# Initiative for Climate Action Transparency – ICAT Project in Lesotho

*Report on designing the national MRV system*

# Initiative for Climate Action Transparency – ICAT

## Deliverable 4.1- Report on designing the national MRV system using the ICAT guidance tailored to the energy related policy, establishment of roles and responsibilities and providing recommendations on how to address barriers/ gaps to improve data collection and reporting for the Energy sector emissions.


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# LIST OF ACRONYMS

| | |
|---|---|
| BAU | Business As Usual Scenario |
| BBCDC | Bethel Business and Community Development Centre |
| BoS | Bureau of Statistics |
| DTT | Department of Traffic and Transport |
| GHG | Greenhouse Gas |
| ICAT | Initiative for Climate Action Transparency |
| LEC | Lesotho Electricity Company (Pty) Ltd |
| LEGCO | Lesotho Electricity Generation Company |
| LESES | Lesotho Solar Energy Society |
| LEWA | Lesotho Electricity and Water Authority |
| LHDA | Lesotho Highlands Development Authority |
| MEM | Ministry of Energy and Meteorology |
| MPWT | Ministry of Public Works and Transport |
| MRV | Measurement, Reporting and Verification |
| MTI | Ministry of Trade and Industry |
| NC | National Communication |
| NDCs | Nationally Determined Contributions |
| NUL | National University of Lesotho |
| RE | Renewable Energy |
| RSL | Revenue Services Lesotho |
| SHSs | Solar Home Systems |
| UNFCCC | United Nations Framework Convention on Climate Change |

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# EXECUTIVE SUMMARY

The Government of Lesotho submitted its first Nationally Determined Contributions (NDC) to the UNFCCC on the 22nd of June 2018. Furthermore, the government is currently in the process of updating the NDC. The NDC of Lesotho form a basis for planning, coordination, resource mobilisation, and transparency on NDC implementation between the Government and partners to work together to help Lesotho achieve its climate and development goals.

The most relevant climate change strategy document is the National Climate Change Policy, to which Lesotho's NDC is closely aligned. Without an NDC implementation plan, the recently adopted National Climate Change Policy and Implementation Strategy (2017-2027) is the main instrument for planning national action to combat climate change in Lesotho. The National Climate Change Policy states that its mission is to address climate change issues locally while engaging globally. Its overarching goal is adapting to and mitigating climate change impacts within sustainable development. Deploying renewable energy sources in power generation has been defined as a priority goal in Lesotho's NDC. The central assumption under the mitigation scenario in the energy sector is the implementation of Lesotho Energy Policy 2015 and Draft Lesotho Renewable Energy Policy 2013, which seek to increase energy efficiency significantly and shift the energy supply to more climate-friendly technologies.

Among other actions proposed in the NDC and Lesotho's climate change strategic plan and action plans, the energy sector (including transport—and industry-related subsectors) is expected to play a significant role in the country's emission profile. Therefore, the Initiative for Climate Action Transparency (ICAT) project focused primarily on Lesotho's energy sector.

UNEP-CCC supported the Government of Lesotho in establishing institutional arrangements for MRV at the national level and piloting sectoral guidance to improve MRV at the sectoral level.

Lesotho ICAT project objectives, which the Government of Lesotho identified, are the following:

- Objective 01- Revision of the selected NDCs making use of GACMO for the energy sector

- Objective 02 - Preparation of an MRV needs and gaps assessment report
- Objective 03 - Harmonizing methodologies for assessing greenhouse gas impacts of policies and actions in the energy sector
- Objective 04 - Design of an MRV System for the energy sector, Establishment of Roles and Responsibilities
- Objective 05 - Dissemination Workshop and Implementation Plan

Thus, one of the objectives (objective 04) is to establish a robust and continuous national MRV system for the energy sector, including designing and implementing legal frameworks, institutional arrangements, data collection, reporting, and verification methodologies and procedures.

This deliverable focuses on MRV methodology, including the calculation of emission reduction from selected mitigation policies, illustrating the data management systems and institutional arrangement, delivering the procedures for data collection for MRV and verifying the data from stakeholders, and preparing the protocol for MRV system for selected mitigation policies in the energy sector. Mitigation actions have been chosen from the NDCs in the energy sector.

| Mitigation actions | Mitigation Policy | Source |
|---|---|---|
| No. 07- MORE EFFICIENT GASOLINE CARS | Reduce 5% VAT for purchasing more efficient vehicles (Hybrid) | Transport Sector Masterplan 2022 |
| No. 06- SOLAR HOME SYSTEMS | Introduction of Tax incentive policies to increase RE | National Energy Policy 2015 – 2025 |

**Measurement**

The Initiative for Climate Action Transparency (ICAT) transport pricing guidance and ICAT Renewable Energy guidance were used to assess the GHG impacts of mitigation policy actions 1 and 2, respectively, to develop the MRV system.

Data required to measure the GHG impact of the mitigation policies are specified in their methodologies. Based on this, responsible institutions were identified, and data collection templates were also developed. Procedures with data collection templates

have been completed using both default values from methodologies and available country-specific data (Annex 01). Procedures with validated data collection sheets will be verified, and country-specific data, which are not available online, will be collected from the national team.

Ex-post emission reductions for each mitigation policy action in the NDC were measured against the reference scenario, which was developed based on the 2017 base year following Lesotho's proposed revised NDC.

**Reporting**

Data management systems were developed to indicate how the data measured should be reported to the relevant users. These systems were mostly built upon the existing data collection and reporting practices. In cases where there are no existing practices for data management, new systems will be developed and introduced in consultation with the relevant stakeholders. The data management system includes the data reporting process, which addresses who will measure, record, and report the data and how often. Data collected from all relevant agencies will be reported to the "Energy sector NDC unit," established under the Ministry of Public Works and Transport or under the Ministry of Energy and Meteorology. Processed information will be reported to the GHG MRV Section, Lesotho Meteorology Services at the Ministry of Energy and Meteorology.

**Verification**

The Ministry of Energy and Meteorology will verify the data reported by each institution. After the data verification, the NDC and MRV units will process all the data. Once the GHG impacts of NDCs are communicated to the Ministry of Energy and Meteorology, the MRV expert committee will verify the emission reduction from each mitigation policy action of the NDC. Finally, the Ministry of Energy and Meteorology will submit the progress in achieving the emission reduction against each NDC to the UNFCCC.

The institutional arrangement was developed based on the existing data management systems and reporting practices. Further information will be collected from the national team to improve the data management systems, procedures, and institutional arrangements.

# 1. INTRODUCTION

## 1.1 Background

In December 2015, the Paris Agreement introduced the Enhanced Transparency Framework (ETF) to track how each country is progressing towards climate commitments. The objective is to improve the transparency of mitigation actions taken by member countries (UNFCCC, 2016). MRVs are intended to contribute to the transparency of mitigation actions as well as take corrective actions to ensure the mitigation policy /action is on track to achieve the objective.

Measurement is needed: a) to identify emission trends; b) determine where to focus GHG reduction efforts; c) track mitigation-related support; d) assess whether mitigation actions planned under NDCs or otherwise are proving effective; e) evaluate the impact of support received; and f) monitor progress achieved in reducing emissions.

Reporting and verification are essential for ensuring transparency, good governance, accountability, credibility of results, and building confidence that resources are being utilised effectively.

There are three types of MRVs: a) MRV of GHG emissions; b) MRV of mitigation actions; and c) MRV of support (WRI, 2016). These have been indicated in Figure 1.1.

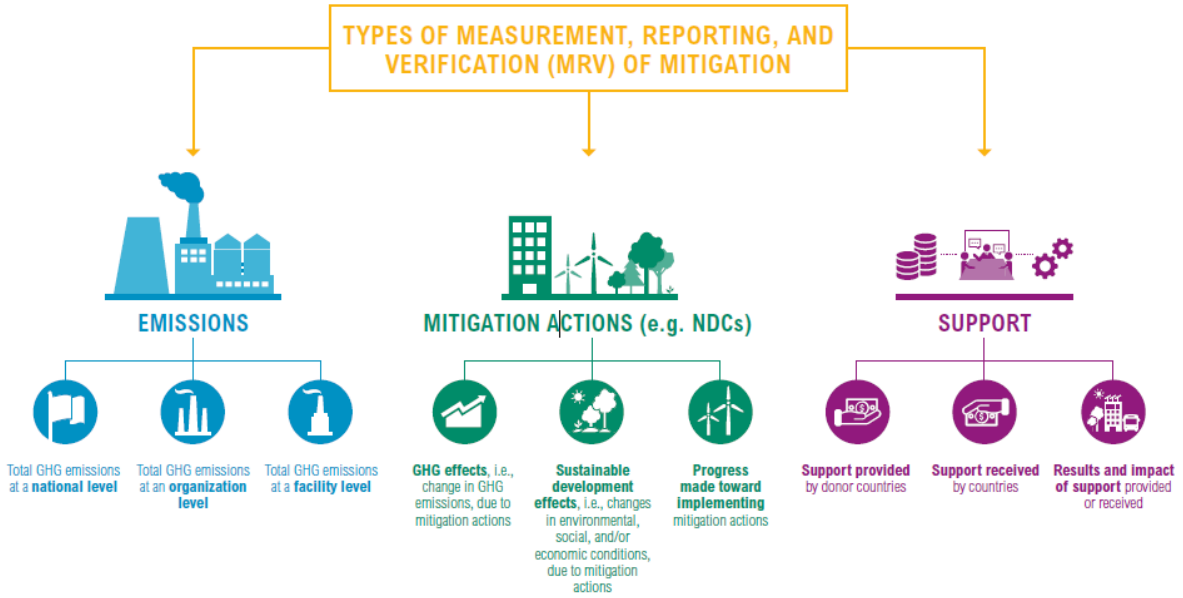


*Figure 1.1: Mitigation Related MRV types Source: World Resource Institute, 2016*

**MRV of GHG emissions**

This MRV is conducted at the national, organizational, and/or facility level to understand an entity's emission profile and report it as an emissions inventory.

**MRV of mitigation actions**

This is to assess the GHG and sustainable development (non-GHG) impacts of mitigation activities and monitor their implementation progress. This type of MRV focuses on estimating the change in GHG emissions or other non-GHG variables, such as the achievement of SDGs, through actions (e.g., policies and projects).

**MRV of support**

This MRV is intended to track the provision and receipt of climate support, monitor results achieved, and assess the impact (e.g., climate finance, technology transfer, and capacity building).

The focus of the work is on developing MRV for mitigation action due to the implementation of Lesotho NDCs in the energy sector.

Measurement (M) applies to efforts to address climate change and the impacts of these efforts, including the level of GHG emissions by sources and removals by sinks, emission reductions, and other co-benefits. Based on the decisions adopted at COP 16 and 17, non-Annex I Parties now need to measure the specific effects of national mitigation actions as well as the support needed and received and to provide this information, including a national inventory report, as part of their BURs. (UNFCCC, 2014)

Reporting (R) includes compiling this information in inventories and other standardised formats to make it accessible to a range of users and facilitate public disclosure of information.

Verification (V) involves periodically subjecting the reported information to some form of review, analysis, or independent assessment to establish completeness and reliability. Verification helps ensure accuracy and conformance with established procedures and can provide meaningful feedback for future improvement.

As such, an MRV system has been developed to monitor GHG emissions and reduce emissions from mitigation actions in the energy sector. This has been developed based

on the "general guidance for domestic measurement, reporting and verification of domestically supported nationally appropriate mitigation actions by developing country Parties" published by the 19th session of the COP and "Handbook on Measurement, Reporting, and Verification for developing country parties" by UNFCCC. (UNFCCC, 2014)

The selected energy sector policies (included in the proposed revised Lesotho NDC) for the development of the MRV system are indicated in Table 1.1. Additionally, the table presents the identified mitigation actions from the previous deliverable and the sources of the policies, which are also included in the deliverables.

*Table 1.1: Selected Energy Sector Policies for the development of the MRV system*

| Mitigation options | Mitigation Policy | Source |
|---|---|---|
| No. 06- SOLAR HOME SYSTEMS | Introduction of tax incentive policies to increase RE | National Energy Policy 2015 – 2025 and Lesotho: Renewable Energy Policy, 2013 |
| No. 07- MORE EFFICIENT GASOLINE CARS | Reduce 5% VAT (from 15% to 10%) for purchasing more efficient vehicles (Hybrid) | Transport Sector Masterplan 2022 |

The selected energy sector policies have also been referred to as "mitigation action policies," "mitigation policies," or simply "mitigation action" in the report.

## 1.2 Objectives

The overall objective of this deliverable is:

- To set up a national MRV system for the selected energy sector policies of Lesotho included in its proposed NDC for emissions reduction.

The specific objectives are to:

- Deliver the MRV methodologies and related formulae for the calculation of emissions reduction from the selected policies.
- Illustrate the associated data management systems and institutional arrangement to implement the MRV system and
- Deliver the procedures and protocol for the same.

# 2. METHODOLOGY

The MRV system was developed according to international best practices, with recommendations to establish an MRV host institution to maintain and operate the system. The main host institution proposed is the Ministry of Tourism, Environment and Culture. A desk review was conducted to map the following data for both energy sector NDCs.

System boundaries, including temporal, sectoral, and geographical boundaries, were defined for each policy action. Causal chains were developed for each mitigation action to identify the impacts of the action. A bottom-up approach was used to create the causal chains. The mitigation effect was one of the following: 1) Avoid, 2) Shift, and 3) Improve.[1]

The Convention does not define the measurement methodologies. Therefore, in undertaking measurements, two ICAT methodologies—ICAT Renewable Energy guidance and ICAT Pricing Guidance—are used to assess the GHG impact of mitigation policies and to develop MRVs.

Parameters that needed to be measured were identified using the selected methodology. Required data were collected through desk review, and collected data was verified by the national team and relevant authorities. Business As Usual Scenario (BAU) and mitigation scenarios were developed using the collected data.

Based on these values, the annual and accumulated volume of emission reduction potential of each mitigation action (with duration) were calculated.

The institutions responsible for monitoring and reporting these data to the MRV coordination entity are identified. Based on available data, Data Management Systems were developed for each action, which will be verified by the national team and through stakeholder consultation.

The Data Management System includes the relationship of parameters that need to be monitored, information on the responsible agency to monitor the parameter and monitoring frequency, and Responsible entities to report the data to NDC units, the National coordination agency, Verifiers, and other interested third parties. Required

[1] Refer 3.1 diagram for better understanding on categorization.

data and feedback will be collected through stakeholder consultations to update the data and improve the Data Management System.

Clearly defined roles and responsibilities are essential for a sustainable MRV system. Therefore, an institutional arrangement was developed to cover identified mitigation actions under the updated NDC. At the stakeholder consultation workshop, the respective authorities will verify and validate each stakeholder's roles and responsibilities.

The verification system will include third-party verification to enhance reliability. The roles and responsibilities of verifiers will also be identified.

# 3. NDC 07- MORE EFFICIENT GASOLINE CARS

## 3.1 Description of the mitigation action

**Mitigation Action**

The proposed mitigation action is to "Reduce VAT by 5%[2] (VAT reduction from 15% to 10%) for purchasing more efficient vehicles (Hybrid)" (Mitigation Action 1 – (MA1)) to promote alternative fuel vehicles[3] against conventional gasoline cars. Without the proposed mitigation action, conventional gasoline and diesel-powered motor vehicles would have dominated the vehicle market. The mitigation action aims to increase the share of alternative fuel vehicles in the vehicle market. This mitigation action is in line with the ASI (Avoid-Shift-Improve) approach.

**Relevance to the NDC**

The proposed mitigation action is falls under NDC 07 (More Efficient Gasoline Cars). This mitigation action aligns with the "Transport Sector Masterplan 2022," which generally aims to improve access to mobility and connectivity of suitable roads in Lesotho in a more economically and environmentally beneficial manner.

## 3.2 Scope and boundaries of monitoring approach

As per the methodology, the boundaries of the mitigation action need to be defined first. The temporal, sectoral, geographical boundaries, and GHGs considered for the assessment are indicated in Table 3.1

*Table 3.1: Boundary elements of Mitigation Action 1(MA 1); Reduction in VAT from 15% to 10%*

| Boundary Elements | Description |
|---|---|
| **Temporal Boundary** | 2023-2030 |
| **Sectoral Boundary** | Transport sector |
| **Geographic Boundary** | Country (Import of inefficient as well as efficient Gasoline cars (hybrid) in the country*) |
| **GHGs Included** | $CO_2$ only |

[2] In Lesotho, value-added tax (VAT) is applicable for the importation of goods from outside the country, typically at a rate of around 15%.
[3] Here, alternative fuel vehicles encompass any vehicles utilizing engine power that doesn't exclusively rely on fossil fuels. Therefore, for the assessment, hybrid vehicles are categorized as alternative fuel vehicles.

*Note: The assessment focused on the GHG impacts of the VAT reduction on hybrid cars (on total emissions from gasoline and hybrid cars).

Figure 3.1 depicts the causal chain illustrating the reduction of VAT from 15% to 10% is expected to have a GHG impact due to increased purchasing of more fuel-efficient vehicles (hybrids). This figure outlines the action, its effects, the indicators to identify these effects, and the expected outcomes of the mitigation action.

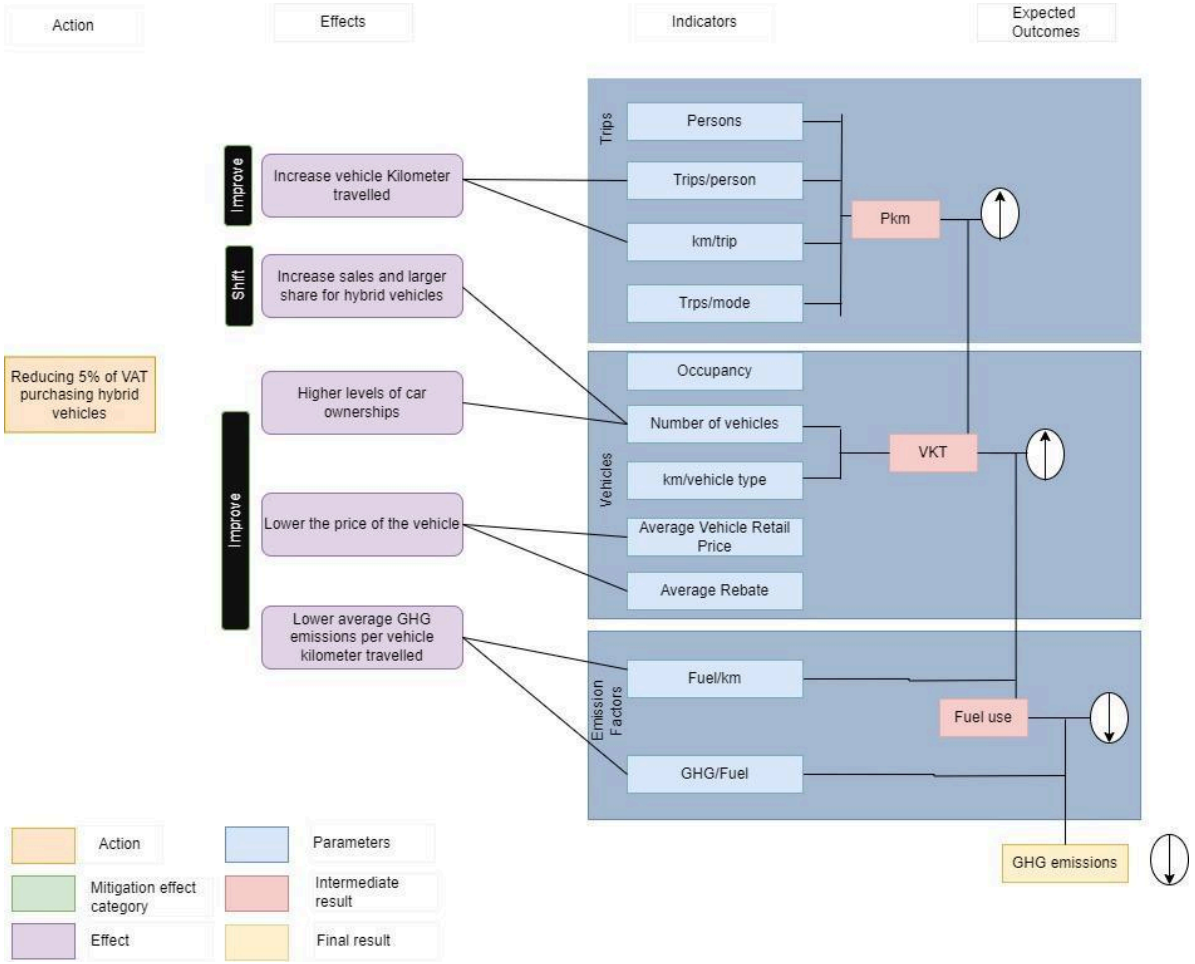


*Figure 3.1 Causal chain diagram for GHG impact from reduction of VAT from 15% to 10% leading to purchasing of more efficient vehicles (Hybrid) (MA 1)*

Source: Own work of author, 2024

## 3.3 Methodology

**The description of the methodology**

ICAT Transport Pricing Methodology (ICAT, 2020) is one of the assessment guides under the ICAT Series of Assessment Guides. It provides methodological guidance for estimating the GHG impacts of transport sector pricing policies. The guide offers a stepwise approach for assessing the GHG impacts of higher fuel prices using price elasticities of demand and a less in-depth approach for estimating the GHG impact of vehicle purchase incentives and road pricing policies.

The assessment utilised a simple approach to calculate the GHG impact of vehicle purchasing incentives, explicitly focusing on the emissions reduction associated with acquiring more efficient vehicles (Hybrid).

Table 3.2 outlines the characteristics of the methodology utilised for mitigation action 1. It covers scope, developer, methodology documentation, data collection guidance, default values, and the tool's cost.

*Table 3.2: Characteristics of the methodology followed for MA1*

| Applicability | **New Hybrid cars that displace the use of gasoline cars** |
|---|---|
| Scope | Passenger transportation |
| Developer | ICAT |
| Methodology documentation | Very good |
| Data collection guidance | Very good **(Available for ex-ante assessments – Chapter 4.2.3, 4.2.4, 7, 10.2.4 and for ex-post assessments - Chapter 11:** Monitoring performance over time) |
| Defaults provided | Yes. Default values for emission factors, net calorific values, and elasticity beta are provided in the methodology. |
| Cost of tool | Free |

**Baseline Emissions**

The baseline scenario represents the events or conditions that would occur without the policy being assessed.

| Baseline scenario: Increasing number of conventional gasoline cars within country vehicle fleet due to less hybrid vehicle favourable taxes |
|---|

i. Key indicators

Key indicators for calculation of baseline emissions

*Equation 3.1: Key equation to conduct baseline assessment*

$$BE_{i,y} \text{ in } CO_2 \text{ emissions } (tCO_2) = [FC_{i,j,y} \text{ in energy units } (TJ)] \times [EF_i (tCO_2 \text{ per } TJ)]$$

Table 3.3 outlines the key baseline parameters relevant to assessing emission reduction for mitigation action 1, which involves more efficient gasoline cars.

*Table 3.3: Key indicators for calculation of baseline emissions (MA 1)*

| Parameter | Description |
|---|---|
| $BE_{j,y}$ | Baseline GHG emissions (with fuel type i, mode j, in year y) |
| $FC_{i,j,y}$ | Total fuel consumption in energy units (from gasoline/hybrid) per mode j of passenger transport (road) in year y |
| $EF_i$ | Emission factor for gasoline fuel ($tCO_2/TJ$) |

ii. Base year approach

Baseline emission calculation for the assessment was conducted based on the "ICAT Transport. Pricing Guidance". The ICAT guidance presents three approaches to calculate baseline emissions according to available activity data and geographical system boundaries.

Table 3.4 presents three approaches outlined in the ICAT Transport Guidance. Additionally, the table compares the data requirements and coverage of each approach.

*Table 3.4: Overview of three approaches under ICAT pricing methodology (MA 1– base year)*

| Approach | Data requirements | Boundaries / Coverage | | |
|---|---|---|---|---|
| | | Geographical system boundaries | Passenger / Freight | Fuel types |
| **A** | Only general fuel consumption data (Basis for calculation: top-down energy-use data) | National, subnational, or municipal | Ground transport (passenger and freight) | Fuel mix (unspecified mix of gasoline, diesel, and/or other transport fuels) |
| **B** | Specific gasoline and diesel consumption data (Basis for calculation: top-down energy-use data) | National, subnational, or municipal | Ground transport (passenger and freight) | Gasoline and diesel |

| | | | | |
|---|---|---|---|---|
| **C** | Comprehensive bottom-up travel activity data (e.g., distance travelled by mode j)<br>(Basis for calculation: top-down energy-use data and bottom-up travel activity data) | Regional, urban | Only passenger transport in an urban context<br>However, the assessment can be conducted for several (large) cities to enable a more extensive geographical coverage. | Gasoline, diesel, and electricity |

*Source: ICAT Transport Pricing Guidance, 2020*

The calculation was conducted using Approach C to reflect these characteristics instead of using the fuel consumption of the car fleet.

**Approach C**

The overview of steps for Approach C calculation is briefly illustrated in Figure 3.2, and the calculation of base year emissions is in Figure 3.3

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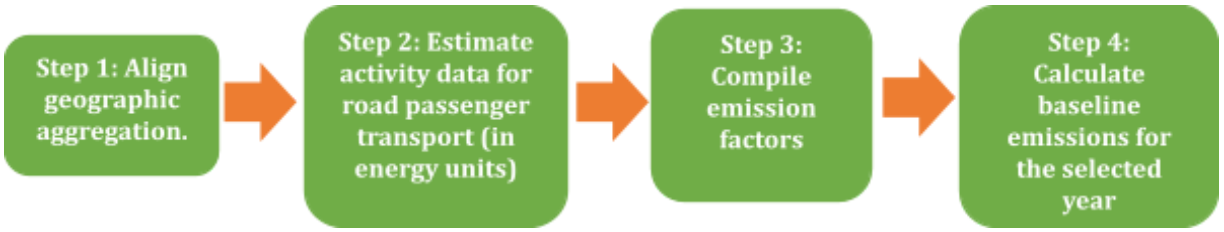


*Figure 3.2 Overview of approach C (Mitigation action 1)*

Source: ICAT Transport Pricing Guidance, 2020

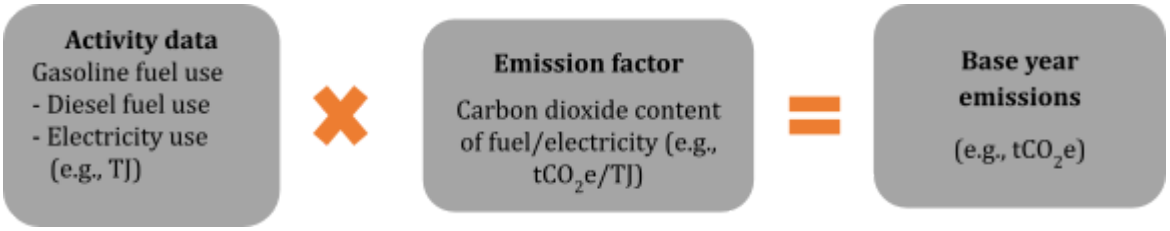


*Figure 3.3 Calculation of base year emissions using approach C (for Mitigation action 1)*

Source: ICAT Transport Pricing Guidance, 2020

i. Data needs for base year calculation

Table 3.5 illustrates the data requirements and availability within Lesotho for assessing base year emissions.

*Table 3.5: Data needs (MA 1 – base year)*

| Parameter | Description | Unit | Availability | Source |
|---|---|---|---|---|
| $d_{i,j,y}$ | Vehicle kilometres travelled (with fuel type i, mode j, in year y). | VKT | Yes | National experts |
| $sfc_{i,j,y}$ | Specific fuel consumption. Average consumption per VKT in municipal, regional, or national fleet | l/100km or kWh/100km | Yes | National experts |
| $\rho_i$ | Density of fuel type i | kg/m$^3$ | Yes | IPCC default |
| $NCV_i$ | Net Calorific value of fuel type i | TJ/Gg | Yes | IPCC default |
| $EF_{gasoline}$ | Emission factor for gasoline fuel | $tCO_2$/TJ | Yes | IPCC default |

ii. Base year calculation

1. Estimate activity data in volume units for average fuel consumption

*Equation 3.2: Total fuel consumption in volume units*

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The following table illustrates the assessment of estimating fuel consumption using the available data.

*Table 3.6: Baseline calculation _ MA 1 _ Step 1*

| Type of vehicles | Vehicle km travelled per year (VKT/year) | Specific fuel consumption (l/100 km) | Total fuel consumption per year (l) |
|---|---|---|---|
| **Gasoline cars** | 1,666,687,500 | 8 | 133,335,000 |

2. Estimate the total energy used

*Equation 3.3: Total fuel consumption in energy units*

Table 3.7 demonstrates the conversion of fuel consumption to energy consumption using conversion factors.

*Table 3.7: Baseline calculation _ MA 1 _ Step 2*

| Type of vehicles | Total fuel consumption per year (l) | Density $p_i$ (kg/m$^3$) | Net Calorific Value (TJ/Gg) | Fuel consumption (TJ) |
|---|---|---|---|---|
| **Gasoline cars** | 133,335,000 | 720 | 44.3 | 4,253 |

3. Calculate base year emissions for the selected year

*Equation 3.4: Base year emission in $tCO_2$*

$$BE_{i,} \text{ in } CO_2 \text{ emissions } (tCO_2) = [FC_{ij,y} \text{ in energy units } (TJ)] \times [EF_i \ (tCO_2 \text{ per} TJ)] \text{...Equation 1.3}$$

Table 3.8 depicts the final step of the base-year emissions calculation, wherein fuel consumption in energy units and the emission factor of the relevant fuel type are used to compute base-year emissions.

*Table 3.8: Baseline calculation _ MA 1 _ Step 3*

| Type of vehicles | Fuel consumption (TJ) | Emission Factor ($tCO_2$/TJ) | Base year Emissions($tCO_2$) |
|---|---|---|---|
| Gasoline cars | 4,253 | 69.3 | 294,723 |

In the ICAT pricing methodology, it is recommended that a projection of baseline emissions for future years of the assessment period be developed. The choice of method fundamentally depends on the input data available. Option 1, "Simplified method for projecting scenarios," was selected.

The key parameter or direct activity data used for the calculation is the distance travelled, mainly influenced by GDP value according to the ICAT pricing methodology.

1. Estimate vehicle km travelled per GDP in the base year

Table 3.9 calculates the VKT per GDP ratio for the base year, which is crucial for projecting baseline emissions and establishing the baseline scenario.

*Table 3.9: Baseline calculation _ MA 1 _ Step 4*

| Type of vehicles | Average vehicle km per year (VKT/year) | GDP in the base year (Billion USD) | VKT per GDP ratio for 2017 (VKT/ GDP in Billion USD) |
|---|---|---|---|
| Gasoline cars | 1,666,687,500 | 2.37 | 0.70 |

2. Baseline projection

The step-by-step calculation of baseline projection for the years 2023, 2025, and 2030 is presented in Table 3.10.

*Table 3.10: Baseline calculation _ MA 1 _ Step 5*

| Year | 2017 | 2023 | 2025 | 2030 |
|---|---|---|---|---|
| **Conventional gasoline cars (VKT per GDP ratio)** | 0.70 | 0.70 | 0.70 | 0.70 |
| **GDP projections (Billion USD)[4]** | 2.37 | 2.31 | 2.44 | 2.79 |
| **Conventional gasoline cars (VKT projection)** | 1,666,687,500 | 1,623,619,479 | 1,721,409,938 | 1,965,886,085 |
| **Conventional gasoline cars (Energy consumption -TJ)** | 4,253 | 4,143 | 4,392 | 5,016 |
| **Conventional gasoline cars (Baseline emissions – tCO2)** | 294,723 | 287,107 | 304,399 | 347,630 |
| **Total emissions (Baseline emissions – tCO2)** | 294,723 | 287,107 | 304,399 | 347,630 |
| **Conventional gasoline cars (Per- km GHG emission - $kgCO_2/km$)** | 0.177 | 0.177 | 0.177 | 0.177 |

**GHG impact**

Introducing hybrid cars within the Lesotho vehicle fleet due to hybrid vehicle favourable taxes

i. Key indicators

Key indicators for calculation of GHG impact

*Equation 3.5: Key equation to conduct GHG impact assessment*

GHG impact per year
= (market share) x (annual new vehicle sale) x (per km emissions reduction) x (average annual km per vehicle)

ii. Approach to calculate GHG impact

Table 3.11 explains the two approaches provided by the ICAT methodology to calculate the GHG impacts of vehicle purchase incentives, as per Lesotho's policy, which pertains to reducing VAT for imported hybrid cars.

*Table 3.11: Overview of two approaches under ICAT pricing methodology (MA 1 – GHG impact)*

| Approach | Description |
|---|---|
| Simplified approach | The simplified approach is based on the aggregate relationship between hybrid vehicle market share and the net impact of VAT reduction for hybrid vehicles. Such a simple approach does not account for all the impacts shown in the causal chain. |
| Advanced approach | The advanced approach captures local market dynamics more sophisticatedly than the simplified approach and can also be applied to a broader range of vehicle technologies. |

After comparing the data intensity of both approaches, the simplified approach has been chosen for the assessment due to data availability.

iii. Data needs for GHG impact

Table 3.12 analyses the availability of data for conducting the GHG impact assessment.

*Table 3.12: Data needs (MA 1 – GHG impact)*

| Parameter/Description | Unit | Availability | Source |
|---|---|---|---|
| **VAT Reduction** | % | Yes | Transport Sector Masterplan 2022 |
| **Retail price of cars** | Maloti | Yes | National Experts |
| **Annual new car sale** | Number of vehicles | No | Based on the information provided in the NDC, an assumption is made. |
| **Average annual km per car** | km | Yes | UNEC and UK government documents[5] |
| **Default value for elasticity beta** | | Yes | ICAT transport pricing guidance, 2020 |

iv. Calculation of GHG impacts

1. Calculate the average value of the VAT reduction as a percentage of the vehicle's retail price

[5] The average annual distance value was derived from multiple sources. (https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy#car-mileage and https://wiki.unece.org/download/attachments/87623769/WT-03-06%20transport-eu.pdf?api=v2)

*Equation 3.6: Average value of VAT reduction*

Avg. value of VAT reduction = Average VAT reduction/ Avg. vehicle retail price

The average value of the VAT reduction is calculated based on the average car retail price and average VAT reduction, as illustrated in the following table.

*Table 3.13: GHG impact calculation _ MA 1 _ Step 1*

| Average car retail price (Maloti) | Average VAT reduction (Maloti) | Average value of the VAT reduction |
|---|---|---|
| 437,487.5 | 19,021.2 | 4.35% |

2. Estimate the change in market share of low-GHG vehicles

*Equation 3.7: Market share*

Market Share (percentage point change) = (beta) x (average VAT reduction value) x market share (% point before rebate)

A default value for elasticity (beta) of 0.3 may be assumed if no country-specific data are available (derived from aggregate market data and the judgment of the ICAT methodology development leads).

Table 3.14 evaluates the next step in calculating the assessment's GHG impact: estimating the percentage change in the market share of low-emission vehicles.

*Table 3.14: GHG impact calculation _ Mitigation action 1 _ Step 2*

| Default Beta Value | Average value of the rebate | Change in market share of hybrid cars after introducing tax | Market share of hybrid (percentage point before rebate) | Market share of hybrid (percentage point change) |
|---|---|---|---|---|
| **0.3** | 4.35% | 0.13% | 0% | 0.13% |

3. Calculate GHG impact

*Equation 3.8: GHG impact assessment per year*

GHG impact per year
= (market share) x (annual new vehicle sale) x (per km emissions reduction) x (average annual km per vehicle)

Table 3.15 presents the final estimation of the emissions impact based on the change in hybrid market share, annual new motor car sales, annual distance travelled, and per-km GHG emission reductions.

*GHG Impact for the 2025 ($tCO_2$) = 0.13% * 27,344 cars * 0.06kgCO2/km* 12,000km*$10^{-3}$*

*Table 3.15: GHG impact calculation _ MA 1 _ Step 3*

| Year | 2025 | 2030 |
|---|---|---|
| **Change in market share of hybrid cars** | 0.13% | 0.13% |
| **New motor car sale** | 27,344 | 31,227 |
| **Per- km GHG emission reductions ($kgCO_2$/km)[6]** | 0.06 | 0.06 |
| **Annual distance travelled (km/ year)[6]** | 12,000 | 12,000 |
| **GHG impact ($tCO_2$) per year** | 26 | 29 |

Note: When per-kilometre emissions data for hybrid cars specific to the country were unavailable for the year 2017, the emissions factor for hybrid vehicles in the UK[7]0.11659 kgCO2/km for an average-sized hybrid car was used to estimate per-km GHG emission reduction.

v. Emission Reduction

Table 3.16 displays the baseline emissions, projected emissions, and the emission reduction resulting from promoting more efficient gasoline cars (hybrids) through VAT reduction.

*Table 3.16: Emission reduction of MA 1*

| Year | 2025 | 2030 |
|---|---|---|
| **Baseline emissions ($tCO_2$)** | 304,399 | 347,630 |
| **Project emissions ($tCO_2$)** | 304,374 | 347,601 |
| **Emission reduction ($tCO_2$)** | 26 | 29 |

**BAU and project scenarios**

Figure 3.4 depicts the Business-As-Usual (BAU) scenario and the project scenario of the GHG impact assessment for NDC 7, which focuses on promoting more efficient gasoline cars.

[6] The estimation of 0.06 kgCO2/km was derived by subtracting the per km emissions of hybrid cars (0.11 kgCO2/km) from the per km emissions of conventional gasoline cars (0.177 kgCO2/km), as indicated under baseline projection.
[7] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017

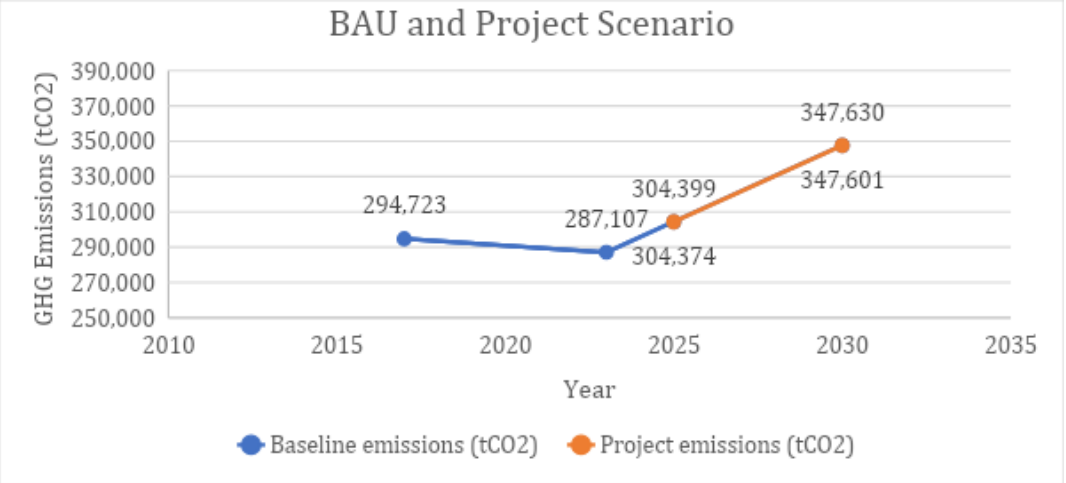


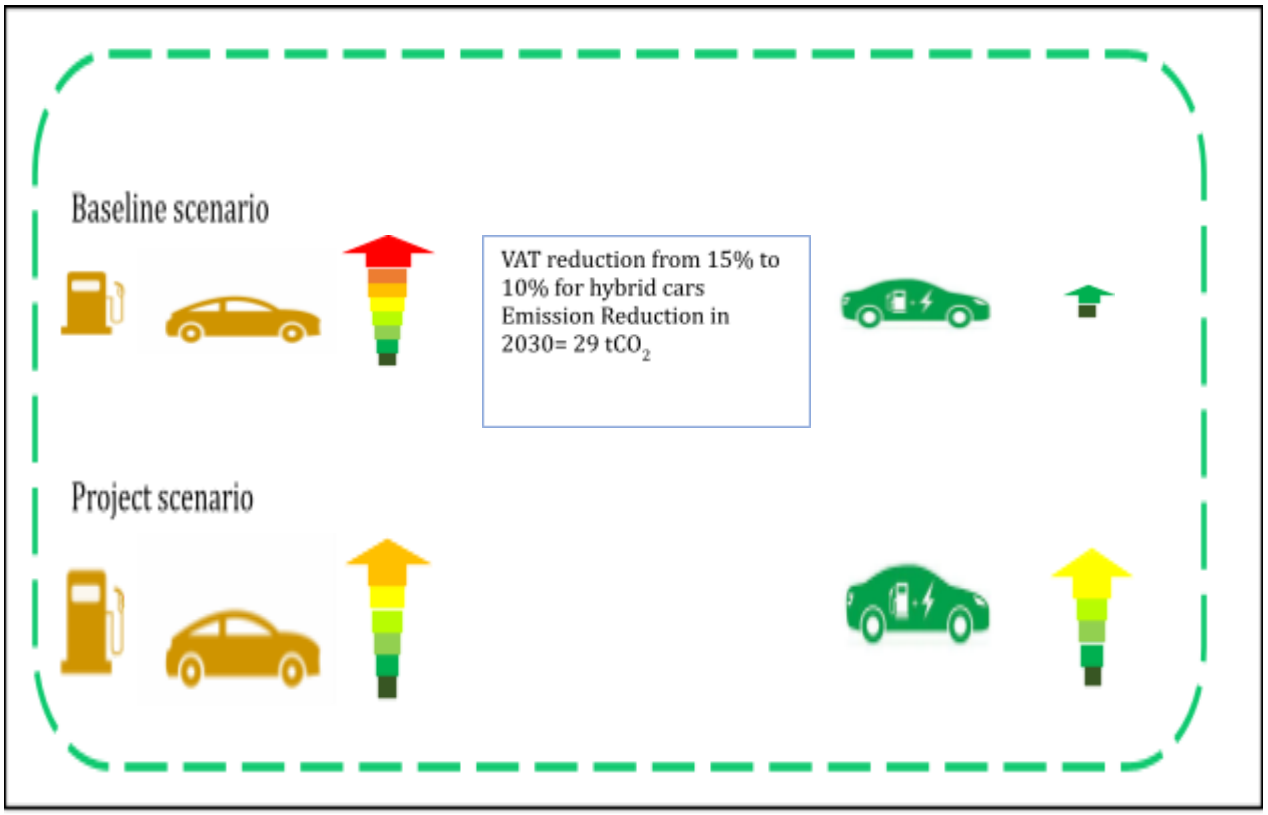

*Figure 3.4 BAU and Project scenarios for mitigation action 1*[8]

Source: Own work of author, 2024

[8] The GHG impact is relatively minor, causing the graphs to overlap, with the baseline emissions graph positioned beneath the project emissions graph.

**Ex-ante GHG impact assessment**

Figure 3.5 visually represents the GHG emission reduction for the ex-ante assessment




Project scenario

Baseline scenario

in a more graphical format.

Petrol

*Figure 3.5 GHG impact of mitigation action 1*

Source: Own work of author, 2024

## 3.4 Data Management System

Figure 3.6 depicts the proposed data management system for NDC 7, which promotes more efficient gasoline cars. It involves key institutions such as the Department of Traffic and Transport (DTT), Revenue Services Lesotho (RSL), and vehicle retailers in Lesotho for data collection. Furthermore, the diagram indicates that the Transport NDC unit is proposed under the Ministry of Public Works and Transport (MPWT).

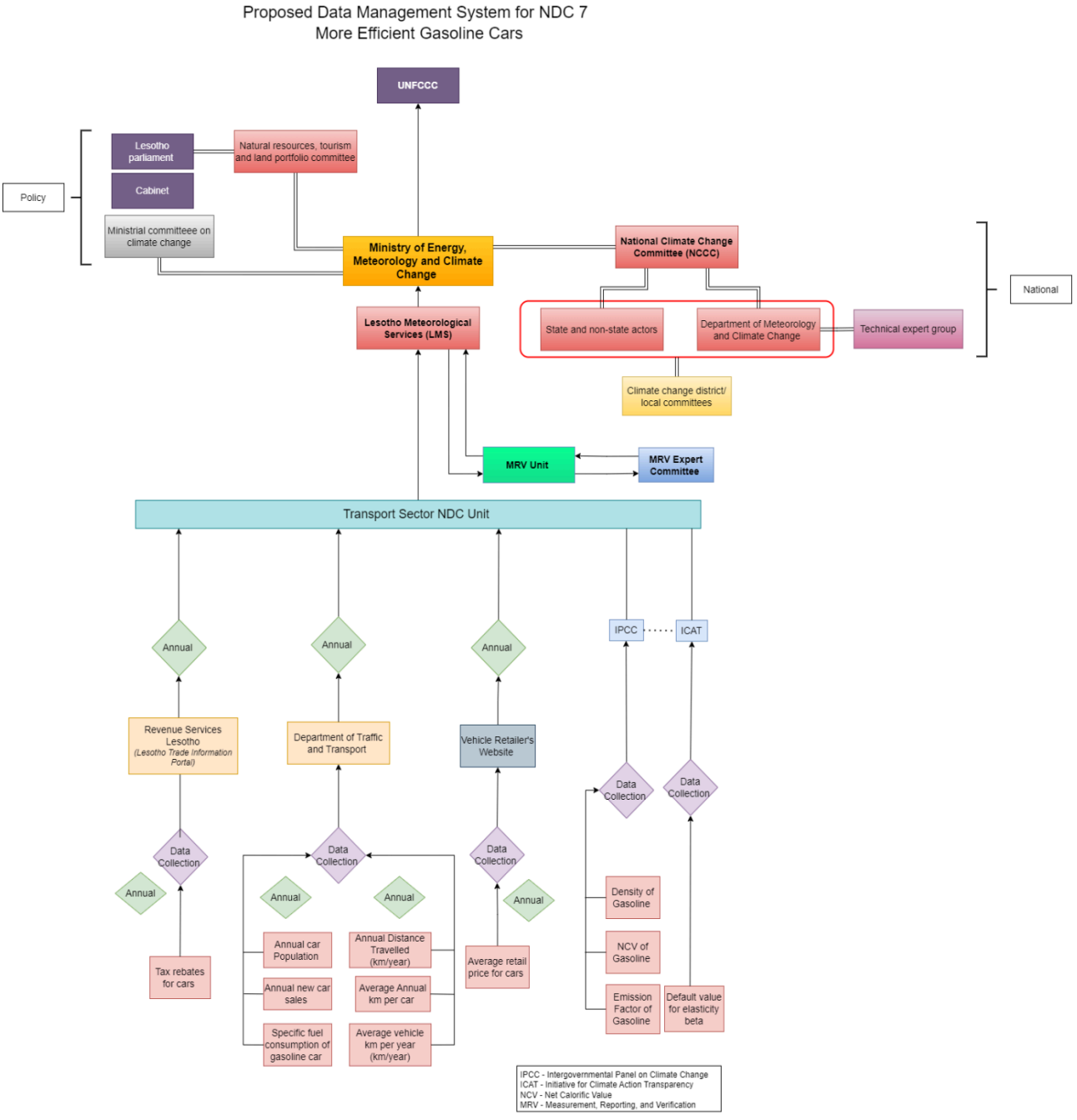


*Figure 3.6 Proposed data management system for mitigation action 1*

Source: Own work of author, 2024

## 3.5 Verification

Respective institutions will annually report the required data to the Ministry of Public Works and Transport. The quality and accuracy of the provided data will be verified by the NDC unit of the Ministry of Public Works and Transport, with support from Lesotho Meteorological Services (LMS). Additionally, the GHG impact of the mitigation action in question will be calculated by the NDC unit, with support from the MRV unit. An independent third party, the MRV expert committee to be appointed by the LMS, will verify the accuracy of the calculations. Approved results will then be submitted to the Ministry of Energy and Meteorology, which will, in turn, submit them to the UNFCCC. As depicted in the data management system, some data will be required from institutions not regulated by the Ministry of Public Works and Transport and Ministry of Energy and Meteorology. Hence, strengthening the legal framework of both the NDC unit and LMS will facilitate the accurate verification process when gathering data from such institutions.

## 3.6 Recommendations

As illustrated in the DMS, data from several ministries and institutions will be required to measure the GHG effect of the mitigation action considered. However, most ministries and institutions have a manual data management system. Data collection through a manual system will be time-consuming. Therefore, digitalising the data collection system is suggested, which is currently managed manually. It is further recommended that the legal framework of the proposed NDC unit be strengthened so that data collection from different entities will be easy, as the Ministry of Public Works and Transport might not have authority over some institutions. Similarly, it is recommended that the legal framework of the LMS be strengthened to facilitate the collection of data from various NDC units under different ministries. The reporting process will be delayed if the data is to be collected through several ministries. Therefore, introducing a digitalised MRV system is recommended to provide direct access to the respective data owners.

# 4. NDC 06- SOLAR HOME SYSTEMS

## 4.1 Description of the mitigation action

**Mitigation action**

The proposed mitigation action entails a reduction in levies and taxes on imported components of renewable energy systems, including solar panels, hydro/wind turbines, and solar collectors, in alignment with the Lesotho Energy Policy, 2015-2025 (LESOTHO, 2015). This measure is further supported by the action stipulating that "all renewable energy systems and equipment will attract a reduced VAT[9] rate of 5% (VAT reduction from 15% to 10%), similar to electricity supplies" (MA2) as proposed by the Lesotho Renewable Energy Policy, 2013. Specifically, in this context, the focus is on Solar Home Systems (SHSs) as the renewable energy technology for the assessment, aligning with the country's National Determined Contributions (NDCs).

As per the Off-Grid Master Plan Report of Lesotho, access to electricity stood at 38.5% in 2017, covering approximately 207,000 households. This leaves around 330,000 households yet to be electrified. The same report indicates that achieving universal access to electricity for all citizens of Lesotho may take over 30 years. However, this timeline could potentially be significantly reduced with a greater emphasis on cost-effective off-grid solutions, such as SHSs under specific conditions. SHSs are independent photovoltaic (PV) systems designed to provide electricity for lighting and appliances in remote off-grid households. Subsequently, to alleviate potential challenges and financial burdens on residents, tax incentives will be introduced to enhance the affordability and cost-effectiveness of SHSs. This, in turn, not only ensures cost savings for individual households but also contributes to a reduction in overall carbon emissions, aligning with global climate goals.

[9] In Lesotho, value-added tax (VAT) is applicable for the importation of goods from outside the country, typically at a rate of around 15%. However, for renewable energy (RE) systems and equipment, the VAT rate is reduced to 10% in accordance with the policy.

**Relevance to NDC**

The proposed mitigation action is under NDC 06 (Solar home systems). This mitigation action is in line with "Lesotho Energy Policy, 2015 - 2025" and "Lesotho Renewable Energy Policy, 2013," which generally aim to improve access to Renewable Energy technologies in Lesotho in a more economically and environmentally beneficial manner.

## 4.2 Scope and boundaries of monitoring approach

As the ICAT RE methodology recommends, Table 4.1 analyses the boundary elements of mitigation action 2. This table covers temporal, sectoral, and geographical boundaries and the GHGs considered for the assessment.

*Table 4.1: Boundary elements of mitigation action 2*

| Boundary Elements | Description |
|---|---|
| **Temporal Boundary** | 2025-2030* |
| **Sectoral Boundary** | Energy sector |
| **Geographic Boundary** | Country (VAT reduction from 15% to 10% for renewable energy technologies in the country focusing mainly on SHSs**) |
| **GHGs Included** | $CO_2$ only |

*Note: The assessment's initial temporal boundary was designed to align with the Lesotho Energy Plan, covering the period from 2015 to 2025. However, due to the non-implementation of the tax incentive policy, the assessment timeframe was adjusted to coincide with the duration specified in the Nationally Determined Contributions (NDC) from 2025 to 2030. This adjustment was also made, considering insufficient data to develop a timeline from 2017.

**Note: The assessment specifically targeted the greenhouse gas (GHG) impacts associated with implementing a VAT reduction from 15% to 10% on Solar Home Systems (SHSs). Furthermore, it should be noted that due to the limitation of data, the assessment estimations focused on the target population without electricity access, even though the initial policy action relevant to VAT applies to the entire country.

**Causal chain for mitigation action 2 for the energy sector**

Figure 4.1 has been developed to analyse the linkage between the causes of a problem and its effects resulting from mitigation action 2. The figure analyses intermediate effects, indicators, and outcomes that occur as a result of action.

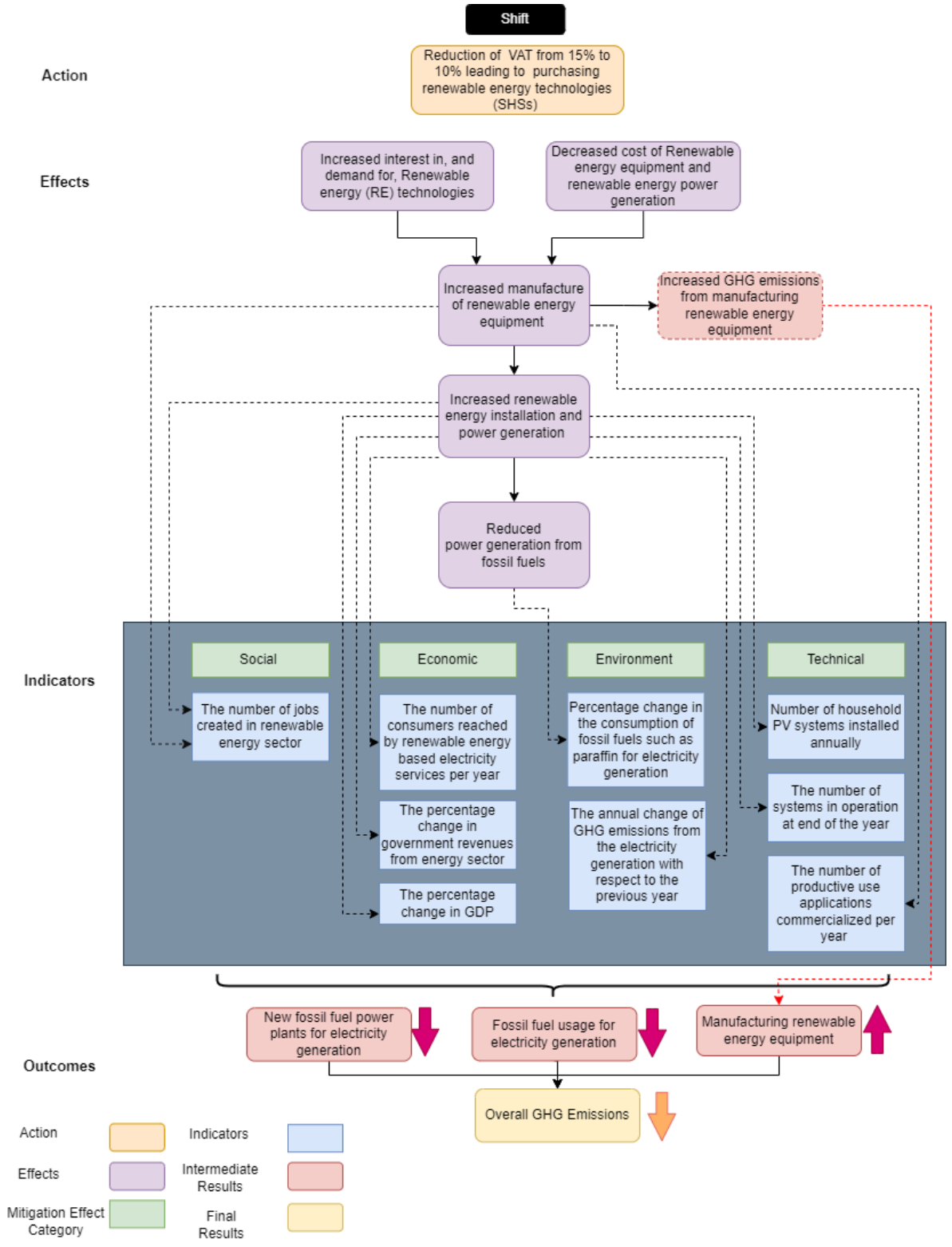



*Figure 4.1: Causal chain diagram for introduction of tax incentive policies on RE technologies*

Source: Own work of Author, 2024

## 4.3 Methodology

The ICAT Renewable Energy (RE) methodology has been utilised to assess the impact of the mitigation action on reducing GHG emissions, considering the methodology coverage of policies such as Feed-in Tariff, Auction/Tender, and Tax Incentives.

Table 4.2 examines the characteristics of the methodology in line with the identified mitigation action stated in NDC 6, which involves reducing the VAT reduction from 15% to 10% for all renewable energy systems and equipment.

*Table 4.2: Characteristics of the methodology followed for MA2*

| Applicability | Tax incentive policies on RE technologies for SHS |
|---|---|
| **Scope** | Solar home systems |
| **Developer** | ICAT |
| **Methodology documentation** | Very good |
| **Data collection guidance** | Very good **(Available for ex-ante assessment: chapter 4.2.3, 4.2.4, 7.2 and for ex-post assessment: chapter 10:** Monitoring performance over time) |
| **Defaults provided** | Yes |
| **Cost of tool** | Free |

When conducting an assessment using the ICAT RE methodology for the ex-ante assessment of a tax incentive policy, three main steps need to be followed:

1. Estimating the renewable energy addition of the policy ex-ante.
2. Estimating baseline scenario emissions.
3. Estimating policy scenario emissions.

**Estimating the renewable energy addition of the policy ex-ante.**

RE addition refers to the additional installation of RE capacity or electricity generation from renewable sources realised through the policy, expressed in megawatts or megawatt-hours. The estimation of RE addition depends on several factors, including

the policy's technical potential for the assessment period, policy design characteristics, financial feasibility of RE technologies, and other barriers.

i. Estimate the technical potential for the assessment period

Technical potential is the maximum amount of renewable energy output achievable by fully implementing demonstrated technologies or practices. In the methodology, the maximum quantity of installed capacity supported by the policy is referred to as the "policy cap," which assists in determining the technical potential for the assessment period.

While the action under the National Energy Policy, 2015-2025, does not have a specific policy cap outlined, the NDC Solar Home Systems, which was encouraged by the National Energy Policy, has a policy cap set for 2025 and 2030, covering the entire assessment period.

Table 4.3 presents the information relevant to both conditional and unconditional scenarios of the mitigation action outlined in the revised NDC in Lesotho.

*Table 4.3: NDC – Conditional and unconditional scenarios*

| Mitigation actions in revised/updated NDC | Proposed Actions/Policies | Unconditional scenario (value in 2025) | Conditional scenario (value in 2025) | Unconditional scenario (value in 2030) | Conditional scenario (value in 2030) |
|---|---|---|---|---|---|
| Solar Home Systems | Scale up SHS for lighting in non-electrified rural households | 250 SHS | 1,400 SHS | 10,500 SHS | 28,000 SHS |

Only the capacities mentioned under the unconditional scenarios were considered for the assessment. This decision was made because the actions outlined under national policies specifically focus on the RE share, which can be improved solely through the country's efforts.

The Nationally Determined Contributions (NDC) outline a target capacity expressed as the number of Solar Home Systems (SHSs) anticipated to be installed during the assessment period. As indicated in the master plan, the typical size for these systems varies from 50Wp up to 1kWp (Lesotho, 2018). To translate the number of SHSs into technical potential, a capacity of 65W was employed.

The following table provides the total technical potential applicable for the unconditional assessment scenario, considering the total capacity of the current SHS of 65 W.

*Table 4.4: RE addition _ MA 2_Step 1*

| Revised/Updated NDCs List | Proposed Actions/Policies | Unconditional scenario (value in 2025) | Unconditional scenario (value in 2030) |
|---|---|---|---|
| Solar Home Systems | Scale up SHS for lighting in non-electrified rural households | 16.25 kW | 682.5 kW |

Due to the absence of specific information about the installation capacity for each year, it was assumed that the installations after 2025 would be equal in amount for each year.

Based on the assumption, the following table 4.5 provides the expected increase in technical potential for each year from 2025 to 2030.

*Table 4.5: RE addition _ MA 2_ Step 1.1*

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| Technical potential (kW) | 16.25 | 149.5 | 282.75 | 416 | 549.25 | 682.5 |

ii. Account for policy design characteristics

Table 4.6 outlines the analysis of the design characteristics of tax incentive policies in line with the mitigation action of NDC 6. There are two main design characteristics common to tax incentive policies.

*Table 4.6: RE addition _ MA 2_ Step 2*

| Design Characteristic | Description | Tax incentive policy (VAT reduction of 5%) for solar technologies | Impact (%) | Adjustment (kW) | Adjusted Capacity Addition (kW) |
|---|---|---|---|---|---|
| Type of tax incentive | • Reduced or complete tax exemption or refunds | Lesotho currently imposes a 15% Value Added Tax (VAT) on most taxable supplies of goods and services (the standard rate). Introducing a reduced VAT rate of 5% to reduce VAT from 15% to 10% for all renewable energy systems and equipment is anticipated to provide a positive impact of 33.33% on the installation of renewable technologies.<br><br>As per the selected national Nationally Determined Contributions (NDC), the target number of households by 2030 stands at 10,500 under unconditional conditions. Correspondingly, the anticipated policy cap for the year 2030 is limited to 682.5 kW. | 0 | 0 | 682.5 |
| Scope of application | • RE-specific taxes or concession fees<br>• Services | The policy encompasses all renewable energy systems and equipment, which has a broad scope of tax incentives. Despite the NDC specifically focusing on solar home systems, there | 0 | 0 | 682.5 |

| | | | | | |
|---|---|---|---|---|---|
| | and equipment | are no known restrictions on eligibility for the VAT reduction. Therefore, there won't be any significant impact on the initial potential. | | | |

The table above elucidates the design characteristics of introducing a VAT reduction from 15% to 10% for Renewable Energy (RE) technologies, with a focus on Solar Home Systems (SHSs), and accounts for their impact on the expected addition to outcome potential for the selected policy during the assessment period. It can be observed that the design characteristics do not significantly restrict the project's final potential.

iii. Account for the effect on the financial feasibility of renewable energy technologies

The financial feasibility of the RE policy plays a crucial role in influencing the expected RE addition during the assessment period. Various factors impact the financial feasibility of RE technologies. In Lesotho, the application of SHSs is targeted at communities without existing access to electricity, and the project scenario will be maintained as off-grid. Therefore, the financial feasibility assessment has been conducted differently from the typical assessments for grid-connected scenarios.

Therefore, the assessment was conducted by analysing other cost considerations in the national context. Since the Solar Home Systems (SHSs) were designed to address the power needs for lighting in each household, the analysis considered factors impacting residential customers' own consumption, including production and end-consumer prices.

Table 4.7 evaluates the impact of the financial feasibility of the tax incentive policy under NDC 6 on the overall technical potential of the assessment.

*Table 4.7: RE addition _ MA 2_ Step 3*

| Other cost consideration | Explanation | Impact (%) | Adjustment (kW) | Adjusted Capacity Addition (kW) |
|---|---|---|---|---|
| Off-grid (Residential customer's own consumption) | The policy's target population is 15% of the non-electrified population in Lesotho. Consequently, there isn't any price that they pay as end consumers for the consumption of electricity from the grid.<br><br>Furthermore, the cost and labour necessary to provide and maintain a stable grid connection to the target areas will be more expensive than providing a Solar Home System (SHS). Hence, it can be assumed that there will not be any reduction in potential due to the evaluation of financial feasibility. | 0 | 0 | 682.5 |

Other policies in the sector may affect the financial feasibility of RE technologies. "Hence, the following policies outlined in Table 4.8, which may interact with the financial feasibility of Renewable Energy (RE) technologies, have been studied.

*Table 4.8: RE addition _ MA 2_ Step 4*

| Type of policies | Relevant policies in the country |
|---|---|
| Emissions trading programmes | Not available according to the current gathered information under ClimateSI |
| Taxes, such as energy or carbon taxes | There is a proposed clean energy levy for fossil fuels used in Lesotho, such as petroleum fuels and coal. It is suggested to start |

| | |
|---|---|
| | the levy at 2 ₵/kWh for electricity, 2₵/litre for petrol, diesel and kerosene and 2₵/Kg for coal, peat and LPG. |
| Energy regulations, such as mandatory closing of inefficient plants, and quotas for fuels | Not available according to the current gathered information under ClimateSI |
| subsidies, such as fossil fuel subsidies or direct and indirect electricity subsidies | An interest subsidy will be provided to reduce the cost of capital for loans (an interest rate of 9%/year can be brought down to 6%/year through the subsidy) and leases of RE equipment. There are also suggestions to start the priority sector directive with a 5% share of renewables in the Bank's loan portfolio in Lesotho. A service subsidy was also proposed to reduce the cost of rural energy services. |

Most of the country's policies support the promotion of RE technologies. Therefore, it was assumed that the SHS project's target capacity could be implemented without significant policy interference.

Furthermore, according to available sectoral trends, a considerable amount of the country's total energy supply comes from renewable energy, and electricity power generation has been dominated by renewable energy since 2015.

Figure 4.2 illustrates Lesotho's energy sector trends, as published by the International Renewable Energy Agency (IRENA).

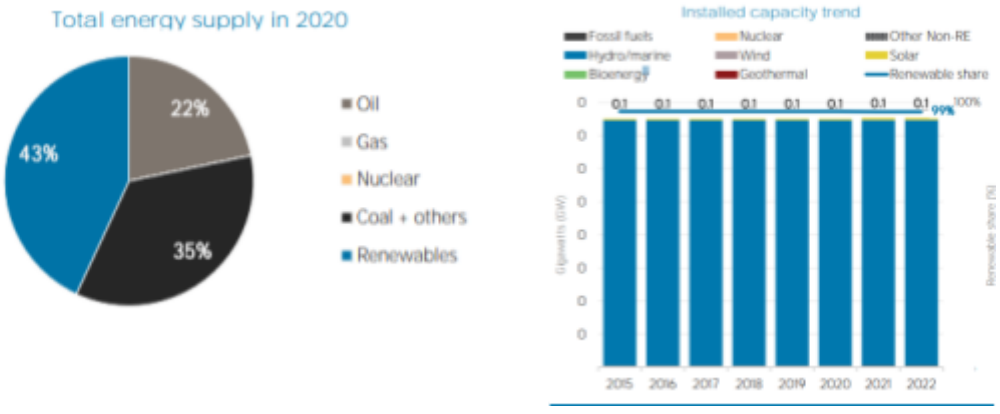



*Figure 4.2: National and international power generation trends*

Source: *(IRENA, 2023)*

According to the global trend reported by the IEA, there has also been an observable increase in non-fossil electricity after 2010, as depicted in Figure 4.3. Therefore, we can safely conclude that sectoral trends at the national and global levels favour RE technologies.

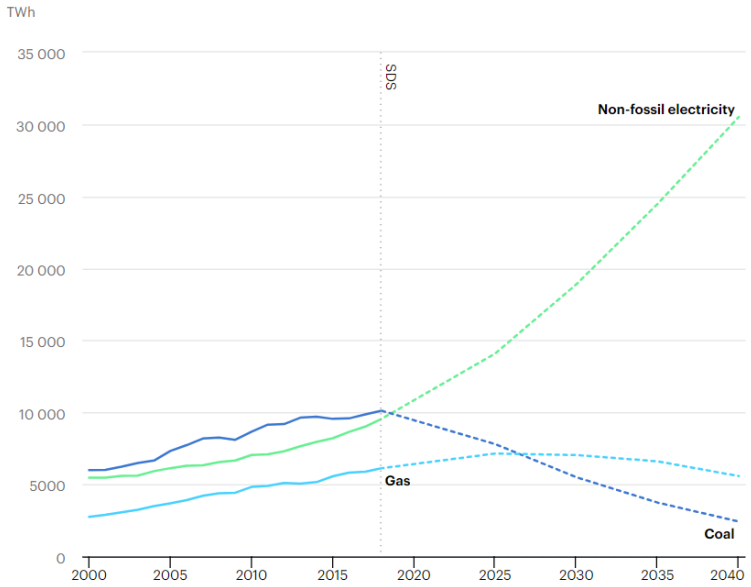



*Figure 4.3: Global coal power generation in the Sustainable Development Scenario 2000 – 2040*

Source: IEA, 2020

*iv.* Account for other barriers[10]

The impacts of other barriers were considered in this section. As provided in Table 4.9, other barriers have been analysed to identify obstacles, including technical barriers, regulatory and policy uncertainty, and lack of awareness of renewable energy and skilled personnel.

*Table 4.9: RE addition _ MA 2_ Step 5*

| Barrier category | Barrier description | Country context | Impact |
|---|---|---|---|
| Technical | • Technical standards | The Off-Grid Master Plan Report underscores the importance of promoting quality standards for | - 10% |

[10] Please note that the assessment was conducted using the data and information that we were able to obtain. Hence, we were unable to conduct a complete barrier analysis.

| | | | |
|---|---|---|---|
| | lacking for some RE technologies<br><br>• Lack of sufficient technology providers | off-grid systems, equipment, and appliances as a crucial factor for the sustainable implementation of the off-grid electrification program in Lesotho. According to the Action & Investment Plan (Lesotho, 2018) of the Lesotho Electrification Master Plan, it is proposed that the off-grid agency should take on the responsibility of ensuring that quality issues are addressed in Lesotho. This can typically be achieved through:<br>a. Product warranties<br>b. Product certification and labeling<br>c. Awareness creation<br>d. Providing good after-sales and maintenance services.<br><br>However, until these standards are properly established and met, there will be a barrier to achieving the full expected capacity of the assessment due to technical constraints. | |
| Regulatory and policy uncertainty | Insufficient clarity and transparency in existing regulations or the development of new policies | The reduction of VAT was considered for the assessment based on Lesotho's draft renewable energy policy in 2013. However, the specific percentage of tax reduction was not mentioned in the energy policy set for 2015 to 2025. Additionally, the importance of tax incentive policies to achieve the country's set SHS targets was not directly emphasised in the NDC. There was also a lack of emphasis on creating an effective policy and regulatory context, ultimately weakening the project's transformative potential and sustainability.<br><br>However, considering the presence of various policies supporting the installation of RE technologies in the country, it can be assumed that there are some regulatory and policy barriers to RE addition, and with the given information, their impact is considered minimal. | - 1% |

| | | | |
|---|---|---|---|
| Lack of awareness of RE and skilled personnel | Lack of general information and access to data relevant to RE deployment | The Off-Grid Master Plan Report emphasizes the critical importance of training future owners of SHSs on how to effectively utilize the equipment. This training is not only focused on device operation but also on understanding the capabilities and limitations of the systems. The report proposes that a portion of the budget (2% per year) allocated to off-grid electrification (20% of the annual electrification budget of M150 million) be invested in promoting and disseminating renewable energy systems in rural areas of Lesotho. This may involve various initiatives such as radio campaigns, TV infomercials, information brochures, or face-to-face workshops.<br><br>Based on this information, it can be inferred that the targeted rural population for the assessment in Lesotho may not be fully aware of SHSs, including the technical aspects necessary to realize the full potential of the assessment. However, with the allocated budget, it is reasonable to assume that awareness will be improved in the future. Considering these factors, it can be concluded that there are certain barriers hindering the achievement of the full potential of the NDC in 2030. | - 2% |
| Total impact | | | - 13% |

After assessing the impact of other barriers, the RE addition has decreased to 14.14 kW in 2025 and 593.78 kW in 2030.

### Baseline scenario emissions

The baseline scenario represents the events or conditions that would most likely occur without the policy being assessed.

The persistent use of kerosene for energy is attributed to the absence of VAT reduction for renewable energy equipment and technologies, which hampers the encouragement for further SHS installation.

i. Key indicators

Key indicators for calculation of baseline emissions[11]

Due to insufficient data to establish a baseline scenario for the entire country's electricity mix, the assessment solely focuses on the target population outlined in the NDC. Consequently, assessment parameters were collected specifically for the identified target population rather than considering the entire country.

*Equation 4.1: Key equation for baseline assessment*

Baseline Emissions ($tCO_2$/year) = [Electricity generation (MW)] x [Emission Factor ($tCO_2$/MWh)]

Table 4.10 delineates the key baseline parameters relevant to assessing emission reduction for mitigation action 2, which involves promoting Solar Home Systems (SHSs).

*Table 4.10: Key indicators for calculation of baseline emissions (MA 2)*

| Parameter | Description |
|---|---|
| Electricity generation | Total electricity generation per technology (MWh/year) |
| Emission Factor | Emission factor per technology ($tCO_2$/MWh) |

Data needs for base year calculations.

Certain modifications were made to the parameters to align them with the baseline scenario outlined in the policy and to mitigate any constraints stemming from data limitations. Table 4.11 illustrates the data requirements for developing the baseline scenario according to the ICAT RE Methodology.

*Table 4.11: Data needs (MA 2 - base year)*

| Parameter | Description | Unit |
|---|---|---|
| $EDpC_t$ | Electricity demand per capita per year t | kWh/capita |
| | Population in the country per year t | Capita |
| $T\&D_{loss}$[%] | Transmission and distribution loss for year t | % |
| OwnUse[%] | Own use of electricity for year t | % |
| $EF_i$ | Emission factor per technology i | $tCO_2$/MWh |

[11] The ICAT RE methodology is better suited for actions where the baseline scenario involves a grid-connected electricity system with a more conventional energy mix. However, the baseline scenario of the policy primarily focuses on the non-electrified population in Lesotho, who predominantly use kerosene as their primary energy source. Therefore, slight methodological adjustments were made during the assessment to align with the proposed policy action.

Future electricity generation is calculated as the total electricity demand, transmission and distribution (T&D) losses, and own use of electricity by generators. However, it's important to note that the baseline scenario for the policy assessment centres explicitly around the population that lacks access to electricity and relies on kerosene for their daily energy needs.

As a result, rather than computing electricity generation from electricity demand for the selected population for the baseline scenario, the monthly energy use estimated per household in the Lesotho energy policy, 2013, was utilised to calculate the energy use per household per year for the selected SHS. Subsequently, the energy use per household per year was employed to calculate the total energy use for the target population for the assessment year (250 SHS to 10,500 SHS). Finally, the baseline emissions were calculated based on the year's total energy use in the targeted population. Thus, the updated data requirements for the assessment baseline are outlined in Table 4.12.

*Table 4.12: Revised data needs (MA 2 - base year)*

| Parameter | Description | Unit | Availability | Source |
|---|---|---|---|---|
| **$EUpH_t$** | Electricity use per household per year t | kWh/household | Yes | Cost of Service Study, 2018 by LEWA (Provided by national experts) |
| | Number of households targeted per year | households | Yes | Based on the information provided in the NDC |
| **EF** | Emission factor for Kerosene (Paraffin) | $tCO_2/MWh$ | Yes | IPCC default |

ii. Baseline scenario emission calculation

Baseline emissions are calculated according to the following steps.

Step 1: Total energy use by the target population for the year t

*Equation 4.2: Total energy use by the target population*

$$TEU_t = EUpH_t \times \text{Number of Households}_t$$

* Note: The methodological equation was adapted to accommodate the baseline scenario outlined in the policy assessment. In the country's context, per-household demand was utilised instead of per-capita demand. Additionally, the number of target households for each year was estimated through a

straightforward calculation based on the given figures for 2025 and 2030 in the NDC. Consequently, population growth was not factored into the calculation.

Table 4.13 offers an analysis determining total energy use per year.

*Table 4.13: Baseline Scenario _ MA 2_ Step 1*

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **Energy use per household for year t ($EUpH_t$) – kWh/ year[12]** | 360 | 360 | 360 | 360 | 360 | 360 |
| **Number of Households per year t** | 250 | 2,300 | 4,350 | 6,400 | 8,450 | 10,500 |
| **Total energy use for year t ($TEU_t$) - MWh** | 90 | 828 | 1,566 | 2,304 | 3,042 | 3,780 |

Step 2: Baseline emissions calculation

*Equation 4.3: Previous baseline equation for the calculation*

Baseline *emissions* ($tCO_2$/year) = [Electricity generation (MW)] x [$E(tCO_2$ /MWh)]

The baseline emission equation has been adjusted to accommodate the baseline scenario considered for the assessment, which focuses on kerosene combustion to generate energy.

*Equation 4.4: Revised baseline equation for the calculation*

Baseline *emissions* ($tCO_2$/year) = [Fuel consumption in energy units (TJ)] x [***EF*** for combustion of fuel ($tCO_2$ /TJ)]

Table 4.14 provides the final estimation of baseline scenario emissions from 2025 to 2030, focusing only on the target population of 250 households in 2025 and 10,500 households in 2030.

*Table 4.14: Baseline Scenario _ MA 2_ Step 2*

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **Total energy use for year t ($TEU_t$) - MWh** | 90 | 828 | 1,566 | 2,304 | 3,042 | 3,780 |
| **Total energy use for year t (TJ)** | 0.32 | 2.98 | 5.64 | 8.29 | 10.95 | 13.61 |
| **IPCC (Other Kerosene) Default EF ($tCO_2$/TJ)** | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 |

[12] Assumption: The minimum energy consumption per month per household is estimated at 30 kWh. (Cost of Service Study, 2018 by LEWA)
In the absence of actual consumption data, this assumption has been made solely for illustrative purposes. Therefore, please refrain from using the results from this exercise in any other context.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Baseline emissions ($tCO_2$/year)** | 23 | 214 | 405 | 596 | 787 | 978 |

**Policy scenario emissions**

The policy scenario represents the events or conditions that would most likely occur in the presence of the policy being assessed.

More customers are willing to purchase and install Solar Home Systems (SHSs) in their households due to VAT reduction for RE technologies.

i. Key indicators

Key indicators for calculation of policy emissions

The VAT reduction has increased individuals' willingness to install off-grid solar home systems, with 100% of the power produced being utilised for household consumption. Similar to the baseline assessment, the final equation of the project scenario has also been modified to assess the kerosene energy consumption emissions at the end of the assessment.

*Equation 4.5: Key equation for project assessment*

$$\text{Project } \textit{emissions } (tCO_2/\text{year}) = [\text{Electricity generation (MW)}] \times [\boldsymbol{E}(tCO_2/\text{MWh})]$$

Similar to the baseline scenario, the project scenario is also determined using electricity generation values and emission factors per technology, as shown in Table 4.15, following the ICAT RE methodology.

*Table 4.15: Key indicators for calculation of project emissions (MA 2)*

| Parameter | Description |
|---|---|
| Electricity generation | Total electricity generation per technology (MWh/year) |
| EF | Emission factor per technology ($tCO_2$/MWh) |

Data needs for project year calculations

As the target population of the assessment is not connected to the grid, the only source of energy consumption in the project scenario other than solar energy is the continued use of kerosene to meet energy demand. Therefore, the emission factor for kerosene is considered for the assessment instead of the emission factors for electricity generation

technology types. Accordingly, the data needed for the project scenario assessment are listed in Table 4.16.

*Table 4.16: Data needs (MA 2 - base year)*

| Parameter and description | | Unit | Availability | Source |
|---|---|---|---|---|
| **Annual capacity factor** | | % | Yes | National experts suggested a capacity factor of 35% for solar PV mini-grid as a substitute. |
| **Annual average operation** | | | No | Assumption[13] |
| **Renewable energy addition** | | MW | Yes | Estimated from previous sections |
| **EF** | **Emission factor per technology** (For this assessment - EF for kerosene combustion) | $tCO_2$/ MWh | Yes | IPCC default |

**ii.** Policy scenario emission trajectory calculation

Step 1: Calculating specific yield

*Equation 4.6: Calculating specific yield*

$$\text{Specific yield}_{\text{solar PV}} = \text{annual capacity factor} \times \text{annual average operation}$$

Table 4.17 estimates specific yield using the annual capacity factor and annual average operation. The data needed for estimation from 2025 to 2030 is assumed to remain the same due to limited available data.

*Table 4.17: Policy Scenario _ MA 2_ Step 1*

| Year | 2025 |
|---|---|
| **Annual capacity factor** | 35% |
| **Annual average operation (hours/ year)** | 8760 |
| **Specific yield $_{\text{solar PV}}$ (MWh/year)/MW** | 3,066 |

Step 2: Electricity generation potential from Solar

*Equation 4.7: Energy generation potential*

$$EG_{\text{solar PV}} = \text{RE addition} \times \text{specific yield}$$

[13] Assumed an annual average operation of 360 days per year.

From 2025 to 2030, solar energy generation per year for the targeted population is provided, as assessed in Table 4.18.

*Table 4.18: Policy Scenario _ MA 2_ Step 2*

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **RE addition per year (MW)** | 0.014 | 0.13 | 0.25 | 0.36 | 0.48 | 0.59 |
| **Specific yield $_{solar\ PV}$ (MWh/year)/MW** | 3,066 | 3,066 | 3,066 | 3,066 | 3,066 | 3,066 |
| **Electricity generation potential of SHS (MWh)** | 43.4 | 398.8 | 754.2 | 1,109.7 | 1,465.1 | 1,820.5 |

Step 3: Project emissions calculation

*Equation 4.8: Project equation for the calculation*

Project *emissions* ($tCO_2$/year) = [Fuel consumption (TJ) – Solar generation (TJ)] x [***EF*** for combustion of fuel ($tCO_2$ /TJ)]

As mentioned earlier, the energy requirement of the target population is met by kerosene consumption for the remaining energy demand after covering the possible energy demand from the solar home system. Therefore, considering the emissions from solar power generation as zero, the emissions contribution for the project scenario only comes from the combustion of kerosene, as assessed in Table 4.19.

*Table 4.19: Policy Scenario _ MA 2_ Step 3*

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **Total energy demand for year t ($TED_t$) - MWh** | 90 | 828 | 1,566 | 2,304 | 3,042 | 3,780 |
| **Electricity generation potential of SHSs (MWh)** | 43.4 | 398.8 | 754.2 | 1,109.7 | 1,465.1 | 1,820.5 |
| **Energy demand that is not covered by solar power generation (TJ)** | 0.17 | 1.55 | 2.92 | 4.3 | 5.68 | 7.05 |
| **IPCC (Other Kerosene) Default EF ($tCO_2$/TJ)** | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 |
| **Project emissions ($tCO_2$/year)** | 12 | 111 | 210 | 309 | 408 | 507 |

### Emission Reduction

Table 4.20 provides the outcome of the assessment as achievable emission reduction.

*Table 4.20: Emission Reduction _ MA 2*

| Year | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|
| **Baseline emissions ($tCO_2$/year)** | 23 | 214 | 405 | 596 | 787 | 978 |
| **Project emissions ($tCO_2$/year)** | 12 | 111 | 210 | 309 | 408 | 507 |
| **Emission reduction ($tCO_2$/year)** | 11 | 103 | 195 | 287 | 379 | 471 |

### BAU and project scenario

Figure 4.4 illustrates the Business-As-Usual (BAU) scenario and the project scenario of the GHG impact assessment for NDC 6, which focuses on promoting solar home systems through VAT reduction.

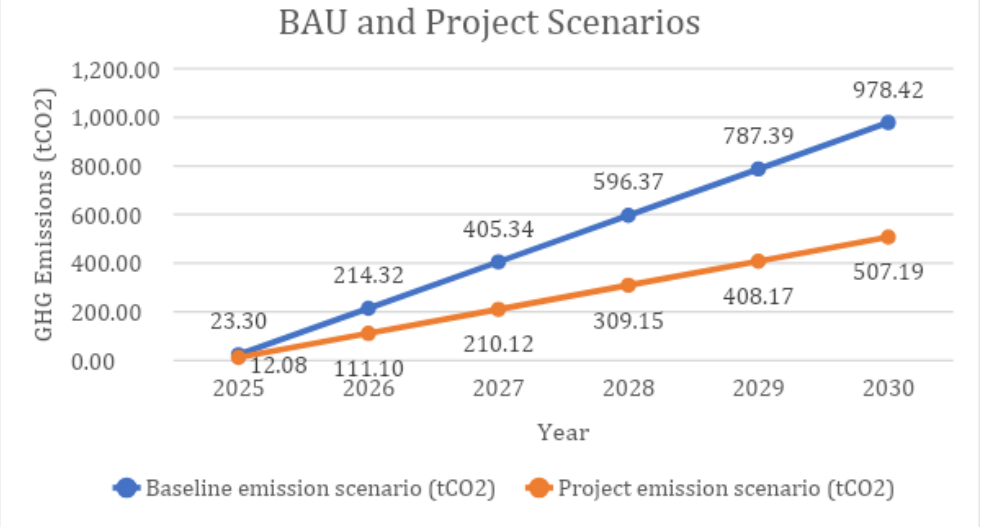



*Figure 4.4: BAU and Project Scenario, 2025 to 2030*

Source: own work of the author, 2024

**Ex-ante GHG impact assessment**

Figure 4.5 visually represents the GHG emission reduction for the ex-ante assessment in a more graphical format.

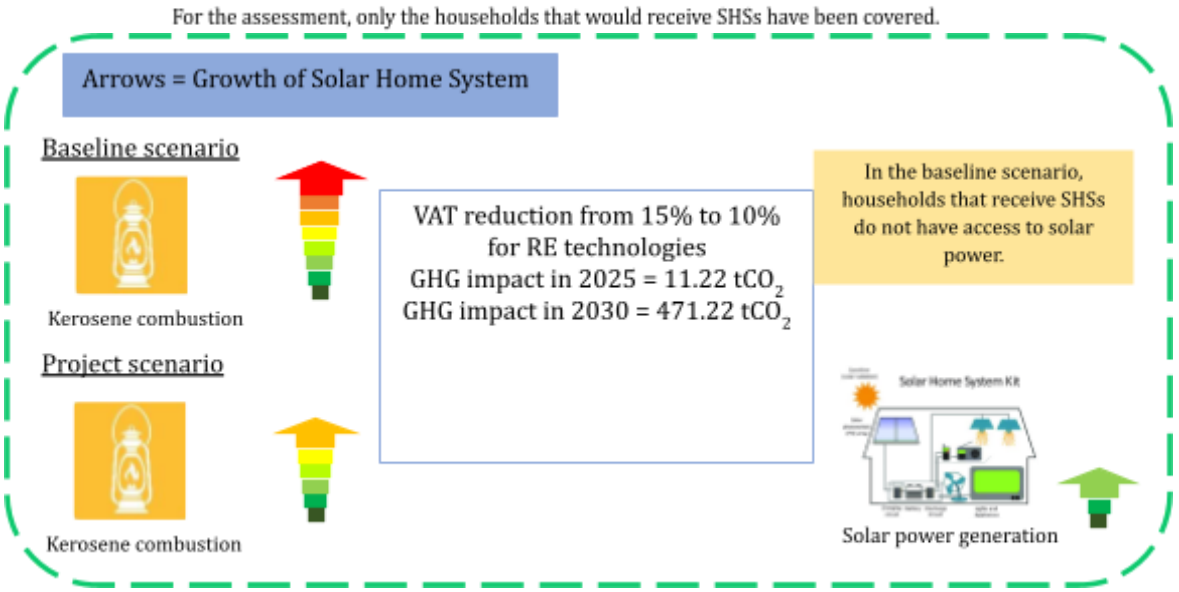



*Figure 4.5: GHG impact of mitigation action 2*

Source: own work of the author, 2024

## 4.4 Data Management System

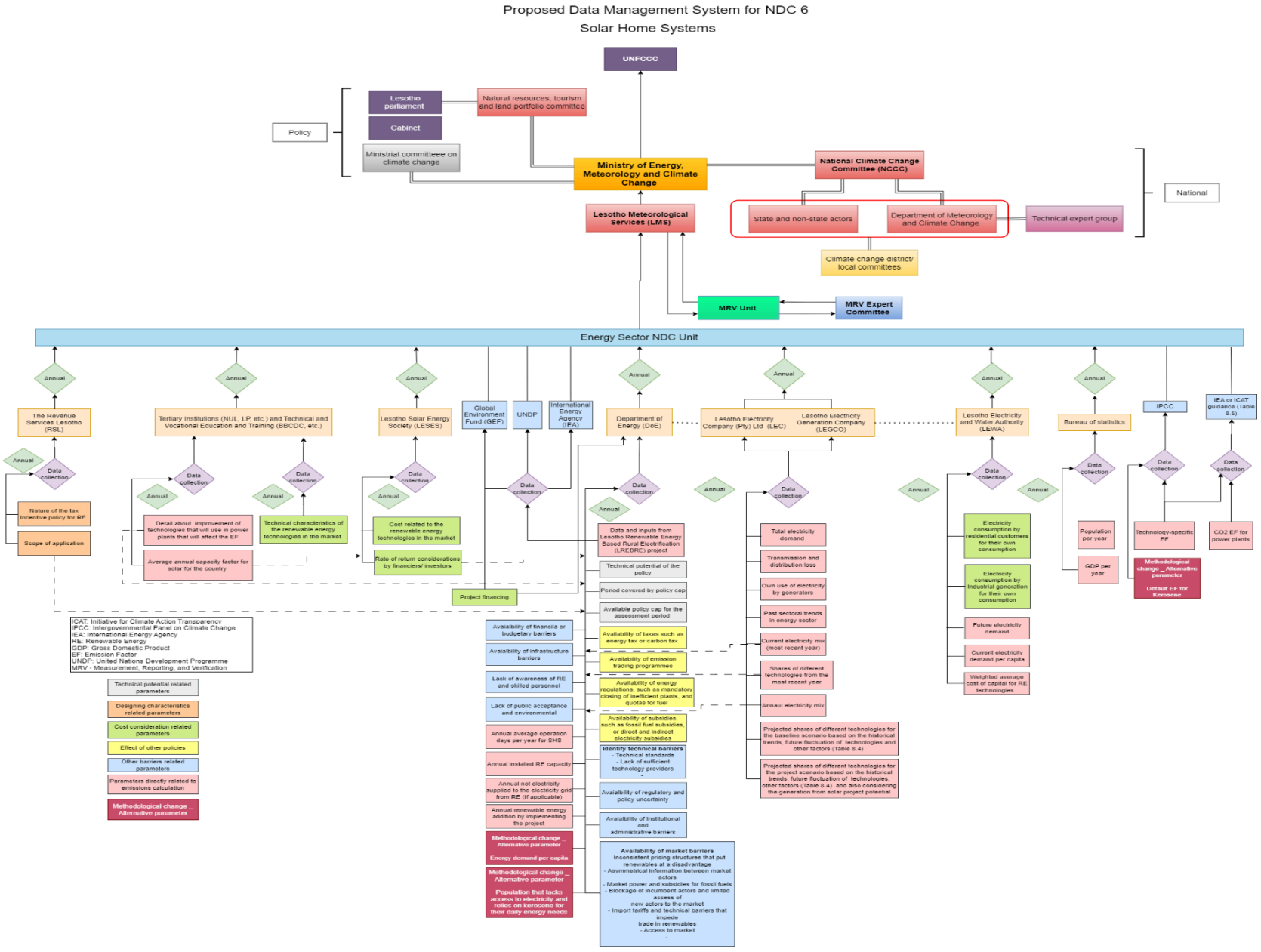



*Figure 4.6: Proposed Data Management System for Mitigation Action 2*

Source: Own work of author, 2024

## 4.5 Verification

Respective institutions will annually report the required data to the Ministry of Energy and Meteorology. The quality and accuracy of the provided data will be verified by the Ministry of Energy and Meteorology's NDC unit, with support from Lesotho Meteorological Services (LMS). Additionally, the GHG impact of the mitigation action in question will be calculated by the NDC unit, with support from the MRV unit. An independent third party, the MRV expert committee to be appointed by the LMS, will verify the accuracy of the calculations. Approved results will then be submitted to the Ministry of Energy and Meteorology, which will, in turn, submit them to the UNFCCC. As depicted in the data management system, data will be required from institutions not regulated by the Ministry of Energy and Meteorology. Therefore, strengthening the legal provisions of the NDC unit and LMS will ensure the proper verification process.

## 4.6 Recommendation

As illustrated in the DMS, data from several ministries and institutions will be required to measure the GHG effect of the mitigation action considered. However, most ministries and institutions have a manual data management system. Data collection through a manual system will be time-consuming. Therefore, digitalising the data collection system is suggested, which is currently managed manually. It is further recommended that the legal framework of the proposed NDC unit and LMS be strengthened so that data collection from different entities will be easy, as the Ministry of Energy and Meteorology might not have authority over some institutions. The reporting process will be delayed if the data is to be collected through several ministries. Therefore, introducing a digitalised MRV system is recommended to provide direct access to the respective data owners.

# 5. PROPOSED NATIONAL INSTITUTIONAL ARRANGEMENT FOR ENERGY SECTOR MRV SYSTEM

Developing a robust institutional structure by including relevant institutions with clearly defined roles and responsibilities is essential for effectively implementing any MRV system. When developing a combined institutional structure for the transport sector and energy sector MRV in Lesotho, it is important to understand the existing governance structure and reporting lines in both sectors. The proposed institutional arrangement is based on the existing system and stakeholder engagement, and a national team will be involved in improving it.

With sound knowledge of the existing institutional structure in both the renewable energy sector and the country's transport sector, an institutional arrangement covering both sectors for NDC implementation is proposed. It is based on the existing systems and makes the best use of existing data collection mechanisms. The overall institutional arrangement for the transport sector and energy sector MRVs is illustrated in Figure 5.1. The institutional arrangement proposed in this document can be linked to any expanded national MRV system in the future to cover all the country's NDCs.

As the national operational focal point of UNFCCC, the Ministry of Energy and Meteorology is responsible for reporting the status of achieving the NDCs. For this purpose, it is proposed that a separate unit within the ministry be established to monitor the progress of achieving NDCs in the country, including transport sector NDCs and energy sector NDCs. All the emission reductions from the policies and actions that help achieve NDCs will be reported to this MRV unit through sectoral NDC units (e.g., “Transport sector NDC unit”). The MRV unit will refer emission reduction calculations to the MRV Expert Committee, a newly established body comprising sectoral experts and MRV specialists. Its role is to verify emission calculations conducted by NDC units, including those for the transport and energy sectors, and to offer guidance for verification to sectoral NDC units. The appointment of this committee will be made by the LMS.

The secretary will establish the NDC unit for the transport sector to the Ministry of Public Works and Transport and will be headed by a director (Director MRV). For the

energy sector, the NDC unit will be established by the secretary to the Ministry of Energy and Meteorology and will be headed by a director (Director MRV). The units will consist of trained staff and necessary infrastructure. All the institutions that are supposed to collect data for policies and actions that fall within the preview of transport sector NDCs and energy sector NDCs will report the required data to this unit. Establishing the NDC unit within the ministry makes institutional coordination easier as most of the data owners for both the transport sector and energy sector NDC are the institutions under the relevant ministries. Also, there is a high tendency to submit data when it is requested at the ministerial level. Therefore, these units act as sectoral coordinating units. An existing institution can do all the roles and responsibilities of these units.

The Ministry of Public Works and Transport, Ministry of Energy and Meteorology, the Department of Traffic and Transport, and Revenue Services Lesotho will be involved as national-level institutions in implementing the transport sector MRV system.

The Ministry of Energy and Meteorology, Revenue Services Lesotho, Lesotho Electricity and Water Authority, Lesotho Electricity Company (Pty) Ltd, and Lesotho Electricity Generation Company will be involved in implementing the energy sector MRV system as national-level institutions.

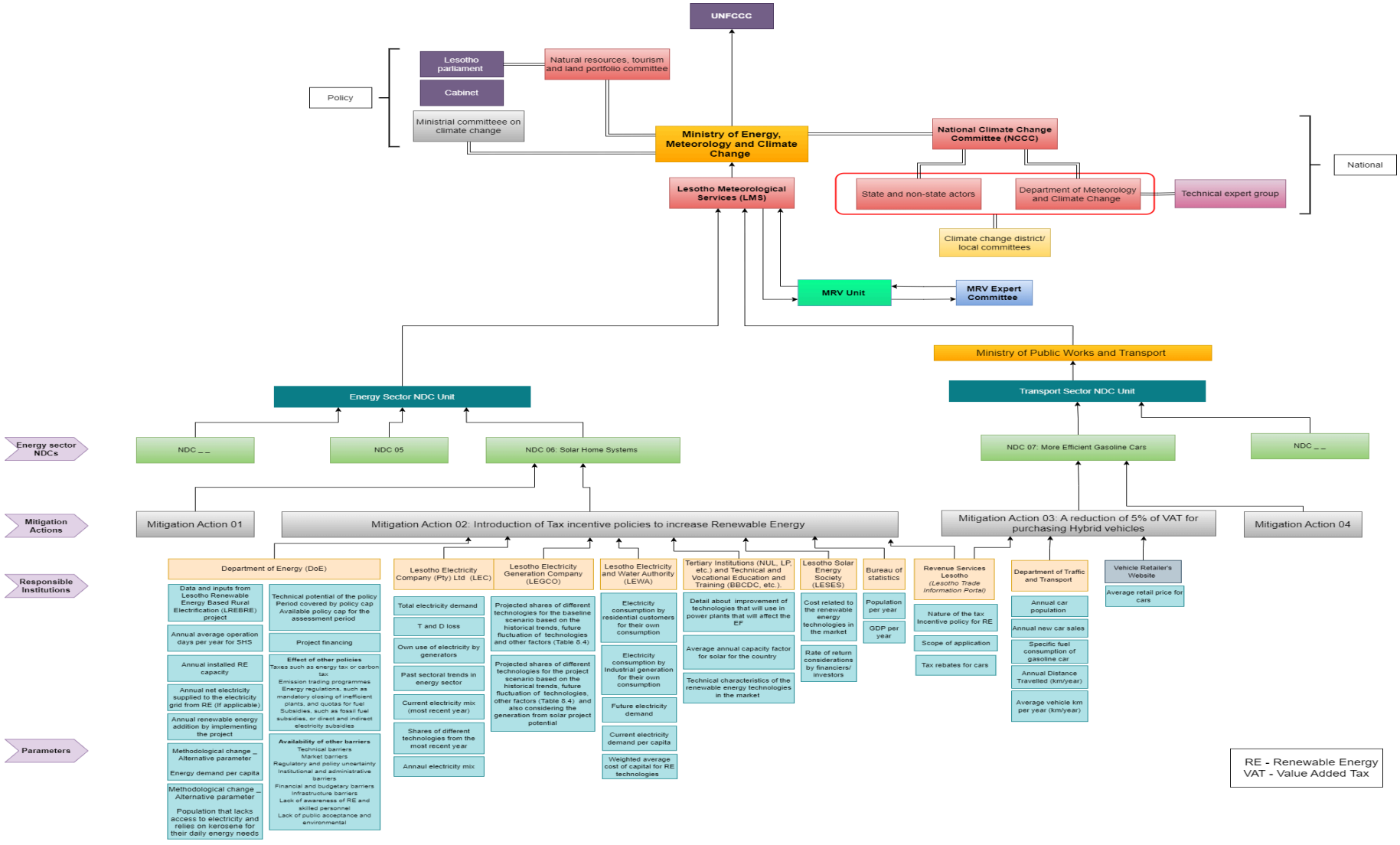

UNFCCC
Lesotho parliament
Natural resources, tourism and land portfolio committee
Policy
Cabinet
Ministrial committeee on climate change
Ministry of Energy, Meteorology and Climate Change
National Climate Change Committee (NCCC)
National
Lesotho Meteorological Services (LMS)
State and non-state actors
Department of Meteorology and Climate Change
Technical expert group
Climate change district/ local committees
MRV Unit
MRV Expert Committee
Ministry of Public Works and Transport
Energy Sector NDC Unit
Transport Sector NDC Unit
Energy sector NDCs
NDC _ _
NDC 05
NDC 06: Solar Home Systems
NDC 07: More Efficient Gasoline Cars
NDC _ _
Mitigation Actions
Mitigation Action 01
Mitigation Action 02: Introduction of Tax incentive policies to increase Renewable Energy
Mitigation Action 03: A reduction of 5% of VAT for purchasing Hybrid vehicles
Mitigation Action 04
Responsible Institutions
Department of Energy (DoE)
Lesotho Electricity Company (Pty) Ltd (LEC)
Lesotho Electricity Generation Company (LEGCO)
Lesotho Electricity and Water Authority (LEWA)
Tertiary Institutions (NUL, LP, etc.) and Technical and Vocational Education and Training (BBCDC, etc.).
Lesotho Solar Energy Society (LESES)
Bureau of statistics
Revenue Services Lesotho (Lesotho Trade Information Portal)
Department of Traffic and Transport
Vehicle Retailer's Website
Parameters
Data and inputs from Lesotho Renewable Energy Based Rural Electrification (LREBRE) project
Annual average operation days per year for SHS
Annual installed RE capacity
Annual net electricity supplied to the electricity grid from RE (If applicable)
Annual renewable energy addition by implementing the project
Methodological change _ Alternative parameter
Energy demand per capita
Methodological change _ Alternative parameter
Population that lacks access to electricity and relies on kerosene for their daily energy needs
Technical potential of the policy Period covered by policy cap Available policy cap for the assessment period
Project financing
Effect of other policies
Taxes such as energy tax or carbon tax
Emission trading programmes
Energy regulations, such as mandatory closing of inefficient plants, and quotas for fuel
Subsidies, such as fossil fuel subsidies, or direct and indirect electricity subsidies
Availability of other barriers
Technical barriers
Market barriers
Regulatory and policy uncertainty
Institutional and administrative barriers
Financial and budgetary barriers
Infrastructure barriers
Lack of awareness of RE and skilled personnel
Lack of public acceptance and environmental
Total electricity demand
T and D loss
Own use of electricity by generators
Past sectoral trends in energy sector
Current electricity mix (most recent year)
Shares of different technologies from the most recent year
Annual electricity mix
Projected shares of different technologies for the baseline scenario based on the historical trends, future fluctuation of technologies and other factors (Table 8.4)
Projected shares of different technologies for the project scenario based on the historical trends, future fluctuation of technologies, other factors (Table 8.4) and also considering the generation from solar project potential
Electricity consumption by residential customers for their own consumption
Electricity consumption by Industrial generation for their own consumption
Future electricity demand
Current electricity demand per capita
Weighted average cost of capital for RE technologies
Detail about improvement of technologies that will use in power plants that will affect the EF
Average annual capacity factor for solar for the country
Technical characteristics of the renewable energy technologies in the market
Cost related to the renewable energy technologies in the market
Rate of return considerations by financiers/ investors
Population per year
GDP per year
Nature of the tax incentive policy for RE
Scope of application
Tax rebates for cars
Annual car population
Annual new car sales
Specific fuel consumption of gasoline car
Annual Distance Travelled (km/year)
Average vehicle km per year (km/year)
Average retail price for cars
RE - Renewable Energy
VAT - Value Added Tax

*Figure 5.1: Overall Institutional Arrangement for energy MRV system*

Source: Own work of author, 2024

# REFERENCES

Bank, W., 2024. *GDP (current US$) - , Lesotho.* [Online]
Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2022&locations=CN%5C%22+style%3D%5C%22color%3A+rgb%2850%2C+104%2C+145%29%3B%5C%22+target%3D%5C%22_blank%5C%22+target%3D%5C%22_blank%5C%22+target%3D%5C%22_blank-LS&start=1960

CDM, 2006. *AM0031 version 3.1.0.* [Online]
Available at: https://cdm.unfccc.int/filestorage/O/D/C/ODC84B1TWGMFUI3XR9V7AZ52E06HKY/EB110_repan03_AM0031%20%28v08.0%29.pdf?t=QmF8cXhvN2U0fDAsff0gI49aPyQIHtS2nzvT

CDM, 2006. *AM0031 version 3.1.0.* [Online]
Available at: https://cdm.unfccc.int/filestorage/O/D/C/ODC84B1TWGMFUI3XR9V7AZ52E06HKY/EB110_repan03_AM0031%20%28v08.0%29.pdf?t=QmF8cXhvN2U0fDAsff0gI49aPyQIHtS2nzvT

CDM, 2010. *CDM Methodology AM0090 version 1.1.0.* [Online]
Available at: https://cdm.unfccc.int/methodologies/DB/4DOIK2WYP8P3AGAVJKT0CHY1NXJ4QP

GEF, 2013. *Terminal Evaluation Report - Lesotho Renewable Energy-Based Rural Electrification Project (LREBRE).* [Online]
Available at: https://www.gefieo.org/sites/default/files/documents/projects/tes/1245-terminal-evaluation.pdf

ICAT, 2020. *ICAT Transport Pricing Guidance.* [Online]
Available at: https://climateactiontransparency.org/wp-content/uploads/2020/04/Transport-Pricing-Assessment-Guide.pdf

IRENA, 2023. *ENERGY PROFILE LESOTHO.* [Online]
Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Africa/Lesotho_Africa_RE_SP.pdf

Lesotho, 2018. *FORMULATION OF THE LESOTHO ELECTRICATION MASTER PLAN - Action & Investment Plan,* s.l.: s.n.

Lesotho, 2018. *FORMULATION OF THE LESOTHO ELECTRICATION MASTER PLAN - Off-Grid Master Plan Report,* s.l.: s.n.

LESOTHO, T. K. O., 2015. *LESOTHO ENERGY POLICY 2015 - 2025,* s.l.: s.n.

Ministry of Environment and Tourism, 2018. *Third National Communication of Mongolia (TNC),* Ulaanbaatar: s.n.

Parthan, D. B., 2013. *Lesotho: Renewable Energy Policy* , s.l.: s.n.

UNFCCC, 2014. *Handbook on MEASUREMENT, REPORTING AND VERIFICATION FOR DEVELOPING COUNTRY PARTIES.* [Online]
Available at: https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf

UNFCCC, 2016. *THE PARIS AGREEMENT.* [Online]
Available at: https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf

WRI, 2016. *MRV 101: UNDERSTANDING MEASUREMENT, REPORTING, AND VERIFICATION OF CLIMATE CHANGE MITIGATION.* [Online]
Available at: https://files.wri.org/d8/s3fs-public/MRV_101_0.pdf

UNFCCC, 2015, Measurement, reporting and Verification for developing country parties
Available at: https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf

# ANNEX 01- PROCEDURES

## 1. SOLAR HOME SYSTEM

### Procedure for Data Collection at the Department of Energy (DoE)

**Procedure: P1_eMRV SHS_DoE**

**Approved by:**

**OVERVIEW**

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Department of Energy (DoE). It shall serve as a manual to describe in detail the relevant data required for assessing the solar home system installed to introduce the tax incentive policies to increase renewable energy.

**Annual Activities**

The MRV focal point at DoE shall;

1. Enter the following information annually into the specific data-collecting logbook at the DoE

*Table 1.1: Data collection template to be used by DoE*

| Data collection template to be used by DoE | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| 1. Amount of renewable energy output obtainable by full implementation of demonstrated technologies or practices for the entire assessment period (MW) – Technical potential of the policy | | | | | | | |
| 2. Period covered by policy cap | | | | | | | |
| 3. Available policy cap for the assessment period | | | | | | | |
| 4. Project financing related to the policy | | | | | | | |
| 5. Availability of taxes such as energy tax or carbon tax within the period that influence | | | | | | | |
| 6. Availability of emissions trading programmes within the period that influence | | | | | | | |
| 7. Availability of energy regulations, such as mandatory closing of inefficient plants and quotas for fuel within the period that influence | | | | | | | |
| 8. Availability of subsidies, such as fossil fuel subsidies or direct and indirect electricity subsidies within the period that influence | | | | | | | |
| 9. Identify technical barriers available | | | | | | | |
| 10. Availability of regulatory and policy uncertainty | | | | | | | |

| | |
|---|---|
| 11. Availability of institutional and administrative barriers | |
| 12. Availability of market barriers | |
| 13. Availability of financial or budgetary barriers | |
| 14. Availability of infrastructure barriers | |
| 15. Lack of RE and skilled personnel | |
| 16. Lack of public acceptance and environmental | |
| 17. Annual installed RE capacity | |
| 18. Annual net electricity supplied to the electricity grid from RE (If applicable) | |
| 19. Annual renewable energy addition by implementing the project | |
| 20. Annual average operation days per year for SHS | |
| Parameters due to methodological change –<br><br>21. Energy demand per capita or household | |
| Parameters due to methodological change –<br><br>22. Population that lacks access to electricity and relies on kerosene for their daily energy needs | |
| 23. Data and inputs from the Lesotho Renewable Energy Based Rural Electrification (LREBRE) project | |
| 24. Current electricity mix (most recent) | |
| 25. Shares of different technologies from the most recent year | |
| 26. Annual electricity mix | |
| 27. Detail about the improvement of technologies that will be used in power plants that will affect the EF | |
| Responsible Person<br>Designation<br>Date | |
| Only for the use of the Energy sector GHGI MRV section | |

*Table 1.2: Data collection template to be used by DoE to collect alternative parameters to estimate renewable energy potential*

| Data collection template to be used by DoE | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |

| | |
|---|---|
| 1. Total solar panel area ($m^2$) | |
| 2. Solar panel yield or efficiency (%) | |
| 3. Annual average solar radiation on tilted panels (shadings not included) | |
| 4. Performance ratio, coefficient for losses (range 0 5–0 9; default value 0 75) | |
| 5. System size (kW, DC) | |
| 6. Module type (std, medium, thin film) | |
| 7. System losses (%) | |
| 8. Array type (fixed open rack, fixed roof mount, 1-axis, backtracked 1-axis, 2-axis) | |
| 9. Tilt angle (degrees) | |
| 10. Azimuth angle (degrees) | |
| 11. DC/AC ratio (optional) | |
| 12. Inverter efficiency | |
| Responsible Person<br>Designation<br>Date | |
| Only for the use of the Energy sector GHGI MRV section | |

# Procedure for Data Collection at the Revenue Services Lesotho (RSL)

## Procedure: P2_eMRV SHS_RSL

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at Revenue Services Lesotho. It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

### Annual Activities

The MRV focal point at RSL shall;

1. Enter the following information annually into the specific data-collecting logbook at the RSL.

*Table 1.3: Data collection template to be filled at RSL*

| Data collection template to be used by RSL | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| 1. Corporate tax rate | | | | | | | |
| 2. Availability of taxes such as energy tax or carbon tax | | | | | | | |
| 3. Tax incentives on RE technologies | **i. Type of tax incentives (Nature of the tax incentives)**<br>Reduced or complete tax exemptions or refunds ☐<br>Deductibles ☐<br>Tax credits ☐<br>Different payment schedules ☐<br>Fiscal stability incentives ☐<br>Other (please specify)<br><br>**ii. Scope of application**<br>Pre-investment expenses related to RE projects ☐<br>Sale of electricity ☐<br>Carbon credits and other ancillary income ☐<br>RE-specific taxes or concession fees ☐<br>Services and equipment ☐<br>Civil works ☐<br>Other (please specify) | | | | | | |
| Responsible Person | | | | | | | |
| Designation | | | | | | | |
| Date | | | | | | | |

| | |
|---|---|
| Only for the use of the Energy sector GHGI MRV section | |

# Procedure for Data Collection at Lesotho Electricity Company (Pty) Ltd. (LEC)

## Procedure: P3_eMRV SHS_LEC

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Lesotho Electricity Company (Pyt) Ltd. (LEC). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at LEC shall;

1. Enter the following information annually into the specific data-collecting logbook at the LEC.

*Table 1.4: Data collection template to be filled at LEC*

| Data collection template to be used by LEC | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| 1. Current energy mix (most recent year) | | | | | | | |
| 2. Total electricity demand | | | | | | | |
| 3. Transmission and distribution loss | | | | | | | |
| 4. Past sectoral trends in energy | | | | | | | |
| 5. Shares of different technologies from the most recent year for which data are available | | | | | | | |
| 6. Own use of electricity by generators | | | | | | | |
| 7.<br>i. Total emissions from electricity generation of a technology in electricity mix in the country | | | | | | | |
| ii. The electricity generated per technology in electricity mix in the country | | | | | | | |

| | | | |
|---|---|---|---|
| 8. Projected shares of different technologies for the baseline scenario based on the historical trends, future fluctuation of technologies and other factors | | | |
| 9. Projected shares of different technologies for the project scenario based on the historical trends, future fluctuation of technologies, other factors and also considering the generation from solar project potential | | | |
| 10. Cost related to the renewable energy technology in the market | i. | Capital cost | |
| | ii. | Operational and maintenance cost | |
| | iii. | Fuel cost | |
| 11. Cost related to the alternative technologies (fossil fuel or nuclear power plant) | i. | Capital cost | |
| | ii. | Operational and maintenance cost | |
| | iii. | Fuel cost | |
| 12. Technical characteristics of the renewable energy technology in the market | i. | Capacity of the technology | |
| | ii. | Load characteristics | |
| | iii. | Operational lifetime of the technology | |
| 13. Technical characteristics of the alternative technologies (fossil fuel or nuclear power plant) in the market | i. | Capacity of the technology | |
| | ii. | Load characteristics | |
| | iii. | Operational lifetime of the technology | |
| Responsible Person | | | |
| Designation | | | |
| Date | | | |
| Only for the use of the Energy sector GHGI MRV section | | | |

## Procedure for Data Collection at Lesotho Electricity Generation Company (LEGCO)

**Procedure: P4_eMRV SHS_LEGCO**

**Approved by:**

**OVERVIEW**

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Lesotho Electricity Generation Company (LEGCO). The procedure shall serve as a manual to describe in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at LEGCO shall;

2. Enter the following information annually into the specific data-collecting logbook at the LEGCO.

*Table 1.5: Data collection template to be filled at LEGCO*

| Data collection template to be used by LEGCO | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| 1. Current energy mix (most recent year) | | | | | | | |
| 2. Total electricity demand | | | | | | | |
| 3. Transmission and distribution loss | | | | | | | |
| 4. Past sectoral trends in energy | | | | | | | |
| 5. Shares of different technologies from the most recent year for which data are available | | | | | | | |
| 6. Own use of electricity by generators | | | | | | | |
| 7.<br>i. Total emissions from electricity generation of a technology in electricity mix in the country | | | | | | | |
| ii. The electricity generated per technology in electricity mix in the country | | | | | | | |
| . Projected shares of different technologies for the baseline scenario based on the historical trends, future fluctuation of technologies and other factors | | | | | | | |
| . Projected shares of different technologies for the project scenario based on the historical trends, future fluctuation of technologies, other factors and also considering the | | | | | | | |

| | | | |
|---|---|---|---|
| | generation from solar project potential | | |
| | Cost related to the renewable energy technology in the market | iv. Capital cost | |
| | | v. Operational and maintenance cost | |
| | | vi. Fuel cost | |
| . | Cost related to the alternative technologies (fossil fuel or nuclear power plant) | iv. Capital cost | |
| | | v. Operational and maintenance cost | |
| | | vi. Fuel cost | |
| i. | Technical characteristics of the renewable energy technology in the market | iv. Capacity of the technology | |
| | | v. Load characteristics | |
| | | vi. Operational lifetime of the technology | |
| ii. | Technical characteristics of the alternative technologies (fossil fuel or nuclear power plant) in the market | iv. Capacity of the technology | |
| | | v. Load characteristics | |
| | | vi. Operational lifetime of the technology | |
| | Responsible Person | | |
| | Designation | | |
| | Date | | |
| Only for the use of the Energy sector GHGI MRV section | | | |

## Procedure for Data Collection at Lesotho Electricity and Water Authority (LEWA)

## Procedure: P5_eMRV SHS_LEWA

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Lesotho Electricity and Water Authority (LEWA). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at LEWA shall;

i. Enter the following information annually into the specific data-collecting logbook at the LEWA.

*Table 1.6: Data collection template to be filled at LEWA*

| Data collection template to be used by LEWA | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| 1. Electricity consumption by residential customers for their own consumption | | | | | | | |
| 2. Electricity consumption by Industrial generation for their own consumption | | | | | | | |
| 3. Electricity price in the market | | | | | | | |
| 4. Current electricity demand per capita | | | | | | | |
| 5. Future electricity demand | i. Growth rates of electricity demand from the regional scenarios | | | | | | |
| | ii. Historical data on electricity demand available for the country | | | | | | |
| 6. Variations in the renewable energy source potential | | | | | | | |
| 7. Weighted average cost of capital for RE technologies | i. Cost of equity (expected return on equity) | | | | | | |

| | | |
|---|---|---|
| | ii. Percentage of financing that is equity | |
| | iii. Cost of debt | |
| | iv. Percentage of financing that is debt | |
| Responsible Person<br>Designation<br>Date | | |
| | | |
| | | |
| Only for the use of the Energy sector GHGI MRV section | | |

# Procedure for Data Collection at Lesotho Solar Energy Society (LESES)/ Installers

## Procedure: P6_eMRV SHS_LESES/Installers

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Lesotho Solar Energy Society (LESES)/ Installers. The procedure shall serve as a manual to describe in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at LESES/Installers shall;

1. Enter the following information annually into the specific data-collecting logbook at the LESES/Installers.

*Table 1.7: Data collection template to be filled at LESES/Installers*

| Data collection template to be used by LESES/Installers | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | | |
| | | | | | | | | |
| 1. Cost related to the renewable energy technology in the market | i. Capital cost | | | | | | | |
| | ii. Operational and maintenance cost | | | | | | | |
| | iii. Fuel cost | | | | | | | |
| 2. Rate of return considerations by financiers/ investors | | | | | | | | |
| 3. Average annual capacity factor for solar for the country | | | | | | | | |
| 4. Technical characteristics of the renewable energy technology in the market | i. Capacity of the technology | | | | | | | |
| | ii. Load characteristics | | | | | | | |
| | iii. Operational lifetime of the technology | | | | | | | |
| Responsible Person | | | | | | | | |
| Designation | | | | | | | | |
| Date | | | | | | | | |
| Only for the use of the Energy sector GHGI MRV section | | | | | | | | |

## Procedure for Data Collection at Tertiary Institutions (NUL, LP, etc.) and Technical and Vocational Education and Training (BBCDC, etc.).

**Procedure: P7_eMRV SHS_TI & TVET**

**OVERVIEW**

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at Tertiary Institutions (NUL, LP, etc.) and Technical and Vocational Education and Training (BBCDC, etc.). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal points at TI & TVET shall;

2. Enter the following information annually into the specific data-collecting logbook at the TI & TVET.

*Table 1.8: Data collection template to be filled at TI & TVET*

| Data collection template to be used by TI & TVET | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| 1. Detail about the improvement of technologies that will be used in power plants that will affect the EF | | | | | | | |
| 2. Average annual capacity factor for solar for the country | | | | | | | |
| 3. Technical characteristics of the renewable energy technology in the market | i. Capacity of the technology | | | | | | |
| | ii. Load characteristics | | | | | | |
| | iii. Operational lifetime of the technology | | | | | | |
| Responsible Person | | | | | | | |
| Designation | | | | | | | |
| Date | | | | | | | |
| Only for the use of the Energy sector GHGI MRV section | | | | | | | |

## Procedure for Data Collection at the Bureau of Statistics (BoS)

**Procedure: P8_eMRV SHS_BoS**

# OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and data entry process at the Bureau of Statistics (BoS). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at BoS shall;

3. Enter the following information annually into the specific data-collecting logbook at the BoS.

*Table 1.10: Data collection template to be filled at BoS*

| Data collection template to be used by BoS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| Population per year | | | | | | | |
| GDP per year | | | | | | | |
| Responsible Person | | | | | | | |
| Designation | | | | | | | |
| Date | | | | | | | |
| Only for the use of the Energy sector GHGI MRV section | | | | | | | |

# Procedure for Data Collection at Energy Sector NDC Unit under the Ministry of Energy and Meteorology (MEM)

## Procedure: P9_eMRV SHS_NDC unit_MEM

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and data entry process at the Energy Sector NDC Unit under the Ministry of Energy and Meteorology (MEM). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

### Annual Activities

The responsible person at NDC unit MEM shall;

1. Gather the following default factor information annually from the specified institutions or their latest published documents.

*Table 1.11: Data collection template to be filled at NDC unit MEM*

| Data collection template to be used by NDC unit MEM | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | D | D | M | M | Y | Y | |
| | | | | | | | |
| Data and inputs from the Lesotho Renewable Energy Based Rural Electrification (LREBRE) project | From GEF, IEA and UNDP | | | | | | |
| Project financing | From GEF | | | | | | |
| Alternative parameters due to methodological change – Default EF for Kerosene | From IPCC | | | | | | |
| Technology-specific EF | From IPCC, IEA and ICAT | | | | | | |
| CO2 EF for power plants | From IEA and ICAT | | | | | | |
| Responsible Person | | | | | | | |
| Designation | | | | | | | |
| Date | | | | | | | |
| Only for the use of the Energy sector GHGI MRV section | | | | | | | |

# 1. MORE EFFICIENT GASOLINE CARS

## Procedure for Data Collection at the Department of Traffic and Transport (DTT)

## Procedure: P10_eMRV TRANSPORT_DTT

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Department of Traffic and Transport (DTT). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at DTT shall;

2. Enter the following information annually into the specific data-collecting logbook at the DTT.

*Table 2.1 Data collection template for specific fuel consumption at DTT*

| Data collection template to be used by DTT | | | |
|---|---|---|---|
| **Date** | | | |
| | | | |
| Year | Car number & Type (conventional or efficient) | Type of Fuel | Specific fuel consumption (litres/100km) |
| … | | | |
| … | | | |
| … | | | |
| … | | | |
| …… | | | |
| | | Responsible Person | |
| | | Designation | |
| | | Date | |
| Only for the use of the Transport sector GHGI MRV section | | | |
| Respective sub-sector | | Road Transport | |

*Table 2.2 Data collection template for vehicle population at DTT*

| DATA COLLECTING TEMPLATE TO BE USED AT DTT | | |
|---|---|---|
| **Date** | | |
| | | |
| Year | Number of vehicles (conventional gasoline cars) | Number of vehicles (efficient gasoline cars) |
| … | | |
| … | | |
| … | | |
| … | | |
| …… | | |
| | Responsible Person | |
| | Designation | |
| | Date | |
| Only for the use of the Transport sector GHGI MRV section | | |
| Respective sub-sector | Road Transport | |

*Table 2.3 Data collection template for annual new vehicle sale at DTT*

| DATA COLLECTING TEMPLATE TO BE USED AT DTT | | | | |
|---|---|---|---|---|
| **Date** | | | | |
| | | | | |
| | Conventional gasoline cars | | Efficient gasoline cars | |
| Year | Annual new vehicle sales | Market share (%) | Annual new vehicle sales | Market share (%) |
| … | | | | |
| … | | | | |
| … | | | | |
| …… | | | | |
| | | Responsible Person | | |
| | | Designation | | |
| | | Date | | |
| Only for the use of the Transport sector GHGI MRV section | | | | |
| Respective sub-sector | | Road Transport | | |

*Table 2.4 Data collection template for annual distance travelled at DTT*

| DATA COLLECTING TEMPLATE TO BE USED AT DTT | | | | |
|---|---|---|---|---|
| **Date** | | | | |
| | | | | |
| | Conventional gasoline cars | | Efficient gasoline cars | |
| Year | Total vehicle kilometres travelled (km) | Average annual km per car | Total vehicle kilometres travelled (km) | Average annual km per car |
| … | | | | |
| … | | | | |
| … | | | | |
| …… | | | | |
| | | Responsible Person | | |
| | | Designation | | |
| | | Date | | |
| Only for the use of the Transport sector GHGI MRV section | | | | |
| Respective sub-sector | | | Road Transport | |

# Procedure for Data Collection at Revenue Services Lesotho (RSL)

## Procedure: P11_eMRV TRANSPORT_RSL

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and data entry process at Revenue Services Lesotho (RSL). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at RSL shall;

1. Enter the following information annually into the specific data-collecting logbook at the RSL.

*Table 2.5: Data collection template for average annual rebate at RSL*

| Data collection template to be used by RSL | | |
|---|---|---|
| **Date** | | |
| | | |
| Year | Type of car | Annual average rebate (VAT) |
| … | | |
| … | | |
| | | |
| … | | |
| …… | | |
| | Responsible Person | |
| | Designation | |
| | Date | |
| Only for the use of the Transport sector GHGI MRV section | | |
| Respective sub-sector | | Road Transport |

# Procedure for Data Collection at the Ministry of Energy and Meteorology (MEM)

## Procedure: P12_eMRV TRANSPORT_MEM

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and entry process at the Ministry of Energy and Meteorology. It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The MRV focal point at MEM shall;

1. Enter the following information annually into the specific data-collecting logbook at the MEM.

*Table 2.6: Data collection template for Grid Emission Factor at MEM*

| Data collection template to be used by MEM | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | | | | | | | | | |
| | | | | | | | | | |
| Grid Emission Factor | | | | | | | | | |
| | | | | | | | | Responsible Person | |
| | | | | | | | | Designation | |
| | | | | | | | | Date | |
| Only for the use of the Transport sector GHGI MRV section | | | | | | | | | |
| Respective sub-sector | | | | | | | | Road Transport | |

# Procedure for Data Collection at NDC unit under the Ministry of Public Works and Transport (MPWT)

## Procedure: P13_eMRV TRANSPORT_NDC unit_MPWT

## Approved by:

## OVERVIEW

This procedure outlines the roles and responsibilities of the personnel involved in the data collection and data entry process at the NDC unit under the Ministry of Public Works and Transport (MPWT). It shall serve as a manual describing in detail the activities to be carried out to ensure comprehensive and accurate monitoring, reporting, and verification (MRV) of the Greenhouse Gas Inventory.

**Annual Activities**

The responsible person at NDC unit MPWT shall;

1. Gather the following default factors and information annually from the specified institutions or their latest published documents.

*Table 2.7: Data collection template for average vehicle km per year at NDC unit MPWT*

| DATA COLLECTING TEMPLATE TO BE USED AT NDC UNIT MPWT | | |
|---|---|---|
| **Date** | | |
| | | |
| Density of fuel type gasoline | From IPCC | |
| The net calorific value of gasoline | From IPCC | |
| Emission factor for gasoline | From IPCC | |
| Default value for elasticity beta | From ICAT | |
| Average retail price of cars | From the Vehicle retailer's website | |
| Responsible Person | | |
| Designation | | |
| Date | | |
| Only for the use of the Transport sector GHGI MRV section | | |
| Respective sub-sector | Road Transport | |

# ANNEX 02- PROTOCOL

## 1. MONITORING, REPORTING AND VERIFICATION PROTOCOL – Solar Home Systems (NDC 6)

**OVERVIEW**

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the Organisational structure, the primary responsibilities of the personnel involved in monitoring and the QA/QC process.

### Introduction

**Mitigation action** - The proposed mitigation action involves the Introduction of tax incentive policies to increase renewable energy consumption. In here, Solar home systems (SHS) are specifically focusing as the renewable energy technology. Currently the project Lesotho Renewable Energy Based Rural Electrification (LREBRE) has installed SHSs in 3 districts of Lesotho. But this project has been unsuccessful due to shortcomings from bad technical quality of installed solar household systems and excessive subsidizing(Pogoda, 2021). Significantly, the financial burden on residents will be alleviated as tax incentives make SHSs more affordable and cost-effective. This, in turn, not only ensures cost savings for individual households but also contributes to a reduction in overall carbon emissions, aligning with global climate goals. Therefore, after introducing this mitigation action residents will receive tax incentives to upgrade and to install SHSs.

### Monitoring plan

P1_eMRV SHS_DoE, P2_eMRV SHS_RSL, P3_eMRV SHS_LEC, P4_eMRV SHS_LEGCO, P5_eMRV SHS_LEWA, P6_eMRV SHS_ LESES/Installers, P7_eMRV SHS_ TI & TVET, P8_eMRV SHS_BoS and P9_eMRV SHS_NDC unit_MEM procedures are applied to monitor and report the relevant parameters.


*Figure 1.1 Monitoring plan for MA 2*

Source: Own work of author, 2024

## Monitoring methodology

Relevant equations and methodologies are described below.

***Energy addition of renewable energy policy***

1. Estimate the technical potential for the assessment period.

*Note: If the amount of renewable energy output obtained by full implementation of demonstrated technologies or practices for the entire assessment period is not available, the following methodologies will be applied to calculate it*

Methodology 1: Policy without cap set for the entire assessment period.

*Table 1.1: Parameters to estimate technical potential for the assessment period-methodology 1*

| Parameter description | Unit |
|---|---|
| Total solar panel area | $m^2$ |
| Solar panel yield or efficiency | % |
| Annual average solar radiation on tilted panels (shadings not included) | $kW/m^2$ |
| Performance ratio, coefficient for losses | N/A |

Or

*Table 1.2: Parameters to estimate technical potential for the assessment period-methodology 1 (alternative)*

| Parameter description | Unit |
|---|---|
| System size (kW, DC) | kW |
| Module type (std, medium, thin film | N/A |
| System losses | % |
| Array type (fixed open rack, fixed roof mount, 1-axis, backtracked 1-axis, 2-axis) | N/A |
| Tilt angle | $^0$ (degrees) |
| Azimuth angle | $^0$ (degrees) |
| DC/ AC ratio (optional) | N/A |
| Inverter efficiency | % |

Methodology 2: Policy with a cap set for a portion of the assessment period

*Table 1.3: Parameters to estimate technical potential for the assessment period-methodology 2*

| Parameter description | Unit |
|---|---|
| Period covered by policy cap | Years |
| Available policy cap for the assessment period | MW |

***Account for the effect on the financial feasibility of renewable energy technologies***

1. Evaluate the financial feasibility of renewable energy technologies (Only applicable for electricity generated by RE technologies will usually be fed directly into the grid).

*Equation 1.1: Levelized cost of electricity generation*

$$LCOE = \frac{\sum_{t=1}^{n} = \frac{I_t + M_t + F_t}{(1+d)^t}}{\sum_{t=1}^{n} = \frac{E_t}{(1+d)^t}}$$

*Table 1.4: Parameters to evaluate financial feasibility of RE technologies (Only applicable for electricity generated by RE technologies will usually be fed directly into the grid)*

| Parameter | Description | Unit |
|---|---|---|
| $r_e$ | Cost of equity (expected return on equity) | Dimensionless |
| $W_e$ | Percentage of financing that is equity | Dimensionless |
| $r_d$ | Cost of debt | Dimensionless |
| $W_d$ | Percentage of financing that is debt | Dimensionless |
| $T_c$ | Corporate tax rate | Dimensionless |
| Parameter | Description | Unit |
| LCOE | The average lifetime levelized cost of electricity generation | USD/kWh |
| $M_t$ | Operational and maintenance costs in year t | USD |
| $F_t$ | Fuel costs in year t | USD |
| $E_t$ | Electricity generation in year t | kWh |
| D | Discount rate (or weighted average cost of capital) | % |
| N | Economic lifetime of the system | Years |
| $P_t$ | Power generation capacity of the system | kW |
| $CF_t$ | Capacity factor in year t | Dimensionless |

*Equation 1.2: Equation for weighted average cost of capital for renewable energy sources*

$$WACC = r_e * W_e + r_d * W_d * (1-T_c)$$

*Table 1.5: Parameters to calculate weighted average cost of capital for RE sources*

2. Evaluate the financial feasibility of renewable energy technologies (Only applicable for electricity generated by RE technologies will not be fed into the grid)

*Equation 1.3: Equation for financial feasibility assessment*

For residential customer's own consumption (ideally with net metering in place) Comparison of production costs + financial support with end-consumer prices.

### *Baseline emissions*

1. Project future electricity generation

*Equation 1.4: Equation for total electricity generation*

$$\text{Total electricity generation} = [\text{total electricity demand}_i\ (\text{MWh})]/\ [1\text{-transmission and distribution loss}\ (\%) - \text{own use}\ (\%)]$$

*Table 1.6: Parameters to calculate total electricity generation*

| Parameter description | Unit |
|---|---|
| Total electricity demand | MWh |
| Transmission and distribution loss | % |
| Power plants' own use of electricity | % |

2. Technology-specific emission factors

*Equation 1.5: Equation of the emission factor of an electricity generation technology in a certain year*

$$EF_i^t\ [tCO_2/\ MWh] = TE\_EG_i^t\ [tCO_2]/\ EG_i^t\ [MWh]$$

*Table 1.7: Parameters to calculate technology specific emission factors*

| Parameter | Description | Unit |
|---|---|---|

| | | |
|---|---|---|
| EF | The emission factor of an electricity generation technology in a certain year | $tCO_2$/ MWh |
| TE_EG | The total emissions from electricity generation of a technology | $tCO_2$ |
| EG | The electricity generation | MWh |
| I | The fossil fuel used for electricity generation (i.e. coal, lignite, gas, oil) | N/A |

3. Calculate grid emission factor (For grid emission factor approach)

*Equation 1.6: Equation for Operating margin emission factor*

$$EF_{EL,m,y} = [\sum_i FC_{i,m,y} * NCV_{i,y} * EF_{co2,i,y}] / EG_{m,y}$$

*Table 1.8: Parameters to calculate operating margin emission factor*

| Parameter | Description | Unit |
|---|---|---|
| $EF_{EL,m,y}$ | The CO2 emission factor of power unit m in year y | $tCO_2$/ MW |
| $FC_{i,m,y}$ | Amount of fuel type i consumed by power unit m in year y | Kg/ $m^3$ |
| $NCV_{i,y}$ | Net calorific value (energy content) of fuel type i in year y | GJ/kg or $m^3$ |
| $EF_{CO2,i,y}$ | The CO2 emission factor of fuel type i in year y | $tCO_2$/ GJ |
| $EG_{m,y}$ | Net quantity of electricity generated and delivered to the grid by power unit m in year y | MWh |
| M | All power units serving the grid in year y except low-cost/must-run power units | N/A |
| I | All fuel types combusted in power unit m in year y | N/A |

*Equation 1.7: Equation for Build margin emission factor*

$$EF_{grid,BM,y} = [\sum_m EG_{m,y} * EF_{EL,m,y}] / [\sum_m EG_{m,y}]$$

*Table 1.9: Parameters to calculate build margin emission factor*

| Parameter | Description | Unit |
|---|---|---|
| $EF_{grid,BM,y}$ | Build margin CO2 emission factor in year y | $tCO_2$/ MWh |
| $EG_{m,y}$ | Net quantity of electricity generated and delivered to the grid by power unit m in year y | MWh |
| $EF_{EL,m,y}$ | The CO2 emission factor of power unit m in year y | $tCO_2$/ MWh |
| M | Power units included in the build margin | N/A |

| | | |
|---|---|---|
| Y | The most recent historical year for which electricity generation data is available | N/A |

## Parameter and procedure

*Table 1.10: Parameters and procedures for MA 2*

| Parameter description | Instrument/ method | Applied for (baseline, project) | Procedure |
|---|---|---|---|
| Detail about the improvement of technologies that will be used in power plants that will affect the EF | National calculated data/ measure | Project | P1_eMRV SHS_DoE P7_eMRV SHS_ TI & TVET |
| Parameters due to methodological change – Energy demand per capita or household | National calculated data/ measure | Baseline | P1_eMRV SHS_DoE |
| Parameters due to methodological change – Population that lacks access to electricity and relies on kerosene for their daily energy needs | National calculated data/ measure | Baseline | P1_eMRV SHS_DoE |
| Corporate tax rate | Calculated national value | Baseline | P2_eMRV SHS_RSL |
| Transmission and distribution loss | National calculated data/ measure/ default | Baseline | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO |
| Projected shares of different technologies for the baseline scenario based on the historical trends, future fluctuation of technologies and other factors | National calculated data | Baseline | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO |
| Current electricity demand per capita | National calculated data | Baseline | P5_eMRV SHS_LEWA |
| Future electricity demand | National calculated data | Baseline | P5_eMRV SHS_LEWA |

| | | | |
|---|---|---|---|
| Current electricity mix (most recent) | National calculated data/ measure | Baseline & Project | P1_eMRV SHS_DoE<br>P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| Shares of different technologies from the most recent year | National calculated data/ measure | Baseline & Project | P1_eMRV SHS_DoE<br>P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| Annual electricity mix | National calculated data/ measure | Baseline & Project | P1_eMRV SHS_DoE |
| Total electricity demand | National calculated data/ measure | Baseline & Project | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| Own use of electricity | National calculated data/ measure | Baseline & Project | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| The total emissions from electricity generation of a technology | Calculated data/ measure | Baseline & Project | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| The electricity generation | Calculated data/ measure | Baseline & Project | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| Population per year | National data | Baseline & Project | P8_eMRV SHS_BoS |
| GDP per year | National data | Baseline & Project | P8_eMRV SHS_BoS |
| Alternative parameters due to methodological change –<br><br>Default EF for Kerosene | IPCC default | Baseline & Project | P9_eMRV SHS_NDC unit_MEM |
| Technology-specific EF | IPCC, IEA and ICAT default | Baseline & Project | P9_eMRV SHS_NDC unit_MEM |
| CO2 EF for power plants | IEA and ICAT default | Baseline & Project | P9_eMRV SHS_NDC unit_MEM |
| Annual installed RE capacity | National calculated data/ measure | Project | P1_eMRV SHS_DoE |
| Annual net electricity supplied to the electricity grid from RE (If applicable) | National calculated data/ measure | Project | P1_eMRV SHS_DoE |
| Annual renewable energy addition by | National calculated data/ measure | Project | P1_eMRV SHS_DoE |

| | | | |
|---|---|---|---|
| implementing the project | | | |
| Annual average operation days per year for SHS | National calculated data/ measure | Project | P1_eMRV SHS_DoE |
| Data and inputs from the Lesotho Renewable Energy Based Rural Electrification (LREBRE) project | Calculated data/ measure | Project | P1_eMRV SHS_DoE P9_eMRV SHS_NDC unit_MEM |
| Projected shares of different technologies for the project scenario based on the historical trends, future fluctuation of technologies, other factors and also considering the generation from solar project potential | National calculated data | Project | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO |
| Average annual capacity factor for solar for the country | Calculated data/ measure/defaul t | Project | P5_eMRV SHS_LEWA P7_eMRV SHS_ TI & TVET |
| Amount of renewable energy output obtainable by full implementation of demonstrated technologies or practices for the entire assessment period (MW) – Technical potential of the policy | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Period covered by policy cap | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Available policy cap for the assessment period | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Project financing related to the policy | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE P9_eMRV SHS_NDC unit_MEM |

| | | | |
|---|---|---|---|
| Availability of taxes such as energy tax or carbon tax within the period that influence | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE<br>P2_eMRV SHS_RSL |
| Availability of emissions trading programmes within the period that influence | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of energy regulations, such as mandatory closing of inefficient plants and quotas for fuel within the period that influence | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of subsidies, such as fossil fuel subsidies or direct and indirect electricity subsidies within the period that influence | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Identify technical barriers available. | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of regulatory and policy uncertainty | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of institutional and administrative barriers | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of market barriers | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of financial or budgetary barriers | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Availability of infrastructure barriers | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Lack of RE and skilled personnel | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Lack of public acceptance and environmental | National data | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |

| | | | |
|---|---|---|---|
| Total solar panel area | Measure | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Solar panel yield or efficiency | Measure | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Annual average solar radiation on tilted panels (shadings not included) | Measure | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Performance ratio, coefficient for losses | Default value | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| System size (kW, DC) | Default value | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Module type (std, medium, thin film | Default | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| System losses | Default | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Array type (fixed open rack, fixed roof mount, 1-axis, backtracked 1-axis, 2-axis) | Default | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Tilt angle | Measure/ default value | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Azimuth angle | Measure/ default value | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| DC/ AC ratio (optional) | Measure/ default value | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Inverter efficiency | Default | Renewable energy addition - For the project scenario | P1_eMRV SHS_DoE |
| Type of tax incentives | National data | Renewable energy addition - For the project scenario | P2_eMRV SHS_RSL |

| | | | |
|---|---|---|---|
| Scope of application of the tax | National data | Renewable energy addition - For the project scenario | P2_eMRV SHS_RSL |
| Cost related to the renewable energy technology in the market | National data | Renewable energy addition - For the project scenario | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO<br>P6_eMRV SHS_LESES/Installers |
| Cost related to the alternative technologies (fossil fuel or nuclear power plant) | National data | Renewable energy addition - For the project scenario | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| Technical characteristics of the renewable energy technology in the market | National data | Renewable energy addition - For the project scenario | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO<br>P6_eMRV SHS_LESES/Installers<br>P7_eMRV SHS_ TI & TVET |
| Technical characteristics of the alternative technologies (fossil fuel or nuclear power plant) in the market | National data | Renewable energy addition - For the project scenario | P3_eMRV SHS_LEC<br>P4_eMRV SHS_LEGCO |
| Electricity consumption by residential customers for their own consumption | Calculated data/ measure | Renewable energy addition - For the project scenario | P5_eMRV SHS_LEWA |
| Electricity consumption by Industrial generation for their own consumption | Calculated data/ measure | Renewable energy addition - For the project scenario | P5_eMRV SHS_LEWA |
| Electricity prices in the market | National data | Renewable energy addition - For the project scenario | P5_eMRV SHS_LEWA |
| Variations in the renewable energy source potential | National data | Renewable energy addition - For the project scenario | P5_eMRV SHS_LEWA |
| Rate of return considerations by financiers/ investors | Calculated data | Renewable energy addition - For the project scenario | P5_eMRV SHS_LEWA |

## Organisation structure and MRV specific responsibilities

*Table 1.11: Organisation structure and MRV specific responsibilities for MA 2*

| Parameter description | Tasks | Responsible staff | Procedure | Comments |
|---|---|---|---|---|
| Detail about the improvement of technologies that will be used in power plants that will affect the EF | Collect national calculated data/ measure and keep records | MRV focal at DoE and TI & TVET | P1_eMRV SHS_DoE P7_eMRV SHS_ TI & TVET | |
| Parameters due to methodological change – Energy demand per capita or household | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Parameters due to methodological change –<br><br>Population that lacks access to electricity and relies on kerosene for their daily energy needs | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Corporate tax rate | Calculated national value and keep records | MRV focal at RSL | P2_eMRV SHS_RSL | |
| Transmission and distribution loss | Collect national calculated data/ measure and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Projected shares of different technologies for the baseline scenario based on the historical trends, future fluctuation of technologies and other factors | Collect national calculated data/ measure and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Current electricity demand per capita | Collect national calculated data/ measure and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |
| Future electricity demand | Collect national calculated data/ measure and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |

| | | | | |
|---|---|---|---|---|
| Current electricity mix (most recent) | Collect national calculated data/ measure and keep records | MRV focal at DoE, LEC and LEGCO | P1_eMRV SHS_DoE P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Shares of different technologies from the most recent year | Collect national calculated data/ measure and keep records | MRV focal at DoE, LEC and LEGCO | P1_eMRV SHS_DoE P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Annual electricity mix | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Total electricity demand | Collect national calculated data/ measure and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Own use of electricity | Collect national calculated data/ measure and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| The total emissions from electricity generation of a technology | Collect national calculated data/ measure and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| The electricity generation | Collect national calculated data/ measure and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Population per year | Collect national data and keep records | MRV focal at BoS | P8_eMRV SHS_BoS | |
| GDP per year | Collect national data and keep records | MRV focal at BoS | P8_eMRV SHS_BoS | |
| Alternative parameters due to methodological change –<br><br>Default EF for Kerosene | Collect IPCC default and keep records | MRV focal at NDC unit MEM | P9_eMRV SHS_NDC unit_MEM | |
| Technology-specific EF | Collect IPCC, IEA and ICAT default | MRV focal at NDC unit MEM | P9_eMRV SHS_NDC unit_MEM | |

| | | | | |
|---|---|---|---|---|
| | and keep records | | | |
| CO2 EF for power plants | Collect IEA and ICAT default and keep records | MRV focal at NDC unit MEM | P9_eMRV SHS_NDC unit_MEM | |
| Annual installed RE capacity | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Annual net electricity supplied to the electricity grid from RE (If applicable) | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Annual renewable energy addition by implementing the project | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Annual average operation days per year for SHS | Collect national calculated data/ measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Data and inputs from the Lesotho Renewable Energy Based Rural Electrification (LREBRE) project | Collect calculated data/ measure and keep records | MRV focal at DoE and NDC unit MEM | P1_eMRV SHS_DoE P9_eMRV SHS_NDC unit_MEM | |
| Projected shares of different technologies for the project scenario based on the historical trends, future fluctuation of technologies, other factors and also considering the generation from solar project potential | Collect national calculated data and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Average annual capacity factor for solar for the country | Collect calculated data/ measure/default and keep records | MRV focal at LEWA and TI & TVET | P5_eMRV SHS_LEWA P7_eMRV SHS_ TI & TVET | |

| | | | | |
|---|---|---|---|---|
| Amount of renewable energy output obtainable by full implementation of demonstrated technologies or practices for the entire assessment period (MW) – Technical potential of the policy | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Period covered by policy cap | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Available policy cap for the assessment period | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Project financing related to the policy | Collect national data and keep records | MRV focal at DoE & NDC unit_MEM | P1_eMRV SHS_DoE P9_eMRV SHS_NDC unit_MEM | |
| Availability of taxes such as energy tax or carbon tax within the period that influence | Collect national data and keep records | MRV focal at DoE & RSL | P1_eMRV SHS_DoE P2_eMRV SHS_RSL | |
| Availability of emissions trading programmes within the period that influence | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Availability of energy regulations, such as mandatory closing of inefficient plants and quotas for fuel within the period that influence | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Availability of subsidies, such as fossil fuel subsidies or direct and indirect electricity subsidies within the period that influence | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Identify technical barriers available. | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Availability of regulatory and policy uncertainty | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |

| | | | | |
|---|---|---|---|---|
| Availability of institutional and administrative barriers | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Availability of market barriers | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Availability of financial or budgetary barriers | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Availability of infrastructure barriers | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Lack of RE and skilled personnel | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Lack of public acceptance and environmental | Collect national data and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Total solar panel area | Measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Solar panel yield or efficiency | Measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Annual average solar radiation on tilted panels (shadings not included) | Measure and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Performance ratio, coefficient for losses | Collect default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| System size (kW, DC) | Collect default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Module type (std, medium, thin film | Collect default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| System losses | Collect default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Array type (fixed open rack, fixed roof mount, 1-axis, backtracked 1-axis, 2-axis) | Collect default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Tilt angle | Measure/ default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |

| | | | | |
|---|---|---|---|---|
| Azimuth angle | Measure/ default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| DC/ AC ratio (optional) | Measure/ default value and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Inverter efficiency | Collect default and keep records | MRV focal at DoE | P1_eMRV SHS_DoE | |
| Type of tax incentives | Collect national data and keep records | MRV focal at RSL | P2_eMRV SHS_RSL | |
| Scope of application of the tax | Collect national data and keep records | MRV focal at RSL | P2_eMRV SHS_RSL | |
| Cost related to the renewable energy technology in the market | Collect national data and keep records | MRV focal at LEC, LEGCO and LESES/Installers | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO P6_eMRV SHS_LESES/ Installers | |
| Cost related to the alternative technologies (fossil fuel or nuclear power plant) | Collect national data and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Technical characteristics of the renewable energy technology in the market | Collect national data and keep records | MRV focal at LEC, LEGCO, LESES/Installers, TI & TVET | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO P6_eMRV SHS_LESES/ Installers P7_eMRV SHS_ TI & TVET | |
| Technical characteristics of the alternative technologies (fossil fuel or nuclear power plant) in the market | Collect national data and keep records | MRV focal at LEC and LEGCO | P3_eMRV SHS_LEC P4_eMRV SHS_LEGCO | |
| Electricity consumption by residential customers for their own consumption | Calculated data/ measure and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |

| | | | | |
|---|---|---|---|---|
| Electricity consumption by Industrial generation for their own consumption | Calculated data/ measure and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |
| Electricity prices in the market | Collect national data and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |
| Variations in the renewable energy source potential | Collect national data and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |
| Rate of return considerations by financiers/ investors | Calculated data and keep records | MRV focal at LEWA | P5_eMRV SHS_LEWA | |

# Proposed Data Management System

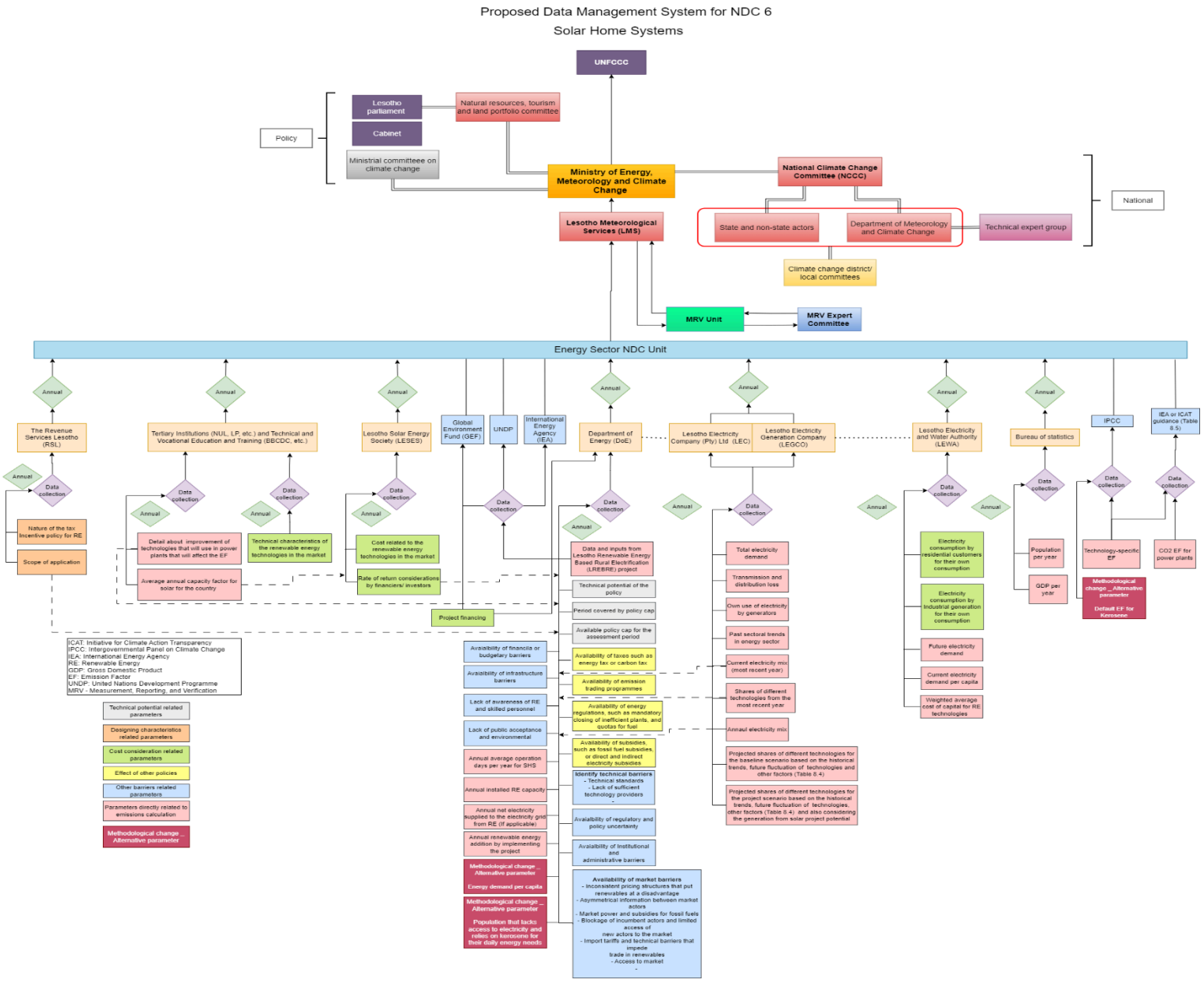



*Figure 1.2 Proposed data management system for MA 2*

Source: Own work of author, 2024

# 3. MONITORING, REPORTING AND VERIFICATION PROTOCOL – More Efficient Gasoline Cars (NDC 7)

**OVERVIEW**

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the Organisational structure, the primary responsibilities of the personnel involved in monitoring and the QA/QC process.

## Introduction

**Mitigation action** - The proposed mitigation action of reducing 5% of VAT for purchasing hybrid vehicles, is properly in line with the "Transport Sector Masterplan 2022". The overall objective of the proposed action is to promote alternative fuel vehicles against conventional gasoline cars. The conventional gasoline and diesel-powered motor vehicles would have dominated in the vehicle market without this proposed mitigation action. Any perceived reduction in tax revenues is going to be offset by the absolute collections and savings to the economy by way reduced petroleum fuel imports.

## Monitoring plan

P10_eMRV TRANSPORT_DTT, P11_eMRV TRANSPORT_RSL, P12_eMRV TRANSPORT_MEM, P13_eMRV TRANSPORT_NDC unit MPWT procedures are applied to monitor and report the relevant parameters.


*Figure 2.1: Monitoring plan MA 1*

Source: Own work of author, 2024

## Monitoring methodology

Relevant equations and methodologies are described below.

*Baseline year vehicle status*

*Table 2.1: Parameters to evaluate baseline year vehicle status*

| Parameter description | | Unit |
|---|---|---|
| Conventional gasoline cars | Number of vehicles | N/A |
| | Average vehicle km per year | km/ year |
| | Specific fuel consumption | l/km |
| Efficient gasoline cars | Number of vehicles | N/A |
| | Average vehicle km per year | km/ year |
| | Specific fuel consumption | l/km |

*Fuel data*

*Table 2.2: Parameters to collect data on fuel*

| Parameter description | | Unit |
|---|---|---|
| Gasoline | Density | Gg/ $m^3$ |
| | Net Calorific value | TJ/ Gg |
| | Emission factor | $tCO_2$/ TJ |

*Passenger km*

*Table 2.3: Parameters to calculate passenger km*

| Parameter description | Unit |
|---|---|
| The average number of persons travelling in the same vehicle | N/A |

*Project Scenario*

*Table 2.4: Parameters for project scenario*

| Parameter description | Unit |
|---|---|
| GDP | USD |
| Average vehicle retail price | USD |
| Average rebate | USD or % |
| Annual new vehicle sales | N/A |
| Per kilometre emissions reductions | $tCO_2eq$ |
| Average annual km per vehicle | km |
| Vehicle lifetime | Years |
| Annual distance travelled | km/ year |

## Parameter and procedure

*Table 2.5: Parameters and procedures for MA 1*

| Parameter description | Instrument / method | Applied for (baseline, project) | Procedure |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Conventional gasoline cars | Number of vehicles | National data | Baseline | P10_eMRV TRANSPORT_DTT |
| | Average vehicle km per year | Calculate the values | Baseline | P10_eMRV TRANSPORT_DTT |
| | Specific fuel consumption | Measure | Baseline | P10_eMRV TRANSPORT_DTT |
| | Market share of cars before the tax | Measure | Project | P10_eMRV TRANSPORT_DTT |
| Efficient gasoline cars | Number of vehicles | National data | Baseline | P10_eMRV TRANSPORT_DTT |
| | Average vehicle km per year | Calculate the value | Baseline | P10_eMRV TRANSPORT_DTT |
| | Specific fuel consumption | Measure | Baseline | P10_eMRV TRANSPORT_DTT |
| | Market share of cars before the tax | Measure | Project | P10_eMRV TRANSPORT_DTT |
| Gasoline | Density | Default value | Baseline | P13_eMRV TRANSPORT_NDC unit_MPWT |
| | Net Calorific value | Default value | Baseline | P13_eMRV TRANSPORT_NDC unit_MPWT |
| | Emission factor | Default value | Baseline | P13_eMRV TRANSPORT_NDC unit_MPWT |
| Average vehicle retail price | | National data | Project | P13_eMRV TRANSPORT_NDC unit_MPWT |
| Average rebate | | National data | Project | P11_eMRV TRANSPORT_RSL |
| Annual new vehicle sales | | National data | Project | P10_eMRV TRANSPORT_DTT |
| Average annual km per vehicle | | Calculate the values | Project | P10_eMRV TRANSPORT_DTT |
| Annual distance travelled | | Calculate the values | Project | P10_eMRV TRANSPORT_DTT |

## Organisation structure and MRV specific responsibilities

*Table 2.6: Organisation structure and MRV specific responsibilities of MA 1*

| Parameter description | | Tasks | Responsible staff | Procedure | Comment |
|---|---|---|---|---|---|
| Conventional gasoline cars | Number of vehicles | Collect national data and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| | Average vehicle km per year | Calculate the values and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| | Specific fuel consumption | Measure and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| | Market share of cars before the tax | Measure and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| Efficient gasoline cars | Number of vehicles | Collect national data and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| | Average vehicle km per year | Calculate the value and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| | Specific fuel consumption | Measure and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| | Market share of cars before the tax | Measure and keep records | MRV focal at DTT | P10_eMRV TRANSPORT_DTT | |
| Gasoline | Density | Collect default value and keep records | MRV focal at NDC unit_MPWT | P13_eMRV TRANSPORT_NDC unit_MPWT | |
| | Net Calorific value | Collect default value and keep records | MRV focal at NDC unit_MPWT | P13_eMRV TRANSPORT_NDC unit_MPWT | |
| | Emission factor | Collect default value and keep records | MRV focal at NDC unit_MPWT | P13_eMRV TRANSPORT_NDC unit_MPWT | |
| Average vehicle retail price | | National data and keep records | MRV focal at NDC unit_MPWT | P13_eMRV TRANSPORT_NDC unit_MPWT | |

| | | | | |
|---|---|---|---|---|
| Average rebate | Collect national data and keep records | MRV focal at RSL | P11_eMRV TRANSPORT _RSL | |
| Annual new vehicle sales | Collect national data and keep records | MRV focal at DTT | P10_eMRV TRANSPORT _DTT | |
| Average annual km per vehicle | Calculate the values and keep records | MRV focal at DTT | P10_eMRV TRANSPORT _DTT | |
| Annual distance travelled | Calculate the values and keep records | MRV focal at DTT | P10_eMRV TRANSPORT _DTT | |

# Proposed Data Management System

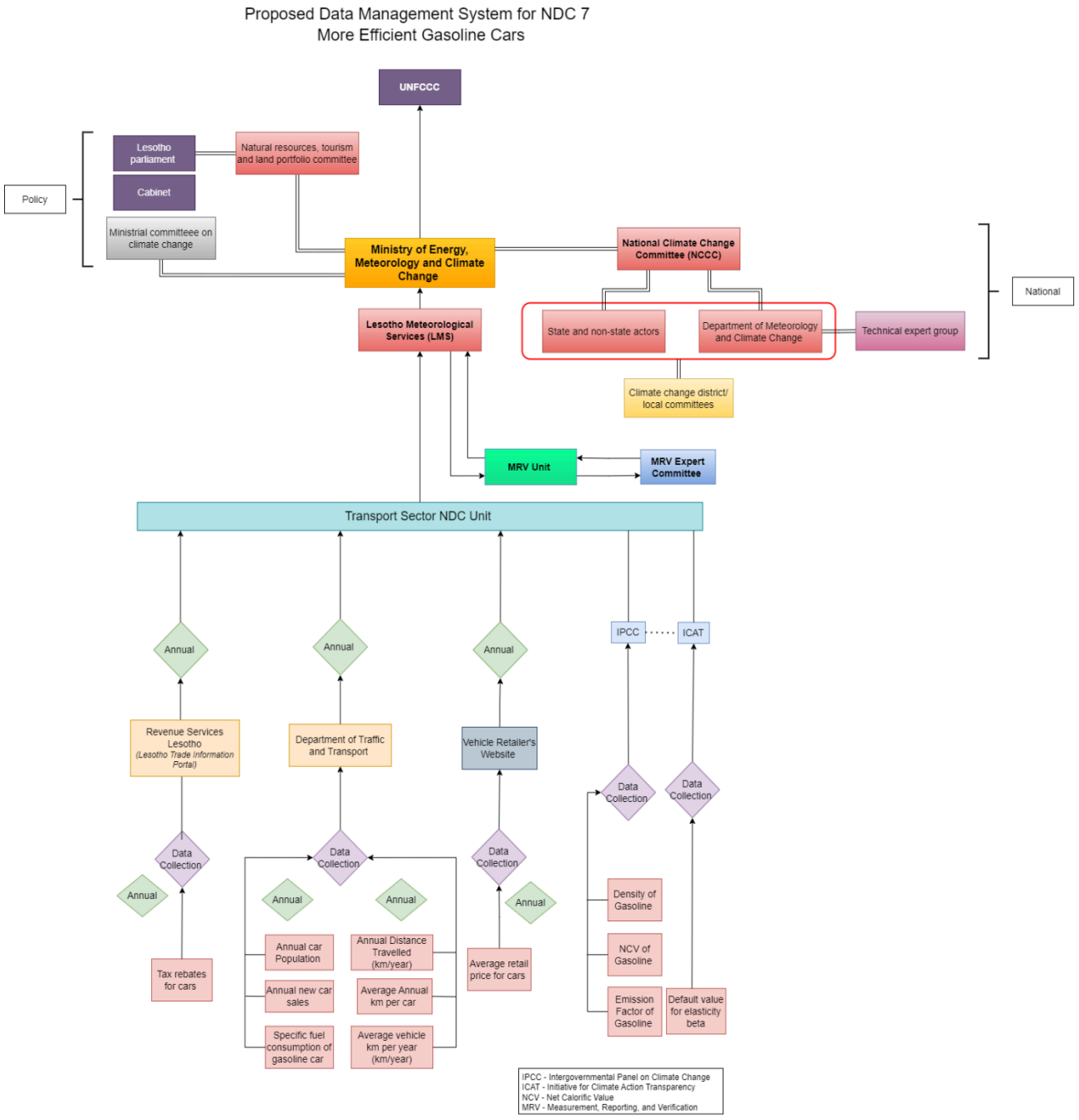



*Figure 2.2: Proposed data management system for MA 1*

Source: Own work of author, 2024