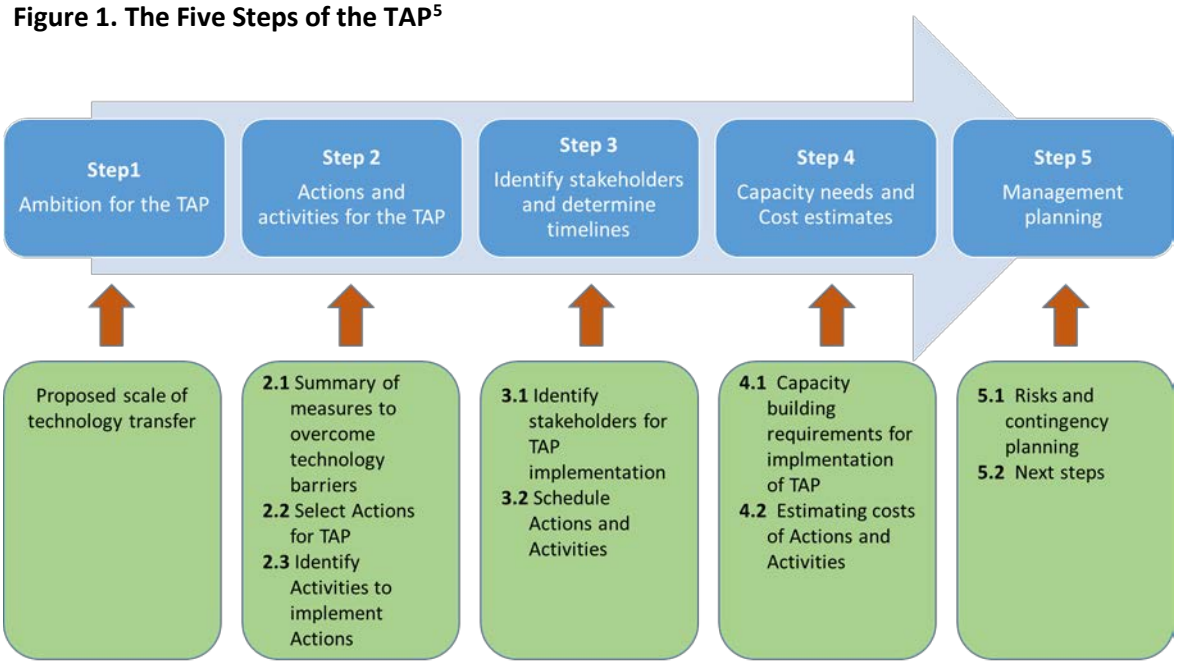
Step 4. Capacity needs and cost estimates. This step involved:
(1) Identifying capacity-building requirements for the implementation of the TAP; and
(2) Estimating the costs of actions and activities.
The Mitigation Consultant, in close collaboration with specialists from the SWGs and with support from lead sector agencies, the GEA and MNR, together with the SWGs,[4] worked to identify the capacity and estimated costs.

Step 5. Management planning. This step involves the identification of risks, contingency planning and next steps. It was conducted by the Mitigation Consultant working closely with the lead agencies for each sector and with support from the SWGs.

[4] In the case of the forests sector, the omission of the Guyana Lands and Surveys Commission from the SWG as an important stakeholder for land planning was an oversight by the TNA team and was only observed at the end of the engagement process. It is recommended that GLSC be included where necessary as a stakeholder in the implementation of actions.

Figure 1 illustrates the five steps (approach and methodology) involved in preparing the TAP.

Figure 1. The Five Steps of the TAP[5]



1.4 National Policies on Climate Change Mitigation and Development Priorities[6]

Several policy initiatives were implemented specifically to address issues related to climate change mitigation. Principal among them has been the development and implementation of Guyana's Low Carbon Development Strategy (LCDS) and its avoided deforestation approach. The LCDS was launched in 2009 to set out a transformative approach towards a low-carbon economy through payments for forest climate services, the enhancement of climate resilience, and economic diversification embracing low-carbon sectors. The implementation of the LCDS was supported by an avoided deforestation (REDD+) partnership between Guyana and the Kingdom of Norway through which Guyana was eligible for payments of up to US$250 Million over a five-year period (GoG, 2013).

Currently, the Government of Guyana (GoG) is advancing efforts towards GE that foster low emissions development across all sectors and builds on the LCDS. In this regard GSDS is currently being prepared to move Guyana along a GE pathway. Significant emphasis is also being placed on developing green towns, especially in the rural regions, and to focus on renewable energy and forests. As a result, there is a national push to establish wind and solar farms along Guyana's coast and mini-hydropower plants in the rural regions. Increasing the use of renewable energy technologies and the application of energy-efficient technologies, specifically for lighting and electricity generation, are seen as critical for the country's progress towards a GE. In addition, sustainable forest management and the prudent utilization of forests within a REDD+ framework are national priorities and important elements of Guyana's approach to the GE.

[5] Adapted from UNFCCC and UNEP-DTU, 'Enhancing Implementation of TNAs: Guidance for Preparing a TAP', Figure 3, Steps of a TAP Preparation Process.

[6] Extracted from the 'Technology Needs Assessment Report: Identifying and Prioritising Mitigation Technologies' as part of Guyana's Technology Needs Assessment Project, Ministry of the Presidency, 2016.

Activities in the energy sector are guided by a National Energy Policy prepared in 1994 that is currently being updated (GEA, 2016c). This revised policy takes into account issues associated with climate change, environmental sustainability, advances in renewable technologies and energy-efficient technologies, as well as reductions in costs. Specifically, the draft policy aims to (GEA, 2016c):

- *Position the energy sector as an engine of national economic growth using a green development strategy that contributes to the achievement of the Millennium Development Goals (MDGs);*
- *Minimize the foreign exchange costs of energy to the national economy;*
- *Reduce the dependence on imported fossil fuels and advance the deployment of renewable energy resources;*
- *Enhance environmental sustainability by reducing the impacts on the environment.*

Moreover, guided by its Strategic Plan 2014–2018, the GEA plans to focus not only on the efficient use of petroleum-based energy sources, but also to promote, test and model the use of renewable sources of energy (GEA, 2014a). Energy conservation and efficiency are important strategically for the GEA as it implements its Strategic Plan in keeping with the transition to a GE. The GEA plans to continue its research in this area to ensure more efficient utilization of energy and sources of energy across all sectors, as well as provide guidance, advice and recommendations. Energy assessments and audits of various public buildings will be undertaken to reduce energy consumption and improve energy awareness through the replacement of inefficient lighting and appliances. Additionally, energy-efficient building designs in the building sector will be encouraged and promoted in order to reduce energy consumption, in particular through the application of occupancy sensors, cool roofs, natural lighting and energy-efficient lighting. In particular, across all sectors, energy-efficient procurement will be promoted through the sourcing of energy-efficient equipment and appliances and the adoption of procurement policies that include life-cycle energy costs (GEA, 2014a).

Guyana's Power Sector Policy was prepared in 2010 for a period of five (5) years in the medium term and fifteen (15) years in the long term. This policy, in conjunction with the draft energy policy, aims to reduce Guyana's dependence on imported fossil fuels for electricity production and focuses on implementing energy-efficient and energy-conservation measures; reduction of losses in the distribution and transmission network; the expansion of electricity generation using alternative sources to fuel oils, such as solar, hydropower, wind and biofuels; and access to financing through the Clean Development Mechanism (GoG, 2010).

In the absence of a national transport sector policy, the NDS (2001-2010) outlines a framework and strategic direction for the transport sector, covering the key modes of transport, namely road, air and maritime. The NDS identifies the construction of a national road network to aid the country's economic development, in particular the construction of a north-south highway parallel to the existing East Bank Highway. The GoG is currently undertaking feasibility studies with support from the IDB. Additionally, a transport sector study was conducted in 2005 that attempted to define the elements of a transport policy. The study suggested regulatory reform, as well as, greater private-sector involvement in the provision of transportation services to encourage competition and measures to ensure the long-term sustainability of the sector's infrastructure and equipment. A critical element within the framework of mitigation under the TNA is the integration of measures to reduce the environmental impacts associated with transport operations and reduce traffic congestion (GoG, 2005).

The National Forest Policy Statement (NFP) was revised in 2011 with the aim of improving the *'conservation, protection, management and utilization of the nation's forest resources while ensuring that the productive capacity of the forests for both goods and services is maintained or enhanced'* (GoG, 2011).

The NFP addresses Guyana's national and global responsibilities for the sustainable management of forests and recognizes the critical role of forests in the absorption of carbon dioxide and in maintaining life-supporting services. It also focuses on the role of forests in climate change mitigation through a REDD+ approach and the implementation of a REDD+ strategy. Currently, efforts are underway by the MNR and Guyana Forestry Commission (GFC) to revise the NFP and the National Forest Plan.

2. Technology Action Plan: Energy Sector

2.1 Technology Action Plan for the Energy Sector

2.1.1 Energy Sector: Overview[7]

Guyana's primary source of energy is imported fossil fuels, representing approximately 70%, with the remainder being bagasse[8] (25.67%[9]), rice husk (4.35%), fuel wood[10] (0.40%) and solar photovoltaic (PV) (approximately 1%) (GoG 2012; GEA 2015b[11]). The country imported an estimated 5,001,497 barrels of petroleum-based products in 2015, representing an estimated consumption of 13,575 barrels per day (GEA, 2015a), the highest volume imported to date.

In recent years, the transportation sector has emerged as the largest consumer total petroleum products at approximately 38%, , exceeding the electricity power-generating sub-sector at 33%. The transport sector consumes mainly gasoline and diesel to service the increasing vehicle fleet in the country (GEA, 2014b; GEA, 2015b). The electricity generation sector comprises electricity generation mainly from Guyana's national electric utility, the GPL, and several small generation facilities (including self-generation) across the country. According to the GEA, and based on an estimate of self-generation and other generation assets across the country, total electricity generation in 2012 was estimated at 944.325 GWh: 96.28% from fossil fuels, 3.52%[12] from bagasse-based cogeneration, and the remaining 0.2% from solar PVs and wind-powered sources (GEA, 2014a).

2.1.2 Preliminary targets for technology transfer and diffusion

Guyana's climate policy is currently articulated by the level of ambition committed and contained in the revised National Determined Contributions (NDCs), which were submitted to the UNFCCC and form part of the Paris Agreement. The vision for climate change mitigation is also aligned with the national development thrust in the pursuit of a GE through the GSDS which is currently being prepared. GoG has expressed its commitment to *'continue the transition of our economy to realise improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcity'* (GoG, 2015b).

The GSDS builds on the experiences and lessons of previous strategies such as the LCDS and National Development Strategy (NDS) with the intention of developing a more inclusive and comprehensive plan (GoG, 2015b) to low-emissions, low-deforestation development. Guyana's Second National Communication (SNC) identified the energy sector, and in particular the power-generating sub-sector, as contributing the largest share of greenhouse gas (GHG) emissions historically. Conversely the forests sector has the greatest potential for carbon dioxide removals (GoG 2012).

---

[7] Overview extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework', as part of Guyana's Technology Needs Assessment Project, Ministry of the Presidency, 2017.
[8] Used in the sugar industry to generate heat and electricity.
[9] This figure was presented in the SNC on page 269, as extracted from the GEA document ''Alternative Energy Programmes in Guyana'' dated 2009, and it reflects the percentage of bagasse as an energy source.
[10] Used in the residential sector for cooking.
[11] Overview of the sector as presented at the Technical Working Group for Energy, November 2015.
[12] This figure represents the percentage of electricity generation from bagasse for 2012 as presented in the GEA Strategic Plan.

Implementation of activities within the framework of a GE commenced in 2015 in two (2) critical sectors, forests and energy, as identified in the NDC. These activities target the reduction of carbon emissions since this has been identified as the leading source of GHGs (GoG, 2015b). The GoG has indicated that the GE plan will focus on a number of areas, including widening the mix of renewable energy projects through wind, solar, biomass and hydropower to supply the demand to the national grid through grid-connected systems and off-grid systems for the rural regions and Bartica as a GE model town (GoG, 2015b).

An important target outlined in the NDC is that, conditional on adequate and timely financial support, Guyana can increase its share of renewable power supply to 100% by 2025. The GoG has decided to revise this target to being achieved to 'as far as possible' by 2025. However, this has not been formally communicated to the UNFCCC. Guyana has committed itself to developing an energy mix consisting of wind, solar, biomass and hydropower to supply grid-connected and off-grid connected systems. It intends to pursue small hydropower systems at specific locations across the country and, in particular, at selected towns using renewable energy sources (GoG, 2015b), commencing with the town of Bartica, Region 7, and including the installation of a large-scale solar farm in Mabaruma with smaller farms in Mahdia and Lethem (GoG, 2016). The GoG also plans to ensure that government buildings will all be powered by renewable energy within the next four (4) years.

Additionally, the GoG budget for 2017 outlines measures to catalyze the deployment of mitigation technologies. Specifically, tax exemptions were proposed on items imported for wind and solar energy investments and a '*one off tax holiday of two (2) years'* on corporation tax for those companies in the business of importing only items for wind and solar energy (GoG, 2016).

2.2 Action Plan for the Technologies

2.2.1 Introduction to the Prioritized Technologies

2.2.1.1 General Description: Solar Farms[13]

Solar farms are large scale application or use of solar PV panels to generate electricity. The generation of electricity using solar PV technology has advanced significantly worldwide, with most such installations being grid-connected (Arvizu *et al.,* 2011*)*. PV solar technologies allow the direct conversion of sunlight to electricity. PV power systems are classified into two (2) types: those connected to the traditional power grid (grid-connected applications), and those not connected to the grid (off-grid applications). Off-grid PV systems can service areas without existing access to electricity and can be established as centralized PV mini-systems in villages or towns and other urban centers. Grid-connected PV systems use an inverter to convert electricity from direct current (DC) to alternating current (AC), the electricity thus generated then being supplied through the distribution network to consumers. This type of system does not require energy storage since the grid is used as a buffer (Arvizu *et al.,* 2011*;* PV Technology Factsheet-Mauritius[14]).

Grid-connected PV systems are further classified into two (2) types of application: distributed and centralized. Grid-connected distributed PV systems can be installed to generate electricity directly into the electricity network or grid-connected customer; they can be on public buildings and can be integrated into the demand side of the electricity meter. This kind of system can be in the range of 1-4kW for residential systems and from 10kW up to several MW for rooftops on buildings. Grid-connected

[13] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project, Report 2.
[14] www.tech-action.org

centralized PV systems function similarly to a centralized power station and are mounted on the ground in capacities greater than 1MW (Arvizu *et al.,* 2011*)*.

Guyana plans to establish several solar farms across the country, especially in outlying rural towns and areas, to increase the share of renewable energy in the energy mix. The current installed capacity of solar PV systems across Guyana is approximately 1.2MW, generating an estimated 1.81GWh annually. Off-grid PV systems were installed mainly under the Unserved Areas Electrification Programme (UAEP), a total of 19,000 systems being installed in homes, schools and community buildings across hinterland villages (GEA, 2014a). The GEA installed an 8.46kW grid-connected distributed PV system demonstration project at its Georgetown office to promote the use of solar PVs and generates about 10.9MWh of energy annually (GEA, 2014a; GEA, 2014b). The subsequent installations of similar systems at the National Parks Commission, the GEA and a private firm translate into a capacity of 66 kW for grid-connected solar PV systems (GEA, 2016a).

2.2.1.2. General Description: Hydropower Plants[15]

Hydropower (hydroelectric power) has been found to be the single largest source of renewable energy in the electricity-generating sector (Kumar *et al.*, 2011). This technology is used to generate electricity by using the energy from naturally falling or flowing water (GEA, 2016b). This renewable technology can be classified by head (difference between the upstream and downstream water levels), size (based on installed capacity) and type of facility. In addition, the efficiency of the system depends on the ability of the turbine and generator to convert the energy from the water source to electricity effectively (GEA, 2016b). The main types of hydropower (based on type of facility) are run-of-river, reservoir (storage hydropower), pumped storage and in-stream technology (GEA, 2016b; Kumar *et al.*, 2011; IRENA 2015).

The most common type of hydroelectric power plant is storage or reservoir hydropower. This system uses a dam to store water in a reservoir, and electricity is produced when water is released from the reservoir to spin the turbine that activates a power generator. The amount of electricity generated by the hydropower facility depends on the 'head' or the vertical distance through which the water falls and the flow rate (measured as volume of water per unit of time). Power plants with 'high head' are the most common, since they store water at an increased elevation. The reservoir is also used to store water during the rainy season and can be released during dry periods. The key components of a typical reservoir-type hydropower plant include a dam for storage or a reservoir, penstock (pipeline), powerhouse, turbine, generators, on-site electrical substation and switchyard, as well as ancillary components, including an electrical inter-connection system to connect to the national grid (GEA, 2016b; Kumar *et al.*, 2011; IRENA, 2015; Technology Factsheet – Lebanon[16]).

While hydropower is not new to Guyana, no plants are operating currently. The first hydropower plant was constructed in 1957 at the Tumatumari Falls on the Potaro River with an installed capacity of 1500kW using two (2) 750kW turbines to provide electricity to the British Guiana Goldfields Ltd mining operation (GEA, 2014a). Subsequently, a 0.5 MW run-of-river hydropower system was constructed in 1999 using the Moco Moco Creek to service the Lethem community in Region 9, but this site too is now defunct (GEA, 2014a). The GoG is currently in the process of having both sites rehabilitated.

[15] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project, Report 2.
[16] www.tech-action.org

2.2.1.3 General Description: Wind Farms[17]

A wind farm is understood to consist of several individual wind turbines located in the same area or space and used to produce electricity. While several wind-energy technologies are available across a range of applications, what is of significance to climate change mitigation is the generation of electricity from large, grid-connected wind turbines either on-shore or off-shore (Wiser *et al*., 2011). On-shore wind-energy applications have advanced over the years and are rapidly being deployed for electricity production in many countries worldwide. Onshore wind turbines are usually grouped together into wind-power plants or wind farms, usually of from –five to 300MW in capacity using either horizontal-axis or vertical-axis wind turbines. While vertical-axis turbines can easily be installed on roof-tops and near the base of buildings to avoid constructing high towers, over the years the horizontal-axis wind turbine has dominated the market (Wiser, *et al*. 2011).

A wind turbine consists of a supporting tower approximately 50-100m in height, with rotors that are often 50 to 100m in diameter. On average, turbines operate with rotational speeds of between 12 and 20 revolutions per minute (RPM). The three (3) blade rotor is connected to the hub, main shaft and nacelle. It also contains a control system, emergency brake (to shut down the turbine in case of major technical problems) and other ancillary systems that maintain or monitor the turbine (Wiser *et al*., 2011; Technology Fact Sheet: Onshore Wind Power, Mauritius[18]).

The cost of wind generation varies depending on the location and factors such as the number of turbines, turbine type, size and output, site works, distribution system etc., with the actual wind-turbine costs accounting for as much 69% of the total project costs. Costs are also a factor in producing economies of scale, where larger turbines cost less per kW installed than smaller ones, and single-turbine sites cost more per kW than multiple-turbine sites. However, the costs of turbines have been coming down with improvements in the technology, and this is likely to continue. [19]

Technology applications selected for further analysis

Solar farms to service urban centers and supply the national grid, *large-scale hydropower plants (over 5MW) to support national energy demands, and stand-alone wind farms to service urban centers and supply the national grid* were prioritized and selected in step 1 of the TNA process. Based on their mitigation potential, economic, environmental and social benefits and costs and the selected technology, applications were further analyzed in the barrier analysis phase. These technology applications, once deployed, will contribute to reductions of national expenditure on the importation of petroleum-based products and energy security by diversifying energy sources for electricity production for the country. In addition, the most significant environmental benefit of the application of solar, hydropower and wind technologies is the displacement of petroleum-based products for electricity generation.

2.2.2 Ambition of the TAP

In 2015, the GoG expressed its commitment to *'continue the transition of our economy to realise improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcity'* (GoG, 2015b). In fulfilling this commitment, the GoG has set itself the goal of transforming the

[17] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project, Report 2.
[18] www.tech-action.org
[19] https://www.renewablesfirst.co.uk/windpower/windpower-learning-centre/how-much-does-a-farm-wind-turbine-small-wind-farm-turbine-cost/

energy sector to 100% renewables by 2025. This goal is based on a medium- to long-term projection to deploy renewable technologies such as solar farms, hydropower and wind farms and to establish and fully operationalize several plants by 2025. The GoG intends to achieve this goal through the development of an energy mix of wind, solar, hydropower and biomass to supply both the demand of the national grid and the energy requirements for towns and villages in Guyana's hinterland (GoG, 2015b). Specifically, the Guyana Power Generation System Expansion Study (2016) and the Guyana National Energy Policy (draft, 2016) set the basis for several renewable energy actions to meet the 2025 target. These have been updated and presented in the Energy Transition Roadmap for Guyana, 2017 (GEA, 2017). Table 3 highlights the contribution of planned actions in respect of solar, hydropower and wind and their projected capacity to meet the overall target of 100% renewables by 2025.

Table 3. Proposed targets by Technology Applications[20]

Technology application	Timeframe	Proposed project / location	Projected capacity
Solar	2017-2018	Solar Phase 1 GPL (WCD)	3 MW
	2017-2018	Solar GPL (Essequibo Coast)	3 MW
	2018-2019	Solar Phase II GPL (EBD)	3 MW
	2017-2019	Mabaruma Power & Light Co. Inc.	400 KW
	2020-2025	Kwakwani Utilities Inc.	2.7 MW (with storage)
	2020-2025	Lethem Power Company	3 MW (with storage)
	2020-2025	Madia Power Company	1.4 MW (with storage)
	2020-2025	Port Kaituma Power & Light	1.3 MW (with storage)
	2020-2025	Mathew's Ridge Power & Light	0.192 MW (with storage)
Hydropower	2017-2025	Mid-scale hydro # 1	150-180 MW
	2023-2031	Mid-scale hydro # 2	150-350 MW
	2018-2024	Small hydro (Moco Moco hydro)	0.5 – 1.0 MW
		Small hydro (Kato hydropower)	320 KW
		Small hydro (Tumatumari hydropower)	3 MW
Wind	2018-2020	Hope Beach	10 MW
	2018-2022	Other sites	16 MW

2.2.3 Actions and Activities selected for inclusion in the TAP

2.2.3.1 Summary of Barriers and Measures to overcome Barriers

By means of a prioritization process in the barrier analysis phase, the TWG identified the lack of a robust policy[21] framework as the most critical barrier hindering the acquisition, deployment and transfer of

[20] Adapted from the Energy Transition Roadmap for Guyana, 2017.

[21] Policy was interpreted by the TWGs to mean a broad framework that includes policy direction and decision-making by the government to pursue and undertake specific actions and included aspects such as policy

technologies in the energy sector, specifically for solar farms, hydropower and wind farms. There was a view that, in the absence of a comprehensive energy policy, there is no clear guidance on the critical elements that will be needed to promote and facilitate the transfer and diffusion of the technologies. This barrier was also linked to the institutional and human capacity barriers. Table 4 lists the specific critical barriers by technology applications and their corresponding identified measures.

Table 4. List of non-financial critical barriers and corresponding proposed measures[22]

Identified critical barriers	Identified measures
Solar farms to service urban centers and supply the national grid	
Absence of a robust policy and regulatory enabling framework	Establish a robust policy framework
Limited technical capacity	Conduct ten-year forecasting study of projected investments and support skills requirements, and implement capacity-building programmes with key stakeholders
	Sustained strategic public awareness and education campaign, including disseminating information on skill-set requirements
	Improved/robust/clear updated policy and regulatory framework with local content requirements
Large hydropower plants (over 5MW) to support national energy demands	
Limited policy framework	Prepare a comprehensive updated energy policy that includes: 1. Preparation of a human resources development plan 2. Updated geological and hydrological studies 3. Regulations to support investment 4. Develop a mechanism to allow for a policy review every five to ten years
Stand-alone wind farms to service urban centers and supply the national grid	
Weak policy and regulatory framework	Preparation of a robust and clearly defined policy
	Improving capacity
	Development of an investment framework
	Identification of a focal point

The first draft energy policy was prepared in 1994. At that time it provided an outlook for the period from 1994 to 2004 with the principal objectives of providing a stable, reliable and economic supply of energy, reducing the country's dependence on imported fuels, promoting where possible the increased utilization of domestic resources, and ensuring that energy is used in an environmentally sound and sustainable manner. That draft of the policy excluded elements related to renewable energy, even though the

statements outlining the vision, goals, objectives and targets of the sector or specific to the technology application; incentives to stimulate uptake of the technology; institutional requirements, including a human and technical resources plan to increase and build capacity; and a supporting Action Plan, Strategy and Legislation for implementation.

[22] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project, Report 2.

potential for hydropower, solar and wind were recognized; there was no definitive policy position on how these would be pursued or diffused.

Further, in the past, individual renewable-energy projects were given a priority even in the absence of an updated energy policy. These projects were major renewable energy interventions able to transform the energy sector from complete dependence on fossil fuels to approximately 90%. They therefore fall within the framework of green energy development, in keeping with Guyana's GE trajectory.

The energy policy has been updated and is currently in the process of stakeholder review. The policy was uploaded on to the websites of the Ministry of Public Infrastructure (MoPI), GEA and Hinterland Electrification Company Inc. (HECI) for comments from the general public. Additionally, through its consultation process on the GSDS, the Department of Environment (DoE) will include a review of the energy policy. The review and finalization process for the energy policy is expected to be completed by the last quarter of 2018.

The updated policy and the process for the implementation of an energy transition road-map, along with the energy target and the commitments of the NDC, represent the foundation of a robust energy policy framework. The policy in its current form incorporates elements related to renewable energy, but with limited scope for how these will be deployed or transferred. The energy transition road-map,[23] however, provides additional details to support the energy policy and reflects specific targets and actions.

2.2.3.2 Actions selected for inclusion in the TAP

During the discussions with the TWG in the barrier analysis process, stakeholders identified the most critical barriers and corresponding critical measures facing Guyana in keeping with the country's sustainable development trajectory and its transformation into a GE. Stakeholders prioritized the selected technology applications, corresponding critical barriers and measures based on their mitigation potential, effectiveness and suitability in the context of Guyana's energy sector.

[23] This road map is currently being reviewed at the ministerial level and is not yet available for wider stakeholder review. It is also expected to be completed at the same time as the final energy policy.

In keeping with the guidance provided by UNEP-DTU for the TAP and the outcome of the BA&EF process, the overarching critical cross-cutting measure for the three (3) technology applications was identified, along with the other measures that were converted into actions. These actions are listed in Table 5.

Table 5. Priority Energy Sector, shortlisted Technology Applications, critical cross-cutting Measures and proposed Actions

Sectors	Shortlisted technology applications	Overarching/ critical measure	Actions	Project ideas
Energy	*Solar farms to service urban centers and supply the national grid* *Large hydropower plants (over 5MW) to support national energy demands* *Stand-alone wind farms to service urban centers and supply the national grid*	Establish a robust policy framework	1. Reaffirm the Focal Point institution for energy. 2. Situate the Energy Policy in the wider national development framework. 3. Implement a sustained Public Awareness and Education Programme. 4. Identify and institute economic and financial incentives to promote investments. 5. Commence a programme for human resources development. 6. Commission research, baseline and other studies. 7. Commit to improving the energy infrastructure.	The actions to *institute economic and financial incentives to promote investments* and *prepare a human resources development plan* were identified through the TAP process as critical actions that, if implemented, would contribute to strengthening the enabling policy environment in the energy sector.

Thereafter, engagements were held with the lead sector institution, the GEA, to discuss the TAP approach and the broad actions which emerged out of the barrier analysis process. The list of actions presented in Table 5 was further categorized into three (3) critical areas, recognizing that some actions had already been implemented, for example, the GEA as the focal point institution for energy, the draft Energy Policy being included by the MoP (DoE) as part of the broad scope of the GSDS and as part of the consultations on the GSDS, and ongoing efforts by GPL through its Demand and Expansion Programme and other support initiatives to improve energy infrastructure, while some actions could merge with or were components of others. The following list of actions was inserted into the TAP:

1. Implement a sustained public awareness and education programme.
2. Institute economic and financial incentives to promote investments.
3. Prepare a human resources development plan.

2.2.3.3 Activities identified for implementation of selected actions

The SWG for the energy sector was convened on June 16, 2017 to review the prioritized measures for overcoming the technology barriers, agree on the actions, and review and identify activities to implement the selected actions. The following three (3) actions were reviewed:

1. Implement a sustained public awareness and education programme.
2. Institute economic and financial incentives to promote investments.
3. Prepare a human resources development plan.

The SWG discussed the actions, reviewed a draft list of activities corresponding to each action and made amendments and adjustments. The revised list is presented in Table 6. During the process the SWG discussed each action. The main points of the discussion are summarized below.

- ***Implement a sustained Public Awareness and Education Programme***
  While the SWG recognized the importance of public awareness, they believed that the primary focus of the programme should be on education. It was suggested that there is some level of awareness regarding renewable energy, but one of the major issues in implementing such technologies is the lack of technical skills. This lack is an impediment to the creation of an energy market, and it is for this reason that an education programme is required to teach the necessary skills.

  Additionally, the SWG stated that the stocktaking and review of existing initiatives should not only seek to determine stakeholders' levels of awareness, attitudes and knowledge regarding energy efficiency, but also determine to what extent this knowledge and awareness can be translated into practice.

  Further, the SWG recommended focusing involvement with the University of Guyana and other training organizations by first undertaking a review or stocktaking of current programmes regarding renewable energy, with focus on the specific technology at the technician and engineering levels. The relevant training organizations will then be engaged to identify opportunities to enhance and develop a curriculum for technician and engineering programmes with a focus on the priority technologies. Furthermore, it was emphasized that, once opportunities have been identified, the action should include not only developing the programme or plan, but also including its implementation. In this context, it is important to note that the mechanical, electrical and industrial engineering programs have incorporated renewable energy into their curriculums and that the University of Guyana, in partnership with Anton De Com University in Suriname, is currently running a Master's program in renewable technology.

  The SWG suggested the inclusion of training institutions such as the Government Technical Institute (GTI) and the Technical Vocational Education and Training (TVET) for the public awareness and education programme. The Working Group further suggested not only identifying the specific target groups and ensuring that the awareness and educational materials and programmes are adapted to specific audiences, but should also evaluate the effectiveness of the awareness and education activities two (2) to three (3) years after their implementation.

  The SWG suggested expanding the public awareness and education programme by building on current initiatives to include both the public and private sectors and not be limited to government and non-governmental initiatives.

- ***Institute economic and financial incentives to promote investments***
  The SWG agreed to disaggregate this action into two (2) main components, one focused on examining the national circumstances, the other on examining the extent to which current incentives are being implemented.

  The SWG suggested expanding the scope to examine not only local (national) circumstances but also to take into consideration the best practices, circumstances for easy deployment and lessons learned from other countries, recognizing that other nations have already made significant strides in renewable energy. The SWG further suggested using the information obtained from the best practices review to identify opportunities to enhance economic and financial incentives.

- ***Prepare a Human Resources Development Plan***
  The SWG agreed to disaggregate the first activity into two (2), namely the procurement of a consultant, followed by assessing the human resources needs in the energy sector. Further, it was determined that the assessment of current national institutions should be clarified and therefore stated as an assessment of the curricula of these national institutions.

  The SWG agreed on the need to include the identification of gaps and areas of overloaded responsibility at the target institutions as an activity under the development of a human resources development plan.

Table 6. Priority Sectors, shortlisted Technology Applications, critical cross-cutting Measures, Actions and Activities

Sectors	Shortlisted Technology Applications	Critical Measures	Actions	Activities
Energy	*Solar farms to service urban centers and supply the national grid* *Large hydropower plants (over 5MW) to support national energy demands* *Stand-alone wind farms to service urban centers and supply the national grid*	Establish a robust policy framework	1. Implement a sustained Public Awareness and Education Programme.	1.1 The lead institution (GEA) procures a consultant to develop a Public Awareness and Education Programme. Through this process, the GEA will establish a framework to guide the process of the consultancy in order to address the transfer of information and the inclusion of support organizations such as the Ministry of the Presidency.
				1.2 Identify the primary stakeholders and undertake a stocktaking or review of existing initiatives and of stakeholder's levels of awareness, benefits, knowledge, attitudes and practices related to renewable energy and energy efficiency.
				1.3 Conduct an analysis of key stakeholder groups in the energy sector to be targeted as part of the Public Awareness and Education Programme, with a focus on the priority technologies.
				1.4 Engage with the University of Guyana and other training organizations such as the Georgetown Technical Institute (GTI) and Technical Vocational Education and Training (TVET) to: 1.4.1 Review or undertake a stocktaking of current programmes on renewable energy, focusing on specific technologies at the technician and engineering levels. 1.4.2 Identify the current renewable energy programme at the technician and engineering levels, focusing on the priority technologies. 1.4.3 Engage leading international institutions with a successful track record in the appropriate field to identify opportunities to enhance and develop the curriculum for technician and engineering programmes with a focus on the priority technologies.
				1.5 Identify awareness-raising and educational materials and activities for the energy sector tailored to specific target groups, with a focus on the priority technologies, and establish a mechanism to evaluate the effectiveness of the activities two (2) to three (3) years after implementation.
				1.6 Prepare and implement the Public Awareness and Education Programme by building on current initiatives in the public and private sectors, including an M&E component.
			2. Institute economic and financial incentives to promote investments	2.1 Procure a consultant to undertake an assessment and identify and elaborate economic and financial incentives for implementation, taking into consideration international experience and lessons learned.
				2.2 Examine Guyana's national circumstances in relation to energy and in keeping with the national direction, as outlined in national strategies such as the GSDS, and consider international best practices, circumstances for easy deployment and lessons learned from other countries.
				2.3 Examine the extent to which incentives are being implemented through engagements with key stakeholders and institutions (policy level, GOINVEST etc.).
				2.4 Identify applicable incentives to promote investments in the energy sector, targeting the priority renewable-energy technologies.
				2.5 Identify opportunities and measures such as net metering to enhance economic and financial incentives and their implementation.
				2.6 Explore including the identified opportunities using the information obtained from international best practice and national assessments within the draft energy policy and obtain Cabinet approval.
				2.7 Include into the road-map for implementation of the energy policy and implement the identified economic and financial incentives.
			3. Prepare a human resources development plan.	3.1 Procure a consultant to prepare a human resources development plan.
				3.2 Assess the human resources needs of the energy sector over the next ten years focusing on the priority technologies.
				3.3 Assess the current curricula of national institutions offering training and capacity-building programmes and identify target institutions to participate in the process.
				3.4 Identify gaps in the curricula of the target institutions in the energy sector.
				3.5 Identify actions to address the identified gaps in target institutions, focusing on the priority technologies.
				3.6 Design an HR Development Plan, which should include short-, medium- and long-term skills development, and enhancing the capacity of target institutions, as well as the external recruitment of skills.

2.2.3.4 Actions to be implemented as Project Ideas

The process of prioritizing actions for the preparation of project concept notes or project ideas was carried out at two (2) levels and took into consideration costs, timings and the most critical action for the acquisition, the deployment and transfer of the priority technologies. The first engagement was with the lead agency, followed by the SWG. In both cases, the preparation of a comprehensive human resources development plan emerged as a critical action. Currently, stakeholders felt that there is a degree of urgency to develop the institutional and technical capacities of key institutions responsible for deploying, regulating and managing the technology applications. The SWG recommended integrating elements of the Public Awareness and Education Programme into the Human Resources Development Plan to allow for continuous or sustained education and development at the tertiary level.

Stakeholders also identified the economic and financial incentives as the next priority action. The rationale behind the selection of this action was that incentives serve as the stimulus for the development of renewable energy in the energy sector. It was also suggested that for any investment opportunity, incentives are critical.

In summary, stakeholders identified the following priority actions for the preparation of project ideas:

1. Institute economic and financial incentives to promote investments.
2. Prepare a Human Resources Development Plan.

However, the identified project ideas do not constitute the entirety of what is required for diffusion of the technologies. While two of the seven actions identified in Table 5 that are related to the most critical measure have been identified to be developed as PINs under the TNA Project, the remaining five actions still remain priorities and should be positioned to receive support through other financing mechanisms such as the Green Climate Fund. In addition, financing for project-specific technology applications could also be pursued on the basis of the Energy Transition Roadmap (Table 3) drawn up by the GoG to outline specific technology application projects, locations and scales. The TNA report also identified a list of technology applications approved by the TNA Committee that could also be considered.

The following is a list of additional project ideas which could at some stage be considered in preparing PINs.

<u>Project Ideas relating to cross-cutting actions</u>

- Situate the Energy Policy in the wider national development framework.
- Implement a sustained Public Awareness and Education Programme.
- Commission research, baseline and other studies.
- Commit to improving the energy infrastructure.

<u>Proposed projects based on the Energy Road Map (Table 3)</u>

- Solar Phase 1 GPL (WCD) 3 MW.
- Solar GPL (Essequibo Coast) 3 MW.
- Solar Phase II GPL (EBD) 3 MW.
- Mabaruma Power & Light Co. Inc. Solar Farm, 400 KW.
- Kwakwani Utilities Inc. 2.7 MW Solar, (with storage).

- Lethem Power Company, 3 MW Solar (with storage).
- Mahdia Power Company 1.4 MW Solar (with storage).
- Port Kaituma Power & Light 1.3 MW Solar (with storage).
- Mathew's Ridge Power & Light 0.192 MW (with storage).
- Mid-scale hydro # 1, 150-180 MW.
- Mid-scale hydro # 2, 150-350 MW.
- Small hydro (Moco Moco hydro), 0.5 – 1.0 MW.
- Small hydro (Kato hydropower), 320 KW.
- Small hydro (Tumatumari hydropower), 3 MW.
- Hope Beach Wind Farm, 10 MW.

Technology applications approved by the TNA Committee

- Co-generation of bagasse at sugar estates.
- Gasification of rice husk and wood waste for the production of electricity at rice mills.
- Methane recovery from livestock waste and biomass residue.
- Reduction of transmission and distribution losses and increased efficiency of power system.
- Introduction of smart grid PMU (phasor measurement units).
- Introduction of electric vehicles.

2.2.4 Stakeholders and Timelines for implementation of the TAP

2.2.4.1 Overview of Stakeholders for the implementation of the TAP

The acquisition, deployment and transfer of energy technologies, namely solar, hydropower and wind, involve multiple stakeholders or participants based on levels of interest at various scales of operation.

The primary responsibility for the acquisition, deployment and/or in some cases the transfer and implementation of any given activity of the TAP for the energy sector lies with the MoPI, with delegated responsibility to the GEA. Both entities, but with the GEA in the lead role, will manage the planning and execution of the TAP's activities.

The MoPI has the overall responsibility for energy, hydropower, utilities, hinterland electrification and electrical inspection, and it executes this mandate through its agencies and departments, such as the GEA, GPL, HECI and the Electrical Inspectorate Department.

Secondary or supporting responsibilities for implementing the activities, especially for negotiating the requisite financial resources and managing relations with donors, rest with the Ministry of Finance, followed by the Ministry of Business and the investment promotion entity, the Guyana Office for Investment (GO-Invest).

2.2.4.2 Scheduling and Sequencing of Activities

The timeframe established for implementation of the TAP's actions leading to the creation of a robust policy framework for the deployment of the prioritized energy sector technologies is 2018 (January to December). This period is aligned with the finalization of the draft energy policy and the implementation of Guyana's Power Generation System Expansion Study. Both of these are necessary precursors for the attainment of the energy-sector goal of increasing the sector to 100% renewables by 2025.

2.2.5 Estimate of Resources Needed for Action and Activities

2.2.5.1 Estimate of capacity-building needs

The capacity development needs for the implementation of the TAP's actions and activities and the strengthening of the enabling framework for the energy sector's technologies were identified in collaboration with the lead agency and the SWG. The capacity needs identified include project management, financial management, investment and trade, and market development, among others. Section 2.2.7 presents an overview of the required capacity needs per TAP action.

2.2.5.2 Estimates of costs of Actions and Activities

The estimated costs and funding needs for the implementation of the specific TAP actions and activities were identified in collaboration with the lead agency and the SWG. The TAP's actions and activities identified during this process are strongly oriented towards public-sector implementation with support from international donors. These activities allow gaps to be filled in strengthening the enabling framework for the energy sector. As such, they support the costs of the responsible institutions (direct expenses), consultants (level of effort) and consultations with stakeholders and decision-makers. Section 2.2.7 outlines the specific costs associated with the implementation of the TAP's actions.

2.2.6 Management Planning

2.2.6.1 Risks and Contingency Planning

Several risks were identified by the lead agency and the SWG. These risks have been categorized as those associated with costs, schedules, capacity and information. Contingency measures were identified for each of the identified risks and are highlighted in Table 7.

Table 7. Risks associated with each TAP action and corresponding contingency measures

Type of Risk	Related to Actions	Description of risk	Contingency Measures	
Cost Risks; Schedule Risks; Information Risks; Capacity Risks	Implement a sustained Public Awareness and Education Programme.	Delays in securing donor financing Activities cost more than originally planned Activities take longer to complete than originally planned Information not being provided in a timely manner or not available Limited capacity of Lead Agency to implement actions	GoG finance preparation of the Public Awareness and Education Programme and utilize donor funds for implementation. Ensure contingency line item in budget can accommodate cost fluctuations. In implementation planning, allow for step-by-step slippage and identify critical path items early. Ensure there is policy-level (high-level) acceptance and support, and establish project steering committee to bring key institutions into the process. Building capacity and strengthening the Lead Agency as part of project implementation. Continuous reassessment of Lead Agency's capacity to implement the projects. Consult with other agencies that may have capacity.	
			Responsibility for contingency measures:	MoPI & GEA
			Timing of contingency measures:	Jan – March 2018
Cost Risks Schedule Risks Information Risks Capacity Risks	Institute economic and financial incentives to promote investments.	Delays in securing donor financing Delays in decision-making by GoG regarding incentives and implementation Information not being provided in a timely manner or not available	GoG finance the work of the consultant. In implementation planning, allow for step-by-step slippage and identify critical path items early. Awareness raising at level of Cabinet and also key Ministries (MoF, MoB) and agencies, (GOINVEST, GRA) as well as private sector Secure timely decisions by Cabinet Ensure there is policy-level (high-level) acceptance and support and establish project steering committee to bring key institutions into the process.	

Type of Risk	Related to Actions	Description of risk	Contingency Measures	
		Limited capacity of Lead Agency to implement actions GPL's capacity, based on current infrastructure, to absorb energy production from renewable sources.	Building capacity and strengthening the Lead Agency as part of project implementation. Continuous reassessment of Lead Agency's capacity to implement the projects. Consult with other agencies that may have capacity. A framework is being established to allow for entry of renewable energy into the grid.	
			Responsibility contingency measure:	MoPI, GEA
			Timing of contingency measure:	Jan – March 2018
Cost Risks Schedule Risks Information Risks Capacity Risks	Prepare a human resources development plan.	Delays in securing donor financing Activities take longer to complete than originally planned Information not being provided in a timely manner or not available Limited capacity of Lead Agency to implement actions	GoG finance preparation of the human resources development plan. In implementation planning, allow for step-by-step slippage and identify critical path items early. Ensure there is policy-level (high-level) acceptance and support and establish project steering committee to bring key institutions into the process. Building capacity and strengthening the Lead Agency as part of project implementation. Continuous reassessment of Lead Agency's capacity to implement the projects. Consult with other agencies that may have capacity.	
			Responsibility for contingency measure:	MoPI, GEA
			Timing of contingency measure:	July – December 2018

2.2.6.2 Next Steps

The immediate requirements and critical next steps are summarized and presented in Table 8.

Table 8. Immediate Requirements and Critical Next Steps	
Immediate requirements	Early engagement with donors, in particular those with a history of and current support to the Energy Sector, to allow for early programming of funds to ensure that activity timelines can be met. The MoPI playing a critical role in ensuring Cabinet awareness and buy-in so as to allow for timely decision-making and also to facilitate support and close collaboration from other Ministries and Line Agencies.
Critical steps	GEA to take present actions to MoPI for support. MoPI to secure Cabinet approval to implement. Early engagement by GoG with donor to secure financing.

2.2.7 TAP Overview Table

Table 9. TAP Planning Table: Activities for the Implementation of Actions

Actions and Activities	Planning				Implementation				Costs and Funding Needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
1. Implement a sustained Public Awareness and Education Programme	Jan 2018	June 2018	GEA	Project Management, Financial Administration and Management	July 2018	Dec 2020	GEA	Project Management, Technical Skills (engineering), Communications and Public Relations, Information Technology and Graphics	U.S$300 000	GoG Donor (bilateral/multilateral institutions)
1.1 The lead institution (GEA) to procure a consultant to develop a Public Awareness and Education Programme.	Jan 2018		GoG							
1.2 Identify the primary stakeholders and undertake a stocktaking or review of existing initiatives undertaken, and stakeholders' levels of awareness, benefits, knowledge, attitudes and practices related to renewable energy and energy efficiency.	Jan 2018	Mar 2018	Consultant							
1.3 Conduct an analysis of key stakeholder groups in the energy sector to be targeted as part of the Public Awareness and Education Programme, with a focus on the priority technologies.	Jan 2018	Mar 2018	Consultant							
1.4 Engage with the University of Guyana and other training	Mar 2018	April 2018	Consultant						U.S$50 000	

Actions and Activities	Planning				Implementation				Costs and Funding Needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
organizations such as the Georgetown Technical Institute (GTI) and Technical Vocational Education and Training (TVET) to: 1.4.1 Review or undertake a stocktaking of current programmes on renewable energy focusing on the specific technologies at the technician and engineering levels. 1.4.2 Identify current renewable energy programme at the technician ans engineering levels focusing on the priority technologies. 1.4.3 Engage the training institutions to identify opportunities to enhance and develop the curriculum for technician and engineering programmes with a focus on the priority technologies.										
1.5 Identify awareness and educational materials and activities for the energy sector tailored to specific target groups with a focus on the priority technologies and establish a mechanism to evaluate the effectiveness of the activities	Mar 2018	April 2018	Consultant							

Actions and Activities	Planning				Implementation				Costs and Funding Needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
two (2) to three (3) years after implementation.										
1.6 Prepare the Public Awareness and Education Programme by building on current initiatives in the public and private sectors, including an M&E component.	May 2018	June 2018	Consultant							
1.7 Implement the Public Awareness and Education Programme.					July 2018	Dec 2020	GEA		U.S$250 000	
2. Institute economic and financial incentives to promote investments	Jan 2018	June 2018	MoF MoPI GEA	Project management, Technology Awareness	July 2018	Ongoing	MoF MoB GOINVEST	Technology Awareness, Financial management, business investment & trade, marketing/market development, engineering, technology deployment/diffusion,	U.S$100 000	GoG Donor(bilateral/multilateral institutions)
2.1 Procure a consultant to undertake an assessment and to identify and elaborate economic and financial incentives for implementation, taking into consideration international experience and lessons learned.	Jan 2018	Mar 2018	Consultant						U.S$100 000	
2.2 Examine Guyana's national circumstances in relation to energy and in keeping with the national direction as outlined in national strategies such as the GSDS; consider international best practices, circumstances for	Jan 2018	Mar 2018	Consultant							

Actions and Activities	Planning				Implementation				Costs and Funding Needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
easy deployment and lessons learned from other countries.										
2.3 Examine the extent to which incentives are being implemented through engagements with key stakeholders and institutions (policy level, GOINVEST etc.).										
2.4 Identify applicable incentives to promote investments in the energy sector targeting the priority renewable energy technologies.	Jan 2018	Mar 2018	Consultant							
2.5 Identify opportunities and measures such as net-metering to enhance economic and financial incentives and their implementation.	Jan 2018	Mar 2018	Consultant							
2.6 Explore including the identified opportunities using the information obtained from international best practice and national assessments within the draft Energy Policy and obtain Cabinet approval.	Apr 2018	June 2018	MoPI							
2.7 Include in the Road-map for implementation of the Energy Policy.	Apr 2018	June 2018	MoPI							
2.8 Implement the identified economic and financial incentives.							MoF MoB GOINVEST			

Actions and Activities	Planning				Implementation				Costs and Funding Needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
3. Prepare a Human Resources Development Plan	July 2018	Dec 2018	GEA	Project Management; Financial Planning				Engineering; Education; Financial management; Business management; Marketing/Market development	U.S$75 000	GoG Donor(bilateral/multilateral institutions)
3.1 Procure a consultant to assess the human resources development plan.	July 2018	July 2018	Consultant							
3.2 Assess the human resources needs for the energy sector over the next ten years focusing on the priority technologies.	July 2018	July 2018	Consultant						U.S$75 000	
3.3 Assess current curricula of national institutions offering training and capacity-building programmes and identify target institutions to participate in the process.	Aug 2018	Sept 2018	Consultant							
3.4 Identify gaps in the curricula of the target institutions in the energy sector	Oct 2018	Oct 2018	Consultant							
3.5 Identify actions to address the identified gaps in target institutions with a focus on the priority technologies.										
3.6 Design an HR Development Plan which should include short-, medium- and long-term skills development; enhancing the capacity of target institutions as well, as external recruitment of skills.	Nov 2018	Dec 2018	Consultant							

3. Technology Action Plan: Forests Sector

3.1 Technology Action Plan for the Forests Sector

3.1.1 Forests Sector: Overview [24]

Over 87% of Guyana's total land mass is covered by forests amounting to approximately 18.48 million hectares (GFC *et al.,* 2015) and containing an estimated 20.4 billion tonnes (or Gt) of carbon dioxide in live and dead biomass pools (GoG, 2015a; GoG, 2015b).

Guyana's total forest cover contains high-density carbon at up to 350 tonnes a hectare and storing 5.31Gt of carbon (GoG, 2015a; GoG, 2015b). The total commercial forest area of the country is estimated at 13.6 million hectares (GoG, 2015b). These forests are classified as swamp forest on the coast, and rainforest, seasonal and dry evergreen forest in the interior. The total annual value of forest products exported over the past fifteen (15) years ranges between US$32 million and US$60 million per year. Over the past fifteen (15) years, timber production has ranged between 300,000 m^3 to 530,000 m^3 per year (GoG, 2015b).

The main land uses in Guyana are forestry, agriculture, mining and protected areas. Anthropogenic activities impacting the forest area and forest biomass stocks include logging, forest removal for the production of charcoal, clearing for agriculture, infrastructure and settlements, mining, land allocation to Amerindian communities and fires (both human-induced and natural). Land-use changes as a result of these activities have significantly impacts on forest-cover biomass and result in deforestation and forest degradation. Through comprehensive assessments of changes to forest areas from 1990 to 2014, anthropogenic drivers of deforestation have been identified and are being measured and monitored on an annual basis (GFC *et al.*, 2015):

- Mining (ground excavation associated with small- and large-scale mining)
- Forestry (clearance activities such as log landings)
- Agricultural conversion
- Infrastructure such as roads (including harvesting and mining roads)
- Fire[25]

The main sources of degradation were identified as (GFC *et al.*, 2015):

- Selective and illegal harvesting of timber
- Shifting cultivation
- Fire
- Degradation associated with mining sites and road infrastructure.

Historically, the total area converted from forest to non-forest over the period from 1990 to 2009 is 74,917[26] ha, 2009 being picked as the benchmark year for assessing changes to forest areas. Thereafter, changes in the period from 2010 to 2014 were assessed annually. Over these five (5) years, forest area changes fluctuated, with a significant increase to 14,655 ha for the period January 2012 to December 2012

[24] Overview extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project, Ministry of the Presidency, 2017.
[25] All considered anthropogenic and, depending on intensity and frequency, can lead to deforestation.
[26] This figure excludes forest degradation caused by selective harvesting, fire or shifting agriculture.

due to an upsurge in mining activity, followed by some indication of a decrease in changes to forest areas to 11,975 ha for January to December 2014 (GFC *et al.*, 2015).

In general, and compared with the rest of the world, Guyana's overall deforestation is low, ranging from 0.02% to 0.079%, with a peak of 0.079% for 2012, 0.068% for 2013 and 0.065% for 2014[27] (GFC *et al.*, 2015). Mining was identified as a key driver of deforestation and forest degradation, with gold-mining resulting in 89% of the deforestation recorded in Guyana over the past three years (2011-2014) (GFC *et al.*, 2015).

3.1.2 Preliminary targets for technology transfer and diffusion

The country's vision for climate change mitigation is aligned with the national development thrust in the pursuit of a GE through the preparation of the GSDS and its commitment as contained in the revised NDC. The GoG has expressed its commitment to *'continue the transition of our economy to realise improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcity'* (GoG, 2015b).

The GoG has committed itself to avoided deforestation and aims to reduce carbon emissions by approximately 48.7MtCO_2e annually (GoG, 2015b) through the implementation of an Emissions Reduction Programme (ERP), as outlined in the NDC. Given that the largest share of emissions from the forest sector comes from mining and logging activities, the ERP focuses on several measures such as (i) Reduce Impact Logging in the timber industry, (ii) Improved Monitoring, Reporting and Verification System (MRV) for assessing levels of forest degradation and deforestation; (iii) Mineral Mapping in mining districts to identify economically exploitable deposits; and (iv) Improved Forest Governance (IFG) & Institutional Capacity Upgrading (ICU) (GoG, 2015b).

Through implementation of the ERP measures, it is envisaged that reforms will be undertaken in the mining and forests sectors, including mineral mapping in the mining districts, to identify economically viable deposits (GoG, 2015b); collateral damage reduction during tree-felling leading to annual emissions reductions of 13.5%; implementation of efficient recovery technologies; conservation of an additional two (2) million hectares of forest through the national protected areas system; and the sustainable management of commercial state forest estate through reduced impact logging (RIL). The strengthening and implementation of RIL techniques in the timber industry will result in annual emissions reductions from 3.5 MtCO_2e to 2.3 MtCO_2e, that is, an 11% reduction in the overall historic emissions level (GoG, 2015b).

[27] The total forest area examined is 18.4Mha (GFC *et al.*, 2015).

3.2 Action Plan for the Technologies

3.2.1 Introduction to the Prioritized Technologies

3.2.1.1 General Description: Geological Surveys and Mineral Mapping[28]

Exploration is the first stage in the mining cycle and is critical to the process of mine planning for purposes of operation and development. According to the Guyana Geology and Mines Commission (GGMC) (2011), *'exploration or prospecting aims to determine the amount, grade, characteristics (such as grain size and shape) of valuable minerals present and the extent of the width and depth of the mineralized areas'*. Exploration or prospecting provides information to the miner to aid in decision-making, thereby allowing the miner to know *'(i) amount of valuable mineral, (ii) estimated value of the minerals present, (iii) characteristics of the minerals (and those most economically feasible), (iv) nature and extent of the host rock, and distribution and depth of the mineralized areas, (v) amount and nature of the ore and overburden, (vi) extent of the mineralized areas or where mineralization stops or becomes uneconomical'* (GGMC, 2011). With this information, the miner is better able to determine the most efficient methods for mining, processing the ore and mineral recovery. Exploration further helps to reduce mining's environmental footprint (GGMC, 2011).

The method of prospecting or exploration depends on the type of gold ore deposits. Veiga (2010) suggests that alluvial gold deposits are located in large flat terrains, while gold concentrated in small veins forms localized alluvial deposits, which are most likely to be accessed by artisanal miners. The methods used for prospecting could range from simple tools and applications to sophisticated techniques. Methods which can be used by small- and medium-scale operators include simple systems such as sampling stream sediments, pitting and trenching (this could be done manually or through the use of excavators), sampling the gravel and other layers, and using a hand auger, as well as panning (using the batel). Thereafter, samples are taken to a laboratory to be analyzed for the presence of gold, base metals and any other economic minerals and elements (GGMC, 2011).

Satellite images can also be used to identify areas being mined (artisanal miners), while magnetometry can be used to detect gold deposits associated with magnetic minerals such as magnetite and pyrrhotite (Veiga, 2010). Field sampling is another method employed in the exploration process, which is done for unexplored areas. A soil geochemical assessment is undertaken, whereby the area is marked out in grids from 100 to 400m and soil samples are collected from a depth of 30m. Exploration using gold geochemistry could be carried out by analyzing the minerals accompanying the gold in the greenstone belts (mineralogy), analyzing soil elements that are usually related to gold-bearing sulphides, gold analysis of soil and drainage sediments and concentration methods (Veiga, 2010). Veiga (2010) explains that panning is a faster, cheaper and easier way to prospect for gold than chemical analysis. Through this process, some information on the amount and size of gold specks can be obtained, as well as the weight and shape of each speck and the total weight of the gold in the concentrate.

The GGMC, and specifically its Geological Services Division, undertakes geological fieldwork throughout Guyana to document the country's geology and mineral resource endowment. The results of these assessments are made available in the form of geological reports. Thus far, the GGMC has produced a regional geological map and a mineral occurrences map or Geochemical Atlas of Guyana from its Regional

[28] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project. Report 2.

Geochemical Surveys. The GGMC has a drilling division and conducts its own drilling (for mineral exploratory work), collects samples and conduct its own assays using its chemical laboratory. Several regional maps summarizing the country's geology, mineral resource potential, geochemistry and licensing status are available from the GGMC. Currently the GGMC provides topographical and basic geological maps to miners at the level of the mining districts or regions, but these are not at a scale that would benefit the small- or medium-scale miners, asthe level of detail specific to economically exploitable deposits is not available for each mining claim.

Thus, in the prospecting phase, large-scale mining operations undertake their own geological surveys to map the extent of gold deposits and the grade of the ore. The mineral inventorying process and associated metallurgical testing, engineering studies and financial analysis all form part of a comprehensive feasibility study. These results inform decisions as to whether or not the company should proceed to mine development. However, small- and medium-scale operators are usually unable to undertake any prospecting or feasibility study prior to extraction because of the high investment costs involved. Also, in many instances the miners do not own the land they word but rather enter into short-term rental arrangements with a title holder, which structurally prohibits them from investing in prospecting. Therefore, by necessity, they operate using a highly speculative 'hit or miss' approach.

On this basis, in 2010 the GGMC conducted a technical assistance programme for miners which included the geological mapping of mining pit faces and ore sampling. This was done recognizing that exploration by small and medium gold miners is critical to the mining cycle. GGMC used the methods of panning and trenching (GGMC, 2010). It also proposed establishing a team with equipment such as drills to conduct in-depth mineral assessments and provide the results at a cost to miners once economically exploitable deposits are identified. Subsequently, in 2014, the MNR announced that, with the assistance of the Chinese government, Guyana will undertake a mineral property assessment to gather geological data on areas that have not yet been geologically mapped.

3.2.1.2 General description: reforesting mined-out areas[29]

Mine-site reclamation and closure form one of the four stages of the 'mining cycle' and must be incorporated or planned for while planning mines (GGMC, 2010). While mine site reclamation and closure are legal requirements for all mining operations, the process involved in doing this varies based on the scale of the operation. 'Reclamation' in Guyana, according to the GGMC, refers to *'the restoration of mined land to safe and usable forms after mining is completed'* (GGMC, 2010). Reclamation not only helps to restore the environment and stabilize the land, it also allows replanting with suitable plant species (GGMC, 2011). The process varies and can commence with the simple re-planting of species to ensure slope stability and reduce erosion or involve extensive reforestation to allow the regeneration of the area's habitats and ecological systems.

Over the years, the GGMC has conducted several pilot studies and established demonstration sites to encourage and promote the reclamation of mined-out areas, especially for small and medium gold-mining operations. Among these are sites at Mahdia and Olive Creek. Re-vegetation or reforestation is one method of mine reclamation that has been promoted by the Commission, especially in the case of large-scale gold-mining operations. For the purposes of this report, reforestation is not limited to small, mined-out areas but includes large expanses of contiguous cleared areas. Although reforestation is not a new

[29] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project. Report 2.

technology in Guyana, it has experienced limited uptake over the years. Nevertheless it is viewed as critical in the extractive industry sector to restore or re-establish ecosystems and functionally disturbed lands within a sustainable land management framework as an effective and replicable way of increasing forest biomass and carbon stocks in keeping with Guyana's REDD+ programme (GoG, 2014).

Over the years, several studies have been conducted and demonstration plots established to guide national decision-making on reforestation and land reclamation in small and medium mined-out areas. Specifically, in 2008 the GGMC established demonstration sites at Noitgedacht and St. Elizabeth and implemented initiatives at Isseneru and Aranka (GGMC, 2011; Goodchild, 2010). The Noitgedacht, St. Elizabeth and Isseneru sites included reforestation trials using *Acacia mangium,* crops such as cassava and citrus*,* pasture grass and six local pioneer forest species. Plant nurseries were also established to support these activities (GGMC, 2011).

3.2.1.3 General description: efficient recovery systems in small- and medium-scale gold-mining[30]

According to GGMC (2011), comparatively speaking the small and medium gold and diamond mining sector represents the majority of mining operations and contributes the largest share to overall mineral production. Approximately 97% of gold and diamond acquired was through alluvial mining, with small-scale operations being the most successful (Wotruba *et al.*, 1998). GGMC noted that the existing mineral properties in 2010 were 14,335 small-scale claims and river locations, 4,879 medium-scale prospecting permit blocks and 742 mining permit blocks (GGMC, 2011).

At this scale, hydraulicking is the preferred method of ore extraction in the sector. This entails breaking apart the ore with water, followed by processing (Wotruba *et al*., 1998). Processing of the ore is the third stage in the mining cycle, and the technology used to recover gold depends on a number of factors, including ore grade, alluvial characteristics, cost, ease of use and mobility. Currently, the technology used in the small- and medium-scale sector recovers gold at very low rates and mainly uses mercury at the secondary stage of processing after passing the ore through a sluice box. The sluice box is used as the main recovery equipment (Bayah, 2015), but, as a result of its low level of efficiency, free gold escapes into the surroundings. As a consequence, tailings are often re-processed and more gold recovered since miners often return to previously mined areas and re-process tailings, especially when technological improvements can recover gold previously lost and/or in times of higher gold prices. Improved recovery efficiency could make the reprocessing of previously mined sites unnecessary and better facilitate the cost-effective reforestation and natural recovery of mine sites, thereby supporting a REDD+ programme.

Over the years, the GGMC has tested several of these recovery methods in order to find the most cost-effective primary and secondary gold systems. The GGMC has focused on technologies to improve overall recovery rates for fine gold by pre-screening the ore using the modified jig as the primary recovery system, followed by using Knelson centrifugal concentrators and the shaking table as secondary devices to recover free gold (GGMC, 2011). The Commission also recommends the use of a hydro-cyclone to dewater the tailings before feeding the tails into the Knelson centrifugal concentrator if a sluice box is used as the primary device (GGMC, 2011). Further, the Commission has undertaken testing of a locally made floatation cell for use as secondary processing equipment to recover gold to as low as 75 microns or 0.075mm with the shaking table as the final processing equipment used (GGMC, 2011).

[30] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project. Report 2.

Sluices or sluice boxes come in different forms and types, such as fan-shaped, vibrating floors and plane tables ,and they cater for both primary and alluvial gold. Sluices are considered to be the most important tools for gravity concentration in small-scale mining and are very common in the industry. Their function is determined by factors related to the types of floors that influence separation (floor with riffles and carpet floors). A number of factors must be taken into consideration during operation, including the following: (i) the feed grain should not exceed that of the largest possible nugget; ii) material must be treated based on the gold size with different traps; iii) sluice box inclination; iv) washing frequency; and v) pulp density (Wotruba *et al.*, 1998).

The jig is another gravity-based technology used in gold recovery, in addition to the pre-concentration and concentration of heavy minerals. The underlying principle of the system is the separation of ore components based on their specific gravity in an aqueous media which relies on alternating between free and hindered sedimentation resulting from liquid pulsations produced from varying artifacts. Two types of jig are hydraulic jigs and mechanical jigs, the primary difference between them being that the former generates pulsations hydraulically through water pressure moving through a valve, while the latter uses a motor-driven diaphragm and connecting rod to produce pulsations mechanically. The jig, much like the sluice, can be used for both primary and alluvial mining, though unlike the sluice, it requires well-trained operators in order to get good results. Nonetheless the technology is quite efficient in recovering both laminated and spongy gold, in addition to complementing product enrichment (Wotruba *et al.*, 1998).

Shaking tables are another gravity-based technology that can be used to concentrate fine and ultra-fine gold using a mechanism that differentiates mineral particles based on their specific weight through the formation of fan-shaped bands. Shaking tables allow samples to be taken directly and can therefore be operated by an apprentice operator. Notably, to be effective the technology relies on pulp density and the homogeneity of the feed. Moreover, it can be used to enrich pre-concentrates acquired from sluice boxes and spirals (Wotruba *et al.*, 1998).

Spiral concentrators separate lighter and heavy materials using a mechanism similar to that of centrifugal force in a cone. Lighter materials are taken to the edges, while heavy materials go to the center, where their speeds are reduced by friction and drag. The system is characterized as high-recovery, low-enrichment, and it facilitates pre-concentration production and desliming materials. It requires very little maintenance and is mainly used to pre-concentrate gold-bearing materials and recovering gold pyrites from the tailings of primary plants (Wotruba *et al.*, 1998).

Centrifugal concentrators are used in recovering gold and in the grinding circuits to separate coarse gold prior to cyanidation and floatation. As the name suggests, they capitalize on centrifugal forces where materials are rotated rapidly and separated by gravity. Centrifugal concentrators come with and without concurrent water injection. While they require other equipment to be used alongside them, this technology can achieve high levels of enrichment for direct smelting, as well as providing security against theft and being labor-saving. Unfortunately, during enrichment ultra-fine gold may be lost. The main issues with the centrifugal concentrator are: a) the high demand for clean water for water injection; b) its minimum ability to recover accompanying heavy minerals; c) operation without the ability to be supervised; and d) propensity for operating alterations. Moreover, high countercurrent water is needed if heavy coarse materials are present, which ultimately results in fine gold being lost (Wotruba *et al.*, 1998).

Other equipment for gravity pre-concentration includes oscillating sluice boxes, hydraulic traps and dry separators. Oscillating sluice boxes are used to concentrate alluvial gold. The system is also characterized

by low water consumption and as such is popular in relatively dry areas; it is also very portable, can be manufactured locally and does not require power. Regular sluice boxes, however, can also operate adequately with limited water. Hydraulic traps are used in both alluvial mining prior to coarse gold undergoing classification and primary mining immediately after grinding (Wotruba *et al.*, 1998).

Apart from the GGMC, an Inter-Agency Working Group (including the Institute of Applied Sciences & Technology (IAST), GGMC, Guyana Gold & Diamond Miners Association (GGDMA), the Guyana Mining School and Training Centre Inc. (GMSTC)) has been established to test alternative technologies, including gold flotation, the Knelson concentrator, shaking tables, the Gold Kacha concentrator, cyanidation, activated carbon and the spiral Concentrator. In partnership with a local (medium–scale) mining company, IAST is conducting laboratory assessments of the cyanidation process using activated carbon. The in-lab results thus far yield about a 90% recovery rate, with field testing still to be undertaken.

Conservation International (CI), with support from the Global Environment Facility (GEF), is currently finalizing a project which will include support to the GGMC and GGDMA in the phasing out of mercury in gold extraction through a pilot demonstration of technology transfer in one mining district. A similar project is also being developed by the World Wildlife Fund (WWF).

3.2.2 Ambition of the TAP

In 2015 the GoG set a goal of avoiding emissions by 48.7MtCO2e annually through reforms in the timber and mining industries as a contribution to the global mitigation effort. ERP Guyana is focusing on several measures, including the conservation of an additional 2 million hectares through the National Protected Area System, and other effective area-based conservation measures based on commitments under the UNCBD, including the protection of conservancies and reservoirs and their watersheds, including the watersheds upstream of new hydro-power sites. It is also concentrating on reduced impact logging in the timber industry, an improved Monitoring, Reporting and Verification System (MRVS) for assessing levels of forest degradation and deforestation, and mineral mapping of the mining districts to identify economically exploitable deposits, among others.

The ERP includes actions by the GGMC to implement policy reforms, education and incentives for the integrated planning and management of the mining sector in order to transform the sector by 2020. The government intends to implement mineral mapping in the mining districts to identify economically exploitable deposits, implement awareness-raising and incentive programmes to improve the efficiency of technologies and practices in the mining industry, and implement policies to institute the mandatory, nation-wide land reclamation and reforestation of mined areas (GoG, 2015b).

3.2.3 Actions and Activities selected for inclusion in the TAP

3.2.3.1 Summary of barriers and measures to overcome barriers

In the barrier analysis phase, by means of a prioritization process, the TWGs identified the absence of a clear policy position and framework as the most critical barrier hindering the deployment and transfer of technologies in the forests sector. This related specifically to geological surveys and mineral mapping and the reforestation of mined-out areas and efficient recovery systems in small and medium gold-mining operations. Recognizing that technology applications all relate to the mining sector, and in particular small- and medium-scale mining, the TWG took the view that a policy position is critical in the absence of a comprehensive mining policy, since there is no clear guidance on the critical elements needed for the diffusion and transfer of the technologies. Table 10 lists the specific critical barriers by technology application and their identified measures.

Table 10. List of non-financial critical barriers and corresponding proposed measures[31]

Identified critical barriers	Identified measures
Introduction of geological surveys and mineral mapping to improve exploration	
Limited human capacity, knowledge and awareness	Enhanced human capacity, education and awareness through targeted programmes
Limited policy framework to support geological surveys and mineral mapping to improve exploration.	Clear policy to support exploration technologies and mineral mapping
Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.	
Lack of a clear policy framework to guide the reforestation of mined-out areas	Clear policy framework that includes the following areas: 1. Updating the mining and environmental regulations 2. Incentives 3. Enhanced monitoring and enforcement 4. Reconciling environmental protection and extraction activities
Deployment of efficient recovery system in small and medium gold-mining operations	
Absence of a clear policy position to support the Technical Assistance Programme	Clear policy for government to provide technical assistance to improve the recovery rates of small- and medium-scale operations
Lack of coordination and planning of initiatives	Enhanced coordination and planning of initiatives for improved recovery in the gold-mining sector

Guyana currently has a mining policy, the elements of which are broadly contained within two documents. The first is the Mineral Policy and Fiscal Regime (MPFR), which was prepared in 1997 and which outlines the policy position on several aspects of the mining sector, such as the fiscal framework, the environment, multiple land uses and mining titles, among other areas. The second is the NDS (2001–2010), which

[31] Information extracted from the 'Technology Needs Assessment Report: Barrier Analysis and Enabling Framework' as part of Guyana's Technology Needs Assessment Project. Report 2.

provides a comprehensive analysis and recommendations on a range of issues within the mining sector (Lowe, 2014).

To date, there has been no consolidated, single document outlining the government's adopted position on mining policy, in particular as it relates to the three priority technology applications. However, the MNR has tasked the Board of the GGMC with developing a policy for mining and to include, among other areas, gold, bauxite and quarry mining.

3.2.3.2 Actions selected for inclusion in the TAP

During the discussions with the TWGs in the barrier analysis process, stakeholders identified the most critical barriers and corresponding critical measures for Guyana in keeping with the country's green development trajectory. Stakeholders prioritized the selected technology applications, corresponding critical barriers and measures based on their mitigation potential, effectiveness and suitability in the context of Guyana's forest sector.

In keeping with the guidance provided by UNEP-DTU for the TAP and the outcome of the BA&EF process, the overarching critical cross-cutting measure for the three (3) technology applications was identified along with the other measures that were converted into actions. These actions are listed in Table 11.

Table 11. Priority Forests Sector, shortlisted Technology Applications, critical cross-cutting Measure and proposed Actions

Sectors	Shortlisted technology applications	Overarching/ critical measure	Actions	Project ideas
Forests	*Introduction of geological surveys and mineral mapping to improve exploration* *Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.* *Deployment of efficient recovery systems in small and medium gold-mining operations*	Establish a clear Policy Framework	1. Identify and confirm a focal institution. 2. Improve planning and coordination of initiatives. 3. Linking the GE development path to climate mitigation. 4. Implement awareness-raising and education initiatives. 5. Identify and institute economic and financial incentives to promote the updating of the technologies. 6. Identify mechanisms for making the technology available in country. 7. Elaborate any legislative amendments that may be required. 8. Enhance technical and human resources capacity.	The actions *improve planning and coordination of initiatives* and *institute economic incentives to promote investments* were identified through the TAP process as critical: if implemented, they would contribute to strengthening the enabling policy environment in the forests sector.

Thereafter, engagements were held with the lead sector institution, the MNR, to discuss the TAP approach and the broad actions that emerged out of the barrier analysis process. The list of actions presented in Table 11 was further categorized into five (5) critical areas, recognizing that some actions were already in place, for example, the MNR as the lead institution overseeing and coordinating the forestry and mining sectors, and these sectors being key components of the NDC and GSDS, while a few actions could merge with or were components of others. The following list of actions was inserted into the TAP:

1. Implement a sustained Public Awareness and Education Programme.
2. Institute economic and financial incentives to promote investments.
3. Update mining and environmental regulations
4. Improve human resources
5. Improve the planning and coordination of initiatives.

3.2.3.3 Activities identified for implementation of the selected actions

The SWG for forests was convened on June 16, 2017 to review the prioritized measures designed to overcome the technology barriers, to agree on the actions, and to review and identify the activities designed to implement the selected actions. The following five (5) actions were reviewed:

1. Implement a sustained Public Awareness and Education Programme.
2. Institute economic and financial incentives to promote investments.
3. Update mining and environmental regulations
4. Improve human resources
5. Improve the planning and coordination of initiatives.

The SWG reviewed a draft list of activities corresponding to each action and made amendments and adjustments. The revised list is presented in Table 12. During the process, the SWG discussed each action, the main points of the discussion being summarized below.

- **Implement Awareness and Education Programme**

The SWG recognized that the lead institution is the MNR, which has responsibility for the GFC and the GGMC. Given that initiatives are being pursued, the SWG suggested that, as a first step, there should be a stocktaking or review of awareness-raising and educational initiatives related to the priority technologies in the mining sector. Also, to assist a programme for awareness and education, a stocktaking or review of stakeholders' levels of awareness, knowledge and attitudes related to the priority technologies in the mining sector should be carried out.

While engagement with the University of Guyana was viewed as important, the SWG stated that, among the other training institutions, the Mining School and the Mineral Processing Unit of the GGMC should be included, since the latter has information on geological surveys, etc., while the former directly trains miners.

The SWG suggested that, instead of only identifying education and awareness-raising materials, a focus should also be placed on developing the necessary materials. Furthermore, it was highlighted that some of these materials already exist for the mining and forestry sectors and should be consolidated. Monitoring and evaluation should be incorporated into the implementation of the programme activity instead of only in the preparation phase.

The SWG further suggested that the education and awareness-raising programme should be field-tested or piloted before implementation and that the GGMC and Mining School have important roles to play in the implementation.

- **Institute economic and financial incentives to promote investments**

The SWG suggested rewording the action to read 'economic incentives' instead of 'economic and financial incentives' since in the broader context the economic incentives will capture the financial ones as well. Disaggregation of activity 2 was also suggested, while at the same time expanding activity 3 to include evaluations of incentives, as well as including a monitoring and evaluation component. It was suggested that, based on the identified incentives, a road map should be developed.

- **Update the mining and environmental regulations**

The working group suggested that consideration should be given during the review and amendment of the mining and environmental regulations to reviewing and possibly amending other related regulations, such as the environmental protection regulations. Stakeholder consultations should also be factored into the process to allow gaps associated with the priority technology applications to be identified. It was recognized that the MNR has initiated the process of revising the Mining Act and that proposals for new draft regulations for the mining sector are currently being developed.

- **Improve human resources**

The SWG suggested that the list of activities should include a stocktaking of current human development resources to ensure that the TNA process captures the existing initiatives. They further suggested amending the timescale of activity 1 from ten years to five to ten years.

It was recognized that the Mining School has benefited from two projects that were supported by the IDB and UNDP. The IDB has facilitated through a technical cooperation grant, Supporting Technical Education in the Extractive Industries, while the UNDP project is being supported by means of GEF financial resources for the implementation of the Mainstreaming Biodiversity in the Mining Sector project. These projects have allowed the School to benefit from a Training of Trainers workshop, mercury-free enhanced gold recovery equipment and training, turbidity test kits, and other equipment that will facilitate enabling miners through field-training exercises to become more compliant with mining and environmental regulations and laws. The Mainstreaming Project has also facilitated a consultancy that has proposed a re-organized structure and curriculum for the Mining School, and this is currently before the GGMC's Board to be considered for implementation.

- **Improve the planning and coordination of initiatives**

The working group suggested that the list of activities should include a stocktaking of current planning and coordination initiatives and establish a team within the MNR to plan and coordinate the initiatives related to the priority technologies.

It was pointed out that currently the MNR has mechanisms, such as scheduled meetings with the various Commissions, which support planning and coordination.

Table 12. Priority Sectors, shortlisted Technology Applications, critical cross-cutting Measures, Actions and Activities

Sectors	Shortlisted technology applications	Critical measures	Actions	Activities
Forests	*Introduction of geological surveys and mineral mapping to improve exploration* *Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.* *Deployment of efficient recovery systems in small and medium gold-mining operations.*	Establish clear policy framework	Implement Awareness and Education Programme.	Identify a lead institution to develop an Awareness and Education Programme and implement and field test the Programme. Procure a consultant to develop the Awareness and Education Programme. Conduct an analysis of key stakeholder groups in the forests and mining sector to be targeted as part of the Awareness and Education Programme, with a focus on the priority technologies. Undertake a stocktaking or review of existing initiatives and assess stakeholders' levels of awareness, knowledge, attitudes and practices related to the priority technologies in the forests sector. Identify and evaluate the efficacy of current awareness and education materials for the forests and mining sectors with focus on the priority technologies. Consolidate and develop awareness-raising and educational materials for the forests and mining sectors, with a focus on the priority technologies. Prepare the Awareness and Education Programme, including curriculum design, by building on current initiatives, as well as monitoring and evaluation.

Sectors	Shortlisted technology applications	Critical measures	Actions	Activities
				Implement the Awareness and Education Programme, including the M&E component.
			Institute economic incentives to promote investments.	Procure a consultant to undertake an assessment and to identify and elaborate economic incentives for implementation.
				Examine Guyana's national circumstances in relation to forests and mining in the context of the national direction as outlined in national strategies such as the GSDS.
				Evaluate the extent to which incentives are being implemented through engagements with key stakeholders and institutions (policy level, GOINVEST etc.).
				Identify and evaluate applicable incentives to promote investments in the mining sector targeting the priority technologies.
				Identify opportunities to enhance economic incentives and their implementation.
				Considering the incentives identified, and develop a road-map for inclusion into the revised Mining Policy.
			Updatemining and environmental regulations.	Undertake stakeholder consultations and review of the updated mining and environmental regulations to identify gaps in promoting the priority technologies.

Sectors	Shortlisted technology applications	Critical measures	Actions	Activities
				Draft new amendments to the environmental legislation under the Mining Act to address gaps in keeping with national circumstances and government direction.
				Conduct stakeholder engagements with the forests and mining sectors to solicit inputs to the draft legislation.
				Table amendments in Parliament.
			Improve human resources.	Procure a consultant to undertaking a stocktaking of current human resources initiatives and to assess the human resources needs for the mining sector over the next five to ten years, with focus a on the priority technologies.
				Assess the current national institutions (Mining School etc.) offering training and capacity-building and identify target institutions.
				Identify actions to address the identified gaps in target institutions, with a focus on the priority technologies.
				Design a Human Resources Development Plan which should include short-, medium- and long-term skills development; enhance the capacity of target institutions, as well as external recruitment of skills.
				Implement the Human Resources Development Plan.

Sectors	Shortlisted technology applications	Critical measures	Actions	Activities
			Improve the planning and coordination of initiatives.	Determine the current efforts at the planning and coordination of initiatives for the priority technologies, including a stocktaking of current initiatives undertaken by different entities in Guyana.
				Establish a team within the MNR with responsibility for improving the planning and coordination of initiatives.
				Develop an agenda and work plan in keeping with the objective of improving the planning and coordination of initiatives in the mining sector.

3.2.3.4 Actions to be implemented as Project Ideas

For the forests sector, the prioritization of actions for the preparation of project concept notes or project ideas was conducted at two (2) levels and took into consideration costs, timings and the most critical action for the acquisition, deployment and transfer of the priority technologies. The first engagement was with the lead agency, the MNR, followed by the SWG. In both cases, the action *'improve planning and coordination initiatives'* emerged as critical. Stakeholders felt that there is a degree of urgency in coordinating efforts not only for the efficient use of resources, but to also to allow streamlined planning. The action to institute economic incentives to promote investments was also selected as a priority action.

In summary, stakeholders identified the following priority actions for the preparation of project ideas:

1. Improve planning and coordination of initiatives.
2. Institute economic incentives to promote investments.

While two of the five actions agreed by the SWG for forests and put forward in the TAP relating to the most critical measure have been identified to be developed as PINs under the TNA Project, the other three actions still remain priorities and should be positioned to receive support through other financing mechanisms, such as the Green Climate Fund. In addition to these actions, implementation of the shortlisted technology applications themselves will also contribute significantly towards achieving the overall mitigation objective. This will help to build on current initiatives being undertaken regarding implementation of the technology applications. The TNA report also identified a list of technology applications approved by the TNA Committee that could also be considered.

The following is a list of additional project ideas which could at some stage be considered in preparing PINs.

<u>Project ideas relating to cross-cutting actions</u>

- Implement a sustained Public Awareness and Education Programme.
- Update mining and environmental regulations.
- Improve human resources.

<u>Shortlisted Technology Applications for the TNA Project</u>

- Introduction of geological surveys and mineral mapping to improve exploration.
- Reforestation of mined-out areas utilizing fast-growing species such as Acacia spp.
- Deployment of efficient recovery systems in small and medium gold-mining operations.

<u>Technology Applications approved by the TNA Committee</u>

- Strengthen the monitoring and verification of deforestation by enhancing the ground-truthing component of MRV using GPS technology.
- Enhancing sustainable forest management through the expansion of RIL techniques.

3.2.4 Stakeholders and Timelines for implementation of the TAP

3.2.4.1 Overview of Stakeholders for the implementation of the TAP

The deployment and transfer of the forest technology applications in the form of geological surveys and mineral mapping, the reforestation of mined-out areas using fast-growing species, and efficient recovery systems in small- and medium-scale gold-mining operations involve different stakeholders at different scales of operation. The primary responsibility for deployment and/or in some cases the transfer and implementation of any given activity of the TAP for the forest-sector technologies lies with the MNR, with responsibility being delegated to the GGMC and GFC, which will also manage the planning and execution of the TAP activities through them.

The MNR has the overall responsibility to *'develop, implement and oversee policies for the responsible exploration, development and utilisation of natural resources whilst ensuring the protection and conservation of the environment and advancement of the GE.*[32]*'* The MNR executes this mandates through its agencies, such as the GGMC, the Guyana Gold Board and the GFC.

Secondary or supporting responsibilities for implementing the activities, in particular negotiating the requisite financial resources and managing donor relationss rest with the Ministry of Finance.

3.2.4.2 Scheduling and sequencing of activities

The timeframe established for the implementation of the TAP's actions that will contribute towards the creation of a robust policy-enabling framework for the deployment of the prioritized forest-sector technology applications is 2018 (January to December).

3.2.5 Estimation of Resources Needed for Action and Activities

3.2.5.1 Estimation of capacity-building needs

The capacity development needs for the implementation of the TAP's actions and activities, as well as for the strengthening of the enabling framework for the forest-sector technology applications, were identified in collaboration with the MNR and the SWG. The capacity needs identified include project management, financial management, communication and public relations, and raising technology awareness, among others. Section 3.2.7 presents an overview of the required capacity needs for each TAP action.

3.2.5.2 Estimating the costs of Actions and Activities

The estimated costs and funding needs for the implementation of the specific TAP actions and activities were identified in collaboration with the MNR and the SWG. The TAP's actions and activities identified during this process are expected to be implemented in the public sector directly by the MNR. These activities allow the policy framework for the forests sector generally and the mining industry in particular to be strengthened. As such, it supports the costs of direct expenses, consultants (level of effort) and consultations with stakeholders and decision-makers. Section 3.2.7 outlines the specific costs associated with the implementation of the TAP's actions.

[32] www.nre.gov.gy

3.2.6 Management Planning

3.2.6.1 Risks and Contingency Planning

Several risks were identified by the MNR and the SWG. These risks have been categorized as those associated with costs, schedules, capacity and information. Contingency measures were identified for each of the identified risks and are highlighted in Table 13.

Table 13. Risks associated with each TAP action and the corresponding contingency measures

Type of risk	Related to actions	Description of risk	Contingency actions	
Cost Risks Schedule Risks Information Risks Capacity Risks	Implement Awareness and Education Programme.	Delays in securing donor financing Activities cost more than originally planned Activities take longer to complete than originally planned Information not being provided in a timely manner or not available Limited capacity of Lead Agency to implement actions	GoG finance preparation of the Awareness and Education Programme and utilize donor funds for implementation. Ensure that contingency line item in budget can accommodate cost fluctuations. In implementation planning, allow for step-by-step slippage and identify critical path items early. Ensure there is policy-level (high-level) acceptance and support, and establish project steering committee to bring key institutions into the process. Building capacity and strengthening the Lead Agency as part of project implementation.	
			Responsibility for contingency measures:	MNR, GGMC/Mining School, DoE, EPA, GFC
			Timing of contingency measures:	January to March 2018
Cost Risks Schedule Risks Information Risks	Institute economic incentives to promote investments.	Delays in securing donor financing Delays in decision-making by GoG regarding incentives and implementation	GoG finance the work of the consultant. In implementation planning, allow for step-by-step slippage and identify critical path items early. Awareness-raising at level of Cabinet and also key ministries (MNR, MoF, MoB) and agencies (GOINVEST, GRA), as well as private sector.	

Type of risk	Related to actions	Description of risk	Contingency actions	
Capacity Risks		Information not being provided in a timely manner or not available Limited capacity of Lead Agency to implement actions	Ensure there is policy-level (high-level) acceptance and support, and establish project steering committee to bring key institutions into the process. Building capacity and strengthening the Lead Agency as part of project implementation.	
			Responsibility for contingency measures:	MNR, MoF
			Timing of contingency measures:	January to March 2018
Cost Risks Schedule Risks Information Risks Capacity Risks	Update mining and environmental regulations.	Delays in securing donor financing Activities take longer to complete than originally planned Information not being provided in a timely manner or not available Limited capacity of Lead Agency to implement actions Push back from stakeholders	GoG finance the work of the consultant. In implementation planning, allow for step-by-step slippage and identify critical path items early. Awareness-raising at level of Cabinet and also key ministries (MoP) and agencies (GGMC), as well as private sector Ensure there is policy-level (high-level) acceptance and support, and establish project steering committee to bring key institutions into the process. Building technical capacity and strengthening the Lead Agency as part of project implementation. Continuous engagement with the sector stakeholders to increase the level of awareness of the regulations and requirements.	

Type of risk	Related to actions	Description of risk	Contingency actions	
		(resistance from stakeholders in the mining community)		
			Responsibility for contingency measures:	MNR
			Timing of contingency measures:	January to March 2018
Cost Risks Schedule Risks Information Risks Capacity Risks	Improve human resources.	Delays in securing donor financing Activities take longer to complete than originally planned Information not being provided in a timely manner or not available Limited capacity of agencies to implement actions	GoG finance preparation of the Human Resources Development Plan. In implementation planning, allow for step-by-step slippage and identify critical path items early. Ensure there is policy-level (high-level) acceptance and support, and establish project steering committee to bring key institutions into the process. Building capacity and strengthening the Lead Agency as part of project implementation.	
			Responsibility for contingency measures:	MNR
			Timing of contingency measures:	January to March 2018
Schedule Risks Information Risks Capacity Risks	Improve planning and coordination of initiatives.	Failures to meet regularly and sloth in implementation of activities Information not being provided in a timely manner or not available	Institute regular (quarterly) reporting of work plan implementation and quarterly review of performance. Ensure there is policy-level (high-level) acceptance and support, and establish project steering committee to bring key institutions into the process.	

Type of risk	Related to actions	Description of risk	Contingency actions	
		Limited capacity of Lead Agency to implement actions	Building capacity and strengthening the Lead Agency as part of project implementation.	
			Responsibility for contingency measures:	MNR
			Timing of contingency measures:	Quarterly

3.2.6.2 Next Steps

The immediate requirements and critical next steps are summarized and presented in Table 14.

Table 14. Immediate Requirements and Critical Next Steps	
Immediate requirements	It is important to determine whether the Actions will be financed by GoG or donors. In the latter case, early engagement is necessary with donors, especially with those with a history of and current support to the natural resources sector, to allow the early programming of funds to ensure activity timelines can be met. The MNR will need to ensure Cabinet awareness and buy-in so as to allow timeline decision-making and also to facilitate support and close collaboration from other ministries and line agencies, especially regarding issues such as economic and financial incentives. Early and continuous engagement with mining stakeholders will be critical to ensure their buy-in regarding the use and application of the technologies and also the legislative amendments.
Critical steps	MNR to secure Cabinet approval for implementation. Early engagement by GoG with donors to secure financing. Commence sensitization of mining sector on the actions to be taken.

3.2.7 TAP Overview Table

Table 15. TAP Planning Table: Activities for the Implementation of Actions

Actions and Activities	Planning				Implementation				Costs and funding needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
Implement Awareness and Education Programme	Jan 2018	June 2018	GGMC/ Mining School	Project Management	July 2018	Dec 2020	GGMC/ Mining School	Project Management Technical Skills (mining, environment, forestry) Communications /Public Relations Information Technology& Graphics	U.S$300 000 – U.S$500 000	GoG Donor
Identify a lead institution to develop an Awareness and Education Programme.	Jan 2018		GoG						U.S$50 000	
Procure the consultant to develop an Awareness and Education Programme.										
Conduct an analysis of key stakeholder groups in the forests and mining sector to be targeted as part of the Awareness and Education Programme with a focus on the priority technologies.	Jan 2018	Mar 2018	Consultant							
Undertake a stocktaking or review of existing initiatives and assess stakeholders' levels of awareness, knowledge, attitudes and practices related to the priority technologies in the forests sector.	Jan 2018	Mar 2018	Consultant							
Identify and evaluate the efficacy of current awareness and educational materials for the forests and mining sectors, with a focus on the priority technologies.	Mar 2018	April 2018	Consultant							

Actions and Activities	Planning				Implementation				Costs and funding needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
Consolidate and develop awareness and educational materials for the forests and mining sectors, with a focus on the priority technologies.	Mar 2018	April 2018	Consultant							
Draw up the Awareness and Education Programme, including curriculum design, building on current initiatives, as well as monitoring and evaluation.	May 2018	June 2018	Consultant							
Implement the Awareness and Education Programme, including the M&E component.					July 2018	Dec 2020	GGMC/ Mining School		U.S$250 000	
Institute economic incentives to promote investments	Jan 2018	June 2018	MNR GGMC	Financing	July 2018	Ongoing	MoF MoB GOINVEST	Technology Awareness	U.S$100 000	GoG Donor
Procure a consultant to undertake an assessment and to identify and elaborate economic incentives for implementation.	Jan 2018	Mar 2018	Consultant						U.S$100 000	
Examine Guyana's national circumstances in relation to forests and mining in the context of the national direction as outlined in national strategies such as the GSDS.	Jan 2018	Mar 2018	Consultant							
Evaluate the extent to which incentives are being implemented through engagements with key stakeholders and institutions (policy level, GOINVEST etc.).										
Identify and evaluate applicable incentives to promote investments in the mining sector targeting the priority technologies.	Jan 2018	Mar 2018	Consultant							
Identify opportunities to enhance economic incentives and their implementation.	Jan 2018	Mar 2018	Consultant							
Considering the incentives identified, develop a road-map for inclusion into the revised mining policy.	Apr 2018	June 2018	MNRI				MoF MoB GOINVEST			
Submit through the MNR and obtain Cabinet approval.	Apr 2018	June 2018	MNR				MoF MoB			

Actions and Activities	Planning				Implementation				Costs and funding needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
							GOINVEST			
Update mining and environmental regulations			MNR - GGMC; DOE - EPA		Jan 2018	Oct 2018	MNR; GGMC; EPA	Technology Awareness	U.S$80 000	GoG Donor
Undertake stakeholder consultations and review the updated mining and environmental regulations to identify gaps in relation to promoting the priority technologies.					Jan 2018	Mar 2018	Consultant		U.S$30 000	
Draft new amendments to the environmental legislation under the Mining Act to address gaps in keeping with national circumstances and government direction.			DOE- EPA & MNR - GGMC		Mar 2018	June 2018	EPA & GGMC, Consultant			
Conduct stakeholder engagements with the forests and mining sectors to solicit inputs to the draft legislation.					July 2018	Sept 2018	MNR		U.S$50 000	
Table amendments in Parliament.						Oct 2018	MNR			
Improve human resources	Jan 2018	June 2018	MNR	Project Management Financial Planning					U.S$75 000	GoG Donor
Procure a consultant to undertaking a stocktake of current human resources initiatives and to assess the human resources needs for the mining sector over the next five to ten years with a focus on the priority technologies.	Jan 2018	Jan 2018	Consultant							
Assess the current national institutions (Mining School etc.) offering training and capacity-building, and identify target institutions.	Feb 2018	Mar 2018	Consultant						U.S$75 000	
Identify actions to address the identified gaps in target institutions with a focus on the priority technologies.	Mar 2018	April 2018	Consultant							

Actions and Activities	Planning				Implementation				Costs and funding needs	
	Start	Complete	Who	Capacity Needs	Start	Complete	Who	Capacity Needs	Costs	Who will fund
Design a Human Resources Development Plan which should include short-, medium- and long term-skills development; enhance the capacity of target institutions, as well as the external recruitment of skills.	April 2018	June 2018	Consultant							
Implement the Human Resources Development Plan.										
Improve the planning and coordination of initiatives	Jan 2018	Mar 2018	MNR	Project Management Financial Planning	Mar 2018	Ongoing	MNR	Project Management Financial Planning	U.S$60 000 annually	GoG
Determine current efforts in the planning and coordination of initiatives for the priority technologies, including a stocktaking of current initiatives undertaken by different entities in Guyana.	Jan 2018	Jan 2018	MNR							
Establish a team within the MNR with responsibility to improve the planning and coordination of initiatives.	Feb 2018	Feb 2018	MNR							
Develop an agenda and work plan in keeping with the objective of improving the planning and coordination of initiatives in the mining sector.	Feb 2018	Mar 2018	MNR							
Allocate human and financial resources for the work of the team.					Jan 2018	Ongoing	MNR		U.S$60 000 annually	

References

Arvizu, D., P. Balaya, L. Cabeza, T. Hollands, A. Jager-Waldau, M. Kondo, C. Konseibo, V. Meleshko, W. Stein, Y. Tamaura, H. Xu, R. Zilles, 2011: Direct Solar Energy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds.)], Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

Bayah, J. (2015): Mining and Process improvements for the Guyana Small Scale Miner. Presentation at Guyana Mining Week. 2015.

Goodchild, K. (2010). *Establishment of a Demonstration Model of Mine Site Reclamation*. Guyana: Guyana Geology and Mines Commission (GGMC).

Government of Guyana (GoG). (2016): Budget Speech 2017 as presented by the Minister of Finance to the National Assembly, November 2016.

Government of Guyana (GoG). (2015a): Reference Level for Guyana's REDD+ Programme.

Government of Guyana (GoG). (2015b): Guyana Nationally Determined Contributions.

Government of Guyana (GoG). (2014): Land Reclamation Project. Project Document (*Draft)*.

Government of Guyana (GoG). (2013): Low Carbon Development Strategy Update: Transforming Guyana's Economy while Combating Climate Change.

Government of Guyana (GoG), (2012): Second National Communication to the UNFCCC.

Government of Guyana (GoG), (2011): National Forest Policy Statement.

Government of Guyana (GoG), (2010*): Guyana Power Sector Policy and Implementation Strategy.*

Government of Guyana (GoG), (2005): National Development Strategy.

Government of Guyana (GoG), (2001): National Forest Policy.

Government of Guyana (GoG), (1994): National Energy Policy.

Guyana Energy Agency (GEA) (2010): Energy Development in Guyana.

Guyana Energy Agency (GEA), (2014a): Strategic Plan 2014 – 2018.

Guyana Energy Agency (GEA) (2014b): Annual Report, 2014.

Guyana Energy Agency (GEA) (2015a): Annual Report, 2015.

Guyana Energy Agency (GEA), (2015b): Statistical Data from GEA.

Guyana Energy Agency (GEA), (2016a): Communication with the Guyana Energy Agency, 2016, during the review of the Technology Needs Assessment Report: Identifying and Prioritising Mitigation Technologies as part of Guyana's Technology Needs Assessment Project. Report 1.

Guyana Energy Agency (GEA), (2016b): GEA public awareness message on Renewable Energy Technologies. Supported by the Government of Guyana and Inter-American Development Bank.

Guyana Energy Agency (GEA), (2016c): Report 2: Draft National Energy Policy of Guyana. Green Paper.

Guyana Energy Agency (GEA) (2017): Energy Transition Roadmap for Guyana.

Guyana Geology & Mines Commission (GGMC), (2010): Mining Supplement.

Guyana Geology & Mines Commission (GGMC), (2011): Mining Supplement.

Guyana Forestry Commission (GFC) and Indufor Asia Pacific (2015): Guyana REDD+ Monitoring, Reporting and Verification System (MRVS). Year 5 Summary Report for the period January 01, 2014 – December 31, 2014.

Gumartini, T., Goudzwaard, L., (no date): *Acacia mangium Wild Tree Factsheet: Forest Ecology and Forest Management Group*. University of Wageningen.

International Renewable Energy Agency (IRENA), (2013): Renewable Power Generation Costs in 2012: An Overview.

International Renewable Energy Agency (IRENA), (2015): Renewable Power Generation Costs in 2014.

Interim report of the Committee on Landscape restoration, replanting and rehabilitation of areas subjected to mining. (2012).

Kaieteur News (2016): Energy efficient stoves among projects for 2016. *Kaieteur News*, Sunday January 03, 2016

Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.-M. Devernay, M. Freitas, D. Hall, A. Killingtveit, Z. Liu, 2011: Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds.)], Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

Livan, M. A. *Revegetation of the North East Kara Kara Mined Out Area Annual Report*. Guyana: Guyana Geology and Mines Commission (GGMC) and National Agriculture Research Institute (NARI).

Livan, M. A. (2005). *Revegetation of the North East Kara Kara Mined Out Area January – June, 2005 Report*. Guyana: Guyana Geology and Mines Commission (GGMC) and National Agricultural Research Institute (NARI).

Livan, M. A. (2006). *Revegetation of the North East Kara Kara Mined Out Area January – June, 2006 Report*. Guyana: Guyana Geology and Mines Commission (GGMC) and National Agricultural Research Institute (NARI).

Lowe, S. (2006): Situation Analysis of small scale mining sector in Guyana. Edited by Michelet Fontaine and Rickford Vieira. World Wildlife Fund, Guianas Regional Programme.

Lowe, S. (2014): Can Mining be part of a Low Carbon, Low Deforestation Development Strategy? The Case of Guyana.

Middleton, B. (1993). *Mission Report to Guyana 8 – 13 March, 1993*. Guyana: MAZDA Gold Mine.

Ministry of the Presidency, (2016): Technology Needs Assessment Report – Identifying and Prioritising Mitigation Technologies as part of Guyana's Technology Needs Assessment Project. Report 1.

Nygaard, I. and Hansen, U. (2015): Overcoming Barriers to the Transfer and Diffusion of Climate Technologies: Second Edition. UNEP-DTU Partnership, Copenhagen.

Office of Climate Change (OCC), 2015: Terms of Reference, TNA Mitigation Consultant.

Skeete, D. (1989): A Review of Mineral Processing Research and Development in Guyana. Mineral Processing and Research Unit. Mines Division. Guyana Geology and Mines Commission.

Skeete, D. and Sefton, V. (1993): The Design and Development of a Demonstration Plant for Enhanced Gold Recovery in Small-Scale Operations. The National Conference on Mining and Quarrying.

Technology Fact Sheet – Mauritius. http://tech-action.org

Technology Fact Sheet – Lebanon. http://tech-action.org

UNEP-DTU (2016). Enhancing Implementation of Technology Needs Assessment: Guidance for Preparing a Technology Action Plan.

Veiga, M, (2010): Gold Ore Characterization and Processing. Norman B. Keevil Institute of Mining Engineering. University of British Colombia. Canada.

Wiser, R., Z. Yang, M. Hand, O. Hohmeyer, D. Infi eld, P. H. Jensen, V. Nikolaev, M. O'Malley, G. Sinden, A. Zervos, (2011): Wind Energy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds.)], Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

Wotruba, H., Hentschel, T., Livan, L., F., H., and Priester, M. (1998). *Environmental Management in Small-Scale Mining.* Bolivia: Medio Ambiente Mineria E Industria (Fundacion MEDMIN).

www.climatetechwiki.org

www.nre.gov.gy

Annex I. List of TNA Committee Members

Organisation	Members, Replacement and Alternates
Ministry of the Presidency	Rear Admiral (rtd) Gary A R Best – Chairman
Ministry of the Presidency Office of Climate Change	Ms. Janelle Christian – Deputy Chair Janelle.Christian.occ@motp.gov.gy Tel: 223 5231
Ministry of Agriculture	Dr. Garvin Cummings Chief Hydrometeorological Officer (ag.) Hydrometeorological Service garvin.cummings@gmail.com Tel: 225 9303
National Agriculture Research and Extension Institute	Mr. David Fredericks Research Scientist fredericks_david@yahoo.com Tel: 614 9547
Guyana Forestry Commission	Mr. Dwayne Griffith Project Officer, REDD Secretariat dwaynegriff@yahoo.com 226 7271-4/ 656 0401
Guyana Energy Agency	Dr. Mahender Sharma Chief Executive Officer mahender.sharma@hotmail.com Ms. Shevon Wood (alternate) Economist shevon.wood@yahoo.com; Tel: 226 0394 Ext 211/ 618 8420
Environmental Protection Agency	Mrs. Angela Franklin Senior Environmental Officer, Water Quality Unit Mr. Frank Grogan (replacement for Angela Franklin) Environmental Officer II, Water Quality Unit Ms. Malicia Hall (replacement for Frank Grogan) Environmental Officer malicia.epa@gmail.com; Tel: 225 5467
Guyana Geology and Mines Commission	Ms. Dianne McDonald Deputy Commissioner mmmdggmc@yahoo.com; Tel: 623 1207 Mr. Lloyd Bandoo (representative) Senior Mineral Processing Engineer Lloyd_bandoo@ggmc.gov.gy; Tel: 610 2832

Organisation	Members, Replacement and Alternates
Ministry of Public Infrastructure Works Services Group	Jermaine Braithwaite Senior Engineer Ministry of Public Infrastructure jobraithwaite81@gmail.com , Tel: 226-0650 ext. 341
Ministry of Communities	Mr. Marlon Daniels Pilot Coordinator, Guyana Wastewater Revolving Fund Shafeek Ali/Gordon Gilkes (replacement for Marlon Daniels) alli_shafeek@yahoo.com, gordon.gilkes@gmail.com Tel: 629 0523
University of Guyana, Faculty of Earth and Environmental Sciences	Ms. Denise Simmons denise.simmons@uog.edu.gy Lecturer II denise.simmons@uog.edu.gy Tel: 639 4610
Institute of Applied Science and Technology	Prof. Suresh Narine, Director sureshnarine@trentu.ca Mr. Deonarine Jagdeo (alternate) djagdeo2000@yahoo.com; Tel: 624 5810
Conservation International-Guyana	Curtis Bernard Technical Director cbernard@conservation.org: Tel: 624 6346
Private Sector Commission	Mr. Lance Hinds Georgetown Chamber of Commerce Email: lance.hinds@brainstreetgroup.com **No replacement**
University of Guyana, Faculty of Technology	Mr. Jomo Gill, Lecturer 1 jomo.gill@uog.edu.gy Vishal Persaud, Head of Department (replacement for Jomo Gill) vishal.persaud@uog.edu.gy; Tel: 645 0966 Ms. Elena Trim (alternate) elena.trim@uog.edu.gy
Ministry of the Presidency Office of Climate Change	Rohini Kerrett, Project Manager projectmanagerocc@gmail.com Tel: 226 6037
Ministry of the Presidency Office of Climate Change	Lucina Singh (project support) Science and Technology Officer singh.lucina@gmail.com Kandila Ramotar (alternate for Lucina Singh) Climate Change Officer Kandila.ramotar.occ@motp.gov.gy

Annex II. List of stakeholders involved and their contacts

Attendees for Mitigation Sector Working Group Meeting (Energy)

No.	Name	Designation	Organisation	Contact Info.
1.	Lucina Singh	Science and Technology Officer	Ministry of the Presidency	singh.lucina@gmail.com; 223 5231
2.	Nonieka Daniels	Chief Accountant	Institute of Applied Sciences and Technology (IAST)	noniekad@yahoo.com
3.	Vickram Persaud	Research Assistant	National Agricultural Research and Extension Institute (NAREI)	vickram05@yahoo.com
4.	Lalita Gopaul	Research Assistant	National Agricultural Research and Extension Institute (NAREI)	andreagopaul@rocketmail.com
5.	Hamwantttee Bisesar	Investment and Promotion and Facilitation Officer	Guyana Office for Investment (GO-Invest)	hbisesar@goinvest.gov.gy
6.	Amir Dillawar	Project Officer	Guyana Power and Light Inc. (GPL)	adillawar@gplinc.com
7.	Desmond Sears	Vice Chairman	Private Sector Commission	dacs1357@gmail.com
8.	Gayle Best	Deputy Chief Executive Officer	Guyana Energy Agency (GEA)	gayle_best@yahoo.com
9.	Denise Simmons	Lecturer	Faculty of Earth and Environmental Sciences, University of Guyana	denise.simmons@uog.edu.gy
10.	Shane Singh	Technical Officer	Office of Climate Change	shane.singh_occ@motp.gov.gy
11.	Horace James	Chief Executive Officer	National Industrial and Commercial Investments Limited (NICIL)	linceo22@yhaoo.com
12.	Ashley Adams	Agronomy Manager	Guyana Sugar Corporation Inc.	ashleya@guysuco.com
13.	Mark Adams	Deputy Principal	Guyana Technical Institute (GTI)	markadams_78@yahoo.com
14.	David Fredericks	Research Scientist	National Agricultural Research & Extension Institute (NAREI)	fredricks_david@yahoo.com

No.	Name	Designation	Organisation	Contact Info.
15.	Rohini Kerrett	Project Manager	Office of Climate Change (OCC)	projectmanagerocc@gmail.com
16.	Preeya Rampersaud	Assistant to the Consultant		preeyarampersaud@gmail.com
17.	Shyam Nokta	Mitigation Consultant		shyamnokta@gmail.com
18.	Ajay Persaud	Assistant to the Consultant		ajay.arjoon02@outlook.com

Attendees for Mitigation Sector Working Group Meeting (Forests)

No.	Name	Designation	Organisation	Contact Info.
1.	Vasquez Ramdas	Environmental Officer	Guyana Gold and Diamond Miners Association (GGDMA)	vasquezramdas@yahoo.com; 639 1012
2.	Godfrey Scott	Senior Environmental Officer	Guyana Geology and Mines Commission (GGMC)	
3.	Veetal Rajkumar	Policy Planning	Ministry of Natural Resources	231 2506 - 11
4.	John Applewhite	Administrator	Guyana Mining School and Training Centre Inc.	639 5923
5.	Dwayne Griffith	REDD+ Officer	Guyana Forestry Commission (GFC)	dwaynegriff@yahoo.com
6.	Nonieka Daniels	Chief Accountant	Institute of Applied Sciences and Technology (IAST)	noniekad@yahoo.com
7.	David Fredericks	Research Scientist	National Agricultural Research and Extension Institute (NAREI)	fredericks_david@yahoo.com
8.	Lucina Singh	Science and Technology Officer	Ministry of the Presidency	singh.lucina@gmail.com; 223 5231
9.	Shane Singh	Technical Officer	Office of Climate Change	shane.singh_occ@motp.gov.gy
10.	Urica Primus	President	Guyana Women Miners Association (GWMO)	

No.	Name	Designation	Organisation	Contact Info.
11.	Rohini Kerrett	Project Manager	Office of Climate Change (OCC)	projectmanagerocc@gmail.com; 226 6037
12.	Preeya Rampersaud	Assistant to the Consultant		preeyarampersaud@gmail.com
13.	Shyam Nokta	Mitigation Consultant		shyamnokta@gmail.com
14.	Ajay Persaud	Assistant to the Consultant		ajay.arjoon02@outlook.com

Other Stakeholders engaged

No.	Name	Designation	Organisation	Contact Info.
1.	Joslyn Mc Kenzie	Permanent Secretary	Ministry of Natural Resources	jmckenzie@nre.gov.gy; 231 2506 - 11
2.	Dr. Mahender Sharma	Chief Executive Officer	Guyana Energy Agency	gea@gea.gov.gy; 226 0394
3.	Curtis Bernard	Technical Director	Conservation International – Guyana (CI-G)	cbernard@conservation.org, 227 8171