

Insurance for energy access: Unlocking economic resilience in rural communities

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Acronyms and Abbreviations

ASP	Adaptive social protection
CDRFI	Climate and Disaster Risk Finance and Insurance
C&I	Commercial and industrial
DFI	Development finance institution
DRE	Distributed Renewable Energy
EaaS	Energy-as-a-Service
EPC	Engineering, procurement and construction
ESMAP	Energy Sector Management Assistance Program
EV	Electric vehicle
FAO	Food and Agriculture Association
FICP	Financial Inclusion and Consumer Protection
FRA	Financial Resilience in Agriculture
GDP	Gross domestic product
GOGLA	Global Off-Grid Lighting Association
IEA	International Energy Agency
IFPRI	International Food Policy Research Institute
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
IRFF	Insurance and Risk Finance Facility
L&H	Life and health
MSMEs	Micro-, small and medium-sized enterprises
MDB	Multilateral development bank
MFI	Microfinance institution
MTF	Multi-Tier Framework
OECD	Organisation for Economic Co-operation and Development
OGS	Off-Grid Solar
PAR30	Portfolio at Risk
PAYGo	Pay-As-You-Go
PCG(s)	Partial credit guarantee(s)
PM-JAY	Pradhan Mantri Jan Arogya Yojana
PPP(s)	Public-private partnership(s)
PRI	Political risk insurance
SHS	Solar Home System(s)
SDGs	Sustainable Development Goals
UAIS	Uganda Agriculture Insurance Scheme
UNDP	United Nations Development Programme
UNSD	United Nations Statistics Division
WHO	World Health Organization

Solar panels in a remote community. Photo: UNDP Cambodia



Executive summary

Access to modern, reliable and affordable energy is essential for development, particularly in rural and off-grid communities across sub-Saharan Africa and Asia. Distributed Renewable Energy (DRE) companies are helping to fill this gap, but they and the communities they serve face a range of financial and operational risks, which are exacerbated by the intensifying impacts of climate change. To build resilience and sustainability, donors and climate finance institutions need to step up support to expand access to insurance and financial risk management tools.

Insurance can help stabilize incomes, reduce exposure to risks and build financial resilience for energy providers and end users. However, its use in the DRE sector is still fragmented and mostly confined to pilot programmes. This report explores how insurance solutions can be integrated into the DRE ecosystem in ways that add clear value.

Drawing on case studies, stakeholder interviews and desk research, this report assesses the main, interconnected risks faced by key DRE stakeholders: end users, DRE companies, financiers, insurance companies and governments. It considers ways in which insurance can address these risks to reduce financial shocks, stabilize revenue streams, improve investability and support community resilience and long-term sustainability in energy supply.

The report proposes five core design principles for designing viable insurance products in the space: affordability, value, accessibility, scalability and alignment with national development goals. Affordability and value are critical to driving adoption, while accessibility and scalability determine whether solutions can reach the required scale to be financially

viable. Alignment with broader development goals, such as financial inclusion, energy access and climate resilience, ensures that insurance programmes generate lasting impact.

Five promising insurance product concepts are assessed in terms of their adherence to these design principles, operational feasibility and the enabling role of other actors.

Index insurance for end users offers protection against climate and environmental shocks that disrupt agricultural production and income, with payouts triggered based on measurable weather data (e.g., rainfall levels). In **Zambia**, a pilot bundled this insurance with PAYGo solar systems, helping farmers maintain access to energy during climate-related agricultural losses.

Government-administered index insurance enables the pooling of systemic risks. Subsidized insurance programmes, such as **Uganda's** agricultural insurance scheme, reduce barriers to insurance uptake and protect against systemic shocks like droughts and floods. Although not currently integrated with energy access solutions, Uganda's scheme illustrates how government support can expand insurance uptake and reduce vulnerability to systemic shocks.

Life and health insurance for households protects people from income shocks due to illness or death, which often lead to loan defaults. Bundling this with PAYGo energy products (as shown in schemes in **Kenya** and **Nigeria**) allows for small, regular premium payments and provides households with greater financial resilience, indirectly stabilizing the customer base for DRE providers.

End user credit risk insurance for DRE companies protects energy providers from revenue losses due to customer defaults, especially in regions affected by climate risks. For example, energy company Vitalite in **Zambia** bundled agricultural index insurance into PAYGo contracts, reducing the likelihood of widespread customer default.

Finally, asset protection for solar home systems (SHSs), or other related equipment, covers theft or damage, reducing financial risks and operational disruptions.

Many stakeholders have a part to play in supporting insurance integration into the DRE ecosystem. Governments can play a key role by subsidizing premiums, creating supportive policies and investing in data systems and consumer education. Development partners can bridge affordability gaps through results-based financing and premium subsidies. Reinsurers can offer critical capacity and knowledge-sharing, while insurers can develop tailored, easy-to-understand products and build trust through timely payouts and clear communication.

The report does not recommend any single product model for immediate implementation. Instead, it identifies promising concepts and outlines pathways for further exploration. It emphasizes the need for feasibility testing, strategic alignment and stakeholder engagement.

Integrating insurance into DRE strategies can enhance resilience and support inclusive growth. While the opportunity is significant, challenges specific to low-income markets must be addressed, including low consumer awareness, affordability barriers, data limitations and fragmented delivery models. Building financial literacy, consumer trust, digital infrastructure and inclusion may be key to ensuring insurance and DRE solutions can evolve together, increasing energy access and improving development outcomes.

Aerial shot of rural community in Sokoto State, Nigeria. Photo: UNDP Nigeria



1. Introduction

Developing countries face intensifying climate and environmental challenges that threaten livelihoods, disrupt services and strain public finances. In this context, improving access to sustainable energy and expanding financial protection mechanisms are complementary development priorities that can strengthen household resilience, support productive activities and reduce the long-term impacts of shocks. Yet many large segments of the population across sub-Saharan Africa, parts of Asia and elsewhere remain underserved by both modern energy services and formal insurance markets. Low insurance penetration and limited access to clean, affordable and reliable energy are among the many factors that constrain economic and social development in emerging economies, highlighting the urgent need for inclusive solutions.¹ For many residing in off-grid or underserved communities, the ability to access financial protection and sustainable energy is not only a driver of economic growth, but also an important factor in enhancing well-being and reducing vulnerability to shocks.²

Developers, operators and financiers recognize that Distributed Renewable Energy (DRE) companies³ can be sustainable. These enterprises operate using deferred payment or service-based models, and rely on steady repayments and ongoing energy use. Demand for energy access and products is high when users are generating revenue from steady economic activities and growth, but it can suffer when income is stretched and trade-offs in spending increase.⁴ Risks beyond the end user's control, especially those affecting entire customer bases, can impact their

ability to meet financial obligations. Both energy providers and consumers are exposed to financial and operational risks, which can be exacerbated by external shocks such as climate events or macroeconomic instability, as well as localized disruptions such as theft or equipment breakage. As these risks increase, this issue becomes more acute.



*A farmer tending her crops in a community working to strengthen resilience against recurring climate shocks.
Photo: UNDP Rwanda*

For energy providers, these uncertainties reduce the predictability of repayments, discourage investment and increase exposure to operational risks. In some contexts, major service disruptions caused by shocks can also lead to greater regulatory scrutiny or enforcement actions, particularly where service obligations or licensing conditions are affected. For end users, financial shocks make it harder to sustain access to essential energy services, sometimes resulting in equipment shutoffs or repossession, which further entrenches poverty and economic vulnerability. Recent data⁵ highlight the magnitude of

1 United Nations, "Affordable and clean energy: Why it matters" (New York, 2023); UNDP, "Almost 90% of people in low-income countries have no access to insurance reveals new study from The Microinsurance Network supported by UNDP", 1 May 2024.

2 Munich Re, "Climate insurance – An opportunity for developing countries", 16 November 2016.

3 In this report, "DRE companies" refers to various sub-sectors, including off-grid solar, mini-grids, captive power and e-mobility focused on energy access applications.

4 ESMAP, Off-Grid Solar Market Trends Report 2024: Outlook (Washington, D.C., World Bank Group, 2024).

5 GOGLA, "Keeping the Lights On: A Study of Repayment and Impact in the PAYGo Solar Market" (Amsterdam, 2025).

this challenge: collection rates across Pay-As-You-Go (PAYGo) solar companies have stagnated at around 65 percent, and Portfolio at Risk (PAR30) stands at approximately 25 percent, indicating that one in four customers is at least 30 days behind on payments. The study also found that over half of surveyed customers cited climate-related events such as drought, crop disease and floods as factors affecting their ability to repay, reinforcing the presence of default clustering tied to environmental shocks.

Insurance can strengthen the resilience of both energy users and providers by mitigating financial risks. For end users, it enhances financial stability by reducing the impact of unforeseen shocks that could otherwise limit their ability to afford energy services and increase the risk of payment defaults. However, affordability remains a critical constraint for many

last-mile customers, particularly for small (Tier 1)⁶ solar home systems (SHSs),⁷ and the addition of insurance premiums may further strain household budgets. For energy providers, insurance can stabilize revenue by protecting against widespread consumer defaults and operational disruptions linked to climate events, macroeconomic volatility and regulatory changes. Additionally, by insuring their own assets and infrastructure, providers can better manage risks related to equipment damage and theft. While supply chain disruptions are less likely to be covered through standard asset insurance, broader business interruption or contingency policies may offer some protection, depending on market availability. Each element helps ensure long-term business sustainability, bankability and potential private investment.



Workers service a solar minigrid in rural Zimbabwe. Photo: UNDP Zimbabwe

6 The Multi-Tier Framework for Energy Access (MTF) categorizes energy access into five tiers, from Tier 0 (no access) to Tier 5 (full access). See M. Bhatia and N. Angelou, *Beyond Connections: Energy Access Redefined*, ESMAP Technical Report 008/15 (Washington, D.C., World Bank Group, 2015).

7 ESMAP, *Off-Grid Solar Market Trends Report 2024: Outlook*. SHSs are stand-alone solar-powered units commonly used in off-grid contexts to provide household-level electricity.

The synergies between energy access and economic resilience are increasingly being recognized. Insurance plays an important role in stabilizing income and mitigating risks that threaten energy access across different user groups. Households and business owners alike face financial vulnerabilities that can lead to payment defaults and reduced demand for energy services.



A fish farm in Nigeria using solar panels.

Sectors such as agriculture, which employ a large portion of the workforce in emerging economies, are particularly affected by extreme climate events that can impact income stability and, by extension, energy affordability. Given that in these countries agriculture employs a substantial portion of the workforce (accounting for an average of around 50 percent of total employment across sub-Saharan Africa⁸) and contributes significantly to gross domestic product (GDP), ensuring financial resilience within this sector is crucial to sustaining livelihoods and promoting economic stability.⁹ At the same time, DRE solutions such as solar-powered irrigation, milling and agricultural processing can enhance productivity and income for rural households, creating a virtuous

cycle where energy access contributes directly to economic resilience.

As a result, the introduction or scaling of meaningful insurance coverage across energy-dependent sectors can provide financial protection to both end users and energy providers, helping to stabilize cash flows, promote investment and ensure the sustainability of energy solutions. By mitigating default risks for providers and shielding consumers from financial shocks, insurance strengthens the long-term viability of energy access business models. This report explores how insurance can help tackle their intertwined challenges.

The potential for scaling insurance products in the small-scale¹⁰ DRE sector is significant. For the purposes of this report, the DRE sector includes SHSs, productive-use appliances and green mini-grids – all of which serve off-grid or weak-grid communities in developing markets. The off-grid solar (OGS) segment alone is projected to require an estimated US\$30 billion in annual investment to achieve universal energy access across developing economies,¹¹ primarily through SHSs and small-scale solutions. The green mini-grid sector is also growing, with over 210,000 mini-grid connections expected annually in sub-Saharan Africa by 2030, requiring targeted financing and risk management solutions to scale effectively.¹²

These market conditions present a substantial opportunity for insurance companies to enter a growing market and develop products tailored to the risks faced by the sector. Currently, the off-grid sector is navigating various growth challenges, with

⁸ World Bank, “[Employment in agriculture \(% of total employment\) \(modeled ILO estimate\) – Sub-Saharan Africa](#)”, DataBank.

⁹ FAO, “[Employment indicators 2000–2022 \(October 2024 update\)](#)”, 24 October 2024; World Bank, “[Agriculture, forestry, and fishing, value added \(% of GDP\)](#)”, DataBank.

¹⁰ In this report, “small-scale” DRE refers broadly to Tier 1 to Tier 3 energy solutions under the MTF, which typically include SHSs, small solar irrigation pumps and other decentralized systems serving individual households or microenterprises. This contrasts with larger systems such as mini-grids or commercial-scale renewable installations that serve aggregated community or institutional loads.

¹¹ Based on the IEA’s Net Zero Emissions by 2050 Scenario. IEA, IRENA, UNSD, World Bank, WHO, [Tracking SDG7: The Energy Progress Report 2024](#) (Washington, D.C., World Bank, 2024).

¹² ESMAP, [Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers](#) (Washington, D.C., World Bank, 2020).



A rural farmers market in Kaduna State, Nigeria. Photo: Africa Minigrids Program/UNDP Nigeria

development partners and governments exploring end user subsidies to help reduce equipment and financing costs. In this context, insurance products could play a complementary role, and in some cases may offer a useful channel for more efficient delivery of such subsidies, while also enhancing household and provider resilience.

This report explores how insurance mechanisms can de-risk the value chain, unlock capital flows and support the achievement of sustainable development outcomes. The findings will offer valuable guidance for governments and other organizations looking to strengthen financial systems and improve risk management in the energy access sector. While agriculture serves as an important case study due to its reliance on energy access, the insights presented in this report extend to a broad range of end users operating in different sectors. Other stakeholders, including financial institutions, development agencies and private sector actors such as energy access providers and financial service providers, can also leverage these insights to drive investment, promote innovation and progress sustainable solutions tailored to the needs of underserved communities.

1.1 Objective of this assessment

The primary objective of this assessment is to explore how insurance mechanisms can be leveraged to enhance the financial resilience and economic viability of stakeholders within the energy access sector, while also de-risking investment in food systems to support sustainable growth. It seeks to identify critical insights to help build actionable strategies that integrate insurance to address the shared vulnerabilities faced by the energy and food systems sectors.

Given that much of the customer base for energy access solutions is located in rural areas, there is a natural intersection with economic activities, including agriculture, which serve as key sources of livelihood in these regions. While the primary focus remains on insurance in energy access, this assessment also evaluates the effectiveness of existing insurance products and explores inclusive solutions that could be scaled within rural communities. In addition to exploring the practical application of insurance, this assessment also seeks to establish the rationale for integrating insurance as part of broader financial solutions for development.

The focus of the report remains exclusively on risks that fall within the traditional domain of insurance. While other risks such as currency and political risks

are recognized as material barriers to investment and long-term viability in the energy access and rural development sectors, they are typically addressed through guarantees or financial instruments such as forwards and swaps, which are not covered in detail in this report. Key features of policy and regulatory frameworks that support the deployment of insurance solutions at scale are touched upon and partnership opportunities identified among public, private and development actors to support this integration.

The report underpins UNDP's ongoing efforts, guiding strategic engagements with key stakeholders like governments, development agencies and impact investors. Future programmatic interventions and policy development can be informed by this assessment, supporting scalable and sustainable energy solutions and financial resilience across energy-dependent sectors, particularly rural livelihoods. Aimed at catalyzing further action and investment in energy access, this report provides a strategic platform for collaborative action. This will enable stakeholders to leverage UNDP's expertise, ongoing programmes, current investments and resources to develop integrated solutions addressing the shared risks of these sectors, contributing to the achievement of the Sustainable Development Goals (SDGs).



A man standing in front of a solar minigrid in Nigeria. Photo: Africa Minigrids Program/UNDP Nigeria

A barber with electric clippers. Often one of the first business types to be introduced after connectivity to electricity, leading to growth in productivity and business. Photo: UNDP Nigeria



2. Stakeholder risk assessment

The integration of insurance into the energy access sector is still in its early stages. Insurance is increasingly recognized as a tool to help manage financial risks across the value chain, improve the resilience of off-grid providers and attract investment into DRE systems. In practice, though, its adoption remains limited. Most market actors do not currently consider insurance as a core element of their risk management approach.



Solar minigrid installation in rural Nigeria.

However, recent years have seen growing interest in using insurance to strengthen energy access and improve financial inclusion. This momentum is being driven by the expansion of mobile technologies, improved access to customer data and the increased presence of donors, impact investors and multilateral agencies in energy and climate finance. These trends present new opportunities for risk-sharing models to emerge.

This section outlines the current state of insurance engagement in the DRE sector. It begins by identifying the types of risks faced by key market actors and then explores existing insurance applications, drawing on global experience. The objective is to understand where insurance is already being used, what gaps remain and how insurance could play a more effective role in supporting the scale-up of energy access solutions.

2.1 End users

End users¹³ often face multiple sources of financial vulnerability that impact their ability to maintain stable livelihoods. These risks extend beyond sector-specific challenges and include broader disruptions such as health shocks, income loss and damage to essential household or productive assets. Financial service uptake remains low in many rural

and off-grid communities due to limited access, low financial literacy and affordability constraints. This perpetuates a cycle of vulnerability, particularly for women (box 1), who often absorb additional caregiving responsibilities and unpaid labour during times of crisis.¹⁴

¹³ Defined in this report as the subset of DRE customers who operate small-scale agricultural operations.

¹⁴ R. Kloeppinger-Todd and M. Sharma, eds., *Innovations in Rural and Agriculture Finance*, IFPRI 2020 vision focus (Washington, D.C., IFPRI, 2010).



A young customer at the UNDP-supported market in Gabiley, Somaliland. Photo: UNDP Somalia

Recent innovations in inclusive finance and energy delivery have started to shift this picture. Tailored products, such as PAYGo solar and bundled services, have linked access to energy and basic financial tools. Some of these approaches now incorporate insurance elements aimed at improving financial resilience. However, risks like the illness or death of a primary income earner can still destabilize households, leading to reduced spending on essentials, missed school days for children or the sale of productive assets.

Consumer protection becomes especially important in this context. Poor sales practices or inappropriate financing models can worsen vulnerability. To be effective, insurance products must be delivered within a framework that ensures fair treatment and responsible practices. With the right safeguards, insurance can help mitigate short-term shocks and reduce long-term impacts. But uptake depends on trust, affordability and relevance. Addressing these interconnected and gendered risks requires tailored risk management strategies that can often be misunderstood by those outside these communities.

Gender considerations in energy access and insurance

Box 1

Gender disparities in energy access significantly impact women's productivity and resilience. Women, who often form the backbone of rural communities, face systemic barriers to resources such as land, credit and technology. This inequality is compounded by the high burden of unpaid labour, including food processing and water collection. Across Africa, for instance, women collectively spend an estimated 40 billion hours annually on unpaid tasks like food processing, time that could be drastically reduced by changing from manual to electric appliances powered by renewable energy. These challenges limit women's ability to engage in productive and income-generating activities, deepening financial insecurity.

Addressing these disparities through gender-sensitive insurance and energy access initiatives presents a unique opportunity to empower women. Tailored insurance products, alongside renewable energy technologies such as solar irrigation, automated processing equipment or energy-efficient appliances, can reduce unpaid labour and enhance financial resilience. Although gender-sensitive insurance products have yet to meaningfully scale in the sector, integrating inclusive risk financing solutions that address the specific needs of women and marginalized groups could further strengthen economic security and access to energy.

Integrating gender considerations into the insurance and energy access nexus not only addresses equity gaps but also strengthens overall community resilience and sustainable development outcomes. This approach aligns with research from CARE, which emphasizes the importance of developing Climate and Disaster Risk Finance and Insurance (CDRFI) solutions that are tailored to the unique needs of women, thereby enhancing their capacity to manage climate-related risks and contributing to broader food security and gender equality goals.¹⁵

Source: IRENA and FAO, *Renewable Energy for Agrifood Systems: Towards Sustainable Energy Use in Food Chains* (Abu Dhabi, IRENA, 2021), pp. 11–15. Available at <https://www.irena.org/publications/2021/Nov/Renewable-Energy-for-Agri-food-Systems>.

¹⁵ C. Mugambi and S. Harmeling, *Gender-responsive Climate Disaster Risk Financing and Insurance (CDRFI) in Developing Countries: Research Report on Actions for Small-scale Farming Communities* (The Hague, CARE, 2022).



Key risks for end users

Addressing the interconnected risks of end users requires unique ex ante and ex post risk management strategies¹⁶ that are sometimes overlooked by those outside these communities. Table 1 outlines these key risks to end users, along with their impacts and potential insurance solutions.

Table 1: Key risks directly addressable through insurance (end users)

Category	Risk type	Description	Insurance or other de-risking measure
Risks directly addressable through insurance	Income risk	Risks from lower income due to erratic weather, pest/plague, supply chain disruptions or market fluctuations that impact revenue.	Business interruption insurance, index-based insurance for weather risks and other forms of asset protection mechanisms.
	Mortality risk	Death of the primary breadwinner affects household income and stability.	Life insurance to provide financial support to the family of the deceased.
	Morbidity risk	Illness or injury of key income earners lead to loss of productivity and income.	Health insurance to reduce financial strain caused by medical expenses and productivity losses.
	Asset risk	Damage of productive equipment or SHS.	Asset insurance for equipment linked to energy access.

¹⁶ D. Cervantes-Godoy, S. Kimura and J. Antón, *Smallholder Risk Management in Developing Countries*, OECD Food, Agriculture and Fisheries Papers, No. 61 (Paris, OECD Publishing, 2013).

Approach to risk management

For households and businesses, managing risk is part of daily life. While some financial risks can be measured, many are addressed through practical strategies developed through experience. Entrepreneurs and rural enterprises routinely consider the likelihood of disruptions, assess their potential impact and weigh the cost of mitigation. This decision-making process is a core capability in underserved communities.

In agriculture, common risk management practices include crop and livestock diversification, crop rotation to preserve soil health and aligning planting

and harvesting with seasonal patterns.¹⁷ In other sectors, small businesses mitigate risk by diversifying income, pooling local resources and adjusting operations to match seasonal demand.

Traditional knowledge and conservation practices also support resilience. Energy-efficient processing, water harvesting and similar approaches help reduce exposure to shocks. Community-based networks, such as cooperatives and savings groups, provide informal protection. However, these mechanisms often fall short when households or businesses face large-scale or systemic financial losses.¹⁸



Reliable water supply, provided by the solar-powered pumps, has expanded production and land use, and allowed the introduction or expansion of higher-value, water-intensive crops like cotton and watermelon. Photo: UNDP Sudan.

17 A. K. Chatterjee and A. Oza, "Agriculture insurance: A risky business", ADB Briefs No. 77 (Manila, Asian Development Bank, 2017); R. Raithatha and J. Priebe, "Agricultural insurance for smallholder farmers: Digital innovations for scale" (London, GSMA, 2020).

18 Chatterjee and Oza, "Agriculture insurance: A risky business".

Insurance applicability

Many rural businesses and energy consumers face persistent barriers in accessing and using financial products, including insurance.¹⁹ Their perceptions of risk and responses are shaped by their experiences, access to information and resource constraints. Without access to digital payment systems or formal banking and with little familiarity with insurance, many rely on informal strategies such as community savings groups. While these informal mechanisms provide support during emergencies, they are often insufficient for managing larger, systemic risks such as climate shocks or prolonged disruptions in energy supply. Other barriers to insurance include low financial literacy, limited product awareness, poor accessibility and affordability constraints. In addition, insurance presents unique challenges. Products typically require up-front payment for future benefits, which demands a high level of trust and understanding. Annual renewal adds another layer of complexity, particularly when no claims have been made, making it harder for users to justify continued coverage.²⁰

Without access to affordable and appropriate insurance, many energy users remain financially exposed. This limits their ability to invest in productive energy use equipment and may force

them to turn to informal lenders with high interest rates. Community-based financing can offer partial relief but often lacks the scale needed to respond to widespread events. In remote and resource-constrained areas, sudden shocks such as health emergencies or unexpected expenses can quickly deplete savings and push households into financial distress. These conditions, combined with the structural characteristics of insurance products, create a difficult environment for rural businesses and households to adopt insurance effectively.

However, PAYGo solar models are proving to be a powerful enabler of both energy access and financial inclusion. In sub-Saharan Africa, over 40 percent of OGS lighting product sales occur through PAYGo systems, and around the world, between 25 million and 30 million people have gained energy access through PAYGo.²¹ PAYGo allows users to pay in small instalments via mobile money, reducing up-front cost barriers and introducing unbanked consumers to digital financial services. In Uganda, for example, 16 percent of PAYGo customers used mobile money for the first time to purchase solar products.²² This entry point helps build credit histories and expands access to other services, including insurance.



A small business powered by solar in a rural community in Nigeria. Photo: Africa Minigrids Program/UNDP

¹⁹ Raithatha and Priebe, "Agricultural insurance for smallholder farmers: Digital innovations for scale".

²⁰ Insights from stakeholder interviews.

²¹ Power for All, "Off-grid PayGo: unlocking affordable energy access and financial inclusion in SSA", Power for All Fact Sheet, April 2022.

²² Ibid.

Summary: End users

End users in rural and off-grid areas face layered financial vulnerabilities, ranging from health shocks and income loss to damage of productive assets. These risks are often exacerbated by low financial literacy, limited access to formal financial services and gendered burdens, particularly for women. While informal coping mechanisms like savings groups and cooperatives offer some protection, they rarely provide adequate support for large-scale or systemic events. Recent innovations such as PAYGo solar have helped improve energy access and introduce digital financial tools, creating new pathways to integrate insurance. However, uptake will depend on trust, affordability and relevance. For insurance to deliver real value, products must be designed with a clear understanding of user realities and embedded within systems that ensure fair treatment and sustained access. Effective risk transfer solutions must not only address immediate shocks but also contribute to long-term resilience, especially for women and low-income households who are disproportionately affected by crises.

2.2 DRE companies

The rapid growth of the DRE industry has led to an increased understanding of the unique risk profile associated with DRE companies. The sector plays an important role in expanding energy access to underserved communities, often in challenging operational environments. DRE companies encounter

a range of insurable risks that are difficult to profile, given the diversity of business models, technologies and operating contexts across geographies and income segments. Some risks are generic, while others are subsegment or company-specific.



A solar minigrid installation in Nigeria. Photo: Africa Minigrids Program/UNDP Nigeria



Key risks for DRE companies

The framework used to assess risk in the DRE sector builds on insights from the UNDP and ETH Zurich Derisking Renewable Energy Investment: Off-Grid Electrification Report,²³ which identifies key barriers to private sector investment in mini-grids. These insights are complemented by more recent perspectives from companies operating in the PAYGo solar market, as well as reflections on other DRE segments such as commercial and industrial (C&I) users and electric vehicle (EV) applications where relevant. This framework supports a structured classification of risks, helping to identify which risks can be addressed through insurance or other risk management tools.

According to the *Off-Grid Solar Market Trends Report 2024* by the Energy Sector Management Assistance Program (ESMAP), the OGS sector has grown significantly.²⁴ Many companies now operate vertically integrated businesses, combining manufacturing, service delivery and consumer financing under one roof. **Market consolidation has led to fewer but larger players with broader product lines and operations across multiple markets.** These companies have attracted substantial investment, although profitability remains uneven. Consolidation often reflects ongoing challenges, particularly the struggle to reduce losses and operate sustainably at scale.

Despite the sector's growing maturity, companies differ widely in their business models. Some focus on higher-value products targeting middle- and upper-income customers. Others are experimenting with alternatives to traditional PAYGo structures, such as rental or service-based approaches that aim to serve lower-income households. While recent large investment deals have centred on Tier 1 systems with short payback periods of 6 to 24 months, there has been limited activity in the mid-range segment, where repayment terms are longer and systems are larger.

Table 2 outlines the main insurable risks faced by DRE companies across several categories. These were selected based on their relevance to the sector and the feasibility of managing them through insurance. The table includes risks that are both insurable and specific to DRE, while broader or cross-cutting risks have been excluded.

23 UNDP and ETH Zurich, Derisking Renewable Energy Investment: Off-Grid Electrification (New York and Zurich, 2018).

24 ESMAP, *Off-Grid Solar Market Trends Report 2024: Outlook*, p. 47.

Table 2: Key risks directly addressable through insurance (DRE companies)

Category	Risk type	Applies to	Description	Insurance or other de-risking measure
Risks directly addressable through insurance	Hardware risk	Mini-grids, SHS companies	Risks related to equipment quality, performance or damage during transit.	Insurance can cover performance warranties and damages, ensuring financial recovery for operators.
	End user credit risk	Mini-grids, SHS companies	Risk of non-payment by end users due to poor creditworthiness or financial instability, including challenges in initial credit assessment or changes in household income over time.	Credit default insurance or payment guarantee schemes to cover revenue losses from defaulting customers.
	Digital (Cyber) risk	Mini-grids, SHS companies	Vulnerabilities in mobile payment systems or risks of data breaches.	Insurance for data breaches or digital payment failures could offset company losses associated with these events.
	Warranty/service risk	Mini-grids, SHS companies	Costs associated with product malfunctions, repairs or replacements.	Extended warranty insurance or maintenance contracts for customers to ensure predictable costs and revenue streams for providers.
	Developer risk	Mini-grids, SHS companies	Risks associated with the developer's financial management, creditworthiness and cash flow stability.	Insurance for end user credit risks can indirectly stabilize developer revenue streams and attract investment.

Approach to risk management

DRE companies apply a range of internal strategies to manage risks, particularly those related to credit and operational performance. The PAYGo model plays a central role in managing credit risk through structured credit assessment and repayment monitoring processes. By linking payments to system usage, it enables low-income customers to access energy products through small, incremental payments, which helps overcome affordability constraints.

However, as companies attempt to scale quickly, some have relaxed their credit controls and lowered up-front payment thresholds. These decisions, combined with limited enforcement capacity and weak after-sales service, have led to rising rates of non-performing loans and equipment repossessions. The financial impact includes reduced liquidity, increased costs and the need to raise prices, which in turn limits affordability for end users and slows market growth.

Insurance solutions are unlikely to be effective if used in isolation. They must be supported by responsible lending practices and investor incentives that reward long-term performance over short-term sales.²⁵ Companies can also reduce reliance on insurance by providing regular maintenance and technical support throughout the repayment period. This helps ensure systems remain operational and reduces the likelihood of payment disruption caused by product failure.

Insurance applicability

Insurance has a clear role to play in supporting DRE companies across the value chain, particularly in managing risks related to the production, procurement and operational performance of renewable energy systems. The most immediate applications relate to protecting physical assets such as SHSs, batteries and mini-grid infrastructure from damage, defects or supply chain disruptions. This type of coverage is critical for maintaining operational continuity and protecting financial viability.

In addition to equipment-related risks, DRE companies face financial exposure linked to customer repayment behaviour. These risks affect revenue stability and limit business growth (see box 2). As the central actors in the energy access value chain, DRE companies are well positioned to observe payment patterns and identify risk factors at the portfolio level. While these data are often proprietary, they reflect valuable insights into consumer behaviour and affordability constraints. DRE companies also engage with governments, insurers and financiers, making them key enablers of insurance product design and deployment at scale.

Payment reliability is one of the most pressing challenges. A recent survey found that two-thirds of respondents identified repayment issues as a major obstacle, and limited access to consumer finance was also flagged as a concern.²⁶ Credit-linked insurance could help mitigate these risks by protecting DRE companies from revenue losses due to customer defaults. These solutions would mirror existing credit insurance models used by microfinance institutions and provide a buffer that enhances financial resilience across the sector.

²⁵ Adapted from D. Murphy and W. Nolens, “Ending the vicious circle in PAYGo solar: How companies and investors can move the sector toward PAYGo 2.0”, Sun Connect News, 22 April 2025.

²⁶ ESMAP, Off-Grid Solar Market Trends Report 2024: Outlook, p. 48.

Mobisol and the potential for insurance to strengthen financial resilience

Box 2

The insolvency and restructuring of Mobisol, an off-grid solar energy company, illustrate the financial risks faced by DRE companies when end user payment defaults and external shocks disrupt revenue stability. While the company successfully provided solar electricity to 600,000 people in rural Africa, its long-term viability was undermined by inconsistent repayment rates, economic downturns and external shocks, including severe drought in Kenya, one of the company's biggest markets.²⁷

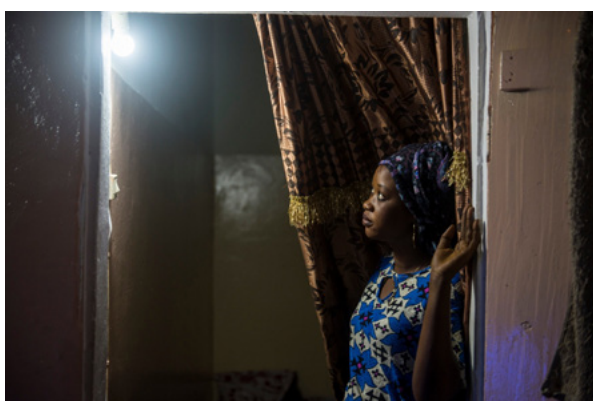
The absence of effective financial safeguards, such as credit-linked insurance, may have contributed to the company's vulnerability to these disruptions. Credit-linked insurance could have mitigated the impact of widespread customer defaults by stabilizing revenue streams and reducing financial uncertainty, while business interruption insurance could have provided financial protection against unexpected disruptions. By addressing these risks at a portfolio level, insurance solutions would have enhanced financial predictability, allowing the company to maintain operations and service obligations despite external pressures.

Asset insurance is another potential application in the sector, addressing hardware risks such as equipment quality, performance issues or damage during transit, installation or routine use. This form of insurance ensures financial recovery for DRE companies, preventing losses due to equipment malfunctions, and protects end users in case of potential damage. Similarly, warranty and service risks, including costs associated with product maintenance or replacement, could be

mitigated through extended warranty insurance or maintenance contracts. These measures can complement existing efforts by DRE companies to ensure product quality and reliability, such as offering service guarantees to retain customers.

Asset insurance can also extend to productive-use appliances like irrigation pumps, refrigerators and milling machines, which are critical for agriculture, small businesses and essential services. These protections benefit both providers and end users by safeguarding investments, supporting customer retention and ensuring reliable energy demand. These solutions help stabilize revenues and lay the groundwork for broader insurance offerings.

Mini-grid developers can benefit from insurance solutions throughout both construction and operational phases. During construction, policies similar to construction all-risk insurance can protect against financial losses due to delays,



*While Senegal has one of the highest electrification rates in West Africa, significant disparities remain among households.
Photo: UNDP Senegal*

²⁷ R. Goodier, "What went wrong with Mobisol? Lessons from a rural solar energy enterprise's insolvency", NextBillion, 4 October 2019.



With access to electricity, a woman in rural Nigeria is able to keep the produce fresh in a small fridge, enabling her to store it for longer.

weather events or supply chain disruptions. While engineering, procurement and construction (EPC) contracts typically include warranties, stand-alone insurance can fill coverage gaps that fall outside the contractor's liability.

Once operational, insurance options resemble those used in the utility and telecommunications sectors. Coverage can include equipment failure, theft, business interruption and third-party liability. Operational insurance for mini-grids would function similarly to power plant insurance, covering ongoing maintenance costs and system breakdowns. In remote areas, where theft and vandalism are

common, lessons from the telecommunications sector can inform insurance practices to safeguard physical infrastructure.

Digital risks also warrant consideration. Vulnerabilities in mobile payment systems or customer data security may expose DRE companies to cyber risks. In cases where these risks are material, cyber insurance could be explored. However, many of these threats may be better addressed through operational improvements and strengthened data protection protocols. Insurance should be considered only where it offers a clear and cost-effective complement to existing risk management strategies.

Summary: DRE companies

DRE companies are central to expanding energy access in underserved markets but face a complex mix of operational, financial and credit-related risks. Their business models vary widely, from vertically integrated solar firms to rental-based or PAYGo providers, each with unique risk exposures across the value chain. Insurance has a clear role in protecting physical assets, stabilizing cash flows and managing customer repayment risk – especially where weak credit screening and rising non-performing loans have undercut liquidity and affordability. However, insurance must be paired with sound lending practices, after-sales service and strategic use of company data. By leveraging their position as trusted intermediaries and tapping into smart metering and mobile payment platforms, DRE companies can help design, distribute and support insurance solutions that enhance resilience both for them and for their customers. Success will depend on aligning incentives, maintaining affordability and ensuring operational risks are managed alongside insurance uptake.

2.3 Financiers

Financiers provide the capital that enables the development, operation and expansion of the DRE sector. This includes both equity investors, such as venture capital funds, and lenders offering debt instruments. These categories often overlap, as some

investors participate across both equity and debt markets. Regardless of the financing structure, all financiers have a shared interest in identifying and managing the specific risks tied to DRE investments.



Key risks for financiers

For financiers, the central concern is whether investments will deliver the expected return relative to the risk taken. Many of these risks are not directly insurable but can be partially mitigated through insurance or managed through other financial instruments and de-risking tools. Table 3 outlines the key risks faced by financiers and highlights where insurance solutions may be applicable or complementary.

Table 3: Key risks directly addressable through insurance (financiers)

Category	Risk type	Description	Insurance or other de-risking measure
Risks directly addressable through insurance	Credit default risk	Risk of DRE companies or end users defaulting on loans due to fluctuating incomes, currency depreciation or weak credit profiles.	Credit insurance to protect borrower defaults and enable better credit terms for DRE companies and end users.
	Operational risk	Risk that operational challenges within DRE companies could affect their ability to generate revenue or manage costs and meet financial obligations to financiers.	Performance guarantees or operational risk insurance to protect financiers from revenue losses due to operational failures.
	Sovereign risk	Political instability or weak governance in target markets.	Political risk insurance to protect investments against expropriation, political violence or breach of contract.

The risks in table 3 overlap with those faced by DRE companies and end users, reflecting the interconnected nature of the value chain. Financiers' financial stability depends on the performance of DRE companies, which in turn depends on the financial resilience of the end users they serve. Consequently, risks tend to cascade across all stakeholder groups. Insurance solutions can therefore be strategically deployed at multiple points along the chain to address shared risks, whether at the end user level, the DRE company level or the financier level.

Some risks are specific to financiers, particularly due to the markets in which DRE investments are concentrated. While these risks are material, they are generally considered to be outside the scope of traditional insurance and are not covered in detail in this report. Instead, they are typically managed through guarantees, financial instruments or risk-sharing arrangements. Investing in emerging and frontier markets exposes capital to political instability, regulatory uncertainty, governance risks and currency volatility. Currency and inflation risks are especially important. Foreign exchange risk arises when a company earns revenue in local currency but holds financial obligations in a foreign currency. Currency convertibility risk refers to the difficulty of repatriating funds due to capital controls or restricted access to hard currency in the local market.

In addition, high transaction costs are a structural feature of investing in fragmented and underdeveloped markets. For the DRE sector, reaching remote customer segments brings added expenses such as infrastructure build-out, last-mile distribution and ongoing servicing. These factors increase operating costs and, given limited end user affordability, can erode margins and delay returns. Financiers must factor in these risks when structuring investments and assessing long-term viability.

Approach to risk management

As entities operating in banking, lending and private capital markets, these stakeholders naturally gravitate toward risk-sharing mechanisms commonly used in their fields:

- **Partial credit guarantees** (PCGs) are a key mechanism often provided by development finance institutions, multilateral development banks (MDBs) or government-backed entities. PCGs offer financial protection against default risks, functioning similarly to insurance by ensuring that financiers recover a portion of their losses in cases of project failure or significant financial setbacks.
- **First-loss capital**, provided by impact investors or philanthropic entities, serves as a protective buffer, absorbing initial losses before senior investors are affected. This improves the risk-return profile of a project and can attract additional private capital.

In high-risk markets, these instruments are particularly valuable, providing financial stability for mini-grid developers and encouraging private investment where traditional market players are hesitant.²⁸ Similar benefits could apply to other segments of the DRE sector. Although other tools like credit default swaps exist in developed markets, they may be impractical in emerging economies with underdeveloped financial markets, due to the lack of historical loss data and the challenge of pricing such products affordably.

28 iGravity, "Engaging with investors to build financial resilience of smallholder farmers and value chains through agriculture insurance: Intermediary report", unpublished, 2025.

Insurance applicability

Although financiers, particularly those in funds or bond structures, are not typically involved in designing or deciding on end user insurance products, they still benefit indirectly from the use of such insurance across the value chain. When lenders directly finance micro-, small and medium-sized enterprises (MSMEs) such as DRE companies, insurance becomes more relevant to their investment strategy. In these cases, insurance for physical assets and operational disruptions is more commonly considered to protect both the enterprise and the investor's returns. However, lenders generally prioritize risk protection at their level through mechanisms such as PCGs, first-loss capital or other structured protections that fall outside the scope of this report.

Political risk insurance can help manage exposure in unstable regions, but its value proposition relative to PCGs and other guarantees depends on cost efficiency and coverage scope. Guarantees, particularly those provided by MDBs and development finance institutions (DFIs), are typically cheaper in

terms of up-front costs and are already widely utilized in high-risk markets. Nonetheless, insurance can offer broader coverage beyond political risks and can help reduce capital provisioning requirements for lenders, potentially complementing existing guarantee structures rather than replacing them.



Training session with UNDP staff on solar system installation, Nouakchott, Mauritania. Photo: UNDP Mauritania

Aligning these risk transfer tools effectively can enhance investor confidence and improve capital deployment efficiency in the DRE sector.

Summary: Financiers

Financiers are essential to scaling the DRE sector, yet their risk exposure is deeply tied to the performance of both DRE companies and end users. Many of their risks cascade across the value chain, including credit defaults, operational disruptions and political instability. While some of these can be addressed through insurance, others are better managed via partial credit guarantees, first-loss capital or other structured risk-sharing tools. Political risk insurance may complement these instruments but must be weighed against cost and coverage scope. In practice, most financiers are not directly involved in insurance design but stand to benefit when insurance stabilizes the sectors in which they invest. Asset and credit insurance for DRE companies, for instance, can improve repayment reliability and enhance the risk profile of financed projects. Aligning these tools thoughtfully can improve capital efficiency and attract private investment, especially in underserved and high-risk markets.

2.4 Insurance companies²⁹

Insurance has the potential to protect individuals while supporting the resilience of the broader energy value chain. However, in many energy access markets, insurance adoption is limited by low awareness, affordability challenges and weak financial infrastructure. These conditions make it difficult for insurers to justify product development unless there is a clear path to scale and commercial return.

Scale is one of the biggest challenges. Insurance depends on large and diverse risk pools, which are often lacking in rural or underserved areas. Reaching remote customers, overcoming digital and financial literacy gaps and managing distribution costs all add complexity. Despite these obstacles, insurers may find strategic value in entering these markets by accessing new customer segments, bundling products and building long-term market presence.



With access to electricity, small businesses can operate for longer hours, while expanding services. Photo: Obgu Eda Community, Nigeria

²⁹ This section focuses on insurers as providers of risk transfer solutions and the factors that shape their participation in the energy access sector. Rather than exploring risks faced by insurers themselves, the emphasis is on market feasibility, product design, operational barriers and financial viability.

Working through energy companies rather than selling directly to households can help overcome some of these challenges. In this model, the energy company manages customer interactions and shares part of the risk, making adoption easier and reducing the insurer's exposure to hard-to-reach end users. Annex B outlines key risk factors insurers consider, although additional risks may apply depending on the market.

A lack of reliable data remains a major barrier. Without accurate information, insurers may resort to broad assumptions that result in mispricing. New technologies are helping close this gap by enabling real-time data collection and more accurate risk assessment. These tools support dynamic pricing and improve product affordability, and can also incentivize proactive risk reduction, such as climate adaptation or better energy management practices (see box 3).

Insurance for e-motorbike riders in Rwanda

Box 3

In Rwanda, Bboxx, a data-driven platform providing clean energy, cooking and mobility solutions, has expanded its insurance offerings to support the transition from traditional petrol-powered motorbikes to electric vehicles (EVs). In partnership with microinsurer RADIANT YACU, Bboxx provides affordable insurance coverage to 130,000 electric motorbike riders, a significant step towards sustainable transportation. This programme provides financial security to riders during their transition to electric mobility.

The insurance product protects against material damage, fire, third-party liabilities, life insurance and total permanent disability. The innovative insurance model, backed by data-driven insights from Bboxx's platform, allows for premiums that are 40 percent lower than the average market rate.

Bboxx uses its platform to monitor data from electric vehicles, enabling more accurate risk assessments and allowing it to adjust insurance premiums when needed. This technology-driven approach not only makes insurance affordable for riders but also ensures that they are financially protected against risks associated with their switch to electric vehicles.

Source: Bboxx, "Bboxx and RADIANT YACU partnership accelerates EV transition for 130,000 motorbike riders with affordable insurance", 17 December 2024. Available at <https://www.bboxx.com/news/bboxx-and-radiant-yacu-partnership-accelerates-ev-transition-for-130-000-motorbike-riders-with-affordable-insurance/>.

Key enablers:

- Data collection and analysis facilitates accurate risk assessment and more affordable premium pricing. This data-driven approach enhances the customer experience while ensuring affordability.
- Real-time data allows for dynamic adjustment of premiums based on risk factors, ensuring that insurance remains affordable for riders while providing financial protection against accidents and injuries.
- Mobile platforms ensure the insurance is easily accessible to riders, particularly in rural areas. This reduces barriers to entry and allows riders to access insurance protection with ease.

There is growing interest in bundling insurance products with off-grid energy solutions (box 4), leveraging complementary functions such as existing payment methods (for example, PAYGo models), which insurers

can link to their product offering. These bundled offerings align insurance with the realities of rural and low-income populations, enhancing accessibility and value and reducing operational costs and risks.

Bundled insurance for solar customers in Nigeria

Box 4

In Nigeria, Bboxx, a data-driven platform providing clean energy, cooking and mobility solutions, has partnered with Turaco, an African insurtech company, to offer a life and health (L&H) insurance package to customers purchasing SHSs. Nigeria's limited access to affordable insurance products, particularly in rural areas, creates significant challenges related to financial shocks. Health crises, disabilities or accidents can push vulnerable households into debt and potentially cause them to lose access to vital services like solar power. To address these challenges, Bboxx bundled affordable health insurance with its solar products, ensuring customers are protected against unexpected health emergencies.

The insurance covers hospitalization, total permanent disability and death, providing a financial safety net for customers facing health crises. Underwritten by Leadway Assurance Company Limited, the policy is offered at an affordable premium of less than \$1.30 (₦2,000) per month. By offering this coverage, Bboxx ensures that customers can continue making payments for their SHSs even if they face unexpected medical challenges.

The insurance product is bundled directly into Bboxx's SHS offerings, available through their PAYGo model. The claims process is fully digitized, allowing for easy claim filing via mobile platforms like WhatsApp or by phone. Claims are processed rapidly, typically within three days, ensuring timely support for customers when they need it most.

Source: Bboxx, "Bboxx partners with Turaco in Nigeria to improve the financial resiliency of their customers through insurance provision", 22 December 2023. Available at <https://www.bboxx.com/local-news/bboxx-partners-with-turaco-in-nigeria-to-improve-the-financial-resiliency-of-their-customers-through-insurance-provision/>.

Key enablers:

- Bundling insurance with solar home systems ensures continued access to solar energy services, even during personal health crises. This integration provides a comprehensive solution that addresses both energy access and financial security.
- Cross-sector partnerships can create innovative solutions to enhance financial resilience for customers, particularly in vulnerable communities.
- Affordable and reflective pricing models must be tailored to customer realities. The L&H insurance package is affordable for low-income customers, ensuring that the product remains accessible without sacrificing necessary coverage for hospitalization, disability and death.
- The insurance product benefits from a fully digitized claims process, which allows for easy claims submission through mobile platforms, improving accessibility and reducing administrative costs.

Respective roles of insurers and reinsurers

Insurers and reinsurers play distinct but complementary roles in the DRE insurance value chain. Insurers underwrite policies, manage claims through distribution partners and provide cover to beneficiaries, which may include end users, DRE companies or financiers. Reinsurers support insurers by absorbing part of the risk associated with larger or more volatile portfolios. This added capacity enables insurers to expand their offerings in high-risk or underserved markets.

Reinsurers are especially important in areas such as climate risk, where local insurers may not have the capacity to absorb losses from extreme weather events. In addition to financial support, reinsurers often contribute technical expertise and share lessons from successful programmes in other regions, helping tailor products to the specific needs of the DRE sector.

The role of reinsurers in the DRE insurance ecosystem can be broken down into five key areas:



1. Risk-sharing

Reinsurers provide insurance companies with the opportunity to share and diversify their underwriting risks, allowing them to underwrite larger policies and take on more significant risks without overexposing themselves financially. In the context of energy access, these risks may include:

- **Climate-related risks** (e.g., extreme weather events like floods or droughts that could damage assets), which can both damage physical assets and reduce customers' ability to make payments.
- **Payment default risks** (e.g., when end users, particularly smallholder farmers or rural communities, fail to pay for energy services due to unforeseen circumstances) for larger DRE companies.

By taking on a portion of these risks, reinsurers enable insurers to cover larger and more complex energy access projects, such as mini-grids, which often involve considerable up-front investment and long-term financial commitments.



2. Product innovation and development

Reinsurers often have experience in developing innovative insurance products for high-risk markets. They support insurers by sharing global insights from successful programmes, particularly in markets with similar risk profiles or in other renewable energy sectors. Reinsurers assist in designing tailored products that meet the specific needs of the DRE sector, such as:

- **Index insurance:** This type of insurance pays out based on predefined parameters (e.g., rainfall levels, wind speeds, expected yield) rather than actual losses, which is particularly useful for addressing climate risks in rural or agricultural communities.
- **Portfolio insurance:** Reinsurers can help insurers offer portfolio-based coverage to DRE operators or developers that spreads risk across multiple mini-grids or systems, increasing the likelihood of financial sustainability even if some systems face disruptions.



3. Financial stability and sustainability

The energy access sector is often volatile and capital-intensive, especially in remote and off-grid markets where the risks are higher and data may be sparse. Reinsurers can play an important role in providing risk capacity to insurance companies, allowing them to manage exposure to large claims and remain solvent in the event of high-loss events.



4. Risk modelling and knowledge-sharing

Reinsurers often have access to advanced risk modelling tools and global data, which enable insurers to more accurately assess and price the risks associated with the DRE sector. This is particularly important in this context, where the risks may be geographically dispersed over a wide area and difficult to assess through on-the-ground assessment. Reinsurers' extensive experience with climate modelling and catastrophe modelling can also improve the accuracy and efficacy of insurance products for natural hazards and systemic risks.



5. Market expansion and scalability

The involvement of reinsurers enables insurers to expand into new markets by providing them with the financial backing to support projects in high-risk areas. In emerging markets, where demand for DRE is growing, reinsurers can help mitigate the barriers to entry for insurers, who may otherwise be hesitant to offer products in regions with limited insurance penetration. This can be particularly important for scaling mini-grids, SHSs or other DRE solutions in rural and remote communities.

Summary: Insurers

Insurers and reinsurers are critical enablers in scaling insurance solutions for the DRE sector. Insurers manage policy design, underwriting and claims, while reinsurers provide the financial capacity and technical expertise needed to support large, volatile or climate-exposed portfolios. However, product development in low-income and off-grid markets remains challenging due to affordability constraints, distribution hurdles and lack of reliable data. Working through energy providers, rather than direct-to-household channels, offers a practical path to scale by bundling insurance into existing PAYGo or equipment financing models. Reinsurers also play a pivotal role in innovation, supporting index insurance, portfolio risk pooling and better climate risk modelling. Case studies from Rwanda and Nigeria demonstrate the growing viability of bundled, tech-enabled insurance models that use real-time data to lower costs and improve access. Ultimately, insurers and reinsurers that engage strategically can unlock new markets while supporting broader financial inclusion and energy resilience goals.



Solar panels installed at an agribusiness in Sri Lanka power a containerized cold storage room. Photo: UNDP Sri Lanka

2.5 Governments

Governments are central to setting policies, providing financial backing, boosting capacity, encouraging innovation and carrying out strategic planning. Government interventions can significantly influence the adoption of insurance solutions in DRE sectors.

These interventions, outlined in table 4, address financial, operational and regulatory challenges while promoting different ways for risk and innovation to be allocated to the most appropriate actors.



Key government interventions

Table 4: Key areas of government interventions supporting insurance uptake in DRE sectors

Mechanism	Measure	Intervention
Financial instruments and assistance	Premium subsidies	Subsidize insurance premiums (e.g., for health, crop or credit risk) to increase affordability and uptake among low-income households and rural DRE users.
	Guarantees and risk-sharing instruments	Use partial credit guarantees or contingent financing to support insurers or aggregators and reduce their exposure to systemic or correlated risks.
	Contingency funds and co-financing	Establish public disaster funds or co-finance pilot insurance schemes to underwrite early-stage risks and catalyse private insurance provision.
	Tax exemptions	Tax incentives (e.g., value added tax exemptions or deductions) can lower the cost of DRE technologies or bundled insurance products, improving affordability for end users and enhancing the viability of insurance schemes targeting energy access and climate resilience.
Partnerships	Public-private partnerships for insurance delivery	Facilitate partnerships between insurers, DRE companies and government to design and distribute bundled insurance products linked to energy access.
	Aggregator engagement	Support aggregators (e.g., cooperatives, DRE providers) to serve as intermediaries in risk pooling and policyholder enrolment, reducing distribution costs for insurers.
Regulation	Insurance-enabling policy frameworks	Develop regulations that enable microinsurance products, index-based designs and inclusive insurance models relevant to the DRE context.
	Mandated or bundled coverage policies	Introduce policies that require or encourage insurance bundling with energy finance schemes or create incentives for covering underserved groups.
Education and Awareness	Insurance literacy campaigns	Promote financial and insurance literacy among target populations to build trust and understanding of coverage benefits and claims processes.
	Institutional capacity-building	Support capacity development for local insurers, regulators and aggregators to improve underwriting, claims management and product innovation.
Data	Risk data and modelling	Invest in weather stations, satellite monitoring and open risk data sets to improve insurance product design and trigger calibration.
	Public-private data-sharing initiatives	Encourage partnerships for data-sharing between insurers, government and DRE providers to enhance pricing accuracy and risk segmentation.

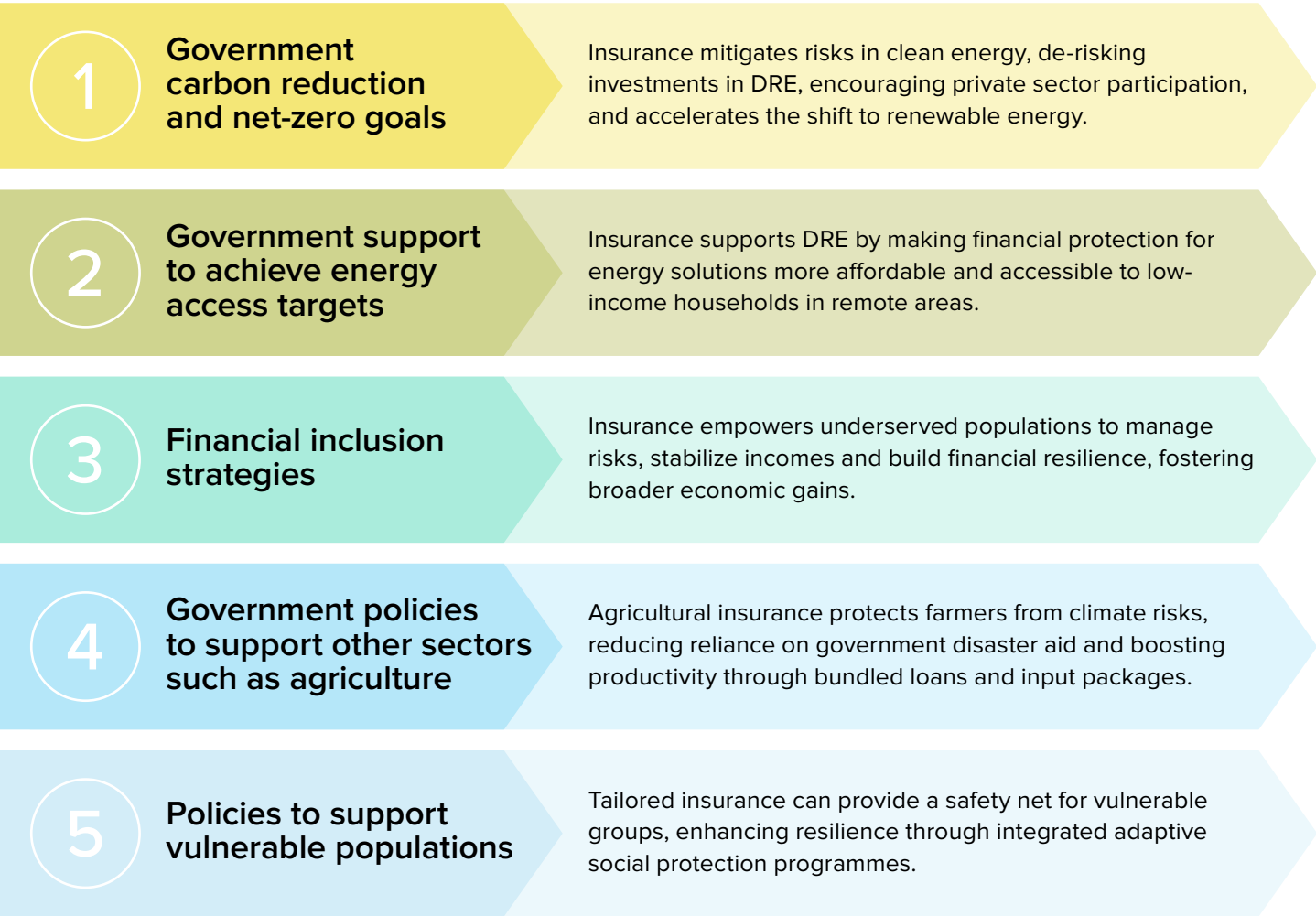
Linking insurance to government priorities

Integrating insurance solutions into national development strategies can help governments advance a range of environmental, social and economic objectives (figure 1). Insurance can support efforts to expand energy access, reduce carbon emissions, promote financial inclusion and protect vulnerable populations. A well-insured economy fosters consumer confidence, attracts private investment and strengthens overall resilience. Collaboration between insurers and DRE providers can also drive innovation and deliver co-benefits that align with government priorities.



With a capacity to store up to 5,000 kg of vegetables, this solar-powered containerized cold room helps buy, store and sell the local vegetable production. Photo: UNDP Sri Lanka

Figure 1: Insurance as a cross-cutting solution to achieve government priorities





A smallholder farmer in Myanmar working on his land. Photo: UNDP Myanmar

Public-private partnerships and enabling environment

Governments can unlock the potential of public-private partnerships (PPPs) to scale insurance products, reduce systemic risks and deliver long-term social and economic benefits.³⁰ In a true PPP arrangement, governments can share underwriting or premium risks with insurers. This may include backing a national insurance programme with public guarantees or subsidizing part of the premium to improve affordability for target beneficiaries. These mechanisms enable private insurers to enter markets that might otherwise be unviable or too risky, while aligning with broader policy goals.

In addition to formal PPP structures, governments can also create an enabling environment for insurance. This includes developing robust legal and regulatory frameworks that offer stability and flexibility as programmes evolve, and supporting awareness

campaigns or financial literacy initiatives to build trust and improve uptake. Capacity-building within public institutions, particularly at the local level, is also important to ensure effective oversight and long-term programme sustainability.

Regulation

Regulatory frameworks can support affordable and accessible insurance products, ensuring that providers can operate in challenging markets. Governments play a pivotal role in ensuring regulatory stability, which is necessary for private investment in insurance-backed financial solutions. Governments may establish clear policies mandating insurance for key assets or providing incentives for bundled products that combine DRE with insurance coverage. Such policies encourage private sector participation and innovation while protecting consumers through fair and transparent practices. By establishing clear regulatory frameworks, governments can help manage risks, protect individuals and drive desired behaviours within the insurance market.

³⁰ M. Solana, [“Making public-private partnerships work in insurance”](#) (Geneva, ILO Impact Insurance Facility, 2015).



Key risks for governments

Governments face significant challenges in supporting financial resilience within the DRE sector, particularly in mitigating financial risks associated with climate shocks and infrastructure resilience. A key issue is the failure to effectively incentivize end users to purchase agricultural insurance, which increases the fiscal burden of disaster response and strains public resources. The absence of structured mechanisms for financing energy-related disruptions can force governments to rely on inefficient and ad hoc funding measures, resulting in delayed and inadequate support for affected communities. This lack of resilience can also accelerate rural-urban migration and food

insecurity, creating broader social and economic imbalances that undermine long-term development objectives.³¹ Addressing these challenges requires governments to adopt holistic and sustainable approaches that balance financial protection, economic stability and social equity.

Other political risks may arise from inadequate energy access policies, failing to ensure equitable access to affordable and reliable energy solutions. Governments need to integrate risk financing within broader development frameworks, ensuring that financial protection mechanisms support long-term energy security, economic growth and climate resilience.

Summary: Governments

Governments play a pivotal role in shaping the enabling environment for insurance in the DRE sector. Their interventions span policy, finance, regulation and data, all of which can help reduce costs, unlock private capital and expand coverage. Tools like premium subsidies, credit guarantees and tax incentives can improve affordability and scale, while legal frameworks and PPPs support innovation and risk-sharing. Strategic use of insurance can also help governments achieve broader priorities by shifting disaster costs away from the public budget and toward prearranged mechanisms. However, weak incentives, limited data and fragmented institutional capacity can hinder effectiveness. Integrating insurance into national development strategies – alongside strong public-private collaboration and regulatory clarity – is critical to long-term resilience and equitable energy transition.

31 Chatterjee and Oza, "Agriculture insurance: A risky business".



3. Insurance product design

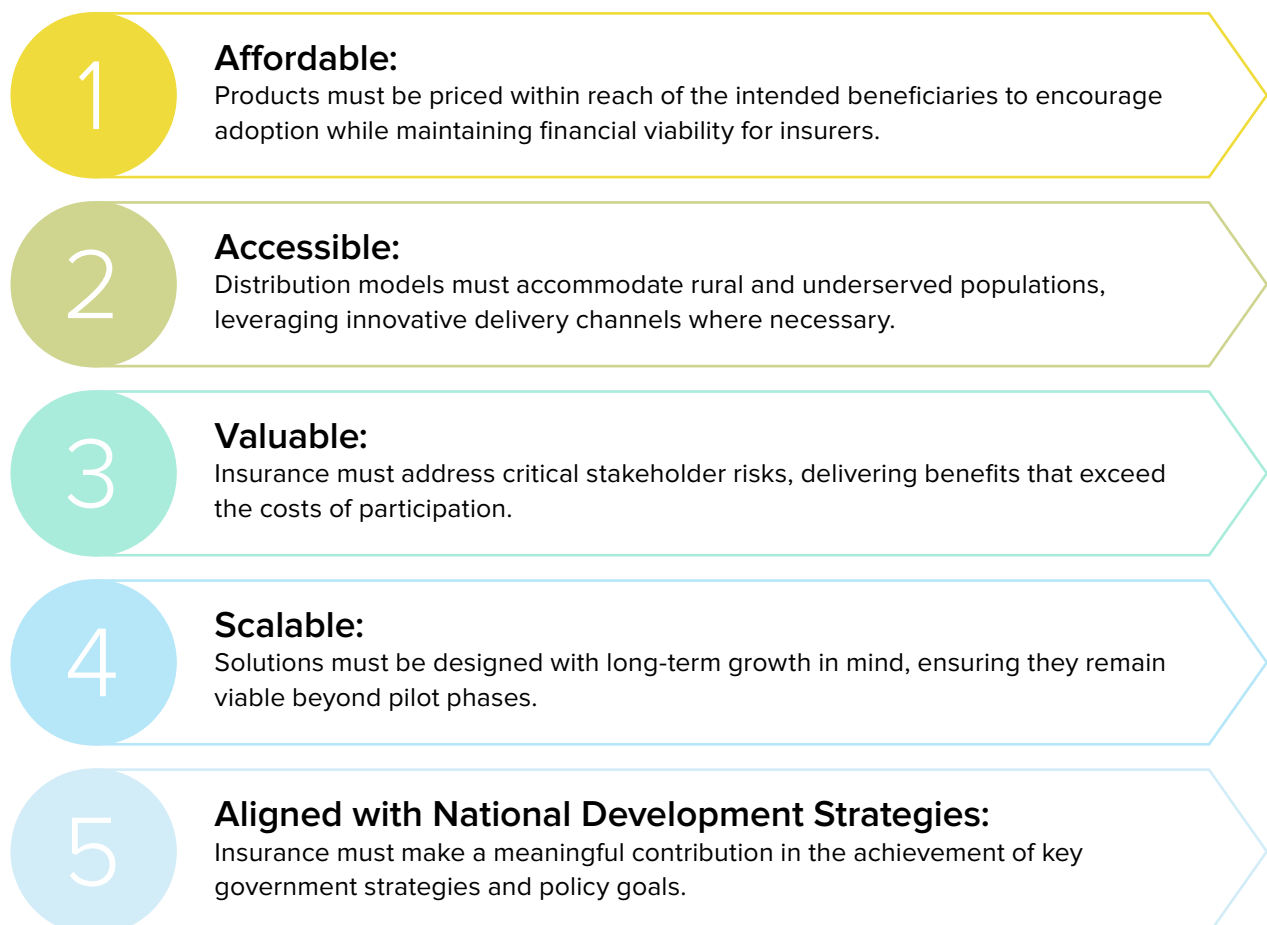
Effective insurance design begins with aligning stakeholder needs and risk profiles to develop practical financial solutions. Insights from the stakeholder risk assessment in section 2 of this report can guide the development of insurance offerings that address real risks, support long-term sustainability and create value across the value chain.

To succeed, insurance products must offer a clear value proposition that builds trust and drives uptake. For policyholders, the value of insurance goes beyond receiving payouts. It includes benefits like improved creditworthiness, access to finance, greater

financial predictability and better decision-making. Insurance also provides peace of mind by protecting against shocks.

To translate this value proposition into effective practice, insurance solutions must be grounded in a clear set of guiding principles. These principles help ensure that products are not only technically sound but also accessible, scalable and aligned with the needs of stakeholders in the DRE and small-scale agriculture sectors. The methodology applied here is framed around five key principles, as outlined in figure 2:

Figure 2: Core insurance design principles



In this section, each of these principles is considered alongside the conceptual design of insurance products before evaluating the feasibility of each

design and assessing their alignment with market conditions, stakeholder capacities and the broader financial ecosystem.



UNDP visit to an Africa Minigrids Program project site in Nigeria.

3.1 Methodology

A structured methodology is used to evaluate potential insurance products, ensuring each design is fit for purpose and aligned with the needs of key stakeholders. The goal is to provide concrete examples of how insurance can be applied to address specific challenges within the DRE value chain. Each product is assessed based on its ability to address key demand-side risks, as well as the operational, financial, regulatory and contextual considerations relevant to insurers. Supply-side risks that are common across most insurance products – such as pricing, profitability and reputational risk – are not repeated for each case.

Each product is assessed against the five core design principles, and any remaining barriers are identified to highlight where further intervention may be needed to support uptake and long-term sustainability.

3.2 Insurance product examples

This section explores a range of insurance products designed to address key risks within the DRE sector and includes:

- **End user index insurance:** Provides financial protection to end users against threats such as climate-related risks or pests.
- **Government-administered index insurance:** A public-sector-driven approach to index insurance, where governments act as facilitators or risk carriers to expand coverage and reduce affordability constraints for vulnerable populations.
- **Life and health insurance for households:** Aims to safeguard lower-income households from income shocks caused by illness, disability or loss of life, ensuring financial security in times of crisis.
- **End user credit risk insurance for DRE companies:** Protects DRE providers against revenue losses resulting from customer non-payment, stabilizing cash flow and reducing the risk of loan defaults.
- **Asset protection for SHSs or other related equipment:** Covers the repair or replacement of critical energy equipment, reducing financial strain on businesses and end users in the event of damage or theft.

3.2.1 End user index insurance

The proposed insurance product is designed as a microinsurance solution using an index insurance model (figure 3), in which the end user directly pays the premium and is the sole beneficiary of any payout.³² Index-based insurance can provide payouts based on predetermined triggers, such as rainfall levels or temperature thresholds. Alternatively, area-yield index insurance links payouts to average agricultural output in a defined region, compensating for losses caused by weather events, pests or other systemic shocks. These products offer faster and more objective payouts, reduce administrative costs and improve accessibility for agricultural end users. While affordability depends on the product's structure and purpose, many successful index insurance schemes have been supported by subsidies. Integrating DRE into the distribution channel could lower fixed costs by using existing payment systems and customer networks, improving both reach and affordability.

Reinsurers typically design the index and triggers,³³ while insurers handle underwriting, policyholder management and, depending on the delivery model, some or all aspects of the claims management. This product can be bundled with PAYGo products to offer end users timely support, enabling greater investment in livelihoods and improved financial resilience.

³² This approach differs from government-led models, where part or all of the insurance premium may be subsidized or fully financed by the government. In such models, the government may also act as the contracting party or co-beneficiary, and the financial burden on the end user is significantly reduced to encourage uptake and improve affordability.

³³ Setting predefined thresholds for covered hazards to determine when insurance payouts are activated.

Figure 3: Roles and cash flows by actor for end user index insurance

End users	DRE companies	Investors	Insurers	Governments
Role • Pay premiums to access insurance coverage. • Report claims incidents for payouts. • Utilize payouts to mitigate agricultural losses.	Role • Act as insurance agents. • Embed insurance products into existing service offerings. • Provide capabilities for premium collection and claims facilitation. • Leverage remote sensing technology to reduce basis risk.	Role • Provide financial incentives for product design and scaling. • Share customer data and account information to streamline underwriting. • Integrate insurance with loan offerings to encourage uptake.	Role • Design and underwrite the insurance product. • Collaborate with reinsurers for risk calibration. • Manage claims processes and ensure payout accuracy. • Monitor the programme's performance and risks.	Role • Create regulatory frameworks to support index insurance. • Provide subsidies or financial literacy programmes to increase accessibility. • Promote public awareness to build trust in the product.
Cash-flow profile • Pay premiums through PAYGo or direct payment methods. • Receive payouts when predefined triggers are met.	Cash-flow profile • Collect premiums as a portion of electricity repayments. • Retain a commission for services. • Transfer remaining premium to insurers. • Facilitate claims payouts via PAYGo structures.	Cash-flow profile • Invest in DRE operations and product scaling. • Facilitate capital for operational costs and risk mitigation.	Cash-flow profile • Collect premiums from DRE companies. • Pay claims directly to end users or through DRE companies. • Transfer a portion of premiums to reinsurers.	Cash-flow profile • Offer direct subsidies for premiums where applicable. • Fund education and awareness campaigns to promote product uptake.

In this model, DRE companies act as the main distribution channel, using their existing customer relationships and digital payment systems to bundle insurance with energy services. Building on the PAYGo model, they can introduce additional offerings such as crop or asset insurance alongside solar products. Smart technologies like remote sensing, weather stations and smart meters can improve the accuracy and trustworthiness of insurance products.

Data from these tools can link environmental conditions to changes in energy use or repayment behaviour, strengthening risk assessment. Governments can support data-sharing frameworks to enhance risk measurement and reduce basis risk.³⁴ More accurate payouts improve user trust and increase long-term uptake, ensuring that support reaches those who need it when they need it.

³⁴ Basis risk in index insurance refers to the mismatch between actual losses experienced by a policyholder and the payout triggered by the insurance index.

Area-yield index insurance in Zambia

Box 5

In Zambia, smallholder farmers face significant challenges due to the combined risks of climate change, poor harvests and limited access to reliable energy. These challenges affect both their agricultural productivity and their ability to repay energy-related costs. Pula, an agricultural insurance provider, piloted a PAYGo-linked insurance model with Vitalite, an energy company providing OGS solutions to rural Zambian households during the 2019/2020 season. The aim was to bundle crop insurance with solar energy assets provided on credit, helping to mitigate defaults caused by climate-induced agricultural losses and stabilize energy access for smallholder farmers. The yield-based index insurance was designed to trigger payouts when weather conditions, such as rainfall or temperature, exceeded predefined thresholds, providing smallholder farmers with financial support in times of crop failure.

This insurance model is integrated into Vitalite's existing PAYGo system, where premiums are paid in small, manageable instalments alongside solar system payments, reducing the financial burden on smallholder farmers. This structure ensures accessibility by leveraging mobile payment systems and agent networks, which are already in place for energy distribution. By offering both insurance coverage and a viable way for smallholder farmers to maintain solar energy access, this model aims to break the cycle of financial instability caused by climate risks, while reducing defaults and repossessions for the energy company.

Key stakeholders in this initiative include Pula, the insurtech provider; Vitalite, the solar energy provider; and the smallholder farmers who benefit from the programme. The partnership has yielded positive results, including improved repayment rates, reduced loan defaults and enhanced financial resilience for smallholder farmers. Currently, Pula serves over 4.5 million smallholder farmers with various insurance products, and the area-yield-based index insurance has proved highly popular among smallholder farmers.

Sources: K. Ramakrishnan, "How can insurance unlock smallholder farmers' access to renewable energy?", Power for All, Podcast interview, 14 July 2021. Available at <https://www.powerforall.org/news-media/interviews/interview-kaushik-ramakrishnan-how-can-insurance-unlock-smallholder-smallholder-farmers-access-renewable-energy>; A. Patel, "Agricultural insurance + energy access: An innovative pilot program reveals the value of bundled services – and the need for cross-sector partnerships", NextBillion, 19 October 2023. Available at <https://nextbillion.net/agricultural-insurance-energy-access-innovative-pilot-program-bundled-services-cross-sector-partnerships/>.

Key enablers:

- The integration of insurance with existing credit systems, such as PAYGo for solar equipment, creates a mutually beneficial solution for both farmers and lenders.
- Education and outreach programmes are essential for ensuring that farmers understand the value of insurance and how it helps mitigate risks.
- Collaboration between insurers, energy companies, government agencies and farmers is crucial to building scalable and sustainable models.
- Government subsidies for insurance premiums could improve affordability and encourage broader adoption.



Floating community in Cambodia with on roof solar panels. Photo: UNDP Cambodia

Looking ahead, there is significant potential to scale this model beyond Zambia, with an estimated \$200 million market opportunity for climate-linked insurance and energy access solutions in rural areas. The integration of new technologies, such as satellite data and mobile platforms, could further enhance the reach and impact of these products. However, challenges remain in educating smallholder farmers on the benefits of insurance, improving financial literacy and addressing regulatory and financial barriers that limit the accessibility of these solutions. Policymakers, in collaboration with insurers and energy companies, can play a key role in creating an enabling environment for the widespread adoption of integrated insurance solutions, including through subsidies and targeted policy interventions.

3.2.2 Government-administered index insurance

In this model (figure 4), rather than providing insurance directly to individual smallholder farmers, the government purchases aggregate index insurance on behalf of the smallholder agriculture sector. This type of insurance would act as a mechanism to support

the government's existing or new contingency funds aimed at addressing systemic agricultural risks. By doing so, the insurance could serve as a backstop to the contingency fund, protecting the financial stability of the small-scale agriculture sector in the face of climate-related events such as droughts, floods or excessive rainfall, which have widespread impacts on crop yields and income.

The government would purchase index insurance for smallholder farmers in an aggregate form, with payouts triggered based on predefined parameters such as rainfall, temperature or soil moisture. The insurance would offer payouts to a broad group of smallholder farmers when a specified threshold is exceeded for a select peril. This could be an index insurance model, triggered by specific weather conditions, or an area-yield model, where payouts are linked to overall agricultural output in a given region.

The insurance product would be simple in its design, with a focus on scalability. The government could allocate a portion of the premiums through an existing contingency or disaster relief fund, with a portion of the fund used to finance the premiums for the index insurance. This would open the opportunity for layering risks within the fund, where a portion could be held in reserve and insurance paid out once a certain threshold is breached.

Figure 4: Roles and cash flows by actor for government-administered index insurance

End users	DRE companies	Investors	Insurers	Governments
Role - Participate in government-backed insurance schemes. - Use payouts to stabilize income and maintain operations.	Role - Act as intermediaries in enrolment and claim facilitation. - Provide technical support for remote monitoring.	Role - Provide financial data for underwriting and scaling. - Reduce exposure through government-backed stability measures.	Role - Provide aggregate insurance coverage to the government. - Design scalable, index-based products for broad risk coverage. - Coordinate with reinsurers for high-risk scenarios.	Role - Act as policyholders and administrators of the programme. - Use contingency funds to pay premiums. - Ensure payouts reach affected farmers efficiently.
Cash-flow profile Indirect beneficiaries of government-funded payouts.	Cash-flow profile - Earn agency commissions for claims processing support. - Facilitate payouts to end users via existing payment structures	Cash-flow profile Benefit indirectly from reduced loan default rates and financial stability	Cash-flow profile - Receive premiums from government contingency funds. - Pay claims directly to the government for disbursement.	Cash-flow profile - Allocate funds for premiums and programme administration. - Facilitate payouts to stabilize the agricultural sector.

Government-led agriculture insurance scheme in Uganda

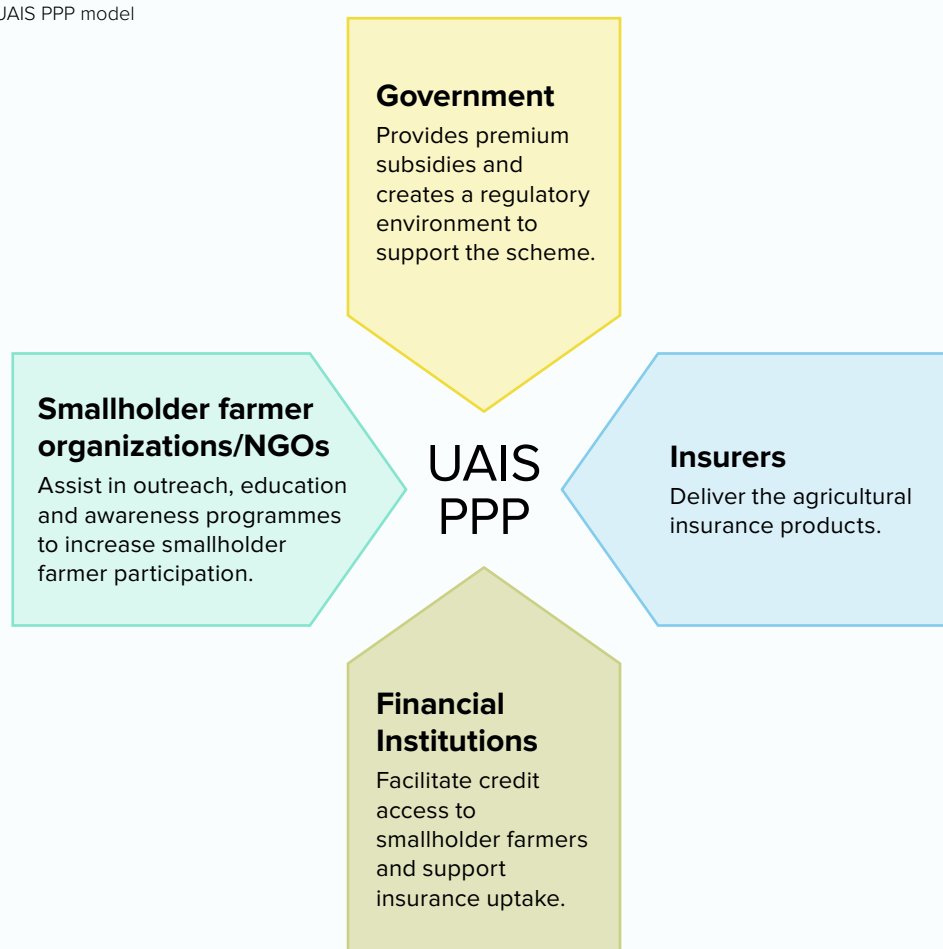
Box 6

The Uganda Agriculture Insurance Scheme (UAIS) is a PPP launched by the Government of Uganda in 2016 to mitigate agricultural risks and support sector growth. It aims to make agricultural insurance more affordable by subsidizing premiums for both small- and large-scale smallholder farmers. The scheme facilitates access to insurance coverage for smallholder farmers facing risks such as drought, pests and diseases, and it encourages commercial banks to lend to the agricultural sector, promoting overall industry development.

UAIS offers several insurance products, including area-yield index insurance, multi-peril crop insurance and weather-based index insurance. The government subsidy helps reduce the financial barrier, making these products more accessible for smallholder farmers. This initiative enables smallholder farmers to manage risks that threaten their agricultural output and livelihoods.

As well as subsidizing premiums, the government plays a central role in UAIS through several functions, including establishing the regulatory framework and providing reinsurance for catastrophic risks. The government also leads public awareness campaigns to inform smallholder farmers about the benefits of agricultural insurance and how to access the scheme.

Figure 5: UAIS PPP model



Government-led agriculture insurance scheme in Uganda

Box 6

As of 2024, the UAIS covers over 160,000 smallholder farmers and significantly reduces financial stress among beneficiaries. The scheme has contributed to income increases for many smallholder farmers, with 59.5 percent reporting higher earnings after enrolling. It has also enabled smallholder farmers to engage in higher-value activities with increased confidence in their ability to manage agricultural risks.

Despite its successes, UAIS faces several key challenges. Limited awareness and understanding of insurance continue to hinder uptake, as many farmers remain unfamiliar with agricultural insurance despite government outreach efforts. Claims settlement issues have also led to dissatisfaction, with delays, insufficient compensation and a lack of transparency in the evaluation process contributing to trust concerns. Additionally, inadequate risk coverage has been noted, with nearly half of beneficiaries believing the existing products do not sufficiently address their needs.

Affordability remains a concern, as the scheme relies on government subsidies to keep premiums accessible, raising questions about long-term sustainability. Low policy renewal rates indicate that once subsidies decrease, many farmers opt out, highlighting the ongoing challenge of making coverage both accessible and financially viable without external support.

Source: Uganda, Insurance Regulatory Authority of Uganda, "Uganda agricultural insurance scheme: Abridged version" (Kampala, 2024). Available at <https://ira.go.ug/wp-content/uploads/2024/04/UAIS-Abridged-Version-February-2024.pdf>.

Key enablers:

- The government's subsidy reduces the financial barrier for smallholder farmers, making insurance affordable, increasing participation and helping smallholder farmers manage risks associated with crop failure and weather-related disruptions.
- The PPP combines government support with private sector expertise in underwriting and claims management, ensuring efficient delivery and sustainability of the scheme.
- Ongoing campaigns and partnerships with smallholder farmer organizations ensure that smallholder farmers understand the benefits of insurance, leading to increased participation and better risk management.
- A network of rural insurance agents, savings and credit cooperatives and financial institutions ensures that insurance products are accessible to smallholder farmers, including those in remote areas.
- Offering a variety of insurance products tailored to different regions and types of farming ensures that smallholder farmers have the right coverage for their specific risks.
- Regular assessments allow for adjustments to the scheme, addressing emerging challenges and improving its effectiveness in meeting the needs of farmers.

3.2.3 Life and health insurance for end users

For end users, L&H risks represent natural barriers to financial stability, regardless of the sector from which they generate an income. Limited access to healthcare services and the financial strain caused by unexpected medical expenses can destabilize livelihoods. If the breadwinner of a family passes away, remaining dependents can be left with immediate expenses (e.g. funeral costs) as well as lost

future income. A combined L&H insurance product addresses both risks, providing comprehensive protection for primary income earners and their families. This product covers essential health services, such as hospitalization, emergency treatment, outpatient care and injury-related medical expenses. It can also provide coverage for disability, ensuring income replacement in cases of long-term impairment, as well as funeral expenses or other financial support to surviving dependents in the event of the death of a covered individual.

Figure 6: Roles and cash flows by actor for L&H insurance

End users	DRE companies	Investors	Insurers	Governments
Role - Enroll in bundled L&H insurance policies. - Utilize benefits to cover medical and funeral expenses.	Role - Bundle insurance with existing SHS offerings. - Facilitate enrolment and claims processing. - Leverage customer networks for product delivery.	Role - Support product scalability through investments. - Monitor risk exposure to ensure sustainability.	Role - Design and underwrite L&H insurance policies. - Oversee claims management processes.	Role - Develop enabling regulations and incentivize participation. - Promote health literacy to increase uptake.
Cash-flow profile - Pay premiums through PAYGo or direct installments. - Receive payouts for health or life-related claims.	Cash-flow profile - Collect premiums alongside SHS repayments. - Retain a commission for facilitation services. - Transfer premiums to insurers.	Cash-flow profile Provide funds to expand product reach.	Cash-flow profile - Collect premiums from DRE companies. - Pay claims directly to healthcare providers or beneficiaries.	Cash-flow profile Fund outreach programmes and offer subsidies where feasible.

By bundling L&H insurance with essential services like credit lines for SHS products, end users gain access to a more comprehensive financial safety net through two main avenues. First, combining L&H insurance reduces the likelihood of end users incurring debt for medical or funeral expenses, allowing them to maintain income-generating activities without disruption.

Second, integrating premium payments into existing PAYGo models enables end users to pay premiums in small, manageable instalments. This approach enhances affordability, especially for those who might otherwise struggle to pay for separate insurance policies.

L&H insurance for PAYGo customers in Kenya

Box 7

In late 2024, SunCulture, a provider of PAYGo agricultural solutions, collaborated with Turaco, a microinsurance company specializing in affordable insurance for underserved populations across Africa, to launch an L&H insurance offering tailored for smallholder farmers using SunCulture's PAYGo devices. This initiative addresses the growing climate-related health risks, with extreme weather events projected to drive millions into financial hardship annually. SunCulture Protect aims to mitigate these shocks, enabling smallholder farmers to continue using their SHS and maintain their livelihoods.

In this arrangement, SunCulture serves as the primary provider of PAYGo solar solutions, improving water access for smallholder farmers and enhancing agricultural productivity. Turaco, as the microinsurance partner, designs and administers the insurance products integrated with SunCulture's solar offerings, ensuring coverage remains both accessible and affordable for farmers.

SunCulture Protect offers L&H coverage to smallholder farmers, providing financial protection for both their agricultural and personal health needs. The product is integrated with SunCulture's PAYGo devices, enabling smallholder farmers to access both energy and insurance without large up-front costs. Premium collection and claims payouts are streamlined through mobile money systems, making the insurance accessible and manageable for smallholder farmers.

One of the challenges identified was the selection of the right insurance products for the market. The decision to focus on L&H coverage was driven by market research suggesting a need to support smallholder farmers during health crises, ensuring they continue to invest in their solar systems without disruption. This product design directly addresses the gap in available coverage and responds to the financial risks faced by the target market.

SunCulture's partnership with Turaco not only helps with financial resilience for smallholder farmers but also strengthens the company's relationship with its customer base, enhancing loyalty and trust. In addition to its benefits for smallholder farmers, SunCulture Protect also provides significant value to improve financing. Funders see promise in this bundled offering, which they consider has the potential to improve repayment rates and increase the financial stability of solar projects. While investors may not always explicitly recognize the link between insurance and improved repayment behaviour, the bundled product is viewed positively as it enhances the overall financial viability of SunCulture's projects.

Sources: AppsAfrica, "SunCulture and Turaco launch SunCulture Protect to build smallholder farmers' resilience against climate change with affordable insurance", 6 December 2024. Available at <https://www.appsafrika.com/sunculture-and-turaco-launch-sunculture-protect/>; T. M. Mutisi, "SunCulture and Turaco launch SunCulture Protect to enhance insurance coverage for smallholder farmers in Kenya", Innovation Village, 11 December 2024. Available at <https://innovation-village.com/sunculture-and-turaco-launch-sunculture-protect-to-enhance-insurance-coverage-for-smallholder-farmers-in-kenya/>; Empower Africa, "SunCulture and Turaco partner to launch initiative to safeguard smallholder farmers from climate risks", 12 December 2024. Available at <https://www.empowerafrica.com/sunculture-and-turaco-partner/>; Insights from stakeholder interview.

Key enablers:

- Insurance should be designed based on thorough market research to ensure it addresses the most pressing risks for the target audience.
- Bundling insurance with solar products through the PAYGo model offers a powerful mechanism to reach underserved populations, improve repayment rates and enhance financial security.
- Mobile technology streamlines claims processing and increases accessibility for rural populations.
- Collaborations between energy providers, insurance companies and stakeholders are needed to scale solutions and ensure long-term sustainability.

3.2.4 End user credit risk insurance for DRE companies

Credit risk, in different forms, is a pervasive issue for all demand-side actors. DRE companies, especially those providing PAYGo solar solutions, offer SHS on credit. These companies are exposed to credit risks when customers fail to repay their loans, often

due to financial hardships and income fluctuations. While the insurance products discussed above can mitigate some of these risks, a certain amount of repayment risk remains. Lenders face the risk of financial losses from the DRE companies they capitalize when loan defaults significantly impact returns. As such, an insurance product design that directly addresses this key risk is likely to be valued by all stakeholders on the demand side.

Figure 7: Roles and cash flows by actor for end user credit risk insurance

End users	DRE companies	Investors	Insurers	Governments
Role • Benefit from continued access to SHS during financial hardships.	Role • Enrol customers in credit insurance schemes. • Manage premium collection and claims processing.	Role • Support the sustainability of DRE companies. • Benefit from reduced credit risk exposure.	Role • Design and underwrite credit risk insurance products. • Manage claims from DRE companies.	Role • Support product uptake through incentives and subsidies. • Develop regulations to ensure fair pricing and access.
Cash-flow profile • Indirect beneficiaries of DRE company protection.	Cash-flow profile • Pay premiums to insurers. • Receive payouts to cover loan defaults.	Cash-flow profile • Allocate funds for product development and scaling.	Cash-flow profile • Receive premiums from DRE companies. • Pay claims for customer defaults.	Cash-flow profile • Fund marketing campaigns and subsidize premiums.

This product could be structured as an all-risk default cover or as a hybrid model combining index triggers with portfolio-level protection against loan defaults, similar to meso-level insurance schemes. It would provide payouts during periods when end users are unable to meet repayment obligations, reducing financial stress on DRE companies and helping them

maintain operations. The all-risk model functions like a partial credit guarantee, while the hybrid version targets correlated risks across the portfolio. In both cases, the insurance supports continued energy access for end users and can be designed to benefit DRE companies, their customers and financiers across the demand-side value chain.

Meso-level insurance – Incofin

Box 8

Incofin, an impact investment firm, launched an insurance initiative designed to address climate-related risks such as droughts and heavy rainfall, which have a significant effect on agricultural productivity. This programme, developed in collaboration with microfinance institutions (MFIs) and insurance companies, uses satellite-based index insurance that triggers payouts based on weather data, including rainfall and temperature, whenever certain thresholds are exceeded. This system ensures financial protection for entire agricultural value chains, such as cooperatives and local agricultural businesses, by pooling risks across groups, which lowers costs and enhances affordability for smallholder farmers.

The initiative incorporates satellite data to monitor weather in real time, enabling automatic payouts when weather conditions meet predefined criteria. This feature removes the delays typically associated with traditional insurance claims processing, improving efficiency. The insurance product is integrated into local financial networks through partnerships with MFIs, which facilitates easy premiums collection and claims payout. The use of satellite technology and mobile platforms removed obstacles so smallholder farmers can quickly access affordable insurance.

The main beneficiaries of this programme are smallholder farmers and agricultural businesses operating in areas that are vulnerable to climate-related events. By protecting against risks like crop failure, the initiative helps stabilize incomes, supports continued agricultural operations and strengthens the financial resilience of agricultural value chains. This model, which focuses on insurance for agricultural groups rather than individual smallholder farmers, is particularly effective in expanding coverage and making insurance more accessible.

Challenges include aligning insurance products with local agricultural practices and understanding the risks of different farming groups. To overcome these issues, Incofin worked closely with local financial institutions and agricultural organizations to tailor insurance offerings. While satellite data provides a more scalable solution than traditional weather stations, the quality and availability of data in some regions remain limited.

Source: iGravity, "Engaging with investors to build financial resilience of smallholder farmers and value chains through agriculture insurance: Intermediary report".

Key enablers:

- Collaborating with MFIs and insurance companies enables the design and implementation of scalable insurance solutions for agricultural value chains.
- Real-time weather monitoring ensures accurate risk assessment and efficient payouts, improving the accessibility and effectiveness of insurance products.
- Partnering with MFIs ensures seamless premium collection and claims disbursement, particularly in rural areas.
- Partnerships with local stakeholders and government bodies have facilitated regulatory support, ensuring the integration of satellite data into the insurance framework.

3.2.5 Asset protection for Solar Home Systems or other related equipment

Asset protection insurance for SHSs or other related equipment could cover loss or damage to essential devices needed for continued energy utilization. This indemnity-style product provides coverage against accidental damage or loss due to

uncontrollable events such as natural hazards. The insurance product could also be extended to cover SHS malfunctions, provided the DRE company has strong control over its supply chain for these systems and can demonstrate confidence in the system's durability and continued use. If the equipment is under warranty, insurance can be added to extend the warranty period, offering additional coverage and prolonging the commitment to continued use by end users.

Figure 8: Roles and cash flows by actor for asset protection for SHSs or other related equipment

End users	DRE companies	Investors	Insurers	Governments
Role • Purchase bundled insurance for SHS and productive equipment. • Utilize payouts to replace or repair damaged assets.	Role • Bundle asset protection insurance with equipment financing. • Handle premium collection and claims processing.	Role • Provide funds to scale insurance offerings. • Reduce exposure to asset-related risks.	Role • Design and underwrite asset protection policies. • Reinsure large risks associated with natural hazards. • Manage claims processes and ensure timely payouts.	Role • Promote awareness of asset protection insurance. • Ensure an enabling regulatory environment for insurers and reinsurers.
Cash-flow profile • Pay premiums through PAYGo or other financing models. • Receive payouts for covered losses.	Cash-flow profile • Collect premiums as part of PAYGo installments. • Transfer premiums to insurers after deducting commissions.	Cash-flow profile • Facilitate investment for scaling insurance programmes.	Cash-flow profile • Collect premiums from DRE companies. • Pay claims for covered asset losses.	Cash-flow profile • Provide financial support for public awareness campaigns.

This product could be bundled with equipment loans or PAYGo plans, with premiums paid in instalments to ease the financial burden on end users. By covering the cost of damaged or lost equipment, it supports affordability and encourages broader adoption of SHSs and other energy technologies. The model is flexible and can be applied to a range of use cases. For example, asset insurance can help maintain payment continuity for urban customers buying smartphones or protect agricultural equipment like solar-powered irrigation systems and cold storage units, helping to stabilize both household productivity and DRE company revenues.



*A man displays his produce in a rural community.
Photo: UNDP Nigeria*

3.3 Initial feasibility assessment

An initial feasibility assessment of the proposed insurance products can evaluate their alignment with key design principles and consider the next steps required to move from concept to implementation.³⁵ The purpose of this section is to assess how well each product addresses the essential criteria for a successful insurance offering. The section also identifies potential gaps or limitations in product design and highlights areas where further research may be necessary. Through this process, stakeholders can more clearly understand each product's potential for long-term success in practice and the necessary steps to ensure products are both effective and sustainable.

3.3.1 Alignment to core insurance design principles

The scorecard approach evaluates how well each insurance product aligns with the five core design principles.³⁶ This section provides a structured assessment framework to help stakeholders understand the relative strengths and weaknesses of each product, ensuring informed decision-making on product viability and areas for improvement. Table 5 summarizes each product's performance against the principles from the end user's perspective, using a simple grading scale: Meets, Partially meets or Does not meet. While the ratings are subjective and context-specific, they highlight areas where products perform well and where improvements are needed, guiding future refinements.

³⁵ While other product concepts were considered, initial analysis suggested the need for more detailed assessments before moving forward with these specific product designs.

³⁶ Alternative frameworks may offer complementary perspectives for evaluating these products. The five design principles used here were selected for their specific relevance to inclusive insurance products in emerging markets.

Table 5: Product scorecard across core design principles

Insurance product	Affordable	Accessible	Valuable ³⁷	Scalable	Aligned with National Development Strategies
End user index insurance	✓✓	✓✓	✓	✓✓	✓
Government-administered index insurance	✓✓	✓✓	✓✓	✓✓	✓✓
Life and health insurance for end users	✓	✓✓	✓✓	✓	✓
End user credit risk insurance for DRE Companies	✓	✓✓	✓✓	✓✓	X
Asset protection for SHSs or other related equipment	✓	✓	✓	✓✓	X

Indicators: Meets (✓✓); Partially meets (✓); and Does not meet (X)



Women in a farm in Nigeria winnowing the grains.

While each product shows high-level potential, a closer look at the details (see Annex C) highlights areas where further action is needed for effective implementation. These gaps can be addressed through targeted support, strategic partnerships or by building an enabling ecosystem of actors. Residual implementation risks will remain, and success will depend on more than just alignment with core design principles. Practical factors such as delivery capacity, coordination and ongoing support must also be considered to ensure long-term viability.

³⁷ Value is considered in the context of the insured party: i.e., the beneficiary of any payout and financial protection.



An installation in Zimbabwe as part of UNDP's Solar for Health programme.

Affordability

Affordability depends not only on premium levels but also on how those premiums are structured. For targeted or small-scale insurance products, distribution costs can be disproportionately high due to the effort required to reach dispersed or specialized customer segments. Insurers may also use lower coverage limits or co-payments to keep premiums manageable. At the same time, premiums must cover operational and reinsurance costs while remaining accessible to low-income users. Integrating DRE companies into the distribution network helps lower costs by leveraging existing payment systems and customer relationships, but affordability also hinges on risk levels, product design and the availability of subsidies.

Each product meets the affordability principle to varying degrees. For example, end user index insurance achieves low premiums by limiting payouts, though this may reduce its effectiveness in severe loss events. Government-administered index insurance benefits from direct public support, which

helps keep premiums low without compromising financial sustainability. In contrast, products like L&H insurance may remain out of reach for many users due to the underlying cost of healthcare, even when bundled with PAYGo. Similarly, affordability challenges exist for end user credit risk insurance for DRE companies and asset protection for SHSs, both of which must balance pricing with high default or claims risk in rural markets.

Accessibility

This largely depends on both the distribution model and the familiarity with the systems and processes to be followed to purchase the insurance. Often, extending insurance into remote locations means overcoming substantial barriers such as limited access and physical presence of financial institutions. DRE companies play a vital role in reaching underserved populations, as they already have a robust distribution network for their solar

systems. Products like end user index insurance and end user credit risk insurance for DRE companies leverage these existing networks, enhancing their accessibility through mobile payment systems and agent networks. However, issues like low financial literacy and lack of awareness about insurance may remain key challenges. While government-administered index insurance benefits from the broad reach of the government, asset protection for SHSs or other related equipment may face accessibility challenges if its uptake is limited to specific market segments or linked to particular equipment where underwriting information is low.



AMP minigrid project site in Mauritania. Photo: UNDP Mauritania

Value

The value of an insurance product depends on how well it addresses the specific risks faced by the purchaser. End user index insurance offers partial protection by covering climate-related risks, but its usefulness is limited when losses fall outside predefined triggers and are caused for example by issues such as pest outbreaks or price shocks. In contrast, L&H insurance provides more comprehensive support for smallholder farmers and their families, though its value depends on whether the benefits meaningfully offset the cost and match the financial vulnerabilities of the target group. Government-administered index insurance adds value by covering systemic risks at scale, with the flexibility to design multi-peril coverage and layer residual risks through other public mechanisms.

Products targeting DRE companies, such as end user credit risk insurance, offer clear value to providers but may hold less perceived benefit for customers unless they lower the cost of access or prevent service disruptions. Similarly, asset protection insurance can help maintain productive use of SHSs and related equipment, but for many users, it may rank lower in priority compared to risks with more immediate consequences, such as health emergencies, crop failure or equipment loss from loan default. In such cases, insurance is more likely to be adopted if it directly addresses urgent and high-impact risks.

Scalability

The scalability of an insurance offering primarily depends on its ability to attract widespread interest or mandate purchases, thereby justifying the investment and commitment from supply-side actors to establish the programme. Additionally, scalability is influenced by how targeted the product needs to be for each insured person or entity, as greater customization can increase administrative complexity and distribution costs, potentially limiting expansion. End user index insurance and government-administered index insurance are both designed with scalability in mind, relying, respectively, on lower underwriting requirements and leveraging technology to rapidly scale. However, L&H insurance might be more challenging to scale, as the claims process is much more individualized than a claims process for index insurance. Asset protection for SHSs or other related equipment may also face challenges in scalability, unless the equipment is of vital importance to the insured.

Alignment with national strategies

Government-administered index insurance is most likely to directly align with national strategies aimed at protecting the agricultural sector from systemic risks. Conversely, end user credit risk insurance for DRE companies and Asset protection for SHSs or other related equipment products are more commercially driven and not commonly embedded in public policy frameworks or strategies, although they can indirectly support development goals like financial inclusion and energy access. L&H insurance for end users might align with national health policies if its focus on reducing financial barriers to healthcare is emphasized, but it is not as directly linked to agricultural or energy access policies. End user index insurance is aligned with broader climate resilience goals but may need stronger integration with national agricultural policies to ensure a coordinated approach.



AMP minigrid project site in Mauritania. Photo: UNDP Mauritania

3.3.2 Product challenges

Each product presents gaps that must be addressed for successful implementation. No design integrates perfectly into existing systems, and several shared challenges persist. End user education is important across all products, particularly for index-based insurance, where misunderstanding trigger mechanisms can lead to dissatisfaction. Voluntary products may face low uptake in price-sensitive markets. Government-administered schemes, while potentially more scalable, often encounter administrative hurdles, limited public trust and political volatility. L&H insurance may face operational challenges in remote areas, including weak claims processing and limited access to accredited healthcare providers, which can erode user confidence and renewal rates. For DRE companies, embedding credit risk insurance into financing structures may create affordability pressures and moral hazard risks. Asset protection insurance also faces limitations due to fragmented equipment markets, variability in repair and replacement options, and insufficient data on failure rates.

While the scorecard provides a structured lens to evaluate product design, it is real-world experience that ultimately validates performance. The case studies in this report offer early insights into delivery models and risk-sharing arrangements, but most remain in pilot stages with limited public data on claims, uptake and impact. As such, their alignment with the core design principles should be seen as indicative rather than conclusive. Continued engagement with pilot stakeholders is needed to extract operational lessons, understand what enables or constrains scale and explore how successful features can be adapted or replicated.



4. Insights

Integrating insurance into energy access presents a significant opportunity to stabilize income, enhance resilience and promote financial inclusion for underserved, off-grid communities. By mitigating financial risks across the value chain, insurance can provide a vital safety net, ensuring continued productivity and investment. However, the implementation of such solutions is complex, with challenges including systemic risks, financial constraints and the gap between theoretical models and practical applications. A critical comparison of the theoretical models for insurance products and their practical applications reveals both opportunities and significant hurdles.

Stakeholder interviews conducted for this report corroborate the overarching view that end users are vulnerable to various risks. Insurance can play a role in stabilizing their cash flow, thereby making them less risky clients for solar companies. This

acknowledgement recognizes that smallholder farmers constitute a significant customer base for solar companies, as they make up the majority of households in rural, unelectrified areas where off-grid energy solutions are most needed. Insurance facilitates access to a broader customer base by bridging the gap between farming and DRE, thereby unlocking productivity in the sector.

Further evidence for this potential is revealed in several pilot programmes and initiatives as cited in the case studies of this report, which demonstrate the capacity of insurance to enhance financial resilience for those benefiting from products and services provided by DRE businesses. Research on a pilot project focused on bundling agricultural insurance with SHSs to support smallholder farmers in Kenya, Senegal and Uganda determined that crop failure was considered the primary reason for non-repayment to solar companies, particularly for



Sample plot harvesting in Myanmar. Picture: UNDP Myanmar

customers purchasing solar products on credit.³⁸ These studies also report that solar companies identify loan defaults and repossessions as the most significant factors affecting their profitability. While a few of these insurance products are already in use, their current scale remains limited and largely experimental.



Tomato cultivation in Plateau State, Nigeria

At present, insurance does not yet play a significant role in improving energy access viability at scale. Existing initiatives suggest it is primarily used to reduce default risks, helping DRE companies maintain customer relationships and repayment flows. However, insurance alone is not a silver bullet and cannot address structural affordability or distribution challenges without complementary measures such as subsidies, improved credit practices or product innovation. Additionally, it should be acknowledged that not all segments of the DRE sector face the same risks, and the relevance of insurance varies across sub-sectors. Designing effective insurance products will require tailoring these distinct operating models and risk exposures.

Evidence on which risks stakeholders prioritize or rank as most important for stakeholders remains unclear. In the study mentioned above on bundling

agricultural insurance with SHSs, most customers reported experiencing crop failures at least once in the past five years, with many encountering it multiple times. Notably, reducing energy expenditure was not a common strategy during poor harvest periods, highlighting the value customers place on their access to solar assets.³⁹ In contrast, SunCulture's product research for their L&H product in Kenya found that unexpected health-related expenses often led to payment defaults on their SHS. These differences could be driven by the likelihood of respective risk events occurring or by psychological influences such as recency bias.⁴⁰

There is a risk of overstating the potential for DRE companies to rapidly scale insurance products by relying solely on their existing distribution networks. Experiences from PAYGo partnerships with microfinance institutions, as well as efforts to bundle other services through PAYGo platforms, show that while these channels can extend reach, real scale requires deeper integration, clear value for customers and strong operational alignment. This somewhat parallels a similar view within the DRE industry in developing countries, where some companies misjudged their market opportunity by believing that technology alone could significantly lower distribution costs and make their products



*A solar powered early warning system in Rwanda.
Photo: UNDP Rwanda*

38 Z. Kovacs, C. Grist, D. Dubovitskaya and M. Balac, "Research on piloting agricultural insurance bundled with solar home systems: Final report" (London, Triple Line Consulting, 2024).

39 Kovacs, Grist, Dubovitskaya and Balac, "Research on piloting agricultural insurance bundled with solar home systems: Final report".

40 The tendency to give greater weight to recent events when assessing risks.



A farmer using a solar-powered irrigation system in Sudan. Due to the renewable irrigation system, the land cultivation capacity and yield have increased, providing significant benefits to the farmers. Photo: UNDP Sudan

affordable, thereby stimulating demand.⁴¹ The subsequent market consolidation of companies – particularly in Africa – suggests some companies did not appreciate the array of other factors required to ensure their business viability.

Similarly, viewing insurance as a perfect risk management solution without considering the broader context may lead to unrealistic expectations and potential challenges. In the PAYGo sector, for instance, many companies struggle with repayment challenges due to weak credit screening, limited customer engagement after the sale and an emphasis on expanding sales rather than managing portfolio quality.

Insurance cannot resolve these underlying issues. When linked to credit, insurance must complement strong credit risk management practices rather than serve as a substitute. In other cases, insurance products still rely on well-functioning systems for enrolment, claims processing and customer communication. Rather than being a stand-alone fix, insurance should be understood as one element within a broader strategy to strengthen financial resilience, improve financial sustainability and expand access to reliable services.

⁴¹ Insight from stakeholder interview.

4.1 Opportunities

DRE companies are already active in areas with many smallholder farmers who may be in need of risk management solutions. For instance, the three-country pilot study revealed that the majority of SHS customers are smallholder farmers, with many operating farms of less than 1 hectare.⁴² Given the strong overlap between agriculture and energy access in rural areas, DRE companies can design bundled insurance products that address key risks faced by smallholder farmers such as income fluctuations, equipment damage or climate-related shocks. By mitigating these risks, these products not only enhance financial stability for farmers but also reduce repayment uncertainties for DRE providers, improving loan performance and business sustainability. Bundling insurance with DRE products also lowers barriers to adoption and simplifies access for smallholder farmers, who may otherwise face challenges in securing insurance through traditional channels.

The role of PAYGo systems in this landscape is also critical. Many DRE companies already have established relationships with customers, using digital payment systems for energy access. These existing systems could be leveraged to repay insurance products on a regular, incremental basis, provided there is a clear legal agreement between the DRE company and the insurance provider. This removes the need for up-front payments by end users and can make insurance more accessible. Additionally, existing technologies employed by DRE companies, including mobile payment platforms, further enhance the ease of distribution, allowing insurance to be integrated into existing payment structures with minimal additional effort required from smallholder farmers.

As the case studies showed, several examples of successful partnerships between DRE companies and insurers exist, demonstrating the practical application of insurance solutions in these markets. While most of these collaborations remain at a relatively small scale, they have allowed DRE companies to diversify their offerings while providing financial protection to their customers. If successful, this model could enable insurers to reach new market segments, offering a substantial market opportunity for expansion. Beyond small-scale agriculture, there are emerging applications for insurance in other sectors, such as the electric vehicle industry. This illustrates how insurance products for renewable energy technologies could have broader applications. The use of electric vehicles in small-scale agriculture, as a type of productive equipment, could leverage similar insurance models, including compulsory third-party insurance.⁴³

Both the existing and conceptual insurance products are strategically aligned with core insurance design principles vital for success. If market conditions are favourable, integrating insurance into energy access systems addresses fundamental risks faced by end users, enhancing financial resilience. Studies have demonstrated that insurance significantly boosts investment in productive activities.⁴⁴ This investment can contribute to a stable and resilient rural economy, thus supporting vulnerable populations and economic development.

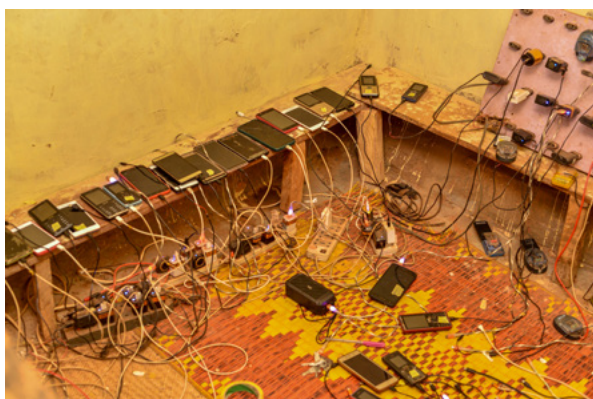
⁴² Kovacs, Grist, Dubovitskaya and Balac, "Research on piloting agricultural insurance bundled with solar home systems: Final report".

⁴³ Referring to a legally mandated insurance policy that provides coverage for liability arising from injury or death caused to third parties, typically in the context of motor vehicle accidents. It does not cover damage to the insured's own vehicle or property.

⁴⁴ M. Carter and T. Chiu, "MRR discussion paper: Evidence landscape for microinsurance and other risk management" (Davis, Feed the Future Innovation Lab for Markets, Risk & Resilience, UC Davis, 2022).

4.2 Challenges

Several challenges will need to be addressed to effectively implement such products in practice. A major obstacle is the complexity of introducing new insurance products to markets that already face significant barriers to financial inclusion and literacy. Practical experiences from pilot projects and stakeholder interviews reveal that low financial literacy and a lack of understanding about insurance products are major hurdles to adoption in rural communities. These challenges can place an additional burden on last-mile DRE distributors, who are already stretched with responsibilities such as credit assessments and client onboarding. Expecting solar agents to also take on the role of insurance educators and facilitators may not always be practical or effective. This suggests that careful product design must be paired with dedicated educational and support strategies to successfully scale these offerings in the target markets.



A business in a corner store in Nigeria enabling people to charge their phones.

Another significant challenge is the need for insurance products that can address both the immediate needs of end users, such as income volatility, and the operational risks faced by DRE companies. The most successful insurance products have been those that effectively meet the diverse

needs of both groups, as demonstrated by credit-linked insurance products.⁴⁵ However, the dual focus on the needs of both end users and DRE companies complicates the design process, raising the question of who benefits most from the insurance. For instance, an insurance product that replaces loan repayments forgiveness may be perceived as primarily benefiting the lender by safeguarding their interests; the end user receives only a reprieve from an obligation, but no compensation for the actual losses incurred. This dynamic can create a sense of inequity by prioritizing DRE companies' income stability over directly securing end users' livelihoods. In cases where an end user faces a high degree of loss, insurance designed solely for DRE companies may leave end users vulnerable, suggesting a careful balance is needed to ensure equitable protection for both parties. This also raises broader questions around consumer protection, which is particularly relevant in the PAYGo sector, where transparency, fairness and shared benefit are essential to building trust and ensuring long-term product viability.

Operational challenges faced by DRE companies present another barrier to integrating insurance products. Many companies already manage complex operations, including product design, distribution and customer support. For smaller companies with limited resources, directly providing or administering insurance could strain operations and require additional expertise, systems and processes. As a result, partnerships with insurers and government agencies will be essential for smaller companies to support the delivery of insurance services and help scale both energy access and insurance solutions. Larger DRE companies with a broader market share, greater reach and improved access to finance, on the other hand, may be better positioned to cross-sell insurance as a part of their market offering.

45 Insight from stakeholder interviews.

Affordability is another important challenge in ensuring the accessibility of insurance for low-income households. While PAYGo systems offer a potential solution by allowing incremental premium payments, the overall cost of insurance may remain prohibitively expensive or provide limited benefits due to capped payouts. This creates a delicate balance between providing meaningful coverage and ensuring that insurance does not become an additional financial burden. Subsidies or alternative pricing models that lower the cost of premiums and make insurance more affordable may need consideration. Without such measures, there is a risk that insurance products could be underutilized, limiting their potential to provide financial protection and resilience to vulnerable populations.

Data availability is a general challenge when pricing insurance products effectively in new markets. The lack of sufficient historical data on specific risks and losses makes it difficult to accurately assess and price insurance products. As one stakeholder noted, data on historical losses over the past 10 years provide some insights but information is limited, especially for rare, highly severe natural hazard events.⁴⁶ This gap in data may lead to inflated premiums, which can reduce the affordability of insurance products. The same can be said for asset-based insurance or coverage of life or health risks. However, these data limitations have been encountered in other markets as well, and insurers typically have established actuarial pricing methods to overcome these challenges. These methods include using proxy data, advanced modelling techniques and expert judgment to estimate risks and develop appropriate pricing models even in the absence of complete data.

Some stakeholders view insurance as a potentially significant enabler for companies operating in these markets, though they argue that the cost of covering risks often outweighs the benefits. These differing perspectives are to be expected and may be influenced by cultural risk tolerance, geographic locations, specific regional risks, varying levels of market development and different abilities to pay among end users. This mixed view aligns with real-world experiences, where ongoing initiatives are juxtaposed with products that have been withdrawn. For example, in sub-Saharan Africa, PAYGo solar companies introduced products with an insurance component aimed at protecting both customers and the company. Despite initial success and perceived demand, these products did not achieve significant uptake and were eventually withdrawn. Contributing factors included challenges in training numerous agents and difficulties in providing insurance due to frequent adverse events in the region.⁴⁷ This example highlights that even a strong commitment to launching a product does not guarantee its survival in a highly dynamic and competitive environment.

⁴⁶ Insights from stakeholder interviews.

⁴⁷ Insights from stakeholder interviews.

4.3 Recommendations

The insights from this analysis lay the groundwork for actionable recommendations to overcome the challenges identified and seize opportunities. A key recommendation is to establish strong partnerships with local entities to enhance data collection and improve risk assessment models. For example, local weather bureaus operate stations that monitor conditions relevant to risk assessment, while DRE companies may track aggregated rates of damage to DRE equipment, providing valuable data on its significance as a risk factor. While historical loss data provides a starting point for insurance product pricing, they are insufficient to capture the full range of risks faced by end users and DRE companies. Therefore, collaborations with local and international organizations will be essential to increase data availability and accuracy.



Electricity leads to connectivity, which can further support in access to digital payments.

Exploring partnerships with demand aggregators is another crucial step. These organizations can bridge the gap between DRE companies and end users by focusing on financial literacy and product education. For instance, cooperatives can raise awareness of insurance offerings and help customers understand the benefits and terms of coverage, while DRE companies can leverage their existing technologies and payment systems to facilitate underwriting and

premium payments. This collaborative approach reduces barriers to insurance product entry and improves accessibility.

Close community engagement will be necessary to understand local challenges. For example, a demand-side study from the Pula pilot programme revealed regional variations in risk perceptions.⁴⁸ In Kenya and Senegal, crop failure was the main cause of non-repayment, while SunCulture's research highlighted that health-related expenses were a more significant concern among its customers in Kenya. Understanding these regional differences can help tailor products to meet the specific needs of various customer segments.

Assessing the willingness of DRE companies to integrate insurance into their business models will be important. While smaller companies may struggle with the added complexity of insurance, larger companies with the necessary scale are better positioned to complement their existing offerings with insurance. These larger companies are also more likely to appeal to insurers and reinsurers. Any future road map to develop this idea should prioritize models that can naturally scale, such as bundling insurance with PAYGo systems, while addressing challenges related to data, affordability and financial literacy.

Long-term resilience and scalability require a strong PPP model. A thorough analysis of available research, case studies and market dynamics highlights the need for greater coordination among stakeholders. Collective engagement built around a strategic road map that incorporates these insights is the best way to identify solutions, guide the formation of partnerships and systematically fill gaps around data accessibility, affordability and financial literacy. The road map should focus on scaling

⁴⁸ Kovacs, Grist, Dubovitskaya and Balac, "Research on piloting agricultural insurance bundled with solar home systems: Final report."

successful models, such as integrating insurance with PAYGo systems, while overcoming barriers to new market development, ultimately enhancing

financial resilience in the small-scale agriculture and energy access sectors and promoting sustainable development in underserved regions.

4.4 Areas for further research

This report has highlighted promising insurance product designs that link insurance with energy access, but it is important to recognize that the field remains in its infancy. Many of the models explored are either still in pilot phases or have only recently entered the market. As such, further research and analysis are essential to refine these designs and gauge their long-term viability.

Firstly, a deeper understanding of market conditions is needed. The lack of robust data to accurately assess the levels of insurance penetration in DRE at regional or country levels makes it difficult to fully assess the market potential. To garner sufficient interest from reinsurers and insurers, conducting a market sizing exercise to quantify the opportunity may be a worthwhile step towards securing buy-in. A market scan and assessment would unify factors such as the scale of energy access as well as existing financial inclusion rates in specific markets, and could be key to identifying where insurance products can have the most significant impact.

Further research is needed to evaluate the specific risks faced by end users and energy providers in different geographies. As the case studies show, risks like crop failure, health crises and asset damage are central to the viability of energy systems. However, these risks can vary depending on location and local conditions. For example, in some regions, health-related expenses might be deemed more critical than other risks, while in others, crop failure might be the primary risk. Research should focus on how these risks impact insurance adoption and design, and whether bundled insurance products, such as those combining health, life and funeral coverage, are the most appropriate.

Additionally, the need for better data remains a significant barrier to the pricing and underwriting of insurance in rural markets. The absence of detailed historical data on weather patterns, crop yields, health incidents, asset failure or theft and energy consumption limits the ability of insurers to develop accurate risk models at the small-scale level. Therefore, alignment with relevant ministries, research institutes and academia to access relevant data, such as satellite imagery and weather station readings, is important. Research into how these data can be integrated into insurance products can lay a foundation for new partnerships with fintech companies to utilize mobile-based platforms for data collection and financial activity tracking. This would help to create a better understanding of the end user target market, streamlining potential claims management processes and reducing operational costs.



Solar panels installed at an agribusiness in Sri Lanka power a containerized cold storage room. Photo: UNDP Sri Lanka

While this report explored various insurance products, including revenue protection insurance for mini-grid operators, such a product would require further investigation. The complexity of pricing risks for mini-grid operators, particularly given the current

limitations in credit risk modelling and operational data, may pose challenges to implementation. However, revenue protection insurance has been noted in sector discussions as a potentially valuable instrument, particularly in settings where mini-grid operators face demand-side uncertainty. It could also play a role if supported through targeted subsidies or applied during early-stage operations to stimulate demand. A more detailed feasibility assessment would be needed to determine the practicality and appropriate structuring of revenue protection insurance, though revisiting its integration with mini-grid operations could still be worthwhile.

A significant area for further research is the regulatory landscape, which remains a key factor in scaling any insurance solution. Many regions, particularly those with underdeveloped financial markets, lack robust regulatory frameworks to incentivize insurers and ensure consumer protection. While some governments have made strides toward supporting energy access, few appear to have tailored their policies to accommodate the integration of insurance with energy. Research into how existing policies can be adapted to support insurance innovation (e.g., tax incentives, subsidies or new regulatory frameworks) would complement this assessment. The findings could better support UNDP in advocating for policy reform and in facilitating the development of regulatory environments that encourage insurers to innovate and enter underserved markets.

The evidence provided by the case studies emphasizes the importance of tailoring insurance products to meet the specific needs of the target populations. While bundled insurance solutions show promise, they should be flexible enough to adapt to the unique socioeconomic realities of different markets. For instance, in regions with high levels of financial exclusion, insurance products must be affordable, accessible and designed with low-income households in mind. Further research into consumer behaviour, willingness to pay and preferences for different types of insurance coverage is needed to develop more appealing products that directly address the challenges faced by smallholder farmers and energy users.

Finally, the integration of insurance with other financial services and sectors – such as microfinance loans and social protection – is an emerging area for research. MFIs are a valuable source of data and market insights in many of the relevant target areas. Their close relationships with low-income clients and extensive experience in financial service delivery can inform the design and targeting of insurance products. As seen in several pilot programmes, bundling insurance with renewable energy solutions holds significant potential to boost the resilience of rural communities. Research should focus on how to expand these models, ensuring that they remain financially viable while meeting the needs of end users. Additionally, there is potential for insurance models to co-exist alongside existing social safety nets or anticipatory action programmes, particularly in regions highly susceptible to climate-related risks.

This assessment seeks to progress the understanding of the role of insurance in supporting energy access. However, further research is needed to fine-tune existing models and explore new, innovative solutions. UNDP can help bridge the gap between theoretical models and practical applications, paving the way for scalable, impactful insurance solutions that enhance financial resilience and drive sustainable development.

Annex A: Glossary

Term	Definition (Report context)
Accessible	Refers to whether insurance solutions can be delivered effectively to rural and underserved populations through appropriate distribution models.
Actor	A stakeholder within the energy access ecosystem, including end users, DRE companies, investors, insurers and governments.
Affordable	Describes insurance products priced within reach of intended beneficiaries to encourage adoption while ensuring viability for insurers.
Agriculture	A key economic activity for many rural end users, used in the report to illustrate risks that affect energy affordability and the need for insurance.
Asset protection	Insurance that covers damage, theft or malfunction of essential energy equipment such as SHSs or related infrastructure.
Asset risk	Risks related to the damage, malfunction or loss of energy equipment that impact service continuity and financial stability.
Cash-flow profile	The revenue and payment patterns that affect the financial health and sustainability of DRE providers and their ability to manage risk.
Credit risk	The risk that end users may be unable to meet their financial obligations, particularly repayment for energy services or products.
Credit risk insurance	An insurance product that protects DRE providers from revenue loss due to customer non-payment or default.
DRE	Distributed Renewable Energy – decentralized energy systems that provide power at or near the point of use, such as SHSs and mini-grids.
Equipment	The physical assets used in DRE systems, including solar panels, batteries and devices required for energy generation and delivery.
Index insurance	A type of insurance that pays out based on pre-agreed triggers (such as rainfall or temperature) rather than individual loss assessment.
Key enablers	Factors that facilitate insurance uptake, such as regulatory clarity, data infrastructure, consumer awareness and affordability.
Key risks addressed	The primary risks that a proposed insurance product seeks to mitigate within the energy access value chain.
Key risks directly addressable	Risks identified in the report as suitable for insurance-based solutions, such as income shocks or asset loss.
Market readiness	Assessment of a market's ability to adopt insurance solutions, considering infrastructure, consumer demand and enabling conditions.
Market scan	Initial analysis of existing products, delivery mechanisms and potential gaps in the current insurance landscape.
Mini-grids	Small-scale decentralized energy systems that generate and distribute electricity to local communities not connected to the main grid.

Term	Definition (Report context)
PAYGo	Pay-As-You-Go – a consumer financing model where users make incremental payments for energy products, often integrated with digital platforms.
PPP	Public-private partnership – a collaborative model involving government and private entities to deliver and scale insurance or energy solutions.
Premiums	Regular payments made by policyholders for insurance coverage; affordability is often a barrier in low-income contexts.
Reinsurers	Entities that provide insurance to insurers, enabling risk-sharing and increasing underwriting capacity for systemic or large-scale risks.
Risk	A condition of exposure to loss, uncertainty or disruption affecting stakeholders across the DRE ecosystem.
Risk profile	A stakeholder-specific summary of financial, operational and environmental risks influencing insurance applicability.
Risk type	A categorization of risks (e.g., income, credit, asset) used to assess alignment with possible insurance mechanisms.
SHS	Solar Home System – a stand-alone solar-powered unit typically used in off-grid households for lighting, charging and basic appliances.
Smallholder	A farmer managing a small-scale agricultural operation, often characterized by informal income and high vulnerability to shocks.
Value/Valuable	The extent to which insurance delivers meaningful protection relative to its cost, influencing user perceptions and willingness to pay.

Annex B: Full risk profile by actor

End users

Table 6: Risk profile – end users

Category	Risk type	Description	Insurance or other de-risking measure
Risks directly addressable through insurance	Income risk	Risks from lower income due to erratic weather, supply chain disruptions or market fluctuations that impact revenue.	Business interruption insurance, index-based insurance for weather risks and other forms of asset protection mechanisms.
	Mortality risk	Death of the primary breadwinner affecting household income and stability.	Life insurance to provide financial support to the family of the deceased.
	Morbidity risk	Illness of key income earners leading to loss of productivity and income.	Health insurance to reduce financial strain caused by medical expenses and productivity losses.
	Asset risk	Damage of productive equipment, such as irrigation pumps or SHS.	Asset insurance for productive-use equipment linked to energy access.
Risks addressed indirectly by insurance	Market price risk	Unpredictable market prices due to external market forces.	Credit insurance for loans tied to agricultural inputs to stabilize cash flow during volatile price periods.
	Loan repayment risk	Inability to repay loans due to seasonal income fluctuations or crop failures.	Insurance for lenders to reduce exposure to borrower default risk, enabling more favourable credit terms for smallholder farmers.
	Utilization risk	Reduced ability to use energy or DRE products due to income volatility or high operating costs.	Insurance on energy costs or subsidies to ensure consistent access to DRE services to continue productive activities.
Limited or no insurance applications	Geographic isolation risk	Barriers to accessing markets, buyers or services due to remote locations.	Infrastructure investments and community-based aggregation initiatives rather than insurance.
	Regulatory risk	Changes in food safety policies or agricultural regulations impacting productivity or pricing.	Advocacy for policy stability; insurance has limited application here.
	Armed conflict and fragility risk ⁴⁹	Exposure to displacement, destruction of assets or market disruption in conflict-affected areas.	International aid or guarantees, as insurance solutions are limited in such high-risk contexts.

49 Considered relevant to some markets, but not subsequently considered in this report due to the specific nature of this risk.

DRE companies

Table 7: Risk profile – DRE companies

Category	Risk type	Applies to	Description	Insurance or other de-risking measure
Risks directly addressable through insurance	Hardware risk	Mini-grids, SHS companies	Risks related to equipment quality, performance or damage during transit.	Insurance can cover performance warranties and damages, ensuring financial recovery for operators.
	End user credit risk	Mini-grids, SHS companies	Risk of non-payment by end users due to poor creditworthiness or financial instability.	Credit default insurance or payment guarantee schemes to cover revenue losses from defaulting customers.
	Digital (Cyber) risk	Mini-grids, SHS companies	Vulnerabilities in mobile payment systems or risks of data breaches.	Insurance for data breaches or digital payment failures could offset company losses associated with these events.
	Warranty/ service risk	SHS	Costs associated with product malfunctions, repairs or replacements.	Extended warranty insurance or maintenance contracts for customers to ensure predictable costs and revenue streams for providers.
	Developer risk	Mini-grids, SHS companies	Risks associated with the developer's financial management, creditworthiness and cash flow stability.	Insurance for end user credit risks can indirectly stabilize developer revenue streams and attract investment.
Risks addressed indirectly by insurance	Social acceptance risk	Mini-grids, SHS companies	Resistance to mini-grid projects due to misinformation or lack of awareness in communities.	Insurance to cover hardware risks and credit risks lower risks associated with off-grid products and incentivize uptake.
	Customer utilization risk	SHS	Reduced ability for customers to utilize or maintain SHS products due to income volatility.	End user credit insurance can improve customer affordability, indirectly stabilizing SHS provider revenues.
	Currency risk	Mini-grids, SHS companies	Volatility in foreign exchange rates affecting revenue and loan servicing.	Addressed through foreign exchange hedging instruments or government-backed currency stabilization programmes.

Category	Risk type	Applies to	Description	Insurance or other de-risking measure
Limited or no insurance applications	Energy market risk	Mini-grids, SHS companies	Uncertainty in market access, tariff regulation or competition from subsidized alternatives.	Requires policy solutions such as tariff transparency, grid integration planning and targeted subsidies for renewable energy.
	Sovereign risk	Mini-grids, SHS companies	Risks tied to political instability, economic governance and legal frameworks.	Addressed through political risk insurance (PRI) or development guarantees rather than conventional insurance products.
	Regulatory risk	Mini-grids, SHS companies	Changes in government policies, tariff structures or import regulations impacting DRE operations.	Policy advocacy for regulatory stability, public-private partnerships or contractual guarantees for tariff adjustments.
	Supply chain risk	SHS companies	Supply chain insurance to protect against logistics-related risks and inventory disruptions.	Addressed through supply chain management or potential forward agreements.
	Labour risk	Mini-grids, SHS companies	Limited availability of skilled labour and associated costs of training or recruitment.	Insurance could be considered to protect against financial losses if staff underperform or leave, but it is not likely to have a material impact on overall financial performance.

Financiers

Table 8: Risk profile – financiers in the DRE sector

Category	Risk type	Description	Insurance or other de-risking measure
Risks directly addressable through insurance	Credit default risk	Risk of DRE companies or end users defaulting on loans due to fluctuating incomes or weak credit profiles.	Credit insurance to protect investors against borrower defaults and enable better credit terms for DRE companies and end users.
	Operational risk	Risk that operational challenges within DRE companies could affect their ability to generate revenue or manage costs and meet financial obligations to investors.	Performance guarantees or operational risk insurance to protect investors from revenue losses due to operational failures.
	Sovereign risk	Political instability or weak governance in target markets.	Political risk insurance (PRI) to protect investments against expropriation, political violence or breach of contract.
Risks addressed indirectly by insurance	Liquidity risk	Limited availability of long-term domestic financing to meet DRE company capital needs.	Insurance for end user loan repayment risk indirectly improves DRE companies' cash flow, enabling repayment of financier obligations.
	Investment risk	Risk of DRE companies underperforming financially or operationally, leading to poor returns.	Portfolio insurance or guarantees for impact investors to reduce exposure to individual project risks.
	Market risk	Risk of uncertain market demand or regulatory changes affecting the profitability of DRE companies.	Advocacy for stable regulatory environments; subsidies or financial incentives for early-stage DRE investments.

Category	Risk type	Description	Insurance or other de-risking measure
Limited or no insurance applications	Regulatory risk	Changes in government policies, tariff structures or import regulations impact DRE operations.	Policy advocacy for regulatory stability, public-private partnerships or contractual guarantees for tariff adjustments.
	Social acceptance risk	Risk of community resistance to DRE projects affecting adoption rates and financial returns.	Limited application of insurance; focus on stakeholder engagement and awareness campaigns.
	Technology obsolescence risk	Investments in outdated or soon-to-be-outdated technologies reduce long-term returns.	Diversification into a portfolio of new technologies; insurance has limited applicability.
	Geographical remoteness risk	Barriers related to community infrastructure, connectivity and customer reach in remote areas.	Infrastructure investments or community-based service aggregation initiatives rather than insurance.
	High transaction costs	High costs associated with due diligence, legal processes and contract enforcement in fragmented markets.	Aggregation of projects to achieve scale, reducing unit transaction costs; insurance for specific risks during due diligence phases.
	Domestic financial sector gaps	Lack of well-capitalized domestic lenders or insufficient expertise in renewable energy financing.	Capacity-building for local financial institutions; guarantees to reduce perceived risks of investing in the DRE sector.
	Currency and inflation risks	Exposure to exchange rate fluctuations and inflation erodes the value of revenues or investments.	Foreign-exchange hedging instruments, inflation-indexed financial products or government-backed stabilization programmes.

Insurance companies

Table 9: Risk profile – insurers in DRE/small-scale agriculture

Risk category	Risk type	Description
Product risks	Access risks	Difficulty in reaching rural, off-grid communities due to lack of distribution channels. Low digital literacy limits the adoption of mobile-based insurance platforms. Limited awareness of microinsurance and its benefits in the target population.
	Cost risks	Products are perceived as unaffordable due to the low and fluctuating incomes of end users. High operational costs relative to premiums collected, undermining profitability.
	Customer experience risks	Delays in claims processing lead to dissatisfaction among customers. Negative interactions with sales agents or customer support representatives. Poor understanding of terms and conditions, resulting in unrealistic expectations or disputes over claims.
	Reputational risks	Perception of product failure due to denied claims, lack of payouts or unmet expectations. Long periods without claims lead to customer scepticism about the product's value.
	Moral hazard risks	Knowing they are insured, customers may engage in riskier behaviour, increasing claims.
	Adverse selection risks	Higher-risk individuals are more likely to purchase insurance, distorting the risk.
Operational risks	Scalability risks	Difficulty in achieving scale due to fragmented markets or inefficient distribution systems. Limited ability to adapt systems to manage growing customer bases and increased transaction volumes.
	Partner risks	Failure of partner agents (e.g., energy companies or cooperatives) to effectively market or support the insurance product. Misalignment of incentives between insurers and partners leading to suboptimal performance.
	Concentration risks	Exposure to systemic risks like natural disasters causing simultaneous claims. Overburdened claims-handling capacity during high-demand periods.
	Claims handling risks	Insufficient capacity to process claims efficiently in peak periods. Risk of fraudulent claims due to weak verification processes.
	Inventory management risks	Supply chain disruptions impacting access to energy equipment or agricultural tools. Price volatility in key inputs like solar panels, batteries or irrigation equipment affecting insurance coverage costs.

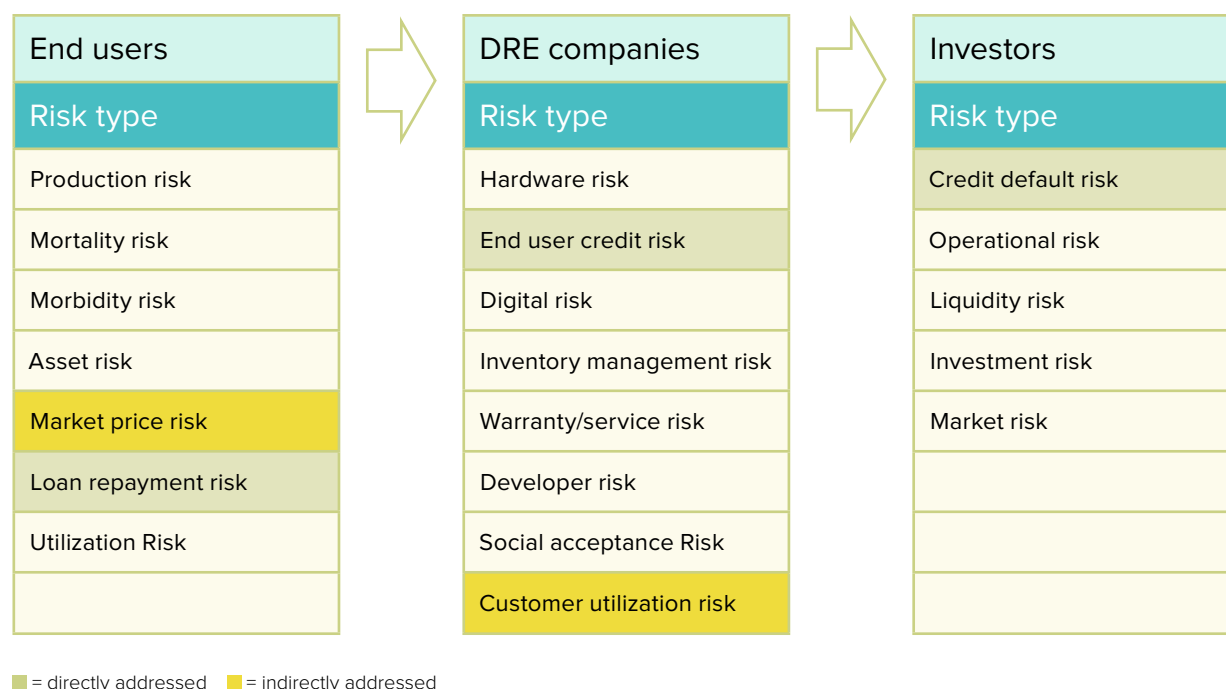
Financial risks	Profitability risks	Inability to generate adequate profit margins due to underpricing or excessive claims. Low customer retention increasing acquisition costs.
	Reinsurance risks	Lack of suitable reinsurance partners for transferring risks. Overreliance on specific reinsurance partner reducing flexibility around pricing. The subsequent withdrawal of any reinsurance line leaving the insurer exposed to the claims risk.
	Pricing risks	Mispricing premiums due to insufficient data on agricultural or energy-related risks. Price sensitivity in target populations reducing uptake. Concentration risk affecting entire regions increase the likelihood of large-scale claims and impact pricing.
Regulatory risks	Regulatory compliance risks	Difficulty navigating unclear or evolving regulatory frameworks for microinsurance. Risk of penalties for non-compliance with local laws.
	Political risks	Changes in government policies affecting energy subsidies, agricultural inputs or taxation. Risk of nationalization or political interference in insurance operations.
Contextual risks	Cultural risks	Resistance to formal insurance due to a preference for informal risk-sharing mechanisms (e.g., savings groups). Mistrust of insurers due to past negative experiences or lack of awareness.
	Economic risks	Inflation erodes the value of premiums relative to claims payouts. Currency volatility affects reinsurance agreements or premium affordability.
	Technical risks	Poor road connectivity limits access to rural customers for direct sales. Limited digital capabilities affecting mobile-based premium collection or claims processing.
	Climate and environmental risks	Increased frequency of extreme weather events (e.g., floods, droughts) leading to higher claims. Environmental degradation affects productivity and income stability in small-scale agriculture.
	Market risks	Uncertainty in demand for microinsurance products due to fluctuating energy or agricultural needs. Seasonal income patterns reduce the ability to pay premiums consistently.
Technology risks	Digital system risks	Vulnerabilities in digital payment systems leading to cybersecurity threats or data breaches. System outages disrupt premium collection or claims processing.
	Data risks	Inaccurate or insufficient data for assessing risks in small-scale agriculture or energy access. Weak data security exposes sensitive customer information.
Strategic risks	Market saturation risks	Entry of competing microinsurance providers reducing market share. Difficulty differentiating products in a crowded marketplace.
	Adoption risks	Low enrolment rates due to misaligned product offerings with customer needs. Challenges in transitioning informal risk-sharing practices into formal insurance models.
	Trust and education risks	Lack of trust in insurance due to unfamiliarity or past grievances. Insufficient customer education efforts fail to communicate the product's value effectively.

Annex C: Risk assessment by product

C.1. End user index insurance

Risk assessment

Figure 9: Key risks addressed through index insurance (individual cover)



Direct risks addressed

- **Income risk:** End users face income risks due to unpredictable weather patterns or other threats from pests. Index insurance directly addresses these risks by triggering payouts when weather conditions (e.g., rainfall or temperature) exceed certain thresholds.
- **Loan repayment risk:** Smallholder farmers who have borrowed money for agricultural investments, such as productive equipment (e.g., solar pumps), could use index insurance to protect against uncontrollable weather-related risks, ensuring that they can meet loan repayment obligations even in the case of a poor harvest. This reduces the risk of default.
- **Asset risk:** Index insurance offers indirect asset protection by supplying financial compensation that maintains smallholder farmers' income. The cash payout could be used to repair or replace damaged equipment or avoid selling productive assets during a loss event.

Indirect risks addressed

- **Market price risk:** While index insurance does not directly address market price risk, it helps offset income losses for market segments such as smallholder farmers. Area-yield index products mitigate the financial impact of yield depreciation, and smallholder farmers can avoid the need to replant or regenerate crops simultaneously with others in their community, which could otherwise create a glut in the market and depress prices at the next harvest.
- **Utilization risk:** As smallholder farmers experience fewer financial shocks, they are more likely to use their energy systems regularly, improving energy service uptake and reducing default rates on solar system payments – providing benefits to both end users and the DRE companies servicing them.

Intrinsic risks from the insurer's perspective

- **Basis risk:** The primary challenge for insurers is the possibility of basis risk, where the payouts do not align perfectly with actual losses. This could arise if the index used in the insurance does not accurately reflect the losses experienced by individual smallholder farmers.
- **Operational risks:** Implementing this insurance in remote areas where infrastructure is poor can involve high operational costs, as some on-the-ground verification is required.
- **Claims handling risks:** For area-yield index product designs, some challenges in verifying claims, especially in areas with limited access to digital infrastructure, can lead to delays and increased administrative costs for insurers.
- **Moral hazard:** In the case of area-yield applications, the smallholder farmer becomes eligible for a payout only if crop failure or livestock production failure occurs, which may inadvertently lead to behavioural changes and create an incentive for them to allow such failures to happen.
- **Adverse selection:** For both index applications, adverse selection may arise when the demand for insurance is positively correlated with the risk of loss, leading higher-risk clients to purchase more coverage than lower-risk ones.

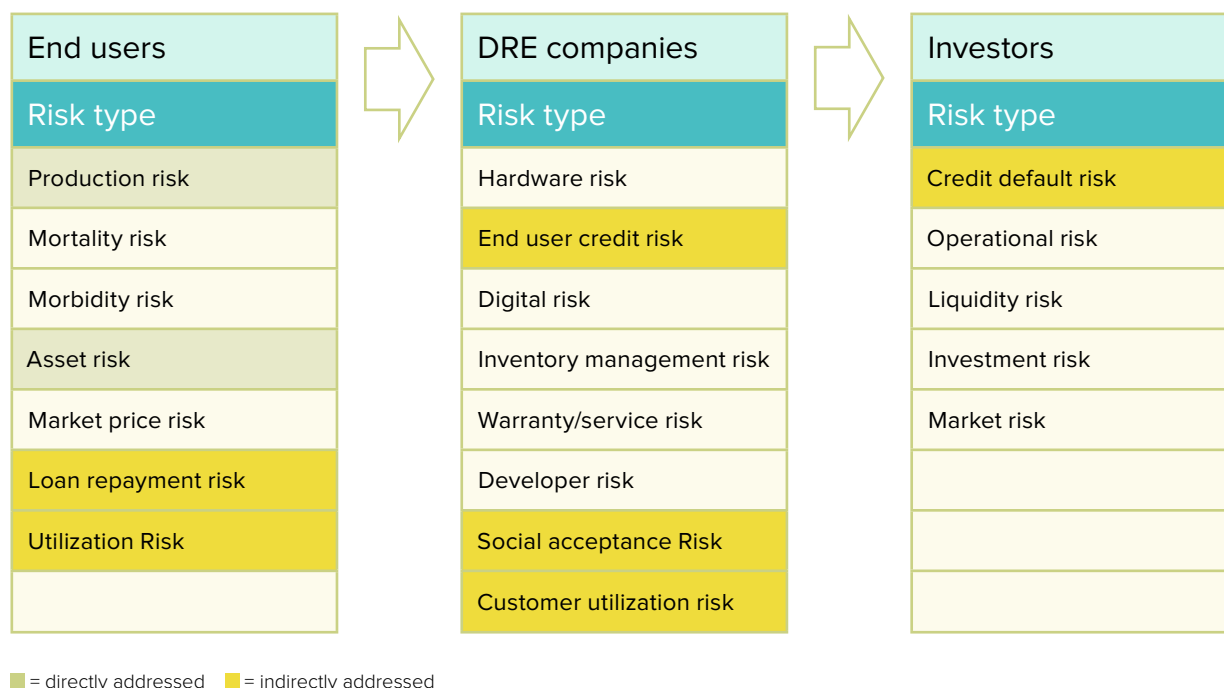
Enablers from value chain actors

- **Government support:** Governments can create an enabling policy environment to scale the index insurance through regulation and other policy incentives. Under this product design, direct premium subsidies to lower the cost of premiums is the most straightforward way to achieve this. Other forms of subsidy could also be considered in the form of financial literacy education and marketing campaigns and public awareness to help build trust, understanding and uptake.
- **Energy companies:** DRE companies can leverage their existing digital capabilities for premium collection and claims verification, reducing operational costs. As when MFIs partner with insurers, similar dynamics and challenges could emerge in the PAYGo sector, including the need for clear roles, data-sharing protocols and incentives. DRE companies could be encouraged to participate through agency commissions and the opportunity to offer value-added services to their customers, positioning insurance as a trusted benefit linked to their core energy offering.
- **Financiers:** These stakeholders benefit indirectly from improved financial protection, as it enhances end users' creditworthiness. Microfinance institutions or other financiers could provide access to data and customer account information to facilitate the expansion of insurance products and could reduce underwriting barriers by streamlining underwriting processes to promote scalability. Other options would also be available to integrate the insurance product within loan offerings to encourage borrowing for greater productivity, while still ensuring end users are financially protected from covered risks.

C.2. Government-administered index insurance

Risk assessment

Figure 10: Key risks addressed through index insurance (aggregate cover)



Direct risks addressed

- **Income risk:** The primary risk addressed by this insurance would be income risk due to uncontrollable weather patterns or other systemic agricultural disruptions. By purchasing aggregate insurance, the government ensures that smallholder farmers facing poor yields or crop failures from key perils receive compensation, helping to stabilize their income and protecting local economies.
- **Asset risk:** As with the microinsurance product design, asset protection is indirectly provided through the government's provision of financial compensation, where smallholder farmers' income is sustained enabling them to replace or repair broken equipment or avoid selling such productive assets when they are faced with a loss event.

Indirect risks addressed

- **Loan repayment risk:** While the insurance is not directly tied to loans in this model, the stability provided by the payouts reduces the risk of defaults, particularly for smallholder farmers who may have borrowed money to finance agricultural operations or DRE products.
- **Market price risk:** Although index insurance does not directly address market price fluctuations, it stabilizes smallholder farmers' income, reducing the financial shocks caused by poor harvests. This, in turn, helps mitigate the risk of replanting crops in large numbers at the same time, which could depress market prices at harvest.

- **Utilization risk:** With financial stability provided by government payouts, smallholder farmers are more likely to utilize energy systems consistently, avoiding payment defaults and ensuring steady use of mini-grids or SHS, providing benefits to both end users and DRE companies servicing them.
- **Social acceptance risk:** As the government backs the scheme, smallholder farmers are more likely to view the insurance as a secure and reliable option, increasing the likelihood of broad participation in the programme.

Intrinsic risks from the insurer's perspective

- **Basis risk:** While potential for basis risk remains under this design, it is partially mitigated through the risk layering approach within the contingency fund. The aggregate cover also helps to diversify risk by covering a wide range of small-scale agricultural risks over a broader geographical area. However, this approach requires a granular understanding of the location, size and nature of specific operations. Without such detailed insight, there is a risk that the index-based payouts may not fully reflect the actual losses experienced by individual smallholder farmers. Technology such as remote sensing and weather stations can help mitigate some of these risks by providing more accurate data for assessing agricultural conditions.
- **Operational complexity:** Managing a large-scale insurance scheme for the agricultural sector could present considerable operational challenges, requiring the government to have adequate human resources and technical expertise to effectively administer the programme, along with strong coordination among all stakeholders involved in its delivery.
- **Claims handling risks:** The sheer volume of claims in the event of a large-scale disaster could overwhelm the system, potentially resulting in delays or inaccurate payouts. This must be accounted for in the claims handling design, especially if DRE companies are responsible for facilitating claims payouts, as they would need to be equipped with surge capacity and the necessary technology to manage these obligations effectively.

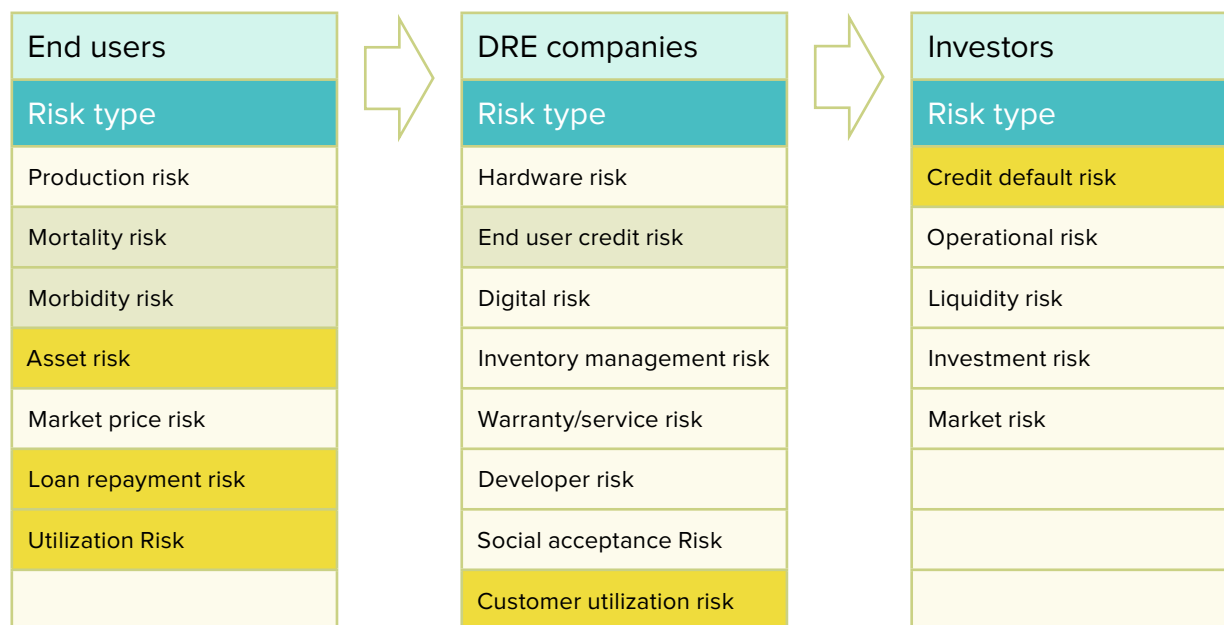
Enablers from value chain actors

- **Government support:** Political support and government buy-in are critical for the success of this product design, as the government would be the central stakeholder responsible for facilitating the purchase and delivery of the insurance. By leveraging existing contingency funds, the government could finance the premiums and integrate the programme with adaptive social protection systems, thereby expanding coverage and ensuring that payouts effectively reach those most in need.
- **DRE companies:** These companies would act as key enablers by helping smallholder farmers register and facilitate claims. Serving as touch points for end users, they would function similarly to agricultural demand aggregators but with the added advantage of having established connections and payment channels. In places where mobile money and PAYGo are already used, DRE companies might handle communication and payouts. However, their reach is still quite limited, and in many cases, cooperatives or other community-based groups may be better suited to take on this role more widely.
- **Financiers:** These stakeholders benefit indirectly from the enhanced financial protection provided by the government programme, which is far more likely to attain scale and thus have a meaningful impact on any investment. In contrast, under an individual product model, achieving similar scale would require mechanisms to enforce or strongly incentivize uptake across a portfolio – an outcome that is difficult to achieve voluntarily and may limit the product's overall effectiveness. In a government programme, the overall risk exposure of the DRE companies is reduced, increasing their investability. This risk mitigation helps maintain the expected return on investment and loan provisions, thereby encouraging increased investment in the energy access sector.

C.3. Life and health insurance for end users

Risk assessment

Figure 11: Key risks addressed through L&H insurance



■ = directly addressed ■ = indirectly addressed

Direct risks addressed

- **Morbidity risk:** Health risks place a significant financial burden on end users by increasing costs, such as medical bills, and reducing income due to lost time from income-earning activities. The health component of this insurance directly addresses these challenges by covering medical expenses related to illness, accidents and injuries, helping to mitigate the financial strain on end users. More complex or long-term coverages, such as disability, are generally excluded due to their cost and the need for ongoing benefits administration, which limits affordability in this context.
- **Mortality risk:** Similarly, life insurance provides a payout in the event of death, which may be used to cover immediate expenses, such as funeral costs, or to offer short-term financing to help manage income shortfalls due to the loss of a key income earner. This reduces the need for surviving dependents to absorb the immediate shock and enables them to avoid selling valuable assets to cover these costs.

Indirect risks addressed

- **Asset risk:** The insurance safeguards end users' assets by offering immediate financial support in the event of death. This ensures that assets can be maintained in the event of damage and avoids the need to liquidate essential equipment.
- **Loan repayment risk:** The product reduces the likelihood of end users resorting to high-interest loans, decreasing the risk of defaulting on loan repayments.
- **Customer utilization risk:** Healthier end users who are not burdened by medical debt are more likely to use their SHS regularly, improving energy consumption and reducing the likelihood of non-payment for energy services.

- **Customer credit default risk:** The combined L&H insurance product helps reduce the likelihood of delinquencies or defaults on payments by end users. By alleviating the financial strain caused by medical emergencies and death, end users are more likely to continue paying for energy services, enhancing the financial resilience of DRE companies. This, in turn, adds confidence for financiers in the long-term viability of mini-grid projects and energy access investments.

Intrinsic risks from the insurer's perspective

- **Moral hazard:** L&H insurance can influence health-related behaviour by reducing financial barriers. This can have mixed effects; some individuals may become less cautious, relying on insurance as a safety net, while others may be more likely to seek care early, especially if price signals such as lower premiums encourage preventive action. Well-designed products can control adverse risks by including features like co-payments or incentives for preventive care, which help steer behaviour toward improved health outcomes and cost-effective service use.
- **Adverse selection:** If only individuals with poor health or higher mortality risk seek coverage, insurers may face higher-than-expected claims, potentially leading to higher premiums.
- **Operational costs:** Managing L&H insurance claims, especially in rural areas with limited access to healthcare services, could lead to increased administrative costs being passed through as higher insurance premiums than a similar product offered to urban-based customers.

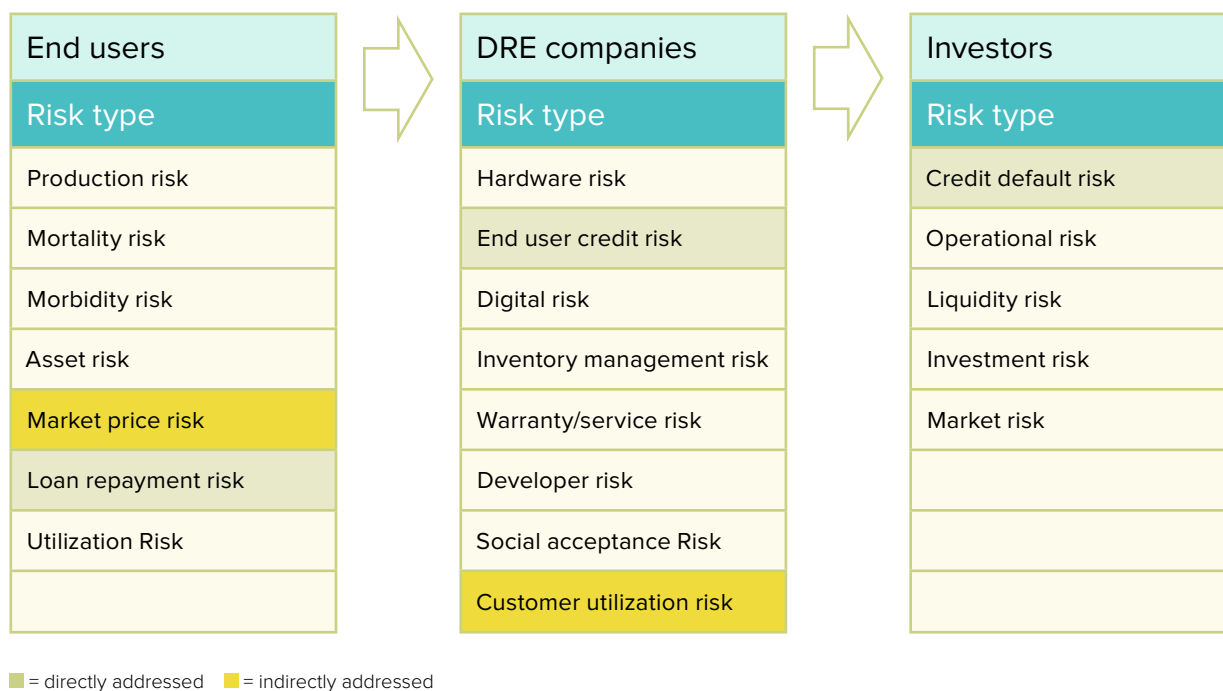
Enablers from value chain actors

- **Energy providers:** DRE companies can act as an intermediary facilitating premium collection and claims processing through their existing customer networks, making the insurance product more accessible to end users.
- **Government support:** Governments can develop policies that make L&H insurance more accessible for remote populations, ensuring greater participation. For example, they can implement premium subsidies, establish public-private partnerships with insurers, or mandate integrated insurance schemes tied to agricultural or social protection programmes. A notable example is India's Pradhan Mantri Jan Arogya Yojana (PM-JAY), which provides subsidized health insurance to low-income households, improving access to essential healthcare services in rural areas.

C.4. End user credit risk insurance for DRE companies

Risk assessment

Figure 12: Key risks addressed through credit risk insurance



Direct risks addressed

- **Loan repayment risk:** End users who experience financial shocks will benefit from this insurance, as it reduces the likelihood of losing access to their SHS due to non-payment.
- **End user credit risk:** The product directly mitigates the credit risk that DRE companies face when lending to customers, ensuring that defaults due to unexpected financial burdens are covered.
- **Credit default risk:** Lower default rates improve the cash flow stability of DRE companies, reduce revenue volatility and enhance their ability to meet operational costs, service debt and attract further investment.

Indirect risks

- **Market price risk:** Financial stability for DRE companies may enable them to maintain more predictable pricing structures for their products, reducing the risk of price volatility for end users.
- **Customer utilization risk:** By protecting customers from the financial impacts of payment default, this product helps ensure that end users can continue to benefit from energy access, promoting regular usage.

Intrinsic risks from the insurer's perspective

- **Operational complexity:** The interdependency on DRE companies, combined with direct limited access to end users, may complicate claims management, increasing administrative burdens.
- **Moral hazard:** There is a risk that customers may become less diligent in making payments, knowing that insurance will cover defaults, leading to increased claims. Similarly, DRE companies may lower their credit assessment standards for new customers if they perceive the insurance as a financial safety net.
- **Adverse selection:** If only financially vulnerable DRE companies take up the product, insurers could face higher-than-expected claims, making the product less sustainable.

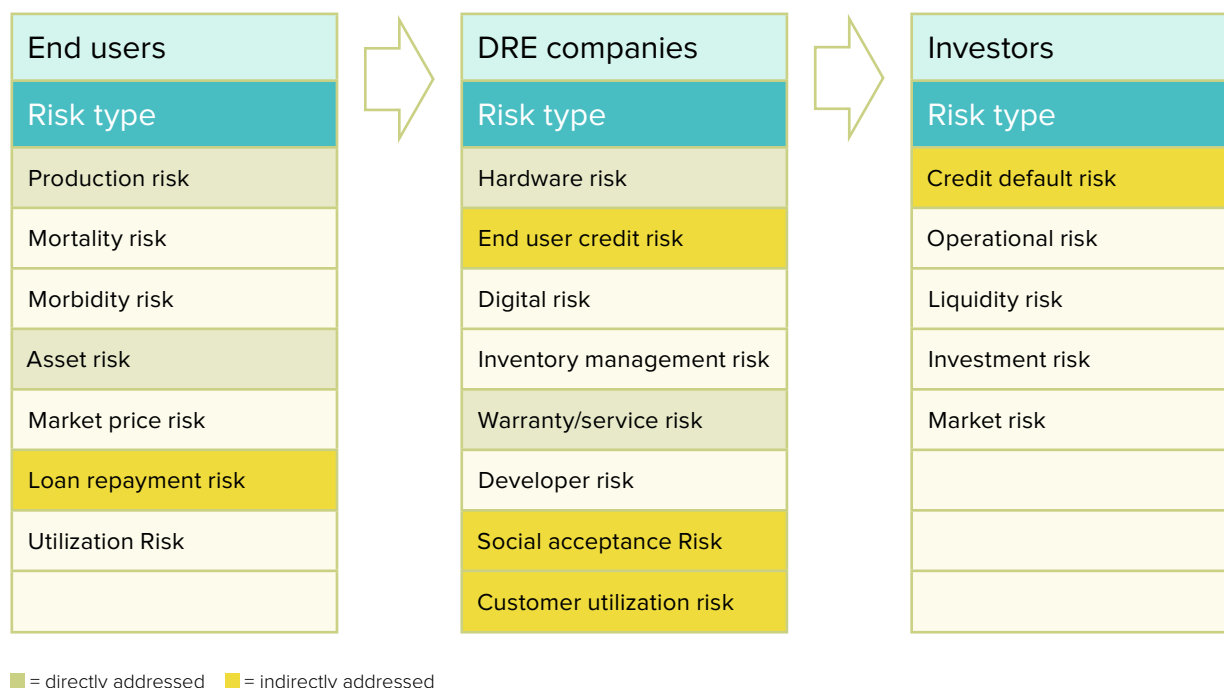
Enablers from value chain actors

- **DRE companies:** These companies can assist with the identification of high-risk customers and can aggregate a portfolio of credit risk to enable diversification of risk and scale and manage the offset of loan losses to insurance payouts without necessarily involving end users.
- **Government:** Governments can incentivize the adoption of this product by providing regulatory support.
- **Financiers:** Financiers in DRE companies may be particularly willing to provide backing for the development of this product, given its direct link to loan repayment and financial stability. Unlike other forms of insurance, credit default insurance is directly tied to investment performance, reducing the risk of revenue shortfalls and improving the financial sustainability of DRE companies.

C.5. Asset protection for Solar Home Systems or other related equipment

Risk assessment

Figure 13: Key risks addressed through asset protection for SHSs or other related equipment



Direct risks addressed

- **Asset risk:** This product directly addresses the risk of equipment damage or malfunction, ensuring that end users relying on such devices do not suffer loss due to unexpected events.
- **Income risk:** If equipment damage occurs, the ability to continue generating an income is compromised. Asset protection insurance mitigates this risk by enabling quicker repairs or replacements.
- **Hardware risk:** DRE companies are exposed to losses from hardware damage. Insurance can cover performance warranties and damages, ensuring financial recovery for operators.
- **Warranty/service risk:** DRE companies can reduce warranty and service risks by bundling the asset protection product with their warranties, offering more comprehensive protection and greater confidence in the longevity of their systems.

Indirect risks addressed

- **Loan repayment risk:** The asset protection product helps mitigate loan repayment risks for end users by ensuring that the equipment they rely on for income generation remains functional, reducing the likelihood of default on loans tied to solar or agricultural equipment.
- **End user credit risk:** By protecting end users from the financial burden of replacing damaged equipment, this insurance reduces the risk of credit defaults, ensuring more predictable revenue streams for DRE companies.

- **Social acceptance risk:** By mitigating equipment failures and financial barriers, trust and confidence in the products increase within communities accessing these energy solutions.
- **Customer utilization risk:** With the financial security provided by the insurance, end users can be assured of continued and consistent use of their energy systems.
- **Credit default risk:** This insurance mitigates the financial impact of loan defaults arising from losses associated with equipment-related issues, thus supporting the overall financial stability of these companies.

Intrinsic risks from the insurer's perspective

- **Claims handling risks:** Managing claims for equipment losses or malfunctions could be complex, especially in remote areas with limited access to repair services and technology. The potential for delayed or inaccurate claims processing could arise if verification mechanisms are not robust.
- **Inventory management risks:** Disruptions in the supply chain for energy equipment could affect the availability of products and parts needed to repair or replace damaged items. Additionally, price volatility in solar panels, batteries and other equipment may impact the cost of insurance coverage.
- **Partner risks:** The success of the asset protection product depends on the performance and reliability of partner organizations, particularly DRE companies supplying at-home devices. Failures in partner operations, such as defective products or inadequate protection during delivery and installation, can lead to higher claims and reduced product efficacy.
- **Moral hazard:** As with other asset-based products, there is a risk that insured parties may not take sufficient care of their equipment, knowing that damage is covered.

Enablers from value chain actors

- **DRE companies:** These companies can facilitate the integration of asset protection into existing product offerings, using their networks to distribute the insurance and collect premiums. They could also support the development or enforcement of basic maintenance standards or quality control measures, which help reduce the frequency of claims and improve the long-term reliability of insured equipment.

Annex D: Product evaluation against design principles

Table 10: Product alignment with core design principles

Smallholder farmers Index Insurance			
Core principle	Score		Explanation
Affordable	✓✓	Meets	Premiums can be tailored to remain affordable while offering adequate coverage.
Accessible	✓✓	Meets	Mobile money and PAYGo systems enhance accessibility, especially for remote smallholder farmers.
Valuable	✓	Partially meets	Covers risks like crop failure, but payouts may not fully cover losses in all cases, limiting the value.
Scalable	✓✓	Meets	Scaling is facilitated by lower underwriting requirements and leveraging DRE company's existing capabilities.
Aligned with National Development Strategies	✓	Partially meets	While it supports financial inclusion and climate resilience, it has a limited impact on electrification rates.

Government-administered index insurance			
Core principle	Score		Explanation
Affordable	✓✓	Meets	Government subsidies or funds can ensure that premiums remain affordable for smallholder farmers.
Accessible	✓✓	Meets	DRE companies and mobile payment systems enhance accessibility.
Valuable	✓✓	Meets	This product offers significant value by protecting smallholder farmers against large-scale agricultural disasters.
Scalable	✓✓	Meets	National backing and digital tools enable broad geographic reach and scaling.
Aligned with National Development Strategies	✓✓	Meets	The product aligns well with government goals like poverty alleviation and rural development.

Life and health insurance for smallholder farmers			
Core principle	Score		Explanation
Affordable	✓	Partially meets	Premiums are affordable via PAYGo, but the coverage may not always meet the high cost of medical care.
Accessible	✓✓	Meets	Existing DRE payment systems and agent networks facilitate access, even in remote areas.

Valuable	✓✓	Meets	Provides essential value by reducing the financial strain from health and funeral costs.
Scalable	✓	Partially meets	The demand may not be as strong as for other products, limiting scalability.
Aligned with National Development Strategies	✓	Partially meets	Offers support for financial inclusion and poverty alleviation but may not align strongly with all government policies.

End user credit risk insurance for DRE companies

Core principle	Score		Explanation
Affordable	✓	Partially meets	Premiums are integrated into PAYGo, but costs could be passed on to end users, reducing affordability.
Accessible	✓✓	Meets	The product can be easily integrated into existing credit or loan offerings.
Valuable	✓✓	Meets	Helps DRE companies, financiers and end users maintain cash flow stability.
Scalable	✓✓	Meets	Leverages exist digital platforms for broad-scale implementation.
Aligned with National Development Strategies	X	Does not meet	Minimal alignment with government policies; the government's role in this product is limited.

Asset protection for SHSs or other related equipment

Core principle	Score		Explanation
Affordable	✓	Partially meets	Premiums depend on the value of the insured asset, which may result in high premiums or low payout.
Accessible	✓	Partially meets	Use of mobile payment systems and agent networks ensures accessibility for remote communities, but cover may be limited to only certain assets.
Valuable	✓	Partially meets	Ensures protection against equipment damage but may not be perceived as critical compared to health or asset risks.
Scalable	✓✓	Meets	Bundled with financing models, the product can be scaled easily.
Aligned with National Development Strategies	X	Does not meet	The product supports economic resilience but is less likely to align with specific government policies.



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