



Feasibility Study for the Utilization of Solar Energy for Sugarcane Irrigation Pumping by Emerging Commercial Small Cane Growers in Eswatini

Guidelines for Policy and Financing Mechanisms for the Solarization of Irrigation Systems for Small-Scale Growers in Eswatini.

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List of Abbreviations

Abbreviations	Meanings
SPIS	Solar Powered Irrigation Systems
EG	Embedded Generation
FI	Financial Institutions
GDP	Gross Domestic Product
GHG	Green House Gas
NDC	Nationally Determined Contributions
NGO	Non-governmental organization
UN CTCN	The United Nations Climate Technology Centre and Network
ECGA	Eswatini Care Growers Association
ESA	Eswatini Sugar Association
EEC	Eswatini Electricity Company
ESERA	Eswatini Energy Regulatory Authority
PV	Photovoltaic
RE FIT	Renewable Energy Feed-in Tariff
GET F	Global energy transfer Feed-in Tariff
FIT	Feed-in Tariff
VAT	Value Added Tax
IPP	Independent Power Producers
PSI	Pioneer Status Incentives
MW	Mega-Watt
EPR	Extended Producer Responsibility
PRO	Producer Responsibility Organization
REAWSA	Renewable Energy Association of Eswatini
FAQ	Frequently Ask Questions
IPR	Individual Producer Responsibility
ESASCCA	Eswatini Association of Savings and Credit Cooperative
SME	Small and Mid-Size Enterprises
ESG	Environmental, social, and governance
PAYGo	Pay as You Go
SWASA	Eswatini Standards Authority

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1 Introduction

Sugarcane farming is a cornerstone of the Eswatini's economy, particularly to the agriculture sector, where half of the total annual agriculture-based output comes from sugarcane. Small and medium size cane growers are a major contributor to this industry, with a 42% of the country's sugarcane production. However, cane growers are facing increasing operational expenses due to the rising costs of grid electricity used for irrigation. Furthermore, electricity from the grid is carbon-rich, leading to increasing greenhouse gas (GHG) emissions within the country.

As part of its Nationally Determined Contributions (NDCs), Eswatini has committed to increasing renewable energy installed capacity, which will, in turn, reduce dependence on electricity imports, taking advantage of the country's high potential for solar energy, due to its abundant solar radiation.

As a global shift towards sustainable and renewable energy sources takes place, Solar Power Irrigation Systems (SPIS) offer a promising alternative to improving the sustainability of sugarcane production while reducing operational costs for the cane growers and contributing towards Eswatini's efforts to promote renewable energy solutions and reduce its carbon footprint. SPIS offer an effective alternative to electric and fuel-based pumps, enabling cane growers to reduce the costs of their electricity bills, while avoiding load shedding, and fuel consumption.

Considerable progress has been made to facilitate the adoption of SPIS among cane growers, there are technology providers active in the country. Furthermore, cane growers, through the Eswatini Cane Growers Association (ECGA) and the Eswatini Sugar Association (ESA) have started to install SPIS and get informed about their benefits. However, ensuring a long-term market-based uptake of this technology requires of an enabling environment that addresses gaps such as affordability of the systems, quality assurance of the products and installation services and provides incentives to make the investment in SPIS more attractive.

This document presents a series of guidelines for possible policy and financing mechanisms that can address the aforementioned gaps and promote an enabling environment that supports the uptake of these systems while providing incentives to the growers and facilitating their transition to SPIS. These guidelines are the result of an extensive desk review of similar mechanisms implemented in other countries, along with the results of a series of stakeholder consultations, where stakeholders from financial institutions and the public sector met to discuss the existing challenges in promoting SPIS for small scale cane growers in Eswatini.



2 Stakeholder Cooperation: Supporting Committee for the Support of Solar Irrigation in Eswatini

The first relevant intervention for this process is the establishment of a dedicated **working committee for the promotion of SPIS in Eswatini**, with the mandate of:

- Supporting the implementation of the key recommendations provided in these guidelines
- Facilitating the successful cooperation among key stakeholders and the design of future international development cooperation projects aimed at mobilising additional finance and technical assistance to further support the large-scale deployment of SPIS among cane growers.
- Monitoring the implementation of the recommendations presented and promoting the development of new interventions
- Facilitating information-sharing across government agencies, non-governmental organisation (NGOs), private sector companies and financial institutions through the organisation of workshop and events
- Engaging international agencies in the promotion of SPIS in Eswatini, including regional and international experts, development cooperation organisations and other key stakeholders
- Collaboration between financial institutions and regulatory bodies in promoting SPIS adoption in Eswatini, this intervention aims to establish a framework for joint efforts and mutual support to advance the renewable energy agenda.
- Facilitate regular information-sharing sessions and capacity-building workshops between financial institutions and regulatory bodies to enhance understanding of each other's roles, responsibilities, and needs.
- Establish mechanisms for jointly monitoring market trends, identifying emerging risks, and assessing the impact of regulatory interventions and financial initiatives on SPIS adoptions.

The following are recommended members of the supporting committee:

- The UN Climate Technology Centre and Network (UN CTCN)
 - As technical assistance and international cooperation partner. Particularly during the first year of the committee, the CTCN can support the moderation of meetings and the cooperation among local and international stakeholders.
- The Eswatini Cane Growers Association (ECGA)
 - Supporting knowledge dissemination and representing the interest of the cane growers as end-users of the technology
- The Eswatini Sugar Association (ESA)
 - Facilitating the sharing of knowledge and advocating on behalf of cane growers
- The Renewable Energy Association of Eswatini (REASWA)
 - Supporting capacity development and engagement with private and civil society sectors.
- The Ministry of Agriculture
 - Representing the public sector and supporting the design of projects and interventions that support cane growers in the affordable acquisition of SPIS.
 - Development of policies that support the adoption of solar powered irrigation systems
- The Ministry of Finance
 - Supporting the design and implementation of financial mechanisms and incentives to support farmers in the acquisition of SPIS, and support the collaboration with financial



institutions to promote innovative financial mechanisms for the acquisition of SPIS within the country.

- The Eswatini Electricity Company (EEC)
 - Support the development and implementation of frameworks that allow the growers in Eswatini to connect their SPIS to the national grid and sell excess electricity.
 - Support capacity building among growers regarding the embedded generation framework, safe connections to the electricity grid and identifying technology providers that fulfil quality standards.
- The Eswatini Energy Regulatory Authority (ESERA)
 - To support the development and enforcement of mechanisms that support the uptake of SPIS among farmers, thus making these systems an attractive and affordable investment for farmers and farming cooperatives.
- The Eswatini Water and Agricultural Development Enterprise (ESWADE)
 - ESWADE is currently engaged with small-scale cane growers, providing them with essential knowledge and guidance on crop maintenance. The organization is well-positioned to further disseminate technological information regarding the SPIS systems to these growers.
- The Ministry of Natural Resources and Energy
 - Align the committee's goals with the country's energy priorities and fostering sustainable agricultural development
 - Establish systems for monitoring the performance and impact of SPIS systems. This involves collecting data on energy production, agricultural yield, and environmental benefits.
- Local Financial Institutions
 - Seek partnerships with various stakeholders within the committee. These collaborations can leverage diverse expertise, resources, and networks, leading to more effective and sustainable outcomes.
 - Support the creation of awareness on financial products for the uptake of solar powered irrigation systems and disseminate this knowledge among cane growers.
 - Research and identify potential funding sources such as government grants, development banks, international donors, and private investors interested in renewable energy and agricultural projects.

This working committee should define a roadmap and targets and set up periodical (monthly or bimonthly meetings).



3 Supporting Policy Mechanisms

3.1 Encouraging Small Scale Embedded Generation (SSEG) among Cane Growers

3.1.1 Status quo and perceived challenges

- The Electricity Act of 2007 established a solid foundation for SSEG in Eswatini envisaging that distribution licensees shall be entitled to build, own, or operate generation from renewables for up to 20% of their electricity demand, this act covers off-grid supply configurations for rural electrification but did not consider the possible feeding-in to the national grid from solar power.
- The Eswatini Electricity Company (EEC) published, in November 2022, the Requirements for Embedded Generation – Conditions and application process to become a grid-tied embedded generator in the Eswatini Electricity Company electrical network. This document that provides the legal requirements; general guidelines; metering; connection criteria; tariffing and application process to become an EG in the country. Furthermore, commissioning reports and application forms are publicly available. However, this approach is currently being piloted and no tariffs for selling excess electricity to the national grid have been yet defined, which needs to be defined with support from ESERA.
- EEC has encouraged cane growers, among other key stakeholders, to register as grid-tied embedded generators. Furthermore, this allows EEC to check the installed systems for compliance with technical and safety requirements. There is a need to ensure that cane growers are aware of this opportunity and are familiar with the requirements to apply for this system and its benefits.
- EEC's efforts on awareness raising on embedded generation and verification of criteria for SSEG suppose additional costs for the organisation, considering that no application fee is charged.

3.1.2 Recommendations

- Engage with ESERA and EEC's technical working group on SSEG and provide technical support to streamline the development, piloting and approval of tariffs for supplying electricity to the EEC network.
- Technical assistance to the EEC for:
 - Development of awareness-raising materials on the SSEG framework and its benefits. These materials should be developed with support from EEC and distributed among cane growers through the ECGA and the ESA networks and events, as well as among technology providers. A key message of this awareness raising is the extent of the embedded generation framework, which focuses on the use of PV systems for self-consumption and feeding-in excess, and not producing electricity for selling as an additional source of income, highlighting that the oversizing of SPIS should be avoided.
 - Design a mechanism that covers for the efforts required to raise awareness on the SSEG and the verification of compliance, such as an application fee.
- Support interested cane growers and technology providers on the application process for the connection of the SSEG system. Growers that already installed SPIS are a particularly relevant entry point, as EEC can support them in verifying the sizing and safety of the installed systems.

While a tariff system is defined and piloted by ESERA and the EEC, ensuring that those interested farmers that implement SPIS are aware of the requirements to connect to the national grid and receive assistance to fulfil them is an intermediate step that will ease the transition to more attractive promotion mechanisms (FiT and net billing) once these are in place.



3.2 Support the Design and Implementation of Economic Incentives for SPIS: FiT, Competitive bidding, Net Billing and Wheeling Framework

3.2.1 Status quo and perceived challenges

- Cane growers lack clarity on the mechanisms by which SPIS can be connected to the national grid, and how feeding-in excess electricity will work. Highlighting a lack of awareness of both technical and regulatory requirements. This concern was also shared by financial institutions.
- The local regulators have taken significant steps to build a regulatory framework that allows for the integration of renewable energy into the national grid, including the already mentioned Small Scale Embedded Generation Framework, the Independent Power Producer (IPP) Policy and the Wheeling Framework. However, the SSEG and the wheeling frameworks are currently being piloted and lack components, such as the establishment of tariffs for supplying excess electricity and operationalisation mechanisms.
- While embedded generation is the preferred option for individual smallholder farmers, alternative approaches, such as the sale of excess electricity to nearby farmers via the Wheeling Framework need to be piloted and discussed with EEC, ESERA and other key stakeholders in order to assess their technical and economic feasibility.

Information box 1. Economic incentives for renewable energy used in Africa

Several African countries rich in solar resources have undertaken policy initiatives and developed regulatory frameworks to promote solar projects and ensure their effective implementation. Early adopters in the solar sectors, such as Egypt and South Africa, initially used FiT for project allocation. However, there is a noticeable shift towards auctions, indicating a move towards a more competitive market and an increase in financing and deployments.

- **Power Purchase Agreements (PPA):** A PPA is a long-term contract between an electricity generator and a customer, which can be a utility, government, or company. These agreements have a duration between 5 and 20 years, during which the power purchaser buys energy at a pre-negotiated price.
- **Feed-in-tariff:** Designed to accelerate investment in renewable energy technologies, under this scheme electricity generation and consumption from the grid are separated and accounted for differently. While energy consumed from the grid is priced at the retail electricity tariff, the excess energy injected into the grid is compensated at a predetermined tariff notified by the regulator, also called the “feed-in tariff”.
 - FiT programs have been successfully implemented in:
 - Namibia for wind, solar, and biomass projects under 5 MW.
 - Tanzania for small hydro projects under 10 MW.

Many African countries that began large-scale solar development a few years ago introduced FiT and their associated frameworks. Initiatives like RE FiT (Renewable Energy Feed-in Tariff) and GET FiT (Global energy transfer Feed-in Tariff) have promoted renewable energy by setting up projects using the FiT mechanism.

- **Net Metering:** Under this mechanism, electricity consumers are charged for their net electricity consumption from the grid, after netting off the electricity injected by the consumer. Countries such as Ghana, Kenya, Tunisia, and Zimbabwe have implemented net metering schemes, typically for small-scale generation with a cap-on eligible project capacity. Morocco permits net metered projects connected to the high-voltage grid that meet at least 80% of the user’s annual electricity needs, available solely to large industrial users. The maximum capacity limit for net metering varies. Mauritius has a cap of 5 kW, Zimbabwe 100 kW, South Africa 100 kW, and Namibia 500 kW.



- **Net Billing:** Net billing is a market-based compensation mechanism based on the actual market value of the kilowatt-hours (kWh) consumed or injected into the grid. Under this framework, the electricity charges from the utility to the consumer are based on the value of withdrawn electricity after subtracting the value of the injected energy.
- **Wheeling Framework:** Wheeling frameworks allow third parties to use the local transmission grid for a fee, which can, promote competition in the energy market by allowing more producers to supply electricity to the grid.
- **Tax exemptions:** To solar equipment, aimed at reducing the capital expenditure on renewable energy components. Various African countries have introduced financial incentives such as tax exemptions for setting up solar plants and the sale of solar equipment. *Table 1* below provides country examples.

Table 1 - Example of financial incentives to promote renewable energy solutions

Country	Financial Incentives
Burkina Faso	Exemption on import duties and Value added tax (VAT) for solar energy equipment for five years.
Cameroon	Full VAT exemption for equipment and materials used in solar PV and solar thermal electricity generation.
Côte d'Ivoire	Reduced VAT rate on solar energy production equipment from 18% to 9% since December 2011.
Egypt	Tax incentives for renewable projects include reductions in customs duties, lower interest rates, reduced sales tax on imported tools, equipment, and machinery, and a 30% reduction in net taxable profits for the first seven years.
Kenya	Exemption from import duty and VAT for solar cells and modules not equipped with elements such as diodes, batteries, or similar equipment. Specialized solar equipment and accessories are also exempt.
Nigeria	Independent Power Producers (IPPs), including renewables, are eligible for Pioneer Status Incentives (PSI), which grant an income tax holiday for three years, extendable by one or two more years.
Zambia	Developers of PV plants can claim tax exemption status for the first five years of the project's lifetime.

3.2.2 Recommendations

Net billing

- Provide technical support to ESERA and the EEC to:
 - Finalise the tariffing system for the net billing mechanism
 - Support the piloting of the net billing system with growers/growing communities that have already registered with the EEC.
 - Support the large-scale operationalisation of the net billing system.
- ESERA should oversee the implementation and enforcement of net billing policies, ensuring compliance and addressing any issues that arise.
- A clear and supportive regulatory framework for the net billing system should include defining eligibility criteria, maximum capacity for net-billed systems, and the processes for connecting to the grid, these requirements should be communicated to cane growers via seminars and awareness raising materials.

Wheeling Framework

- Support via technical assistance and mobilisation of funding for:
 - The finalisation of the wheeling framework, including provisions for its roll-out and operationalisation
 - A pilot project to establish the technical, economic and regulatory feasibility and requirements for cane growers and communities to supply excess electricity to nearby



growers, such a pilot project will require close cooperation with EEC, ESERA and the Ministry of Natural Resources and Energy (MNRE).

- Development of awareness-raising material on the wheeling framework, particularly on the wheeling procedures and costs.

Tax Incentives

Some possible tax incentive measures to make more attractive the introduction of SPIS in Eswatini and improve affordability among end-users are the following:

- Reduction or waiver of import Duties and Taxes: Import duties and taxes on renewable energy equipment, including SPIS for should be reduced or waived.
- VAT Refunds on Renewable Energy Equipment: To further reduce the financial burden on farmers and investors.
- Introduction of fossil fuel and carbon tax.

It is crucial to review various tax and customs obligations, including deductions, exemptions, and special incentives for renewable energy products and investments. This process should be conducted with support from the Ministry of Finance and aims to create a clear and attractive investment framework for potential investors.

3.3 End-of-life (EoL) management of solar systems

3.3.1 Status quo and perceived challenges

- As the market for solar energy expands in Eswatini, the volume of PV waste is anticipated to increase. As an example, South Africa projects a significant increase in PV-waste volumes in the next decades, ranging from 8,500 to 80,000 tons in 2030 and from 750,000 to 1,000,000 tons by 2050.
- Currently there is not a regulatory framework in place that places responsibilities for the collection, disposal and recycling of end-of-life solar PV products, which will lead, in the future, to an unsafe and polluting disposal of these products.
- Formal or public recycling schemes are non-existent. The country relies solely on private and informal recycling initiatives. These private efforts are primarily focused on commercial and industrial waste, leave domestic waste largely unaddressed. Informal recycling is widespread, with waste pickers sorting through materials at landfills and dumpsites.
- The National Solid Waste Management Strategy for Swaziland has categorised waste into 4 main divisions i) General Waste ii) Health care waste iii) Hazardous waste and iv) waste generated from Peri-Urban and Rural Areas. Each of these categories has strategic partners from the Government.
- Eswatini is conducting efforts towards the categorisation and management of e-waste, with the Eswatini Environmental Authority working on the development of e-waste regulation, which presents as an opportunity to develop, in parallel, specific provisions for the collection and transport of solar PV waste.
- Eswatini requires the development of regulation that ensures the environmentally sound and safe end-of-life management of solar products and their end-of-life.



Information box 2. Good practices for end-of-life management of products

Principles of Extended Producer Responsibility

This environmental policy approach extends the responsibility of the “producer” of a product (in this case the importers of PV components) to the post-consumer phase of a product’s life cycle by placing economic and physical responsibility fully or partially on the producers, which translates into ensuring that waste products are collected, sorted, transported, disposed of or recycled in a safe and sound manner under acceptable practices.

Principles of EPR

- Producers, defined as those introducing a product into a national market, are accountable for environmentally sound management at end of life.
- Producers should ensure the collection and management of an equivalent amount of introduced product types, not just their own branded items.
- Responsibility can be fulfilled individually or collectively through collaborations with other producers.

Financial principles:

- Producers and importers may pay fees upon market entry for the end-of-life management, pooled into funds managed by a Producer Responsibility Organization (PRO) or government.
- These funds finance environmentally sound e-waste collection and recycling efforts.

Table 2 - End-of-Life Management Practices for Around the World

Country	End-of-Life Management Practices
China	<ul style="list-style-type: none"> – Waste Electrical and Electronic Product Recycling Management Regulation 2011 – National High-tech R&D Programme PV Recycling and Safety Disposal Research provides policy and technology signpost for future regulations on end-of-life PV panels.
India	<ul style="list-style-type: none"> – E-waste (Management and Handling) Rules of 2016 by the Ministry of Environment Forest and Climate Change) – Industrial-scale e-waste recycling infrastructure exists but applies only to household electronics, not PV.
Germany	<ul style="list-style-type: none"> – EU-WEEE directive translated into German law: Electrical and Electronic Equipment Act (Elektroaltgerätegesetz or ElektroG 2015) – National Register for Waste Electrical Equipment (Stiftung EAR)
The United Kingdom	<ul style="list-style-type: none"> – UK WEEE legislation (based on the EU WEEE directive) replaced voluntary producer initiatives.
The United States of America	<ul style="list-style-type: none"> – The Resource Conservation and Recovery Act: No specific requirement for PV panels, but a general regulatory framework for waste management. – California is in the process of developing regulations on PV panels' end-of-life management
Japan	<ul style="list-style-type: none"> – Construction Waste Recycling Law (METI and MOE, 2015) - PV panels integrated into building material may fall under these guidelines for promoting proper end-of-life treatment (including recycling) of renewable energy equipment published in April 2016 – A proposed amendment to Japan’s feed-in-tariff scheme for renewable electricity includes the consideration of end-of-life management with recycling but without obligations and penalties (METI, 2015)

3.3.2 Recommendations

- Support the Ministry of Environment in establishing comprehensive regulations specifically targeting the EoL management of Solar PV panels and inverters, distinct from general e-waste regulations. These regulations should address unique challenges and materials associated with solar panels.



- Develop guidelines on best practices for the collection and disposal of solar equipment, such guidelines should ensure adherence to high environmental, health, and safety standards to minimize the impact of collection and recycling processes.
- Promote the development of local recycling industries by providing technical and financial support. This assistance can help build the necessary infrastructure within Eswatini to manage solar panel waste domestically, reducing dependence on international recycling facilities.
- The National Solid Waste Management Strategy for Swaziland should be updated to specifically address the waste generated by Solar Powered Irrigation Systems (SPIS). This update should include detailed guidelines for the disposal and recycling of SPIS components.

Enhancing Extended Producer Responsibility [1] [2]

- Conduct a comprehensive baseline assessment of the current practices for end-of-life management of solar products and the supporting regulatory framework in place, including:
 - Existing waste management systems, focus on collection, reuse, recycling, and disposal practices.
 - Regulatory framework evaluation, with a focus on existing waste disposal regulations and their impact on solar energy access projects.
 - PV components collection practices review, including the effectiveness of formal systems and the role of informal sector operators.
 - Reuse and recycling efforts: Identify national and regional companies involved in the repair and recycling of products, evaluating their environmental and health performance.
- Based on the information provided by the baseline study, support the Ministry of Environment, the Eswatini Environmental Authority and other relevant key stakeholders in establishing clear responsible parties for the collection and disposal of solar equipment. This intervention could lead to establishing an EPR system, if it fits the country needs. Furthermore, EPR systems can be implemented under different approaches that place the responsibilities under different parties. Some of the main approaches include:
 - Voluntary implementation by producers: Encourage producers to voluntarily take responsibility for the end-of-life management of their products without legal mandates.
 - Mandatory Implementation through legislation: Enact laws and regulations that require producers to manage end-of-life products, ensuring compliance across the industry.
 - Individual Producer Responsibility (IPR): Hold each producer accountable for managing their products at end-of-life.
 - Collective Producer Responsibility: Facilitate the formation or participation in Producer Responsibility Organizations (PROs) or compliance schemes, allowing producers to meet their EPR obligations collectively.
 - Government-Led Programs: Consider scenarios where the government plays a more active role in managing product collection and recycling, with financial contributions from producers.
 - Hybrid Models: Implement a combination of approaches, such as offering both individual and collective producer responsibility options, to provide flexibility.



4 Quality Infrastructure (QI) Development [3]

Information box 3. Components of a comprehensive quality infrastructure framework

Quality Infrastructure (QI) is a framework that ensures the reliability, safety, and performance of products, including those in the rapidly growing solar photovoltaics sector. The establishment of a robust and credible QI framework is essential for the thriving and rapidly growing solar technology markets. Such a framework guarantees that the expectations of both investors and end-users for technology performance, durability, and safety are not just met but exceeded. It becomes the bedrock upon which long-term sustainability is built, fostering trust along the entire supply chain of the products it attains, including consumers, suppliers, and financiers. The key components of a comprehensive QI framework are:

- **International standards:** Compliance with international standards serves as a warranty that solar components, installation and operation procedures fulfil a minimum of quality and performance requirements.
- **Conformity assessment bodies and certification:** A certification is a formal verification by a conformity assessment body to assess and verify that a product or service corresponds to the requirements of a standard, issuing a certificate. The certification of solar installers plays a crucial role in promoting quality, safety, and consumer trust within the solar industry by ensuring that solar PV systems are installed correctly, efficiently, and safely and that solar installers have received proper training and have demonstrated proficiency in the design, installation, and maintenance of solar PV systems.
- **Testing:** Testing of solar products ensures that solar products fulfil quality and safety requirements. Testing is essential for ensuring the accuracy and reliability of solar equipment. Without testing, equipment performance can be inconsistent, leading to inefficiencies and failures. Reliable testing protocols build consumer confidence in solar products, encouraging wider adoption and investment.

4.1 Certification framework for Solar Installers

4.1.1 Status quo and perceived challenges

- Cane growers, financial institutions and the EEC have expressed a lack of technology service providers for solar energy. Furthermore, it has been highlighted that it is difficult to assess when a solution provider is reliable, and its products and operation fulfil international standards. This increases the risks perceived by financial institutions in granting loans for SPIS.
- Eswatini has yet to introduce a certification framework for solar installers. To address this, the following steps can be taken

4.1.2 Recommendations

- Design a certification framework for solar installers, including completing specific training courses, demonstrating competency in the installation of solar systems and compliance to the national grid code and the SSEG framework.
- Design and implement a code of practice for installers and assign oversight of the certification process to regulatory bodies. The code of practice and certification framework can be designed via technical assistance by specialized firms.
- Maintain a database of registered installers and solution providers and educate consumers on the importance of hiring certified professionals. Solution providers can register with REAWSA and ESERA, and this database communicated to relevant authorities and end-user groups such as the ECGA and the EEC.
- Secure funding for engaging experts who will play a crucial role in benchmarking the curriculum and standards applied during the certification of installers.



4.2 Support the operationalisation of a certification framework for PV products, standards for PV products and grid-compliance codes.

4.2.1 Status quo and perceived challenges

- The installation of substandard solar PV products in Eswatini causes numerous problems, not only poorly performing systems have lower efficiency and shorter lifespans, leading to higher maintenance costs and failures, but also affect the trust of end-users and financial institutions. Hindering the deployment of PV systems. Furthermore, not following the grid-compliance code leads to an unsafe grid connection for PV systems.
- Eswatini is currently developing standards relevant to PV systems. The Eswatini Standards authority (SWASA) is currently working, together with a technical committee on a series of standards for i) mini-grids and off-grid systems; ii) PV systems design equipment and installation and iii) electricity safety. Additionally, in 2023, ESERA published a comprehensive grid code. Overall, this makes for a comprehensive regulatory framework to ensure quality that requires operationalisation and awareness raising.
- SWASA has is currently developing a comprehensive list of standards that cover various aspects of solar energy in Eswatini. These standards include:
 1. Solar Project Development and Management
 2. Solar PV Project Design and Installation
 3. Component-based solar PV Systems
 4. Equipment and Appliances that use Solar, e.g. Solar pumps

4.2.2 Recommendations

- Provide support to SWASA and the technical committee to finalise the development of the standards and its operationalisation and enforcement. This support should include:
 - Engaging with organisations such as the Southern African Development Community to ensure the standards are tailored to local needs.
 - Supporting the establishment of connections between international standardization experts, organizations, and regional stakeholders through events, seminars, and networking sessions.
 - Preparation of awareness raising materials on the standard requirements and how to identify compliant products.
 - Design of enforcement mechanisms to ensure standards compliance
- Maintain a database of products that are compliant with international product component certification requirements, this database can be shared with cane growers, EEC, ESERA, project developers and local authorities.
- Raise awareness on the internationally recognised PV certification schemes and labels (for example: TUV Rhineland or UL) to ensure that end-users can recognise products that are labelled as compliant with international standards.



Information box 4. Certification of solar installers in South Africa [4]

The South African PV GreenCard is a safety certification, a quality assurance standard, and a training program for solar installers. Quality and safety are assured via the specialized education and training provided to solar PV installers before being certified and registered on the PV GreenCard database.

On completion of an installation, a certified PV GreenCard installer will issue the client with both a digital and physical document that details all the solar PV system's specifications and a checklist that all of the required installation steps have been completed to the required standard.

This document can be used as proof of compliance for insurance and finance.

The PV GreenCard provides customers (e.g. smallholder farmers) with peace of mind that their system is safe, compliant, and in line with the Eswatini and international standards.

This initiative has three focus areas:

1. A database of Installers: The South African Photovoltaic Industry Association (SAPVIA) the representative voice of the solar PV industry recommends installers based on a strict criterion to ensure a qualified workforce. The benefit of choosing an industry vetted installer is that one is confident to receive a high quality, safe and reliable solar PV system installation done by qualified individuals who are following standardized practices.

2. Training and Assessment (Installers): Education and training are the key requirement to a suitably qualified workforce, ensuring adherence to best practice and safeguarding the future industry.

Initiatives include.

- Solar training centres
- Solar assessment centres
- Training schedules
- Assessment schedules

3. Standards and Guidelines: SAPVIA with associates and partners has developed industry guidelines as an interim measure to ensure best practices are followed in solar PV installations. A list of approved standards and guidelines are used for the development of the PV Greencard

Results: The South African PV GreenCard has promoted safe and quality installations based on training, accreditation, standardisation, and documentation of embedded solar PV installations. There are currently 442 companies registered with about 1,200 installers trained and with 18 approved training centres and 15 approved assessment centres across the country through the SAPVIA programme.



5 Recommendations for Financial Institutions

5.1 Exploring the integration of insurance to SPIS finance

5.1.1 Status quo and perceived challenges

- Insurance is a crucial tool for managing the financial risks that Eswatini growers face due to frequent extreme events like floods and droughts. Policymakers are urged to introduce tailored support measures, such as insurance premium subsidies, and integrate them with support services to boost the uptake of SPIS and generate trust within the market.
- Eswatini introduced the Micro Insurance Regulation in 2020 to make insurance accessible and affordable for low-income earners. The country is enhancing insurance access through the Eswatini Association of Savings and Credit Cooperative (ESASCCA), banks, and post offices.
- In Eswatini, the Eswatini Royal Insurance Company (ESRIC) provides two kinds of insurance for SPIS systems. One at the time of installation, it covers the risks related to the installation process and lasts between 10 – 24 Months. The second kind of insurance offered is *fire and special perils* insurance, it includes Insurance against physical loss or damage proximately caused by fire and lightning storm, wind and hail.
- The insurance premiums are determined based on the capital cost of the solar equipment. Therefore, if a small-scale grower installs a small SPIS system for personal use, the premium for the insured product would inherently be low.

5.1.2 Recommendations

- Integration of insurance with financial products:
 - Financial institutions should require growers to insure their equipment before granting financing for SPIS systems. This approach significantly de-risks the investment for the financial institution, as any insurance claims will be paid directly to the financial institution until the loan is fully repaid or used towards the repairs of the system.
 - Financial institutions should ensure that growers maintain insurance coverage at both the installation stage and post-installation stage covering *fire and special perils* until the period that the loan is paid off
 - Financial institutions should take responsibility for annually verifying that the grower's insurance coverage has been renewed, ensuring continuous protection for their investment.
- Collective insurance:
 - Financial Institutions can also mobilise group insurance, where a cooperative or an association insures a larger, shared SPIS system. This approach offers several benefits. By insuring a communal system, the overall risk is distributed among multiple growers, which reduces the exposure for both the financial institution and individual growers. Consequently, the premiums paid by each grower are likely to be lower compared to individual insurance policies.

5.2 Leveraging funding from international and development finance institutions

5.2.1 Status quo and perceived challenges

- Attracting funding from development finance institutions is crucial because it provides stability, lowers the cost of capital, and catalyses additional private investment. These institutions align



their investments with public policy goals, offering significant funding capacity and technical expertise.

- Eswatini has already established some partnerships, such as the EIDC's collaboration with the EU/UNDP for a 50:50 financing of solar pumps. It is recommended to expand these efforts by additional partnerships with a diverse range of institutional investors. This approach will enhance resource mobilisation.
- A major challenge faced by local financial institutions in Eswatini when applying for financing from larger institutions is their lack of understanding of the technological aspects of SPIS systems, which hinders their ability to conduct accurate risk assessments.
- The size of the projects is not yet large enough to secure larger funding from international and development finance institutions.

5.2.2 Recommendations

- Create partnerships between local financial institutions, agricultural banks and international development finance institutions to channel large-scale capital into financial support and technical assistance to scale-up the uptake of SPIS. Some Financial Institutions (FIs) have existing pipelines with international organisations, such as the Green Climate Fund (GCF) that should be replicated for the provision of SPIS finance.
- Support existing financial institutions throughout the process of identifying interested cane growers to develop a project pipeline and preparing funding proposals, recognizing the unique needs of each proposal and the varying expertise required at different stages. To streamline this process, the following recommendations can be implemented:
 - Establish strategic partnerships with key institutions that can provide the necessary technical and sector-specific expertise. When preparing a project pipeline and a funding proposal, FIs can collaborate with institutions such as the ECGA, the ESA and the outgrower department from the milling groups, as these organisations have the capacity to aggregate cane growers and have experience with the provision of technical support to the growers.
 - Develop a standardized framework for identifying and engaging relevant stakeholders at each stage of the funding process, tailored to the specific requirements of each proposal.
 - Outsource the technical due diligence and risk assessment components to specialized third-party firms with expertise in SPIS systems and agricultural financing.
 - Implement a clear protocol for receiving, reviewing, and integrating inputs from these external experts into the funding proposals.
- Implement a standardised due diligence process for the application of funding. While applying for possible funding the following documents could be made mandatory to present:
 - A declaration from the EEC that the system has been designed in consultation with them and has met their criteria
 - A warranty from the installer
 - A detailed project proposal outlining the scope, timeline, and expected outcomes of the SPIS implementation
 - A risk assessment report detailing potential risks and mitigation strategies related to the SPIS installation and operation



- Develop risk assessment tools tailored to agricultural solar projects to help institutional investors evaluate these opportunities more effectively. This risk assessment can also be outsourced to a verified third party or an independent risk assessor.
- Explore partnerships with agricultural cooperatives or associations to aggregate demand and create larger, more attractive investment opportunities.
- Work with development finance institutions to create blended finance structures that can help de-risk the bundled portfolios and make them more attractive to institutional investors

Information box 5. Potential Institutions for supporting renewable energy investment[4]

- **International financial institutions** include global and regional multilateral development banks that provide funds, financing instruments and risk mitigation instruments. Some of these are:
 - World Bank Group
 - Asian Development Bank (ADB)
 - the European Investment Bank (EIB)
 - The European Bank for Reconstruction and Development (EBRD)
 - African Development Bank (AfDB)
 - The Islamic Development Bank
 - The Inter-American Development Bank
 - The Asian Infrastructure Investment Bank
 - The New Development Bank
- **Development Finance Institutions (DFIs)** include most of the international financial institutions mentioned above and include bilateral development agencies:
 - AFD (the French Development Agency)
 - KfW (the German Development Bank)
 - JICA (the Japanese International Cooperation Agency)
- **Climate finance institutions** include international climate funds and intermediary institutions created by multiple government donors to channel public funds from developed countries to climate-relevant projects in developing countries
 - Global Environment Facility (GEF)
 - The Climate Investment Funds (CIFs)
 - the Green Climate Fund (GCF)

5.3 Interest Rate Subsidies

5.3.1 Status quo and perceived challenges

- The upfront costs of installing SPIS present a financial challenge for cane growers in Eswatini, making it unaffordable. This issue is further compounded by their limited access to capital.
- Cane growers encounter difficulties in securing affordable financing options for investing in SPIS due to the reluctance of financial institutions to provide loans, stemming from the perceived risks associated with agricultural projects.
- The price of SPIS required large loans with long repayment periods, leading to high-interest payments. Because interest rates are partly based on perceived risk, subsidizing these interest payments can help make the systems more affordable with minimal market distortion. This subsidy also provides increased incentives for financing institutions and suppliers to offer consumer financing.

5.3.2 Recommendations

- Implement a grant-funded program to subsidise interest payments on loans and other financing for SPIS.



- Promote the adoption of first loss guarantees (see Information box below), to protect financial institutions from initial losses and encourage them to provide loans for solar equipment.
- Design the subsidy program to gradually phase out as the market for solar equipment becomes more established.
- Conduct regular market assessments to adjust the level of subsidies and avoid long-term dependence on financial support.
- Monitor the impact of subsidies on the solar equipment market, adjusting the program as necessary to minimise market distortion.
- Subsidizing interest payments and system prices makes SPIS more affordable for cane growers, reducing their financial burden and enabling investment without jeopardising their financial stability. Lower interest rates further alleviate financial pressure, while the affordability of SPIS facilitates access to modern, efficient technology, boosting agricultural productivity. Risk mitigation through first-loss guarantees encourages financial institutions to offer more loans, increasing farmers' access to necessary financing and boosting their willingness to take out loans.

Information box 6. First Loss Guarantee by Green Max Capital [16]

The Green-for-Access First Loss Facility (G4A) is a risk mitigation initiative designed to promote increased local currency financing for energy access projects by local financial institutions. G4A employs a tiered fund structure, blending grant funds in the first loss tranche with private philanthropic and impact junior debt in the middle tranche, and senior loans from development finance institutions (DFIs) in the top tranches. G4A's inaugural product is a physical cash deposit fund placed with local lenders, covering up to the first 20% of losses across a portfolio of energy access loans. Currently in its pilot phase, G4A is envisioned as a USD 50 million closed-end fund, aiming to leverage nearly USD 1 billion in energy access investments.

G4A has organized six pilot portfolios with partner FIs in Kenya, Malawi, Nigeria, Tanzania and Uganda. With support from the IKEA Foundation and CLASP, the first pilots will be launched in Nigeria and Uganda in 2023.



6 Capacity Building & Training

6.1 Status quo and perceived challenges

Extensive stakeholder consultations with representatives of cane growers, financial institutions, non-governmental organizations and the public sector revealed a series of knowledge gaps regarding solar PV and its benefits. Some of the identified knowledge gaps are as follows:

Sugarcane growers:

- Fundamentals of SPIS and technical requirements to switch from grid-tied irrigation systems to grid-tied SPIS.
- EEC registration programme to register as a small-scale embedded generator (SSEG)
- Available financing options for the acquisition of SPIS
- Operation of SPIS and optimal use of SPIS (e.g. revising irrigation schedule to ensure maximum use of daylight)
- Identification of certified technology solution providers that offer a comprehensive after-sale service package (warranty, customer support and maintenance)
- Identification of labels that certify the quality of solar products
- Benefits of SPIS and upcoming net-billing framework
- Financial literacy, including opportunities for acquiring formal financing, requirements and benefits

Policy makers:

- International standards and best practices for end-of-life management of solar products
- Tariffing, operationalisation of wheeling framework, SSEG framework and net billing, as these approaches are currently under pilot stage.

Financial institutions

- Common best practices for the design, sizing and installation of SPIS, including typical conditions for system lifetime, warranty, maintenance and customer service
- Cost reduction potential from SPIS, including the additional benefits from upcoming policy initiatives such as the SSEG framework and the net billing mechanism
- Assessing the risk of granting finance for SPIS and integrating these risks into loan appraisal systems
- Identifying certified installers and technology providers
- Reading SPIS quotations and assessing the technical and economic feasibility of PV projects
- Identifying certified PV products that fulfil national or international quality standards, including compliant inverters for grid connection (Compliant to standards NRS 097 or in the Cape Town inverter list)

Technology providers

- EEC's SSEG and registration requirements
- National and international standards for solar PV products
- ESERA's Eswatini Grid Connection Code



- Identifying certified PV products that fulfil national or international quality standards, including compliant inverters for grid connection (Compliant to standards NRS 097 or in Cape Town inverter list)

The provision of training, capacity building and awareness raising among the key actors along the value chain of SPIS build trust in the technology among various the stakeholders and facilitate the market-based uptake of this technology.

6.2 Recommendations

Overall recommendations

General recommendations include interventions aimed at fostering an environment that allows for knowledge exchange among key stakeholders, including:

- Designing a stakeholder engagement and public awareness campaign on the benefits of solar PV, the potential of PV systems for irrigation, available options and requirements to install a SPIS and available sources of funding. This campaign should include testimonials from cane growers that have already implemented SPIS and the requirements to participate in the SSEG framework among key messages.
- Strengthening the capacity of financial institutions and regulatory bodies for effective collaboration through targeted capacity-building programs, technical assistance, and resource mobilization efforts.
- Foster partnerships and collaboration with international development agencies, international experts, universities and private sector companies to ensure knowledge transfer and dissemination among Eswatini key stakeholders.
- Provide training and capacity-building initiatives for sugarcane growers to enhance their understanding of solar PV technology, energy management practices, and financial literacy.

Recommendations targeted at sugarcane growers:

- Design of a capacity building programme for cane growers on SPIS. This program can be designed and delivered through technical assistance, taking advantage of the infrastructure and events from the ESA and the ECGA. The training materials should be jointly designed in consultations with REAWSA, ESERA, SWASA, EEC, local technology providers and local financial institutions. The content of the materials should cover the following areas:
 - Basic knowledge of solar energy
 - Components and operation of SPIS
 - Benefits of SPIS
 - Basic operation and maintenance of SPIS
 - Safety considerations of SPIS
 - Identification and troubleshooting of common operational issues
 - Financial literacy, including account management, record-keeping, budgeting, and loan repayment strategies
- In addition to the capacity building materials, an awareness raising campaign for cane growers should be conducted in parallel. The materials for the awareness raising campaign should include the following topics:
 - Available financial products and subsidies for the implementation of SPIS



- Certified solar PV installers and technology providers
- Labels and standards that allow for the identification of quality products
- The EEC registration process and the SSEG programme, with a special emphasis on the EEC application form to be part of this process; the need to approach a technology provider that can comply with the EEC's requirements for embedded generation and the requirement of seeking EEC's approval of the system prior to start the construction phase of a project.
 - The net billing system, its requirements and benefits
- The training and awareness raising materials for sugarcane growers should be produced in local languages and disseminate through videos for a better understanding.
- Organizing regular meetings where sugarcane growers come together and share their knowledge and experiences through a combination of in-person workshops, practical demonstrations, digital resources, and interactive platforms to ensure accessibility and engagement for cane growers across different regions.
- Establishing a dedicated online platform for training sugarcane growers. This platform will feature Frequently Asked Questions (FAQs), resources, forums, online training, discussion boards, and document-sharing for easy access to information. Support for this initiative can come from the Ministry of Agriculture, REAWSA, ESERA, ECGA, and SWASA, leveraging their media and social platforms.

Recommendations targeted at Policy makers:

- Provision of support SWASA, REAWSA and other key stakeholders in the areas of operationalisation and enforcement of supporting mechanisms for decentralized renewable energy systems (e.g. net billing, feed-in-tariffs, embedded generation). The scope of this technical assistance can include:
 - Mobilisation of funding
 - Technical support in the development, adoption and operationalisation of standards and policy documents
 - Organisation of international conferences with international experts for knowledge exchange
 - Provision of training to key staff

Recommendations targeted at financial institutions

- Collaboration between financial institutions and the Ministry of Agriculture to develop and implement educational initiatives aimed at raising awareness about the bank's tailored programs and products in the agricultural sector.
- Support financial institutions in the development of an awareness raising campaign on their financial products for the agriculture sector and for renewable energy solutions.
- Delivery of trainings and capacity building of loan officers and key staff of financial institutions in the areas of:
 - Basic concepts of solar energy and solar irrigation, including benefits
 - Economic benefits of SPIS, including supporting mechanisms for embedded generation and net billing
 - Evaluation and risk assessment of PV projects, including:
 - Key performance indicators



- Good practices for design and sizing of PV systems
 - Typical lifetimes, warranties, maintenance and customer services expected from technology developers
 - Quality standards for PV systems
 - Available quality certifications for solar products, installation of solar systems and connection to the grid
- Provide technical support to financial institutions to incorporate risk assessment of PV systems and SPIS into their loan appraisal process.

Recommendations targeted at Technology providers

- Development of a training programme for solar installers, in cooperation with REAWSA, this programme should focus on good practices for sizing, installation, maintenance and after sale services for solar PV systems. Additionally, this programme should incorporate EEC's embedded generation requirements, ESERA's grid connection code and other key frameworks for the installation of grid-tied solar PV systems.
- This training programme can be accredited and overseen by relevant industry bodies such as the Directorate for Industrial and Vocational Training (DIVT) or ESERA) that ensure that installers receive quality and up-to-date training.
- Support the development and enforcement of a code of practice for installers and assign oversight of the certification process to regulatory bodies.



7 References

- [1] H. Wuester, J. Jungmin Lee, and A. Lumijarvi, "Unlocking Renewable Energy Investment: The role of risk mitigation and structured finance," IRENA, 2016.
- [2] D. Khattar, "The emerging solar policy and regulatory landscape in Africa - REGlobal -," REGlobal. Accessed: Jan. 01, 2024. [Online]. Available: <https://reglobal.org/the-emerging-solar-policy-and-regulatory-landscape-in-africa/>
- [3] Ministry of Energy and Petroleum and Kenya Renewable Energy Association, "National RoadMap on Scaling Up Productive Use of Renewable Energy."
- [4] R. Kumar, A. Kumar, Tribhuvan Singh Rajpurohit, None Shubham, and Hansa Kantwa, "Measurement tool for training needs of farmers for solar power water pump system," *Journal of krishi vigyan*, vol. 12, no. 1, pp. 121–125, 2024, doi: [10.5958/2349-4433.2024.00022.9](https://doi.org/10.5958/2349-4433.2024.00022.9).
- [5] German Sparkassenstiftung, "Global green finance products, services and programs in rural areas."
- [6] Eswatini sugar industry, "Facts and Figures (Industry) – Eswatini Sugar Association," Eswatini Sugar Industry. Accessed: Jan. 01, 2024. [Online]. Available: <https://esa.co.sz/facts-and-figures-industry/>
- [7] R. and Markets, "Eswatini Sugar Industry Report 2022: Profiles of Key Players Crookes Plantations, Royal Eswatini Sugar Corporation, Tambankulu Estates and Ubombo Sugar." Accessed: Jul. 05, 2024. [Online]. Available: <https://www.prnewswire.com/news-releases/eswatini-sugar-industry-report-2022-profiles-of-key-players-crookes-plantations-royal-eswatini-sugar-corporation-tambankulu-estates-and-ubombo-sugar-301500908.html>
- [8] ESWATINI SUGAR ASSOCIATION, "Eswatini Sugar Industry | About Us - Sugar Industry," esa.co.sz. Accessed: Jan. 01, 2024. [Online]. Available: <https://esa.co.sz/ISOCouncil/about/sugar/>
- [9] "End-of-life Management: Solar Photovoltaic Panels," IRENA, Jun. 2016.
- [10] M. Andreas, M. Dr. Mirja, S. Tobias, and H. Inga, "End-of-Lide management on solar energy access projects," Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany, 2022.
- [11] M. Federica, S. K. Deepali, and K. Athina, "E-Waste Policy Handbook," Africa Clean Energy Technical Assistance Facility, Jul. 2019.
- [12] J. O. Akotey and C. K. D. Adjasi, "Does Microcredit Increase Household Welfare in the Absence of Microinsurance?" *World Development*, vol. 77, no. C, pp. 380–394, 2016.
- [13] United Nations Development Programme, "COP26: Eswatini Pledges to Increase Renewable Energy," UNDP. Accessed: Jan. 01, 2024. [Online]. Available: <https://www.undp.org/eswatini/news/cop26-eswatini-pledges-increase-renewable-energy>
- [14] S. M. Simelane, S. E. Terblanche, and M. T. Masarirambi, "Collective Action For Access To Inputs, Finance, Markets And Extension For Smallholder Farmers In Eswatini," *South African Journal of Agricultural Extension (SAJAE)*, vol. 47, no. 2, 2019, doi: [10.17159/2413-3221/2019/v47n2a500](https://doi.org/10.17159/2413-3221/2019/v47n2a500).
- [15] A. C. Ruane and C. Rosenzweig, "Climate Change Impacts on Agriculture," *World Scientific Series in Grand Public Policy Challenges of the 21st Century*, pp. 161–191, 2018, doi:



[16] Greenmax Capital, “Green-For-Access First Loss Facility (G4A) - GreenMax,” *Greenmax*, Jul. 15, 2024. <https://greenmaxcap.com/service/green-for-access-first-loss-facility-g4a/>