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Affordable Financing for Decentralised Renewable Energy Technologies

Scaling Institutional Credit for
Clean Energy-Powered
Livelihoods

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Foreword

Even as India's rural workforce gradually diversifies beyond farming, agriculture will remain central to rural life for years to come, currently standing as the sector employing the largest share of India's population. Absorbing this transition will depend, in part, on the strength of India's growing MSME ecosystem. And the key to that transition is meeting increasing energy needs. However, in the days to come, the non-farm rural sector is progressively going to be important. Decentralised Renewable Energy (DRE) technologies (including solar pumps, solar cold storage, solar food processors, solar rice mills, and solar refrigerators) offer a means to power both ends of this transition: strengthening productivity on the farm, and enabling new enterprises, through energy that is affordable, reliable, and available locally, at the point of income generation. The DRE ecosystem has the potential to increase incomes and productivity, control post-harvest losses, and enable decentralised value addition, with minimum operating costs or transitions.

As financial institutions align their lending priorities with national objectives, including through Priority Sector Lending, financing DRE technologies for rural livelihoods represents a significant yet untapped opportunity. and a study by CEEW (Waray, Patnaik, and Jain 2018) estimates that DRE livelihood technologies could impact 37 million livelihoods, unlocking a market opportunity standing at USD 50 billion. However, adoption remains a fraction of what the sector could ultimately support. One of the critical gaps between the potential and the uptake is a gap in financing, and closing it will require financial institutions to see the sector as a mainstream commercial lending opportunity. In stepping forward to finance this sector, banks and financial institutions have the opportunity to help shape the next chapter of India's agricultural and enterprise economy; one powered by clean, decentralised energy.

It is with this opportunity that the National Institute of Bank Management and the Council on Energy, Environment and Water (CEEW) as a part of their Powering Livelihoods programme with Villgro, with their respective specialisations in lending and DRE, have come together to develop this white paper. Drawing on ground-level evidence, the report maps the DRE technology ecosystem and financing landscape, profiles innovative models that have already been implemented, and highlights key levers and recommendations to scale financing for the sector. In particular I compliment Dr Naveen Kumar from NIBM and Ms Tishya Sheel Doraiswamy, Ms Sanjita Singha, Ms Divya Gaur from CEEW, and Ms Pooja Ravindra from Villgro, for focusing their intellectual energy and drafting this pertinent piece of work to move the banking sector towards prioritising green innovations. It is our hope that this work would equip financial institutions with the insight and confidence to further engage with this sector, and in doing so, to play their part in building a more productive, resilient, and sustainable rural economy.

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Contents

Executive Summary	1
The Indian context	1
DRE technologies as a solution	1
Proven viability and the case for accessible finance	2
Objectives	3
Key findings	3
Recommendations	5
1. The Indian context	7
2. DRE livelihood technologies: Overview, viability, and potential impact	8
2.1. Economic viability and market potential of DRE technologies	9
2.2. Socio-economic and environmental impact of DRE technologies	10
2.3. Policy integration for DRE technologies in India	13
2.4. Acceleration for scaling clean energy livelihoods	14
3. Financing for DRE livelihood technologies	16
3.1. Key barriers to scaling financing for DRE livelihood technologies	16
3.2. The scale of the financing requirement	17
3.3. Asset tiers and their livelihood impact	18
3.4. Asset tiers and lender alignment	18
3.5. Overcoming the barriers to financing DRE livelihood technologies	22
3.6. DRE livelihoods financial assessment toolkit	23
3.7. Qualitative considerations in assessing a DRE technology	24
3.8. Case stories from ground: Innovative financing solutions supported through blended financing	25
3.9. Learnings from the Powering Livelihoods initiative	28
4. Way forward: Recommendations	31
5. Conclusion	33
Endnotes	34
References	36
Acronyms	40
Annexure	41
A1. Estimated annual income assumptions	41
A2. Estimated financing requirement methodology	44
A3. DRE livelihood technologies: mapping to bank lending verticals	45
The authors	48

Executive Summary

The Indian context

India's rural economy stands at an inflection point. Agriculture employs 46.1 per cent of the country's workforce, yet contributes only 17.8 per cent to gross domestic product (GDP), highlighting a persistent gap between employment and productivity (MoSPI 2024; National Accounts Statistics 2025). Among the country's 93.1 million agricultural households, the average monthly household income is INR 19,696, underscoring the need to improve the productivity and profitability of rural livelihoods (NSSO 2019; ICRIER 2024). This productivity and income is constrained for two reasons: Low mechanisation and high farm losses. At the production stage, low levels of mechanisation further constrain agricultural productivity. Only around 45 per cent of farm operations are mechanised, despite evidence that mechanisation can reduce labour costs by 20–30 per cent and increase productivity by 10–15 per cent (Tiwari et al. 2019). Post harvest food loss also forms a significant share, exacerbating the decline in farmers' income and productivity. In 2022, a study commissioned by the Ministry of Food Processing Industries and conducted by National Bank for Agriculture and Rural Development (NABARD) Consultancy Services estimated annual post-harvest losses of INR 1.53 lakh crore across major crop categories. These losses stem not only from inadequate storage, cooling and processing infrastructure, but also from unreliable electricity supply in rural areas, which limits the viability of energy-dependent post-harvest technologies (Kabiraj and Smridhi 2023). This makes it increasingly important to improve the efficiency of farm operations through mechanisation and adequate infrastructure at the farm gate, while enabling higher-value activities such as processing, storage and aggregation that generate greater returns from agricultural produce. Beyond the farm gate, improving agricultural productivity while expanding rural enterprises is also central to India's employment challenge. India is projected to require 90 million non-farm jobs by 2030, with rural enterprises expected to play a critical role in generating them (Sankhe et al. 2020). Rural India is already home to 51 per cent of the country's 63 million micro, small and medium enterprises (MSMEs), making enterprise-led growth an important pathway for income diversification and local economic development (Nagpal 2025; FICCI n.d.).

Reliable, appropriately scaled energy and greater mechanisation can help address these constraints by enabling increased productivity, local value addition and enterprise. Decentralised renewable energy (DRE) livelihood technologies represent one such opportunity. Across applications ranging from irrigation and spraying to food processing, cold storage, dairy and fisheries, these technologies can enable reliable energy access, support mechanisation, reduce operating costs, and facilitate value addition. As a result, they offer a practical pathway to strengthening rural livelihoods while advancing India's clean energy transition.

DRE technologies as a solution

DRE-powered technologies are small-scale, modular energy systems that use renewable sources (solar, biomass, small wind, or micro-hydro) and are deployed close to the point of livelihood or energy use. DRE systems generate and use energy locally, reducing dependence on unreliable grid supply and volatile

diesel prices while providing affordable and reliable energy for productive activities. Applications of DRE livelihood technologies span several farm and non-farm value chains, ranging from pre-harvest mechanisation through solar pumps and sprayers, to food processing and value addition through solar drying, processing, and milling, to cold chain, animal husbandry and dairying, livestock and fisheries, and textiles and enterprise creation. These assets have the **potential to impact over 37 million livelihoods and unlock a market opportunity of nearly USD 50 billion** (Waray, Patnaik, and Jain 2018). Currently, DRE adoption stands at approximately 0.56 million deployments, led by solar irrigation pumps under *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan* (PM-KUSUM), followed by solar dryers, cold rooms, milk chillers, and food processing equipment; yet this remains well below the sector's potential of over 20 million deployments (Jain, Khalid, and Jindal 2023).

Achieving commercial scale depends not only on technology or manufacturing capability, but also on an ecosystem in which grassroots organisations drive awareness, distributors extend market reach, financiers enable ownership through credit, and policymakers create enabling conditions—together underpinning five interdependent levers: customer awareness, last-mile service capacity, product standardisation, market linkages, and financing. Of these, financing remains particularly critical given the high upfront cost of these technologies and low awareness about the viability of these innovations. For farmers, microentrepreneurs, self-help groups (SHGs) and small retailers who can benefit from such assets, affordable credit access can determine whether adoption happens at all.

Proven viability and the case for accessible finance

In its market viability report (Jain, Khalid and Jindal 2023), the Council on Energy, Environment and Water (CEEW) assesses technologies spanning agriculture, livestock, food processing, cold chain, and textiles, and demonstrates strong economic viability of various DRE assets. Asset values range from approximately INR 19,000 for a solar sprayer to more than INR 20 lakh for a cold storage unit (20 metric tonnes (MT)), with discounted payback periods ranging from five months to around 52 months depending on the technology and financing terms.

This viability translates into measurable impact on the ground: evidence from CEEW and Villgro's Powering Livelihoods programme shows that 87 per cent of 660 surveyed users experienced income gains after adoption, with median increases of up to INR 40,000 (or 33 per cent) annually, driven by more earning days, lower input and energy costs, and improved productivity and product quality. Among users who experienced income gains and made some upfront contribution towards the technology, 46 per cent could repay their initial loan using their increased incomes alone; this share rises to 68 per cent if loan tenures are extended, indicating that better-structured financing and increased access to credit could make repayment viable for a large share of users (Yasaswi, Gaur, and Jain 2025). Beyond income, users report reduced physical drudgery, greater financial resilience and confidence in building assets, and reduced migration pressures, with benefits particularly pronounced for women through greater mobility, skill-building, and decision-making agency. Together, this evidence points to DRE livelihood technologies as both financially viable investments and a meaningful driver of economic and social empowerment in rural India.

Despite growing evidence of commercial viability, financing remains a key constraint to scale. DRE livelihood assets are capital-intensive, requiring high upfront investment relative to end-users' incomes, despite comparatively lower operating costs over the asset's life. Ticket sizes vary widely across technologies, and financing therefore needs a tailored approach: lower-ticket assets impose disproportionately high origination, appraisal, and monitoring costs relative to loan size, while higher-ticket assets require stronger evidence of utilisation and successful deployment before lenders will finance them at scale. This is compounded by limited lender familiarity with DRE technologies and the absence of standardised appraisal benchmarks, which make risk difficult to assess. Consequently, most deployments currently rely on philanthropic capital, or subsidies rather than commercial credit, keeping the sector dependent on concessional funding. Within the Powering Livelihoods programme's own experience, non-banking financial companies (NBFCs) and peer-to-peer (P2P) platforms have been the primary financing partners, helping build early evidence of the sector's commercial viability. However, scaling further requires the participation of commercial and institutional credit, particularly as many DRE technologies already qualify under government schemes involving subsidy-linked loans routed through banks. Leveraging commercial and institutional credit is therefore essential to unlocking the sector's full livelihood and economic potential.

Objectives

This whitepaper aims to map the DRE livelihood financing ecosystem, diagnose the barriers limiting institutional credit flow, and propose practical recommendations to help banks and financial institutions (FIs) integrate DRE livelihood technologies into mainstream lending portfolios. In doing so, its objective is to equip the financing ecosystem with a clearer picture of the DRE livelihoods sector and technologies available, the policies and schemes that can be leveraged to support their uptake, learnings from the sector, and the key considerations involved in financing these assets.

Key findings

The estimated financing requirement for five high potential technologies is up to USD 5.7 billion

Estimates from CEEW and Villgro's Powering Livelihoods programme place the current financing requirement for just high potential DRE technologies (solar dryers, solar refrigerators, solar food processors, vertical fodder grow units and solar cold storage) at up to **USD 5.7 billion** per current market potential. A detailed scenario analysis is expanded on in the main report.

Two structural bottlenecks exist in financing DRE livelihood technologies: a 'missing middle' for mid-tier assets, and an inverse interest-rate relationship that raises costs for small borrowers.

A "missing middle" exists for mid-tier assets (INR 1–5 lakh, including solar dryers, micro-processors, micro cold storages, and looms), which are too large for typical microfinance institution (MFI) ticket sizes, yet small relative to the fixed costs of origination and appraisal that larger banks incur, thus offering lower returns against their cost of funds and giving these lenders limited incentive to prioritise such loans over larger-ticket exposures, an effect compounded by the absence of standardised technology benchmarks. Second, an inverse interest-rate relationship persists, where smaller-ticket assets attract higher interest rates and shorter tenures than larger ones, raising costs for the borrowers least able to absorb them.

DRE livelihood technologies vary widely in ticket size and use case; different lender types are therefore suited to financing different segments of the market.

Microfinance institutions, SHG–bank linkage models, and small finance banks (SFBs) are best placed for small-ticket, first-time, collateral-free borrowers. SFBs, regional rural banks (RRBs), and NBFCs are better suited to mid-sized productive assets using enterprise cash-flow assessments. Public sector banks (PSBs) and commercial banks are best positioned for capital-intensive assets requiring long-tenure project finance, subsidies, and refinance support. A differentiated, ecosystem-based lending approach, rather than reliance on a single channel, is required to appropriately match capital to each segment.

ES Table 1 | Comparative assessment of lender types for financing DRE livelihood technologies

Parameter	PSBs	RRBs	SFBs	Cooperative Banks	MFIs	NBFCs	Peer-to-Peer (P2P)	Private Banks
Rural reach ⁸	Medium	Very High	Medium	High	High	Medium	Medium	Low
Agriculture & livelihood portfolio ⁹	High	Very High	Medium	High	Medium	Medium	Medium	Low
MSME lending capability ¹⁰	High	Medium	High	Low	Low	High	Medium	High
Sanction government subsidies/schemes ¹¹	High	High	Medium	High	NA	NA	NA	Medium
Cash-flow / enterprise-based appraisal ¹²	Medium	Medium	High	Medium	High	High	High	High
Collateral-free lending ¹³	Low	Medium	High	Medium	Very High	High	Very High	Medium
Tolerance for thin/no CIBIL history ¹⁴	Low	Medium	High	High	Very High	High	High	Low
Women-focused lending ¹⁵	High	Very High	High	High	Very High	Medium	Medium	Medium
Digital origination & onboarding ¹⁶	Medium	Low	High	Low	High	Very High	Very High	Very High
Speed & flexibility of underwriting ¹⁷	Low	Medium	High	Medium	High	Very High	Very High	High

Source: Authors' synthesis based on Abraham (2006); Ahmed, Casiraghi, and Ogawa (2023); Ahmed, S. (n.d.); Berger and Udell (2002); Business Standard (2025a, 2025b, 2026); Department of Financial Services (n.d., 2026); Kumar, Kaveri, and Shah (2024); KPMG (2024); MFIN (2024); NABARD (n.d., 2024); PIB (2025, 2026); Reserve Bank of India (2017, 2022 [updated 2025], 2025a, 2025b); Sa-Dhan (2025); Sarthak Law (2025); Sebastian (n.d.); Sudarshan and Hegade (2024); The New Indian Express (2019); and Vision IAS (2025).

Methodology note: This comparative assessment draws on a synthesis of secondary sources, authors' analysis and insights from the Powering Livelihoods programme's engagement with lenders, DRE enterprises, and end-users. Parameters were selected to reflect dimensions relevant to a lender's decision to finance DRE livelihood technologies, spanning outreach, risk appetite, operational capability, strategic alignment, and use of government subsidies/guarantees. Ratings are qualitative and relative, indicating how a lender category compares to other categories on a given parameter.

Last mile support on loan screening and collection offer a replicable model.

Ground-level ecosystem partners are central to scaling DRE finance. Beyond generating leads and supporting users after installation they help reduce lending risk by screening borrowers, identifying early signs of repayment stress, and assisting with collections and troubleshooting when repayments are missed. Their unique value comes from their sustained local presence. Familiarity with borrowers allows them to assess repayment capacity beyond formal appraisal, build confidence in financing, and provide low-cost follow-up and collection support. Financing outcomes also show strong geographic concentration, suggesting scale is best achieved by replicating successful local partner ecosystems rather than uniform national rollout or purely demand-driven expansion. Early traction indicates that embedded

actors with both sales influence and repayment responsibility can be essential to unlocking rural credit uptake at scale.

The presence of a credible anchor institution can enable financier entry into this asset class.

As DRE livelihood technologies are still an emerging lending segment, financiers have often relied on anchor institutions such as enterprises or ecosystem partners to aggregate demand, provide after-sales support, and build confidence in the technology and market. Assessing the strength of the anchor partner can therefore serve as a practical entry strategy alongside conventional borrower and asset appraisal.

Recommendations

This paper proposes key recommendations to scale financing for the DRE sector moving forward:

Capacity building

- **Build institutional capacity through specialised training** for PSBs, RRBs, cooperative banks, and other FIs through dedicated training programmes on DRE technologies, business models, and risk assessment. Institutions such as the National Institute of Bank Management (NIBM) and the Bankers Institute of Rural Development (BIRD) can play a leading role in designing and delivering these programmes.
- **Develop technology-specific standardised appraisal benchmarks** and model credit assessment frameworks for commonly financed DRE livelihood technologies. Standardised benchmarks would improve consistency in credit appraisal, reduce reliance on individual lender expertise, and increase confidence in financing newer technologies.
- **Develop lending guidelines** for DRE technologies to support loan structuring, documentation requirements, collateral assessment, and monitoring practices across FIs.

Instrument design

- **Strengthen refinance and risk-sharing support** for DRE livelihood lending and establish a dedicated credit guarantee mechanism, anchored by NABARD or the Small Industries Development Bank of India (SIDBI), to provide partial credit guarantees and loss covers for DRE livelihood portfolios. This would reduce lender risk, encourage wider participation by FIs, and catalyse lending for DRE livelihood technologies. Concessional climate finance could further enhance the facility and improve credit affordability.
- **Reduce the cost of originating and appraising small-to-medium ticket size loans through aggregation models** bundling small borrowers into bankable portfolios, technology-specific standardised appraisal benchmarks, and digital loan origination. Potential aggregators include DRE enterprises, farmer producer organisations (FPOs), SHG federations, cooperatives, and other rural intermediaries with existing customer relationships and networks.
- **Promote the integration of DRE livelihood financing across existing rural credit programmes** and institutional networks to enable wider outreach, particularly through PSBs, RRBs, and cooperative banks that have an extensive rural presence.
- **Leverage concessional climate finance to mobilise commercial capital.** Blended finance mechanisms can improve the bankability of DRE livelihood investments by absorbing early-stage and default risk.

NABARD and SIDBI, both accredited to the Green Climate Fund (GCF) already manage climate finance, guarantee, and concessional lending facilities that could be adapted for DRE livelihoods. These existing multilateral and domestic financing channels provide an institutional platform through which concessional capital and risk-sharing instruments could be directed towards DRE livelihood technologies. Commercial lenders and development finance institutions can work with NABARD and SIDBI to structure guarantee and credit-enhancement facilities under existing accreditations, thereby unlocking private sector participation. Multilateral platforms like the Asian Development Banks' India Green Finance Facility (IGFF) demonstrate how blended credit lines and risk-sharing mechanisms can mobilise private investment in DRE. Under this, the DRE sector has an IGFF allocation of USD 130 million and total mobilised financing of USD 322 million (Green Climate Fund 2024).

- **Adopt cash flow-based lending approaches for productive assets.** Given that repayment capacity is closely linked to income generated by productive-use DRE technologies, credit appraisal frameworks may progressively incorporate projected enterprise cash flows alongside conventional borrower assessments. Loan tenures and repayment schedules aligned with seasonal income patterns would further improve product suitability and repayment outcomes for rural livelihood investments. Commercial banks, NBFCs, and SFBs can pilot such lending approaches, while NABARD and NIBM can support the development of standardised appraisal methodologies and operational guidance.

Policy

- **Integrate DRE livelihood technologies within mainstream lending portfolios.** FIs may consider integrating DRE livelihood technologies systematically within their agriculture, MSME, and renewable energy portfolios. Such investments align with Priority Sector Lending objectives and complement the increasing integration of climate and ESG considerations into banking operations. PSBs, RRBs, Cooperative Banks, and SFBs are well positioned to expand lending across different borrower segments, and NABARD's refinance support could be extended to DRE livelihood technologies to reduce the financing burden on RRBs and Cooperative Banks and strengthen affordable rural lending.
- **Strengthening policy convergence for DRE financing.** Existing government schemes offer instruments that can support DRE livelihood technologies, but these are typically accessed in isolation rather than combined, and further have no dedicated DRE category. Each instrument addresses a different barrier, and together they can make financing more viable than when deployed independently. The ambiguity in classifying DRE livelihood technologies under the existing Priority Sector Lending (PSL) framework further underscores the need for guidance mapping commonly financed technologies to the relevant PSL provisions. Given DRE's potential in enhancing rural livelihoods and climate goals, there is a case for creating dedicated DRE windows or ring-fenced allocations within existing schemes, rather than requiring these technologies to compete within broader agriculture or MSME budgets.

1. The Indian context

India's rural economy stands at an inflection point, with a simultaneous need to boost agricultural productivity, diversify livelihoods, and create sustainable economic opportunities. As India pursues its climate and development goals, there is a growing need for investments that enhance rural incomes, improve productivity, and support a low-carbon economic transition.

Agriculture employs 46.1 per cent of India's population but contributes only 17.8 per cent to gross domestic production (GDP) (MoSPI 2024, 2025), reflecting a structural mismatch between employment and productivity. Amongst the country's 93.1 million agricultural households (NSSO 2019), the average monthly household income stands at INR 19,696 (ICRIER 2024). Only approximately 45 per cent of farm operations are mechanised (PIB 2025), despite evidence that mechanisation can reduce labour costs by 20–30 per cent, increase productivity by 10–15 per cent, and lower input costs by 15–20 per cent (Tiwari et al. 2019). Clean mechanisation can further reduce dependence on diesel, shielding farmers from fuel price volatility while supporting more sustainable and climate-resilient agricultural systems.

Compounding this, inadequate post-harvest infrastructure and unreliable rural power supply add to farm losses: a 2022 study commissioned by the Ministry of Food Processing Industries (MoFPI) and conducted by National Bank for Agriculture and Rural Development (NABARD) Consultancy Services (NABCONS) estimated annual post-harvest losses of INR 1.53 lakh crore a year across major crop categories¹. These losses are driven by gaps in handling and storage infrastructure, while erratic rural electricity supply undermines the viability of cold storage and other post-harvest technologies (Kabiraj and Smridhi 2023).

As labour shifts away from agriculture, India is expected to require 90 million non-farm jobs by 2030, highlighting the need for scalable livelihood solutions that can enhance productivity while creating new economic opportunities (Choithani, van Duijne, and Nijman 2021; Sankhe et al. 2020). Rural India is already home to 51 per cent of the country's 63 million micro, small and medium enterprises (MSMEs), making enterprise-led growth a key pathway for income diversification and rural development (Nagpal 2025; FICCI n.d.).

Decentralised renewable energy (DRE) powered technologies can address these challenges by enabling reliable, affordable, and appropriately scaled energy for productive use in farm and non-farm sectors. These are small-scale, modular renewable energy-based systems deployed close to the point of livelihood or energy use, reducing dependence on unreliable grid supply and diesel. Across applications spanning pre-harvest agriculture, food processing, cold storage, dairy, and fisheries, they support mechanisation, increase productivity, reduce operating costs, and enable value addition. With the potential to **impact over 37 million livelihoods and unlock a market opportunity of nearly USD 50 billion**, DRE livelihood technologies offer a pathway to strengthening rural livelihoods while advancing India's clean energy transition (Waray, Patnaik, and Jain 2018). Realising this potential will require financing models that enable widespread adoption, making financial institutions (FIs) key to scaling DRE-powered livelihoods.

2. DRE livelihood technologies: Overview, viability, and potential impact

Over the last few years, several energy efficient technologies (Table 1) have emerged across agricultural, food processing, animal husbandry, textile and other sectors, creating opportunities to enhance incomes and livelihoods in India's MSME and agriculture sectors. These solutions are typically small-scale, modular systems, deployed close to the point of livelihood (on-farm, enterprise, or community level), and can be adopted by individual farmers, microentrepreneurs, farmer producer organisations (FPOs), self-help groups (SHGs), and local service providers. By delivering clean, affordable energy where it is needed, they reduce dependence on unreliable grid supply and fossil fuels while improving productivity, lowering operating costs, and enabling local value addition.

While significant market potential remains untapped, adoption of DRE livelihood technologies has grown steadily. Over 560,000 technologies have been deployed across irrigation, food processing, cold storage, dairy, fisheries, and rural enterprises (Jain, Khalid, and Jindal 2023). Solar irrigation pumps account for the majority of installations (driven by *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan*, or PM-KUSUM), while technologies such as solar dryers, cold rooms, milk chillers, and food processing equipment are gaining traction across value chains, signalling a shift from pilot deployments to commercially viable enterprise solutions.

Table 1 | Overview of existing DRE technologies

Value chain	Technology
Food processing	Solar mini rice mills
	Solar flour and millet mills
	Solar oil expellers
	Solar pulverisers & grinders
	Multipurpose food processors
	Solar spice grinding units
	Solar powered spice grinding and milling
	Solar chips/ chakli/ vermicilli/ papd/ roti making machines
Cooling and cold chain	Solar/Biomass cold rooms and cold storage
	Solar refrigerators
	Small-scale cooling units (sub-MT, generally 20-300kg)
Textiles	Solar-powered silk reeling & spinning machines
	Solar- powered looms
	Solar sewing machines
Pre-harvest	Solar water pump
	Solar sprayers
	Solar animal deterrents

Value chain	Technology
	Paddy weeders and transplanters
Animal Husbandry and dairying	Milk chillers
	Solar-powered vertical fodder grow units
	Solar milking machines
	Solar chaff cutter
	Solar butter churning
Livestock - poultry	Poultry rakers
	Solar egg incubators
Fisheries and aquaculture	Solar fish aerators
	Mini Recirculatory Aquaculture System

Source: Author's analysis based on SELCO Foundation (2023), Powering Livelihoods project documentation, and stakeholder interactions with portfolio enterprises and end-users.

Note: The basket of technologies presented is illustrative and reflects the broad set of solutions available. The table is therefore not intended to represent the full universe of mature DRE livelihood applications.

2.1. Economic viability and market potential of DRE technologies

A central question in the deployment of DRE livelihood technologies is whether they are economically viable for the micro-entrepreneurs and smallholder farmers who adopt them. Evidence indicates that, across a range of technologies and use cases, these assets generate meaningful returns, with ownership and operating costs generally commensurate with the value they create.

Table 2 presents a summary of the economic parameters for twelve DRE technologies across five sectors. Asset values range from INR 32,000 for a solar silk reeling unit to INR 9,00,000 for a 5-metric-tonne cold storage facility. Monthly income potential spans from INR 2,000 for a fodder grow unit to over INR 26,000 for a cold storage unit. Discounted payback periods, estimated using a common reference² discount rate, range from as little as five months for the Sabjee Cooler operating under a commodity trading model, to 52 months for a solar-powered grain mill.

Table 2 | Economic viability of DRE livelihood technologies

Sector	Technology	Asset value (INR)	Estimated annual income (INR)	Loan tenure (years)	Payback period (months) at various annual interest rates				Deployment potential
					9%	12%	16%	18%	
Agriculture	Sub-HP Solar Pump	45,000	45,000	3	11.9	12.4	13.1	13.4	3,425,032
	High-HP Solar Pump	250,000	102,000	4	29.1	30.6	32.7	33.8	8,195,269
Livestock	Fodder Grow Unit	42,000	24,000	1	21.0	21.4	21.8	22.0	3,379,510
Food Processing	Food Processor (40L/hr)	137,780	96,000	3	17.1	17.8	18.7	19.2	546,718
	Grain Mill (150 kg/hr)	730,986	188,160	4	46.1	48.5	51.9	53.6	946,684
	Solar Dryer (100 kg)	130,000	80,950	2	19.2	19.8	20.5	20.8	1,680,315

Sector	Technology	Asset value (INR)	Estimated annual income (INR)	Loan tenure (years)	Payback period (months) at various annual interest rates				Deployment potential
					9%	12%	16%	18%	
Cold Chain & Storage	DC Refrigerator (100L)	95,000	35,000	3	32.2	33.9	36.2	37.4	1232368
	Bulk Milk Chiller	709,015	210,375	4	40.0	42.1	45.0	46.5	90224
	Cold Storage (5 MT)	900,000	319,380	3	33.4	35.2	37.6	38.9	141,984
Textiles	Solar Silk Reeling Unit	32,000	53,500	1	7.2	7.3	7.4	7.5	78,000
	Solar Charkha	43,599	50,000	1	10.5	10.6	10.8	10.9	386,500
	Solar Loom	177,600	261,500	1	8.2	8.3	8.4	8.5	620,915

Source: Deployment potential is based on internal analysis using NSSO 73rd round data and CEEW research (Khalid et al. 2021; Jindal, Khalid, and Jain 2021; Khalid et al. 2022; Khalid, Jindal, and Jain 2022; Jain, Khalid, and Jindal 2023).

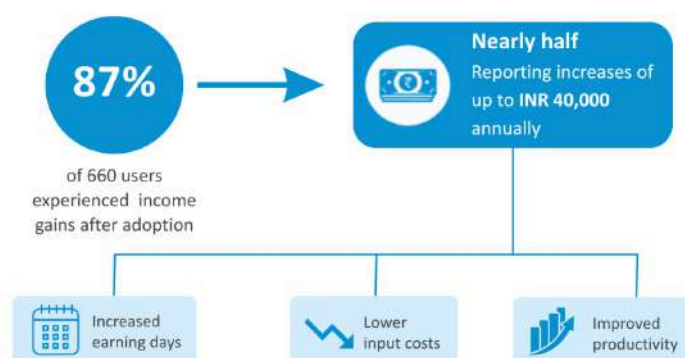
Note: Income figures represent modelled average annual income potential. Asset values are based on manufacturer prices. Discounted payback periods assume a 10% discount rate and 10% upfront contribution.

DRE livelihood technologies can increase incomes through several pathways. By mechanising operations and reducing reliance on diesel or grid electricity, they can lower labour and energy costs. Solar sprayers and poultry rakers, for example, reduce the time and effort required for pesticide application and poultry-litter management. Solar dryers and food processors enable value addition, extend shelf life, and reduce post-harvest losses, while cold-chain technologies reduce perishability and enable longer storage of produce, dairy, and animal products. Through these pathways—cost savings, reduced losses, value addition, productivity gains—DRE technologies can increase incomes while strengthening the resilience and viability of rural livelihoods.

2.2. Socio-economic and environmental impact of DRE technologies

DRE technologies can meaningfully improve livelihoods by increasing incomes through various pathways (highlighted in Section 2.1). Evidence from the Powering Livelihoods programme shows that 87 per cent of 660 users experienced income gains after adoption, with almost half reporting increases of up to INR 40,000 annually, and a median income increase of 33 per cent (Yasaswi, Gaur, and Jain 2025). These gains stem from more earning days, lower input costs (particularly lower energy costs), improved productivity, and, in some cases, better product quality and prices enabled by value addition or product preservation.

Figure 1 | Almost 90 per cent of 660 users experienced income gains after adoption



Source: Yasaswi, Gaur, and Jain 2025

Beyond economic benefits, DRE technologies also generate significant social impact. They reduce physical drudgery and save time, making livelihoods less labour-intensive and more efficient. Users also report greater financial resilience³, including an increased ability to save, invest in household needs, and smooth consumption; 81 per cent felt more confident in building assets, while many reported reduced migration pressures. Benefits are particularly pronounced for women, who reported greater participation in community activities, mobility, skills, and decision-making agency. These outcomes highlight the potential of DRE technologies to advance economic and social empowerment (Yasaswi, Gaur, and Jain 2025).

While India has made progress in creating an enabling ecosystem for DRE livelihoods, scaling adoption requires deeper integration of DRE within government schemes to improve project viability (through subsidies, market linkage, working capital support and entrepreneurship support) and credit access. The following case studies illustrate how combining public schemes with formal credit can accelerate technology adoption and create on-ground impact:

Figure 2 | End-user financing enabled access to DRE-powered processing technologies, reducing energy costs while supporting decentralised value addition, business expansion, and revenue growth.

A. Enhancing farmer enterprises in Valsad, Gujarat through PMEGP- supported deployments



*Bilaj Thakor using solar-powered multi-food processor
Value added product – Turmeric Powder*

After completing her education, Bilaj Thakor from Valsad, Gujarat dedicated herself to her family enterprise, Radheeka Organics & Ayurveda, which produces organic turmeric, and vegetable and fruit juices.

Recognising the growing demand for value-added organic products, Bilaj and her husband decided to expand their operations through clean-energy powered processing solutions.

They invested INR 20 lakh in multiple technologies, including a 100 kg solar powered multi-food processor, dehydrator machine, solar-powered atta chakki, packaging machine, and a 10 kW solar panel system. To finance this, they availed a loan of INR 16 lakh from Bank of Baroda for an interest rate of 7.9 per cent, and received a 35 per cent subsidy worth INR 5.74 lakh under the *Prime Minister's Employment Generation Programme scheme* (PMEGP).

Today, with a 6 member team, the enterprise has expanded its production and market reach. Through this adoption, her income increased by ~300 per cent, with the business generating annual profits of INR 8 lakh.

B. Clean energy powered enterprise as catalyst for rural development: a Mudra loan supported success story from Gonda, UP



Dharamraj Singh using atta chakki for processing flour

Dharamraj Singh, a farmer from Belsar village in Gonda, Uttar Pradesh, realised the lack of affordable and reliable agro-processing services in his village. To address this, he set up a solar-powered atta chakki and oil expeller unit, which today serves customers from villages within a 2 km radius.

The unit processes 100 kg of grain per hour, with services priced at INR 1/kg, making it more affordable than diesel or electric alternatives. Dharamraj also provides oil extraction services at INR 10/kg, with flexible pricing based on whether customers keep the byproduct.

With nearly 40% capital subsidy under Powering Livelihoods and a INR 6 lakh Mudra loan through *Pradhan Mantri Mudra Yojana* (PMMY), Dharamraj turned his idea into a sustainable rural enterprise. The solarised set up has reduced operating expenses, created livelihood opportunities for his family and improved access to affordable services for nearby villages.

C. Solar-powered tailoring unit enables women-led enterprise to scale in Bargarh, Odisha

In Bargarh, Odisha, a women-led producer group managed by Mrs Hemlata Sahu, Mrs Jharana Sahu, and other members transformed its tailoring unit by adopting solar-powered sewing machines, lighting, and fans. Previously, frequent power cuts of 3-4 hours a day disrupted production and prevented time completion of orders.

The group invested INR 5.28 lakh in the solar-powered system, financed through a Block Level Federation (BLF) loan of INR 1 lakh at 6 per cent interest with a 12-month tenure, while the remaining cost was supported through gap financing for DRE ecosystem development.

The intervention increased daily production from fewer than 15 garments to over 20, raising monthly incomes by INR 4,500-5,000 per woman. With reliable power, the group could also work in the evenings and take on larger orders. Today, the enterprise has expanded to 72 sewing machines, employs 22 people, and has secured government contracts to manufacture school uniforms, with an average profit of INR 100 per uniform.

Solar sewing machine helps tailor build credit history and diversify his enterprise (Levine 2022)

In Odisha, Ramsingh Kabadi, a tailor and member of the Gondi community, supported his seven member family through tailoring, and earned approximately USD 50 per month with a manual sewing machine. Despite having steady orders, limited productivity due to the manual machine, and unreliable electricity prevented him from scaling, while the cost of an electric machine was unaffordable.

Through support from SELCO, Ramsingh was able to secure a USD 250 loan from a local bank to purchase a solar-powered sewing machine and lighting. SELCO provided assistance in preparing the loan proposal and accompanied him to the bank. For someone who had limited prior interaction with formal FIs, this support was critical in understanding the process of loan application, as well as in increasing his confidence in engaging with banks in the future.

Ramsingh's productivity and income doubled within just months. He repaid the loan through monthly instalments of USD 9, and after six months of timely repayments, the bank extended a second loan to help him purchase another sewing machine and bring his brother into the business. He subsequently applied for a third loan to purchase a solar-powered rice hulling machine, enabling him to diversify his income.

Source: End-user case stories compiled through on-ground interviews; SELCO Foundation 2023; Levine 2022

2.3. Policy integration for DRE technologies in India

Adoption of DRE solutions depends on an enabling financing and policy ecosystem that reduces upfront costs, lowers lending risks, and improves access to finance. While many DRE technologies are commercially viable over their lifetimes, high upfront cost remains a key barrier. India has developed a supportive policy environment in which renewable energy, agriculture, rural development, and enterprise promotion can converge to enable DRE-powered livelihoods. At the national level, the Ministry of New and Renewable Energy's *Framework for Promotion of Decentralised Renewable Energy (DRE) Livelihood Applications* (Ministry of New and Renewable Energy 2022) provides the world's first dedicated policy framework for productive-use DRE, recognising end-user financing, market development, quality assurance, innovation, and institutional convergence as key enablers.

A significant opportunity lies in converging existing government schemes and institutional financing mechanisms into a more comprehensive financing architecture for DRE livelihood technologies. PM-KUSUM demonstrates how blended financing (combining Central Financial Assistance, state subsidies, beneficiary contributions, and institutional credit) can reduce upfront investment and de-risk lending. Similarly, the *Agriculture Infrastructure Fund (AIF)*, *Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE)*, *Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME)*, *Start-up Village Entrepreneurship Programme (SVEP)*, *Sub-Mission on Agricultural Mechanisation (SMAM)*, and *Mission for Integrated Development of Horticulture (MIDH)* address complementary needs across infrastructure, enterprise development, mechanisation, horticulture, and market linkages. Aligning these schemes with DRE technologies can improve project viability, lower adoption costs, and strengthen access to affordable credit.

Development finance institutions can play an important role in expanding climate finance for DRE livelihoods. NABARD, India's National Implementing Entity (NIE)/Direct Access Entity for the Green

Climate Fund (GCF) and Adaptation Fund⁴, channels international climate finance into rural and climate-resilient development programmes and serves as the NIE for the National Adaptation Fund for Climate Change (NAFCC). These mechanisms could potentially be aligned with DRE livelihood financing and NABARD's existing agricultural and rural refinancing support, strengthening the flow of concessional finance through FIs. Similarly, the Small Industries Development Bank of India's (SIDBI) refinance and green finance programmes could be leveraged for MSMEs to improve lender liquidity, lower financing costs, and expand access to credit for enterprises and end users adopting DRE livelihood technologies.

The Reserve Bank of India's *Draft Disclosure Framework on Climate-related Financial Risks* (2024) requires regulated FIs to assess, manage, and disclose climate-related risks within their portfolios. Once implemented, the framework is expected to embed climate considerations into banks' and FIs' lending and portfolio decisions, which could potentially result in greater recognition of climate-aligned sectors such as DRE.

Despite this progress, financing remains a key barrier to scaling DRE-powered livelihoods. While national policy recognises the need for convergence and improved end user financing, this has yet to translate into a financing architecture capable of supporting diverse DRE technologies at scale.⁵ Green finance remains concentrated in mature, utility-scale sectors, while distributed applications remain comparatively underfunded.⁶ Users continue to rely on personal savings or subsidies, while FIs face challenges in appraising small-ticket loans with variable cash flows. Addressing these barriers will require stronger convergence across government schemes, greater access to context-appropriate credit, and financing models that recognise the income-generating potential of DRE technologies.

2.4. Acceleration for scaling clean energy livelihoods

Currently, DRE adoption stands well below the sector's estimated potential. Despite strong on-ground demand, achieving commercial scale requires more than innovative technologies or capable manufacturers; it depends on an ecosystem in which stakeholders strengthen different links across the value chain. Civil society organisations (CSOs), Non-governmental organisations (NGOs), and other channels play a critical role in generating demand, building awareness, and providing training and after-sales handholding. Distributors and go-to-market partners extend enterprise reach into otherwise inaccessible markets. Financiers enable ownership by providing credit to users unable to meet upfront costs, while policymakers create enabling conditions through subsidies, credit guarantees, and market development initiatives.

These complementary and interdependent roles translate into five interdependent ecosystem levers that determine whether DRE livelihood technologies can scale sustainably: customer awareness and accessibility, financing, market linkages, last-mile service capacity and product standardisation.

Customer awareness is a foundational lever to scaling DRE livelihood technologies. Building end-users' understanding of the technologies, their benefits, and the cash flows they can generate can accelerate adoption. Similarly, greater awareness among financiers and policymakers can strengthen technology appraisal, expand access to finance, and support wider adoption.

Financing is a key lever, directly addressing the high upfront cost of these technologies. Most DRE livelihood technologies are targeted towards segments with limited savings and formal credit histories, including small and marginal farmers, first-time micro-entrepreneurs, SHGs, small retailers, and street vendors. For these users, credit can determine whether a technology is accessible at all: consequently, financing not only reduces the upfront cost of adoption but can determine whether users are able to adopt the technology and realise its benefits at all.

Market linkages, both forward and backward, determine whether adoption converts into sustained income: reliable local availability of inputs and raw materials, alongside markets to sell outputs, can meaningfully impact returns on a DRE investment. FPOs can play a key role by consolidating input procurement and output sales for their members, thus moving beyond borrowers to help build the market linkages that de-risk both adoption and financing.

Last-mile service capacity, including training, strong local service networks and timely repairs and maintenance, is essential to sustaining user confidence and long-term technology use. Weak after-sales support can discourage adoption by raising concerns around reliability, maintenance costs, repair delays, and potential disruptions to income generation.

Product standardisation gives users and financiers consistent benchmarks for price, quality, and specifications across manufacturers, making it easier to gauge performance and risk and building confidence in newer or less familiar technologies.

Beyond affordability, wider access to end-user financing can generate ecosystem-level effects. Greater deployment can create the market density needed for local sales, service, and maintenance networks to emerge; generate operational and repayment data that strengthens lender confidence; and increase awareness by making technologies more visible and accessible to potential users. These effects, however, are not automatic. Financing can support sustained scale only when complemented by reliable products, strong last-mile services and market linkages, and awareness building.

3. Financing for DRE livelihood technologies

The financing landscape for DRE livelihood technologies remains constrained despite growing evidence of commercial viability. Limited credit histories and low formal financial inclusion often restrict rural users from accessing affordable loans. This is compounded by unfamiliarity with DRE livelihood technologies and the resulting perceived technology risk, which makes lenders cautious even where a borrower's underlying repayment capacity may be sound. This section examines the structural barriers limiting DRE financing, quantifies the potential scale of the unmet demand for credit, assesses suitability of different FIs in lending for various DRE assets, profiles innovative financing models, and outlines key on-ground learnings.

3.1. Key barriers to scaling financing for DRE livelihood technologies

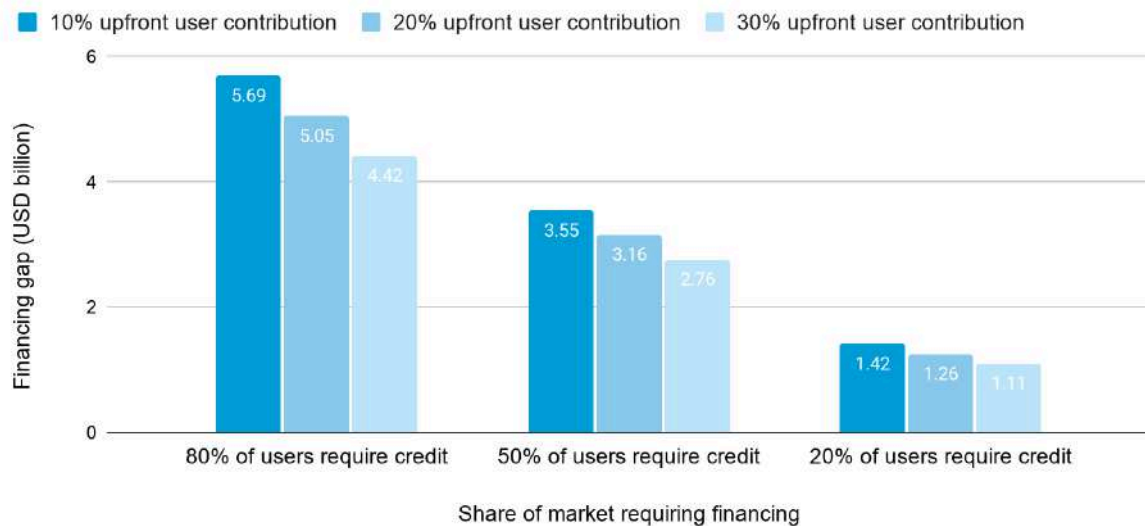
While emerging evidence suggests that DRE technologies can be economically viable in many contexts, financing for the sector remains constrained. The financing gap is particularly pronounced due to the capital-intensive nature of DRE assets despite relatively low operating costs. Nascent DRE technologies may also have limited secondary markets, restricting asset-backed lending options. As a result, access to affordable and flexible financing is critical to enable adoption and scale. DRE technologies also vary widely in ticket size, resulting in unique appraisal challenges: small ticket loans can result in loans that are operationally expensive to service as appraisal, documentation, verification, and monitoring carry largely fixed costs that yield low returns relative to loan size. For larger-ticket assets, lenders may look for greater evidence of successful deployment and asset utilisation before extending credit at scale. Across both, assessing DRE technologies requires consideration of asset utilisation rates, throughput, seasonality, and commodity-specific price dynamics. Limited lender familiarity with these technologies and their context-specific business models further complicates assessment. The absence of standardised technology benchmarks and appraisal frameworks can increase perceived risk, leading DRE assets to be treated as niche, costly-to-assess exposures. Simultaneously, many users, including small and marginal farmers, first-time entrepreneurs, SHGs, small retailers, and street vendors, often have limited or no formal credit histories and low levels of financial inclusion, restricting access to affordable loans through conventional channels. Policy and regulatory gaps further compound these constraints as government schemes are typically accessed in isolation rather than converged, and none include a dedicated DRE category, leaving these technologies to compete within broader agriculture or MSME allocations. Ambiguity under the RBI's Priority Sector Lending framework further complicates financing, as the same DRE technology may fall under different classifications depending on the borrower and use case, with no clear category for DRE livelihood assets.

As a consequence of these gaps, the DRE sector has remained dependent on concessional and grant-based funding rather than mainstream lending. This report argues that subsidies should instead be treated as catalytic support rather than as a substitute for demonstrating a project's standalone commercial viability, in order to sustainably enable commercial scale in the sector. Developing clear appraisal frameworks and equipping lenders with guidance on relevant parameters can improve viability assessments, strengthen risk evaluation, and increase confidence in lending.

3.2. The scale of the financing requirement

CEEW's estimates place the current requirement in financing for end-users for the five high potential DRE technologies at between **1.1 and 5.7 billion USD**.

Figure 3 | Estimated financing requirement for five high potential DRE technologies across different scenarios ranges from USD 1.1 to 5.7 billion



Source: Author's analysis based on market estimates from Jain, Khalid, and Jindal (2023); Khalid et al. (2021); and Khalid, Jindal, and Jain (2022).

Note: Financing requirements in the figure aggregate the requirements across five high potential DRE technologies (solar dryers, solar refrigerators, solar cold storage, solar food processor and solar fodder grow unit). Details of the calculations are available in the annexure.

Figure 3 estimates the finance required for five mature DRE livelihood technologies under different financing scenarios. The analysis is based on two key assumptions: firstly, the proportion of the potential market that requires financing support, and secondly, the share of asset cost contributed upfront by the end-user. In this analysis, the financing requirement refers to the total amount of credit required by the end-users after accounting for their upfront contribution.

For instance, under the first scenario, 20 per cent of the potential market is assumed to lack adequate finance and therefore require credit to purchase DRE livelihood technologies. With a 10 per cent upfront contribution, the remaining financing requirement is approximately USD 1.42 billion. As the upfront contribution rises to 20 or 30 per cent, the external financing requirement declines accordingly. Conversely, assuming 50 or 80 per cent of the potential market has limited access to finance results in progressively higher credit requirements, reaching up to USD 5.7 billion.

Meeting this financing demand will require greater participation from FIs alongside innovative financing mechanisms, rather than continued reliance on subsidies and grants. As the DRE sector scales, appropriate lending products, standardised appraisal frameworks, risk-sharing mechanisms, and cash-flow-based lending will be essential to bridge the credit gap and unlock its livelihood and economic potential.

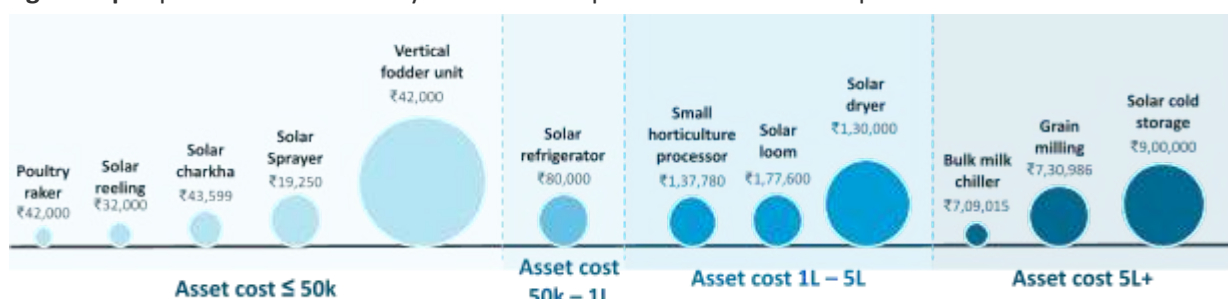
3.3. Asset tiers and their livelihood impact

DRE livelihood assets span various value chains and have a wide range of capital investment requirements. Since lender mandates, borrower profiles, and repayment logic all differ as ticket size grows, DRE financing cannot be treated as a uniform market. Market potential for these technologies will be unlocked only if capital is matched to each segment.

DRE livelihood technologies can be grouped into four asset cost tiers:

- **Tier 1 ($\leq$ INR 50,000):** solar sprayer, silk-reeling unit, vertical fodder grow unit, poultry raker, solar charkha, sub-HP solar pump, sabjee cooler.
- **Tier 2 (INR 50,000–1 lakh):** DC refrigerator, small dryers and multi-purpose food processors, fodder grow stations.
- **Tier 3 (INR 1–5 lakh):** solar dryer (≥ 100 kg), micro-food processor (≥ 60 kg), solar loom, high-HP solar pump, higher-capacity refrigerators (≥ 200 L).
- **Tier 4 ($\geq$ INR 5 lakh):** bulk milk chiller, mini grain mill, solar/biomass cold storage, large solar dryers ($\geq 1,000$ kg).

Figure 4 | Representative assets by tier and their potential livelihood impact



Source: Author's analysis

Note: Standard variants of technologies have been taken. Many technologies have variants spanning asset cost tiers. The sizes of each circle represents their proportional potential livelihood impact.

The livelihood stakes differ markedly across tiers. Bridging financing for only Tier 1 and Tier 3 technologies alone could unlock potential livelihood impact exceeding almost 8 million users (~4.9 and 2.8 million livelihoods respectively).

3.4. Asset tiers and lender alignment

This section consolidates four dimensions (1) lender type, (2) customer segment, (3) technology type, and (4) commercial terms into the four asset cost tiers highlighted in Section 3.3.

Table 3 | A multi-dimensional financing matrix for DRE livelihood technologies

Asset Tier	Representative Technologies	Primary Customer Segment	Best-Fit Lender Types	Commercial Terms
Tier 1 ≤ INR 50,000	- Solar sprayer - Solar silk-reeling unit - Vertical fodder grow units - Poultry rakers - Solar charkha - Sub-HP solar pump - Sabjee cooler	- Individual micro-entrepreneurs - Small and marginal farmers - SHGs and joint liability groups (JLGs) - Artisans, street vendors - First-time borrowers	- Microfinance institutions (MFIs) / non-banking financial institution-MFIs (NBFC-MFIs) - Small finance banks (SFB) - SHG-Bank Linkage (Primary Agricultural Credit Societies (PACS) / regional rural banks (RRBs)) - Asset-financing NBFCs - Pay-as-you-go (PAYG) / lease providers	Interest 18–26% p.a. (MFI/ JLG); 12–24% NBFC; Nil–low for small agri/SHG loans and 10–15% for larger term loans (NABARD refinance norms) (RRBs) Tenure 6–24 months Margin 0–20% / PAYG deposit Security Collateral-free; group guarantee
Tier 2 INR 50k – INR 1L	- DC refrigerator - Small processing units (dryers and multi-purpose food processors) - Fodder grow stations	- Established micro-enterprises - Retailers, dairy and fishery vendors - SHG-run micro-enterprises - Individual farmers with cash flow	- SFBs - NBFCs - RRBs - Cooperative Banks - Upper-ticket MFIs	Interest 10–24% p.a.; Nil–low for small agri/SHG loans and 10–15% for larger term loans (NABARD refinance norms) (RRBs) Tenure ~12–36 months Margin 10–20% Security Asset hypothecation (NBFCs); collateral-free by regulation for MFIs, SFBs/banks, RRBs (agri-allied, ≤₹2L)
Tier 3 INR 1L – INR 5L	- Solar dryer (≥ 100kg) - Micro-food processor (≥ 60 kg) - Solar loom - High-HP solar pump - Higher capacity refrigerators (≥200L)	- Small farmers and agri-entrepreneurs - FPOs and producer groups - SHGs and SHG federations - Women-led enterprise clusters	- RRBs and Public sector banks (PSBs) (agri term / Kisan Credit Card (KCC)) - NBFCs and SFBs - Cooperative Banks - CGTMSE-backed lenders	Interest 10–16% (bank); 4–7% pumps via KUSUM+KCC; 16–22% NBFC Tenure 2–5 years Margin 10–20% Security Asset hypothecation; CGTMSE / scheme guarantee; collateral-free by regulation for, SFBs/banks, RRBs (agri-allied, ≤₹2L)
Tier 4 INR 5L +	- Bulk milk chiller - Mini grain mill - Solar / biomass cold storage - Large solar dryers (≥1000kg)	- FPOs and agri-cooperatives - Dairy cooperatives and aggregators - Established MSMEs - Rural agri-entrepreneurs	- PSBs - Large NBFCs - RRBs (higher ticket) - NABARD refinance / AIF convergence	Interest 8–12% (effective 5–9% with AIF subvention) Tenure 1–7 years Margin 10–30% Security Collateral-free up to CGTMSE limits; hypothecation of stock/receivables + collateral beyond that

Source: Author's analysis

Note: Ranges are indicative and vary by lender, state, borrower profile, and scheme convergence. ‘Margin’ denotes borrower down-payment. Asset values are drawn from the technology assessment in the preceding section.

MFI - Microfinance institution; JLG - Joint liability group; NBFC - Non-banking financial institution; PACS - Primary Agricultural Credit Societies; RRB - Regional rural bank

Reading across the matrix demonstrates that a differentiated financing approach is needed to match lender models with the characteristics of DRE livelihood technologies and their users. Smaller, low-cost assets can be financed through MFIs, SHG-bank linkage programmes, and small finance banks (SFBs), which are suited to first-time borrowers with limited credit histories through collateral-free lending and low upfront contributions. The Reserve Bank of India’s 2022 guidelines also require NBFC-MFIs, SFBs, and RRBs to adopt borrower-centric repayment policies that allow flexibility based on borrowers’ cash flows and repayment capacity (RBI 2022). As asset costs rise, SFBs, RRBs, and NBFCs can finance larger productive assets using cash-flow-based assessments, asset hypothecation where appropriate, and repayment schedules aligned with income generation.

The tier matrix also reveals a financing ecosystem that is potentially well-suited to finance DRE livelihood technologies at the extremes, however, with distortions.

The missing middle in mid-tier assets

Tier 3 (INR 1–5 lakh) represents a potentially underserved segment within the financing ecosystem, sitting above the typical microfinance ticket size but below the threshold at which commercial banks may be comfortable deploying financing at scale. This can create a financing gap for assets such as solar dryers, micro-processors, and looms.

A key financing barrier for these technologies is a mismatch between ticket sizes and lender appraisal models. MFIs are structured around small loans, averaging INR 60,000 (Business Standard 2026), making assets like a INR 1.8 lakh solar loom difficult to finance. Larger banks may be hesitant to assess these assets due to unfamiliar cash-flow profiles and the absence of standardised benchmarks, making them relatively costly to appraise. Many DRE assets lack comparable standardisation and fall outside established lending templates.

This highlights the cost problem these assets face. As costs of originating, appraising, and monitoring loans are not proportionate to loan size, mid-tier assets generate lower returns relative to a lender's cost of funds even if underlying risk is manageable. Addressing this requires two sets of instruments.

- **Aggregation models** that bundle small borrowers into bankable portfolios, standardised technology benchmarks, and digital loan origination address this cost barrier, reducing the fixed cost of appraising and servicing each loan.
- **CGTMSE-style guarantees**, first-loss or risk-sharing facilities, and blended or concessional capital address risk-appetite, giving lenders confidence to enter segments where limited credit history, appraisal frameworks, or technology unfamiliarity make risk difficult to assess.

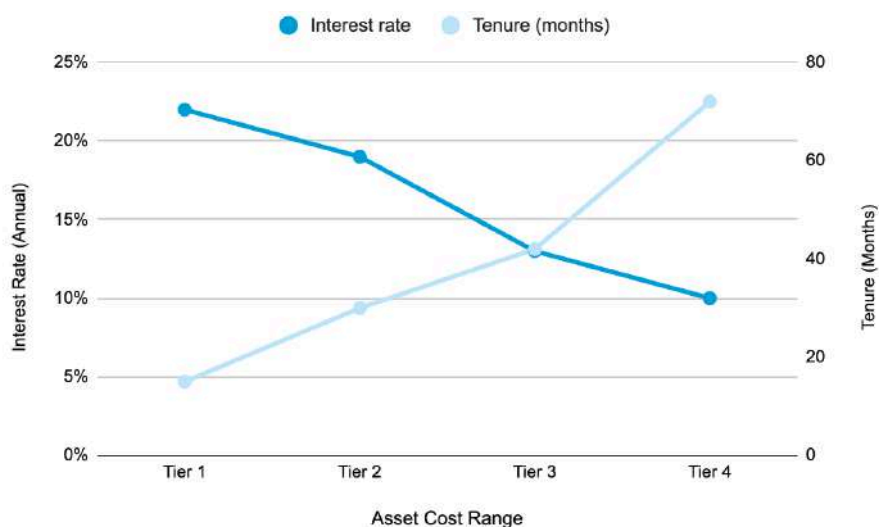
While risk-sharing instruments improve a lender's willingness to enter unfamiliar segments, they do not change the underlying cost structure of originating and servicing small-ticket loans. Similarly, while cost-reducing instruments improve unit economics, they cannot on their own address a lender's

reluctance to bear exposure to unfamiliar cash-flow profiles or higher-risk borrowers. Closing this ‘missing middle’ gap requires a combination of solutions addressing both.

The inverse interest-rate relationship

A second trend observed is an inverse interest-rate relationship between asset cost and borrowing rates. Customers availing loans for lower-cost assets typically face higher interest rates and shorter tenures, while borrowers financing higher-value assets benefit from lower-cost capital.

Figure 5 | Small ticket size assets are subjected to higher interest rates and lower loan tenures



Source: Author's analysis

Note: Interest rate and tenures have been taken as averages based on values in Table 3.

High financing costs for small DRE assets reflect the disproportionate burden of loan origination, monitoring, and collection costs on small-ticket loans, compounded by the higher perceived risk of low-collateral, thin-file borrowers. This raises borrowing costs for users least able to absorb them, reducing the viability of smaller DRE investments and slowing adoption. Addressing this requires reducing both lending costs and risk through concessional interest rates (as with KCC), credit guarantees, digital loan origination and servicing, and viability-gap or results-based grants that improve affordability while preserving lender viability.

3.5. Overcoming the barriers to financing DRE livelihood technologies

Closing the financing gaps for DRE livelihood technologies calls for solutions that can enable cost reduction and risk-sharing, such as aggregation models and CGTMSE-style guarantees. Additionally, it is important to match institution types to the segments they are best placed to serve, and design repayment around cash flows.

Matching institutions to segments

Overcoming the distortions outlined in Section 3.4 requires drawing on the complementary strengths of India's diverse lender base, which differ in branch network, customer base, regulatory mandate, liability structure, and risk appetite, positioning each to serve distinct segments of the market. No single

institution type is likely to finance the entire DRE ecosystem; financing is best understood as a collective effort in which different institutions support different technology and borrower segments.

Table 4 compares the strengths of different lender categories in financing DRE livelihood technologies across key parameters. Rather than indicating absolute performance, the ratings highlight the comparative suitability of each institution for different aspects of DRE financing. This illustrates how different lender types can play complementary roles in expanding access to finance diverse technologies and customer segments. Overall, the analysis underscores that scaling DRE livelihood financing requires a differentiated, ecosystem-based approach leveraging the comparative advantages of each lender segment, rather than relying on any single institutional channel.

Table 4 | Comparative assessment of lender types for financing DRE livelihood technologies

Parameter	PSBs	RRBs	SFBs	Cooperative Banks	MFIs	NBFCs	Peer-to-Peer (P2P)	Private Banks
Rural reach ⁸	Medium	Very High	Medium	High	High	Medium	Medium	Low
Agriculture & livelihood portfolio ⁹	High	Very High	Medium	High	Medium	Medium	Medium	Low
MSME lending capability ¹⁰	High	Medium	High	Low	Low	High	Medium	High
Sanction government subsidies/schemes ¹¹	High	High	Medium	High	NA	NA	NA	Medium
Cash-flow / enterprise-based appraisal ¹²	Medium	Medium	High	Medium	High	High	High	High
Collateral-free lending ¹³	Low	Medium	High	Medium	Very High	High	Very High	Medium
Tolerance for thin/no CIBIL history ¹⁴	Low	Medium	High	High	Very High	High	High	Low
Women-focused lending ¹⁵	High	Very High	High	High	Very High	Medium	Medium	Medium
Digital origination & onboarding ¹⁶	Medium	Low	High	Low	High	Very High	Very High	Very High
Speed & flexibility of underwriting ¹⁷	Low	Medium	High	Medium	High	Very High	Very High	High

Source: Authors' synthesis based on secondary sources cited in the References section.

Note: This comparative assessment draws on a synthesis of secondary sources alongside the authors' analysis and insights from the Powering Livelihoods programme's engagement with lenders, enterprises, and end-users. Parameters were selected to reflect dimensions relevant to a lender's decision to finance DRE livelihood technologies, spanning outreach, risk appetite, operational capability, and strategic alignment. Ratings are qualitative and relative, indicating how a lender compares to other categories on a parameter. The table is intended to support directional decision-making on which lender types are best positioned to serve which segments of the DRE financing ecosystem

No single institution type can finance the entire DRE livelihood ecosystem; the lender categories in Table 4 differ across various parameters, and are therefore suited to distinct segments. RRBs and SFBs, in particular, stand out among formal institutions. RRBs have high rural reach and agriculture/livelihood portfolio strength of any lender category, are suitable for women-focused lending and have high alignment with government subsidy and scheme disbursement, making them well positioned to reach first-time, agriculture-linked borrowers at scale. SFBs complement this with strong operational

capabilities: high MSME lending capacity, cash-flow/enterprise-based appraisal, collateral-free lending and tolerance for thin/no CIBIL (Credit Information Bureau (India) Limited) history, and high digital origination and underwriting speed, making them well suited to productive, cash-flow-dependent enterprises with limited formal credit histories.

Cash-flow-based lending design

Financing models should shift from collateral- and asset-based lending towards cash flow-based assessments that evaluate repayment capacity and align loan structures, repayment schedules, and risk mitigation mechanisms with both asset value and the borrower's maturity. This approach is already gaining traction in other sectors: agriculture uses collateral-free, cash-flow-linked instruments such as the KCC, while the RBI's Expert Committee on MSMEs recommended information- and cash-flow-based lending using GST data, the Udyam portal, and the Account Aggregator framework (RBI Expert Committee on MSMEs, 2019). Similarly, the viability of DRE loans depends on the interaction between an asset's income-generating potential, financing costs, tenure, utilisation, and local cash-flow cycles. Lending should therefore incorporate technology- and context-specific cash-flow assessments rather than standardised norms, with seasonal repayment structures where appropriate to align obligations with borrower incomes, reduce credit risk, and expand access to finance.

The case for cash-flow-based repayment is particularly relevant for livelihood assets with seasonal income patterns. A solar dryer, for instance, may generate limited income during the off-season but substantially higher earnings during harvest and processing periods. Fixed equated monthly installments (EMIs) impose the same repayment obligation throughout the year, irrespective of this variation. Aligning repayments with cash flows can ease the burden during lean periods and increase repayments during peak months, while keeping the total repayment unchanged over the loan tenure. This can reduce repayment stress and the need for distress borrowing among borrowers with seasonal incomes.

3.6. DRE livelihoods financial assessment toolkit

A key requirement for expanding finance to DRE livelihood technologies is the availability of robust risk assessment tools that enable FIs to evaluate the income-generating potential of these assets and their capacity to support loan repayment. Conventional credit appraisal frameworks are built to assess borrower-level credit risk but are less equipped to assess the viability of the underlying livelihood activity that the DRE asset enables, which vary by business model, technology used, and local operating conditions, and are not captured by standardised, historical borrower data. As a result, financiers face challenges in assessing the technology and business-model risk embedded in the loan, or whether the DRE-enabled activity will generate sufficient and reliable cash flows. A key requirement for expanding finance to DRE livelihood technologies is the availability of robust risk assessment tools to evaluate technology viability and risk. Conventional credit appraisal frameworks often rely on standardised assumptions and historical borrower information, which are not well suited to productive-use DRE technologies, causing challenges in accurately assessing technology risk and contributing to cautious lending practices and higher financing costs.

Efforts have been made to address this gap through the development of specialised assessment tools. One such example is the Powering Livelihoods Decentralised Renewable Energy Livelihoods Financial

Assessment Toolkit, which provides a structured framework for evaluating the commercial viability and financing potential of DRE livelihood technologies. Rather than relying on generic assumptions, the toolkit incorporates context-specific factors that influence enterprise performance, including asset utilisation, seasonal demand patterns, throughput, local market prices, and operating conditions. By integrating these variables into technology-specific cash flow and loan serviceability assessments, it enables financiers to generate more realistic estimates of income potential and repayment capacity, thereby supporting more informed and risk-sensitive lending decisions. As DRE financing scales, similar technology-specific, usage-based assessment frameworks will be essential for improving lender confidence, expanding access to finance, and supporting the commercial scale-up of emerging DRE livelihood technologies.

3.7. Qualitative considerations in assessing a DRE technology

Beyond quantitative metrics, financiers must evaluate a set of qualitative factors that directly influence asset performance and repayment reliability. These include product durability, after-sales support, user training, and risk-sharing mechanisms, among others.

Table 5 | Key qualitative considerations in financing DRE technologies and examples from ground

Guiding qualitative considerations	Examples from the ground
Durability of the product Durable, high-performing assets reduce downtime and maintenance costs, ensuring stable income and lowering default risk	To ensure durability, the storage chambers of Cool Crop's solar-powered cold storage systems feature sealed and locked insulation panels to prevent system contamination. These units can operate over a range of temperatures to store different crops, enhancing the asset's utilisation. Similarly, Raheja Solar Food Processing uses weather resistant materials that can endure extreme temperatures and humidity in building their solar dryers. Limited moving parts in the technology reduce wear and tear, enabling prolonged use.
Optimal utilisation of the DRE product Enhances product effectiveness, ensuring consistent operations and reduced risk of loan defaults that can arise due to sub-optimal asset utilisation.	Devidayal Solar Solutions provides guidelines in the form of a do's and don'ts chart to ensure that the solar-powered refrigerator is utilised optimally. Along with guidance on proper temperature maintenance and prevention of vent blocking or overloading, they provide users with guidance on which product combinations to store and which to avoid.
Availability of technical/after-sales support, and grievance redressal mechanisms Reliable after-sales support enables prompt issue resolution, sustained product use, and steady income generation. Higher technology density also reduces service response times.	For Kissan Dharambir, service requests are handled by a technical team based in Haryana. Minor issues are resolved remotely within 1–2 days through video support, while faulty components can be shipped to the enterprise for repair and return. Technicians also provide on-site support when required.
Need and availability of user training and provision of on-demand training Capacity building and training are crucial for enhancing user competency and ensuring proper usage and maintenance of the technology. They minimise misuse and maximise product life, thereby improving the likelihood of timely loan repayments.	CoolCrop familiarises users with its cold storage systems through structured training and orientation. Following installation, users receive an SOP, temperature and storage guidance charts, warranty documentation, and operational training. The enterprise provides one mandatory training at commissioning, two optional refresher sessions during the following year, and on-demand support in the first year. Phone-based and local support for operations, maintenance, system monitoring, and market linkages builds user confidence and ensures utilisation.

Guiding qualitative considerations	Examples from the ground
Provision of warranties/guarantees Warranties provide security and assurance to users and financiers, reducing perceived risk and enhancing the attractiveness of the technology.	Devidayal Solar Solutions offers a two-year warranty for all the components of its solar-powered refrigerator, a three-year warranty for the battery, and a ten-year warranty for the solar panels. These warranties cover manufacturing defects and malfunctions under normal use conditions.
Provision of a buy-back facility Buy-back facilities mitigate market and asset risk for users and provide assurance to financiers by improving income predictability, strengthening loan repayment confidence.	Raheja Solar Food Processing offers a buyback facility for the technology's value-added end products. To tackle the issue of market linkages, the enterprise has identified 15–20 major end products, such as dried tomatoes, bananas, pineapples, etc.

Source: Wusqa, Khalid, and Jain 2026

3.8. Case stories from ground: Innovative financing solutions supported through blended financing

Insights from the Powering Livelihoods programme indicate that improving access to affordable finance can significantly accelerate the uptake of DRE technologies (Wusqa and Khalid 2025). Several innovative models like first-loss default guarantee (FLDG), interest subvention, blended finance and peer-to-peer lending have been successfully implemented on-ground to improve access to commercial financing. The following cases highlight financial models demonstrating the viability and scalability of DRE livelihood technologies.

First-loss default guarantee (FLDG)

FLDG is a credit-risk sharing mechanism where a third party absorbs a predefined share of losses if borrowers default to reduce lender risk and enable greater access to finance for rural users.

Evidence from Powering Livelihoods shows that structured risk sharing plays a significant role in improving financiers' confidence while expanding credit to first-time borrowers. The partnership between Devi Dayal Solar Solutions (a clean-tech enterprise providing solar-powered cold chain solutions) and its lending partner¹⁸, an NBFC, reflects this approach in practice.

Table 6 | Impact snapshot of DD Solar's FLDG partnership

Parameter	Details
Technology	Solar-powered DC refrigerator
Financing model	25 per cent FLDG
Loan tenure	12 months
Interest rate	9.33 - 10.08 per cent
Total disbursement	~1.7 crore
NPA	2.5 per cent
Borrowers	434

Source: Devi Dayal Solar Solutions

Devi Dayal Solar Solutions implemented a 25 per cent FLDG for solar powered DC refrigerators with an average ticket size of INR 37,313. The initiative reported a low non-performing asset (NPA) rate of 2.5 per cent, with nearly 57 per cent of beneficiaries being new-to-credit. As repayment performance strengthened and lender confidence increased, the FLDG was reduced from 25 per cent to 15 per cent.

Peer-to-peer (P2P) lending

P2P lending is a community-driven financing model that enables individuals to lend directly to rural borrowers or small businesses through an online platform, offering faster access to credit.

Powering Livelihoods' partnership with a P2P lending platform¹⁹ has improved access to affordable finance for DRE livelihood technologies like hydroponic fodder units, solar refrigerators and solar dryers, while also creating pathways for new-to-credit borrowers. The model has mobilised financing from 272 investors, at an interest rate of 10.5 per cent (including processing fee of 2.5 per cent), offering an alternative to other higher-cost financing available in the market. While the portfolio is still at an early stage and available performance data is limited, customers so far have repaid INR 13.9 lakh of their outstanding loans, equivalent to ~44 per cent of the portfolio's investment principal. However, the portfolio also recorded a NPA ratio of 17.9 per cent, highlighting the need for robust credit and technology assessments and strong on-ground collections partners as the model scales.

While P2P finance can provide an alternative channel for small-ticket DRE lending, wider adoption will depend on continued investor participation, affordable interest rate, sound portfolio performance and appropriate risk-mitigation mechanisms. Such evidence will be important for assessing whether the model can move beyond a partnership-led approach towards a larger and more sustainable source of financing DRE assets.

Table 7 | Impact snapshot of Powering Livelihoods' P2P lending partnership

Parameter	Details
Technology	Hydroponic fodder unit, solar refrigerator and solar dryers
Financing model	P2P lending
Loan tenure	1-24 months
Interest rate	10.5 per cent
Total loan disbursed	~31.6 lakhs
Current Repayment	44.12 per cent
NPA	17.9 per cent
Borrowers	96

Source: Powering Livelihoods

Experiences emerging from the Powering Livelihoods initiative demonstrate how innovative financing has the potential to reshape rural livelihoods through the integration of clean energy solutions. Innovative financing models can gradually reduce lenders' hesitation, unlocking first-time-credit access and improving the commercial viability of DRE livelihood solutions in underserved markets. However, customised repayment structures such as Pay-as-you-go (PAYG) models, cash-flow based financing, diversified loan offerings, and asset-backed financing mechanisms could help further mitigate lending risks and financing barriers associated with end-users adopting these technologies (Wusqa, Khalid, and Jain 2026).

Beyond the Powering Livelihoods programme, there are several successful cases where positive portfolio performance has been achieved, which have potential to scale further. The remainder of Section 3.8 provides further examples from ground:

A. Solar-powered sewing machines strengthen credit access for tailoring households (SELCO Foundation 2023)

In Goverdhanpur village, Balasore, Odisha, the Jogi community, comprising 180 tailoring households, supplies school uniforms and ready-made garments across the district. However, frequent power outages disrupted production, delayed deliveries, and reduced business profitability. To address this, SELCO Foundation retrofitted existing sewing machines with solar power systems. As the upfront cost was unaffordable, a local enterprise Aurosharee Traders facilitated credit linkages with Canara Bank. The project financed ten households with a total investment of INR 3.95 lakh, including a bank loan of INR 3.65 lakh at 10 per cent interest over a 60-month tenure. A risk guarantee initially covered five households to reduce lender risk. Following the borrowers' successful and timely repayment, Canara Bank financed five additional households without requiring a risk guarantee, demonstrating how repayment performance helped build lender confidence. With reliable power, the entrepreneurs increased production, began supplying readymade garment shops, and planned to further expand their tailoring businesses.

B. SELCO Foundation's programmatic intervention with Karnataka Vikas Grameena Bank (IRENA and SELCO Foundation 2022)

SELCO Foundation partnered with Karnataka Vikas Grameena Bank (KVGB), a RRB operating across nine districts, to expand access to finance for solar-powered livelihood enterprises. Through sustained engagement with bank officials and evidence-based advocacy, SELCO demonstrated the commercial viability of DRE livelihood technologies by sharing information on the technologies, their business models, and their potential to improve enterprise cash flows. This approach led KVGB to adopt DRE livelihoods as a dedicated lending programme, with a target of financing 1,000 sustainable energy-based livelihood enterprises within 12 months. The bank subsequently introduced loan products for solar lighting, solar water heaters, solar irrigation pumps, and off-grid rooftop solar systems under both general and subsidy-linked schemes, continuing to work with SELCO Foundation to support implementation.

C. SwitchON Foundation's partnership with Punjab National Bank, Axis Bank, and RBL Bank for end user financing of solar irrigation pumps through a FLDG (Roy et al. 2026)

SwitchON, an organisation working in clean energy access and sustainable agriculture with small and marginal farmers in West Bengal, Odisha, and Jharkhand, found that many farmers frequently struggled to access financing for solar irrigation pumps because banks perceived them as high-risk borrowers. To address this gap, SwitchON developed an innovative financing partnership with Punjab National Bank, Axis Bank, and RBL Bank by creating a FLDG fund. The fund pooled resources from corporate social responsibility (CSR) contributions and donor funding to reduce lender risk and enable loans for solar irrigation pumps. The fund was placed as a fixed deposit with partner banks to partially cover potential loan defaults. This credit enhancement reduced the perceived lending risk for Punjab National Bank, Axis Bank, and RBL Bank, enabling them to extend loans to individual farmers for solar irrigation pumps. By March 2024, the initiative had facilitated bank financing for over 300 small and marginal farmers, demonstrating how blended finance can improve project bankability and unlock end-user credit for DRE technologies.

3.9. Learnings from the Powering Livelihoods initiative

Powering Livelihoods²⁰ has worked to mobilise end-user finance for DRE-based livelihood products through partnerships with FIs, starting with NBFCs and P2P lending platforms. Through these partnerships, the programme has enabled 583 loans amounting to approximately INR 3 crore in disbursements, reaching customers across five states and 40 districts, with dense concentrations in Uttar Pradesh (76.6 per cent of loans) and Maharashtra (19.9 per cent of loans), with women constituting 27.5 per cent of borrowers and a portfolio comprising several new-to-credit customers. This experience offers several learnings that may be relevant to FIs considering entry into, or expansion within, the DRE livelihoods financing space.

Catalysers

- **Geographic concentration supports both scale and repayment efficiency.** Financing outcomes have shown strong geographic concentration, suggesting that scale is best achieved by replicating successful local partner ecosystems, rather than uniform national rollout or purely demand-driven expansion. Repayment efficiency is further improved when loans are geographically clustered and repayment dates standardised, supporting consistent product use and, in turn, more stable income generation—reinforcing repayment further.
- **Ground-level ecosystem partners are central to scaling DRE finance,** particularly where trust-based and relationship-driven. Beyond generating leads and supporting users post-sale, these stakeholders can serve as an active risk-mitigation layer by screening leads requiring loans, and providing early-warning and collections support. When repayments are missed, they are well placed to diagnose the cause and route responses accordingly. For financiers, the presence and quality of such a partner may be a meaningful indicator to understand portfolio risk beyond what is visible in standard credit assessments. This effect is strongest where the partner has a locally trusted, relationship-based presence.
- **The presence of a credible anchor institution can enable financier entry into this nascent asset class.** As DRE livelihood technologies are still an emerging lending segment, financiers have often relied on anchor institutions such as enterprises or ecosystem partners to aggregate demand, provide after-sales support, and build confidence in the technology and market. Assessing the strength of the anchor partner can therefore serve as a practical entry strategy alongside conventional borrower and asset appraisal.
- **Risk-sharing mechanisms have been a critical enabler of lending and can be phased down as repayment evidence accumulates.** Instruments like first-loss guarantees have enabled NBFCs and P2P lenders to finance new enterprises and emerging DRE asset classes by absorbing early portfolio losses. As cohort performance has strengthened, the level of risk cover required has declined, indicating that these instruments are effective transitional tools. Similarly, CGTMSE offers institutional lenders a practical entry point by reducing collateral risk while they build portfolios and repayment histories in the sector. Technology provider risk-sharing offers a complementary mechanism to align incentives between lenders and suppliers. Under such models, a portion of the asset value is retained by the lender from the technology provider and released upon successful loan repayment by the end user. This encourages providers to remain engaged throughout the loan tenure by ensuring reliable user support, thereby improving asset performance and reducing default risk.

Barriers

- **Subsidy-linked expectations currently shape the activation of demand,** independent of loan availability. Rural borrowers are often conditioned to view credit as incomplete without an accompanying subsidy, and many choose to wait for subsidy-based credit even when market loans are available. This suggests financing models must either integrate with subsidy pipelines or compete on speed and certainty, offering fast-track loans with clear timelines and communicating the cost of waiting (e.g., seasonal income loss) relative to subsidy delay.

- **Longer sales/underwriting cycles and high interest rates erode purchase intent.** Documentation friction and rejection cycles reduce motivation to buy. Without incentives or streamlined processes, channel partners deprioritise loan facilitation against other responsibilities. Further, willingness to borrow declines sharply once interest rates are perceived as unaffordable, particularly for low-income rural borrowers with limited repayment capacity. Affordable and frictionless credit is a precondition for generating demand for DRE livelihood technologies, rather than merely a financing preference.

4. Way forward: Recommendations

Scaling institutional credit for DRE livelihood technologies will require coordinated action across FIs, policymakers, and development finance actors. Building on the barriers and opportunities identified through this analysis, the following recommendations offer a practical way forward for integrating DRE livelihood technologies into mainstream lending portfolios.

Capacity building

- **Build institutional capacity through specialised training for FIs** through dedicated training programmes on DRE technologies, business models, and risk assessment. Institutions like the National Institute of Bank Management (NIBM) and the Bankers Institute of Rural Development (BIRD) can play a leading role in designing and delivering these programmes.
- **Develop technology-specific standardised appraisal benchmarks** and model credit assessment frameworks for commonly financed DRE livelihood technologies. Standardised benchmarks would improve consistency in credit appraisal, reduce reliance on individual lender expertise, and increase confidence in financing newer technologies.
- **Develop model lending guidelines** for DRE livelihood technologies to support consistent loan structuring, documentation requirements, collateral assessment, and monitoring practices.

Instrument design

- **Strengthen refinance and risk-sharing support** for DRE livelihood lending and establish a dedicated credit guarantee mechanism, anchored by NABARD or SIDBI, to provide partial credit guarantees and loss covers for DRE livelihood portfolios. This would reduce lender risk, encourage wider participation by FIs, and catalyse lending for DRE livelihood technologies. Concessional climate finance could further enhance the facility and improve credit affordability.
- **Reduce the cost of originating and appraising small-to-medium ticket loans through aggregation models** bundling small borrowers into bankable portfolios, technology-specific standardised appraisal benchmarks, and digital loan origination. Potential aggregators include DRE enterprises, FPOs, SHG federations, cooperatives, and other rural intermediaries with existing customer relationships and field networks.
- **Promote the integration of DRE livelihood financing across existing rural credit programmes** and institutional networks to enable wider outreach, particularly through PSBs, RRBs, and cooperative banks that have an extensive rural presence.
- **Leverage concessional climate finance to mobilise commercial capital.** Blended finance mechanisms can improve the bankability of DRE livelihood investments by absorbing early-stage and default risk. NABARD and SIDBI, both accredited to the Green Climate Fund (GCF) already manage climate finance, guarantee, and concessional lending facilities that could be adapted for DRE livelihoods. These existing multilateral and domestic financing channels provide an institutional platform through which concessional capital and risk-sharing instruments could be directed towards DRE livelihood technologies. Commercial lenders and development finance institutions can work with NABARD and SIDBI to structure guarantee and credit-enhancement facilities under existing accreditations, thereby unlocking private sector participation. Multilateral platforms like the Asian Development Banks' India

Green Finance Facility (IGFF) demonstrate how blended credit lines and risk-sharing mechanisms can mobilise private investment in DRE. Under this, the DRE sector has an IGFF allocation of USD 130 million and total mobilised financing of USD 322 million (Green Climate Fund 2024).

- **Adopt cash flow-based lending approaches for productive assets.** Given that repayment capacity is closely linked to income generated by productive-use DRE technologies, credit appraisal frameworks may progressively incorporate projected enterprise cash flows alongside conventional borrower assessments. Loan tenures and repayment schedules aligned with seasonal income patterns would further improve product suitability and repayment outcomes for rural livelihood investments. Commercial banks, NBFCs, and SFBs can pilot such lending approaches, while NABARD and NIBM can support the development of standardised appraisal methodologies and operational guidance.

Policy

- **Integrate DRE livelihood technologies within mainstream lending portfolios.** FIs may consider integrating DRE livelihood technologies more systematically within their agriculture, MSME, and renewable energy portfolios. Such investments align with Priority Sector Lending objectives and complement the increasing integration of climate and ESG considerations into banking operations. PSBs, RRBs, Cooperative Banks, and SFBs are well positioned to expand lending across different borrower segments, and NABARD's refinance support could be extended to DRE livelihood technologies to reduce the funding burden on RRBs and Cooperative Banks and strengthen affordable rural lending. The annexure indicates a mapping of DRE livelihood technologies into various lending verticals as per RBI's Priority Sector Lending.
- **Strengthening policy convergence for DRE financing.** Existing government schemes offer instruments that can support DRE livelihood technologies, but these are typically accessed in isolation rather than combined, and further have no dedicated DRE category. Each instrument addresses a different barrier, and together they can make financing more viable than when deployed independently. The ambiguity in classifying DRE livelihood technologies under the existing Priority Sector Lending (PSL) framework further underscores the need for guidance mapping commonly financed technologies to the relevant PSL provisions. Given DRE's potential in enhancing rural livelihoods and climate goals, there is a case for creating dedicated DRE windows or ring-fenced allocations within existing schemes, rather than requiring these technologies to compete within broader agriculture or MSME budgets.

5. Conclusion

DRE-powered livelihood technologies present a significant opportunity to simultaneously enhance rural productivity, strengthen livelihood resilience, and contribute to India's clean energy transition. While evidence increasingly demonstrates their economic viability across a range of productive-use applications and value chains, access to appropriately structured, accessible finance remains the principal constraint to widespread adoption. The scale of this challenge is reflected in the estimated financing requirement of USD 1.1-5.7 billion for just five DRE livelihood technologies, underscoring the substantial capital required to unlock commercial deployment at scale. Realising the sector's broader estimated market potential will therefore require financing systems that recognise the distinct characteristics of DRE livelihood assets and incorporate context-specific credit appraisal, suitable financial products, and institutional capacity to support their deployment.

Endnotes

1. Cereals: 3.9-5.9%; Pulses: 5.7-6.7%; Oilseeds: 2.9-7.5%; Fruits: 6-15%; Vegetables: 4.9-11.6%; Plantation crops/spices: 1.3-7.3%; Milk: 0.9%; Fisheries: 4.9-8.8%; Meat: 2.3%; Poultry: 5.6%; Egg: 6%. Reported losses in F&V, cereals, plantation crops, were driven by inefficient harvesting, handling, storage, and transportation.
2. Actual financing costs may differ across financial institutions and borrower segments depending on product risk, loan size, collateral, and lender type; the analysis applies a single reference discount rate of 10 per cent annually to enable comparison across technologies.
3. Indicated by increase in users' ability to save money, reduced chances of migrating for better livelihoods
4. Established under the Kyoto Protocol to the UNFCCC to finance projects to help developing nations and vulnerable communities adapt to climate change
5. <https://www.downtoearth.org.in/energy/mnre-s-new-policy-framework-recognises-distributed-renewable-energy-as-solution-for-uplifting-rural-economy-81623>
6. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2219915&lang=1®=20>
7. Rigid, fixed-installment repayment is poorly matched to irregular agricultural incomes. In practice, NABARD's SHG-Bank Linkage Programme allows cash credit/overdraft lending to SHGs), and some SFBs — e.g., Ujjivan's Kisan Pragati Card (cash credit, overdraft, flexible tenure) and ESAF's Kisan Sampada scheme — advertise flexible repayment for agri-linked loans.
8. RRBs: Approximately 92% of branches are in rural/semi-urban areas across 700 districts | PSBs: Approximately 33% of PSB branches are in rural areas per RBI/Department of Financial Services data. Despite large absolute numbers, this has therefore been classified as medium | Cooperative Banks and MFIs retain qualitative "High" ratings, consistent with NABARD's characterisation of PACS/DCCBs and last-mile MFI agent networks as the primary institutional presence in unbanked rural pockets. | P2P: Digital-only marketplace by regulatory design—rural reach depends on an on-ground presence or partner for sourcing borrowers | Private banks: Private banks directed 37.5% of new branches to rural/semi-urban centres in FY25, versus 67.3% for PSBs (RBI, reported in Business Standard, Dec 2025). Despite faster rural/semi-urban branch growth since 2017 (Business Standard, 2021), the stock of rural presence remains well below PSBs, RRBs and Cooperative Banks.
9. RRBs: Statutory mandate under the RRB Act, 1976 for agricultural/rural development, supervised by NABARD | PSBs: Nationalised in 1969/1980 to expand agricultural credit; largest KCC/agri-term-loan books | Cooperative Banks: Originated as PACS/DCCBs to finance farmers; NABARD's core short-term agri-credit channel | SFBs: Mandated for financial inclusion, not agriculture specifically | MFIs: Serve agriculture via general-purpose JLG loans, no agri-specific mandate | NBFCs: finance agri-adjacent assets under general mandate | P2P: general purpose loans, no specific sector mandate; offer small-ticket loans | Private banks: Private banks have historically fallen short of the 18% agriculture PSL sub-target (RBI 2024)
10. PSBs: Largest absolute MSME book, backed by CGTMSE and mandated PSL sub-targets | SFBs: Licensed explicitly to serve MSMEs; core to their charter | NBFCs: major MSME financiers via asset-backed, equipment, and invoice financing | RRBs: PSL nominally includes MSME, but expertise and products stay agri-oriented | Cooperative Banks: Built for retail deposits and crop loans; exposure ceilings and limited appraisal capacity constrain enterprise lending | MFIs: Microfinance-loan definition (collateral-free, income-capped, small-ticket) excludes most MSME-scale needs; JLG appraisal isn't built for enterprises | P2P: general purpose loans, no specific sector mandate; offer small-ticket loans | HDFC Bank, ICICI Bank and Axis Bank are named among the leading MSME financiers in market studies (HTF MI, 2025) and run dedicated digital MSME underwriting journeys using GST/ITR/bank-statement data (e.g., Indian Bank's IND DIGI MSME).
11. PSBs: Principal disbursing agency for subsidy schemes | RRBs: Direct beneficiaries of NABARD's concessional STRRB refinance fund plus routine CGTMSE/KCC access | Cooperative Banks: StCBs/DCCBs draw the larger STCRC concessional refinance pool and are eligible CGTMSE MLIs | SFBs: CGTMSE-eligible and access NABARD's long-term refinance, but at closer-to-market rates, outside the concessional funds reserved for RRBs/cooperatives | MFIs: CGTMSE/NABARD-eligible in principle, but access has come through narrow, one-off

channels (e.g., 2020 Special Liquidity Facility) rather than standing concessional support, and aren't scheme-disbursing agents | NBFCs: Same eligibility in principle, but draw only non-concessional refinance and aren't subsidy-scheme implementing agents. | Private banks: Eligible Member Lending Institutions under CGTMSE and similar schemes not the principal disbursing agency for government subsidy schemes.

12. Directional, qualitative judgement, not a published statistic. Drawn from secondary sources and Powering Livelihoods' engagement with lenders and enterprises. Read as relative standing, not a verifiable score.
13. RBI permits banks and NBFCs alike to extend collateral-free microfinance loans to households earning up to ₹3 lakh; eligibility is broadly uniform, though practice diverges. For NBFC-MFIs, this is a regulatory core: a minimum share of qualifying assets must be microfinance loans (60% as of 2025) — no comparable requirement applies to banks or RRBs. A NABARD-linked SHG-BLP study (2006) found SHG lending under 1% of commercial banks' portfolios, markedly higher for select RRBs, indicative of RRBs' stronger historical engagement with group credit. For non-MFI NBFCs, evidence on secured-unsecured composition remains limited; their positioning here is indicative | P2P: RBI Master Directions (2025) state that NBFC-P2Ps shall not facilitate or permit any secured lending linked to its platform—only clean loans are permitted | Private banks: Offer CGTMSE-backed collateral-free MSME loans and unsecured retail credit, but rural/livelihood-asset lending is more selective than MFIs' or SFBs' collateral-free books, which are built around group-lending and financial-inclusion mandates.
14. Under RBI's Credit Information Reporting Directions, 2025 (6 January 2025, under the CIC Act, 2005), every credit institution type must report to all CICs. What differs is reliance on the bureau score. Industry reporting (Business Standard, 2025) notes large banks treat it as "the main eligibility benchmark," while "microfinance lenders and many NBFCs catering to informal or thin-file customers" are "structurally less reliant on bureau scores since a large share of their borrowers fall outside the traditional credit net." | Private banks: Large banks are reported to treat bureau scores as "the main eligibility benchmark" for retail and MSME lending decisions (Business Standard, 2025), a description that applies to large private banks alongside PSBs.
15. PSBs: Core SHG-Bank Linkage Programme partners, over 84% of linked SHGs women-only | RRBs: NABARD's primary SHG-BLP delivery channel, closest to SHG formation given their rural mandate | Cooperative Banks: PACS/DCCBs are foundational village-level SHG-BLP partners, often the first formal credit point for women's groups | SFBs: Mandated for underserved segments; many originated from MFI conversions, retaining majority-women JLG books | MFIs: JLG model is built around all-women groups (Sa-Dhan, 2025); gender focus is structural | NBFCs: Mixed book, no mandated group-lending or gender design | P2P: Mixed book, no mandated group-lending or gender design | Private banks: Private banks extend enhanced CGTMSE guarantee coverage (up to 90%) for women entrepreneurs and run some women-focused retail/business-banking propositions, but lack the structural scale of PSB/RRB/Cooperative Bank participation in the SHG-Bank Linkage Programme, where women constitute the large majority of borrowers.
16. Directional, qualitative judgement, not a published statistic. Drawn from secondary sources and Powering Livelihoods' engagement with lenders and enterprises. Read as relative standing, not a verifiable score.
17. Directional, qualitative judgement, not a published statistic. Drawn from secondary sources and Powering Livelihoods' engagement with lenders and enterprises. Read as relative standing, not a verifiable score.
18. The identity of the lending partner has not been disclosed due to confidentiality considerations
19. The identity of the lending partner has not been disclosed due to confidentiality considerations
20. Powering Livelihoods is a CEEW-Villgro initiative that aims to boost India's rural economy by scaling up the penetration of clean energy-powered appliances for livelihoods.
21. The impact of such capacity building is evidenced in Bangladesh's IDCOL Solar Home System programme, launched in 2003, aiming to electrify off-grid rural households through standalone solar systems (World Bank, 2021). IDCOL built capacity by training and certifying a network of Programme Operators — mainly existing microfinance institutions — providing technical standards, refinancing, grants, and soft loans (World Bank, 2021; Malakar & Villa, 2022). This enabled the programme to scale from a target of 50,000 households to several million rural connections within a decade. (Malakar & Villa, 2022).

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Acronyms

AIF	Agriculture Infrastructure Fund	MoFPI	Ministry of Food Processing Industries
BIRD	Bankers Institute of Rural Development	MSME	Micro, small and medium enterprises
BLF	Block Level Federation	MT	Metric Tonne
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprises	NABARD	National Bank for Agriculture and Rural Development
CIBIL	Credit Information Bureau (India) Limited	NABCONS	NABARD Consultancy Services
CSO	Civil Society Organization	NAFCC	National Adaptation Fund for Climate Change
CSR	Corporate Social Responsibility	NBFC	Non-Banking Financial Company
DRE	Decentralised renewable energy	NGO	Non-Governmental Organization
EMI	Equated Monthly Instalment	NIBM	National Institute of Bank Management (NIBM)
FI	Financial institution	NIE	National Implementing Entity
FLDG	First Loss Default Guarantee	NPA	Non-Performing Asset
FPO	Farmer Producer Organisation	P2P	Peer-to-Peer
GCF	Green Climate Fund	PACS	Primary Agricultural Credit Societies
GDP	Gross domestic product	PAYG	Pay As You Go
GST	Goods and Services Tax	PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
hr	hour	PMEGP	Prime Minister's Employment Generation Programme
IGFF	India Green Finance Facility	PMFME	Pradhan Mantri Formalisation of Micro Food Processing Enterprises
INR	Indian rupee	PMMY	Pradhan Mantri MUDRA Yojana
JLG	Joint Liability Group	PSB	Public sector bank
KCC	Kisan Credit Card	PSL	Priority Sector Lending
kg	kilogram	RBI	Reserve Bank of India
km	kilometre	RRB	Regional rural bank
KVGB	Karnataka Vikas Grameena Bank	SFB	Small finance bank
kW	kilowatt (kW)	SHG	Self-help group
L	Litre	SIDBI	Small Industries Development Bank of India
MFI	Microfinance institution	SMAM	Sub-Mission on Agricultural Mechanization
MIDH	Mission for Integrated Development of Horticulture	SVEP	Start-up Village Entrepreneurship Programme
MNRE	Ministry of New and Renewable Energy	USD	United States Dollar

Annexure

A1. Estimated annual income assumptions

Sub-HP Solar Pump

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with micro solar pump manufacturers and users.

Estimated Annual Income: INR 45,000 (INR 3,750/month).

High-HP Solar Pump

Component	INR/month
Diesel/kerosene expenditure avoided	5,500
Incremental income from more timely irrigation / additional land brought under cultivation	3,000
<i>Total incremental benefit</i>	<i>8,500</i>

Estimated Annual Income: INR 1,02,000 (INR 8,500/month) = 12 × INR 8,500.

Fodder Grow Unit

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023), based on consultations with solar-powered vertical fodder grow unit manufacturers and users.

Estimated Annual Income: INR 24,000 (INR 2,000/month).

Micro Food Processor

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with horticulture processor manufacturers and users.

Estimated Annual Income: INR 96,000 (INR 8,000/month).

Grain Mill (150 kg/hr)

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on the logic outlined below.

Income is estimated demand-backward: each villager consumes 48 kg of wheat/rice a year, and the mill earns a INR 2/kg milling charge — i.e. INR 96/person/year in milling revenue. This is applied to the number of people served under four catchment-size scenarios, then weighted by the estimated share of villages falling into each catchment-size band:

Households served	People served	Income potential (INR)	Share of such villages
100	400	38,400	15%
250	1,000	96,000	40%
500	2,000	1,92,000	25%

Households served	People served	Income potential (INR)	Share of such villages
1,250	5,000	4,80,000	20%

Weighted average $(38,400 \times 0.15) + (96,000 \times 0.40) + (1,92,000 \times 0.25) + (4,80,000 \times 0.20) = \text{INR}1,88,160 / \text{year}$.

Estimated Annual Income: INR 1,88,160 (INR 15,680/month).

Solar Dryer (100kg)

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with solar dryer manufacturers and users to develop the logic outlined below.

For each of ten candidate dried products where buyback rates are available:

Annual net income = (annual throughput of 8,000 kg fresh produce $\times$ drying-yield fraction $\times$ buyback rate for the dried product) $-$ (8,000 kg $\times$ raw-material cost per kg):

Product	Buyback rate (INR/kg)	Drying proportion	Quantity dried	Raw material cost (INR/kg)	Net income (INR)
Dried Mango	480	10%	8000	35	$(8,000 \times 0.1 \times 480) - (8,000 \times 35) = 1,04,000$
Dried Banana	360	10%	8000	25	88,000
Dried Amla	180	12.5%	8000	12	84,000
Dried Rose Petals	325	10%	8000	22	84,000
Dried Rose Buds	415	10%	8000	30	92,000
Dried Orange & Lemon	440	10%	8000	35	72,000
Dried Methi	440	6.7%	8000	20	74,667
Dried Tomatoes	360	5%	8000	11	56,000
Dried Black Grapes	440	16.7%	8000	60	1,06,667
Dried Spinach	360	10%	8000	30	48,000

Average across all ten products = ~INR 80,950/year.

Estimated Annual Income: ~INR 80,950 (INR 6,745/month).

DC Refrigerator (100L)

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with solar DC refrigerator manufacturers.

Estimated Annual Income: INR 35,000 (INR 2,917/month).

Bulk Milk Chiller

Annual income estimate has been sourced using logic from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023).

Income is chilling throughput (litres/day, at 500 L rated capacity) × INR 1.5/litre chilling margin, calculated at four utilisation levels:

Utilisation	Litres/day (500 × utilisation × 330 days ÷ 365)	Annual income (INR) = litres × ₹1.5
70%	115,500 litres/yr	1,73,250
80%	132,000 litres/yr	1,98,000
90%	148,500 litres/yr	2,22,750
100%	165,000 litres/yr	2,47,500

Average across the four utilisation levels = INR 2,10,375/year.

Estimated Annual Income: INR 2,10,375 (INR 17,531/month).

Cold Storage (5MT)

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with manufacturers to develop the logic below.

Total annual storage capacity = 5,000 kg × 365 days = 18,25,000 kg-days/year.

Income = storage quantity (at a given utilisation) × ₹0.25/kg/day:

Utilisation	Storage quantity (kg-days/yr)	Annual income (INR) = qty × INR 0.25
60%	10,95,000	2,73,750
70%	12,77,500	3,19,375
80%	14,60,000	3,65,000

Average across the three utilisation levels = ~INR 3,19,380/year.

Estimated Annual Income: INR 3,19,380 (INR 26,615/month).

Solar Silk Reeling Unit

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with manufacturers and impact assessment analysis.

Estimated Annual Income: INR 53,500 (INR 4,458/month).

Solar Charkha

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with manufacturers to develop the logic below.

Income is yarn-sale profit per day (INR/kg profit × 2 kg output/day), over 250 operating days/year, at three profit scenarios:

Profit (INR/kg)	Output (kg/day)	Annual income (INR) = profit × output × 250 days
50	2	25,000
100	2	50,000

Profit (INR/kg)	Output (kg/day)	Annual income (INR) = profit × output × 250 days
150	2	75,000

Average across the three scenarios = INR 50,000/year.

Estimated Annual Income: INR 50,000 (INR 4,167/month).

Solar Loom

Annual income estimate has been sourced from Powering Livelihoods' [market viability report](#) (Jain, Khalid, and Jindal 2023) based on consultations with manufacturers to develop the logic below.

Income is net weaving margin per day (revenue per metre of cloth, less input cost per metre), over 300 operating days/year, at three output scenarios:

Output (m/day)	Revenue (INR/m)	Input cost (INR/m)	Net income/day (INR)	Annual (INR) = net/day × 300
12	150	686	1,114	3,34,286
15	100	857	643	1,92,857
6	200	343	857	2,57,143

Average across the three scenarios = ~INR 2,61,500/year.

Estimated Annual Income: INR 2,61,500 (INR 21,792/month).

A2. Estimated financing requirement methodology

This report estimates the total financing requirement that could arise from adoption of five high potential DRE livelihood technologies across India: Solar Dryer (100kg), Cold Storage (10MT), Solar Refrigerator (100L), Food Processor (60L), and a Vertical Fodder Growing Unit (32-tray).

The estimate is built in four steps:

1. Addressable market size for each technology
2. Asset cost and loan amount per unit, depending on share of cost a buyer pays upfront
3. Share of that addressable market assumed to require financing rather than paying cash
4. Combining these into a total national loan requirement under Low/Medium/High scenarios.

Step 1: Market Potential per Technology: Estimated number of deployments for each technology (derived from internal analysis and consultations with manufacturers):

Technology	Market demand (units)	Asset cost per unit (₹)
Solar Dryer (100kg)	1,680,315	1,30,000
Cold Storage (10MT)	1,41,983	15,00,000
Solar Refrigerator (100L)	12,32,367	95,000
Food Processor (40L)	5,46,718	1,20,000
Vertical Fodder Unit (32-tray)	33,79,510	30,700

Technology	Market demand (units)	Asset cost per unit (₹)
Total	6,980,893	—

Step 2: Loan Amount per Unit: Assumes the buyer makes an upfront user contribution of 10% (Low), 20% (Medium), or 30% (High) of asset cost, and finances the rest through a loan:

Technology	User contribution			Loan amount (INR)		
	Low (10%)	Medium (20%)	High (30%)	High (90%)	Medium (80%)	Low (70%)
Solar Dryer	13,000	26,000	39,000	1,17,000	104,000	91,000
Cold Storage	1,50,000	3,00,000	4,50,000	13,50,000	12,00,000	10,50,000
Solar Refrigerator	9,500	19,000	28,500	85,500	76,000	66,500
Food Processor	12,000	24,000	36,000	1,08,000	96,000	84,000
Vertical Fodder Unit	3,070	6,140	9,210	27,630	24,560	21,490

Step 3: Estimating Financing Demand: Looks at the three scenarios of addressable market that requires financing.

Estimated financing demand = Market demand × addressable market share requiring financing:

Technology	Low (20% of market)	Medium (50% of market)	High (80% of market)
Solar Dryer (100kg)	336,063	840,158	1,344,252
Cold Storage (10MT)	28,397	70,992	113,586
Solar Refrigerator (100L)	246,473	616,184	985,894
Food Processor (60L)	109,344	273,359	437,374
Vertical Fodder Unit (32-tray)	675,902	1,689,755	2,703,608
Total units needing financing	1,396,179	3,490,447	5,584,714

Step 4: Overall Financing Requirement: The total loan requirement combines the number of units needing financing (Step 3) and the loan amount per unit (Step 2) — separately for each of the five technologies, then sums across technologies.

In billion USD, assuming conversion rate of INR 1 = US 0.011, i.e. roughly INR 91/USD:

Financing demand scenario	10% upfront user contribution	20% upfront user contribution	30% upfront user contribution
80% of users require credit	5.69	5.05	4.42
50% of users require credit	3.55	3.16	2.76
20% of users require credit	1.42	1.26	1.11

A3. DRE livelihood technologies: mapping to bank lending verticals

The appropriate Priority Sector Lending (PSL) classification for DRE livelihood technologies cannot be inferred from the technology name alone. While many DRE technologies are solar-powered, the RBI's PSL framework

requires each loan to be classified under a single category, and the Renewable Energy category has a limited scope that does not encompass most renewable energy-powered livelihood assets. Consequently, technologies such as solar dryers, cold storage units, rice mills, refrigerators, and sprayers are generally more likely to be classified under Agriculture or MSME, depending on their end use and borrower profile, than under Renewable Energy. The mapping presented below provides guidance on the most appropriate PSL classification for different DRE livelihood technologies, as per *RBI (Priority Sector Lending – Targets and Classification) Directions, 2025*.

Technology	PSL vertical	Basis in RBI Master Directions 2025	Where the ambiguity sits
Sub-HP / High-HP Solar Pump	Agriculture — Farm Credit	Explicitly named: loans to farmers for stand-alone solar agri pumps and solarisation of grid-connected pumps (para 9.1.A.viii)	Low ambiguity: explicit, named clause exists in guidelines.
Solar Sprayer	Agriculture — Farm Credit	Farm Credit covers "pre and post-harvest activities viz., spraying, harvesting, grading and transporting of own farm produce" (para 9.1.A.iii)	Low ambiguity if the borrower is the farmer using it on own produce; shifts to MSME if run as a paid CHC/custom-hire service.
Solar Animal Deterrent	Agriculture — Farm Credit (by extension)	No explicit clause; reasoned as an input to crop protection, analogous to spraying/harvesting inputs under 9.1.A	No named clause.
Solar-Powered Vertical Fodder Grow Unit	Agriculture — Farm Credit / Allied Activities	"Allied activities" is defined to include dairy, animal husbandry (para 4.1.i); fodder production for own livestock falls under medium/long-term loans for allied activities (9.1.A.ii)	Clear if the borrower owns the livestock; unclear if sold to an aggregator/enterprise.
Poultry Raker	Agriculture — Farm Credit / Allied Activities	Poultry is explicitly listed as an allied activity (para 4.1.i, 9.1.A.ii)	Low ambiguity for individual/farm-owned poultry units.
Solar-Powered Silk Reeling & Spinning Machines	Agriculture (sericulture, if farmer-owned); MSME (if enterprise run); Weaker Sections (artisans, village industries where individual credit limits are under INR 2 lakh)	Sericulture is listed as an allied activity (para 4.1.i); alternatively MSME covers "decentralised sector... artisans, village and cottage industries" (para 10.2.i–iii); if individual credit limits are under INR 2 lakh for artisans, they may also qualify under Weaker Sections (171.ii)	High ambiguity — same asset, three entirely different verticals depending on whether the reeler is classified as a farmer engaged in sericulture or as a micro-enterprise/artisan.
Solar Charkha / Solar Loom	MSME	Village/cottage/Khadi industries are explicitly categorised as micro enterprise lending (para 10.2.i–iii)	Clear once the borrower is a registered or informally-verified micro-enterprise.
Small Horticulture Processor	Agriculture — Ancillary/Food Processing	Food and Agro-processing is an explicit Ancillary Activity up to ₹100 crore (para 9.3.iii, Annex III); Annex III explicitly lists "Processing of F&V into different products... jam, jellies... etc."	Explicitly listed as an ancillary activity under Agriculture.
Solar Dryer	Agriculture — Ancillary/Food Processing	Annex III (Food Processing eligible activities) explicitly names "Sun Drying and Mechanical Drying: Solar Drying, Hot air drying..." as item 5	Explicitly listed as an ancillary activity under Agriculture.

Technology	PSL vertical	Basis in RBI Master Directions 2025	Where the ambiguity sits
Solar-Powered Rice Mill	Agriculture — Ancillary/Food Processing (Annex III, item 10)	Milling of grains/pulses is explicitly listed in Annex III	Explicitly listed as an ancillary activity under Agriculture.
Small Solar Refrigerators (dairy, fish, retail)	MSME, or Agriculture (dairy/fisheries) if producer-owned	Dairy is an allied activity (para 4.1.i) if the borrower is a farmer/dairy producer; otherwise falls to MSME as a retail/cold-chain micro-enterprise	The same technology falls into different verticals for different products.
Solar/Biomass Cold Storage	Agriculture Infrastructure	Explicitly named: "storage facilities... including cold storage units/cold storage chains designed to store agriculture produce" (Annex II, Item 1.i), aggregate limit ₹100 crore per borrower (para 9.2)	Low ambiguity: explicit, named clause exists in guidelines.
Small-Scale Cooling Units (street vendors)	Ambiguous for vendors; for farmers, Agricultural Infrastructure	Street/local vendors are typically neither directly engaged in agriculture nor necessarily formally registered enterprises (thus ineligible under Agriculture and MSME categories). For farmers, explicitly named: "storage facilities... including cold storage units/cold storage chains designed to store agriculture produce" (Annex II, Item 1.i).	High ambiguity, particularly for vendors.
Bulk Milk Chiller	Agriculture — Allied Activities / Infrastructure	Dairy is an allied activity; large-scale chillers for cooperatives may also qualify under Agriculture Infrastructure (storage) depending on structure	Depends on whether the borrower is a dairy cooperative/FPO vs. an individual aggregator (more ambiguous).

Source: RBI (Priority Sector Lending – Targets and Classification) Directions, 2025.

Reading across the sixteen technologies, three structural patterns emerge:

1. The determining variable is the *borrower's relationship to the asset* alongside the asset itself.
2. "Solar-powered" is not itself a PSL category for these assets.
3. Non-farmer, informal micro-entrepreneurs (street vendors, small retailers) are the segment with no clean PSL category.

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Council on Energy, Environment and Water (CEEW)

CEEW – a home-grown institution with headquarters in New Delhi – is among the world's leading climate think tanks. The Council uses data, integrated analysis, and strategic outreach to support public policy, transform markets, shape technology, and nudge behaviour. It addresses pressing regional and global challenges through an integrated and internationally focused approach. The Council prides itself on the independence of its high-quality research and strives to impact sustainable development at scale.

Villgro

Villgro Innovations Foundation is India's foremost impact-first incubator. Established in 2001, Villgro's mission is to make innovative, impactful businesses succeed in Health, Agribusiness, and Climate Action. We believe that innovation and for-profit business models are the sustainable route to solving critical social and environmental problems in India. Since 2001, we have worked with over 350 enterprises which have impacted over 20 million lives. Villgro was awarded the Top Incubator Award by the Department of Promotion of Industry and Internal Trade (GoI) in 2020 and the DivHERsity Awards in 2023.

Powering Livelihoods

A joint initiative between CEEW and Villgro, Powering Livelihoods (PL) is boosting India's rural economy by scaling up the penetration of clean energy-powered (decentralised renewable energy) livelihood technologies, especially amongst women. It is doing so by:

- providing deep technical and capital assistance to social impact enterprises deploying RE-powered livelihood equipment
- enabling sectoral partnerships with various enabling stakeholders, including financiers, investors, state government departments, and go-to-market partners.
- generating bespoke market research insights and evidence at scale about the impact and viability of DRE livelihoods
- supporting national and sub-national policy frameworks to mainstream DRE livelihoods to positively impact rural incomes, especially of women.

Solar refrigerators, energy-efficient food processors, solar reeling machines, cold storage, solar dryers, etc., are some of the technologies supported under the programme. By leveraging these enterprises' growth, the programme generates rigorous evidence about these solutions' impact, viability, and scalability to garner the support of investors, financiers, and policymakers to realise a potential USD 50 billion market opportunity. As of September 2026, through the PL supported enterprises, more than 42,000 livelihoods have been positively impacted, with around 40 per cent being women, driven by over 33,000 technology deployments.

National Institute of Bank Management (NIBM)

NIBM was established in 1969, by the Reserve Bank of India and the banking industry, as an apex institution for teaching, training, research and consultancy in banking and finance. The institute offers a two-year, full-time Post-Graduate Diploma in Management (Banking and Financial Services) (PGDM), which has served as the definitive source of skilled young personnel to the BFSI sector. This apart, the faculty are engaged in research and consultancy in the areas of banking and finance.

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