Initiative for Climate Action Transparency - ICAT -

An Assessment of the Sustainable Development Impacts of the Kenya Off Grid Solar Access Program (K-OSAP)

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Deliverable #3

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Date of the deliverable: 23rd September 2019

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Ministry of Environment and Forestry, The Republic of Kenya

PREPARED UNDER

Initiative for Climate Action Transparency (ICAT) project supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the Children´s Investment Fund Foundation (CIFF), the Italian Ministry for Environment, Land and Sea Protection, and ClimateWorks

The ICAT project is hosted by the United Nations Office for Project Services (UNOPS)

AKNOWLEDGEMENT

We would like to acknowledge and express gratitude to all those who contributed to the various discussions and consultations that led to this report.

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Abbreviations

AIDs	-	Acquired Immune Deficiency Syndrome
CBO	-	Community Based Organization
CRA	-	Commission on Revenue Allocation
DALYs	-	Disability-Adjusted Life Years
EPRA	-	Energy and Petroleum Regulatory Authority
ESMF	-	Environmental and Social Management Framework
FAO	-	Food and Agriculture Organization
GDP	-	Gross Domestic Product
GoK	-	Government of Kenya
HIV	-	Human Immunodeficiency Virus
IAP	-	Indoor Air Pollution
ICAT	-	Initiative for Climate Action Transparency
KAM	-	Kenya Association of Manufacturers
KEPSA	-	Kenya Private Sector Alliance
K-OSAP	-	Kenya Off-Grid Solar Access Program
KPLC	-	Kenya Power and Lighting Company
MoE	-	Ministry of Energy
MRV	-	Monitoring, Reporting and Verification
NCCAP	-	National Climate Change Action Plan
NEMA	-	National Environment Management Authority
NGO	-	Non-Governmental Organization
PM	-	Particulate Matter
PPP	-	Public-Private-Partnership
PV	-	Photovoltaics
REREC	-	Rural Electrification and Renewable Energy Corporation
SDG	-	Sustainable Development Goal
SIA	-	Social Impact Assessment
SME	-	Small and Medium Enterprise
UNDP	-	United Nations Development Program
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
UNICEF	-	United Nations International Children's Emergency Fund
WHO	-	World Health Organization
WRI	-	World Resource Institute

Foreword

This report is the fourth deliverable of the project, *Initiative for Climate Action Transparency (ICAT) Support to MRV in the Energy Sector in Kenya*. This report provides a step wise approach of assessing the sustainable development impacts of a policy/action using the ICAT guidance tools. The assessment was based on a pilot case study of the Kenya Off-Grid Solar Access Program (KOSAP).

Through a one-year contract under the ICAT project, ClimateCare, supported Kenya's efforts to establish a domestic MRV system for tracking progress of NDC implementation of the energy and transport sectors in line with the enhanced transparency framework of the Paris Agreement.

CHAPTER 1: GENERAL INFORMATION OF THE ASSESSMENT

The scope of the assessment is to identify the ex-ante sustainable development impacts of Kenya Off Grid Solar Access Program (K-OSAP) currently under implementation in Kenya, which aim to provide underserved rural communities with access to electricity.

The purpose of the assessment is to identify the sustainable development impacts of K-OSAP. The main aim of K-OSAP is to provide access to electricity and water for rural communities in the listed underserved rural communities. The assessment has been conducted by ClimateCare for the Government of Kenya (GoK) as part of a 1-year project entitled 'Initiative for Climate Action Transparency (ICAT) Support to MRV in the Energy Sector in Kenya'. Through the project, ICAT seeks to support Kenya's efforts to establish a domestic Measuring, Reporting and Verification (MRV) system for tracking of progress with NDC implementation in the energy and transport sectors in line with the requirements of the enhanced transparency framework of the Paris Agreement.

Specifically, the project aims to deliver the following results to the GoK and ICAT:

1. The assessment of needs and gap for MRV of the energy and transport sectors in Kenya.
2. Strengthening of the institutional arrangements for MRV in the energy and transport sectors.
3. Development of capacity for data management to track NDC implementation in the energy and transport sectors supported by use of the ICAT Series of Guidance, where relevant.
4. Development of a road map to ensure the sustainability of ICAT outcomes with the support of UNEP-DTU Partnership) and World Resource Institute (WRI).

The assessment used the Initiative for Climate Action Transparency (ICAT) Sustainable Development Guidance tool to assess the environmental, social and economic impacts of the project during its lifetime. Both qualitative and quantitative approaches have been used. Environmental impacts have been quantified while social and economic impacts have been assessed qualitatively. The assessment entails evaluation of both short-term and long-term impacts. A summary of the assessment is provided in Table 1 below:

Table 1: Brief Summary of the K-OSAP Sustainable Development Assessment

Information	Description
Title of the policy or action assessed	Kenya Off-Grid Solar Access Program (K-OSAP)
Person/organization undertaking the assessment	Tom Owino and Lilian Kagume – ClimateCare Limited
Date of Assessment	December 2018- May 2019
Whether the assessment is an update of a previous assessment	Not applicable
Objective of the assessment	To identify the sustainable development impacts of the K-OSAP
Intended Audience of the assessment	Government of Kenya Ministry of Energy Ministry of Environment and Forestry The National Treasury of Kenya Rural Electrification and Renewable Energy Corporation (REREC) Kenya Power The World Bank; International Bank for Reconstruction and Development (IBRD) Private sector actors from the power sector National Environment Management Authority (NEMA)
Whether the assessment consists of a qualitative and/or quantitative impact assessment and tracking progress of indicators over time	Qualitative and quantitative impact assessment done. Tracking the progress of indicators over time is not a component of this assessment
Opportunities for stakeholders to participate in the assessment	Key stakeholders were identified using the ICAT stakeholder tool. The stakeholders were interviewed individually followed by a stakeholder's validation workshop which was held on 28th August 2019 in Nairobi. The consultations can be classified as a low level of stakeholder's engagement. The feedback achieved from the consultations were used to identify relevant impact categories and specific impacts included in the assessment.

CHAPTER 2: PROGRAM/POLICY DESCRIPTION

2.0 The Program

The Kenya Off Grid Solar Access Program (KOSAP) involves increasing access to electricity and water supply services in a number of underserved counties in Kenya through the introduction of the following technologies:

1. Solar PV mini-grids for community facilities, enterprises, and households.
2. Standalone solar systems for community facilities.
3. Solar water pumps for community facilities.
4. Stand-alone solar home systems for households in Kenya.

The project is a Public-Private-Partnership (PPP) and its implementation largely involves the GoK through the Ministry of Energy (MoE), Rural Electrification Authority (REA), Kenya Power (KP) and County Governments in the targeted areas. The K-OSAP directly aims at supporting the use of solar technology to drive electrification of households, enterprises, and community facilities.

The project will be implemented in 14 underserved counties which have been identified as “marginalised areas” by the Commission on Revenue Allocation (CRA). These include:

1. Garissa
2. Narok
3. Isiolo
4. Samburu
5. Kilifi
6. Taita Taveta
7. Kwale
8. Tana River
9. Lamu
10. Turkana
11. Mandera
12. Wajir
13. Marsabit
14. West Pokot.

These counties collectively represent about 72% of the country’s total land area and 20% of the country’s population and are currently not connected to the grid. The areas are geographically dispersed hence the need for introduction of individual solar home systems to address the challenge. These counties are also characterised by

infrastructural deficits, including lack of access to roads, electricity, water and social services. Their population is highly dispersed, at a density four times lower than the national average. There is also significant insecurity in certain areas, giving rise to substantial numbers of displaced persons and livelihood adaptations that further undermine economic prosperity. The 14 counties are as indicated in Figure 1 below.

Target Counties for KOSAP programme

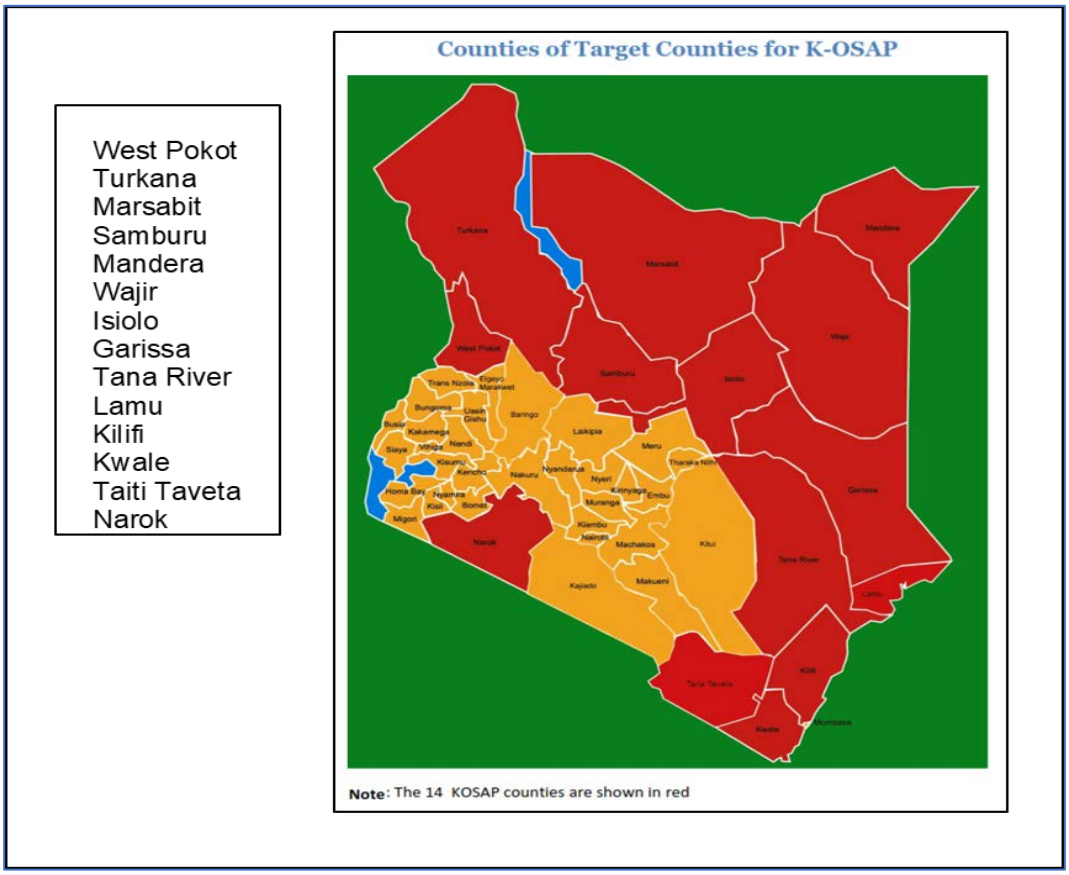


Figure 1: Map Showing the 14 targeted counties for K-OSAP (Adapted from Commission on Revenue Allocation (www.crakenya.org)

The key beneficiaries of the project will receive modern and climate-friendly infrastructure services such as electricity, improved water, and cooking solutions replacing consumption of alternative fuels and unimproved options. These include both households, public and community institutions, enterprises and community facilities and consist primarily of the relatively cash-poor, remote, indigenous, and pastoralist population.

2.1 Objective of the Program

The key objective of K-OSAP is to increase access to modern energy services in the 14 underserved counties of Kenya.

The project is aligned with the Country Partnership Strategy whose goal is to promote the sustainable reduction in poverty and increase in shared prosperity. The policy is also in line with Kenya's Vision 2030 and its Medium-Term Plan. The GoK has developed the Kenya Vision 2030 as the country's new development blueprint. The vision aims at transforming Kenya into a newly industrializing, middle-income country providing a high quality of life to all its

citizens by the year 2030 and has identified provision of energy as the key to meet its goals. Aligned to this strategy document, Kenya has implemented the Energy Policy 2004, targeting to reach 40% electricity connectivity of the rural population by 2020, and has subscribed the UN Sustainable Energy for All Initiative.

The Medium-Term Plan highlights three domains of engagement including:

1. Competitiveness and sustainability.
2. Protection and potential human resource development for shared prosperity.
3. Consistency and equity.

Additionally, the policy action seeks to contribute towards the broader country's objectives as outlined in the Kenya SDG Agenda of transforming the following six sectors (Ministry of Devolution and Planning of Kenya, 2017):

1. Education and training
2. Health including HIV and AIDS
3. Water and sanitation
4. Environment
5. Housing and urbanisation
6. Gender, youth and vulnerable groups

The policy is also aligned to the key four outlined areas of development (Big Four agenda) which include food security, affordable housing, manufacturing, and affordable healthcare for all. The program was officially launched in July 2019 and its implementation is expected to provide electricity services to approximately 277,000 households (close to 1.3 million people), 1,097 community facilities, and 380 boreholes. Additionally, 150,000 efficient cookstoves will be sold and installed within the target counties.

Table 2: Brief Description of the Policy Action

Information	Description
Title of the policy or action	The Kenya Off-Grid Solar Access Program (KOSAP)
Type of policy or action	Introduction of new technologies
Description of specific interventions	Standalone solar systems for community facilities ("stand-alone systems"), Solar water pumps for community facilities ("water pumps") and Stand-alone solar home systems for households ("household systems")
Status of the policy	Under implementation
Date of implementation	2019
Date of completion (if applicable)	2024
Implementing entity or entities	Rural Electrification and Renewable Energy Corporation (REREC) Kenya Power and Lighting Company Limited (Kenya Power) Ministry of Energy International Bank for Reconstruction and Development (IBRD) Private Sector The National Treasury of Kenya

Objectives and intended impacts or benefits of the policy or actions	The objective and the intended benefits of the project is to increase access to electricity services in 14 underserved counties in Kenya
Level of the policy or action	Project level
Geographic coverage	14 counties outlined in table 1
Sectors targeted	Energy sector
Other related policies or actions	The GoK targets to increase energy access by 2030[1]

Table 3: Additional Information on the Assessment of the Policy/Action

Information	Assessment Information
Relevant SDGs	The policy shall contribute to the following SDGs: SDG 1 - No poverty SDG 2 - Zero hunger SDG 3 - Good health and well-being SDG 4 - Quality education SDG 5 - Gender equality SDG 6 - Clean water and sanitation SDG 7 - Affordable and clean energy SDG 8 - Decent work and economic growth SDG 9 - Industry, Innovation and Infrastructure SDG 10 - Reduced inequalities SDG 11 - Sustainable Cities and Communities SDG 12 - Responsible consumption and production SDG 13 –-Climate Action Goal 15 - Life on Land
Specific intended targets, such as intended level of indicators	The policy aims to provide electricity to approximately 250,000 households, install 1,030 Standalone solar systems for community facilities ("stand-alone systems"), 620 Solar water pumps for community facilities ("water pumps") and 250,000 and Stand-alone solar home systems for households ("household systems"). Additionally, 150,000 efficient cook stoves will be sold and installed within the target counties. The policy will lead to increased electricity access to households and businesses, resulting to increased economic development, access to clean water and affordable health care.
Title of establishing legislation, regulations, or other founding documents.	National Climate Change Action Plan (NCCAP) 2018-2022
Monitoring, reporting and Verification procedures	K-OSAP/Project Implementation Unit (PIU)
Enforcement Mechanisms	N/A
Reference to relevant mechanisms	World bank website: http://projects.worldbank.org/P160009?lang=en Kenya power website: http://www.kplc.co.ke/content/item/1943 Ministry of energy website: http://energy.go.ke/?page_id=7185

[1] http://vision2030.go.ke/project/connection-of-new-customers/

	Rural Electrification and Renewable Energy Corporation (REREC)
The broader context or significance of the policy or action	The project intends to increase electricity access to the 14 underserved counties which comprise of 72% of Kenya's total land area with about 20% of the county's population. This is in line with the government's vision 2030 where Energy is identified as one of the key sectors that will promote economic growth.
Key Stakeholders	Ministry of Energy Kenya Power and Lighting Company Rural Electrification and Renewable Energy Corporation (REREC) The users (households and institutions) Private sector service providers

CHAPTER 3: ASSESSING IMPACT CATEGORIES AND INDICATORS

3.0 Introduction

This section explains the impact categories resulting from the policy action being assessed. To ensure a relevant and complete assessment of impacts, three aspects of impact categories have been considered:

1. *Significance* - categories significantly affected by the policy action which include both positive and negative impacts.
2. *Relevance* - this covers the relevance for SDGs and priorities, the stakeholders, national objectives, policy objectives.
3. *Comprehensiveness* - this includes both positive and negative assessment of Sustainable Development impacts of the policy.

3.1 Literature Review

An Environmental and Social Management Framework (ESMF) of the project was prepared and was issued with an Environmental Impact Assessment (EIA) licence by the National Environment Management Authority (NEMA). The EIA outlines requirements and conditions to be followed while implementing the project. In addition to the ESMF, the project carried out a Social Impact Assessment and prepared a Social Assessment Report, Resettlement Plan and Indigenous Peoples Plans . These plans are supposed to guide the implementation of the project. During this assessment, a review of these documents was conducted to make the assessment more comprehensive.

The ICAT Sustainable development guidance (2018) was also reviewed to inform the assessment of the environmental, social and economic impacts of the K-OSAP solar PV policy.

It was observed that during the ESIA process, the project conducted extensive consultation with the key stakeholders across all the 14 counties . These consultations were aimed to aid the project design and planning, and the inputs recorded in the ESIA report. The various impacts associated with implementing the policy identified in the ESIA process have been included in this assessment. The specific objectives of the Public Consultation process were:

1. To keep stakeholders informed about the project components at different stages of implementation
2. To address the environmental and social concerns/ impacts, and device mitigation measures taking into account the opinion/ suggestions of the stakeholders
3. To generate and document broad community support for the sub-projects
4. To improve communications among interested parties
5. To establish formal complaint submittal / resolution mechanisms
6. To discuss about K-OSAP project and document its issues, concerns and mitigation measures.

Both positive and negative impacts were identified, and these include:

Positive impacts

1. Money savings as the policy will replace using kerosene lamps which are expensive to operate.
2. Poverty alleviation due to increased economic activities in the area and sourcing of some materials locally.
3. Employment opportunities for the locals during solar installation and maintenance.
4. Electricity connectivity to the areas which are currently not connected to the grid due to their remote nature.
5. Increased access to HIV and AIDs information as the community will have access to information disseminated through radio and TVs.
6. Improved health benefits due to reduced Indoor Air Pollution (IAP), since kerosene lamps emit particles that pollute the air.
7. Benefits to studies as children with access to electricity will have more time to study.
8. Improved security due to well-lit environment.
9. Improved communication though media such as radio, TVs, and mobile phones

Negative impacts

1. Minimal impact on flora and fauna during installation of solar water pumps, construction of mini grids and construction of low voltage distribution lines. Though site clearing might affect the habitats occupied by animals and interfere with breeding sites, the impact is expected to be minimal.
2. Air pollution from vehicle exhaust emissions which could occur during transportation of construction material or exhaust fumes and dust during excavation for construction of the mini grids.
3. Solid waste generation which comprises of rocks, soil, construction waste and domestic waste from construction workers.
4. Noise and vibrations during transportation and installation of equipment.

Mitigation measures for the negative impacts were identified and included in the ESIA report.

3.2 Stakeholders consultations

The participation of stakeholders in policy and activity planning and implementation fosters greater transparency, effectiveness, trust and ambition in climate change. Stakeholder participation contributes to the realisation of the following objectives:

1. Improve design of policies and actions
2. Build understanding, participation and support for policies and actions among key stakeholders
3. Assess stakeholder participation in policy and action design, implementation and assessment
4. Identify, prioritize and improve assessment of sustainable development impacts
5. Identify, prioritize and improve assessment of transformational change impacts

For this ICAT pilot process, stakeholder participation (with reference to the ICAT Stakeholder Participation Guidance; Climate Community & Biodiversity Alliance & VCS, 2017) was applied in the assessment of the Kenya Off-Grid Solar Access Program (KOSAP). The stakeholder participation was aimed at building understanding and support among the stakeholders. This in turn would enhance the sustainable development impacts of KOSAP.

Stakeholder consultation were conducted at various levels during the program design stage, preparation of resettlement plan framework (RPF), Social Impact Assessment (SIA) and Environmental and Social Management Framework (ESMF).

The process of identifying the stakeholders to consult and/or engage basically follows four steps as outlined below:

1. Establishment of a criteria for identifying stakeholders.
2. Establishment of a participatory process for identifying stakeholders and their legitimate representatives.
3. Following of a transparent and participatory process for understanding the interests, power and influence of different stakeholder groups, their stake in the policy and the way and extent to which they may be affected, as well as their expectations of the participation process.
4. Identification of the key opportunities and barriers affecting the participation of different stakeholders, particularly for women, indigenous peoples, youth and other groups that may be marginalised, and involve these stakeholders in identifying appropriate methods and approaches to enable their effective participation.

These steps were followed while conducting the assessment. Once the potential stakeholders were identified, a list was prepared which included those affected by the programme and those with influence over it. A scoring system was then added (scores 1-low to 5-high for interest and influence as shown in Table 4 below. The results were then plotted on a stakeholder's matrix as indicated in Table 6.

Table 4: Assessment of Stakeholders Interest and Influence

Stakeholder	Interest	Influence
CEC- Energy ministers in the 14 counties	4	5
CEC-Environment Ministers in the 14 counties	4	4
Climate Change Directorate	3	5
Community Based Organizations	5	2
Development Partners	5	4
Investors	5	4
KEBS	2	5
Kenya Association of Manufacturers	4	2
Kenya Forest Service	3	2
Kenya Power	5	5
KETRACO	4	2
Land owners affected by the project	5	4
Local NGOs	5	2
Ministry of Devolution	3	5
Ministry of Education	3	2
Ministry of Energy	5	5
Ministry of Environment and Forestry	4	2
Ministry of Health	4	3
Ministry of Interior& Co-ordination	3	5

Ministry of Water	4	3
National Environment Management Authority	3	4
National Treasury	5	5
Private Sector Service Providers (KEPSA)	4	2
Representatives of youths, people with disability and women	5	2
REREC	5	5
Selected solar companies	5	2

Stakeholders' consultation was conducted using a bottom-up approach, which ensured the views and concerns of all the relevant stakeholders were integrated in the assessment. The ICAT Stakeholder Participation Guidance (Climate Community & Biodiversity Alliance & VCS, 2017) was used to identify the different stakeholders and their roles in implementation of the policy.

For the ICAT SD assessment, stakeholders were consulted at three levels:

1. Personal interviews with key representatives from
2. Distribution of documents to stakeholders for comments via email
3. Stakeholder consultation workshop

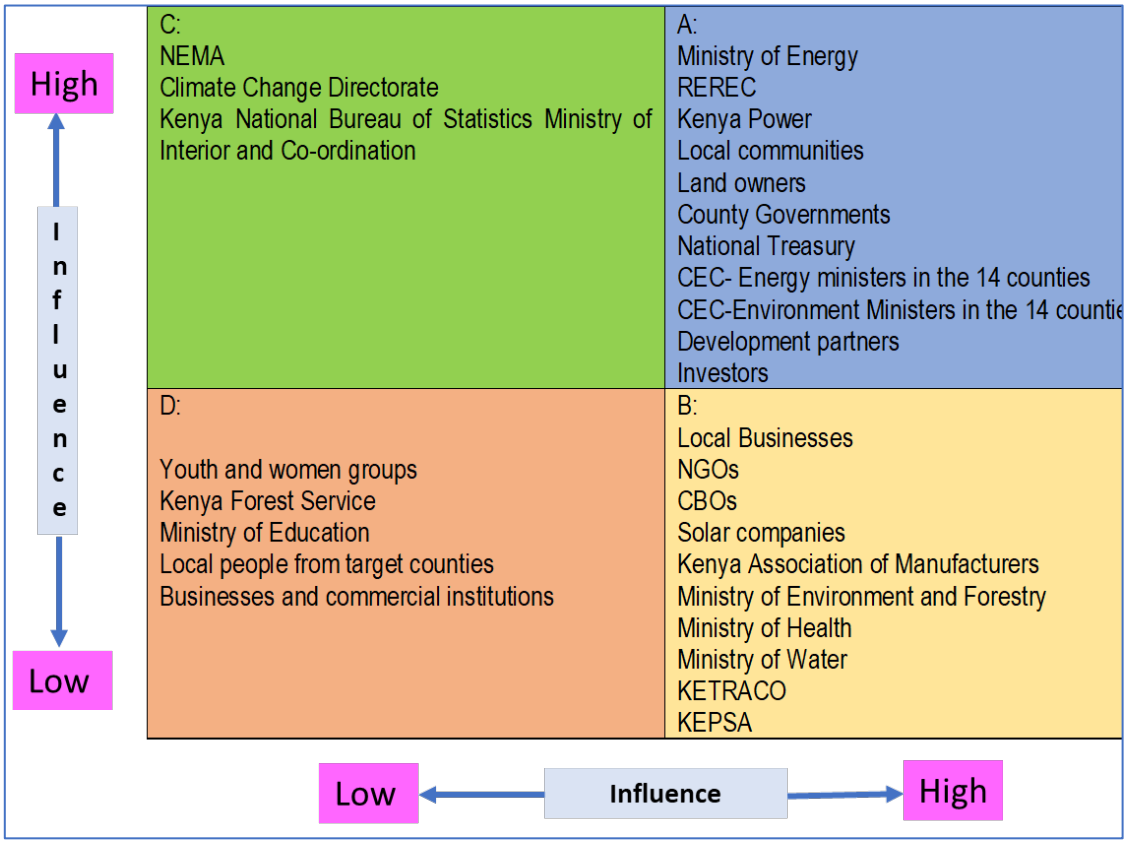
The consultant conducted phone interviews with the key stakeholders involved in the K-OSAP programme. This informed the assessment especially in understanding of the policy scenario and anticipated impacts. The draft SD assessment report was also circulated to the identified stakeholders in August 2019. This was aimed at soliciting stakeholder inputs on the anticipated environmental, social and economic benefits of the project identified in the report. The inputs of these consultations were incorporated in the SD assessment report which was presented at the Stakeholders validation workshop which was held on the 28th August 2019 at the Fairview Hotel in Nairobi. The purpose of the workshop was to validate the SD report and also obtain further input on the impacts identified and assess their significance. Table 5 below highlights the various stakeholders including their roles in the implementation of the policy.

Table 5: Role of Stakeholders in Policy Implementation

Stakeholder	Role in Policy implementation
Ministry of Energy	Overall coordination and supervision of the K-OSAP project through the PCU and Implementation of Component 2. Promotion of the transition to clean cooking
Ministry of Environment and Forestry and the Climate Change Directorate	Overall implementation and coordination of the Climate Change Act 2016
Ministry of Health, Ministry of Interior& Co-ordination, and Ministry of Water	Part of the PCU technical working groups.
KPLC/KETRACO/REREC	Implementation of different components of the K-OSAP program
CEC-Environmental and Energy ministers in the 14 counties	Local implementation and support to the implementation of K-OSAP in the specific counties. Part of the PCU County Working Groups
Representatives of youths, people with disability and women	Beneficiaries of the K-OSAP program and special interest groups
Local NGOs and CBOs.	Project support and sensitization of the locals about the project

Private sector (selected solar companies)	-Supply solar products and services -Give information on how they intend to address environmental and social sustainability issues that could be associated with the provisions of those services. - Implementing the safeguards on the ground, including ensuring compliance with occupational health and safety imperatives and dealing with de-manufacturing of out-of-use solar devices, e-waste disposal and recycling.
KAM and KEPSA	Increase energy efficiency in the manufacturing sector
KFS	Promote the transition to clean cooking with improved cooking stoves
NEMA	Advise on management of e-waste generated through this policy

Table 6: Stakeholders Matrix Indicating Levels of Interest and Influence in the Project



A: High interest/high influence
B: High Interest/low influence
C: Low interest/high influence
D: Low interest/low influence

Figure 2: Participants attending the Stakeholders Validation Workshop in Nairobi

During the stakeholders' consultation exercise, the stakeholders were asked to highlight the significant impacts of the policy that they felt needed assessment and measurement. The stakeholders were also required to rank the impact categories of the policy that were viewed to be the most relevant. A summary of the feedback is as indicated below:

1. Majority of the stakeholders attributed more social and economic impacts to the project.
2. Emphasis was on local impacts which were perceived to have both direct and indirect, short- and long-term impacts to the targeted communities.
3. Some of the major impacts of the policy that were highlighted by the stakeholders included improved local economic activities, improved education, improved access to clean energy, better healthcare, enhanced access to clean water, and climate change mitigation.
4. Some of the negative impacts mentioned include impact on land due to clearance of vegetation, to set the mini grids, and waste generation and disposal from old solar PV materials and used PV batteries.

The impact categories that were viewed to be most relevant by the stakeholders include:

1. Education
2. Energy access
3. Business growth
4. Water access
5. Health benefits
6. Employment opportunities
7. Reduced expenses for electricity
8. Quality healthcare.

CHAPTER 4: IMPACT CATEGORIES

During the study, only the impacts that were considered most significant and relevant were included in the assessment. Table 4 below shows a summary of the selected impact categories.

Table 7: List of the different Impact Categories including their relevance and significance included in the assessment

Dimension	Impact Category	Relevant?	Significant	Included?	Brief description (rationale for the determination of relevance and significance)	Indicator
Environmental	Climate Change mitigation	Y	Y	Y	The project will replace use of fossil fuel thus positively contributing to this category	Net GHG emissions
	Air quality/ health impacts of air pollution	Y	Y	Y	Solar provides clean energy hence reducing production of GHGs hence contributing positively to this category.	Number of deaths/illnesses resulting from indoor air pollution
	Waste generation and disposal	Y	Y	Y	The policy will have both positive and negative contribution by reducing wastes from fossil fuel and negatively by increasing solar waste e.g. solar bulbs for lighting, solar panels and batteries.	Not quantified
	Energy	Y	Y	Y	The policy will increase renewable energy by replacing fossil fuels.	Renewable energy installed
	Availability of freshwater	Y	Y	Y	The policy will positively affect this category since solar water pumps will be used to pump underground water.	Number of households and institutions with access to water pumped using the solar pumps
	Land use change	Y	N	N	The policy will negatively affect this category since there might be resettlement. There is a plan for Resettlement Policy Framework in place to address this issue.	Not quantified since it's unclear of the number of resettlements that may occur.
	Biodiversity of terrestrial ecosystem	Y	N	N	This policy is not expected to significantly affect these impact categories.	Not quantified
Social	Access to clean, affordable and reliable energy	Y	Y	Y	The policy positively affects this category by providing solar energy since households and institutions are not connected to electricity yet.	Number of households and institutions with access to solar PV
	Capacity, skills, and knowledge development	Y	Y	Y	The policy is expected to improve skills and knowledge in solar installation and maintenance.	Number of people trained for solar installation and maintenance

	Poverty alleviation	Y	Y	Y	This policy is expected to improve the livelihoods of the locals through job creation, monetary savings and business improvement due to access to solar electricity.	Number of people and institutions with access to solar PV
	Security	Y	Y	Y	Considered both relevant and significant since there will be improved lighting due to access to solar electricity	Not quantified
	Gender Equality and empowerment of women	Y	Y	Y	Gender equality and women empowerment because it's among the focus areas of SDGs which Kenya has adopted.	-Percentage of women with access to solar power -Percentage of women enrolled in education and training programs
Economic	Employment	Y	Y	Y	This policy will create employment opportunities through solar installation and maintenance hence this category is considered both significant and relevant.	Number of people employed
	Income	Y	Y	Y	Income will be generated by the people employed by the policy. Additionally, this will boost economic activities in the area thus this category is relevant.	Not quantified
	New business opportunities	Y	Y	Y	Considered significant since the policy is expected to create new business opportunities.	Number of new businesses established
	Agricultural Productivity	Y	Y	Y	Considered significant since the policy is expected to improve access to water for irrigation which will be a boost to agriculture	Number of people utilizing water pumps for irrigation
	Electricity expense's	Y	Y	Y	This is considered relevant due to change from baseline source.	Amount of money spent in USD

The criteria used for selecting the indicators was based on the objective of the assignment and the need to represent the specific aspects of each impact category. This was also guided by the following principles:

1. *Relevance:* to ensure indicator is relevant in measuring what is needed.
2. *Credibility:* to ensure data collected is credible and provides information on the actual situation.
3. *Validity:* to ensure the indicators reflect what is set to be measured and gives accurate information.
4. *Reliability:* to ensure data collected is reliable and can yield replicable results.
5. *Feasibility:* to ensure indicators used are manageable and cost effective.

CHAPTER 5: BASELINE ESTIMATION

5.0 Description of Baseline and Policy Scenario

An analysis of the baseline scenario in the assessment is required, mostly to inform the quantitative assessment by estimating the baseline values.

5.1 Overview of the Baseline Scenario

The approach used in determining the baseline scenario in the assessment is constant baseline, which adopts the use of historical and/or current values. These values are expected to remain constant within the assessment period, and the assumption is that in the absence of the policy, no change would be realised in the selected impact categories i.e. the target areas will have no access to electricity in the entire assessment period.

In this assessment, the baseline values used were obtained from credible existing data sources including published studies, peer-reviewed scientific literature, government statistics and reports, and other reports done for the policy such as the ESMF framework, SIA and RPF reports.

In the baseline scenario, the total number of customers not connected to a grid is 31,800 and comprises of households, businesses and institutions. The reference year is 2024, which is the year when all the mini-grids and standalone household and community systems are expected to be fully operational. The total community facilities in the project area without access to electricity include 207 secondary schools, 784 health facilities (642 level 2-dispensaries and 142 Level 3-health centres), and 106 Assistant County Commissioner offices.

The aim of the K-OSAP programme is to electrify the rural areas in the selected counties through solar mini-grids and standalone systems. Overall, mini-grids been running since the early 1980's. Presently, there are twenty-one mini-grid stations in the country, where 19 are owned by the Rural Electrification and Renewable Energy Corporation (REREC).and managed by Kenya Power (KPLC) and the other two stations are owned and managed by Kenya Electricity Generating Company (KenGen). The total installed capacity for these mini-grids is 24.8 MW comprising of 23.7 MW thermal, 0.55 MW wind and 0.569 MW solar subsidy. This will go a long way towards the realisation of the National Climate Change Action Plan opportunities for renewable energy which targets to install 442 MW of solar energy[2].

According to research on household lighting fuel costs in Kenya, published by IFC's Lighting Global in December 2012[3], households in underserved counties without access to grid electricity or solar home systems rely largely on kerosene for lighting, followed by firewood and dry cells. The usage on kerosene, batteries, solar lanterns, generators range from 3 hours/day-8 hours/day. This represents household expenditures of up to 2.91 percent, 1.53 percent, and 0.57 percent of annual income, respectively. The price of kerosene varies depending on the fluctuations in oil prices and geographical location. The price of kerosene in Nairobi at the time of this assessment was US$ 1.01 per litre compared to US$ 1.08 in Marsabit and US$ 1.14 in Mandera towns[4].

According to the 2009 Kenya Population and Housing Census (KPHC), the overall proportion of households using paraffin was 14.0 per cent. A study on "Scaling up clean cooking in Urban Kenya with LPG & Bio-ethanol" by Dalberg reports that the average annual household kerosene consumption (assuming 3,500MJ / HH annual

[2] http://www.kenyamarkets.org/wp-content/uploads/2019/02/NCCAP-2018-2022-Online-.pdf

[3] https://www.lightingafrica.org/wp-content/uploads/2016/07/LightingAfrica-KenyaKeroseneUse-Dec2012-rev.pdf

[4] https://calculator.co.ke/erc-kenya-fuel-prices

consumption) in 2018 was 284L and the average price was US$ 0.79 / L which brings the annual cost to an average US$ 224. This translates to an average monthly expense of about US$ 18.66 (Kshs. 1,866) per household.[5]

Data by Kenya National Bureau of Statistics in 2018 on electricity usage indicates that a family consuming about 50 kWh of electricity for domestic use paid a bill of Kshs. 649.73 (US$64.97) in November 2017 and Kshs. 757.72 (US$75.77) in November 2018 which gives an average bill of Kshs. 703.72 (US$7.37) [6]. A comparison of these costs is a clear indication that electricity is a cheaper option than using kerosene for lighting by about US$11.29 (Kshs. 1,129)per month for each household. Torches, flashlights and candles are other lighting options for rural households. A study by Carbon Africa Limited et al. (2015) found that on average, households, businesses and institutions spend 4.3, 6.7 and 9.1 dry cell batteries per month respectively.

The K-OSAP project will enable households and community facilities to obtain savings which can be diverted to other economic uses.

Irrigation in areas without connection to electricity remains a key challenge especially in arid and semi-arid areas where access to water is a huge problem. In some areas, communities have resorted to use of diesel-powered water pumps.

Use of diesel generators in areas without electricity is very common especially for facilities that require a constant supply of energy such as health centres and small businesses. In a survey conducted by Carbon Africa Limited et al. (2015), 5% of the businesses and 12% of institutions surveyed reported to use diesel/petrol generators[7]. A figure of 2.78 L/user/day (derived by Maso, 2018) has been used for this assessment to conservativeness.

Some households have also been reported to use solar home systems (SHS), mostly for lighting. These systems vary from very small systems to larger ones. Carbon Africa (2015) reports 13% and 25% of households and businesses, respectively, using SHS. Similarly, these figures have been adopted for this assessment and the SHS have been assumed to have 20 Wp capacity and a 22 W Li-ion battery, each.

Given the time constraint, a simplified baseline scenario model was adopted based on a number of assumptions as outlined below:

1. Li-ion battery cells, which are dry-cell batteries that can be reused multiple times, are used to represent the dry-cell batteries assessed. Their weight is assumed to be 15 g (the most common batteries).
2. Kerosene is normally burned in kerosene lamps, which are made from used cans or bottles.
3. The Emission Factors (EFs) used for kerosene's combustion are as follows: PM 2.5-93 g/kg fuel, CO_2 - 3,190 g/kg and CO-11 g/kg of fuel.
4. Other minor sources of light, such as candles and wood, have not been considered due to their scarce use.
5. Specific data on the generators used by businesses and institutions could not be obtained. Hence, a diesel genset of 18.5 kWh has been selected.
6. The lifetime of the SHS is quite uncertain and has been assumed to be 5 years.

[5] https://www.lightingafrica.org/wp-content/uploads/2016/07/2010-Conference-Report-Updated.pdf

[6] http://www.knbs.or.ke/wp-content/uploads/2018/11/cpi112018.pdf

[7] https://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final(1).pdf

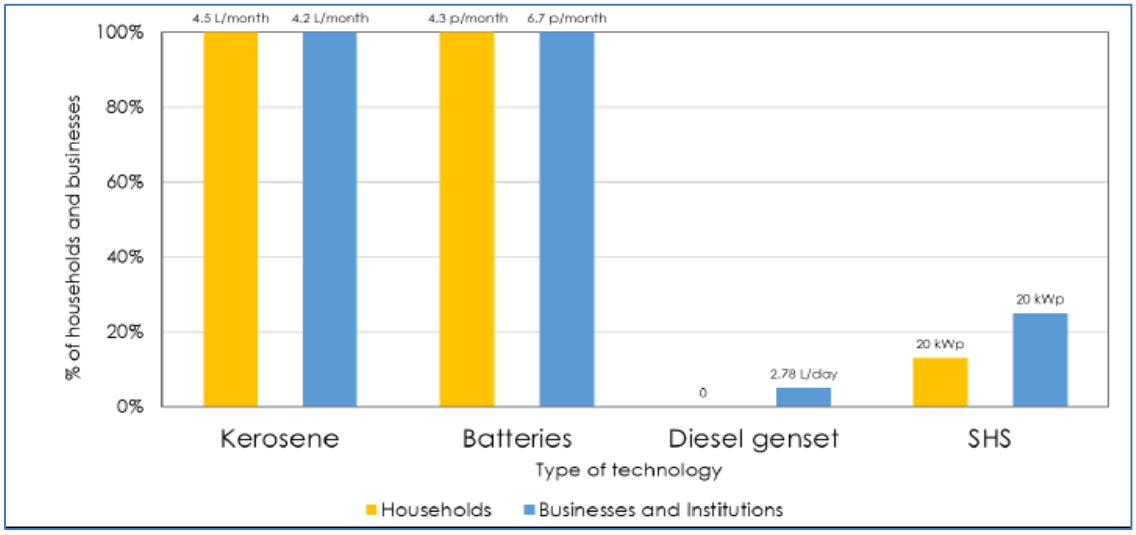


Figure 3: Energy Use in the Baseline Scenario, source (Maco, 2018)

5.2 Overview of Policy Scenario

The policy scenario presents an assessment of the implications of the policy on communities upon implementation of the project. In this scenario, the assumption made is that all the baseline scenario technologies and practices used shall be completely displaced by the project. The policy scenario analyses the same number of customers (31,800) for the same period (2024-2030) as outlined in the baseline, assuming that all will be connected to solar PV mini-grids and standalone households and community solar systems. The sustainable development assessment has been done on the three components of the policy scenario as discussed below.

5.3 Project Components

Component 1: Mini-grids for Community Facilities, Enterprises, and Households

This component will support the electrification of areas where electricity supply through mini-grids represents the least cost option from a country perspective, as underpinned by the geospatial plan. Depending on the number of users to be supplied, and the service level defined for each type of user (households, enterprises, community facilities, etc.), the generation system of each specific mini-grid will combine solar PV, battery storage and thermal units running on diesel. Mini-grids will be developed under a Public-Private-Partnership (PPP) whereby private investment and public funds co-finance construction of generation facilities, and public funding is used to construct the distribution network. A single private service provider (PSP) will be responsible for construction (and partial financing) of the generation system and for construction of the distribution network of each mini-grid. The same PSP will sign two long-term contracts with KPLC: (i) a 7-10-year power purchase agreement (PPA) for the operation and maintenance of the generation system, and recovery of the privately financed part of the investment; and (ii) a 7-10-year service contract for operation and maintenance (O&M) of the distribution network, including revenue cycle services (as required). Ultimately, after the recovery of the private investments, all assets (both generation and distribution) will be in GoK ownership. All electricity consumers supplied through mini-grids will be KPLC customers and will pay the same tariff for each category charged to users connected to the national grid, ensuring effective implementation of a national uniform tariff policy.

The component will be implemented in approximately 120 locations throughout the 14 target counties, typically in mini-grids supplying 100-700 prospective users, with approximate total demand of 20-300kW. These potential sites, capturing approximately 27,000 consumers in total, have preliminarily been identified as part of the geospatial plan.

Each service territory will comprise 20 or more mini-grids located in geographically contiguous areas, with 2,000 or more serviceable customers. There will be a mix of more densely populated sites and less densely populated sites in each lot, where possible, to enhance their overall commercial attractiveness.

REREC and KPLC will jointly implement the component, with the procurement of lots divided among them. This component will be complemented by technical assistance, under sub-component 4.2, to (i) confirm the sites through further feasibility studies and techno-economic analysis (ii) promote productive and efficient use of energy by users (iii) technical, legal, and procurement support to effectively design the bidding documents and supervise the construction of the mini-grid assets.

Scenario analysis

REREC will build 25 mini-grids consisting of a 60 kWp silicon crystalline solar panel pack, a 50-kVA diesel back-up, and a 3,200 Ah 48 V Lithium-ion (Li-ion) battery (REA, 2016). The expected lifetime has been reported to be 25 years for the panel and 20 years for the battery (REA, 2016). Each system is designed to supply 90% renewable energy to 200 household customers with an expected daily demand of 200 kWh per system (Ministry of Environment and Forestry, 2018; REA, 2016). Businesses and local institutions have been considered as part of the 200 customers, assumed to account for 23% of all customers. Based on this, the mini-grids are expected to provide electricity to a total of 5,000 customers of which 1,150 are businesses and local institutions and 3,850 are households.

Component 2A: Standalone Solar Systems for Households

This component will support off-grid electrification of households in the 14 target counties where standalone solar systems are the most appropriate to deliver energy services, leveraging Kenya's unique off-grid solar market dynamics and innovations. The component will provide incentives for solar off-grid companies currently operating in the more densely populated areas of Kenya to expand to underserved counties and provide services to the off-grid households in these counties. These services, provided through portable solar home systems, are well-suited to some of the population in the underserved counties, as households do not always live in permanent structures. In addition, affordability is increased by allowing households to pay for systems over time. Willingness to pay analysis, confirmed by the preliminary results from the MTF surveys shows there are over a half-million households that could theoretically afford a Tier 1 level solar home system.

The component will be accomplished via two financing instruments to which eligible solar service providers (SSPs) will have access:

i. Grant Facility - Competitively awarded expansion grants, to compensate SSPs for initial, ongoing incremental, and opportunity costs associated with an expansion of operations in underserved counties. A percentage cap will be set within each lot so that multiple service providers will have the opportunity to operate within the space. A competitive approach will be used, whereby service providers will bid based on a grant amount per household connection, with the lowest grant requirements winning. Results-based financing will specify instalment payments based on the achievement of pre-agreed connection milestones and satisfactory after sales service support.

ii. Debt Facility - Debt financing to solar service providers, to support upfront costs associated with getting hardware inventory into the market, and medium-term consumer financing to enable households to pay off the systems over time. Two typologies of business models underpin the majority of solar service providers that operate in the Kenyan market. First are service providers that sell solar products on an over-the-counter (cash sale) basis. These service providers require shorter term debt in US$ or other major foreign currency to finance costs associated with hardware manufacture and transit to Kenya (typically from China) until a sale is made. This cycle typically lasts anywhere from 6 to 9 months. A second prevailing business model is pay-as-you-go, whereby customers pay for the systems in monthly instalments (typically between 12-36 months), and SSPs carry the default risk during the payback period. These businesses typically require debt financing that is commensurate with

the lending terms that they extend to their customers. Given that service providers 'revenues are in local currency, the debt instrument will also offer loans in Kenyan Shillings in addition to US$.

The implementation of this component will be under a direct oversight of MoE. MoE will competitively select the expansion debt-grant facility manager, which will be a consortium with demonstrated experience with managing similar instruments in Kenya and similar geographies. An OP 10.00 assessment of financial intermediary financing will be carried out for on the debt facility manager.

Component 2B: Clean Cooking Solutions for Households

This sub-component will support a transition from low-efficiency baseline stoves to cleaner, higher efficiency improved stoves. To accomplish this objective, cleaner household cooking appliances and fuels will be promoted. Activities will begin by focusing on four underserved counties in the north western part of the country (West Pokot; Turkana; Samburu; and Marsabit).

During project preparation, a Stove-Market Testing Program is being undertaken in the municipal, town, and densely settled parts of Turkana County. The stoves to be included will be determined following a call for Expressions of Interest for stove manufacturers wanting their products to be exposed to these new markets. To be eligible for inclusion in the market tests, a woodstove will have to be Tier 2 (roughly 30 percent efficient) and a charcoal stove will have to be Tier 3 (roughly 40 percent efficient). . These tests will involve exposing both consumers and suppliers (retailers, wholesalers, and distributors) in the urban areas of Turkana County to these improved stoves. The results will be shared with the communities and interested parties. Field testing for additional stoves models may be considered during the project implementation.

This sub-component will operate a window in the grant facility established for Component 2A to support sales of eligible stoves in targeted counties. The grant facility will provide the selected distributors with financial support on a matching grant and results-based scheme to enable them to market their stoves locally within the target counties, to increase their inventories of the selected higher quality stoves, to purchase and transport them to the target communities in large numbers and to sell them to willing buyers in the communities.

Improved cookstoves have several benefits including:

1. Health improvements from better indoor air quality
2. Reduced cooking times
3. Improved stove aesthetics and social standing from the use of cleaner stoves
4. Environmental benefits to society, such as reduced deforestation, black carbon and greenhouse gas emissions .

Component 3: Standalone Solar Systems and Solar Water Pumps for Community Facilities

The component takes account of new and existing community facilities including health facilities (level 2 - dispensaries and 3-health centres), educational facilities (secondary schools and technical training institutes), and administrative offices.

Component 3A: Standalone Solar Systems for Community Facilities

This component will support the provision of electricity services to community facilities in remote areas in the 14 underserved counties. The core activity under the component includes the supply, installation, and maintenance of standalone solar systems in community facilities which targets about 1,100 facilities. KPLC, the implementing agency, would sign two (2) contracts with the contractor in each service territory – one for the supply and

installation of the standalone solar systems and the second for the provision of maintenance services for a 7 to 10-year duration.

The contract specifies the minimum requirements in terms of quality standards in electricity supply to KPLC - Kenya Off-Grid Solar Access Project (K-OSAP) for underserved counties. It also stipulates the minimum package acceptable as "basic service" but allows room for provision of additional services to community facilities. The proposed project will cover the supply and installation costs and KPLC will pay the contractor for fees under the maintenance contract with allocation or revenues from beneficiary facilities. The costs of maintenance contracts are expected to be passed through into tariff revenues recognised by the Energy and Petroleum Regulatory Authority (EPRA).

KPLC will take the retail risk of serving these new consumers, for which their payment record for such an arrangement is still unknown. Therefore, a payment risk mechanism would be available to KPLC, for which the proposed project will set aside funds equivalent to 6-12 months of maintenance fees that KPLC can draw upon in case of inadequate revenues to pay the contractor.

Component 3B: Solar Water Pumps for Community Facilities:

This component aims at supporting financing of solar powered pumping systems to increase sustainable access to water supply by equipping new boreholes and replacing existing diesel-powered boreholes within community facilities at the target counties. A private sector contractor will be competitively selected for each service territory to supply, install, and maintain standalone solar systems in community facilities.

REREC, the implementing agency, would sign 2 contracts with the contractor in each service territory for:

1. The supply and installation of the standalone solar systems
2. The provision of maintenance services for 7-10-year duration - similar to the design in Component 3A. The payment for these maintenance services will be recouped on a monthly basis by the community facilities hosting these boreholes.

A payment risk mechanism would be available to REREC, for which the proposed project will set aside funds equivalent to 6-12 months of maintenance fees that REREC can draw upon in case of inadequate allocation from the beneficiary facilities to pay the contractor.

The literature on the cost-benefit analysis between diesel and solar powered pumping clearly indicates that the life-cycle costs are significantly lower for solar-powered water schemes. A solar water pump in Kenya costs between US$ 300 to US$ 3,000. Solar water pumping systems are more reliable and affordable making it a better water pumping technology of choice for off-grid rural communities. This sub-component of the policy is designed to allow counties the flexibility of investing in equipping new boreholes or replacing existing diesel-powered generators with solar PV. All the boreholes are associated with community facilities (located within or near the premises). By using the solar pumps, the households can obtain savings of up to US$ 350 per week on expenses incurred in buying diesel.

5.4 Summary of the Policy Scenario

The policy scenario can be summarized as follows:

Overall objective of the policy (2024)

1. 1,272,525 people shall be provided with new or improved electricity service.
2. 1,097 community facilities will have access to new or improved electricity service.
3. Renewable energy generation capacity of 9.60 MW will be constructed under the project.

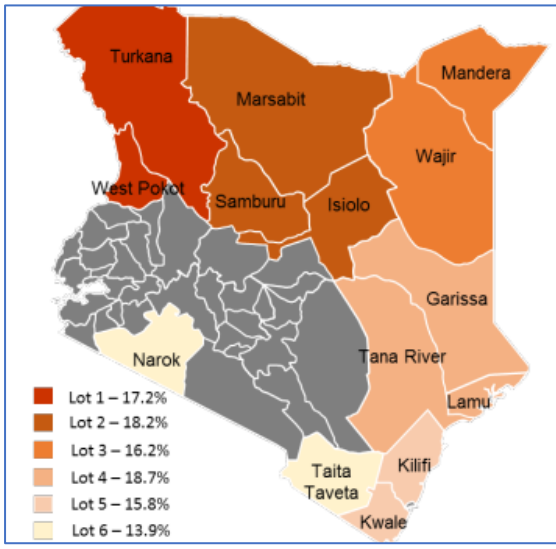
Intermediate objectives for mini-grid systems (2020)

1. Households provided with access to electricity by mini-grids in the intermediate period are 20,750.
2. 20% women headed households will have access to electricity by mini-grids.
3. 6,050 enterprises will be provided with access to electricity through the mini-grids.
4. 200 community facilities will have access to electricity by the mini-grids.
5. 5 MW renewable energy generation capacity of mini-grids constructed under the project.

Intermediate objectives for standalone systems(2020)

6. 250,000 households provided with new electricity connections by stand-alone systems.
7. 20% women headed households provided with new electricity connections by stand-alone systems.
8. 4.60 MW renewable energy generation capacity of stand-alone systems constructed under the project.
9. 897 community facilities provided with access to electricity by stand-alone systems.
10. 620 boreholes equipped with solar pumping systems.
11. 150,000 clean and efficient household stoves sold in target counties.
12. 3,890,000 tCO_2e volume of GHG emissions reduced (tCO_2e).

The interventions will be distributed across the 14 target countries as shown in Figure 3 below.



Lot/ Service Territory	County	Mini-grid Sites	Solar Systems				Solar Pumping Systems	Cook stoves
			Homes	Secondary Schools	Level 2 & 3 Health Clinics	ACC Offices		
1 Northwest	West Pokot	26	42,953	42	165	22	65	34,018
	Turkana							
2 North	Marsabit	29	45,432	28	133	17	69	35,982
	Samburu							
	Isiolo							
3 Northeast	Mandera	32	40,537	23	112	23	62	20,066
	Wajir							
4 East	Garissa	23	46,695	15	127	22	71	23,114
	Tana River							
	Lamu							
5 Southeast	Kilifi	1	39,568	52	104	5	60	19,586
	Kwale							
6 South	Taita Taveta	10	34,815	47	143	17	52	17,233
	Narok							
	Total	121	250,000	207	784	106	380	150,000

Figure 4: Distribution of interventions in the 14 target counties

CHAPTER 6: ESTIMATING IMPACT EX-ANTE

The aim of estimating ex-ante impacts is to determine the anticipated future impacts of the policy over time, by putting into consideration the identified quantifiable impacts. The assessment is as summarised in Table 8 below.

Table 8: Summary of estimated impacts of the K-OSAP Programme

Impact category	Indicator quantified	Estimated Impact
Climate Change mitigation	Net GHG emissions	Reduction of 3,890,000 tCO2e
Air quality/ health impacts of air pollution	Reduced particulate matter Disability-Adjusted Life Years (DALYs)	96% Reduction of particulate matter and -593 DALYs.
Energy	Renewable energy installed (MW)	Increase of 5 MW and 4.60 MW of renewable energy capacity by mini-grids and standalone systems respectively
Availability of freshwater	Number of household/facilities with access to clean water	Increase of 620 existing and abandoned community boreholes installed with solar water pumps
Access to clean, affordable and reliable energy	Increased number of households/businesses/facilities with access to clean energy	Increase of 207 secondary schools, 784 health facilities, 106 Assistant County Commissioner offices and 1,272,525 households with access to clean energy
Employment creation	Number of new jobs resulting from the policy during construction, installation, manufacturing, operation and maintenance.	12.84 jobs//year
Monetary savings	Savings in kerosene/diesel expenses by households and businesses	Monthly saving of Kshs.933.14 (US$10.86)

CHAPTER 7: QUALITATIVE IMPACT ASSESSMENT

7.0 Qualitative Assessment of Policy Impacts

This chapter details qualitative assessment of sustainable development impacts quantitatively of the solar PVs to communities in the target areas. The approach involves describing the impacts of a policy or action on the selected impact categories in qualitative terms. Impact categories in this assessment were identified though the following steps:

1. All impact categories identified in the previous chapter were included in the assessment.
2. The assessment period was considered to be short term (1-3 years), up to 2030 (medium-term) and beyond 2030 (long-term).
3. Each impact was characterized based on the likelihood of its occurrence, the magnitude of each impact and the nature of the change, whether positive or negative. Based on the assessment of likelihood and magnitude, impacts that are significant based on the consultation with the stakeholder were determined.
4. The qualitative assessment results for each impact category was summarised in table form.

The following steps were applied in the characterisation of each specific impact:

1. Step 1: An impact is assessed on the likelihood of its occurrence. Assessing the likelihood of an impact can fall into any of five categories i.e. very likely, likely, possible, unlikely and very unlikely.
2. Step 2: Impacts are also assessed on their magnitude based on three categories (major, moderate and minor).
3. Step 3: Significance of the sustainable development impacts is determined by combining the scores on likelihood and magnitude.
4. Step 4: Determining the nature of change involved (positive or negative).
5. Step 5: Reporting the outcomes on a table format.

7.1 Qualitative Impacts

Increased access to electricity

An estimated 1.1 billion people (14% of the global population) lack access to electricity according to Energy Access Outlook 2017. Many more suffer from poor quality of supply. According to the International Energy Agency, around 84% of those without electricity access reside in rural areas and more than 95% of those living without electricity are in countries in sub-Saharan Africa and developing Asia[8]. The Energy Progress Report released by World Bank in May 2016, covering the period between 1990-2016, indicates that electricity access in Kenya among the rural population increased from 7.17% in 2010 to 48.39% in 2016 while that of the urban population grew from 58.2% to 77.6%. As at March 2017, 5.9 million households had been connected to the grid through the government-led national electrification programmes[9]. The estimate of the national access rate to electricity as at April 2016 is 56%.

[8] https://www.iea.org/energyaccess/database/

[9] http://www.kplc.co.ke/content/item/1951/kenya-power-confirms-5.9-million-customers-connected-to-the-grid

This is based on total electricity customers of 4.6 million and average household size of 5.5. The interconnected electricity system largely covers the densely populated southern and central belt of the country, while a vast area, especially the Northern and North Eastern counties, has limited grid infrastructure.

The country's electricity generation is currently driven by large-scale hydro power, fossil fuels, and recent focus on geothermal, while other renewable energy sources such as solar and wind play only a minor role (GoK, 2015). However, the grid-connected wind energy generation capacity in Kenya has recently increased significantly after the commissioning of the 310 MW Lake Turkana Wind Power in Northern Kenya.

Solar energy has been reported to be the fastest growing renewable power technology worldwide. Rural electrification using solar PV in Kenya has emerged as a viable option since its regarded as a reliable, clean, and environment-friendly energy, leading to a high demand. However, despite the high potential, the country is still not sufficiently exploiting its solar energy resources. Studies show that this is due to a number of barriers such as limited awareness about the technology, inadequate technical and end-user capacity, and lack of value chain financing, all which can be addressed through a suitable policy framework[10]. The main expected benefit of the policy action is to provide access to electricity in villages which are not yet connected in order to benefit the local people, while enabling social and economic development.

The 14 counties where the policy is being implemented are remote and currently not connected to the grid. The average access rate for these counties is 12.6% and average population density is 19.8 persons per square km. Due to the wide geographic dispersion, these counties will largely benefit through the policy which will provide mini-grid and off-grid solutions. With implementation of the policy action, the local population will "very likely "have access to electricity which would have "major" impacts on the communities through job creation, increased access to information and improved businesses.

Climate change mitigation

The NCCAP 2018-2022 indicates that the energy sector, excluding transport and industry, accounted for 7.1% of total emissions in 2015, a figure that is projected to rise to 29.7% of the country's total emissions in 2030. Traditional sources of energy contribute significantly to the level of emissions, which has led to increasing pressure to shift to clean energy to control the impacts of climate change. Kenya's current primary energy mix mainly comprises biomass (69%), petroleum (22%) and electricity (9%). Kenya's consumption of petroleum energy has been on the rise, where as reported in the 2018 Economic Survey by the Kenya Bureau of Statistics, the total volume of petroleum products imported into the country increased from 5,990.0 thousand tonnes in 2016 to 6,347.7 thousand tonnes in 2017. However, domestic exports of petroleum products declined by 2.3 per cent to 32.4 thousand tonnes over the same period.[11] In 2018, the Government of Kenya has introduced measures to cut kerosene consumption such as through increased taxes, in a bid to encourage shift to cleaner fuels for cooking[12]. Kenya's Intended Nationally Determined Contribution (INDC) commits to reducing GHG emissions by 30% relative to Business as Usual (BAU) scenario of 143 $MtCO_2e$ by 2030

Through this policy action, the consumption of kerosene and other petroleum-based products is expected to drop gradually, resulting in 3,897,389 tonnes of avoided CO_2 by 2024 (PAD, 2017). Shift to solar will "very likely" reduce the level of GHG emissions, thus having a "major" impact in combating climate change.

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[10] https://www.researchgate.net/publication/280689563_Solar_PV_for_Enhancing_Electricity_Access_in_Kenya_What_Policies_are_Required

[11] https://www.knbs.or.ke/download/economic-survey-2018/

[12] https://www.erc.go.ke/maximum-retail-pump-prices-for-the-period-15th-january-2019-to-14th-february-2019/

Poverty alleviation

Energy plays an important role in poverty alleviation. Globally, poverty is now recognised as not only low income and consumption, but also low achievement in education, health, nutrition, and other areas of human development[13]. Introduction of solar electricity through the policy will contribute towards poverty alleviation due to increased economic activities. Access to electricity can impact Small and Medium Enterprises (SMEs) by enabling them to use electric tools and equipment in their businesses thus improving the productivity, and quality and quantity of their products. This may potentially lead to increased sales and thus increasing the revenue base. A study done on SMEs in Mpeketoni on 12 carpentries and 5 tailoring shops revealed that access to electricity enabled SMEs to use electric tools which contributed to increased productivity per artisan by between 100-200%, depending on the task at hand. As the SMEs produced more, there was an increase in the number of products in the market and thus the prices reduced. According to the SMEs the prices dropped due to an increase of sales made resulting in 20-80% increase in revenue. [14] Accelerating the pace of electrification through the policy, in line with the government's target of 70 percent electrification by 2020 shall significantly contribute to eliminating extreme poverty and achieving shared prosperity. This impact has been categorized as "likely" with "major" effect on poverty alleviation.

Employment opportunities

In a recent study by the United Nations Development Programme (UNDP), Kenya was ranked as having the highest unemployment rate in East Africa region, where one out of every five youths in Kenya is unemployed. As at December 2017, a report by the World Bank (2016) revealed that the unemployment rate in Kenya stood at 11.47% compared to 11.52 in 2016.[15] A shift towards utilisation of solar energy through the policy will "very likely" create numerous employment opportunities for the locals, through involvement in solar installation, distribution and maintenance. Juchau & Solan (2013) report solar PV to be the second highest technology in terms of number of jobs created per MWp (behind nuclear) with 1.91 jobs/MWp/year, and absFolutely the highest in terms of average MW production, with 12.84 jobs/MWa/year, during construction, installation, manufacturing, operation and maintenance. This will in turn have a "major" effect on incomes due to increased earnings for the locals thus easing the level of unemployment rate in the 14 counties and contribute in the country's GDP.

The policy is also likely to have "ripple effect" on employment by increasing jobs in the solar manufacturing sector and supply of local material during the construction phase. Some of these can be expected to be sourced locally and the rest through importation. Therefore, the project will generate new income revenues for the local population across the 14 counties. The new income revenues received will create demand for other goods and services causing a trickledown effect to the entire economy. This is also "likely" to impact on unrelated local businesses which will benefit from increased household and business incomes, and the creation of new infrastructure. The magnitude of this has been assessed as "moderate".

Improved air quality

The K-OSAP project is anticipated to contribute positively towards improvement of air quality by replacing the use of kerosene by households in the target area. Research shows that burning a litre of kerosene emits PM51 micrograms per hour which is just above the World Health Organization 24-hour mean standard of PM10 of 50 micrograms per cubic meter. Using kerosene lamp as a source of lighting leads to Indoor Air Pollution (IAP) as devices which use kerosene can emit high amounts of fine particulate matter, nitric oxides, carbon monoxide and

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[13] https://www.researchgate.net/publication/278684170_Socio-economic_impacts_of_energy_poverty_alleviation_in_rural_areas_of_developing_countries

[14] https://rael.berkeley.edu/wp-content/uploads/2015/04/Kirubi-WorldDevelopment-minigrid-2008.pdf

[15] https://www.ceicdata.com/en/indicator/kenya/unemployment-rate

Sulphur dioxide. Studies on kerosene used for cooking or lighting provide some evidence that their emissions may impair lung function and increase infectious illness (including tuberculosis), asthma, and the risk of cancer.[16] About 4.3 million people – mainly women and children – die every year because of indoor air pollution, which make it the world's largest single environmental health risk. Use of solar PV systems will "very likely" reduce consumption of kerosene in households thus reducing exposure to indoor air pollutants, resulting into" major" health benefits for locals.

Although generation of solar power do not generate any poisonous or harmful emissions, implementation of the project is expected to have short-term negative impacts arising from exhaust emissions that are likely to be generated during excavation for construction of the mini grids and during use of fuel-run equipment including vehicles, generators, and compressors. Oxides of nitrogen, carbon monoxide and oxides of sulphur may also be emitted from internal combustion engines during construction. Further, motor vehicles that will be used to ferry construction materials will also impact on air quality by emitting pollutants through exhaust emissions. This impact will "very likely" occur but its magnitude is "minor" if mitigation measures are properly implemented.

Education benefits

In most developing countries, children spend at least an hour per day on average fetching water and fuelwood. Improved access to electricity shall reduce this burden and allow the children to expand their opportunity for school attendance and other educational activities. Several studies indicated that areas with access to electricity have reported an increase of study time by 1 hour (World Bank, 2008). The policy will increase access to electricity in communities which will consequently provide extra hours for study to the students both at home and at school. This impact has been ranked as "very likely" and its magnitude "major". Further, better access to lighting provides children with opportunities to increase the quality and time of their study. It is estimated that there are approximately 1.2 billion people globally who do not have access to electricity and hence resort to use of kerosene lamps[17]. Without electricity, there is not enough luminescence for study in a household at night which affects study. Access to electricity will play a big role in providing lighting to households thus creating a child-friendly educational environment. This impact has been assessed as "very likely" and "major".

In Kenya, lighting has enabled existing teachers to provide extra teaching early in the day and late at night to make up for material not adequately covered during normal hours, due to a shortfall of staff.[18] Further, according to UNICEF (2015), Sub-Saharan Africa has the lowest rate of primary school electrification, with just 35% of schools having access to electricity. This impact has been ranked as "likely" and its magnitude "minor".

Additionally, the quality of education has been improved through facilities such as laboratory and the computers. In rural Kenya, electricity has yielded the ability to conduct experiments in a science laboratory thus yielding academic improvements particularly in science subjects.[19] Additionally, having computers and photocopying machines has, improved the efficiency of processing information, particularly exams, at the school. This would not be possible without electricity hence there is a direct connection between access to electricity and improved academic performance at the School. Schools have also begun to offer expanded vocational classes in engineering, welding, metal works, and carpentry, all made easier with electric appliances and tools.[20] This impact has been considered as "likely" and "moderate".

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[16] https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10229.pdf

[17] https://nextbillion.net/solar-lighting-in-remote-rural-areas-oversold-or-truly-illuminating/

[18] https://sustainabledevelopment.un.org/content/documents/1608Electricity%20and%20Education.pdf

[19] https://rael.berkeley.edu/wp-content/uploads/2015/04/Kirubi-WorldDevelopment-minigrid-2008.pdf

[20] https://sustainabledevelopment.un.org/content/documents/1608Electricity%20and%20Education.pdf

Electricity enhances staff retention and lead to better teacher training. According to UNESCO ,"Teachers are understandably reluctant to work in deprived areas, which lack basic facilities such as electricity, good housing and health care.". The presence of household electricity in rural areas can also attract more qualified teachers. Teachers also get better training, new skills and techniques from improved practices in classroom through better conditions and aids electricity offers. This impact has been assessed as "possible" and "minor".

Improved security

Improving street lighting and security lighting is identified as one strategic area for reducing crime in the Kenya's Community Policing by the Kenya Police Service. Solar lighting solutions can be easily integrated into rural areas to provide lighting in locations that need it most such as dark intersections, pathways, parks, signs, and other applications. Providing lighting in rural areas will largely boost safety and security, consequently reducing the rate of crime, and enhancing economic activities through prolonged working hours at night. By installing floodlight masts in areas where the mini-grids will be stationed, there will be reduction in petty night crimes and insecurity incidences especially in pastoralist areas, brought about by tracking the movement of the militants. This impact has been considered as "very likely" and its magnitude "major".

Access to communication, information and entertainment facilities

Access to electricity enhances access to information communication and entertainment through use of mobile phone, and electronic devices such as television and radio. Solar power enables telecommunication in non-electrified areas as revealed by a study by Lighting Africa in Uganda where 80% of phone owners indicated they charged their phones using solar systems[21]. Use of mobile phones eases communication which is essential for doing business especially for Small and Medium enterprises, which can easily and conveniently contact their clients and suppliers. This impact has been assessed as "very likely" and "major".

Solar electricity enables communities to access information shared through radio and television which provides crucial information on health-related issues, local events, weather and other natural disasters. This in turn enables knowledge sharing, planning and risk and disaster preparedness. For example, a study by the World Bank in 2008 which reviewed [9] rural electrification programmes found that increased access to television and radio increased knowledge about health and contraception, which, in turn, improved health outcomes and reduced fertility rates. This impact has been categorized as "likely" and "moderate".

HIV/AIDS control will also be boosted due to increased awareness creation disseminated through media such radio, television and telephone messages, which will be made possible by the policy. In Kenya, 1.5 million people are estimated to be living with HIV.[22] HIV education and awareness are important component of HIV prevention in Kenya and mass media play a main role in this. The community and affected with access to solar will "very likely" have access to relevant information including good nutritional habits which can be shared with other members, leading to "major" impact on community HIV/AIDs awareness and management.

Availability of freshwater

Kenya has a rapidly growing population of about 46 million, with 41 percent (about 19 million people) of the population still relying on unimproved water sources, such as ponds, shallow wells and rivers. These challenges are especially pre-dominant in the rural areas and the urban slums.[23.] Adequate and reliable access to safe water and improved sanitation services is central to achievement of better health and wellbeing of communities. The main effect is on prevention of waterborne diseases which in turn may reduce mortality rates and health expenditure.

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[21] https://www.lightingafrica.org/wp-content/uploads/2016/12/Uganda-2.pdf

[22] https://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/kenya

[23] https://water.org/our-impact/kenya/

Solar-based water pumping solutions offer a cost-effective alternative to grid- or diesel-based irrigation pumps. Large-scale utilization of solar pumps can support the expansion of irrigation, reduce dependence on grid electricity or fossil fuel supply, mitigate local environmental impacts and reduce government subsidy burdens.[24] The policy seeks to distribute solar water pumps to 620 community existing/abandoned community boreholes. This will make pumping of water simpler and will "very likely" lead to increased access to clean water for consumption by households and have "major" impacts on the community.

Accessibility to quality healthcare

A study by the World Health Organisation (WHO) in 2012 revealed that only about 28% of the health facilities in the Sub-Saharan Africa have reliable access to electricity.[25] For effective operation, the healthcare industry including health clinics, maternity wards, surgery blocks, medical warehouses, and laboratories rely on electricity to refrigerate medicines, power the lights and operate life-saving medical devices. This means that healthcare is a sensitive and energy intensive sector which requires 24 hours uninterrupted supply of electricity to run medical equipment and undertake various processes such as labour room procedures, surgical operations, child care units, ICU, among others. Intermittent or unreliable power source puts lives at risk. In realisation of the opportunities that solar power presents in the health sector, international organisations, such as UNDP, have come up with various programs such as UNDP's Solar for Health initiative which is supporting governments to install solar systems in health centres and clinics in rural areas with the aim of promoting access to healthcare for all.[26] The policy action will enhance access to solar electricity which will boost the quality of healthcare by providing dependable source of power for maintaining the refrigeration required for safe and effective storage of vaccines and medicines, cold rooms and IT systems for stock management. This impact has been considered as "very likely "and "major".

Additionally, using solar electricity will help the healthcare facilities to obtain savings that would otherwise be spent on paying electric bills and on diesel power generation. These can be used to make operational improvements, purchase new equipment or simply operate more efficiently. UNDP has estimated that the return on investment by health facilities can hit 100 percent within two to five years, when health facilities with unreliable energy sources install solar systems. This impact has been considered as "likely "and "moderate".

Gender equality and women empowerment

Energy poverty, one aspect of broader economic poverty, has distinct gender characteristics that disproportionately affect women and girls. In particular, women and girls are often primarily responsible for collecting fuel and water at the community level (UNDP, 2016). Increasing access to solar electricity will bring disproportionate benefits for women - in health, education and productive activities. Women spend more time than men in non-income-based domestic activities such as cooking and collecting water and fuel to satisfy the demand for their households. This also exposes them to health risks associated with the toilsome work of energy and water collection. This burden consequently results in 'time poverty' which is described as the lack of time for rest and leisure after considering the time spent working, whether in the labour market or at home. Implementation of the policy action will help to improve on the health and productivity of women by providing better access to modern energy for lighting and pumping water. This impact has been categorized as "very likely "and "major".

Access to solar lighting and motive power shall also save on the time and energy spent in search of fuelwood and water. Women are also exposed to other health risks linked to the toilsome work of energy collection. They carry greater loads compared to men but have a lower intake of calories as most customs dictate that men receive more food and water. Women's poor nutrition vis-à-vis their workloads increases their susceptibility to anaemia and

[24] https://www.irena.org/documentdownloads/publications/irena_water_energy_food_nexus_2015.pdf

[25] https://www.esi-africa.com/india-best-practice-solar-power-can-improve-healthcare-services/

[26] https://stories.undp.org/solar-for-health?locale=en%3Fmore%3Dtrue%3Fmore%3Dtrue

perinatal mortality, while the drudgery of energy collection could entail postnatal complications and takes a toll on women's well-being. According to UNDP, the diffusion and increased uptake of renewable technologies, coupled with the spread of energy-efficient household practices like the use of improved cookstoves, benefits women on many levels. It reduces drudgery in energy collection, and it has the potential to promote social progress in poor communities[27]. The time saved will allow women to venture into other income generating activities and businesses that can increase their incomes. This impact has been considered as "very likely" and "major".

The policy shall also contribute immensely towards women empowerment. Women's empowerment is very crucial for economic growth and for sustainable development. Access to electricity enables women to enrol into trainings, education and literacy programs. Research in Brazil by UNDP shows that girls in rural areas with access to electricity are 59 percent more likely to complete primary education by the time they are 18 years old compared to those without. The K-OSAP programme presents a unique opportunity to not only empower women to be more energy efficient energy at the household and community levels but also to be committed about expanding access to sustainable renewable energy and to enter the energy industry as workers or entrepreneurs. This impact has been assessed as "likely "and "moderate".

Improved business environment

The implementation of the policy is expected to impact on the economic activity of the community, through creation of new businesses, longer working hours and increased productivity. Lack of electricity especially after dark usually people the opportunities for earning income by cutting the productive day short due to insufficient or unreliable light.[28] Access to solar electricity through the policy intervention will lead to a conducive business environment through improved lighting in business operation areas, prolonging working hours and enhancing security. The probability of this impact occurring is "very likely "and will have "major" effect on the community especially business persons.

Further as discussed above, solar electricity has been viewed to improve communication and information access through mobile phones and media (radio and televisions). This has a major impact on business due to increased income from sales, and access to marketing and communication and financial services to boost businesses. Previous studies report increases in income of businesses ranging from 20-70% (Kirubi et al., 2009; Willcox et al., 2015) and up to 140% for households with access to electricity (Willcox et al., 2015). This impact is "likely" to occur and can have "moderate" effects on businesses.

Access to clean, affordable and reliable energy

Access to energy is a main challenge affecting rural communities, especially women and children spend hours collecting firewood for domestic use like cooking, heating and lighting. According to a report by International Energy Agency (2012), around 40% of the world's population globally still rely on traditional biomass to meet household cooking needs. In sub-Saharan Africa, 70% of the rural population rely on traditional biomass and kerosene lamps for lighting, which contribute to pollution. Kenya has a high solar energy potential due to high insolation rates, with an average of 5-7 peak sunshine hours and average daily insolation of 4-6 kWh/m2.[29] This energy can be converted into electricity which can be utilized by the community for various uses. K-OSAP project intends to provide electricity to approximately 1,272,525 households, 1,097 community facilities and 620 boreholes.

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[27] https://www.undp.org/content/dam/undp/library/gender/Gender%20and%20Environment/UNDP%20Gender%20and%20Sustainable%20Energy%20Policy%20Brief%204-WEB.pdf

[28] https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10229.pdf

[29] https://www.africa-eu-renewables.org/market-information/kenya/renewable-energy-potential/

Additionally, 150,000 efficient cook stoves will be sold and installed in the target counties which will have an impact on ensuring access to clean, efficient and reliable cooking methods (PAD, 2017).

Recently, international attention has refocused on the continued cooking with solid fuels as it has been linked to high rates of respiratory tract infections among the people using them. In addition, the use of traditional and even ceramic-lined cookstoves has lagged behind the innovation in the marketplace. New stoves are being produced that can raise the energy efficiency by 100 percent, thereby reducing exposure to ground-level pollutants and reducing household expenditures on fuel supplies. Following this international trend, the GoK has recently removed all import duties and value added tax from improved stoves. Not only has this helped reduce the retail price of the improved stoves being sold in Kenya, but it has also shown the industry that the GoK will listen to the stove industry stakeholders and values the contribution that these products can make to national development. Given that solar power is a dependable and cost-effective energy source, implementation of this policy will "very likely" lead to increased access to clean, affordable and reliable electricity, with "major" impact on the livelihoods of the beneficiary households.

Monetary savings

Use of kerosene lamp is one of the main sources of lighting for households which are expensive to maintain. In Kenya, the current cost of kerosene is about Kshs. 104.30 which is relatively high. The policy promotes use of solar electricity which shall replace use of kerosene lamps for lighting. This will enable households to obtain savings previously spent in buying kerosene. The savings can be diverted to other uses such as buying food, education costs (i.e. fees, uniforms, books), farming inputs such as fertiliser, seeds, and equipment, and investment in other types of small-scale businesses. Further, the likelihood of achieving this impact is "very likely" and its magnitude will be "moderate" upon successful implementation of the policy.

Agricultural productivity

Solar powered water pumps can play a key role in boosting agriculture through irrigation. In rural areas where diesel fuel is expensive or where reliable access to the electricity grid is lacking, these pumps can provide a relatively flexible and climate friendly alternative energy source and can be used for both small and large-scale irrigation. This will allow for livelihood diversification for the communities especially in pastoralism dependent areas as access to water will enable venture into small scale irrigated agriculture and establishment of kitchen gardens. The implications of solar energy in agricultural production has been identified as "likely" and if well effected can have "major" effects in boosting food security.

According to Food and Agriculture Organization (FAO), at least one-third of food produced is lost or wasted globally through the food chain.[31] Using solar electricity helps in managing post-harvest losses through possible refrigeration and value addition processing, which enhances sustainability and competitiveness. Energy is required to preserve food, extend its availability over a longer period and reduce post-harvest losses. Food drying stands out among other food preservation techniques because it can be performed using low-temperature thermal sources and is applicable to many different food types (including fruits and vegetables), and the dried food is usually light in weight, easily stored and transported, and has an extended shelf life. The policy will facilitate access to solar electricity by households which can be utilised to preserve food thus reducing post-harvest losses. The occurrence of this impact is "possible", but the magnitude has been identified as "moderate".

[30] https://www.erc.go.ke/maximum-retail-pump-prices-for-the-period-15th-january-2019-to-14th-february-2019/

[31] http://www.fao.org/docrep/014/mb060e/mb060e02.pdf

Waste generation and disposal

Use of solar electricity has led to reduced waste generation and disposal from fossil fuels and e-waste connected with the use of dry-cell batteries. The likelihood of this impact has been indicated as "likely", and the magnitude "moderate", due to the expected reduction in the quantity of waste.

However, solar PVs have been associated with increased generation of electronic waste arising from recycle and disposal of spent batteries at the end of their useful lives, which is usually 3-5 years. As the global PV market increases, so will the volume of decommissioned PV panels. Given an average panel lifetime of 30 years, large amounts of annual waste are anticipated by the early 2030's. According to IRENA, (2016), growing PV panel waste presents a new environmental challenge, but also unprecedented opportunities to create value and pursue new economic avenues. These may include recovery of raw material and the emergence of new solar PV end-of-life industries. Rechargeable batteries for storing solar energy may run on nickel cadmium, nickel metal hydride, lithium-ion, lead-acid or lead-gel. The world's total annual electrical and electronic waste (e-waste) reached a record of 41.8 million metric tonnes in 2014. Annual global PV panel waste was 1,000 times less in the same year. Yet by 2050, the PV panel waste added annually could exceed 10% of the record global e-waste added in 2014[32]. Due to the anticipated environmental and human health impacts such as cancers, irritation of skin and respiratory system, damage to skin and eyes, and corrosion, these batteries should not be disposed in standard landfills due to presence of heavy metals such as mercury, lead, cadmium and nickel.

In Africa, recycling and disposal facilities for electronic waste (e-waste) are not common and often tend to be based in large cities. Limited knowledge about the associated hazards of not appropriately recycling waste from solar systems such as batteries poses a potential risk for the environment. The program is anticipated to lead to an increase in e-waste from solar PV and batteries which is believed to be "possible", due to the uncertainty of the situation, and "major" due to the large quantities of PV e-waste that will be generated.

Impact on land and biodiversity

Some activities of the project may result to minimal loss of use of property, vegetation, or land by the affected person. This is likely to occur due to clearance during construction and installation of the mini-grids in the remote areas, installation of solar water pumps and construction of the low voltage distribution lines to connect electricity to new customers. The effects will result in an interruption in the current use of property or land by the affected person during installation of solar panels or mini-grids. This is a permanent effect but has been addressed through a resettlement policy framework (RPF) has been prepared to ensure all the affected persons are fully compensated and their livelihoods restored in accordance with the World Bank Policy on Involuntary Resettlement, OP 4.12. These are direct impacts and have been considered as "very likely" but their magnitude is "minor" since a compensation plan is in place.

7.2 Summary of qualitative impacts

Table 5 below gives a summary of the qualitative impacts by listing the impact categories qualitatively, and their specific impacts evaluated according to their likelihood, magnitude, and significance.

[32] https://www.irena.org/documentdownloads/publications/irena_ieapvps_end-of-life_solar_pv_panels_2016.pdf

Table 9: Summary of Qualitative Impact Assessment

Impact Category	Specific impacts identified	Jurisdiction	Likelihood	Magnitude	Positive or negative Impact	Significance	Summary of qualitative assessment results for each impact category	Methods/sources used
Electricity access	Increased access to electricity by households currently not connected to the grid	In	Very Likely	Major	Positive	Yes	The policy will increase access to solar electricity resulting to major positive impact on the communities in the 14 counties where policy will be implemented.	GoK, 2015 https://www.researchgate.net/publication/280689563_Solar_PV_for_Enhancing_Electricity_Access_in_Kenya_What_Policies_are_Required http://www.kplc.co.ke/content/item/1951/kenya-power-confirms-5.9-million-customers-connected-to-the-grid https://www.iea.org/energyaccess/database/
Poverty Alleviation	Increased productive economic activities by small and medium enterprises (SMEs) due to enhanced access to solar electricity.	In	Likely	Major	Positive	Yes	Major positive impact from increased economic activities for SME businesses.	https://www.researchgate.net/publication/278684170_Socio-economic_impacts_of_energy_poverty_alleviation_in_rural_areas_of_developing_countries https://rael.berkeley.edu/wp-content/uploads/2015/04/Kirubi-WorldDevelopment-minigrid-2008.pdf

Employment opportunities	Increased employment opportunities for the locals, in solar installation, distribution and maintenance	In	Very Likely	Major	Positive	Yes	Major positive impact from increased job opportunities in solar installation and maintenance.	https://www.ceicdata.com/en/indicator/kenya/unemployment-rate World Bank, (2016)
	Increased "ripple effect" on employment due to improvement of unrelated businesses and supply of local materials	In	Likely	Moderate	Positive	Yes	Moderate positive impact due to increased employment creation in unrelated business due to access to solar electricity.	
Education Benefits	Increased quality and length of study time by children	In	Very Likely	Major	Positive	Yes	Major positive impact from prolonged study time due to electricity access, and enhanced quality of study due to improved luminescence	https://nextbillion.net/solar-lighting-in-remote-rural-areas-oversold-or-truly-illuminating/
	Increased teaching hours by teachers	In	Likely	Minor	Positive	No	Minor positive impact from increased teaching hours at school by teachers due to availability of electricity.	https://sustainabledevelopment.un.org/content/documents/1608Electricity%20and%20Education.pdf
	Increased quality of education	In	Likely	Moderate	Positive	Yes	Moderate positive impact from increased quality of education due to improved access to facilities such as laboratories and computers.	https://rael.berkeley.edu/wp-content/uploads/2015/04/Kirubi-WorldDevelopment-minigrid-2008.pdf

	Increased staff retention in schools	In	Possible	Minor	Positive	No	Minor possible impact due to increased staff retention due to attraction of teachers into areas with access to solar electricity	https://sustainabledevelopment.un.org/content/documents/1608Electricity%20and%20Education.pdf
Improved security	Improved lighting in rural areas	In	Very likely	Major	Positive	Yes	Major positive impact due to access to lighting in rural areas especially through community flood masts	
Access to communication, information and entertainment facilities	Increased ease of communication due to access to radio, tv and mobile phones	In	Very likely	Major	Positive	Yes	Major positive impact from increased communication through mobile phones and electronic media due to access to solar electricity.	https://www.lightingafrica.org/wp-content/uploads/2016/12/Uganda-2.pdf
	Increased access to information	In	Likely	Moderate	Positive	Yes	Moderate positive impact from increased access to important information shared through the media	
	HIV/AIDS control	In	Very likely	Major	Positive	Yes	Major positive impact from increased HIV/AIDs awareness creation through media.	https://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/kenya
Availability of freshwater	Increased access to clean water for consumption and agriculture	In	Very likely	Major	Positive	Yes	Major positive impact due to increased access to clean water through solar water pumps	https://water.org/our-impact/kenya/ https://www.irena.org/documentdownloads/publications/irena_water_energy_food_nexus_2015.pdf

Accessibility to Quality healthcare	Increased access to healthcare facilities due to access to dependable power for storing vaccines	In	Very likely	Major	Positive	Yes	Major positive impact due to enhanced access to healthcare facilities.	https://www.esi-africa.com/india-best-practice-solar-power-can-improve-healthcare-services/
	Improved healthcare facilities due to power savings	In	Likely	Moderate	Positive	Yes	Moderate positive impact due to improvement in healthcare facilities due to obtained power saving by using solar energy.	https://stories.undp.org/solar-for-health?locale=en%3Fmore%3Dtrue%3Fmore%3Dtrue
Gender Equality and women empowerment	Improved health and productivity of women	In	Very likely	Major	Positive	Yes	Major positive impact from improved health and productivity of women through solar electricity	UNDP, 2016
	Increased opportunities to venture into other income generating activities	In	Very Likely	Major	Positive	Yes	Major positive impact from increased opportunities to venture in income generating activities	https://www.undp.org/content/dam/undp/library/gender/Gender%20and%20Environment/UNDP%20Gender%20and%20Sustainable%20Energy%20Policy%20Brief%204-WEB.pdf
	Increased opportunities for women to enroll into trainings, education and literacy programs	In	Likely	Moderate	Positive	Yes	Moderate positive impact from enhanced opportunities for women to enroll into literacy programs	
Improved business environment	Increased new businesses opportunities, longer working hours and increased productivity	In	Very likely	Major	Positive	Yes	Major positive impact from solar electricity is significant	https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10229.pdf

	Increased business operations due to better communication and information access	In	Likely	Moderate	Positive	Yes	Moderate positive impact due to increased access to communication and information.	https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10229.pdf (Willcox et al., 2015); (Kirubi et al., 2009)
Access to clean, affordable and reliable energy	Increased access to clean, affordable and reliable energy	In	Very likely	Major	Positive	Yes	Major positive impact from access to solar electricity by communities	IEA, 2012 https://www.africa-eu-renewables.org/market-information/kenya/renewable-energy-potential/
	Access to clean, efficient and reliable cooking sources	In	Very likely	Major	Positive	Yes	Major positive impact from access to improved cookstoves by communities	PAD, 2017
Monetary savings	Increased household energy expense savings	In	Very likely	Moderate	Positive	Yes	Moderate positive impact from increased savings by households through use of solar electricity	https://www.erc.go.ke/maximum-retail-pump-prices-for-the-period-15th-january-2019-to-14th-february-2019/
Agricultural productivity	Increased productivity due to improved access to water for irrigation through solar powered pumps	In	Likely	Major	Positive	Yes	Major positive impact due to access to water for irrigation from solar pumps	http://www.fao.org/docrep/014/mb060e/mb060e02.pdf https://www.erc.go.ke/maximum-retail-pump-prices-for-the-period-15th-january-2019-to-14th-february-2019/
	Reduced post-harvest losses	In	Possible	Moderate	Positive	Yes	Moderate positive impact from reduced post-harvest losses due to solar technology	http://www.fao.org/docrep/014/mb060e/mb060e02.pdf

Waste generation and disposal	Reduced waste generation and disposal from fossil fuels and e-waste connected with the use of dry-cell batteries	In	Likely	Moderate	Positive	Yes	Moderate positive impact due to reduced waste generation from fossil fuels	
	Increase e-waste generation from solar PV and batteries	Both	Possible	Major	Negative	Yes	Major negative impact due to increased and poor disposal of e-waste from solar PV and batteries.	https://www.irena.org/documentdownloads/publications/irena_ieapvps_end-of-life_solar_pv_panels_2016.pdf
Impact on land and biodiversity	minimal loss of use of property, vegetation, or land	In	Very likely	Minor	Negative	No	Minor negative impact from minimal loss of land and biodiversity, insignificant effect	

CHAPTER 8: QUANTITATIVE IMPACT ASSESSMENT

8.0 Climate Change Mitigation

The impact of the K-OSAP on Climate Change Mitigation has been assessed using the GHG emissions, expressed as tCO_2e. In the baseline scenario, combustion of kerosene by households is found to be the main contributor of GHG emissions accounting for 78%. In the policy scenario, the project is expected to contribute significant GHG emissions avoidance by replacing household usage of candles, kerosene, and charcoal fuels as well as diesel and firewood consumption in public facilities and farms. Most project activities will not directly emit GHG due to the use of solar technologies, except for mini-grids that will be partially be fuelled by diesel, as well as cookstoves that will continue to use renewable biomass fuels. For systems such as mini-grids, household SHS, community SHS, and solar pumps, GHG emissions over 20 years have been analysed. For household cookstoves, GHG emissions have been analysed over 5 years due to their shorter economic life. Total baseline emissions are estimated to be 5,096,218 tCO_2e, whereas the project emissions total 1,198,829 tCO_2e . Therefore, the project will result in 3,897,389 tCO_2e of emissions reduction. In the policy scenario, the project anticipates displacing about 3,890,000 tonnes of tCO_2e emissions, which represents a 76% drop compared with the baseline scenario.

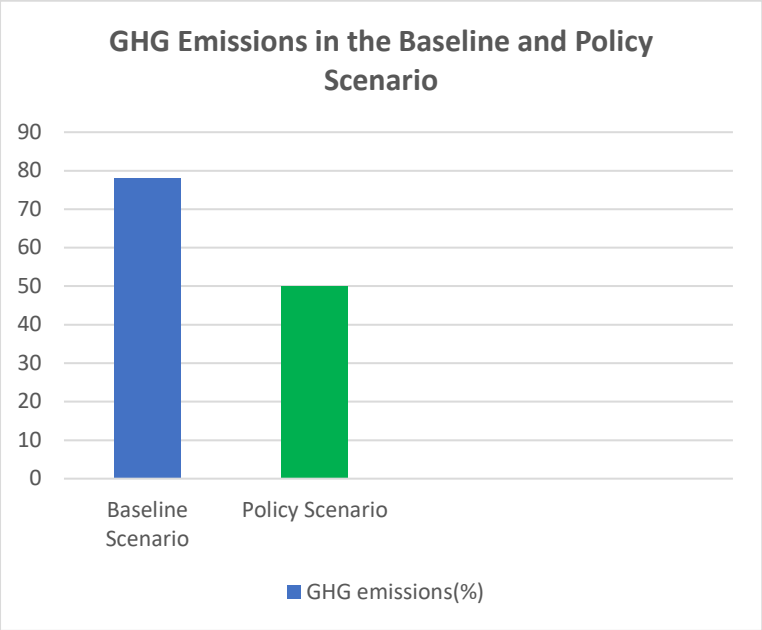

Figure 5: GHG emission levels in the baseline and policy scenarios

8.2 Monetary Savings

Information on the exact amount of money spent by businesses, community facilities and households, on purchase of kerosene and other types of fossil fuels is not readily available and hence the results included for this impact category is a perceived average. Various surveys conducted in Kenya in recent years, report expenses for kerosene ranging from US$ 2.08 to US$ 5.26 per month. The average monthly spend on kerosene was Kshs.399.28 .

Costs for using other sources such as candles and batteries are around US $ 4.15-4.42 per month.

Monthly expenses for charging mobile phones are US $2.06 (Rom et al., 2017; Van Acker et al., 2014; Carbon Africa Limited et al., 2015). The average expenditure on mobile phone charging each month was Kshs.115 (US$ 1.34), but the distribution has an unusual modality. The average cost per mobile phone charge was Kshs.20

(US$ 0.23), a value similar to that reported in developing communities in other parts of the world. Local people in areas without access to generators or PV panels can travel an average distance of between 0.9 Km to 2.3 Km to recharge their mobile phones. This indication shows that the policy has an opportunity in the target areas and will impact the community through creation of new businesses such as mobile phone charging businesses.

5% of the businesses within the policy area have been assumed to use diesel generators and consume 2.78 L of diesel daily. Considering a price of 1.12 US$/L ("Kenya diesel prices | GlobalPetrolPrices.com,") and normalising that for the 1% of the customers, a monthly average expense of US$ 1.04 is estimated. Finally, Pueyo & DeMartino (2018) report a monthly cost of US$ 4.86 for SHS. Considering that it has been assumed that 13% of households and 25% of businesses use SHS, an average monthly cost of US$ 0.77 is derived among those assessed.

The expenditures on batteries was typically for small capacity disposable dry cell batteries, such as those used in radios or flashlights. The average monthly expenditure on batteries was Kshs.300.1 (US$ 3.50) per month. This is higher than the US$ 1.27 average reported in other rural villages in Africa [10]. Monthly expenditure on candles averaged Kshs.55.8 (US$ 4.65), but exhibited a large spread evidenced by a standard deviation of Kshs.114.1 (US$ 1.33).

The total monthly expenditure on energy sources likely to be replaced or reduced by the solar PV project averaged Kshs.933.14 (US$ 10.86).

Table 10: Comparison of baseline and policy scenario

Scenario	Baseline scenario				Policy scenario
Source	Kerosene	Candles and batteries	Mobile charging	Diesel generator	Standalone solar systems for communities and households (National Uniform tariff)
Cost	2.08-5.26 (US$/month)	4.15-4.42 (US$/month)	2.06 (US$/month)	1.04 (US$/month)	0.20 (US$/kWh)
Total cost /month	US$ 10.10-13.55 ($/month)				6.08 ($/month)

Source: Adapted from Maco, 2018

8.3 Improved Air Quality

Indoor air pollution has been reported to kill about 3.8 million people annually from illness attributable to the household air pollution caused by the inefficient use of solid fuels and kerosene for cooking (WHO, 2018). However, these estimates only focused on emissions from cooking, and not from lighting, which is considerably less. If we consider the total population under assessment, which is estimated to be around 140,000, we get around 0.004 DALYs per person, due to indoor air pollution. Particulate matter has been used to calculate the Impact Score for Air Pollution. The results presented Table 8, reported in Disability-Adjusted Life Years (DALYs), reveal that the policy scenario is expected to substantially lower the Particulate Matter emissions of the baseline scenario by 96%, bringing a net impact of -593 DALYs.

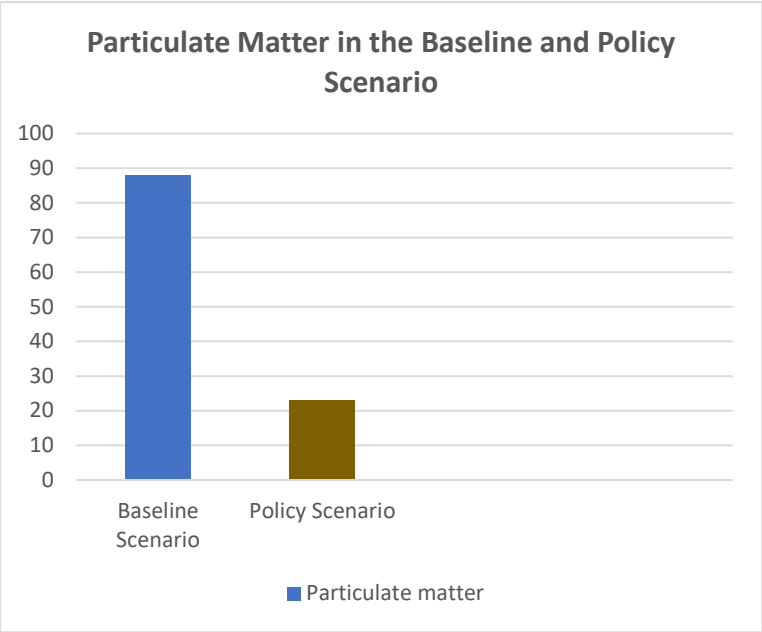

Figure 6: Analysis of particulate matter between baseline and policy scenario

8.4 Impact on Forest Resources

Nearly three billion people around the world burn wood, charcoal, coal, or kerosene in open fires or in inefficient stoves for daily cooking and heating. This reliance on inefficient cookstoves and fuels leads to a wide variety of environmental problems including environmental degradation, air pollution, and climate change. Study shows that household air pollution accounts for about 12% of ambient air pollution globally. The ambient pollution which occurs as a result of household cooking with solid fuels has major implications for both human health and the environment. In addition to air pollution, burning solid fuels releases emissions of some of the most important contributors to global climate change such as carbon dioxide, methane, black carbon, and other short-lived climate pollutants (SLCPs). In Kenya, it is estimated that biomass contributes about 76% of the primary energy needs. Due to population pressure for settlements, infrastructure, demand for wood products, and conversion to agriculture, forest cover had been reduced to about 6.9% in 2017(NCCAP 2018-2022). Using improved cookstoves have been shown to reduce fuelwood use by 30-60%, resulting in fewer greenhouse gas and black carbon emissions and reducing impacts on forests, habitats, and biodiversity.[33] A key action during the 2018-2022 medium-term planning period of the National Climate Change Action Plan is to increase the forest cover to at least 10% of the country's land area.

[33] http://cleancookingalliance.org/impact-areas/environment/

8.5 Summary of environmental benefits

Table 11: Analysis of environmental benefits between baseline and policy scenario

Impact category	Indicator	Baseline Scenario (1 year)	Policy scenario (1 year)	Net impact (1 year)	Baseline Scenario (7 years)	Policy scenario (7 years)	Net impact (7 years)	In-jurisdiction
Climate Change Mitigation	GHG emissions [tCO_2 e.]	6,900	1,800	-5,100	48,000	12,000	-36,000	-36,000
Reduced Air Pollution	Particulate matter [DALY]	88	3	-85	616	23	-593	-593
Impact on Forest Resources	Energy demand from biomass (%)	76	70	6	76	50	26	-26

CHAPTER 9: ASSESSING UNCERTAINTY

Uncertainty analysis refers to the systematic procedure to quantify or qualify the uncertainty associated with the impact assessment results (WRI and UNEP-DTU, 2018). The identification, documentation and assessment of uncertainties in a policy aims at highlighting the key parameters that may affect the level of confidence in the results obtained, and any other major areas of uncertainty. Level of confidence is used to express the certainty in validity of a parameter or value obtained. It is highly recommended that uncertainty analysis is done during the assessment in order to help in understanding and determining where to apply conservative estimates.

There are two approaches to uncertainty analysis which include both qualitative and quantitative analysis. Qualitative analysis is mostly used to assess qualitative impacts whereas quantitative approach can be used in both qualitative and quantitative assessment to give more robust, clear, transparent results. However, the approach chosen is determined by several factors including the objective of assessment, required accuracy level, data availability, capacity and resources.

In qualitative analysis, the level of certainty depends on quality and quantity of the evidence (robust, medium or limited) and degree of agreement of the evidence on a scale low-medium-high. Quantitative analysis entails characterising uncertainty of key parameters and the approaches used include using default uncertainty estimates, probability and standard deviations and uncertainty factors from literature sources.

In this assessment, most of the parameters used were adapted from previous research and review of literature. As such a detailed uncertainty and sensitivity analysis has not been conducted.

CHAPTER 10: MONITORING AND REPORTING

10.0 SDGs Performance

Implementation of the policy action is anticipated to impact 14 SDGs and 24 targets. This is based on the assessment done on the impact categories and the specific qualitative and quantitative impacts expected.

A detailed description of the impact categories and the SDG targets is presented in Table 12.

Table 12: Contribution of K-OSAP Towards Sustainable Development

Impact category	SDG target	Explanation
Climate Change mitigation	9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities 13.2 Integrate climate change measures into national policies, strategies and planning.	9.4. Implementation of the policy will impact on climate change mitigation through "reduced use on non-renewable energy sources such as kerosene and biomass" through adoption of clean and environmentally sound technology and resource-use efficiency. 13.2 The K-OSAP components has integrated climate change mitigation measures and its implementation is on a national level through the selected counties.
Improved Air quality	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.	3.9 Use of solar technology and improved cookstoves in the policy scenario will have an impact on "reduced indoor pollution" thus reducing the number of deaths and illnesses associated with air contamination.
Electricity access	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services. 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least	7.1 Some of the direct impacts of the policy include "Access to clean, reliable and affordable electricity" and "Access to clean sources of cooking" contribute to access to affordable, reliable and modern energy services 7.2 The policy shall impact the access to clean energy through adoption of renewable energy (solar), which will displace use of non-renewable energy such as fossil fuels, kerosene and biomass in target areas. 7.b The access to solar electricity evaluated in this impact category consists of construction, installation and distribution of modern infrastructure such as mini-grids and upgrade of existing technologies e.g.

	developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support.	solar powered boreholes in marginalized counties of Kenya which is a developing country.
Poverty Alleviation	1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance.	1.4 The policy shall enhance access to solar electricity which will enable locals' access basic services such as healthcare and education and improve businesses. This will ensure that even the vulnerable groups have access to basic services, appropriate new technology and financial services, including microfinance.
Employment opportunities	8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	8.3 The policy is in line with this target by increasing employment opportunities for the locals, in solar installation, distribution and maintenance "and "increased ripple effect on employment due to improvement of unrelated businesses and supply of local materials" hence stimulating productive activities, decent job creation, entrepreneurship, creativity and innovation, and encouraging the formalization and growth of micro-, small- and medium-sized enterprises in target areas
Education Benefits	4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes 4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy 4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all 4.c By 2030, substantially increase the supply of qualified teachers,	4.1 The policy action will impact on education through "Increased quality and length of study time by children" thus ensuring that all girls and boys have access to free, equitable and quality primary and secondary education 4.6 "Increased teaching hours by teachers" will help in ensuring that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy 4.a Through the impact "Increased quality of education" the action upgrades education facilities through access to solar electricity for running school facilities such as laboratories 4.c The specific impact "Increased staff retention in schools" will have an impact

	including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States	supply and retention of qualified teachers especially in rural areas.
Improved security	11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	The impact of "Improved lighting in rural areas" shall result to provision of safe, accessible and inclusive space for the local communities in the targeted areas
Access to communication, information and entertainment facilities	9.c. Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020 3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	9.c. The specific impacts "increased ease of communication" and "increased access to information" through radio, tv and mobile phones will be made possible by the policy, significantly increasing access to information and communication 3.3 Through the impact "HIV/AIDs control" the policy will increase access to communication and information sharing relating to HIV/AIDs awareness and management reducing number of new infections
Availability of freshwater	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1 The specific impacts "Increased access to clean water for consumption and agriculture" will affect access to safe and affordable drinking water for all through access to solar water pumps by locals.
Accessibility to Quality healthcare	3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	3.8 The specific impacts of the policy on "Increased access to healthcare facilities due to access to dependable power for storing vaccines" and "Improved healthcare facilities due to power savings" are strongly connected with accessing quality health-care services and vaccines for all.
Gender Equality and women empowerment	5.6 Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences 5.B. Enhance the use of enabling technology, in particular information	5.6 Through the specific impact "Improved health and productivity of women" the policy will support women in accessing information on sexual and reproductive health. 5.B. Through the specific impact "Increased opportunities for women to

	and communications technology, to promote the empowerment of women	enroll into trainings, education and literacy programs" due to access to information and communication technology.
	11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	11.7 The policy will impact on access to safer public spaces, in particular for women and children through "increased opportunities to venture into other income generating activities" due to access to solar power prolonging working hours especially at night.
Improved business environment	8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	8.3 Both through the specific impacts on "Increased new businesses opportunities, longer working hours and increased productivity" the policy is in support of productive activities, entrepreneurship, and growth of micro-, small- and medium-sized enterprises
	1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	1.4 By providing "improved business operations due to better communication and information access" the policy actions ensure that locals, have access to basic services, appropriate new technology and financial services, including microfinance for their businesses
Access to clean, affordable and reliable energy	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1 The specific impacts "Access to clean, reliable and affordable electricity" and "Access to clean, efficient and reliable cooking sources" contribute to access to clean, affordable, reliable energy services
	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	7.2 The access to solar energy evaluated in this impact category will occur through utilization of renewable energy, which will substitute use of fossil fuels and biomass in the target areas
	7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least	7.b The access to energy evaluated in this impact category consists of establishment of modern infrastructure and upgrade of technologies in a developing country

	developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support	
Monetary savings	10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average	10.1 By "Increased household energy expense savings", the economy of the households will improve due to support of income growth of the bottom 40 per cent of the population by the policy
Agricultural productivity	2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	2.3 The specific impact "increased productivity due to improved access to water for irrigation" and "reduced post-harvest losses" through use of solar powered pumps from boreholes will affect agricultural productivity of small-scale food producers.
Waste generation and disposal	12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment. 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	12.4 The specific impacts on "Reduced waste generation and disposal from fossil fuels and e-waste" and "Increased e-waste generation from solar PV and batteries" will have an effect on the generation and management of solid waste. 12.5 The same specific impacts will also have an effect on the waste cycle including prevention, reduction, recycling and re-use of waste
Impact on forest resources	15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.2 The impact categories on "improved utilization of forest resources" due to the policy initiative will promote sustainable management of forest through use of improved cookstoves.

10.1 Monitoring Indicators

Indicators play significant role in tracking the performance of the policy by monitoring the identified impacts categories and progress towards SDGs over time. This is necessary to track whether the policy/action is achieving the set goals, and within the set timelines as shown in figure 5.

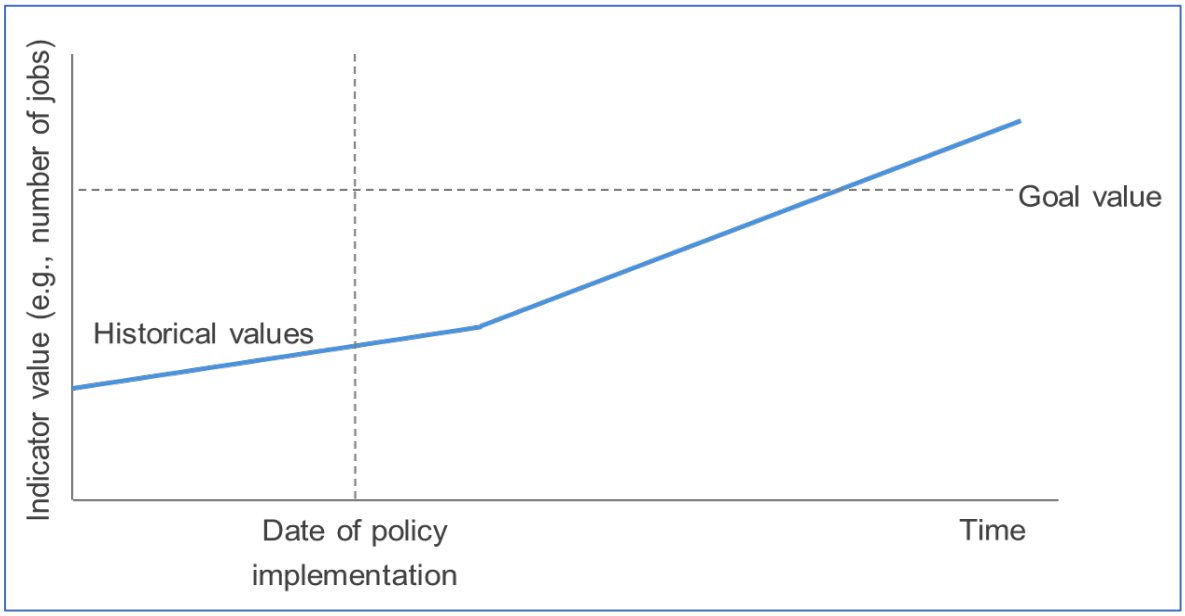

Figure 7: Monitoring performance of a policy/action over time

The monitoring plan has not been put in place at present but could be development ex-post using the proposed list, provided in Table 13 below.

Table 13: Proposed Monitoring Plan for Selected Impact Categories

Impact Category	Specific Impact (if applicable)	Indicator	Explanation (if necessary)
Climate Change mitigation (SDG 13)	Reduced use on non-renewable energy sources such as kerosene and biomass	GHG emissions [ton CO2 eq.]	Same indicator but the results should be updated with the new data chosen for the mini-grid, kerosene consumption, diesel usage, and number of unconnected customers.
Improved Air quality (SDG 3)	Reduced indoor pollution	PM [DALY]	Same indicator but the results should be updated with the new data chosen for the mini-grid, kerosene consumption, diesel usage, and number of unconnected customers.
Electricity access (SDG 7)	Increased access to electricity by households currently not connected to the grid	Number of households, businesses and community facilities connected to the grid	-
Poverty Alleviation (SDG 1)	Increased productive economic activities by small and medium enterprises (SMEs) due to enhanced access to solar electricity.	Number of new small and medium enterprises (SMEs) Change in economic output of existing SMEs connected to the grid	- -
Employment opportunities (SDG 8)	Increased employment opportunities for the locals, in solar installation, distribution and maintenance	Number of persons employed by companies working in the project	-
	Increased "ripple effect" on employment due to improvement of unrelated businesses and supply of local materials	Employment/unemployment rate in the target areas	-
Improved health benefits (SDG 3)	Reduced exposure to Indoor Air Pollution due to reduced use of kerosene and fuelwood	Number of indoor air pollution illnesses and deaths reported	-

Education Benefits (SDG 4)	Increased quality and length of study time by children	Number of hours spent studying at home and school	-
	Increased teaching hours by teachers	Number of extra teaching hours by teachers in schools	-
	Increased quality of education	Number of new facilities established in schools (labs, libraries, boarding halls e.t.c.)	-
	Increased staff retention in schools	Number of new qualified teachers employed and retained in schools	-
Improved security (SDG 11)	Improved lighting in rural areas	Number of community flood masts installed	-
Access to communication, information and entertainment facilities (SDG 9)	Increased ease of communication due to access to radio, tv and mobile phones	Number of households, businesses with access to mobile phones	-
	Increased access to information	Number of households, businesses with access to electronic devices (radio and tv	-
Availability of freshwater (SDG 6)	Increased access to clean water for consumption and agriculture	Number of new and existing boreholes installed with solar powered pumps	-
Accessibility to Quality healthcare (SDG 3)	Increased access to healthcare facilities due to access to dependable power for storing vaccines	Number of health centers/clinics with vaccines´ storage facilities/refrigerators	-
	Improved healthcare facilities due to power savings	Energy expense savings achieved by healthcare facilities using solar power ($)	-
Gender Equality and women empowerment (SDG 5, 8)	Improved health and productivity of women	-	Difficult to quantify. Interviews could be used for a qualitative evaluation.
	Increased opportunities to venture into other income generating activities	% of women who have ventured in income generating activities	-
	Increased opportunities for women to enroll into trainings, education and literacy programs	% of women enrolled into trainings, education and literacy programs	-
Improved business environment (SDG 8)	Increased new businesses opportunities, longer working hours and increased productivity	Number of new businesses with access to power established, Number of business operation hours per day	-
	Increased business operations due to better communication and information access	Number of businesses with access to using mobile phones and internet and electronic devices (tv, radio)	-

Access to clean, affordable and reliable energy (SDG 7)	Increased access to clean, affordable and reliable energy	% of households connected to the mini-grid % of business connected to the mini-grid % of institutions connected to the mini-grid	-
	Access to clean, efficient and reliable cooking sources	% of households with improved cookstoves % of households with light cooking solar appliances	-
Monetary savings (SDG 10)	Increased household energy expense savings	Average monthly savings [US$/month]	-
Agricultural productivity (SDG 2)	Increased productivity due to improved access to water for irrigation through solar powered pumps	Agricultural output ($)	-
	Reduced post-harvest losses	Number of refrigerators for food storage and solar powered food drying facilities	-
Waste generation and disposal (SDG 12)	Reduced waste generation and disposal from fossil fuels and e-waste connected with the use of dry-cell batteries	-	Quantitative assessment of the indicator is not feasible but can be monitored through qualitative assessment.
	Increased e-waste generation from solar PV and batteries	Number of mini-grids and standalone solar systems with a proper end-of-life waste management plan in place	-
Impact on forest resources (SDG 15)	improved utilization of forest resources	Number of households with modern improved cookstoves	-

CHAPTER 11: CONCLUSION

Using the ICAT Sustainable Development Guidance and stakeholder participation tool to complete the SD assessment has been an iterative learning process. Users including governments, donor agencies and financial institutions, businesses, research institutions and NGOs, and stakeholders affected by the policy/action can adopt the tool to assess the environmental, social and economic impacts of policies and actions. The tool is applicable to any level of government (national, subnational, municipal) in all countries and regions, and can be adopted by multiple sectors. Further it can be applied for planned, adopted or implemented policy/actions, and for new policies/actions, or extensions and modifications of existing policies/actions.

Further, the guidance was found to be user friendly, flexible and participatory which is key in building sustainability of policies/actions. However, some aspects of the assessment such as establishing the baseline and conducting quantitative analysis are slightly technical. This can be addressed through capacity building to train the users on how to conduct the assessment effectively. Also, conducting the stakeholder consultations is resource intensive in terms of finances and time. However, given the overall outcome of the process, it is worthwhile for users to apply the guidance in order to achieve an objective, transparent and participatory reporting on sustainable development impacts of a policy/action. Additionally, this not only builds an understanding of the assessment but also creates a sense of trust and ownership by the involved stakeholders.

During the validation workshop of this report, all the stakeholders agreed that the ICAT Sustainable Development Guidance and stakeholder participation tool were very useful in their work and that they needed urgent capacity building to be able to apply the guidance on their projects and programmes.

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