



Liberia

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE MITIGATION

REPORT III

TECHNOLOGY ACTION PLAN FOR THE ENERGY SECTOR OF LIBERIA

March 2022



TECHNOLOGY ACTION PLAN FOR CLIMATE CHANGE MITIGATION TECHNOLOGIES IN THE ENERGY SECTOR OF LIBERIA

REPORT III

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Disclaimer

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Foreword



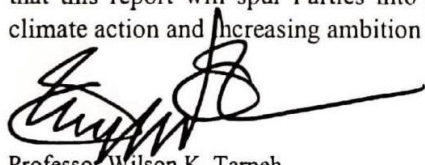
In September 2015, Liberia, as a signatory to the UN Climate Change Convention, submitted the Nationally Determined Contribution (INDC) in advance of the new climate change agreement reached at the UN Climate Conference in Paris in December. Liberia's INDC was designed as a platform to integrate its Low Carbon Development Strategy into the country's long-term sustainable development Vision by 2030 (Agenda for Transformation). Liberia ratified the Paris Agreement in August

2018 and is working hard to revise its NDC for submission.

Regardless of the many contributions to climate change, Liberia, like many other developing countries, is especially vulnerable to its impacts. The country is at this moment susceptible to the adverse effects of climate change such as Shifting cultivation in the agriculture sector, unsustainable logging practices, unregulated coastal mining, high level of biomass consumption in the form of charcoal and fire wood for local energy use, and decreasing river flow due to high level of evaporation. The agricultural sector, which ensures the livelihoods of around 70% of the population remains vulnerable to flooding, erosion with changing rainfall patterns putting lives at risk in a country where nearly 8 out of 10 people do not have secure access to food. Current climate change vulnerability in Liberia include; increase in extreme events (e.g., exacerbated floods, extreme drought), sea level rise, flooding and coastal erosion being experienced on an annual basis that eats up the coast as observed in Monrovia, Buchanan and Greenville.

I would like to add that Liberia has an overall lack of energy. In most rural areas in Liberia, less than 5% of the population has access to electricity while most homes run mini generators. The current energy situation in Liberia is characterized by a dominance of traditional biomass consumption, low access to poor quality and relatively expensive modern energy services. It is estimated that over 95% of the population rely on firewood, charcoal, and palm oil for their energy needs.

The EPA of Liberia is overly happy with the level of the assessment done by the Technology Needs Assessment Team (TNA) through a national stakeholder's participatory process emulating from the identification and prioritization of environmentally sound technologies to the diffusion of these technologies to mitigate and adapt to climate change. We would like to recognize the United Nations Environment Programme (UNEP), DTU Partnership and Global Environment Facility (GEF). Your contributions have resulted in this rich source of information and we hope that this report will spur Parties into seeking out partnerships for the purpose of accelerating climate action and increasing ambition in Liberia.

A handwritten signature in black ink, appearing to read 'Wilson K. Tarpeh', written over a horizontal line.

Professor Wilson K. Tarpeh
EXECUTIVE DIRECTOR/CEO

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List of Acronyms and Abbreviations

AfDB	African Development Bank
AfT	Agenda for Transformation
BAEF	Barrier Analysis and Enabling Framework
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
ECOWAS	Economic Community of West African States
EPA	Environmental Protection Agency
ERC	Energy Research Centre
EU	European Union
GCF	Green Climate Funds
GEF	Global Environment Facility
GHG	Greenhouse gas
GoL	Government of Liberia
GW	Gigawatt
HAP	House-hold Air Pollution
INC	Liberia's Initial National Communication
INDCs	Intended Nationally Determined Contributions
IPPs	Independent Power Producers
kW	Kilowatt
kWh	Kilowatt-hour
LEAP	Liberia Energy Access Practitioners Network
LEC	Liberia Electricity Corporation
LERC	Liberia Electricity Regulatory Commission
LFA	Logical Framework Approach
MCA	Multi-Criteria Analysis
MFDP	Ministry of Finance and Development Planning
MCA	Multi-criteria analysis
MIC	Middle-income country
MME	Ministry of Mines and Energy

MPW	Ministry of Public Works
MW	Megawatt
NGOs	Non-Governmental Organizations
NIC	National Investment Commission
O&M	Operation and Maintenance
PIs	Project ideas
PV	Solar photovoltaic
RESMP	Rural Energy Strategy and Master Plan
RREA	Rural & Electrification Energy Agency
SDGs	Sustainable Development Goals
SHP	Small hydropower
SHS	Solar home system
SMG	Solar Mini-grid
TAP	Technology Action Plan
TJ	Terajoules
TNA	Technology Needs Assessment
TORs	Terms of references
TVET	Technical and Vocational Education and Training
UDP	United Nations Environment Programme and Technical University of Denmark Partnership
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-CCC	United Nations Environment Programme Copenhagen Climate Centre
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank

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Report III

Technology Action Plan

Executive Summary

Liberia is one of 23 countries taking part in Phase III of the Technology Needs Assessment (TNA) process under the United Nations Framework Convention on Climate Change (UNFCCC) technology mechanism on technology development and transfer from 2018 to 2020. The process was extended until 2021 as a result of the COVID-19 pandemic. The TNA process aims to help developing countries who are parties to the UNFCCC decide on their technological priorities for mitigating greenhouse gas emissions and climate change.

The Technology Needs Assessment Report III is the third and final phase of the TNA process. This phase builds on the outcomes of two prior reports, "*Technology Needs Assessment (TNA Report I)*" and "*Barrier Analysis and Enabling Framework for Mitigation (TNA Report II)*". In Report I, the technologies for climate change mitigation in Liberia's energy sector were identified and prioritised using multi-criteria analysis (MCA). The prioritized technologies selected were Solar PV Home System (SHS), Solar PV Mini-grid System (SMG) and Small Hydropower System (SHP) respectively. Report II documents the barriers impeding the acquisition, deployment and diffusion of the prioritized technologies in the country. The second report discusses in detail the appropriate measures to overcome the identified barriers and create an enabling environment for the implementation of the prioritized energy sector's technologies.

This TAP report (Report III) is intended to serve as a strategic tool for securing funds at the national, regional, and international levels to facilitate the successful diffusion of the prioritized technologies for climate change mitigation. It also serves as a valuable source of information for both national and international stakeholders for the purposes of planning, improving coordination and collaboration among responsible bodies and promoting mitigation technologies. The TAP defines actions and activities, funding sources, responsible body and focal point, time frame, risks, success criteria, budget per activity and indicators for monitoring of implementation. Some of the TAP's actions and activities are developed further as Project Ideas in order to secure funding for implementation.

To produce the TAPs the following processes were followed: (a) The ambition of the TAP was provided, (b) Actions and activities selected for inclusion in the TAP were outlined, (c) Stakeholders and timelines for implementation were listed, (e) Scheduling and sequencing of activities were provided, (f) Summary costs and resources needed for actions and activities were estimated, (g) Technological action plans for mitigation technologies, (h) Management planning including risk management and contingency measures were identified, (i) Summary of immediate requirements and critical steps for implementation were provided, and finally (j) Project ideas were developed.

The last part of the TAP report focuses on Project Ideas prepared for the three prioritized technology in the energy sector which can be found in Tables 1.26, 1.27 and 1.28 of the report. The specific PIs identified and developed for each of the technologies are (a) Specific Project Idea 1: Deployment of solar PV rooftop systems in 500 rural public schools in Liberia, (b) Specific Project Idea 2: Construction of 70 kW solar PV-diesel hybrid mini-grid power plant and clean water system for three districts hospital in Lofa County, Liberia and (c) Specific Project Idea 3: Promotion of small hydropower plants in Liberia.

The following are the next steps that should be taken as soon as possible for TAP development in the country's energy sector:

- The EPA should ensure that the TAP's outcomes are approved at the Cabinet level.
- Project proposals based on the project ideas should be develop as soon as possible.
- Government engagements with donors must begin early to secure financing for TAP projects so that activities timelines are met.

The TAP overview for the technology Action Plan is presented in the tables below.

TAP overview table for Solar PV Home System

TAP overview table								
Sector	Energy							
Sub-sector	Electricity production							
Technology	Solar PV Home System							
Ambition	By 2030: Provide 200,000 households in five rural communities in each of the 15 counties of the country with solar PV home systems.							
Benefits	Social	<ul style="list-style-type: none"> - Saved income to be used for other needs - Some job creation through availability of electricity - Reduce gender inequality and encourage stronger participation of women on rural energy sector activities 						
	Economic	<ul style="list-style-type: none"> - Electricity bill savings - Income generating opportunities with availability of electricity 						
	Environment	<ul style="list-style-type: none"> - Greenhouse gas emissions avoided 						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity (US\$)
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	GoL, CTCN, WB, AfDB, GIZ, USAID	EPA	2021 - 2023	Non-commitment and bureaucracy on the part of responsible body	- Fully equipped implementation unit with highly competent personnel	- A working implementation unit meeting key performance index	25,000
Action 2 Reduce cost of SHS equipment	2.1 Solicit inter- national financial support from develop- ment partners to leverage the domestic financial environment for off-grid electrifi- cation using SHS technology.	GEF, GCF, EU, AfDB, USAID	LERC, EPA, RREA	2021 - 2024	Delay in securing donor financing	- Increased number of projects and budget for SHS - Amount of bilateral and multilateral financing	- Number of project proposal developed, submitted and funded	1,000,000
	2.2 Provide appropriate subsidies, incentives and waiver of customs import duties on all SHS components for suppliers and end-users.	GoL	MFDP	2021- 2024	Delay in decision making by GoL regarding incentives and subsidies	- Implementation of a comprehensive incentives and subsidies policy for the diffusion of the technology	- Number of new homes deploying SHS technology - Number of distribution outlets nation-wide	20,000
Action 3 Enhance access to financing	3.1 Work with developers to provide innovative and affordable financial plans or business models for the purchase of SHS targeted at people in the rural and peri-urban areas who are not connected to the national grid.	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, GEF, UNFCCC,	EPA RREA	2021 - 2025	Customer growth rates could fall well below those envisaged in the business plans or models	- Development of a well-designed business model for SHS technology that is relevant and appropriate for the Liberian context - Number of private developers involved in SHS deployment	- High uptake of SHS electricity using business model - A well-designed business model for SHS technology that is relevant and appropriate for the	15,000

	3.2 Encourage commercial banks to lower the interest rate and extend the duration on loans	GoL	EPA MFDP	2021 - 2024	Delay due to insufficient resources	- Increased and available favorable loans for SHS - Increased number of projects that accessed loans	Liberian context -Increased number of loans for business and investment in SHS technology; -Number of SHS systems deployed in rural areas	10,000
	3.3 Make the Renewable Energy Development Fund fully operational to provide loans with zero or low interest rates with acceptable loan duration for poor rural households to acquire SHS.	GoL, WB, AfDB, EU, GCF, GEF	EPA RREA MFDP	2022 - 2026	- Delays due to insufficient resources or limited access to low interest loans	- Sufficient funds available to support SHS projects - Soft loans are made accessible	- Number of financial mechanisms from government and international partners available to make Renewable Development Fund sustainable	15,000
	3.4 Provide support for local production of components to lower the initial investment cost of SHS for suppliers and customers.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GCF, UNEP, CTCN, GEF,	MFDP MME	2022 - 2027	Poor response from high-quality components manufacturers	- High quality manufacturers are keen to set up local production of solar PV components in the country	- The technology supplied conforms to the best practice of the day - Manufacturer performance guarantees on the modules	1,000,000
Action 4 Increase awareness and knowledge on SHS	4.1 Intensify adequate information, public education and awareness campaigns on SHS for different stakeholders through print and electronic media, social media, seminars, workshops, conferences and community engagements.	GEF, GCF, EU, USAID, WB	EPA LEC RREA	2021 - 2027	Unqualified public relations team	- Public awareness campaigns and program for SHS technology implemented - 80% of rural communities are aware of SHS technology and financial support	Information and awareness programs are approved and implemented	500,000
	4.2 Establish information hubs or centers in each county to increase and improve the awareness about SHS equipment costs, benefits and performance for local communities, financial institutions, cooperatives, and entrepreneurs.	GoL, WB, EU, other developing partners	EPA RREA	2021 - 2027	Inadequate funds available	- Number of information hubs or centers established in all counties of the country	- Number of information hubs or centers established in all counties of the country	800,000

Action 5 Build or strengthen capacity of key stakeholders	5.1 Provide periodic and specialized technical training courses in solar PV home systems installation, operation, management, maintenance and business development to strengthen the capacity of personnel, such as technicians, private entrepreneurs or developers and engineers, with inclusive gender participation.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF, GCF	EPA RREA Tertiary institutes	2022 - 2028	- Preference is in favor of international experts - Local trained staff and technicians remain unemployed	- Availability of highly trained Liberian engineers and contractors - Number of institutions implementing training programs	- Well-developed curricula - Number of new direct and indirect job for both male and female relating to the technology created	1,000,000
	5.2 Enhanced the capacities of staff in financial institutions, regulatory agencies and policy making institutions.	GoL, WB, AfDB, GIZ, EU, GCF USAID, UNDP, UNEP, CTCN, GEF, UNFCCC,	EPA LERC RREA	2022 - 2028	- High cost for training program and materials - Those for whom training programs are developed are not interested in participating	- Training program designed and implemented - Number of staff trained	- Institutional capacity and human resources are improved	500,000
Action 6 Develop standards for SHS	6.1 Establish a national quality assurance process with the appropriate codes, standards and certification to help end-user identify the best quality products.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF, GCF	EPA RREA LEC LERC	2021 - 2023	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or law	- Standards, codes and certification scheme developed - Number of skilled technical personnel trained to enforce standards	- Standard testing labs functional	30,000
	6.2 Develop labor skill standards for SHS installers to improve the overall quality and sustainability of SHS technology in the country.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GEF, UNEP, GCF, CTCN, UNFCCC	EPA RREA MME	2021 - 2023	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or law	- Labor skill standards developed, approved, and enforced - Number of skilled technical personnel trained to enforce standards	- Compliance and enforcement of standards	10,000

TAP overview table for Solar PV Mini-grid System

TAP overview table		
Sector	Energy	
Sub-sector	Electricity production	
Technology	Solar PV Mini-grid System	
Ambition	Increase rural electricity access to 35% by 2030 and provide electricity to approximately 265,000 homes or 1.34 million people, in peri-urban and rural areas remote or isolated from the national grid.	
Benefits	Social	- Saved income to be used for other purposes - Some jobs are created as a result of the availability of electricity

		- Reduce gender disparities and encourage greater female engagement in rural energy-related activities.						
	Economic	- Electricity bill savings - With the availability of electricity, income-generating options abound.						
	Environment	- Reduction of Greenhouse gas emissions (GHG) by avoiding the need of diesel generators to power rural households and reducing the usage of kerosene and charcoal.						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity (US\$)
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	GoL, CTCN, AfDB, GIZ, WB, USAID	EPA	2021 - 2023	Non-commitment and bureaucracy on the part of responsible body	- Fully equipped implementation unit with highly competent personnel	- A working implementation unit meeting key performance index	25,000
Action 2 Reduce high investment cost of solar PV mini-grid systems	2.1 Mobilise public and private investment from bilateral or multilateral development agencies and philanthropic organisations for the depolyment SMG systems in remote communities from the national grid.	GEF,GCF WB, EU, AfDB, USAID	EPA, RREA, MFDP, MME, LERC, DP	2021 - 2027	Delay in securing donor financing	- Increased number of projects and budget for SMG - Amount of bilateral and multilateral financing	- Number of project proposal developed, submitted and funded	4,000,000
	2.2 Provide subsidies and incentives up to 90% of the capital cost under rural electrification schemes, waiver of customs import duties to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff.	GoL, DP	MFDP, EPA, RREA	2021- 2025	Delay in decision making by GoL regarding incentives and subsidies	- Implementation of a comprehensive incentives and subsidies policy for the diffusion of the technology	- Number and type of incentives in place	10,000
	2.3 Provide loan guarantees or issue “green bonds” to local and foreign commercial banks to enable them offer long-term and affordable finance to SMG system project developers at different stages of project development.	GoL, EU, WB, GCF, GEF	MFDP	2021 - 2026	Insufficient funds available	Banks are offering loans for SMG projects	Number of loans provided for SMG projects	25,000

Action 3 Enhance access to financing	3.1 Adopt proven financial business models and good quality business plan that will take account of ability to pay (ATP) and willingness to pay (WTP) for the cost of electricity from SMG projects by remote and low-income groups who are not connected to the national grid.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, RREA	2021 - 2025	Customer growth rates could fall well below those envisaged in the business plans or models	- Development of a well-designed business model for SMG technology that is relevant and appropriate for the Liberian context - Number of private developers involved in SMG deployment	- High uptake of SMG electricity using business model - A well-designed business model for SMG technology that is relevant and appropriate for the Liberian context	35,000
	3.2 Make the Renewable Energy Development Fund operational to lend to developers, installers and rural households wishing to access energy from SMG technology.	GoL, WB, AfDB, EU, GCF, GEF, USAID	EPA, RREA, MFDP, DP	2021 - 2024	Delay due to insufficient resources	- Sufficient funds available to support SMG projects - Revolving loan fund established	- Number of financial mechanisms from government and international partners available to make Renewable Development Fund sustainable - Number of loans provided by Fund	1,000,000
	3.3 Provide support for local production of components to lower the initial investment cost of SMG technology.	GoL, WB, AfDB, EU, GCF, GEF, CTCN	MFDP, MME, RREA, EPA	2021 - 2026	Delay due to insufficient resources or limited access to low interest loans	- Sufficient funds available to support produce components locally	- Components are manufactured by local factories	500,000
Action 4 Increase awareness and knowledge on the potential of solar mini-grid systems	4.1 Run promotional campaigns and training programmes to raise awareness on the potential and benefits of SMG systems and to remove the myths about these systems being unreliable.	GEF, GCF, EU, USAID, WB, AfDB	EPA, LERC, RREA	2021 - 2027	Unqualified public relations team	- Public awareness campaigns and program for SMG technology implemented - 80% of rural communities are aware of SMG technology and financial support	- Information and awareness programs are approved and implemented	550,000
	4.2 Establish information hubs or centers in each county to run promotional campaigns and training programmes to raise awareness and provide information on the benefits, actual and perceived risks, financing options, licensing processes, tariff rates, reliability and performance of SMG systems for investors, local	GoL, WB, EU, DP	EPA, RREA	2022 - 2027	Delay due to insufficient resources	- Number of information hubs or centers established in all counties of the country	- Number of information hubs or centers established in all counties of the country	800,000

	communities, financial institutions, cooperatives, and entrepreneurs.							
Action 5 Build or strengthen local technical capacity	5.1 Include standard modules on renewable energy technologies in training programmes carried out by local institutions in SMG systems installation, operation, management, maintenance and business development to strengthen the technical capacity of personnel, such as technicians, engineers, and private developers, with inclusive gender participation.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, RREA, Tertiary institutes	2022 - 2028	- Preference is in favor of international experts - Local trained staff and technicians remain unemployed	- Availability of highly trained Liberian engineers and contractors - Number of institutions implementing training programs	- Well-developed curricula - Number of new direct and indirect job for both male and female relating to the technology created	1,000,000
	5.2 Adopt an integrated approach to enhance existing skills by providing training for staff in financial institutions, regulatory agencies and policy making institutions.	GoL, WB, AfDB, GIZ, EU, UNDP, GCF, GEF USAID, UNEP, CTCN, UNFCCC	EPA, LERC, RREA, DP	2022 - 2028	- High cost for training program and materials - Those for whom training programs are developed are not interested in participating	- Training program designed and implemented - Number of staff trained	- Institutional capacity and human resources are improved	500,000
Action 6 Develop standards for solar PV mini-grid systems	6.1 Develop codes and standards and establish certification, testing, and enforcement institutes	GoL, AfDB, GIZ, GCF, GEF, USAID, EU UNDP, UNEP, WB, CTCN, UNFCCC	EPA, RREA, LEC, LERC, DP	2021 - 2024	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or laws	- Standards, codes and certification scheme developed - Number of skilled technical personnel trained to enforce standards	- Standard testing labs functional	45,000
	6.2 Develop stringent technical skill standards and quality control for installers of SMG systems to ensure quality standards of installations are met.	GoL, AfDB, GIZ, GEF, GCF UNDP USAID, WB, UNEP, EU, CTCN, UNFCCC	EPA, RREA, MME	2021 - 2025	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or laws	- Labor skill standards developed, approved, and enforced - Number of skilled technical personnel trained to enforce standards	- Number of skilled technical personnel trained to enforce standards	50,000
	6.3 Develop the appropriate policy, regulatory, institutional frameworks to define the role of each actor and create the enabling environment for large-scale deployment of SMG system for rural electrification.	GoL, AfDB, GIZ, GEF, GCF UNEP USAID, EU, UNDP, WB, CTCN, UNFCCC	EPA, MME, LERC	2021 - 2026	Lack of participation from key institutional stakeholders	Multi-stakeholders committee set up and operational through regular meetings	Number of institutions participating in committee meetings	40,000

TAP overview table for Small Hydropower Mini-grid System

TAP overview table								
Sector	Energy							
Sub-sector	Electricity production							
Technology	Small Hydropower Mini-grid Plant System							
Ambition	Construct Small Hydropower plants with total capacity 50 MW by 2030 at specific remote and isolated rural locations across the country as indicated by the Rural Energy Strategy and Master Plan (RESMP) and the National Renewable Energy Action Plans (NREAPs).							
Benefits	Social	<ul style="list-style-type: none"> - Saved income to be used for other purposes - Some jobs are created as a result of the availability of electricity - Improve women's access to energy and minimise their reliance on fuelwood collecting. 						
	Economic	<ul style="list-style-type: none"> - Electricity bill savings - Encourage productive energy use in rural areas - With the availability of electricity, income-generating options abound. 						
	Environment	<ul style="list-style-type: none"> - Reduction of greenhouse gas emissions (GHG) by avoiding the need of diesel generators to power rural households and reducing the usage of kerosene and charcoal. 						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity (US\$)
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	GoL, CTCN, AfDB, GIZ, USAID, WB	EPA	2021 - 2023	- Non-commitment and bureaucracy on the part of responsible body-	- Fully equipped implementation unit with highly competent personnel established - Increased number of quality project proposal and funding	- A functional implementation unit meeting key performance index - Number of proposal developed, submitted and funded - Comprehensive and informative reports	25,000
Action 2 Reduce the high capital investment costs of small hydropower plant systems	2.1 Use public-private partnerships concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country.	GEF, GCF, WB, EU, AfDB, USAID	MFDP, EPA, LERC, MME, DP, RREA	2022 - 2030	- Delay in securing donor financing - Lack of interest from private sector	- Number of joint venture project initiated - High interest from private investors - Amount of bilateral and multilateral financing	- Number of project proposal developed, submitted and funded - Number of public-private partnership developed	8,000,000

	2.2 Reduce investment costs for SHP system project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).	GoL, WB, AfDB, GCF, GEF	MFDP, EPA, RREA, MME	2022- 2030	- Delay in decision making by government regarding incentives and subsidies	- Implementation of comprehensive incentives and subsidies policy for the diffusion of the technology approved	- Number of new installed small hydropower plants	500,000
Action 3 Improve access to financing	3.1 Provide annual government budgetary allotments in addition to international grants, subsidies, concessionary loans to development SHP mini-grid in the country.	GoL, AfDB, EU, GCF, GEF, UNDP, USAID, GIZ, UNEP, WB, CTCN	MFDP	2021 - 2027	- Lack of political will or interest - Inadequate state budgetary allocation	- Amount of funds allocated	- First annual budgetary allotment approved and provided	2,000,000
	3.2 Make the Renewable Energy Development Fund operational to provide low interest loans, loan guarantees, and grants as targeted subsidies to ensure energy is accessed by the poor.	GoL, WB, AfDB, EU, GCF, GEF	EPA, RREA, MFDP, DP	2022 - 2028	- Delays due to insufficient funds	- Sufficient funds available to support SHP projects - Revolving loan fund established	- Number of financial mechanisms from government and international partners available to make Renewable Development Fund sustainable - Number of loans provided by Fund	1,500,000
	3.3 Provide support for local production of components to lower the capital investment cost of SHP technology.	GoL, WB, AfDB, GIZ, GCF, GEF, USAID, UNDP, EU, UNEP, CTCN, UNFCCC	MFDP, EPA, MME, RREA	2022 - 2028	- Lack of political will or interest - Delays due to insufficient resources	- Sufficient funds available to support SHP projects	- Increased number of loans for business and investment in SHP technology - Number of local businesses producing SHP components	1,000,000
	3.4 Implement financial business models, high-quality business plan and an affordable tariff structure based on customers' ability and willingness, allowing poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest.	GEF, GCF, EU, WB, USAID,	LERC, LEC, RREA, EPA	2022 - 2030	- Customer growth rates could fall well below those envisaged in the business plans or models	- A well-designed business model for SHP technology that is relevant and appropriate for the Liberian context is developed and implemented	- Increased number of loans for business and investment in SHP technology	800,00
Action 4 Raise public awareness and	4.1 Provide adequate information and public awareness about the SHP	GoL, AfDB, USAID, WB,	LEC, LERC, EPA, LWSC,	2021 - 2027	- Unqualified public relations team	- Public awareness campaigns and	- Information and awareness	950,000

knowledge about the benefits of small hydropower systems	technology through communication campaigns using electronic, print, social media, seminars, training workshops, conferences and community engagements for all stakeholders.	EU, UNDP, UNEP	RREA		-Insufficient fund available	programmes for SHP technology planned, prepared and implemented using print, electronic & social media -Awareness level of public increased by 50%	programs are approved and implemented - Number of public awareness programmes prepared and implemented	
	4.2 Provide information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SHP systems, among others.	GoL, AfDB, UNEP, GIZ, GCF, USAID, WBU, NDP, EU, CTCN, UNFCCC,	LERC, MME, EPA, RREA	2022 - 2028			Number of information hubs or centres established in all counties of the country	50,000
	4.3 Provide support for renewable resource assessment and site reconnaissance studies, especially for small hydropower mini-grid development in the country. Information on the hydrological data will help investors and project developers make informed decisions.	GoL, AfDB, UNDP, WB, GIZ, GCF, UNEP, USAID, CTCN, EU, UNFCCC,	LERC, MME, RREA, EPA	2021 - 2025	- Lack of technical capacity - Delay in getting funds - Equipment for studies costing more than the money available	- Improved quality of data	- Type, quantity and quality of data available -Equipment for studies procured	1,000,000
	4.4 Develop a platform for sharing information on small hydropower potential in the country.	GoL, UNDP, GCF, AfDB, GIZ, UNEP, USAID, WBG, EF, EU	LERC, MME, RREA, EPA	2022 - 2024	- Delay in getting funding	- Platform for open sharing of information on SHP developed and approved	- Platform for open sharing of information on SHP developed and functional	25,000
Action 5 Build or strengthen local technical capacity	5.1 Allocate funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions to train both male and female local experts to manage the SHP technology.	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF	MFDP, EPA, RREA, MPW, Tertiary institutes	2022 - 2030	- No funds allocated for training - Preference is in favour of international experts - Local trained staff and technicians remain unemployed	-Funds allocated for training - Availability of highly trained local technicians, engineers and contractors - Number of institutions implementing training programs	-Types and number of trainings conducted - Well-developed curricula - Number of new direct and indirect job for both male & female relating to the technology created	450,000
	5.2 Conduct specialized training to build the capacity and expertise of their workforce in installation, operation,	GoL, WB, AfDB, EU, GCF, GEF,	MME, LEC, MPW, RREA	2022 - 2030	- Inadequate financial and human resources	- Training program designed and implemented	- Institutional capacity and human resources are	200,000

	management, maintenance and business development the SHP technology.	USAID, UNDP, UNEP, CTCN			for capacity building - Trainings are not delivered to the right people or need	- Number of staff and technicians trained	improved -Number of trainings and participants attended	
Action 6 Develop a legal, regulatory and institutional framework for SHP technology	6.1 Create enabling policies and regulatory frameworks, particularly in the areas of tariffs, licencing and permits, and grid connectivity, and to apply them in a credible and transparent manner.	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP	MME, LERC, EPA, RREA	2022 - 2025	-Policies and regulatory framework may not be approved - Delay due to changing or revising existing regulations or laws	- Policies and regulatory framework approved	- Policies and regulatory framework drafted and approved	50,000
	6.2 Develop codes and standards and establish certification, testing, and enforcement institutes.	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP, CTCN	EPA, RREA, LEC, LERC	2022 - 2024	- Non-compliance and enforcement of standards - Delays due to slow process of policy, regulations and legal formulation	Codes and standards developed and accepted by all relevant stakeholders	- Quality codes and standards developed and approved - Compliance and enforcement of codes & standards functional	80,000
	6.3 MME, LERC, RREA and EPA must develop the appropriate policy, regulatory, institutional frameworks to define the role of each player and create conducive environment for the development of SHP technology for rural electrification.	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP	MME, LERC, RREA, EPA	2022 - 2025	-Lack of participation from key institutional stakeholders	- Multi-stakeholders committee set up and operational through regular meetings	- Number of institutions participating in committee meetings -Number of meetings and key decision taken to promote SHP technology	50,000

Chapter 1 Technology Action Plan and Project Ideas for the Energy Sector

1.1 Technology Action Plan for Liberia's Energy Sector

This chapter focuses on the Technology Action Plan (TAP) for the energy sector. The TAP considers the following technologies: solar home PV system (SHS); solar PV mini-grid system (SMG) and small hydropower system (SHP).

1.1.1 Energy sector overview

The energy sector is the primary driver of the country's national socioeconomic development. However, Liberia has no domestic fossil fuel resources and strongly depends on imported fuel resources to meet its energy demand. The country's present primary energy source is based mainly on biomass (93.4%), petroleum products for transportation and electricity generation (6.3%) and the rest including small-scale hydro and solar electric (0.3%). In 2012, petroleum products imported into the country were estimated to be 76.6 million US gallons, or 11,132 terajoules (TJ). By December 2018, Liberia's total installed generation capacity was 126 MW from the rehabilitated Mount Coffee Hydropower Plant (88 MW) and three heavy fuel oil/light fuel oil thermal generation plants (38 MW) (World Bank, 2018). Liberia has one of the lowest access rates to electricity in the world, with fewer than 3% of the country's rural population having access to electricity, and just about 31% in the capital city of Monrovia. Electricity consumption in 2016 in the country was estimated to be about 279 million kWh (The World Fact book, 2020). Liberia's energy sector with approximately 5.4 MtCO_{2e} (49%) is the largest contributor to the country's total greenhouse gas (GHG) emissions (EPA, 2013).

Most of the emissions from this sector come from petroleum products (primarily gasoline and diesel, and some jet fuel and kerosene) which supply over 95% of the country's main energy. Consumption of petroleum products increased by 66% from 1999 to 2008, with transportation consuming 61% and electricity generation (which uses gasoline and diesel oil) 29% in 2008 (EPA, 2013). Most vehicles in the country are often poorly maintained and consume low grade diesel and mixed petroleum fuel that have a high potential for GHG emissions.

The Government of Liberia (GoL) has a number of key legal and regulatory instruments in place in that directly addresses energy issues. These instruments form part of the enabling framework for climate change mitigation and are outlined below as follows:

National Environmental Policy of 2003

The National Environmental Policy of Liberia is a legal instrument that provides a broad framework for the implementation of national environmental objectives and plans (EPA, 2003). The primary objective of the policy is to "ensure a sound management of resources and the environment, and attempts to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment". This primary objective of the policy is expected to be pursued and achieved through the harmonization and enforcement of relevant laws on environment protection. The policy also seeks to integrate environmental considerations in sectoral, structural, regional, and socio-economic planning at all levels.

Electricity Law of Liberia of 2015

The Electricity Law provides the legal and regulatory framework for the production, transportation, distribution and sale of energy products and services in Liberia. The Law further regulates the import and export of energy products and defines the rights and obligations of all entities and parties involved in or affected by the energy activities. The law aims to facilitate the implementation of the goals of the National Energy Policy (Republic of Liberia, 2015a).

National Energy Policy of Liberia 2009

The National Energy Policy (NEP) expresses the country's national vision for the energy sector and set clear development goals for the short, medium and long term energy strategies at the urban, rural and regional levels. The primary objective of the NEP is to ensure universal and sustainable access to affordable and reliable modern energy supply in order to foster the economic, political, and social development of Liberia (Republic of Liberia, 2009).

Agenda for Transformation 2012 - 2017

The Agenda for Transformation (AfT) is the GoL five-year development plan which articulates the country's goal and aspirations of attaining middle income status by 2030 through sustained and inclusive economic growth (Government of Liberia, 2012). The plan focuses on five strategic pillars to increase productivity, boost economic growth, and improve social inclusion, particularly by creating jobs, specifically for its young population. One of the strategic objectives contained in the AfT is for the energy sector to increase its environmental sustainability and at the same time reducing the use of charcoal and wood as fuel. Among the priority interventions set out in the AfT is for Government to support communities without access to power from the grid with the development of alternative energy such as small-scale thermal- hydro- and solar- energy.

Rural Energy Strategy and Master Plan (RESMP) of 2016

The Rural Energy Strategy and Master Plan (RESMP) of Liberia for the period until 2030 major objective is to set clear targets, to identify least-cost projects and technologies, to propose concrete investments for funding and implementation, with appropriate institutional framework and capacity to increase energy access and renewable energies to the country's rural areas and population – meaning all areas and population outside of greater Monrovia (RREA, 2016). The Master Plan identifies 92 projects and investments to electrify 265,000 homes and 1.34 million people outside Monrovia until 2030.

National Policy and Response Strategy on Climate Change of 2018

The National Climate Change Policy and Response Strategy is a framework to establish specific provisions for dealing with climate change issues, understanding the extent of the threat and putting in place specific actions to mitigate potential impacts (Republic of Liberia, 2018). The policy and strategy is intended to guide national response measures in addressing climate change. The strategy further provides guidance on incorporating climate change issues into national development planning efforts at national, county, district and local levels for effective implementation. It also highlights adaptation and mitigation policies in key sectors in the country.

Pro-Poor Agenda for Prosperity and Development 2018 to 2023 (PAPD)

The Pro-Poor Agenda for Prosperity and Development 2018 to 2023 (PAPD) is the second in the series of 5-year National Development Plans (NDP) anticipated under the Liberia Vision 2030

framework (Government of Liberia, 2018). It follows the Agenda for Transformation 2012-2017 (AfT). It is informed as well by lessons learned from the implementation of the Interim Poverty Reduction Strategy 2007 (IPRS) and the Poverty Reduction Strategy (2008-2011).

Renewable Energy and Energy Efficiency Policy and Action Plan of Liberia (2007)

The purpose of this Policy is to increase national awareness on renewables and energy efficiency and remove barriers to investment and market development through a national policy instrument (Republic of Liberia, 2007). According to the renewable energy and energy efficiency policy, its primary objective is “to support the development process in Liberia by exploiting renewable energy resources to attract investment, develop the market, transfer technology and build local capacity in the renewable energy sub-sector”.

Climate Change Gender Action Plan (CCGAP)

The overall objective of the CCGAP is to ensure that gender equality is mainstreamed into Liberia’s climate change policies, programs and interventions so that both men and women have equal opportunities to implement and benefit from mitigation and adaptation initiatives in combating climate change and positively impact on the outcome of “Liberia Rising 2030” (Government of Liberia, 2012).

United Nations Framework Convention on Climate Change (UNFCCC)

Liberia is a signatory to the UN Framework Convention on Climate Change, which demands that all parties to the Convention contribute to the drive toward low-carbon development by reducing greenhouse gas emissions.

1.1.2 Action Plan for Solar Home PV System (SHS)

1.1.2.1 Introduction

Solar home PV system (SHS) is a stand-alone PV system that is not connected to the grid to power lighting and appliances for homes and businesses located in sparsely populated remote locations or areas with poor grid reliability. A typical SHS comprises a 10 to 100 W_p PV solar panel or module, supporting structures, an inverter, a rechargeable battery, a charge controller and light-emitting diode (LED) lamps. The solar panel absorbs light energy and converts it directly to electricity. SHS uses batteries to store and supply electricity when the solar panels are not producing energy at night or cloudy days. It can provide electricity for powering household appliances such as lights, radio, television, mobile phones, refrigerator, fans and more.

The SHS has many benefits: (i) it displaces the use of kerosene, candles and woodfuel for lighting thereby reducing risk of fires and house-hold air pollution; (ii) it displaces dry cell batteries which address both the economic and environmental aspects of the people; (iii) it can improve the local economy by generating new job opportunities as well as establishing small-scale industries; (iv) it enhances the quality of life of the rural poor women and children by offering a clean and sustainable energy supply; (v) it can extend study and work hours into the evening so that children have more time to study and women no longer have to depend solely on sunlight to complete their household chores; and (vi) it helps in reducing national level GHG emissions. More information on the expected outcomes of this technology can be found in the TNA mitigation report.

1.1.2.2 Ambition for the TAP

The ambition is to provide 100,000 homes or 750,000 beneficiaries from communities that are in remote areas, without access to the national grid with off-grid solar PV home systems by 2030. The scope could be expanded to include hospitals, schools and clinics with similar characteristics. Solar PV home systems with a total capacity of about 10 MW are expected to be deployed. The beneficiaries will come from 5 districts in each of the 15 counties of the country. It is anticipated that these communities will abandon the use of kerosene lamps which endanger human health and property, as well as the useage of diesel generators, thus improving their living conditions, and providing opportunities for educational advancement. This will create about 900 new jobs for both men and women in these remote communities.

1.1.2.3 Actions and Activities selected for inclusion in the TAP

This section provides a discussion of the actions and activities that have been selected for inclusion in the TAP for solar PV home system.

Summary of barriers and measures to overcome barriers

Table 1.2 is a summary of the main barriers and measures associated with the transfer and diffusion of solar PV home system which were identified in the Barrier Analysis and Enabling Framework (BAEF) report.

Table 1.2: Selected barriers and their measures for the solar PV home system (SHS) technology

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	High initial investment cost of system	<ul style="list-style-type: none"> • Provide support for local production of components to lower the initial investment cost for suppliers and customers. • Arrange financial support or assistance to poor rural households at zero or low interest rates with acceptable loan duration for them to acquire system. • Put in place appropriate subsidies, incentives and waiver of customs duties on all solar PV system components for suppliers and household. • Capitalize the REFUND and make it operational to provide financial support, capital subsidies, production-based subsidies to investors, suppliers, dealers and consumers of off-grid solar PV system targeted at remote areas and islands without access to electricity. • Develop financial models that will take account of affordability and willingness to pay for the cost of acquisition of SHS products.
Technical	Inadequate local technical expertise	<ul style="list-style-type: none"> • Establish training and accreditation centers to train and accredit human resource for the renewable energy sector. • Set up scholarship program to incentivize the enrollment of women for gender mainstreaming.
Information and awareness	Inadequate and limited information sharing	<ul style="list-style-type: none"> • Intensify adequate information, public education and awareness campaigns through print, electronic and social media; seminars, workshops, and conferences. • Increase local capacity and community engagement to strengthen positive socio-economic impact and increase awareness of the benefits of renewable energy among end users.
Cultural, social and gender	Absence of inclusive gender participation in SHS projects	<ul style="list-style-type: none"> • Provide incentives for women active participation in the management, development, operations, installations, engineering, procurement, construction, maintenance and repair works of renewable energy technologies.
Weak legal, regulatory and institutional framework	Cheap and substandard equipment	<ul style="list-style-type: none"> • Develop codes and standards and the institutional framework to enforce them.
	Inadequate legal, regulatory and	<ul style="list-style-type: none"> • Develop certification procedures, and institutions, including test and measurement facilities.

	institutional framework	<ul style="list-style-type: none"> • Develop clear regulatory guidelines renewable energy off-grid solar PV home systems.
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Actions selected for inclusion in the TAP for SHS

This section provides a list of each of the measures selected as actions, along with narrative descriptions, that will be included in the TAP in order to increase the diffusion and penetration of solar PV home system (SHS) applications in Liberia. The most important barriers were selected by the stakeholders of the consultation working group during a TNA workshop for Technology Action Plan and Project Ideas meeting held on January 22, 2021. The actions and their activities are presented in Table 1.3.

Action 1: Establish a unit to oversee or lead the implementation of the TAP which is critical for the successful deployment and diffusion of the solar home PV system technology in the country. It will be the implementing unit for all the actions and proposed projects in the TAP. This unit will be responsible for the technical coordination and management of the projects. The unit must be adequately staffed with highly skilled personnel capable of developing terms of references (TORs) and scopes of work, as well as carrying out the required actions and activities of the proposed projects.

Action 2: Reduce cost of solar home system equipment through long-term consumer credit with monthly payments as equivalent to current monthly payments for conventional energy (e.g., kerosene and batteries) expenditures as possible; provision of appropriate subsidies, incentives and waiver of customs import duties on all solar PV system components for suppliers and household by the government. This would promote increased investment by reducing the costs, allowing suppliers to offer SHS at lower prices.

Action 3: Enhance access to financing through innovative and affordable financial plans or business models from both the public and private sectors targeted at individuals both in the rural and peri-urban areas who are not connected to the national grid for the procurement of SHS. A Renewable Energy Development Fund should be made operational to lend to developers, installers and those wishing to access SHS technology. This will facilitate the removal of a key stumbling block for the diffusion and deployment of SHS technology in the rural and urban areas where individuals have limited saving potential with no access to conventional energy technologies.

Action 4: Increase awareness and knowledge on solar home systems by intensifying adequate information, public education and awareness campaigns for different stakeholders through print and electronic media, social media, seminars, workshops, conferences and community engagements. This will help expand entrepreneurial activities and provide users with information including data on SHS equipment cost and performance.

Action 5: Build or strengthen capacity of key stakeholders it will also require that technicians, especially in rural areas, be trained to provide servicing of PV systems. Training, orientation and awareness programmes for various target groups, conferences/seminars/workshops for experience sharing among various stakeholders, etc.

Action 6: Develop standards for solar PV home systems by establishing a national quality assurance process with the appropriate codes, standards and certification to help buyers identify the best quality products. It is also recommended that labour skill standards for SHS installers be developed to improve the overall quality and sustainability of SHS.

Activities identified for implementation of selected actions

Selection of activities for each action was carried out through a stakeholder consultation process at a meeting in January 2021. This section summarizes the identified actions into more specific activities. These activities are things that need to be done to make each identified action work. A list of activities needed for the implementation of each identified action is presented in Table 1.3.

Table 1.3: List of activities identified for the implementation of selected actions of SHS TAP

Action	Activity
1. Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.
2. Reduce cost of SHS equipment	2.1 Liberia Electricity Regulatory Commission (LERC), Environmental Protection Agency (EPA), and Rural & Electrification Energy Agency (RREA) must solicit international financial support from development partners (specifically GEF, GCF, EU, AfDB, USAID) to leverage the domestic financial environment for off-grid electrification using SHS technology 2.2 Government of Liberia (GoL) through the Ministry of Finance and Development Planning (MFDP) must provide appropriate subsidies, incentives and waiver of customs import duties on all SHS components for suppliers and end-users.
3. Enhance access to financing	3.1 EPA and RREA to work with developers to provide innovative and affordable financial plans or business models for the purchase of SHS targeted at people in the rural and peri-urban areas who are not connected to the national grid. 3.2 MFDP and EPA to encourage commercial banks to lower the interest rate and extend the duration on loans to acquire SHS. 3.3 EPA, RREA and MFDP to make the Renewable Energy Development Fund fully operational to provide loans with zero or low interest rates with acceptable loan duration for poor rural households to acquire SHS. 3.4 MFDP and Ministry of Mines and Energy (MME) should provide support for local production of components to lower the initial investment cost of SHS for suppliers and customers.
4. Increase awareness and knowledge on SHS	4.1 EPA, Liberia Electricity Corporation (LEC) and RREA should intensifying adequate information, public education and awareness campaigns on SHS for different stakeholders through print and electronic media, social media, seminars, workshops, conferences and community engagements. 4.2 EPA and RREA should establish information hubs or centers in each county to increase and improve the awareness about SHS equipment costs, benefits and performance for local communities, financial institutions, cooperatives, and entrepreneurs.
5. Build or strengthen capacity of key stakeholders	5.1 EPA, RREA and tertiary institutions should provide periodic and specialized technical training courses in solar PV home systems installation, operation, management, maintenance and business development to strengthen the capacity of personnel, such as technicians, private entrepreneurs or developers and engineers, with inclusive gender participation. 5.2 EPA, LERC and RREA should enhanced the capacities of staff in financial institutions, regulatory agencies and policy making institutions.
6. Develop standards for SHS	6.1 LERC, RREA, LEC, and EPA should establish a national quality assurance process with the appropriate codes, standards and certification to help end-user to identify the best quality products. 6.2 MME, RREA and EPA should develop labour skill standards for SHS installers to improve the overall quality and sustainability of SHS technology in the country.

1.1.2.4 Stakeholders and Timeline for implementation of SHS TAP

Overview of Stakeholders for the implementation of the SHS TAP

There are a number of key stakeholders whose full cooperation and participation is required for the SHS TAP's implementation. The TNA project falls under the purview of the United Nations Framework Convention on Climate Change (UNFCCC) and the Focal Point is located in Environmental Protection Agency of Liberia. Hence, the EPA is the implementing agency for all the actions and projects proposed in the TAP. However, there will be other stakeholders involved in the implementation each actions and activities. The list and roles of the key stakeholders who have been identified for the implementation of each actions of the TAP for SHS is provided in Table 1.4.

Table 1.4: List of key stakeholders and their roles for the implementation of different activities of the SHS TAP

#	Stakeholder	Action	Role
1	Environmental Protection Agency (EPA)	1, 2, 3, 4, 5, and 6	<ul style="list-style-type: none"> - Implementing agency for all the actions and projects proposed in the TAP - Focal Point of the UNFCCC - Sourcing funds from Green Climate Fund and Global Environmental Facility - Responsible for environmental policies and management
2	Rural & Electrification Energy Agency (RREA)	2, 3, 4, 5, and 6	<ul style="list-style-type: none"> - Manage the Renewable Energy Fund - Promote renewable energy technologies - Develop solar PV standards
3	Liberia Electricity Regulatory Commission (LERC)	2, 5, and 6	<ul style="list-style-type: none"> - Regulate the energy sector, issue licenses, approve tariffs, ensure liberalization of the sector, improve service delivery, protect consumers and create a vibrant electricity sector - Monitor and enforce quality standards on all solar PV components and spare parts imported in to the country
4	Ministry of Finance and Development Planning (MFDP)	2 and 3	<ul style="list-style-type: none"> - Responsible for fiscal policies including incentives and subsidies -Negotiate loans for funding renewable energy projects
5	Ministry of Mines and Energy (MME)	3 and 6	<ul style="list-style-type: none"> - Formulate policies for the energy sectorand create a conducive environment for delivery of electricity and rural electrification.
6	Liberia Electricity Coporation (LEC)	4 and 6	<ul style="list-style-type: none"> - Sole provider of electricity in the country and owner of the grid.
7	Tertiary institutions	5	<ul style="list-style-type: none"> - Provide technical training courses in solar PV home systems installation, operation, management, maintenance and business development
8	Development partners and funds: WB, AfDB, GIZ, EU, USAID,UNDP, UNEP, CTCN, UNFCCC, GEF, GCF		<ul style="list-style-type: none"> -Provide technical and financial support for diffusion of SHS technology

Scheduling and sequencing of specific activities

The timeframe established for planning and implementation of the SHS TAP's actions and activities leading to the creation of a robust policy framework for the deployment of the prioritized energy sector technologies is 10 years (2021 to 2030). This period is aligned with the finalization of the rural energy strategy and master plan for Liberia, the Sustainable Development Goal 7 and Liberia's Intended Nationally Determined Contributions. These are key national policies related to development priorities and climate change mitigation for the attainment of the Liberia's energy sector goal of raising the share of renewable energy to at least 30% of electricity production and 10% of overall energy consumption by 2030. Table 1.5 describes the sequence and timing of specific activities and responsibilities.

Table 1.5: Schedule and sequence of activities for SHS TAP

Action	Activities	Timelines (Planning to Implementation)	Responsible body
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	2021 - 2023	EPA
Action 2 Reduce cost of SHS equipment	2.1 Solicit international financial support from development partners to leverage the domestic financial environment for off-grid electrification using SHS technology.	2021 -2024	LERC, EPA, RREA
	2.2 Provide appropriate subsidies, incentives and waiver of customs import duties on all SHS components for suppliers and end-users.	2021 -2024	MFDP
Action 3 Enhance access to financing	3.1 Work with developers to provide innovative and affordable financial plans or business models for the purchase of SHS targeted at people in the rural and peri-urban areas who are not connected to the national grid.	2021 -2025	EPA, RREA
	3.2 Encourage commercial banks to lower the interest rate and extend the duration on loans to acquire SHS.	2021 -2024	EPA, MFDP
	3.3 Make the Renewable Energy Development Fund fully operational to provide loans with zero or low interest rates with acceptable loan duration for poor rural households to acquire SHS.	2022 -2026	EPA, RREA MFDP
	3.4 Provide support for local production of components to lower the initial investment cost of SHS for suppliers and customers.	2022 -2027	MFDP, MME
Action 4 Increase awareness and knowledge on SHS	4.1 Intensify adequate information, public education and awareness campaigns on SHS for different stakeholders through print and electronic media, social media, seminars, workshops, conferences and community engagements.	2021 -2027	EPA, LEC, RREA
	4.2 Establish information hubs or centers in each county to increase and improve the awareness about SHS equipment costs, benefits and performance for local communities, financial institutions, cooperatives, and entrepreneurs.	2021 -2027	EPA, RREA
Action 5 Build or strengthen capacity of key stakeholders	5.1 Provide periodic and specialized technical training courses in solar PV home systems installation, operation, management, maintenance and business development to strengthen the capacity of personnel, such as technicians, private entrepreneurs or developers and engineers, with inclusive gender participation.	2022 -2028	EPA, RREA, Tertiary institutes
	5.2 Enhance the capacities of staff in financial institutions, regulatory agencies and policy making institutions.	2022 -2028	EPA, LERC RREA
Action 6 Develop standards for SHS	6.1 Establish a national quality assurance process with the appropriate codes, standards and certification to help end-user identify the best quality products.	2021 -2023	EPA, LEC RREA, LERC
	6.2 Develop labour skill standards for SHS installers to improve the overall quality and sustainability of SHS technology in the country.	2021 -2023	EPA, RREA MME

1.1.2.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

In collaboration with stakeholders, the capacity development needs for efficient implementation of the TAP's actions and activities, as well as strengthening of the enabling framework for energy sector technologies, were identified. There is a need to build capacity in sourcing international funds as well as training and accrediting of local personnel on the installation, operation and management of solar PV home systems in order to ensure accelerated diffusion of the technology in the country.

Estimations of costs of actions and activities

The estimated cost for the implementation of the TAP's actions and activities were identified in collaboration with stakeholders during the TAP workshop. Table 1.6 provides an estimate of the cost in United States Dollar (US\$) for implementing of each actions and activities that makes up the TAP. The total estimated cost for implementing the SHS TAP is US\$ 4,925,000.

Table 1.6: Summary estimation of costs and resources needed for SHS actions and activities

Action	Activities to be support	Estimated cost (US\$)	Source of funds
Action1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	25,000	GoL, CTCN, WB, AfDB, GIZ, USAID
Action 2 Reduce cost of SHS equipment	2.1 Solicit international financial support from development partners to leverage the domestic financial environment for off-grid electrification using SHS technology.	1,000,000	GEF, GCF, EU, AfDB, USAID
	2.2 Provide appropriate subsidies, incentives and waiver of customs import duties on all SHS components for suppliers and end-users.	20,000	GoL
Action 3 Enhance access to financing	3.1 Work with developers to provide innovative and affordable financial plans or business models for the purchase of SHS targeted at people in the rural and peri-urban areas who are not connected to the national grid.	15,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF,
	3.2 Encourage commercial banks to lower the interest rate and extend the duration on loans to acquire SHS.	10,000	GoL
	3.3 Make the Renewable Energy Development Fund fully operational to provide loans with zero or low interest rates with acceptable loan duration for poor rural households to acquire SHS.	15,000	GoL, WB, AfDB, GCF, GEF
	3.4 Provide support for local production of components to lower the initial investment cost of SHS for suppliers and customers.	1,000,000	GoL, WB, AfDB, GIZ, GEF, GCF USAID, UNDP, UNEP, CTCN,
Action 4 Increase awareness and knowledge on SHS	4.1 Intensify adequate information, public education and awareness campaigns on SHS for different stakeholders through print and electronic media, social media, seminars, workshops, conferences and community engagements.	500,000	GEF, GCF, EU, USAID, WB
	4.2 Establish information hubs or centers in each county to increase and improve the awareness about SHS equipment costs, benefits and performance for local communities, financial institutions, cooperatives, and entrepreneurs.	800,000	GoL, WB, EU, other developing partners

Action 5 Build or strengthen capacity of key stakeholders	5.1 Provide periodic and specialized technical training courses in solar PV home systems installation, operation, management, maintenance and business development to strengthen the capacity of personnel, such as technicians, private entrepreneurs or developers and engineers, with inclusive gender participation.	1,000,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF,
	5.2 Enhanced the capacities of staff in financial institutions, regulatory agencies and policy making institutions.	500,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF
Action 6 Develop standards for SHS	6.1 Establish a national quality assurance process with the appropriate codes, standards and certification to help end-user identify the best quality products.	30,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF
	6.2 Develop labour skill standards for SHS installers to improve the overall quality and sustainability of SHS technology in the country.	10,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF,
Total		4,925,000	

1.1.2.6 Management Planning

Risks and Contingency Planning

Table 1.7 provides a summary of key risks identified in the activities and the contingency plan to mitigate these risks for the successful implementation of the Solar PV Home System TAP.

Table 1.7 Risk and contingency plan for the implementation of SHS TAP

Risk	Description	Contingency plan
Cost risk	Delays in securing donor funds	GoL use budgetary support to set up the implementation unit, finance the preparation of the public awareness and promotional campaigns and utilize donor funds for implementation.
Performance risk	Delays in decision making regarding incentives, subsidies and implementation	Ensure there is strong high-level political and institutional acceptance or support from the Cabinet and also key Ministries and agencies.
Schedule risk	The schedule can be delayed or may take longer to complete than expected if financial and human resources are not secured on time as well as due to delays in the delivery of equipment, contracts, and consultant non-performance.	To avoid this risk, effective project planning and implementation schedule should be monitored on a regular basis with the involvement of all stakeholders. Moreover, the schedules should contain enough lead periods for imported equipment delivery as well as identifying and managing the critical path items on the schedule early.
Information risk	Information not being provided in a timely manner and inadequate cooperation or collaboration amongst stakeholders	Establish project steering committee to bring together key Ministries and institutions into the implementing process. Ensure that the project will be managed by professional managers with proven track record using best management practices

Next Steps

Table 1.8 provides a summary of the immediate requirements and critical steps for the successful implementation of the SHS TAP.

Table 1.8 Summary of immediate requirements and critical steps for implementation of SHS TAP

Immediate requirements:	<ul style="list-style-type: none">a) The EPA should schedule a meeting with other key stakeholders such as RREA, MME, MFDP, and others to disseminate the outcomes of the TAP.b) EPA should equip the implementation unit's office with highly competent personnel and logistics so that it can effectively and efficiently implement the TAP.c) EPA together with the key stakeholders need to integrate this TAP into the country's Rural Energy Strategy and Master Plan, Nationally Determined Contributions (NDC), and Nationally Appropriate Mitigation Actions (NAMA).
Critical steps:	<ul style="list-style-type: none">a) The EPA should ensure that the TAP's outcomes are approved at the Cabinet level.b) Project proposals based on the project ideas should be develop as soon as possible.c) GoL must engage with donors early to secure financing for TAP projects to ensure that activities timelines are met.

1.1.2.7 TAP overview table for Solar PV Home System (SHS)

The overview of the Technology Action Plan (TAP) for the SHS is provided in Table 1.9

Table 1.9: TAP overview table for Solar PV Home System

TAP overview table								
Sector	Energy							
Sub-sector	Electricity production							
Technology	Solar PV Home System							
Ambition	By 2030: Provide 200,000 households in five rural communities in each of the 15 counties of the country with solar PV home systems.							
Benefits	Social	<ul style="list-style-type: none"> - Saved income to be used for other needs - Some job creation through availability of electricity - Reduce gender inequality and encourage stronger participation of women on rural energy sector activities 						
	Economic	<ul style="list-style-type: none"> - Electricity bill savings - Income generating opportunities with availability of electricity 						
	Environment	<ul style="list-style-type: none"> - Greenhouse gas emissions avoided 						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity (US\$)
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	GoL, CTCN, WB, AfDB, GIZ, USAID	EPA	2021 - 2023	Non-commitment and bureaucracy on the part of responsible body	- Fully equipped implementation unit with highly competent personnel	- A working implementation unit meeting key performance index	25,000
Action 2 Reduce cost of SHS equipment	2.1 Solicit inter- national financial support from develop- ment partners to leverage the domestic financial environment for off-grid electrifi- cation using SHS technology.	GEF, GCF, EU, AfDB, USAID	LERC EPA RREA	2021 - 2024	Delay in securing donor financing	- Increased number of projects and budget for SHS - Amount of bilateral and multilateral financing	- Number of project proposal developed, submitted and funded	1,000,000
	2.2 Provide appropriate subsidies, incentives and waiver of customs import duties on all SHS	GoL	MFDP	2021- 2024	Delay in decision making by GoL regarding incentives and subsidies	- Implementation of a comprehensive incentives and subsidies policy for	- Number of new homes deploying SHS technology in rural Liberia	20,000

	components for suppliers and end-users.					the diffusion of the technology	Number of distribution outlets nation-wide	
Action 3 Enhance access to financing	3.1 Work with developers to provide innovative and affordable financial plans or business models for the purchase of SHS targeted at people in the rural and peri-urban areas who are not connected to the national grid.	GoL, AfDB, GIZ, USAID, GEF, CTCN, GCF, WB, UNDP, EU, UNEP, UNFCCC,	EPA, RREA	2021 - 2025	Customer growth rates could fall well below those envisaged in the business plans or models	- Development of a well-designed business model for SHS technology that is relevant and appropriate for the Liberian context - Number of private developers involved in SHS deployment	- High uptake of SHS using business model - A well-designed business model for SHS technology that is relevant and appropriate for the Liberian context	15,000
	3.2 Encourage commercial banks to lower the interest rate and extend the duration on loans to acquire SHS.	GoL	EPA MFDP	2021 - 2024	Delay due to insufficient resources	- Increased and available favorable loans to acquire SHS - Increased number of projects access to loans	- Increased number of loans for business and investment in SHS technology; number of SHS units deployed in rural areas	10,000
	3.3 Make the Renewable Energy Development Fund fully operational to provide loans with zero or low interest rates with acceptable loan duration for poor rural households to acquire SHS.	GoL, WB, AfDB, EU, GCF, GEF	EPA RREA MFDP	2022 - 2026	Delay due to insufficient resources or limited access to low interest loans	- Sufficient funds available to support SHS projects - Soft loans are made accessible	- Number of financial mechanisms from GoL and international partners to make Renewable Development Fund sustainable	15,000
	3.4 Provide support for local production of components to lower the initial investment cost of SHS for suppliers and customers.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GCF, UNEP, GEF, CTCN	MFDP MME	2022 - 2027	Poor response from high-quality components manufacturers	- High quality manufacturers are keen to set up local production of solar PV components in the country	- The technology supplied conforms to the best practice of the day - Manufacturer performance guarantees on the modules	1,000,000
Action 4 Increase awareness and knowledge on SHS	4.1 Intensify adequate information, public education and awareness campaigns on SHS for different stakeholders through print and electronic	GEF, GCF, EU, USAID, WB	EPA LEC RREA	2021 - 2027	Unqualified public relations team	- Public awareness campaigns and program for SHS technology implemented - 80% of rural	- Information and awareness programs are approved and implemented	500,000

	media, social media, seminars, workshops, conferences and community engagements.					communities are aware of SHS technology and financial support		
	4.2 Establish information hubs or centers in each county to increase and improve the awareness about SHS equipment costs, benefits and performance for local communities, financial institutions, cooperatives, and entrepreneurs.	GoL, WB, EU, other developing partners	EPA RREA	2021 - 2027			- Number of information hubs or centers established in all counties of the country	800,000
Action 5 Build or strengthen capacity of key stakeholders	5.1 Provide periodic and specialized technical training courses in solar PV home systems installation, operation, management, maintenance and business development to strengthen the capacity of personnel, such as technicians, private entrepreneurs or developers and engineers, with inclusive gender participation.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GCF, UNEP, GEF, CTCN, UNFCCC	EPA, RREA, Tertiary institutes	2022 - 2028	- Preference is in favor of international experts - Local trained staff and technicians remain unemployed	- Availability of highly trained Liberian engineers and contractors - Number of institutions implementing training programs	- Well-developed curricula - Number of new direct and indirect job for both male and female relating to the technology created	1,000,000
	5.2 Enhanced the capacities of staff in financial institutions, regulatory agencies and policy making institutions.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GEF, CTCN, UNFCCC	EPA LERC RREA	2022 - 2028	- High cost for training program and materials - Those for whom training programs are developed are not interested in participating	- Training program designed and implemented - Number of staff trained	- Institutional capacity and human resources are improved	500,000
Action 6 Develop standards for SHS	6.1 Establish a national quality assurance process with the appropriate codes, standards and certification to help end-user identify the best quality products.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF, GCF	EPA RREA LEC LERC	2021 - 2023	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or laws	- Standards, codes and certification scheme developed - Number of skilled technical personnel trained to enforce standards	- Standard testing labs functional	30,000

	6.2 Develop labor skill standards for SHS installers to improve the overall quality and sustainability of SHS technology in the country.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GEF, UNEP, GCF, CTCN, UNFCCC	EPA RREA MME	2021 - 2023	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or laws	- Labor skill standards developed, approved, and enforced - Number of skilled technical personnel trained to enforce standards		10,000
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1.1.3 Action Plan for Technology 2: Solar PV Mini-grid System (SMG)

1.1.3.1 Introduction

Liberia has enormous potential for solar energy. Solar PV mini-grid (SMG) technology offers a viable alternative for meeting the energy demands of citizens in many poorer peri-urban and rural disadvantaged areas in Liberia that are remote from the national grid. They have the capacity to promote socioeconomic growth and improve the living conditions of the people who live in these impoverished urban and rural areas. Mini-grids are small-scale electric power generation and distribution networks that provide electricity to small number customers in remote isolated communities or hundreds of thousands of people in a town or city (ESMAP, 2019). They range in a size from a few kilowatts up to 10 megawatts. Smaller mini-grids are sometimes referred as "micro-grids" or "nano-grids". In the TNA Report II, stakeholders ranked the SMG as the second most important technology for reducing greenhouse gas (GHG) emissions in the energy sector and for the transfer and diffusion of climate change mitigation technologies in Liberia.

SMG has a wide range of benefits which includes energy security, job creation, health, local economic stimulation, climate change mitigation and adaptation. It can improve the quality of life of the rural poor women and children by providing a clean and sustainable energy supply. There are numerous opportunities for public, private, and hybrid interventions. The TNA Report II contains more information on the expected outcomes of this technology.

1.1.3.2 Ambition for the TAP

The ambition of this technology consistent with GOL's ambitious plan, as outlined in Liberia's Rural Energy Strategy and Master Plan (RESMP), to increase rural electricity access to 35% by 2030 and provide electricity to approximately 265,000 homes or 1.34 million people, in peri-urban and rural areas remote or isolated from the national grid. The benefits of this initiative include avoiding the need of diesel generators to power these households and reducing the usage of kerosene and charcoal.

1.1.3.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

Table 1.10 is a summary of the key barriers and measures associated with the transfer and diffusion of solar PV mini-grid system which were identified in the Barrier Analysis and Enabling Framework (BAEF) report.

Table 1.10: Selected barriers and their measures for the solar PV mini-grid system (SMG) technology

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	High initial investments and transaction costs of SMG system	<ul style="list-style-type: none">• To reduce high investments and transaction costs of solar PV mini-grid systems, provide loan guarantees or issue "green bonds" for local and foreign commercial banks to enable them offer lower interest rate loans with longer tenor to investor/developer.• Secure from international donors or cooperation agencies concessionary loans or grants for the promotion of SMG project in isolated and rural areas in the country.• Put in place subsidies, incentives and tax waiver schemes for SMG investors, developers and household to boost deployment of technology in remote areas without access to the national grid.• Capitalize the REFUND and make it operational to provide financial support, capital subsidies, production-based subsidies to investors, suppliers, dealers and consumers of off-grid solar PV system targeted at

		<ul style="list-style-type: none"> remote areas and islands without access to electricity. Adopt proven financial business models and good quality business plan that will take account of affordability and willingness to pay for the cost of electricity from SMG projects.
Technical	Inadequate local technical expertise	<ul style="list-style-type: none"> To overcome the inadequate local technical expertise, institute capacity building initiatives to train both males and females as technicians, engineers, scientists for installation, operation and maintenance, research and development for the renewable energy sector.
Information and awareness	Inadequate and limited information sharing	<ul style="list-style-type: none"> To address the inadequate and limited information barrier, provide adequate information, public education and awareness campaigns to private investors and the general public on advantages and opportunities of SMG technology.
Cultural, social and gender	Absence of inclusive gender participation in SMG projects	<ul style="list-style-type: none"> Provide incentives for women active participation in the management, development, operations, installations, engineering, procurement, construction, maintenance, and repair works of renewable energy technologies.
Weak legal, regulatory and institutional framework	Inadequate legal, regulatory and institutional framework	<ul style="list-style-type: none"> In order to overcome the legal, regulatory, and institutional framework barrier to the transfer and diffusion of the SMG, develop and adopt clear legal, regulatory and institutional framework policies and ensure straight adherence to best practice and international standards.

Actions selected for inclusion in the TAP for SMG

This section provides a list of each of the measures selected as actions, along with narrative descriptions, that will be included in the TAP in order to increase the diffusion and penetration of solar PV mini-grid system (SMG) technology in Liberia. The most important barriers were selected by the stakeholders of the consultation working group during a TNA workshop for Technology Action Plan and Project Ideas meeting held on January 22, 2021. The actions and their activities are presented in Table 1.11.

Action 1: Establish a unit to oversee or lead the implementation of the TAP which is critical for the successful deployment and diffusion of the solar home PV system technology in the country. It will be the implementing unit for all the actions and proposed projects in the TAP. This unit will be responsible for the technical coordination and management of the projects. The unit must be adequately staffed with highly skilled personnel capable of developing terms of references (TORs) and scopes of work, as well as carrying out the required actions and activities of the proposed projects.

Action 2: Reduce high investment cost of solar PV mini-grid systems by providing loan guarantees or issue “green bonds” for local and foreign commercial banks to enable them offer lower interest rate loans with longer payback periods to investors/developers.

Action 3: Enhance access to financing by using public finance in combination with grants, subsidies, concessionary loans, and the development of innovative inclusive financial instruments to expand access to off-grid SMG. Adopt proven financial business models and good quality business plan that will take account of ability to pay (ATP) and willingness to pay (WTP) for the cost of electricity from SMG projects by remote and low-income groups who are not connected to the national grid. The Renewable Energy Development Fund should be made operational to lend to developers, installers and those wishing to access energy from SMG technology.

Action 4: Increase awareness and knowledge on the potential of solar mini-grid systems by providing enough information and awareness raising campaigns for various stakeholders via print and electronic media, social media, seminars, workshops, conferences and community engagements. This will provide stakeholders with information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SMG systems, etc.

Action 5: Build or strengthen local technical capacity will require that technicians, especially in rural areas, be trained to provide servicing of PV systems. Training, orientation and awareness programmes for various target groups, conferences/seminars/workshops for experience sharing among various stakeholders, etc.

Action 6: Develop standards for solar PV mini-grid systems by developing codes and standards and establishing certification, testing, and enforcement institutes. Adequate standards and quality frameworks must be in place to guarantee that the SMG systems installed can operate reliably and safely in off-grid environments. In order to improve the overall quality and sustainability of SMG, labour skill standards for SMG installers should be developed.

Activities identified for implementation of selected actions

Selection of activities for each action was carried out through a stakeholder consultation process at a meeting in January 2021. This section summarizes the identified actions into more specific activities. These activities are things that need to be done to make each identified action work. A list of activities needed for the implementation of each identified action is presented in Table 1.11.

Table 1.11: List of activities identified for the implementation of selected actions of SMG TAP

Action	Activity
1. Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	<p>1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia;</p> <p>1.2 Establish and equip the office the Project Implementation Unit.</p>
2. Reduce high investment cost of solar PV mini-grid systems	<p>2.1 LERC, EPA, MME and RREA should mobilise public and private investment from bilateral or multilateral development agencies and philanthropic organisations for the depolyment SMG systems in remote communities from the national grid.</p> <p>2.2 GoL through the MFDP, RREA and EPA to provide subsidies and incentives up to 90% of the capital cost under rural electrification schemes, waiver of customs import duties to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff.</p> <p>2.3 GoL through MFDP to provide loan guarantees or issue “green bonds” to local and foreign commercial banks to enable them offer long-term and affordable finance to SMG system project developers at different stages of project development.</p>
3. Enhance access to financing	<p>3.1 RREA and EPA to adopt proven financial business models and good quality business plan that will take account of ability to pay (ATP) and willingness to pay (WTP) for the cost of electricity from SMG projects by remote and low-income groups who are not connected to the national grid.</p> <p>3.2 EPA, RREA and MFDP to make the Renewable Energy Development Fund operational to lend to developers, installers and rural holdholds wishing to access energy from SMG technology.</p> <p>3.3 MFDP, MME, RREA, and EPA should provide support for local production of components to lower the initial investment cost of SMG technology.</p>
4. Increase awareness and knowledge on the potential of solar mini-grid systems	<p>4.1 EPA, LEC and RREA should run promotional campaigns and training programmes to raise awareness on the potential and benefits of SMG systems and to remove the myths about these systems being unreliable.</p> <p>4.2 EPA and RREA should establish information hubs or centers in each county to run</p>

	promotional campaigns and training programmes to raise awareness and provide information on the benefits, actual and perceived risks, financing options, licensing processes, tariff rates, reliability and performance of SMG systems for investors, local communities, financial institutions, cooperatives, and entrepreneurs.
5. Build or strengthen local technical capacity	<p>5.1 EPA, RREA and tertiary institutions should include standard modules on renewable energy technologies in training programmes carried out by local institutions in SMG systems installation, operation, management, maintenance and business development to strengthen the technical capacity of personnel, such as technicians, engineers, and private developers, with inclusive gender participation.</p> <p>5.2 EPA, LERC and RREA should adopt an integrated approach to enhance existing skills by providing training for staff in financial institutions, regulatory agencies and policy making institutions.</p>
6. Develop standards for solar PV mini-grid systems	<p>6.1 LERC, RREA, LEC, and EPA should develop codes and standards and establish certification, testing, and enforcement institutes.</p> <p>6.2 MME, RREA and EPA should develop stringent technical skill standards and quality control for installers of SMG systems to ensure quality standards of installations are met.</p> <p>6.3 MME and LERC in collaboration with EPA to develop the appropriate policy, regulatory, institutional frameworks to define the role of each actor and create the enabling environment for large-scale deployment of SMG system for rural electrification.</p>

1.1.3.4 Stakeholders and Timeline for implementation of SMG TAP

Overview of Stakeholders for the implementation of the SMG TAP

There are a number of key stakeholders whose full cooperation and participation is required for the SMG TAP's implementation. The TNA project falls under the purview of the United Nations Framework Convention on Climate Change (UNFCCC) and the Focal Point is located in Environmental Protection Agency of Liberia. Hence, the EPA is the implementing agency for all the actions and projects proposed in the TAP. However, there will be other stakeholders involved in the implementation each actions and activities. The list and roles of the key stakeholders who have been identified for the implementation of each actions of the TAP for SMG is provided in Table 1.12.

Table 1.12: List of key stakeholders and their roles for the implementation of different activities of the SMG TAP

#	Stakeholder	Action	Role
1	Environmental Protection Agency (EPA)	1, 2, 3, 4, 5, and 6	<ul style="list-style-type: none"> - Implementing agency for all the actions and projects proposed in the TAP - Focal Point of the UNFCCC - Sourcing funds from Green Climate Fund and Global Environmental Facility - Responsible for environmental policies and management
2	Rural & Electrification Energy Agency (RREA)	2, 3, 4, 5, and 6	<ul style="list-style-type: none"> - Manage the Renewable Energy Fund - Promote renewable energy technologies - Develop solar PV standards
3	Liberia Electricity Regulatory Commission (LERC)	2, 5, and 6	<ul style="list-style-type: none"> - Regulate the energy sector, issue licenses, approve tariffs, ensure liberalization of the sector, improve service delivery, protect consumers and create a vibrant electricity sector - Monitor and enforce quality standards on all solar PV components and spare parts imported in to the country
4	Ministry of Finance and Development Planning (MFDP)	2 and 3	<ul style="list-style-type: none"> - Responsible for fiscal policies including incentives and subsidies -Negotiate loans for funding renewable energy projects
5	Ministry of Mines and Energy (MME)	2, 3 and 6	<ul style="list-style-type: none"> - Formulate policies for the energy sector and create a conducive environment for delivery of electricity and rural electrification.
6	Liberia Electricity Corporation (LEC)	4 and 6	<ul style="list-style-type: none"> - Sole provider of electricity in the country and owner of the grid.

7	Tertiary institutions	5	- Provide technical training courses in solar PV mini-grid systems installation, operation, management, maintenance and business development
8	Development partners and funds: WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, GCF, CTCN, UNFCCC, GEF,	2, 3, 5 and 6	-Provide technical and financial support for diffusion of SMG technology

Scheduling and sequencing of specific activities

The timeframe established for planning and implementation of the SMG TAP's actions and activities leading to the creation of a robust policy framework for the deployment of the prioritized energy sector technologies is 10 years (2021 to 2030). This period is aligned with the finalization of the rural energy strategy and master plan for Liberia, the Sustainable Development Goal 7 and Liberia's Intended Nationally Determined Contributions. These are key national policies related to development priorities and climate change mitigation for the attainment of the Liberia's energy sector goal of raising the share of renewable energy to at least 30% of electricity production and 10% of overall energy consumption by 2030. Table 1.13 describes the sequence and timing of specific activities and responsibilities.

Table 1.13: Schedule and sequence of activities for SMG TAP

Action	Activities	Timelines (Planning to Implementation)	Responsible body
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	2021 to 2023	EPA
Action 2 Reduce high investment cost of solar PV mini-grid systems	2.1 LERC, EPA, MME and RREA to mobilise public and private investment from bilateral or multilateral development agencies and philanthropic organisations for the deployment SMG systems in remote communities from the national grid.	2021 -2027	EPA, MME, RREA, MFDP, LERC, DP
	2.2 GoL through the MFDP, RREA and EPA to provide subsidies and incentives up to 90% of the capital cost under rural electrification schemes, waiver of customs import duties to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff.	2021 -2025	MFDP, EPA, RREA
	2.3 GoL through MFDP to provide loan guarantees or issue "green bonds" to local and foreign commercial banks to enable them offer long-term and affordable finance to SMG system project developers at different stages of project development.	2021 -2026	MFDP
Action 3 Enhance access to financing	3.1 RREA and EPA to adopt proven financial business models and good quality business plan that will take account of ability to pay (ATP) and willingness to pay (WTP) for the cost of electricity from SMG projects by remote and low-income groups who are not connected to the national grid.	2021 -2025	EPA, RREA
	3.2 EPA, RREA and MFDP to make the Renewable Energy Development Fund operational to lend to developers, installers and rural households wishing to access energy from SMG technology.	2021 -2024	EPA, RREA, MFDP, DP
	3.3 MFDP, MME, RREA, and EPA should provide support for local	2021 -2026	MFDP, MME,

	production of components to lower the initial investment cost of SMG technology.		EPA RREA
Action 4 Increase awareness and knowledge on the potential of solar mini-grid systems	4.1 EPA, LEC, LERC, RREA should run promotional campaigns and training programmes to raise awareness on the potential and benefits of SMG systems and to remove the myths about these systems being unreliable.	2021 -2027	EPA, LEC, LERC, RREA
	4.2 EPA and RREA should establish information hubs or centers in each county to run promotional campaigns and training programmes to raise awareness and provide information on the benefits, actual and perceived risks, financing options, licensing processes, tariff rates, reliability and performance of SMG systems for investors, local communities, financial institutions, cooperatives, and entrepreneurs.	2022 -2027	EPA, RREA
Action 5 Build or strengthen capacity of key stakeholders	5.1 EPA, RREA and tertiary institutions should include standard modules on renewable energy technologies in training programmes carried out by local institutions in SMG systems installation, operation, management, maintenance and business development to strengthen the technical capacity of personnel, such as technicians, engineers, and private developers, with inclusive gender participation.	2022 -2028	EPA, RREA, Tertiary institutes
	5.2 EPA, LERC and RREA should adopt an integrated approach to enhance existing skills by providing training for staff in financial institutions, regulatory agencies and policy making institutions.	2022 -2028	EPA, LERC, RREA
Action 6 Develop standards for solar PV mini-grid systems	6.1 LERC, RREA, LEC, and EPA should develop codes and standards and establish certification, testing, and enforcement institutes.	2021 -2024	EPA, RREA, LEC, LERC, DP
	6.2 MME, RREA and EPA should develop stringent technical skill standards and quality control for installers of SMG systems to ensure quality standards of installations are met.	2021 -2025	EPA, RREA, MME
	6.3 MME and LERC in collaboration with EPA to develop the appropriate policy, regulatory, institutional frameworks to define the role of each actor and create the enabling environment for large-scale deployment of SMG system for rural electrification.	2021 - 2026	MME, EPA, LERC,

1.1.3.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

In collaboration with stakeholders, the capacity development needs for efficient implementation of the TAP's actions and activities, as well as strengthening of the enabling framework for energy sector technologies, were identified. There is a need to build capacity in sourcing international funds as well as training and accrediting of local personnel on the installation, operation and management of solar PV home systems in order to ensure accelerated diffusion of the technology in the country.

Estimations of costs of actions and activities

The estimated cost for the implementation of the TAP's actions and activities were identified in collaboration with stakeholders during the TAP workshop. Table 1.14 provides an estimate of the cost in United States Dollar (US\$) for implementing of each actions and activities that makes up the TAP. The total estimated cost for implementing the SMG TAP is US\$ 8,580,000.

Table 1.14: Summary estimation of costs and resources needed for SMG actions and activities

Action	Activities to be support	Estimated cost (US\$)	Source of funds
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	25,000	GoL, CTCN AfDB, GIZ USAID, WB,
Action 2 Reduce high investment cost of solar PV mini-grid systems	2.1 LERC, EPA, MME and RREA should mobilise public and private investment from bilateral or multilateral development agencies and philanthropic organisations for the depolyment SMG systems in remote communities from the national grid.	4,000,000	GEF, GCF, WB, EU, AfDB, USAID
	2.2 GoL through the MFDP, RREA and EPA to provide subsidies and incentives up to 90% of the capital cost under rural electrification schemes, waiver of customs import duties to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff.	10,000	GoL,
	2.3 GoL through MFDP to provide loan guarantees or issue “green bonds” to local and foreign commercial banks to enable them offer long-term and affordable finance to SMG system project developers at different stages of project development.	25,000	GoL
Action 3 Enhance access to financing	3.1 RREA and EPA to adopt proven financial business models and good quality business plan that will take account of ability to pay (ATP) and willingness to pay (WTP) for the cost of electricity from SMG projects by remote and low-income groups who are not connected to the national grid.	35,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, GEF UNFCCC,
	3.2 EPA, RREA and MFDP to make the Renewable Energy Development Fund operational to lend to developers, installers and rural households wishing to access energy from SMG technology.	1,000,000	GoL, WB, AfDB, EU, GCF, GEF
	3.3 MFDP, MME, RREA, and EPA should provide support for local production of components to lower the initial investment cost of SMG technology.	500,000	GoL
Action 4 Increase awareness and knowledge on the potential of solar mini-grid systems	4.1 EPA, LEC and RREA to run promotional campaigns and training programmes to raise awareness on the potential and benefits of SMG systems and to remove the myths about these systems being unreliable.	550,000	GEF, GCF, EU, USAID, WB
	4.2 EPA and RREA to establish information hubs or centers in each county to run promotional campaigns and training programmes to raise awareness and provide information on the benefits, actual and perceived risks, financing options, licensing processes, tariff rates, reliability and performance of SMG systems for investors, local communities, financial institutions, cooperatives, and entrepreneurs.	800,000	GoL, WB, EU, DP

Action 5 Build or strengthen capacity of key stakeholders	5.1 EPA, RREA and tertiary institutions should include standard modules on renewable energy technologies in training programmes carried out by local institutions in SMG systems installation, operation, management, maintenance and business development to strengthen the technical capacity of personnel, such as technicians, engineers, and private developers, with inclusive gender participation.	1,000,000	GoL, WB, AfDB, EU, GEF, GIZ, USAID, UNDP, GCF, UNEP, CTCN, UNFCCC,
	5.2 EPA, LERC and RREA should adopt an integrated approach to enhance existing skills by providing training for staff in financial institutions, regulatory agencies and policy making institutions.	500,000	GoL, WB, EU, GIZ, GEF, GCF, AfDB, USAID, UNDP, CTCN, UNFCCC, UNEP
Action 6 Develop standards for solar PV mini-grid systems	6.1 LERC, RREA, LEC, and EPA should develop codes and standards and establish certification, testing, and enforcement institutes.	45,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF
	6.2 MME, RREA and EPA should develop stringent technical skill standards and quality control for installers of SMG systems to ensure quality standards of installations are met.	50,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, UNEP, CTCN, UNFCCC, GEF
	6.3 MME and LERC in collaboration with EPA to develop the appropriate policy, regulatory, institutional frameworks to define the role of each actor and create the enabling environment for large-scale deployment of SMG system for rural electrification.	40,000	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP, CTCN,
Total		8,580,000	

1.1.3.6 Management Planning

Risks and Contingency Planning

Table 1.15 provides a summary of key risks identified in the activities and the contingency plan to mitigate these risks for the successful implementation of the Solar PV Mini-grid System TAP.

Table 1.15 Risk and contingency plan for the implementation of SMG TAP

Risk	Description	Contingency plan
Cost risk	Delays in securing donor funds	GoL use budgetary support to set up the implementation unit, finance the preparation of the public awareness and promotional campaigns and utilize donor funds for implementation.
Performance risk	- Delays in decision making regarding incentives, subsidies and implementation - Failures of the installed mini-grid system to perform according to the expectations of the mini-grid operator and the customers	- Ensure there is strong high-level political and institutional acceptance or support from the Cabinet and also key Ministries and agencies. - Use standardised components which adhere to quality standards and rely on component suppliers who offer quality products that come with comprehensive warranty and customer service.
Schedule risk	- Delays in putting in place regulations and policies to facilitate the diffusion of the SMG technology.	- Integrate policies and regulations with regards to solar PV mini grids and rural electrification in general into the national policies on electrification and renewable energy integration into the grid.
Information	Information not being provided in a	Establish project steering committee to bring together key Ministries and

risk	timely manner and inadequate cooperation or collaboration amongst stakeholders.	institutions into the implementing process. Ensure that the project will be managed by professional managers with proven track record using best management practices
Political risk	The returns on investments in SMG projects could suffer as a result of political or economic instability and corruption in the country.	Investors and lenders must obtain political risk insurance or multilateral development banks guarantees to cover risks like breach of contract, changes in political regime, currency inconvertibility, transfer restriction, expropriation, terrorism, war, and civil unrests.

Next Steps

Table 1.16 provides a summary of the immediate requirements and critical steps for the successful implementation of the SMG TAP.

Table 1.16 Summary of immediate requirements and critical steps for implementation of SMG TAP

Immediate requirements:	<p>a) The EPA should schedule a meeting with other key stakeholders such as RREA, MME, and MFDP to disseminate the outcomes of the TAP and to clearly define each stakeholder's roles, responsibilities and overall timelines.</p> <p>b) EPA should equip the national TAP implementing unit's office with highly competent personnel and logistics to ensure successful, effective and efficient implementation the TAP.</p> <p>c) Comprehensive mapping should be done to identify ideal locations and sites for mini-grid installations, as well as any planned main grid expansions, to serve as a crucial reference for developers considering solar PV mini-grid projects.</p> <p>d) GoL should develop a budget line for funding TAP activities</p>
Critical steps:	<p>a) The EPA should ensure that the TAP's outcomes are approved at the Cabinet level.</p> <p>b) Project proposals based on the project ideas should be develop as soon as possible.</p> <p>c) GoL must engage with donors early to secure financing for TAP projects to ensure that activities timelines are met.</p>

1.1.3.7 TAP overview table for Solar PV Mini-grid System (SMG)

The overview of the Technology Action Plan (TAP) for the SMG is provided in Table 1.17.

Table 1.17: TAP overview table for Solar PV Mini-grid System

TAP overview table								
Sector	Energy							
Sub-sector	Electricity production							
Technology	Solar PV Mini-grid System							
Ambition	Increase rural electricity access to 35% by 2030 and provide electricity to approximately 265,000 homes or 1.34 million people, in peri-urban and rural areas remote or isolated from the national grid.							
Benefits	Social	<ul style="list-style-type: none"> - Saved income to be used for other purposes - Some jobs are created as a result of the availability of electricity - Reduce gender disparities and encourage greater female engagement in rural energy-related activities. 						
	Economic	<ul style="list-style-type: none"> - Electricity bill savings - With the availability of electricity, income-generating options abound. 						
	Environment	<ul style="list-style-type: none"> - Reduction of Greenhouse gas emissions (GHG) by avoiding the need of diesel generators to power rural households and reducing the usage of kerosene and charcoal. 						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity (US\$)
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	GoL, CTCN, WB, AfDB, GIZ, USAID	EPA	2021 - 2023	Non-commitment and bureaucracy on the part of responsible body	Fully equipped implementation unit with highly competent personnel	A working implementation unit meeting key performance index	25,000
Action 2 Reduce high investment cost of solar PV mini-grid systems	2.1 Mobilise public and private investment from bilateral or multilateral development agencies and philanthropic organisations for the depolyment SMG systems in remote communities from the national grid.	GEF, GCF, WB, EU, AfDB, USAID	EPA, MME, RREA, LERC MFDP, DP	2021 - 2027	Delay in securing donor financing	Increased number of projects and budget for SMG Amount of bilateral and multilateral financing	Number of project proposal developed, submitted and funded	4,000,000

	2.2 Provide subsidies and incentives up to 90% of the capital cost under rural electrification schemes, waiver of customs import duties to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff.	GoL, DP	MFDP, EPA, RREA	2021 - 2025	Delay in decision making by GoL regarding incentives and subsidies	Implementation of a comprehensive incentives and subsidies policy for the diffusion of the technology	Number and type of incentives in place	10,000
	2.3 Provide loan guarantees or issue “green bonds” to local and foreign commercial banks to enable them offer long-term and affordable finance to SMG system project developers at different stages of project development.	GoL, EU, WB, GCF, GEF	MFDP	2021 - 2026	Insufficient funds available	Banks are offering loans for SMG projects	Number of loans provided for SMG projects	25,000
Action 3 Enhance access to financing	3.1 Adopt proven financial business models and good quality business plan that will take account of ability to pay (ATP) and willing-ness to pay (WTP) for the cost of electricity from SMG projects by remote and low-income groups who are not connected to the national grid.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, RREA	2021 - 2025	Customer growth rates could fall well below those envisaged in the business plans or models	- Development of a well-designed business model for SMG technology that is relevant and appropriate for the Liberian context - Number of private developers involved in SMG deployment	- High uptake of SMG electricity using business model - A well-designed business model for SMG technology that is relevant and appropriate for the Liberian context	35,000
	3.2 Make the Renewable Energy Development Fund operational to lend to developers, installers and rural holdholds wishing to access energy from SMG technology.	GoL, WB, AfDB, EU, GCF, GEF, USAID	EPA, RREA, MFDP, DP	2021 - 2024	Delay due to insufficient resources	- Sufficient funds available to support SMG projects - Revolving loan fund established	- Number of financial mechanisms from government and international partners available to make Renewable Development Fund sustainable - Number of loans provided by Fund	1,000,000

	3.3 Provide support for local production of components to lower the initial investment cost of SMG technology.	GoL, WB, AfDB, EU, GCF, GEF, CTCN	MFDP, MME, RREA, EPA	2021 - 2026	Delay due to insufficient resources or limited access to low interest loans	- Sufficient funds available to support produce components locally	- Components are manufactured by local factories	500,000
Action 4 Increase awareness and knowledge on the potential of solar mini-grid systems	4.1 Run promotional campaigns and training programmes to raise awareness on the potential and benefits of SMG systems and to remove the myths about these systems being unreliable.	GEF, GCF, EU, USAID, WB, AfDB	EPA, LEC, LERC, RREA	2021 - 2027	Unqualified public relations team	- Public awareness campaigns and program for SMG technology implemented - 80% of rural communities are aware of SMG technology and financial support	- Information and awareness programs are approved and implemented	550,000
	4.2 Establish information hubs or centers in each county to run promotional campaigns and training programmes to raise awareness and provide information on the benefits, actual and perceived risks, financing options, licensing processes, tariff rates, reliability and performance of SMG systems for investors, local communities, financial institutions, cooperatives, and entrepreneurs.	GoL, WB, EU, DP	EPA, RREA	2022 - 2027	Delay due to insufficient resources	- Number of information hubs or centers established in all counties of the country	- Number of information hubs or centers established in all counties of the country	800,000
Action 5 Build or strengthen local technical capacity	5.1 Include standard modules on renewable energy technologies in training programmes carried out by local institutions in SMG systems installation, operation, management, maintenance and business development to strengthen the technical capacity of personnel, such as technicians, engineers, and private developers, with inclusive gender participation.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, RREA, Tertiary institutes	2022 - 2028	- Preference is in favor of international experts - Local trained staff and technicians remain unemployed	- Availability of highly trained Liberian engineers and contractors - Number of institutions implementing training programs	- Well-developed curricula - Number of new direct and indirect job for both male and female relating to the technology created	1,000,000

	5.2 Adopt an integrated approach to enhance existing skills by providing training for staff in financial institutions, regulatory agencies and policy making institutions.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, LERC, RREA, DP	2022 - 2028	- High cost for training program and materials - Those for whom training programs are developed are not interested in participating	- Training program designed and implemented - Number of staff trained	- Institutional capacity and human resources are improved	500,000
Action 6 Develop standards for solar PV mini-grid systems	6.1 Develop codes and standards and establish certification, testing, and enforcement institutes.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GCF, GEF, UNEP, CTCN, UNFCCC	EPA, RREA, LEC, LERC, DP	2021 - 2024	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or laws	- Standards, codes and certification scheme developed - Number of skilled technical personnel trained to enforce standards	- Standard testing labs functional	45,000
	6.2 Develop stringent technical skill standards and quality control for installers of SMG systems to ensure quality standards of installations are met.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, RREA, MME	2021 - 2025	- Non-compliance and enforcement of standards - Delay due to changing or revising existing regulations or laws	- Labor skill standards developed, approved, and enforced - Number of skilled technical personnel trained to enforce standards	- Number of skilled technical personnel trained to enforce standards	50,000
	6.3 Develop the appropriate policy, regulatory, institutional frameworks to define the role of each actor and create the enabling environment for large-scale deployment of SMG system for rural electrification.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, UNEP, CTCN, GEF, GCF, UNFCCC	EPA, MME, LERC	2021 - 2026	Lack of participation from key institutional stakeholders	Multi-stakeholders committee set up and operational through regular meetings	Number of institutions participating in committee meetings	40,000

1.1.4 Action Plan for Technology 3: Small Hydropower System (SHP)

1.1.4.1 Introduction

Small hydropower (SHP) is an essential technology for addressing the challenges of energy security, access to clean energy, and climate change mitigation all at the same time and in a sustainable manner. SHP technology has the potential to significantly contribute to satisfying the electricity needs of urban, peri-urban, and remote rural communities. Small hydropower mini-grids can provide an economically feasible, ecologically sustainable, and climate-friendly alternative to fossil fuel-based electricity sources by exploiting Liberia's considerable hydropower potential. SHP generates power by using the flow of water to turn turbines connected to a generator. The amount of energy produced is related to the head drop and the amount of water discharged from the turbine.

According to the Economic Community of West African States (ECOWAS) hydropower systems with capacity less than 30 MW are defined as small hydropower systems (ECOWAS, 2012). The adoption of small hydropower system technology is aligned with Liberia's Agenda for Transformation development strategy, which intends to extend electricity service, reduce electricity costs, encourage renewable energy resources and reduce the amount of greenhouse gases emissions. These are key components for long-term economic development and poverty alleviation.

Liberia has more than 2,300 MW of hydro potential identified under the Rural Energy Strategy and Master Plan (RESMP) study with 88 MW currently installed. The country hydro potential includes numerous potential small hydropower sites with indicative capacities of less than 10 MW. Twenty-four of these sites have an estimated combined total capacity of 86 MW. Across the country there are also hundreds of other sites with smaller hydropower capacities. Despite these potential, SHP below 10 MW remain unexploited for the production of electricity in the country. Some benefits of SHP are:

- Promotes and creates new economic activity and jobs for the rural poor, as well as boost local development and increases income in communities where power is supplied.
- It replaces of the use of diesel engine power generators, wood and charcoal fuels resulting in a significant decrease in GHG emissions and air pollution.
- It can improve the quality of life of the rural poor women and children by providing a clean and sustainable energy supply.
- It has the potential to improve essential social services such as health care and education.
- It is eco-friendly because it produces little or no overflow; minimal deforestation; and has low impact on flora, wildlife, and biodiversity.

More details on the expected outcomes of this technology can be found in the TNA Report II.

1.1.4.2 Ambition for the TAP

The ambition for technology transfer and diffusion of small hydropower (SHP) technology is to construct SHP with total capacity 50 MW by 2030 at specific remote and isolated rural locations across the country as indicated by the Rural Energy Strategy and Master Plan (RESMP) and the National Renewable Energy Action Plans (NREAPs).

1.1.4.3 Actions and Activities selected for inclusion in the TAP

This section provides a discussion of the actions and activities that have been selected for inclusion in the TAP for small hydropower systems.

Summary of barriers and measures to overcome barriers

Table 1.18 is a summary of the key barriers and measures associated with the deployment, transfer and diffusion of small hydropower system which were identified in the Barrier Analysis and Enabling Framework (BAEF) report.

Table 1.18: Selected barriers and their measures for the small hydropower (SHP) technology

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	High capital investment costs for SHP	<ul style="list-style-type: none"> To reduce the high capital costs for SHP, remove taxes and duties on imports of SHP equipment. The government should solicit concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country. Put in place financial business models, good quality business plan and an affordable tariff structure based on customers' ability and willingness to pay which will allow poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest. The government need to design strategies to reduce investment costs for renewable energy technologies' project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).
Technical	Inadequate local technical expertise	<ul style="list-style-type: none"> To solve the problem of unavailability of local technical expertise, government should provide funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions so that they can train experts to manage the technology. MME, LEC and RREA need to build the capacity and expertise of their staff. Inclusion of women and girls in the training programmes for gender mainstreaming.
Public awareness and Information	Inadequate and limited information sharing	<ul style="list-style-type: none"> Provide adequate information and raise public awareness on the technology through communication campaigns in the electronic, print and social media for all stakeholders.
Cultural, social and gender	Absence of inclusive gender participation in SHP projects	<ul style="list-style-type: none"> To overcome the barrier of the absence of inclusive gender participation in SHP projects, address gender sensibility to ensure that options provided in the design of the projects meet the needs of women, children and other vulnerable groups in the communities. Promote gender equality by involving women in rural electrification decision making process and educate them so that they participate in the construction and maintenance of the SHP plant system.
Weak legal, regulatory and institutional framework	Absence of adequate legal, regulatory and institutional framework	<ul style="list-style-type: none"> To overcome the problem of inadequate legal, regulatory and institutional framework, the GOL need to provide and implement adequate legal, institutional and regulatory frameworks for small hydropower mini-grids deployment and operation. To overcome the problem of cheap and substandard equipment, special training programs should be organize for relevant staff of the Ministry of Commerce, the Bureau of Standards, Customs agency, the MME Department of Energy and other relevant agencies of government on certification procedures, compliance monitoring, and enforcement of national standards and regulation for SHP equipment and spare parts.

Actions selected for inclusion in the TAP for SHP

This section focuses on a list of each of the measures selected as actions, along with narrative descriptions, that will be included in the TAP in order to encourage the development of small hydropower system (SHP) technology in Liberia. During a TNA workshop for Technology Action Plan and Project Ideas on January 22, 2021, the stakeholders of the consultation working group selected the most important barriers. The actions and their activities are presented in Table 1.19.

Action 1: Establish a unit to oversee or lead the implementation of the TAP which is crucial for the successful development of the small hydropower system technology in the country. It will be the implementing unit for all the actions and proposed projects in the TAP. The technical coordination and management of the projects will be the responsibility of this unit. The unit must be sufficiently equipped with highly trained personnel capable of developing terms of reference (TORs) and scopes of work as well as carrying out the proposed projects' required actions and activities.

Action 2: Reduce the high capital investment costs of small hydropower systems through public-private partnerships, concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country. The government also must design strategies to reduce investment costs for renewable energy technologies' project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).

Action 3: Improve access to financing by combining government budgetary allotments with grants, subsidies, concessionary loans, and the development of innovative inclusive financial mechanisms to increase access to SHP mini-grid. Implement financial business models, high-quality business plan and an affordable tariff structure based on customers' ability and willingness, allowing poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest. The Renewable Energy Development Fund should be made operational provide low interest loans, loan guarantees, and grants as targeted subsidies to ensure energy is accessed by the poor.

Action 4: Raise public awareness and knowledge about the benefits of small hydropower systems by providing adequate information and raising public awareness about the technology through communication campaigns using electronic, print, social media, seminars, workshops, conferences and community engagements for all stakeholders. Provide more information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SHP systems, among others.

Action 5: Build or strengthen local technical capacity by providing funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions so that they can train experts to manage the technology. MME, LEC and RREA must build the capacity and expertise of their workforce in the SHP technology. Gender mainstreaming in the sector will enhance by the involvement of women in the training programmes.

Action 6: Develop a legal, regulatory and institutional framework for small hydropower technology by encouraging the government to create enabling policies and regulatory frameworks, particularly in the areas of tariffs, licensing and permits, and grid connectivity, and to apply them in a credible and transparent manner.

Activities identified for implementation of selected actions

Selection of activities for each action was carried out through a stakeholder consultation process at a meeting in January 2021. This section summarizes the identified actions into more specific activities.

These activities are things that need to be done to make each identified action work. A list of activities needed for the implementation of each identified action is presented in Table 1.18.

Table 1.19: List of activities identified for the implementation of selected actions of SHP TAP

Action	Activity
1. Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	<p>1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia;</p> <p>1.2 Establish and equip the office the Project Implementation Unit.</p>
2. Reduce the high capital investment costs of small hydropower systems	<p>2.1 MFDP, LERC, EPA, MME and RREA must use public-private partnerships concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country.</p> <p>2.2 MFDP, MME, RREA and EPA must reduce investment costs for SHP system project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).</p>
3. Improve access to financing	<p>3.1 MFDP must provide annual government budgetary allotments in addition to international grants, subsidies, concessionary loans to development SHP mini-grid in the country.</p> <p>3.2 EPA, RREA and MFDP to make the Renewable Energy Development Fund operational to provide low interest loans, loan guarantees, and grants as targeted subsidies to ensure energy is accessed by the poor.</p> <p>3.3 MFDP, MME, RREA, and EPA should provide support for local production of components to lower the capital investment cost of SHP technology.</p> <p>3.4 LERC, LEC, RREA, and EPA implement financial business models, high-quality business plan and an affordable tariff structure based on customers' ability and willingness, allowing poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest.</p>
4. Raise public awareness and knowledge about the benefits of small hydropower systems	<p>4.1 EPA, LEC, LWSC, and RREA should provide adequate information and public awareness about the SHP technology through communication campaigns using electronic, print, social media, seminars, training workshops, conferences and community engagements for all stakeholders.</p> <p>4.2 LERC, MME, RREA and EPA must provide information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SHP systems, among others.</p> <p>4.3 LERC, MME and RREA must support renewable resource assessment and site reconnaissance studies, especially for small hydropower mini-grid development in the country. Information on the hydrological data will help investors and project developers make informed decisions.</p> <p>4.4 LERC, MME, RREA and EPA must develop a platform for sharing information on small hydropower potential in the country.</p>
5. Build or strengthen local technical capacity	<p>5.1 MFDP, EPA, MPW, and RREA must allocate funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions to train both male and female local experts to manage the SHP technology.</p> <p>5.2 MME, LEC, MPW and RREA must conduct specilized training to build the capacity and expertise of their workforce in installation, operation, management, maintenance and business development the SHP technology.</p>
6. Develop a legal, regulatory and institutional framework for SHP technology	<p>6.1 MME, LERC, EPA and RREA must create enabling policies and regulatory frameworks, particularly in the areas of tariffs, licencing and permits, and grid connectivity, and to apply them in a credible and transparent manner.</p> <p>6.2 LERC, RREA, LEC, and EPA should develop codes and standards and establish certification, testing, and enforcement institutes.</p> <p>6.3 MME, LERC, RREA and EPA must develop the appropriate policy, regulatory, institutional frameworks to define the role of each player and create conducive environment for the development of SHP technology for rural electrification.</p>

1.1.4.4 Stakeholders and Timeline for implementation of SHP TAP

Overview of Stakeholders for the implementation of the SHP TAP

There are a number of key stakeholders whose full cooperation and participation is required for the SHP TAP's implementation. The TNA project falls under the purview of the United Nations Framework Convention on Climate Change (UNFCCC) and the Focal Point is located in Environmental Protection Agency of Liberia. Hence, the EPA is the implementing agency for all the actions and projects proposed in the TAP. However, there will be other stakeholders involved in the implementation each actions and activities. The list and roles of the key stakeholders who have been identified for the implementation of each actions of the TAP for SHP is provided in Table 1.20.

Table 1.20: List of key stakeholders and their roles for the implementation of different activities of the SMG TAP

#	Stakeholder	Action	Role
1	Environmental Protection Agency (EPA)	1, 2, 3, 4, 5, and 6	<ul style="list-style-type: none"> - Implementing agency for all the actions and projects proposed in the TAP - Focal Point of the UNFCCC - Sourcing funds from Green Climate Fund and Global Environmental Facility - Responsible for environmental policies and management
2	Rural & Electrification Energy Agency (RREA)	2, 3, 4, 5, and 6	<ul style="list-style-type: none"> - Manage the Renewable Energy Fund - Promote renewable energy technologies - Develop SHP standards
3	Liberia Electricity Regulatory Commission (LERC)	2, 3, 4 and 6	<ul style="list-style-type: none"> - Regulate the energy sector, issue licenses, approve tariffs, ensure liberalization of the sector, improve service delivery, protect consumers and create a vibrant electricity sector - Monitor and enforce quality standards on all SHP components and spare parts imported in to the country
4	Ministry of Finance and Development Planning (MFDP)	2, 3 and 5	<ul style="list-style-type: none"> - Responsible for fiscal policies including incentives and subsidies -Negotiate loans for funding renewable energy projects
5	Ministry of Mines and Energy (MME)	2, 3, 4, 5 and 6	<ul style="list-style-type: none"> - Formulate policies for the energy sector and create a conducive environment for delivery of electricity and rural electrification.
6	Liberia Electricity Corporation (LEC)	3, 4, 5 and 6	<ul style="list-style-type: none"> - Sole provider of electricity in the country and owner of the grid.
7	Tertiary institutions	5	<ul style="list-style-type: none"> - Provide technical training courses in SHP mini-grid systems installation, operation, management, maintenance and business development
8	Development partners and funds: WB, AfDB, GIZ, EU, UNFCCC, USAID, UNDP, UNEP, CTCN, GEF, GCF	2, 3, 5 and 6	<ul style="list-style-type: none"> -Provide technical and financial support for diffusion of SHP technology

Scheduling and sequencing of specific activities

The timeframe established for planning and implementation of the SHP TAP's actions and activities leading to the creation of a robust policy framework for the deployment of the prioritized energy sector technologies is 10 years (2021 to 2030). This period is aligned with the finalization of the rural energy strategy and master plan for Liberia, the Sustainable Development Goal 7 and Liberia's Intended Nationally Determined Contributions. These are key national policies related to development priorities and climate change mitigation for the attainment of the Liberia's energy sector goal of raising the share of renewable energy to at least 30% of electricity production and 10% of overall

energy consumption by 2030. Table 1.21 describes the sequence and timing of specific activities and responsibilities.

Table 1.21: Schedule and sequence of activities for SHP TAP

Action	Activities	Timelines (Planning to Implementation)	Responsible body
Action1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	2021 - 2023	EPA
Action 2 Reduce the high capital investment costs of small hydropower systems	2.1 MFDP, LERC, EPA, MME and RREA must use public-private partnerships concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country.	2022 -2030	MFDP, LERC, EPA, MME, DP RREA
	2.2 MFDP, MME, RREA and EPA must reduce investment costs for SHP system project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).	2022 -2030	MFDP, MME, RREA, EPA,
Action 3 Improve access to financing	3.1 MFDP must provide annual government budgetary allotments in addition to international grants, subsidies, concessionary loans to development SHP mini-grid in the country.	2021 -2030	MFDP
	3.2 EPA, RREA and MFDP to make the Renewable Energy Development Fund operational to provide low interest loans, loan guarantees, and grants as targeted subsidies to ensure energy is accessed by the poor.	2021 -2027	EPA, RREA, MFDP, DP
	3.3 MFDP, MME, RREA, and EPA should provide support for local production of components to lower the capital investment cost of SHP technology.	2022 -2028	MFDP, MME, RREA, EPA
	3.4 LERC, LEC, RREA, and EPA implement financial business models, high-quality business plan and an affordable tariff structure based on customers' ability and willingness, allowing poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest.	2022 -2030	LERC, LEC, RREA, EPA
Action 4 Raise public awareness and knowledge about the benefits of small hydropower systems	4.1 EPA, LEC, LWSC, and RREA should provide adequate information and public awareness about the SHP technology through communication campaigns using electronic, print, social media, seminars, training workshops, conferences and community engagements for all stakeholders.	2021 -2027	EPA, LEC, LWSC, RREA
	4.2 LERC, MME, RREA and EPA must provide information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SHP systems, among others.	2022 -2028	LERC, MME, RREA, EPA
	4.3 LERC, MME and RREA must support renewable resource assessment and site reconnaissance studies, especially for small hydropower mini-grid development in the country. Information on the hydrological data will help investors and project developers make informed decisions.	2021 -2025	LERC, MME, RREA
	4.4 LERC, MME, RREA and EPA must develop a platform for sharing information on small hydropower potential in the country.	2022 -2027	LERC, EPA MME, RREA

Action 5 Build or strengthen local technical capacity	5.1 MFDP, EPA, MPW, and RREA must allocate funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions to train both male and female local experts to manage the SHP technology.	2022 -2030	EPA, RREA, MPW, MFDP Tertiary institutes
	5.2 MME, LEC, MPW and RREA must conduct specilized training to build the capacity and expertise of their workforce in installation, operation, management, maintenance and business development the SHP technology.	2022 -2030	EPA, LERC, RREA, MPW
Action 6 Develop a legal, regulatory and institutional framework for SHP technology	6.1 MME, LERC, EPA and RREA must create enabling policies and regulatory frameworks, particularly in the areas of tariffs, licencing and permits, and grid connectivity, and to apply them in a credible and transparent manner.	2022 -2025	EPA, RREA, LEC, LERC, DP
	6.2 LERC, RREA, LEC, and EPA should develop codes and standards and establish certification, testing, and enforcement institutes.	2022 -2024	EPA, LEC, RREA, MME LERC
	6.3 MME, LERC, RREA and EPA must develop the appropriate policy, regulatory, institutional frameworks to define the role of each player and create conducive environment for the development of SHP technology for rural electrification.	2022 - 2025	MME, LERC, EPA

1.1.4.5 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

In collaboration with stakeholders, the capacity development needs for efficient implementation of the TAP's actions and activities, as well as strengthening of the enabling framework for energy sector technologies, were identified. There is a need to build capacity in sourcing international funds as well as training and accrediting of local personnel on the installation, operation and management of small hydropower systems in order to ensure accelerated diffusion of the technology in the country.

Estimations of costs of actions and activities

The estimated cost for the implementation of the TAP's actions and activities were identified in collaboration with stakholders during the TAP workshop held in Monrovia, Liberia. Table 1.22 provides an estimate of the cost in United States Dollar (US\$) for implementing of each actions and activities that makes up the TAP. The total estimated cost for implementing the SHP TAP is US\$ 16,680,000.

Table 1.22: Summary estimation of costs and resources needed for SHP actions and activities

Action	Activities to be support	Estimated cost (US\$)	Source of funds
Action1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	25,000	GoL, WB, CTCN, GIZ, AfDB, USAID
Action 2 Reduce the high capital investment costs of small hydropower systems	2.1 MFDP, LERC, EPA, MME and RREA must use public-private partnerships concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country.	8,000,000	GEF, GCF, WB, EU, AfDB, USAID

	2.2 MFDP, MME, RREA and EPA must reduce investment costs for SHP system project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).	500,000	GoL, WB, AfDB, GCF, GEF
Action 3 Improve access to financing	3.1 MFDP must provide annual government budgetary allotments in addition to international grants, subsidies, concessionary loans to development SHP mini-grid in the country.	2,000,000	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, GEF, UNEP CTCN, UNFCCC,
	3.2 EPA, RREA and MFDP to make the Renewable Energy Development Fund operational to provide low interest loans, loan guarantees, and grants as targeted subsidies to ensure energy is accessed by the poor.	1,500,000	GoL, WB, AfDB, EU, GCF, GEF
	3.3 MFDP, MME, RREA, and EPA should provide support for local production of components to lower the capital investment cost of SHP technology.	1,000,000	GoL, WB, AfDB, EU, GIZ, GCF, GEF, CTCN, USAID, UNDP, UNEP, UNFCCC,
	3.4 LERC, LEC, RREA, and EPA implement financial business models, high-quality business plan and an affordable tariff structure based on customers' ability and willingness, allowing poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest.	800,000	GEF, GCF, EU, USAID, WB
Action 4 Raise public awareness and knowledge about the benefits of small hydropower systems	4.1 EPA, LEC, LWSC, and RREA should provide adequate information and public awareness about the SHP technology through communication campaigns using electronic, print, social media, seminars, training workshops, conferences and community engagements for all stakeholders.	950,000	AfDB, EU, USAID, WB, UNDP GoL, UNEP
	4.2 LERC, MME, RREA and EPA must provide information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SHP systems, among others.	50,000	GoL, AfDB, USAID, EU, UNDP, WB, GEF, GCF, CTCN, UNEP, GIZ, UNFCCC,
	4.3 LERC, MME, RREA and EPA must support renewable resource assessment and site reconnaissance studies, especially for small hydropower mini-grid development in the country. Information on the hydrological data will help investors and project developers make informed decisions.	1,000,000	GoL, WB, GEF, GCF, AfDB, GIZ, UNEP, EU, USAID, UNDP, CTCN, UNFCCC,
	4.4 LERC, MME, RREA and EPA must develop a platform for sharing information on small hydropower potential in the country.	25,000	GoL, AfDB, GIZ, EU, GCF, GEF, USAID, UNDP, WB, UNEP, CTCN, UNFCCC,

Action 5 Build or strengthen local technical capacity	5.1 MFDP, EPA, MPW, and RREA must allocate funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions to train both male and female local experts to manage the SHP technology.	450,000	GoL, AfDB, GIZ, GCF, USAID, UNDP EU, UNEP, GEF CTCN, WB, UNFCCC,
	5.2 MME, LEC, MPW and RREA must conduct specialized training to build the capacity and expertise of their workforce in installation, operation, management, maintenance and business development the SHP technology.	200,000	GoL, WB, AfDB, EU, GCF UNEP USAID, UNDP GEF CTCN
Action 6 Develop a legal, regulatory and institutional framework for SHP technology	6.1 MME, LERC, EPA and RREA must create enabling policies and regulatory frameworks, particularly in the areas of tariffs, licencing and permits, and grid connectivity, and to apply them in a credible and transparent manner.	50,000	GoL, AfDB EU, GCF, GEF, UNEP USAID, UNDP, WB
	6.2 LERC, RREA, LEC, and EPA should develop codes and standards and establish certification, testing, and enforcement institutes.	80,000	GoL, AfDB, EU, GCF, GEF, UNEP USAID, WB, UNDP CTCN
	6.3 MME, LERC, RREA and EPA must develop the appropriate policy, regulatory, institutional frameworks to define the role of each player and create conducive environment for the development of SHP technology for rural electrification.	50,000	GoL, AfDB, EU, GCF, GEF, USAID, UNDP, WB, UNEP
Total		16,680,000	

1.1.4.6 Management Planning

Risks and Contingency Planning

Table 1.23 provides a summary of key risks identified in the activities and the contingency plan to mitigate these risks for the successful implementation of the Small Hydropower Mini-grid System TAP.

Table 1.23 Risk and contingency plan for the implementation of SHP TAP

Risk	Description	Contingency plan
Cost risk	Financial resources are not secured from development partners for implementation	GoL use national budgetary support to set up the implementation unit, finance the preparation of the public awareness and promotional campaigns and utilize donor funds for implementation.
Performance risk	- Delays in decision making regarding incentives, subsidies and implementation - Failures of the installed mini-grid system to perform according to the expectations of the mini-grid operator and the customers	- Ensure there is strong high-level political and institutional acceptance or support from the Cabinet and also key Ministries and agencies. - Increase local human capacity to undertake feasibility studies for SHP plant development, operation, and maintenance.
Schedule risk	- Delays in putting in place regulations and policies to facilitate the diffusion of the SHP technology.	- Integrate policies and regulations with regards to SHP mini-grids and rural electrification in general into the national policies on electrification and renewable energy integration into the grid. - More hydrological and meteorological data needs to be collected over a longer period of time. - Create a one-stop shop to expedite the implementation of SHP plant projects.

Information risk	- Information not being provided in a timely manner and inadequate cooperation or collaboration amongst stakeholders.	<ul style="list-style-type: none"> - Establish project steering committee to bring together key ministries, agencies and institutions into the implementing process. - Improve collaboration and coordination among agencies in charge of water resources, the environment and electricity. Avoid duplicating mandates and conflicts and shorten the time required for approval or authorization processes. - Ensure that the project will be managed by professional managers with proven track record using best management practices
Political risk	- The returns on investments in SHP projects could suffer as a result of political, social or economic instability and corruption in the country.	- Investors and lenders must obtain political risk insurance or multilateral development banks guarantees to cover risks like breach of contract, changes in political regime, currency inconvertibility, transfer restriction, expropriation, terrorism, war, and civil unrests.

Next Steps

Table 1.24 provides a summary of the immediate requirements and critical steps for the successful implementation of the SHP TAP.

Table 1.24 Summary of immediate requirements and critical steps for implementation of SHP TAP

Immediate requirements:	<ul style="list-style-type: none"> a) The EPA should schedule a meeting with other key stakeholders such as RREA, MME, and MFDP to disseminate the outcomes of the TAP and to clearly define each stakeholder's roles, responsibilities and overall timelines. b) EPA should equip the national TAP implementing unit's office with highly competent personnel and logistics to ensure successful, effective and efficient implementation the TAP. c) Develop a national programme on harnessing the small hydropower potential in Liberia. d) GoL should develop a budget line for funding TAP activities
Critical steps:	<ul style="list-style-type: none"> a) The EPA should ensure that the TAP's outcomes are approved at the Cabinet level. b) Project proposals based on the project ideas should be develop as soon as possible. c) GoL must engage with donors early to secure financing for TAP projects to ensure that activities timelines are met.

1.1.4.7 TAP overview table for Small Hydropower (SHP) Mini-grid System

The overview of the Technology Action Plan (TAP) for the SHP is provided in Table 1.25

Table 1.25: TAP overview table for Small Hydropower Mini-grid System

TAP overview table								
Sector	Energy							
Sub-sector	Electricity production							
Technology	Small Hydropower Mini-grid Plant System							
Ambition	Construct Small Hydropower plants with total capacity 50 MW by 2030 at specific remote and isolated rural locations across the country as indicated by the Rural Energy Strategy and Master Plan (RESMP) and the National Renewable Energy Action Plans (NREAPs).							
Benefits	Social	<ul style="list-style-type: none"> - Saved income to be used for other purposes - Some jobs are created as a result of the availability of electricity - Improve women's access to energy and minimise their reliance on fuelwood collecting. 						
	Economic	<ul style="list-style-type: none"> - Electricity bill savings - Encourage productive energy use in rural areas - With the availability of electricity, income-generating options abound. 						
	Environment	<ul style="list-style-type: none"> - Reduction of greenhouse gas emissions (GHG) by avoiding the need of diesel generators to power rural households and reducing the usage of kerosene and charcoal. 						
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity (US\$)
Action 1 Establish a Project Implementation Unit (PIU) at the EPA to oversee and lead the implementation of the TAP	1.1 Recruit highly skilled personnel to develop a project implementation plan for the roll out of the TAP in Liberia; 1.2 Establish and equip the office the Project Implementation Unit.	GoL, CTCN, WB, AfDB, GIZ, USAID	EPA	2021 - 2023	<ul style="list-style-type: none"> - Non-commitment and bureaucracy on the part of responsible body - 	<ul style="list-style-type: none"> - Fully equipped implementation unit with highly competent personnel established - Increased number of quality project proposal and funding 	<ul style="list-style-type: none"> - A functional implementation unit meeting key performance index - Number of proposal developed, submitted and funded - Comprehensive and informative reports 	25,000
Action 2 Reduce the high capital investment costs of small hydropower plant systems	2.1 Use public-private partnerships concessionary loans or grants support from international development partners, bilateral and multilateral donors and other dedicated funding sources such as the Green	GEF, GCF, WB, EU, AfDB, USAID	MFDP, LERC, EPA, MME, DP RREA	2022 - 2030	<ul style="list-style-type: none"> - Delay in securing donor financing - Lack of interest from private sector 	<ul style="list-style-type: none"> - Number of joint venture project initiated - High interest from private investors - Amount of bilateral and multilateral financing 	<ul style="list-style-type: none"> - Number of project proposal developed, submitted and funded - Number of public-private partnership developed 	8,000,000

	Climate Fund and Adaptation Fund for the promotion of SHP project in remote and isolated rural communities across the country.							
	2.2 Reduce investment costs for SHP system project developers and investors using direct subsidies, tax exemptions, feed-in tariff systems, green bonds, World Bank's Clean Technology Fund and the Clean Development Mechanisms (CDM).	GoL, WB, AfDB, GCF, GEF	MFDP, EPA, RREA, MME	2022- 2030	- Delay in decision making by government regarding incentives and subsidies	- Implementation of comprehensive incentives and subsidies policy for the diffusion of the technology approved	- Number of new installed small hydropower plants	500,000
Action 3 Improve access to financing	3.1 Provide annual government budgetary allotments in addition to international grants, subsidies, concessionary loans to development SHP mini-grid in the country.	GoL, WB, AfDB, GIZ, GCF, GEF USAID, , EU, UNDPUNEP, CTCN, UNFCCC	MFDP	2021 - 2027	- Lack of political will or interest -Inadequate state budgetary allocation	- Amount of funds allocated	- First annual budgetary allotment approved and provided	2,000,000
	3.2 Make the Renewable Energy Development Fund operational to provide low interest loans, loan guarantees, and grants as targeted subsidies to ensure energy is accessed by the poor.	GoL, WB, AfDB, EU, GCF, GEF	EPA, RREA, MFDP, DP	2022 - 2028	- Delays due to insufficient funds	- Sufficient funds available to support SHP projects - Revolving loan fund established	- Number of financial mechanisms from government and international partners available to make Renewable Development Fund sustainable - Number of loans provided by Fund	1,500,000
	3.3 Provide support for local production of components to lower the capital investment cost of SHP technology.	GoL, AfDB, GIZ, EU, GCF, USAID, WB, UNDP, GEF, UNEP, CTCN, UNFCCC	MFDP, MME, RREA, EPA	2022 - 2028	- Lack of political will or interest - Delays due to insufficient resources	- Sufficient funds available to support SHP projects	- Increased number of loans for business and investment in SHP technology - Number of local businesses producing SHP components	1,000,000

	3.4 Implement financial business models, high-quality business plan and an affordable tariff structure based on customers' ability and willingness, allowing poorer consumers to benefit from targeted subsidized tariffs, including life-line rates for the poorest.	GEF, GCF, EU, USAID, WB	LERC, LEC, RREA, EPA	2022 - 2030	- Customer growth rates could fall well below those envisaged in the business plans or models	- A well-designed business model for SHP technology that is relevant and appropriate for the Liberian context is developed and implemented	- Increased number of loans for business and investment in SHP technology	800,00
Action 4 Raise public awareness and knowledge about the benefits of small hydropower systems	4.1 Provide adequate information and public awareness about the SHP technology through communication campaigns using electronic, print, social media, seminars, training workshops, conferences and community engagements for all stakeholders.	GoL, AfDB, USAID, WB, EU, UNDP, UNEP	EPA, LEC, LERC, LWSC, RREA	2021 - 2027	- Unqualified public relations team - Insufficient fund available	- Public awareness campaigns and programmes for SHP technology planned, prepared and implemented using print, electronic & social media - Awareness level of public increased by 50%	- Information and awareness programs are approved and implemented - Number of public awareness programmes prepared and implemented	950,000
	4.2 Provide information on tariff rates, actual and perceived risks, financing options, licensing processes, the importance and benefits of SHP systems, among others.	GoL, WB, AfDB, GIZ, EU, USAID, UNDP, GCF, UNEP, GEF, CTCN, UNFCCC,	LERC, MME, EPA, RREA	2022 - 2028			Number of information hubs or centres established in all counties of the country	50,000
	4.3 Provide support for renewable resource assessment and site reconnaissance studies, especially for small hydropower mini-grid development in the country. Information on the hydrological data will help investors and project developers make informed decisions.	GoL, WB, EU, GIZ, GEF, GCF, AfDB, USAID, UNDP, CTCN, UNFCCC, UNEP	LERC, MME, RREA, EPA	2021 - 02025	- Lack of technical capacity - Delay in getting funds - Equipment for studies costing more than the money available	- Improved quality of data	- Type, quantity and quality of data available - Equipment for studies procured	1,000,000

	4.4 Develop a platform for sharing information on small hydropower potential in the country.	AfDB, GIZ, GoL, CTCN, GCF, USAID, GEF, UNDP, WB, UNEP, UNFCCC EU	LERC, MME, RREA, EPA	2022 - 2024	- Delay in getting funding	- Platform for open sharing of information on SHP developed and approved	- Platform for open sharing of information on SHP developed and functional	25,000
Action 5 Build or strengthen local technical capacity	5.1 Allocate funds to strengthen existing training facilities such as universities and Technical and Vocational Education and Training (TVET) institutions to train both male and female local experts to manage the SHP technology.	GoL, WB, AfDB, GIZ, EU, GCF, USAID, UNDP, GEF, UNEP, CTCN, UNFCCC,	MFDP, EPA, RREA, MPW, Tertiary institutes	2022 - 2030	- No funds allocated for training - Preference is in favour of international experts - Local trained staff and technicians remain unemployed	-Funds allocated for training - Availability of highly trained local technicians, engineers and contractors - Number of institutions implementing training programs	-Types and number of trainings conducted - Well-developed curricula - Number of new direct and indirect job for both male and female relating to the technology created	450,000
	5.2 Conduct specilized training to build the capacity and expertise of their workforce in installation, operation, management, maintenance and business development the SHP technology.	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP, CTCN	MME, LEC, MPW, RREA	2022 - 2030	- Inadequate financial and human resources for capacity building - Trainings are not delivered to the right people or need	- Training program designed and implemented - Number of staff and technicians trained	- Institutional capacity and human resources are improved -Number of trainings and participants attended	200,000
Action 6 Develop a legal, regulatory and institutional framework for SHP technology	6.1 Create enabling policies and regulatory frameworks, particularly in the areas of tariffs, licencing and permits, and grid connectivity, and to apply them in a credible and transparent manner.	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP	MME, LERC, EPA, RREA	2022 - 2025	-Policies and regulatory framework may not be approved - Delay due to changing or revising existing regulations or laws	- Policies and regulatory framework approved	- Policies and regulatory framework drafted and approved	50,000
	6.2 Develop codes and standards and establish certification, testing, and enforcement institutes.	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP, CTCN	EPA, RREA, LEC, LERC	2022 - 2024	- Non-compliance and enforcement of standards - Delays due to slow process of policy, regulations and legal formulation	Codes and standards developed and accepted by all relevant stakeholders	- Quality codes and standards developed and approved - Compliance and enforcement of codes and standards functional	80,000

	<p>6.3 MME, LERC, RREA and EPA must develop the appropriate policy, regulatory, institutional frameworks to define the role of each player and create conducive environment for the development of SHP technology for rural electrification.</p>	GoL, WB, AfDB, EU, GCF, GEF, USAID, UNDP, UNEP	MME, LERC, RREA, EPA	2022 - 2025	-Lack of participation from key institutional stakeholders	- Multi-stakeholders committee set up and operational through regular meetings	- Number of institutions participating in committee meetings -Number of meetings and key decision taken to promote SHP technology	50,000
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1.2 Project Ideas for the Energy Sector

1.2.1 Brief summary of the Project Ideas for Energy Sector

Three Project Ideas (PIs) are developed in this report. The details of these specific Project Ideas identified and retained by the country's energy sector technical working group based on the technologies' contribution to socio-economic development and their climate change mitigation potentials are summarized in Tables 1.26, 1.27, and 1.28. Each of these PIs support the promotion and diffusion of the technologies discussed in the previous chapters. They include brief project background, objectives, outputs, their relation to country's sustainable development priorities, project deliverables, project scope and possible implementation, project activities, timelines and project budget.

1.2.2 Specific Project Ideas

1.2.2.1 Specific Project Idea 1: Deployment of solar PV rooftop systems in 500 rural public schools in Liberia

Table 1.26: Specific Project Idea 1: Deployment of solar PV rooftop systems in 500 rural public schools in Liberia

Sector	Energy
Subsector	Electricity
Technology name	Solar PV home system
Project name	Deployment of solar PV rooftop systems in 500 rural public schools in Liberia
Introduction/ Background	<p>Liberia suffers from a general lack of energy access, which poses a significant impediment to the country's development strategy. The country has one of the lowest access rates in the world, with fewer than 3% of the country's rural population having access to electricity, and just about 31% in the capital city of Monrovia. Access to electricity outside Monrovia is limited, inefficient and extremely unreliable with negative impact on the socio-economic development, life and livelihood of the rural communities of Liberia. Hence, rural inhabitants excessive dependence on firewood, candles, kerosene and oil lanterns for cooking and lighting which lead to severe indoor smoke and toxic household air pollution especially for women and children</p> <p>Solar home system (SHS) is a stand-alone PV system that consists of a PV solar panel or module, supporting structures, an inverter, a rechargeable battery, a charge controller and lamps. SHS uses batteries to store and supply electricity when the solar panels are not producing energy at night or cloudy days. Moreover, electricity from solar PV home system can provide energy resource savings and exposure to GHG emissions especially for consumers in off-grid and rural areas.</p> <p>It is essential to ensure that schools in rural areas have the same potential to offer a quality education as schools in urban areas. The program goal is to contribute to Liberia's drive to increase the share of Renewable Energy (RE) sources in its overall generation and to reduce GHG emissions. It is estimated that approximately 30 tCO_{2e} GHG emissions equivalent per annum can be avoided.</p>
Objectives	<ol style="list-style-type: none"> 1. To demonstrate the potential of solar PV systems as a viable power source for improving education in the remote rural public school in Liberia. 2. To install solar PV rooftop systems with capacity of 1.5 kW in 500 rural public schools which is equivalent to a total installed capacity of 750 kW. 3. To provide technical training on operation and maintenance of the solar PV systems to local staff and technicians. 4. Promote the use of clean, environmentally friendly renewable energy technology to improve the education services.

Outputs	<p>The expected outputs of the project are:</p> <ol style="list-style-type: none"> 1. Five hundred rural public schools will have access to environmentally friendly renewable energy technology which will be used for overall lighting in the school and to operate computer s/laptops for teaching and learning. 2. Over a 10 years lifespan of the systems, a total of 350 tCO₂e GHG emissions will be avoided. 3. Enabled teaching and learning to extend into the early morning and after dark which will improve the quality of education. 4. Build local capacity in the installation of operation and maintenance of solar PV systems. 5. Evening classes will now be possible, providing the chance for adults in the village to learn how to read and write. 6. Improves delivery of curricula 7. Helps attract and retain teachers 8. Job creation for locals
Relationship to the country's sustainable development priorities	<p>Solar PV mini grid systems play a key role in the Liberia's GHG emissions mitigation reduction strategy, one of the country's current national sustainable development as set out in the following documents:</p> <ol style="list-style-type: none"> a) National Energy Policy (NEP, 2009) b) Liberia's Intended Nationally Determined Contribution (INDC, 2015) c) Rural Energy Strategy and Master Plan (RESMP, 2016) d) The Pro-Poor Agenda for Prosperity and Development (PAPD, 2017) e) National Policy and Response Strategy on Climate Change (NPRSCC, 2018) a) The Sustainable Development Goals of Liberia for the period up to 2030 b) Liberian Agenda for Transformation for the period up to 2030
Project Deliverable	<ol style="list-style-type: none"> 1. Installation of a 1.5 kW solar PV system to 500 remote public schools in Liberia. 2. Build local capacity by training of at least one staff member or teacher to operate and maintain the system. 3. Reduction of both CO₂ emissions and fossil fuel consumption.
Project Scope and Possible Implementation	<p>The project implementation area is all counties of Liberia, with a focus on rural public schools in remote areas where the grid is not expected to reach within the next 10 years.</p>
Project Activities	<ol style="list-style-type: none"> 1. Feasibility study and social acceptability survey 2. Sign memorandum of understanding (MOU) and setup of project management team 3. Secure funding for implementation of project 4. Design, procure, construct, install, operate and maintain solar PV systems 5. Train staff and technicians on operation and maintenance of the solar PV system 6. Monitor performance of installed solar PV systems 7. Monitor impact of intervention
Timelines	<p>The project will be implemented over a period of 24 months, starting from the project's initial feasibility study.</p>
Budget/ Resource requirements	<p>The estimated budget for the project is US\$ 1,500,000.</p>
Measurement/ Evaluation	<ol style="list-style-type: none"> 1. Impact of project on the students' academic performance and learning ability 2. Progress reports and visits the project sites for progress evaluation first-hand
Complications/ Challenges	<ol style="list-style-type: none"> 1. Delay in securing funding 2. Weak coordination between responsible bodies 3. Roles of project manager, contractors and sub-contractors not well-defined can lead to uncoordinated exchange of information 4. No acceptance by government for financial incentives 5. Vandalism and theft of equipment 6. Low quality solar PV system components
Responsibilities and Coordination	<p>Environmental Protection Agency, Rural & Electrification Energy Agency, Ministry of Education, Ministry of Mines and Energy</p>

1.2.2.2 Specific Project Idea 2: Construction of 70 kW solar PV-diesel hybrid mini-grid power plant and clean water system for three districts hospital in Lofa County, Liberia

Table 1.27: Specific Project Idea 2: Construction of 70 kW solar PV-diesel hybrid mini-grid power plant and clean water system for three districts hospital in Lofa County, Liberia

Sector	Energy
Subsector	Electricity
Technology name	Solar PV mini-grid
Project name	Construction of 70 kW solar PV-diesel hybrid mini-grid power plant and clean water system for three districts hospital in Lofa County, Liberia
Introduction/ Background	Lofa County is the second largest county in Liberia. It lies in the north-west corner of Liberia. Voinjama, Kolahu and Foya districts has populations of 110, 827, 71,648 and 61,642 respectively. These districts lack the provision of modern electricity. The scarce power generated comes from private generators of the UN agencies, NGOs and private citizens. Most hospitals and homes used candles, kerosene and oil lanterns for light. A solar-diesel mini grid hybrid system can eliminate or reduce the need for candles, kerosene, liquid propane gas, and/or battery charging, and provide increased convenience and safety, improved indoor air quality, and a higher quality of light than kerosene lamps for hospital operations. The solar PV mini-grid system has been prioritized and retained as the preferable mitigation technology to provide reliable, sustainable and affordable electricity and clean water to one hospital in each of Lofa County's three districts by installing a solar-diesel hybrid mini grid system in an environmentally sound manner. It is estimated that approximately 2.0 tCO ₂ GHG emissions equivalent per annum can be avoided resulting in a total of 20 tCO ₂ GHG emission over 10 years.
Objectives	<ol style="list-style-type: none"> 1. To install a 70 kW solar-diesel hybrid system in 3 hospitals in Voinjama, Kolahu, and Foya districts of Lofa County, Liberia 2. To reduce the quantity of diesel fuel used for electricity by more than 60%. 3. To reduce fuel costs while boosting the availability of electricity and fresh water in hospitals. 4. Promote the use of clean, environmentally friendly renewable energy technology.
Outputs	<p>The expected outputs of the project are:</p> <ol style="list-style-type: none"> a) Electricity and clean water are delivered to the hospitals on a consistent and sustainable basis. b) The carbon footprint and noise pollution associated with each hospital are reduced. c) Build local capacity in the installation of operation and maintenance of solar PV mini-grids systems. d) Financial resources formerly spent on diesel for electricity generation could now be invested on other healthcare demands. e) The hospital's technician will obtain technical expertise in solar energy production and equipment maintenance. f) Job creation for locals. g) Better storage of medicine and vaccine h) Improve delivery of health services, including night services
Relationship to the country's sustainable development priorities	<p>Solar PV mini grid systems play a key role in the Liberia's GHG emissions mitigation reduction strategy, one of the country's current national sustainable development as set out in the following documents:</p> <ol style="list-style-type: none"> a) National Energy Policy (NEP, 2009) b) Liberia's Intended Nationally Determined Contribution (INDC, 2015) c) Rural Energy Strategy and Master Plan (RESMP, 2016) d) The Pro-Poor Agenda for Prosperity and Development (PAPD, 2017) e) National Policy and Response Strategy on Climate Change (NPRSCC, 2018) f) The Sustainable Development Goals of Liberia for the period up to 2030 g) Liberian Agenda for Transformation for the period up to 2030

Project Deliverable	The deliverable will include: 1. Installation of a 70 kW solar-diesel hybrid system and boreholes equipped with water pumps to provide electricity to one hospital each in 3 districts in Lofa County. 2. One technician from each hospital will be trained to operate and maintain the system. 3. GHG emission reductions
Project Scope and Possible Implementation	The project intends to install a solar-diesel hybrid mini grid system to provide reliable, sustainable, and affordable electricity and clean water to one hospital in Voinjama, Kolahu and Foya districts of Lofa County.
Project Activities	1. Formal introduction of the project to the management of the hospitals and signing of MOU. 2. Secure funding for implementation of project 3. Detail audit of existing energy needs and environment impact assessment of project sites. 4. Technical design of solar-diesel hybrid mini grid system with battery storage. 5. Procure, install and operate solar-diesel hybrid mini grid system at each hospital 6. Drill boreholes, install water pumps and connect them to solar-diesel hybrid mini grid system 7. Train technicians to operate and maintain solar-diesel hybrid system at each hospital 8. Monitor performance of installed systems 9. Provide annual funds for O&M of hybrid system from district's health development budget. 10. Monitor impact of intervention
Timelines	The project will be implemented over a period of 3 years.
Budget/ Resource requirements	The total cost of installing the three solar-diesel hybrid systems, drilling the boreholes and installing the water pumps was determined to be US\$ 935,000. The amount also includes the training on one technician at each hospital to operate and maintain the system.
Measurement/ Evaluation	The system will be monitored for performance and annual reports produced.
Complications/ Challenges	1. Problems obtaining finances to implement and sustain the project 2. Lack of policy framework for the technology; 3. Limited and inadequate national technical expertise to implement the project; 4. Inadequate cooperation or coordination amongst responsible stakeholders.
Responsibilities and Coordination	Environmental Protection Agency, Rural & Electrification Energy Agency, Ministry of Health, Ministry of Mines and Energy

1.2.2.3 Specific Project Idea 3: Promotion of small hydropower plants in Liberia

Table 1.28: Specific Project Idea 3: Promotion of small hydropower plants in Liberia

Sector	Energy
Subsector	Electricity
Technology name	Small hydropower plant
Project name	Promotion of small hydropower plants in Liberia
Introduction/ Background	Liberia has an overall lack of energy access which presents a major challenge to the country's development agenda. At approximately 12%, Liberia has one of the lowest electricity access rates in the world. In the capital city of Monrovia, less than 20% of the population has access to electricity. In most rural areas of Liberia, less than 5% of the population has access to electricity unlike those in some part of the South-eastern counties like Maryland, Grand Gedeh and the Northern part of Nimba that import power from neighbouring countries under the West African Power Pool Project (WAPP). The current energy situation in Liberia is dominated by traditional biomass consumption for cooking, heating and lighting. Less than 2% of rural population has access to the relatively poor quality and expensive modern energy services. It is estimated that over 95% of the country's energy needs are met by firewood, charcoal, and palm oil. As a result, there is an urgent need for reliable and affordable

	<p>improved electricity services to support Liberia's economic transformation and improved human development post-conflict.</p> <p>Liberia has six major rivers. They are Mano River, St. Paul River, St. John River, Cavalla River, Lofa River, and Cestos River. The Liberian rivers are rain-fed and empty into the Atlantic Ocean. The country has two major seasons; the dry and the rainy seasons. The seasons are divided into equal parts which makes it feasible to implement small hydropower project to reduce the use of biomass for energy. Liberia records an annual rainfall of 5 meter per year which is an enormous hydroelectric potential. Liberia has more than 2.3 GW of hydro potential identified under the RESMP study. The country hydro potential includes numerous potential small hydropower sites with indicative capacities of less than 10 MW. Small hydroelectric systems can provide clean electricity to communities with very little environmental impact and greenhouse gas emissions.</p> <p>Liberia must attract domestic and international investments in renewable energy in order to meet its NDC objectives of 30% renewable energy by 2030 and carbon neutrality by 2050.</p> <p>The proposed project intends to develop, construct and operate a 6.4 MW hydropower plant distribution network which will consist of 4 sets of generating facilities with a capacity of 2.5 MW each. This will provide renewable energy to about 6,000 households. The project also aims to accelerate the uptake of small hydropower plants systems so as to reduce national dependency on imported fossil fuels, support Liberia on its path towards more decentralized, inclusive and resilient development, and to meet the country's NDC objectives of 30% renewable energy by 2030 and carbon neutrality by 2050. The project is expected to displace approximately 110,000 tCO₂ GHG emissions equivalent over 10 years.</p>
Objectives	<ol style="list-style-type: none"> 1. To provide Liberians with affordable modern electricity while also contributing to the country's social, environmental and economic sustainability by increasing the share of renewable energy in the total electricity consumption. 2. To demonstrate the viability of small hydropower for improving energy security, air quality, and local community livelihoods, as well as the development of sustainable renewable energy technology.
Outputs	<ol style="list-style-type: none"> a) Reduction of greenhouse gas emissions and other pollutants such as particulates, sulphur dioxide, and nitrogen oxides resulting from fossil fuel power generation in Liberia b) Creation of local employment opportunities during the construction and operation period c) Entrepreneurial opportunities for women d) Dissemination of advanced technology to the local residents e) Help to stimulate and diffuse the small hydropower industry in Liberia f) Help Liberia reduce importation of fossil fuels for electricity generation g) Purifying and cleaning the water for irrigation h) Improved lighting for communal facilities (schools, town halls, health centers and public offices)
Relationship to the country's sustainable development priorities	<p>The government of Liberia gives high priority to the development of the electricity industry. Small Hydropower systems play a key role in the Liberia's GHG emissions mitigation reduction strategy, one of the country's current national sustainable development as set out in the following documents:</p> <ol style="list-style-type: none"> a) National Energy Policy (NEP, 2009) b) Liberia's Intended Nationally Determined Contribution (INDC, 2015) c) Rural Energy Strategy and Master Plan (RESMP, 2016) d) The Pro-Poor Agenda for Prosperity and Development (PAPD, 2017) e) National Policy and Response Strategy on Climate Change (NPRSCC, 2018) h) The Sustainable Development Goals of Liberia for the period up to 2030 i) Liberian Agenda for Transformation for the period up to 2030 j) Public Health Act k) The Natural Resources Law

	l) The Environment Protection and Management Law m) National New Forestry Reform Law
Project Deliverable	1. Provide 6.4 MW small hydropower electricity to 6,000 households in various counties of Liberia. 2. GHG emission reductions 3. Provide job opportunities to the local community during the project's construction and operation 4. Growth of local economy in terms of new market opportunities for local produce, increased trade and upgrading of road infrastructure in project area.
Project Scope and Possible Implementation	The project is proposed for Nimba, Cape Mount and Lofa Counties. The hydro assessment study identified several locations of rivers in these counties with high natural heads and flows above 50 m ³ /s which are ideal for small hydropower plants (5 to 20 MW).
Project Activities	Project activities are: 1. Aware raising program 2. Investor sign appropriate contract with RREA 3. Obtain all permits 4. Contact all local authorities 5. Sign power purchase agree with appropriate agencies 6. Procure all equipment and materials 7. Construct dam, pressure pipelines, powerhouse, outdoor substation, reservoir 8. Train technicians to operate and maintain system 9. Monitor performance of installed system
Timelines	The expected construction duration is 3 years once procurement is completed.
Budget/ Resource requirements	Total cost of project is US\$ 5,800,000
Measurement/ Evaluation	The system will be monitored for performance and GHG emissions avoided estimates. Annual reports will be produced.
Complications/ Challenges	1. Lack of financial resources to fund project 2. Banks hesitant to extend loans for small hydropower project 3. Inadequate hydrological studies and analysis 4. Difficulties in acquiring plots of land 5. Problems with connection to the electricity transmission lines 6. Inadequate knowledge and experience of local technicians and mid-level professionals. 7. Lack of cooperation or coordination amongst responsible stakeholders
Responsibilities and Coordination	Ministry of Finance and Development Planning, Environmental Protection Agency, Rural & Electrification Energy Agency, Ministry of Agriculture, Ministry of Mines and Energy, Liberia Electricity Corporation, Forestry Development Authority

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Annex I. List of stakeholders involved and their contacts

Table 1.29: Names and Contacts of the Energy Sector Technical Working Group for the TAP

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