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Strengthening rural livelihoods in Assam through Decentralized Renewable Energy (DRE)

Policy Roadmap for systematic sector-wise DRE integration

February 2024

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Key takeaways

- Tremendous potential for rural and agri-based livelihoods in Assam, but mechanisation and technology adoption are low in most livelihoods sectors
- Exposure to technology and reliable energy, gaps in customised technology solutions among others, constrain mechanisation. Diesel generators are commonly used as backup
- Sustainable growth in major livelihoods sectors – agriculture including horticulture, fisheries, livestock, handlooms & sericulture, handicrafts, tourism, cottage-level tea – is possible with adoption of new technologies powered by reliable clean energy
- Decentralised renewable energy (DRE) – a large and diverse group of solutions including Renewable Energy (RE)-powered mini grids, solar lanterns, solar pumps, improved biomass boilers, dryers etc. can address the challenge of energy gaps, bring in an innovative ecosystem, open up possibilities of green / climate financing
- Many factors make Assam a good candidate state for DRE- good RE potential, progressive state RE policy 2022, dominance of rural livelihoods at the “cottage” scale, strong network of Non-Governmental Organizations (NGOs) and Community Service Organisations (CSOs), presence of technology institutes like IIT-Guwahati, North-East Center for Technology Application and Reach (NECTAR) in the region, major programmes like Assam Agribusiness and Rural Transformation (APART) of World Bank
- A pro-DRE ecosystem needs to be created – generate specific knowledge and awareness about how DRE has helped and can help Assam, support for DRE and plans for DRE integration to be woven into sectoral policies, capacity-building, innovative business models to support Operation and Maintenance (O&M), financing
- DRE for livelihoods framework of Ministry of New & Renewable Energy (MNRE) provides an overall structure at the national level. An Assam customised DRE for livelihoods framework can catalyse growth in many sectors
- A dedicated and empowered nodal entity at the state level is needed for DRE integration and facilitation across several sectors of rural economy

With systematic, inter-departmental co-ordination, Assam can be a front-runner in DRE-powered rural livelihoods in the North-Eastern region and for India as a whole

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Abbreviations

AEDA	Assam Energy Development Agency
APART	Assam Agribusiness and Rural Transformation
APDCL	Assam Power Distribution Company Limited
BDTC	Biogas Development and Training Centres
BLC	Block level cluster
CEEW	Council on Energy, Environment and Water
CFC	Common Facility Centre
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprises
CHC	Custom Hiring Centres
CHCDS	Comprehensive Handloom Cluster Development Scheme
CLEAN	Clean Energy Access Network
CMO	Chief Minister's Office
CMSGUY	Chief Minister Samagra Gramya Unnayan Yojana
CNG	Compressed Natural Gas
CSC	Common Service Centres
CSO	Community Service Organisations
CSR	Corporate Social Responsibility
DC	Direct Current
DIDF	Dairy Infrastructure Development Fund
DONER	Development of North-Eastern Region
DRE	Decentralized renewable energy
ELIS	Eligible Lending Institutions
ESG	Environmental, Social, Governance
FIDF	Fisheries and Aquaculture Infrastructure Development Fund
FPC	Farmer Producer Company
FPO	Farmer Producer Organization
GoA	Government of Assam
GobarDHAN	Galvanizing Organic Bio-Agro Resources Dhan
GoI	Government of India
GSDP	Gross State Domestic Product
HMNEH	Horticulture Mission for North-Eastern Region and Himalayan States
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council of Agricultural Research
IREAP	India Renewable Energy Appliances Portal
KVIC	Khadi and Village Industries Commission
MER	Monitoring, Evaluation, Reporting

MIDH	Mission for Integrated Development of Horticulture
MMKSSY	Mukhya Mantri Krishi Sa Sajuli Yojana
MNRE	Ministry of New and Renewable Energy
MSMEs	Micro, Small and Medium Enterprises
MVR	Monitoring, Verification & Reporting
MW	Mega Watt
NABARD	National Bank for Agriculture and Rural Development
NBM	National Bamboo Mission
NE	North-East
NECTAR	North-East Center for Technology Application and Reach
NGO	Non-Governmental Organizations
NIDA	NABARD Infrastructure Development Assistance
NLM	National Livestock Mission
NMOOP	National Mission on Oil Seeds & Oil Palm
NPDD	National programme for dairy development
NRLM	National Rural Livelihood Mission
O&M	Operation and Maintenance
ONPTR	Orang National Park and Tiger Reserve
PDMC	Per Drop More Crop
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PMMSY	Pradhan Mantri Matsya Sampada Yojana
PNG	Piped Natural Gas
PPP	Public-Private-Partnership
QU&PD	Quality upgradation and product diversification
R&D	Research and Development
RE	Renewable Energy
RIDF	Rural Infrastructure Development Fund
RPVY	Rashtriya Pashudhan Vikas Yojana
SCGJ	Skill Council for Green Jobs
SFAC	Small Farmers' Agri-Business Consortium
SHG	Self-help group
SMAM	Sub-Mission on Agricultural Mechanization
TAI	Tea Association of India
TDPS	Tea Development & Promotion Scheme
TRL	Technology Readiness Index
USD	United States Dollar

Executive summary

1. Assam has a vibrant natural resource-based economy. During the last four years, the state achieved a remarkable growth rate of over 10% per year with agriculture and allied activities leading the growth. Agriculture along with livestock, forestry, and fishing account for over a quarter of the state's income. Other major livelihoods sectors include tourism, handicrafts, and sericulture. It is recognised that the state has tremendous potential for growth, particularly given its rich natural resource base, its positioning as the gateway to the North-East region of India and to export markets in South Asia and South-East Asia.
2. Mechanisation and technology adoption is low in livelihoods sector– for instance, agricultural mechanisation in Assam is just 0.99 kW/hectare[1] (as compared to 4.4 kW/ha in Punjab) and only 5% of gross cropped area is under irrigation. The reasons cited for low technology adoption include low affordability, lack of technology customisation, lack of exposure and erratic power supply.
3. While overall shortfall of power in the state is only 2%, farming and other rural livelihoods activities are constrained by outages, affecting their productivity. Diesel powered generators are commonly used as back-up. In such a context, Decentralised Renewable Energy can prove to be a game-changer.
4. DRE systems are typically small-scale energy units that use renewable sources of energy like small hydro, agriculture & forest biomass waste, wind, solar, etc. to generate and distribute energy close to the point of use, ensuring limited or no transmission and distribution loss. The unique characteristics of use of DRE include local availability and no or low impact on both the local and global environment.
5. DRE also contributes to climate change mitigation and protecting natural capital. It is less vulnerable to the volatility of the fossil fuel markets and brings added benefits of stimulating local employment, technological development, and economic growth.
6. DRE interventions have multiple benefits in agriculture and associated sectors[2]:
   - Energy security- access to affordable, reliable, and quality energy services
   - Drudgery reduction in farm work and reduction in manual labour
   - Food preservation and farm level value addition by increasing the shelf life of food products through cold storage, drying, milling, etc.
   - Income augmentation at farm level through local level value addition and preprocessing
   - Increase in productivity with mechanization replacing manual processes in rural and remote areas
7. A recent study shows that just 12 DRE technologies can impact 37 million livelihoods and create revenue of USD 48 billion in India[3]. DRE offers an opportunity to Assam's economic growth to be decoupled from emissions such that Assam can move to a low or zero carbon growth pathway by adopting DRE.
8. This study has analyzed policies in key livelihoods sectors in Assam with the objective to enhance the productivity of these sectors through DRE integration. The analysis has focused on seven livelihood sectors – agriculture, livestock, fisheries, tourism, bamboo, handloom, and tea. The sectors were identified on account of the following:

   (I) Policies impacting rural livelihood options which were currently yielding sub optimal incomes to poor people

1. https://eands.dacnet.nic.in/PDF/February2021.pdf
2. It is estimated in the agriculture and allied sectors for Africa, for instance that, by powering irrigation, cold storage and lighting with DRE, emissions can be reduced by 20%. Cold storage can additionally avoid emissions from food wastage (Powering Agriculture with Renewable Energy- A Just Transition for Food Systems), https://www.powerforall.org/
3. https://eands.dacnet.nic.in/PDF/February2021.pdf

due to lack of access to reliable energy sources

(ii) The sectors have the highest potential for transformative change in the lives of a large number of rural poor with decentralized energy access

(iii) A DRE based intervention in the sectors would offer significant contribution to the Gross State Domestic Product (GSDP) of Assam from rural areas

(iv) The sectors offered scope for equitable development across genders and regions

9. The methodology for the policy analysis comprised study of all schemes of identified livelihood sector ministries at the national and state (Assam) level. Policy support for powered equipment in the schemes was compiled. Specific mention of DRE products and appliances in the schemes were collated. The analysis tried to understand the lack of support for DRE options in the schemes of different ministries. Considering the weak grid situation in many parts of Assam, the analysis identified DRE based technology options or mature DRE products that met the same need as the powered equipment for which financial support by the Government was committed.

10. Further, the need for development of more DRE products was assessed which could potentially be included in the schemes of different livelihood focused ministries. Emerging livelihood needs were identified that could be met by yet to be developed DRE products or DRE products still in a very nascent stage.

11. One of the key schemes that can be taken up on priority for DRE integration which can have impacts across multiple sectors, is the Chief Minister Samagra Gramya Unnayan Yojana (CMSGUY). The scheme can take up DRE Integration through the Mega Mission and its eight sub-missions covering several sectors that have been identified as priority sectors for DRE, i.e., agriculture including horticulture, food processing, dairy, poultry, fisheries, and sericulture.

12. In addition to demand side policies (i.e. livelihoods and end-use sectors), the analysis also covers two key policies on the supply side (i.e. DRE)– MNRE Draft Policy Framework for DRE Livelihood Applications and Assam Renewable Energy Policy, 2022. The analysis aims at strengthening these policies to ensure DRE is at the centre stage of planning for energising livelihoods sectors.

13. The policy analysis has visualized an opportunity for technology leapfrogging by Assam in its transition to a low carbon economy. It is ideally positioned to demonstrate DRE enabled sustainable development. Assam is a power deficient, resource rich, agrarian state, with 85% of the population residing in rural areas. DRE can offer to Assam an opportunity to convert its weakness into strength. A spin off of the approach would be replication of the Assam model by the other north-eastern states.

14. Based on the policy analysis and drawing on insights from CLEAN's consultations with state-level stakeholders over the last couple of years and a multi-stakeholder roundtable held in Guwahati on November 9, 2023, a roadmap for integrating DRE in livelihoods sectors in Assam is developed. The roadmap provides specific recommendations for DRE integration in selected end-use livelihoods sectors. The recommendations include identifying ecosystem enablers encompassing technology customization, knowledge creation, inter-departmental coordination among others, required to facilitate the DRE integration.

15. It further conceptualises a dedicated "DRE Implementation and Upscaling Facility" to be anchored at an appropriate state level institution. The proposed facility aims at providing technical support to all DRE projects in the state implemented by different departments/ ministries; facilitate central and state level financial support; coordinate with all agencies, both governmental and non-governmental to ensure synergies in planning, procurement, implementation of DRE projects; undertake capacity building and training programmes, among others. The proposed facility would need adequate resources, both financial and human resources to undertake above roles.

Summary of sectoral policy analysis and recommendations is provided below:

Sector/ Department	Relevant state-level policy that can be the entry point	DRE equipment/ interventions mentioned in the policy	Suggestion for DRE inclusion in the policy
• Multiple sectors: state-wide	• Chief Minister Samagra Gramya Unnayan Yojana - ambitious scheme launched by the Government of Assam with the aim of doubling farmer's income	• Solar powered pumps being supported under the scheme	Subsidies and incentives for relevant DRE technologies across agriculture, fisheries, livestock, sericulture can be extended: • Solar powered micro irrigation system • Solar rice milling, solar and biomass-based appliances for powering equipment to make puffed rice, flattened rice (poha) • Research and Development (R&D) of solar powered combined harvester • Solar aerators, solar ice boxes, solar power plant to power aquaculture
• Agriculture / horticulture	Mukhya Mantri Krishi Sa Sajuli Yojana (MMKSSY)	• Provides financial assistance to farmers to procure farm tools/ farm implements (not powered equipment)	• Expanding the current scheme to include support for DRE appliances • Support R&D for solar powered paddy transplanter as a new DRE product
Livelihoods focussed on cattle-rearing, piggery, backyard poultry	Livestock policies based largely on national policies – National Livestock Mission (NLM)	• NLM support powered equipment for breeding and fodder cultivation that are available as solar powered • Dairy Sahakar Policy mentions support for renewable energy plants • Galvanizing Organic Bio-Agro Resources Dhan (GobarDHAN) scheme provides financia assistance for cluster/community level biogas plants	Support for following DRE-powered equipment could be provided • DRE-powered sheds (lighting, ventilation), egg incubators • DRE for milk chilling, milk collection centres, milk processing • Biogas generation from animal waste • Solar pumps for fodder cultivation • Improved cook stoves for animal feed preparation • Solar powered semen/ vaccines stations; Solar freezers for semen storage
Fisheries	Assam Fisheries and Aquaculture Policy 2023	• Encourages use of renewable energy (solar) especially in small fishing units at various stages of fish production and supply chain, including post-harvest management and value addition	Specific DRE (solar as well as biomass) technologies may be suggested and incentivised: • Solar PV to power aquaculture equipment • Biomass based dryers and cold storage • Solar powered freezers on-boat • Solar PV on boats • Solar ice-making plants • Solar lights and ventilation

Sector/ Department	Relevant state-level policy that can be the entry point	DRE equipment/ interventions mentioned in the policy	Suggestion for DRE inclusion in the policy
Tourism	Tourism Policy of Assam 2022	• Focuses on sustainable, inclusive tourism. Supports purchase of equipment or technology that reduces waste, encourages green energy adoption • Reimbursement of 25% investment on renewable energy available, but mentions a need to study the program on subsidies	• Subsidy to tourism units installing renewable energy systems should continue • Corporate Social Responsibility (CSR) and carbon financing can be roped in • DRE interventions such as rooftop solar, small wind, small hydro may be considered for support • Biomass-based thermal systems for cooking and heating must be supported • Use of battery-operated vehicles charged by solar, solar powered boats; biomass pellet fired bon fires • Use of solar energy for electricity generation, cooking needs and hot water requirements
Bamboo	The Assam Bamboo and Cane Policy	• Policy has provision for 50% capital investment subsidy on electrical equipment. There are references to ethanol production from bamboo • National Bamboo Mission (NBM) include activities such as making of pellets and activated carbon, bio energy extraction and establishment of gasifier for ethanol production	• Policy provision on electrical equipment can be modified to include DRE-powered equipment • Incentives for ethanol production may be considered under policy • Suggestion to use bamboo waste and/ or solar to power bamboo processing centres • Bamboo and cane waste to produce biomass pellets – can be suggested and incentivised
Handloom/ Sericulture	Assam Handloom Policy has not been extended; Assam Textile and Apparel policy was operational till 2022; National Handloom Development Programme (NHDP) in operation	• NHDP mentions funding for other solar products like solar lighting, solar powered silk reeling and twisting machine, solar operated winding machine, solar power system for operating jacquard lifting mechanism	Several options for DRE integration can be suggested: • Solar sprinkler, solar irrigation pump for mulberry cultivation • Biomass fired baby boilers/ improved biomass stoves for dye houses • Solar water heaters/ improved biomass fired stoves - Generation of hot water • Solar/ biomass fired hot air generators for cocoon stifling • Solar charkha, Solar powered motorized handlooms DRE can also be incorporated into processes like effluent treatment mandated for sustainable handloom

Sector/ Department	Relevant state-level policy that can be the entry point	DRE equipment/ interventions mentioned in the policy	Suggestion for DRE inclusion in the policy

Tea industry	Tea Development & Promotion Scheme (TDPS) of Tea Board of India
	Component 1: Plantation Development for Small Tea Growers
	Component 2: Quality Upgradation and Product Diversification
		• Supports electrical equipment for irrigation (sprinkler equipment, motors, pump sets, etc.), mechanization (pruning machine, mechanical harvester, etc.), setting up of new and mini factories through subsidy extension	• Electrically powered quipment that are already eligibile for subsidy can be taken to include standalone or grid-interactive solar-powered equpment
			• Other DRE technologies for integration in the tea industry that can be suggested including:
			  • Solar roof top – powering crucial equipment
			  • Solar pumps, Solar sprinklers – Irrigation
			  • Small hydro/ solar mini grids - powering crucial equipment
			  • Biomass briquettes/ pellets - Can replace coal/ Piped Natural Gas (PNG) for drying/ withering
			  • R&D grant can be used to develop and demonstrate new DRE products for the sector

01

The context

1.1 Socio-economic profile of Assam

Assam, India's gateway to south-east Asia is critically important state for India. With a geographical area is 78,438 sq. kms (2.4% of India's geographical area) and a population of 3.12 crores (2.6% of India's population) as per 2011 census[4], Assam is the largest of the north-eastern states. 86% of Assam's population lives in rural areas. It shares borders with Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and West Bengal and it has to deal with several interstate issues. The state's proximity to SAARC countries like Bangladesh, Nepal and Bhutan and the possibility of cross-border trade makes it an attractive region for investment.

The Gross State Domestic Product of Assam at current prices is estimated at over INR 412 thousand crores representing an average annual growth of around 10% over the last five years. With per capita income of over Rs 1.02 lakhs, Assam is a primarily agragrian state. Agriculture and allied activities contribute to over quarter of the state's GSDP (Figure 1)

The state government is focusing on promoting sustainable development in agriculture and increasing the use of technology and skill development. Assam has the largest tea growing area in the world, accounting for over 53% of India's overall tea production. The state is one of India's oldest oil-producing states accounting for 13% of the country's total oil production and the largest producer of natural gas, accounting for 10% of national production at 3,289 MMSCM (million metric standard cubic metres). Tea, oil, and natural gas continue to dominate the state's industrial scene. Assam government is now incentivising other industries such as tourism, telecom, and pharmaceuticals. Tourism is one of the fastest-growing sectors, accounting for 5.5% of GSDP and approximately 10.5% of total employment

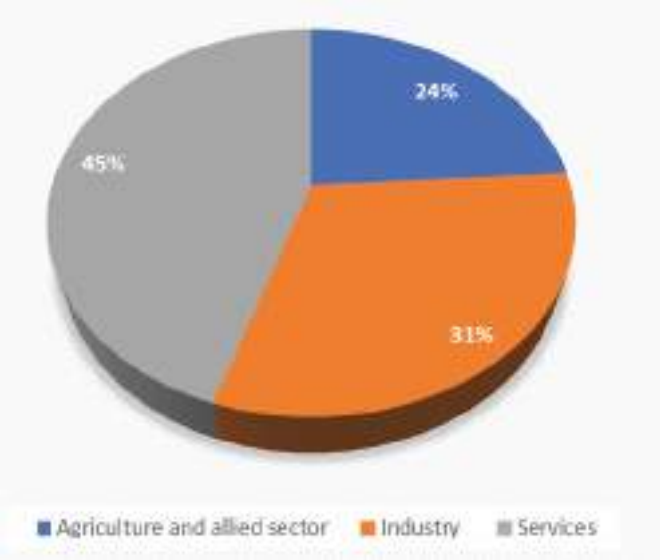

Figure 1: Sectoral contribution of Assam GSDP for 2021-22

in the state. Despite its strategic geographic location as India's gateway to southeast Asia, Assam has yet to exploit its full growth potential.

1.2 Profiling rural livelihoods

This policy analysis has focused on livelihood sectors in Assam. The criteria for selection of the specific sectors chosen – agriculture, livestock, fisheries, tourism, bamboo, handloom, and tea- were

i. Policies impacting rural livelihood options which were currently yielding sub optimal incomes to poor people due to lack of access to reliable energy sources – both thermal and electrical

ii. Potential for transformative change in the

4. Economic survey – Assam – 2022-23

lives of a large number of rural poor with decentralized energy access

iii. Potential for significant contribution to the GSDP of Assam from rural areas

iv. Scope for equitable development of men and women.

- Agriculture is the main source of livelihood for 70% of Assam's rural population[5]. The agriculture census 2015-16 states that 27.42 lakhs households are dependent on agriculture for their livelihood[6]. Horticulture, although occupying less cultivated area compared to agriculture, is also a prime area for income and employment generation.
- Livestock is an integral part of the mixed-farming system that characterizes agriculture in Assam. Besides contributing to food and crop production, livestock and poultry is source of daily earning for many poor rural households and is insurance against adversity. More than 90% of the population in Assam is non vegetarian[7].
- Fishery is another prominent sector of Assam generating huge incomes and employment opportunities. About 25 lakh people earn their livelihood from fisheries and related activities[8]. The demand for fishery products is high as around 90% of the population are fish eaters.
- Assam offers wildlife, natural beauty, unique flora & fauna, holy shrines, lush green tea gardens, turbulent rivers, vibrant and colourful cultural festivals to tourists. Tourism in the state is growing with over 98 lakh tourists visiting Assam in the year 2022[9].
- Bamboo is a major natural resource of Assam with more than half of the population earning an income from bamboo. Bamboo is used in mainly in buildings, furniture, and household products / handicrafts[10]. Around 51 species of bamboo are grown in Assam.
- Handloom sector is next to agriculture in providing income to people in Assam. As per 4th National Handloom Census (2019-20), more than 12.83 lakh handloom weavers and 12.46 lakh handlooms are available in the state[11]. Sericulture is also an important contributor to livelihood in Assam. It is a way of life for Assamese people as silk weaving is passed down to each generation.
- The tea industry contributes significantly to the state economy employing over 10 lakh workers working in 856 tea estates in Assam[12].

1.3 Understanding constraints due to energy gaps

Assam is a power deficient state. The installed power capacity of the state is 411 MW as of September 2023. To meet the power requirement, the state is purchasing power from the central and private sector generating stations. Including these sources, Assam has a total installed power capacity of 1,889 MW as of September 2023. Its peak demand is

Year	Peak electricity demand
2018-19	1894 MW
2019-20	2051 MW
2020-21	2073 MW

5. Economic survey – Assam- 2021-22
6. https://agcensus.nic.in/chartin.html
7. https://assamlivelihoods.in/livestock.aspx
8. Assam State Fisheries and Aquaculture Draft Policy 2023
9. https://timesofindia.indiatimes.com/city/guwahati/tourist-footfall-in-assam-rose-to-98-lakh-in-2022-23/articleshow/103619614.cms
10. https://www.switch-asia.eu/site/assets/files/3663/bamboo_state_profile_-_assam-v2.pdf
11. https://dht.assam.gov.in/about-us/detail/state-profile-0
12. https://www.business-standard.com/article/elections/as-assam-goes-to-polls-spotlight-on-10-lakh-tea-garden-workers-121031400263_1.html

increasing as shown below. The share of renewables in this installed capacity is only 191 MW[13].

There are reports of frequent power outages in various parts of Assam due to power demand increase to 2,500 MW in the peak summer of 2023 leading to a huge supply and demand gap[14]. Ministry of Power has reported an average of 19 hours of power supply in a day to rural areas in Assam during September 2019[15]. A survey conducted by CEEW in 2018 shows that rural households in Assam face six or more hours of daily power outages[16]. According to Tea Association of India (TAI), erratic power supply in Assam's Barak Valley has led to a crop loss of approximately 5.5 million kg during March to June 2020[17].

The percentage of households using fuel wood in Assam is approximately 72%, much higher than the national average of 49%[18], pointing to a gap in access to clean cooking (thermal) energy in the state. This is confirmed by a study in Dhemaji district of Assam – a district with a high percentage of rural population, which states that the use of non-commercial fuel (firewood, biomass, agro residue) is high compared to the commercial fuel (electricity, LPG, etc.) for cooking[19].

1.4 Role of DRE – what is DRE and how it can help

DRE systems are typically renewable energy (small hydro, agriculture & forest biomass waste, wind and solar) based small-scale energy generation units that generate and deliver energy close to its generation point, ensuring limited or no transmission and distribution loss. Use of DRE technologies contribute to climate change mitigation and protecting natural capital. It is less vulnerable to the volatility of the fossil fuel markets and brings added benefits of stimulating local employment, technological development, and economic growth. DRE technologies offer options for both thermal and electrical energy. Figure 2 provides more details of DRE products and appliances.

DRE technologies can be enabled at different scales, for meeting a variety of needs and for different user groups including household, community, farmer groups, Micro, Small and Medium Enterprises (MSMEs). In 2019, more than 176 million people globally had access to some form of DRE based electricity. This is an eightfold increase compared to 2011[20]. There are several robust, market ready DRE technologies available in India. Studies like the recent study of 12 DRE appliances by CEEW

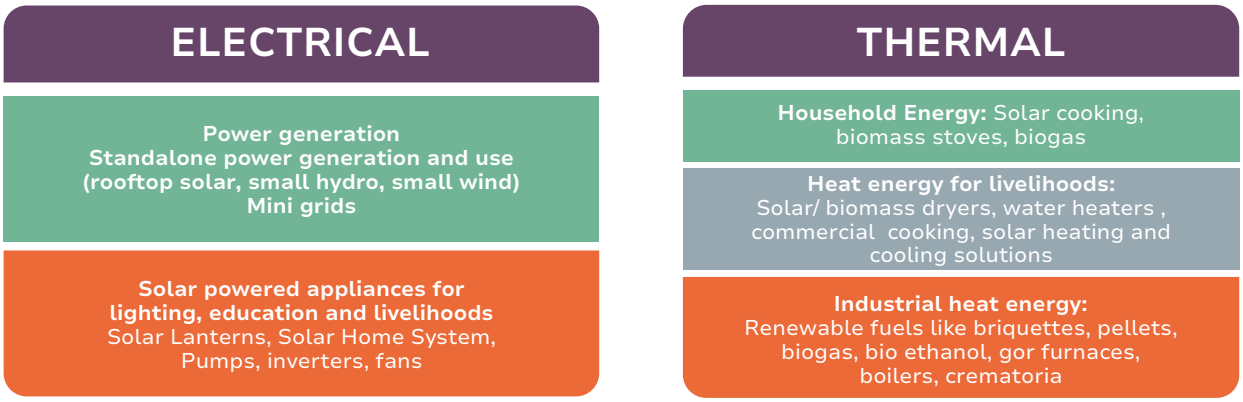

Figure 2: Examples of typical DRE technologies for livelihoods

13. https://cea.nic.in/dashboard/?lang=en
14. https://timesofindia.indiatimes.com/city/guwahati/amid-power-crisis-cm-asks-people-to-adjust/articleshow/103451195.cms?from=mdr
15. https://pib.gov.in/Pressreleaseshare.aspx?PRID=1592833
16. https://www.ceew.in/publications/access-to-electricity-availability-and-electrification-percentage-in-india
17. https://energy.economictimes.indiatimes.com/news/power/erratic-power-supply-posing-a-challenge-to-tea-industry-in-assam-s-barak-valley-tai/77281207
18. https://iigeo.org/wp-content/uploads/2018/06/5-Status-of-biomass-energy-resource-in-Assam-Darshana-Sarmah-Jnanashree-Borah-and-Madhushree-Das.pdf
19. https://www.ijstr.org/final-print/jan2020/Energy-Consumption-Pattern-Of-Rural-Households-A-Case-Study-Of-Dhemaji-District-Of-Assam.pdf
20. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Livelihood_Decentralised_Renewables_2022.pdf?rev=7f7ca5cd9eea443483dea7987ef

and feedback from CLEAN members indicate that almost all DRE appliances are attractive when electricity is unreliable. DRE technologies can positively impact 37 million livelihoods and create revenue of USD 48 billion in India[21].

Several existing appliances are or can be powered through DRE. New DC power-based DRE appliances are also being developed. These would help in agriculture mechanization, food processing, livelihood development and creation of new DRE based jobs in product assembly and servicing. DRE interventions have multiple benefits such as:

- Energy security; access to affordable, reliable, and quality energy services
- Drudgery reduction in farm work and reduction in manual labour.
- Food preservation and farm level value addition by increasing the shelf life of food products through cold storage, drying, milling, etc.
- Income augmentation at farm level through local level value addition and pre-processing.
- Increase in productivity with mechanization replacing manual processes in rural and remote areas. DRE can enable higher output with less work and over shorter time

Some examples of DRE technologies and appliances are depicted in Figure 3 below.

Figure 3: Examples of DRE technologies and appliances supporting livelihoods

21. https://www.ceew.in/publications/decentralised-renewable-energy-technologies-market-impact-potential-for-sustainable-livelihoods-india

1.5 Why should Assam consider DRE?

DRE offers an opportunity for Assam's economic growth to be decoupled from emissions. Assam can move to a low or zero carbon growth pathway by adopting DRE. Being a small and decentralized system, DRE offers opportunities to create models of energy self-reliance. Livelihoods and community services (like schools, hospitals) that are constrained by unreliable energy can benefit from DRE integration. Opportunities offered by DRE to the state of Assam are shown below.

Strengths of DRE	Opportunities in Assam
DRE can energize various applications in agriculture and allied sectors such as - • mechanization of processing which can reduce drudgery and improve productivity • safe storage – to reduce wastage and improve shelf life • ventilation and lighting of buildings for higher productivity	**Oorja Atmanirbhar Livelihoods clusters** can emerge in the state The state can create micro-enterprises in multiple sectors aligned with **Sva-niyojan yojana**
Compared to large-scale RE, the job creation potential of DRE is at least five-fold[22]	This aligns well with the **Sva-niyojan yojana** in the state
Energy generation possibilities – from cow dung, fruit waste, dry agri-waste	State can enhance its commitment to **net zero, Mission LiFE and Swachh Bharat Abhiyan**
DRE technologies and products are low-carbon, modern and energy efficient	State can t**ap into carbon financing market and emerging energy efficiency market** by integrating DRE in various sectors of economy
DRE can eliminate / considerably reduce dependence on fossil fuels, e.g. diesel generators, diesel pumps used across various sectors of economy	State can enhance its commitment to **net zero and Mission LiFE**
DRE can play a key role when electric transmission and distribution networks collapse and / or when restoration of grid power is found to be unsafe[23].	Inclusion of DRE for alternative source of energy in **Assam State Disaster Management Plan (strategic action plan)** would benefit the state in increasing its disaster management and resilience

1.6 Addressing the challenges around DRE

DRE, being a nascent sector, has multi-dimensional challenges associated with technology customization, financing, market design, acceptability, after-sales service, etc. However, there are case examples and good practices that have showcased the way to address these challenges, which will benefit the process of DRE integration in end-use sectors.

22. more people were employed for installing just 3.8 GW of rooftop solar than were employed for installing 26.2 GW of utility-scale solar in the last five years in India
23. based on review of blog on www.thecleannetwork.org

Challenges of DRE	Addressing the challenges
Financial viability of DRE projects • What are returns on investments • What would be payback periods from users' perspective	Observations from studies and customer insights: • All DRE appliances are cost-effective when electricity is unreliable • Solar dryer is financially attractive irrespective of electricity situation • Viability is best when products are used over the lifetime of around 10 years • Higher usage days per year improves financial returns – e.g. for a horticulture processor or dryer, usage of the appliance for multiple crops in different seasons improves viability
Affordability • Despite being financially attractive, mobilizing capital for investing in DRE becomes a challenge especially when working with socio-economically marginalized groups	• Targeted subsidies and policy incentives will make DRE more affordable • Business model innovations around "Energy as a service", "Rent-to-own or Pay-As-You-Go" address this challenge (details in Section 4.3.2)
Customization and quality control • Ensuring low cost and reducing entry barriers is important for a new sector like DRE, but it is equally important to ensure quality • While some DRE products are well-developed, other applications need R&D support • Some well-developed products need customization to the local context with respect to type of crop being processed, water table from which pumping is to be done	Empowering the DRE user / adopter/ purchaser on the following: • Technical competency must be made available to the procurer (requiring a nodal agency as the guide) • Procurement process (pre-installation) must take into account what is needed, what is possible, development of system specifications for the tender with support of technically competent persons • Selection of vendor-criteria of pre-qualification and / or selection of vendors must also be done carefully; should include warranties, service contract etc.
• Post-installation, there could be skills / capacity gap for proper upkeep, operations, and maintenance	• Village level entrepreneurs can set up DRE service networks • Training can be imparted in partnership with government and private ITIs • DRE vendors should be made responsible for proper training at the time of installation
• Specific awareness and understanding of what, why, how, and where about DRE technologies is lacking	• An anchor needed for DRE planning in the state, role of agencies like CLEAN is important. Local expos to be organized. IREAP (India Renewable Energy Appliances Portal)[24] and similar portals can be used effectively

24. https://ireap.thecleannetwork.org/

02

Analysis of major livelihoods policies in Assam

2.1 Methodology for the policy review

The policy review team comprised policy experts in decentralized renewable energy, veteran practitioners disseminating DRE technology, a recently retired official of the Assam Energy Development Agency (AEDA) and the CLEAN team. The review team also had access to the Board and members of CLEAN who have helped formulate renewable energy policies and have participated in the implementation of MNRE schemes. The team could also formally consult with representatives of different livelihood ministries in Assam and learn from their experience, expertise, and needs.

The methodology for the policy analysis was initiated with a goal setting consultation about the transformative role of DRE for Assam and the selection of the livelihood sectors that were most relevant for Assam. The policy review team carried out the following tasks:

- Collection and study of policy documents from different ministries at the national, regional (DONER Ministry) and state level for each of the identified livelihood sectors.
- In some cases and depending on need, policies of other north eastern states were also reviewed (bamboo policy of Nagaland and Tripura for example) to understand the policy formulation imperatives of other states in the region.
- The focus of policy scrutiny was the policies that were currently under implementation. However, if the situation warranted and, in an attempt, to understand policy transition, as in the case of the tourism policies, past or expired policies were also studied.
- Keeping in mind the relevance of DRE to the rural economy of Assam, MNRE's policy framework to promote DRE livelihood applications in rural areas was also studied.
- Assam Renewable Energy Policy 2022 was studied to strengthen the case of DRE across several sectors
- References to DRE in schemes of identified livelihood sector Ministries at the national level were compiled. It was observed that the state policies were a careful selection of national policies that best suited the state.
- Policy support for powered equipment in the schemes was compiled. The analysis tried to understand the lack of support for DRE options in the schemes of different Ministries/ Departments. Considering the acute shortage of grid power in Assam, the team looked for a DRE based technology option or a mature DRE product that met the same need as the powered equipment where financial support by the Government was committed.
- The policy team assessed the need for development of more DRE products which could potentially be included in the schemes of different livelihood focussed Ministries. It has also attempted to identify emerging livelihood needs that could be met by yet to be developed DRE products or DRE products still in a very nascent stage.

The analysis paved the way for the quick and easy recommendations for integration of DRE into the state level schemes and the mechanisms under which they could be incorporated.

2.2 Agriculture and horticulture

2.2.1 Overview

Agriculture contributes 24% to the state income and is a livelihood to about 70% of Assam's rural population. The net and gross cropped areas are 28.11 (35.1% of geographical area) and 40.99 lakh hectares, respectively with a cropping intensity of 144%. Approximately 54.11% of the state's total area is covered by agriculture. Of the total cropped area, 25 lakh ha is under rice, 5.84 lakh ha in horticulture and the rest under other crops[25].

Major agricultural crops produced in the state include rice, wheat, maize, pulses, oilseeds, and sugarcane. The state has produced 52.7 lakh tonnes of rice in the year 2021-22 and is among the top 10 producers of rice in India[26].

Assam grows wide range of fruits and vegetables. In the year 2021-22, Assam's fruit production was 2,540 thousand metric tonnes and vegetable production was 3,748 thousand metric tonnes. It is the second largest producer of pineapple in India. It also grows mushrooms, medicinal and aromatic plants, spices (ginger, turmeric, coriander), and plantation crops (arecanut, bamboo). It is the third-largest producer of ginger[27] in India.

Post harvest losses of agricultural and horticultural crops are in the range of 30 to 60%[25]. One of the reasons for this high crop loss is power shortage. Rural Assam especially is power deficient. The availability of farm power in Assam was 1.25 HP per hectare in 2014 against national average of 2.25 HP per hectare[25]. The state is beset with adverse and unpredictable weather conditions and in the absence of irrigation facilities, it is unable to pursue multi-cropping. Assam's ultimate irrigation potential is estimated to be 27 lakh hectares. However, there is a huge gap between irrigation potential created and irrigation potential utilized because of the erratic power supply in rural areas[28]. DRE offers a great opportunity to increase area under irrigation, reduce post-harvest crop loss, increase GSDP and simultaneously create jobs through DRE powered farm level food processing.

2.2.2 Energy use in agriculture and horticulture

Advancement in agriculture practices and use of technology, has created an additional demand for energy in agriculture. Figure 4 below illustrates the major activities where energy is required in agriculture and horticulture sectors.

On-farm mechanization Post harvest Value addition	Post harvest	Value addition
Land Preparation	Preservation technologies	Drying
Irrigation	like cold storage	Grinding
Fertilizing	Preservation by Drying /De humidification	Milling
Crop protection	Mechanized sorting/ grading	Juice extraction
Harvesting/ Threshing		Frying/ other processing

Figure 4: Activities requiring energy in agriculture & horticulture

25. https://diragri.assam.gov.in/sites/default/files/swf_utility_folder/departments/diragri_medhassu_in_oid_4/menu/document/2.9.pdf
26. Agricultural statistics at a glance 2022, Government of India, Ministry of Agriculture & Farmers Welfare
27. https://worldfoodindia.gov.in/public/pdf/1689057673_1951679149.pdf
28 https://www.sentinelassam.com/topheadlines/only-1920-out-of-3753-minor-irrigation-schemes-functional-in-assam-632344

2.2.3 Relevant policies and schemes for agriculture

A review of these policies and schemes for agriculture and horticulture formulated by the Assam Government is presented below.

Agricultural Draft Policy, Assam[25]

The state government has issued its agriculture policy which is still in the draft form. The goal of the policy is to double farmers' income primarily through increased food production. The policy discusses the need to augment farm power availability and embrace mechanization at a significant scale.

The policy aims to halve crop losses to 15-30 per cent by embracing established and novel technologies developed by the state agricultural university for specific crops and locations. The policy refers to 80% government support for larger farm equipment and also mentions the setting up of custom hiring centres. **However, the policy is silent on use of DRE technologies for irrigation, farm mechanization or post-harvest management.**

Chief Minister Samagra Gramya Unnayan Yojana

CMSGUY is an ambitious scheme launched by the Government of Assam with the aim of doubling farm income. The on-farm mechanization and post-harvest management schemes under the CMSGUY are presented in Table 1 below:

Table 1: List of schemes for farm mechanization and post-harvest management under CMSGUY

Name of the scheme	Objective	Features	DRE technology in the scheme
Top Up subsidy for Micro Irrigation Component of Per Drop More Crop (PDMC)	• To improve water use efficiency through micro irrigation technologies • To benefit 28,783 nos. of beneficiaries and irrigate approx. 28,627 Ha	• Top-up subsidy for implementation of micro irrigation component of PDMC[29] under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) • Beneficiaries' share reduced to 15% of the total cost with 85% subsidy provided by both the central & state government	No mention of DRE Solar powered micro irrigation system may be integrated as part of PMKSY scheme
Distribution / Installation of hybrid (Solar water pumps and shallow tube well	• To introduce a hybrid irrigation system by powering the IP set through solar and / or electric power	• Farmers contribution @ 15% of the total cost of the solar water pumping system and 25% of the cost of the shallow tube well excluding the cost of electric connection which would be borne by Assam Power Distribution Company Limited (APDCL) • Farmer has the option of selling the power generated by solar panel to APDCL when irrigation is not required	**Solar powered pumps being supported under the scheme**

29. Per Drop - More Crop (PDMC) is an integral component of PMKSY, focuses on maximizing water use efficiency at the farm level. Major activities under PDMC can be categorized into "Micro Irrigation" including Drip, Sprinkler, Micro Sprinklers etc. and "Supplementary Water Management Activities (SWMA)/ Other interventions". SWMA activities include farm level secondary storage structures

Setting up/ up gradation of rice mills in Assam	To provide capital subsidy for establishment of mini modern rice mills and also technology up-gradation and expansion of existing units	• Financial assistance of INR 10-15 lakhs for setting up rice mills and INR 5 lakhs for upgradation of mills from 1 ton/hr to 2 ton/ hr • The beneficiaries could be individuals, self-help group (SHG), co-operatives, Farmer Producer Organization (FPO), partnership ventures	No mention of DRE Possibility exists for inclusion of robust, mature DRE products like solar rice milling. Opportunity exists for demonstrating biomass-based heating systems and solar powered equipment to make puffed rice and flattened rice (poha)
Distribution of Combined Harvester[30]	To distribute one Mini Combined Harvester in each Assembly Constituency of Assam at subsidized rate to farmer groups	• 80% subsidy for procuring Mini Combined Harvester • To distribute 126 mini combine harvester in each of the Assembly Constituencies of Assam in 1stphase.	No mention of DRE A solar powered mini combined harvester can be developed and the same offered through the scheme after adequate testing.

Mukhya Mantri Krishi Sa Sajuli Yojana[31]

The scheme, limited to small and marginal farmers was launched by the government of Assam in the FY 2018-19 to increase the farm productivity, meet the growing demand for farm produce and ensure higher income for farmers. The scheme provides financial assistance of INR 5,000 to each farmer to procure farm tools/ farm implements which are not powered equipment. The scheme could consider permitting a farmer group to jointly own a DRE equipment instead of individual farmers buying small equipment.

Sub-Mission on Agricultural Mechanization (SMAM)

SMAM is a central sector scheme launched in 2014-15 under the aegis of National Mission on Agricultural Extension & Technology to promote farm mechanization and increase the ratio of farm power to cultivable unit area up to 2.5 kW/ha[32]. The scheme promotes:

- Mechanization of agricultural and post-harvest technology through training, testing, followed by demonstration, distribution of post-harvest technology products,
- Financial assistance for procurement of agriculture machinery and equipment,
- Establishment of farm machinery banks, (including DRE powered farm machinery) for custom hiring and promotion of farm machinery and equipment in North-Eastern Region.

Horticulture Mission for North-Eastern Region and Himalayan States (HMNEH) under the Mission for Integrated Development of Horticulture (MIDH) scheme

HMNEH is one of the sub-schemes of MIDH scheme for overall development of horticulture implemented by the State Horticulture Missions in the North-eastern and Himalayan States. The scheme covers support for research, plantation infrastructure development, integrated post-harvest management, food processing, and marketing. Though DRE equipment are not specifically mentioned, the Guidelines mention support for solar thermal systems and solar PV panels under alternate technologies introduced in cold chains. A wide range of pre- and post-harvest equipment find support in the MIDH guidelines as tabulated below[33].

30. A combined harvester is a machine that harvests grain crops. Its work can be stated as follows: Harvesting, feeding of crops to the threshing unit, threshing the seed from the head, separating the seed from the straw, and cleaning the seed from the chaff. It enables farmers to harvest larger amounts and quickly
31. https://diragri.assam.gov.in/schemes/mukhya-mantri-krishi-sa-sajuli-yozana
32. https://agrimachinery.nic.in/Files/Guidelines/SMAMGiudeline2020-21.pdf
33. https://agri horti.assam.gov.in/sites/default/files/swf_utility_folder/departments/horticulture_medhassu_in_oid_5/menu/schemes/Cost%20norms%20of%20HMNEH%20Guideline.pdf

National Mission on Oil Seeds & Oil Palm (NMOOP)

The objective of the mission is to increase the production and productivity of oil crops. The Mission has two sub-missions–

- Mini Mission I (MM I): covering conventional oil seed crops like rape, mustard, sesame, groundnut
- Mini Mission II (MM II): covering Oil Palm

Equipment supported under the two sub schemes are:[34]

MM I: Oil seeds	• Manual sprayers, power sprayers • Improved farm implements • Sprinkler/mobile sprinkler/Rain gun
MM II: Oil Palm	• Micro irrigation system • Pump set (diesel/electric/petrol) up to 10HP • Chaff cutter for chaffing of oil palm leaves • Processing unit, setting up of mill

2.2.4 Scope of DRE integration in policies and schemes

There is a huge scope for integrating DRE technologies in the above-mentioned policies and schemes. DRE products can enable farm mechanization, provide irrigation, prevent of crop loss, power farm level value addition, and create energy linked jobs. They can significantly contribute to the Prime Minister's commitment of doubling farm incomes.

Their absence in schemes could be because of lack of awareness among policy makers about their benefits and likely impacts especially in power deficient regions. Only solar pumping has been mentioned in schemes because of the wide publicity and policy support that they have received across Ministries. Table 2 below provides the list of DRE technologies which can be included in schemes of the Ministry.

Table 2: List of DRE technologies for on farm and post-harvest management and value addition

Activity	DRE technology	Application
On-farm mechanization	Solar water pump	To draw surface or ground water out for irrigation
	Solar agriculture sprayer	For spraying the pesticide on the farm
	Solar powered sprinkler	To distribute water through pipes by pumping and spraying it into the air for irrigating the land
	Solar powered drip irrigation	To deliver water close to the root of the crop through pipes by pumping
Post harvest management	Solar/ biomass cold storage	To provide a temperature-controlled environment for storing fruits and vegetables and thus prevent crop loss
	Rooftop solar PV	Generate power to operate machines for a range of preservation and processing technologies

34. https://agri-horti.assam.gov.in/sites/default/files/swf_utility_folder/departments/diragri_medhassu_in_oid_4/menu/schemes/Guidelines-Oil%20Seed%20scheme%20under%20NMOOP.pdf

Activity	DRE technology	Application
Value addition	Solar grain milling machine	Generates electricity using solar power to make flour from cereals and grains
	Solar rice huller	To remove the chaff (outer husks) from rice grains
	Customized Improved biomass stoves for heat nergy needs	To generate, hot air / hot water / steam etc. for a variety of post-harvest processes
	Solar/ biomass dryer	To dry and so extend the shelf-life of perishable farm produce like fruits, vegetables, seeds, etc.
	Solar powered horticulture processor	Used for preparing pulp and juice from fruits and vegetables
	Solar water heater	To generate hot water for value addition activities
	Rooftop solar PV	Used to generate clean electricity locally for value addition to farm produce

2.3 Livestock

2.3.1 Overview

Livestock is an integral part of the mixed-farming system that characterizes agriculture in Assam. For many poor households, livestock is a daily source of earning and is insurance against adversity. Animal traction is significant in Assam because of the increasing miniaturization of landholdings and high fuel cost that limits the use of machinery. Livestock products are integral to local diet as more than 90% of the population is non vegetarian.

According to the 20th Livestock Census 2019, the total livestock population of India is 5,367.6 lakhs with Assam contributing 180.9 lakhs (excluding poultry). Between 2012 and 2019 the livestock population increase was 4.8%. Table 3 provides the data on livestock population in India and Assam as per 20th Livestock Census 2019.

India's pig population is 90.6 lakhs compared to a world population of 9,772 lakhs. Assam has the highest number of pigs in India (21.0 lakhs). India's pork requirement is around 8.8 lakh tons, but the country produces only 0.33 tons of pork which is huge gap between demand and supply.

Pigs convert inedible feeds and garbage into valuable and nutritious meat and are prolific

Table 3: Data on livestock population in India and Assam

Livestock	India (in lakhs)	Assam (in lakhs)
Cattle	1,934.6	109.1
Buffalo	1,098.5	4.2
Sheep	742.6	3.3
Goat	1,488.8	43.2
Pig	90.6	21.0
Poultry		467.0[35]
Others	12.5	0.15

35. https://animalhusbandry.assam.gov.in/information-services/livestock-census

breeders farrowing 10 – 12 piglets at a time. Pig is vital in increasing meat production in the north-eastern region and contributing to the livelihood security of rural tribal population. Pig production in the north-east requires a transformation from backyard subsidiary to a commercial venture. According to the Livestock Census 2019, the total estimated wet cow dung production in India is 5,620 lakhs tons out of which only 15% is utilised. Cattle contributed around 60% and buffalos contributed around 40% of the total dung produced in India. Average biogas production from fresh dung is 40 litres/kg. The excreta of pigs can be used as a manure to maintain soil fertility, or it can be converted into biogas.

Assam has a shortage of 2,230,292 MT in fodder production. The annual requirement of fodder is 2,315,925 MT, but the annual production of fodder is only 85,633 MT[36]. Assam is deficient in both food grain production and food from animal origin. It needs to undertake a massive programme to increase food production of both agriculture and animal origin.

The presentation to the Chief Minister of Assam at the Chintan Shivir has identified animal husbandry as a sector requiring increase in productivity. Specific suggestions included breed improvement, establishment of feed & fodder units, processing, and value addition. Decentralized renewable energy can increase energy access to remote and rural areas and contribute to achieving the goal of doubling farmer income.

2.3.2 Energy use in livestock

Energy consuming activities in the livestock sector are given in Figure 5. TIDE, a CLEAN Member estimates that Northeast India is burning about 6,000 tons of firewood valued at INR 3 crores every day for pig feed preparation.

Pre-production	Production	Post-production
• Feed preparation • Fodder cultivation • Semen stations	• Semen storage • Farrowing pens • Brooders • Milking • Lighting • Ventilation	• Pasteurization of milk • Milk chilling • Preparation of dairy products

Figure 5: Activities requiring energy in livestock sector

2.3.3 Relevant policies and schemes on livestock

Animal husbandry is a state subject. The central government supplements the efforts and the finances of the state government, but states develop their own programmes. Policies of the state governments usually flow from the contents of the national policy but with local level customization and adaptation. The National Livestock Mission is being implemented by Department of Animal Husbandry & Dairying, Government of India since 2014-15 through state department. NLM scheme has been revised and realigned from FY 2021-22. Many livestock initiatives of Assam and other north-eastern states have their origin in the National Livestock Mission. Table 4 below presents a list of policies in the livestock sector that have potential for incorporation of DRE.

36. Fodder Development Officer, Chenikuthi, Animal Husbandry and Veterinary Department, Assam

Table 4: Select policies with potential for incorporation of DRE

Policy	Features

Animal husbandry infrastructure development fund	• GoI set up INR 15,000 crore fund to incentivise investments in
	  • dairy processing and value addition infrastructure,
	  • meat processing and value addition infrastructure
	  • Animal Feed Plant

National Action Plan for Egg and Poultry[37]	• Transforming backyard poultry to a commercial economic model • Boosting entrepreneurship development and employment generation • Encouraging processing as presently only 6% of the poultry products is processed • Intensifying education, awareness and skill development

Rashtriya Krishi Vikas Yojana	• Animal husbandry identified as a primary target area
	• Focus of dairy development in Assam:
	  • Increase in milk production (present milk production in Assam is 39 lakhs tons)
	  • Increase in milk processing capacity
	  • Milk delivery through any time milk, milk vending machines
	  • Network of bulk milk cooler

Rashtriya Pashudhan Vikas Yojana (RPVY)[38]	• Aims to improve the quantity and quality of livestock production systems in India while enhancing the ability of all stakeholders • All earlier schemes related to dairy and livestock put together under the umbrella of RPVY
National Programme for Dairy Development (NPDD)	• Objective of creating and strengthening dairy infrastructure for procurement, processing and marketing of milk and milk products • Implemented across the country from 2021-22 to 2025-26 with a budget outlay of INR 2,400 crore • Provision of technical and financial assistance for creating any infrastructure related to processing, production, marketing and procurement by the milk federation/unions
Dairy Infrastructure Development Fund[39]	• Launched by the Central government to provide subsidized loans to capital-stressed milk cooperatives for replacing their decades-old chilling and processing plants and setting up of value-added product plants[40] • Funding period revised to 2018-19 to 2022-23 with a total project outlay of INR 11,184 crores[41]
Dairy Sahakar Policy	• Implemented by National Cooperative Development Corporation • Framework of financial assistance to encourage cooperatives to achieve higher outcomes in Environmental, Social, Governance (ESG) linked activities • Includes creation of new infrastructure by cooperatives or modernization and/or expansion of existing infrastructure
GOBARdhan Scheme	• Launched by the Ministry of Drinking Water & Sanitation in April 2018 under the Swachh Bharat Mission (Grameen) • Provides financial assistance up to INR 50 lakh per district for setting up of cluster/community level biogas plant • Period of assistance: 2020-21 to 2024-25

37. https://dahd.nic.in/sites/default/filess/Seeking%20Comments%20on%20National%20Action%20Plan-%20Poultry-%202022%20by%2012-12-2017.pdf
38. RASHTRIYA GOKUL MISSION | Department of Animal Husbandry & Dairying (dahd.nic.in)
39. Dairy processing & Infrastructure Development Fund (DIDF) | Department of Animal Husbandry & Dairying (dahd.nic.in)
40. DIDF - Dairy Processing & Infrastructure Development Fund — Vikaspedia
41. DIDF in Brief | nddb.coop

The only livestock policy that has reference to DRE is the Dairy Sahakar Policy of Ministry of cooperation, GoI and implemented by National Cooperative Development Corporation. The eligible DRE components mentioned are renewable energy infrastructure/plants and energy efficiency infrastructure if the energy generated or saved economises running cost of the existing plant.

The GOBARdhan Scheme (technically not a livestock policy) provides financial assistance for setting up of cluster/community level biogas plants. The biogas plants envisaged under GOBARdhan Scheme are classified under four broad models: Individual Household Model, Cluster Model, Community Model, Commercial Model. The minimum capacity of the biogas plant is 2 cu.ms. GOBARdhan projects can be implemented by GPs through SHGs/Farmers Producers Organisations/CBOs developed under DAY-NRLM/Milk Cooperatives/Milk Unions/Agencies selected or empanelled by States or Districts/Biogas Development and Training Centres (BDTCs), etc.

The National Livestock Mission has mentioned powered appliances in its schemes suggesting that solar powered appliances could be eligible in the scheme. This needs to be clarified.

2.3.4 Scope for DRE integration in policies and schemes

There is a vast scope for integrating DRE equipment in livestock policies and schemes. Table 5 below provides the list of powered appliances that are mentioned in different livestock schemes and their application. There is potential to substitute grid power with DRE in the scheme. Further, Table 6 below provides the various DRE options that can be suggested

Table 5: Powered equipment mentioned in the schemes of national livestock mission

Sector	Particulars	Application
Poultry	Electric brooder	To rear young chicks with their feed and water
	Incubator	To keep eggs warm at a particular temperature range and correct humidity
	Hatcher	For proper hatching of the eggs
	Generator set	Providing electricity
Sheep and goat	Chaff cutter	Cutting fodder straw or hay into small pieces
	Integrated silage making machine	To make silage for feeding it to animal
Piggery	Farrowing pen	To provide ideal conditions both for the sow and the piglets

Table 6: Suggested DRE interventions in different animal husbandry sectors*

Sector	DRE in pre-production	DRE in production	DRE in post-production	DRE energy generation
Poultry		Solar lighting and heating brooders	Egg incubator (hatching)	Biogas from poultry litter
Sheep and goat	Solar powered chaff cutter			
Piggery	Improved stoves and biogas plants for pig feed preparation	Heating of farrowing pens		Biogas from pig waste for pig feed preparation or fuel-efficient biomass fired stoves
	Solar-powered semen stations and vaccines storage in rural areas			
Dairy	Solar pumps for fodder cultivation Solar water heaters for clean in place processes	Freezers for semen storage	Solar water pre-heaters for boilers used for milk pasteurization	Biogas for heat and electricity generation
	Solar powered chaff cutters	Milking machines	Fuel pellets / briquettes from agriculture residues for boilers	
	Improved cookstoves and biogas plans for cattle feed preparation,	Lighting of cowsheds	Milk chilling infrastructure Refrigerated vehicles	
			Milk marketing nrastructure, bulk vending, milk parlours	
			DRE powered appliances for value added dairy products	

*DRE for abattoirs has not been considered

2.4 Fishery

2.4.1 Overview

Fishery is a prominent livelihood sector in Assam. It can create job opportunities and generate attractive income[42]. Assam is endowed with vast fishery resources like ponds, derelict water bodies, beels, reservoirs etc covering about 2.86 lakh ha. In addition, the two major river systems the Brahmaputra and the Barak and their 53 tributaries cover about 4,820 km. They are the backbone of the state economy. Various types of indigenous fish fauna having commercial importance are available in the state.

Between 2015-16 and 2021-22, fish production in Assam increased from 2.94 lakh tonnes to 4.32 lakh tonnes, registering an increase of 46.9%. Assam's contribution to India's fish production however remains low at just 2.7%. Assam is procuring 10-15 tonnes of fish daily from other states to meet its fish demand which results in huge cash outflow. According to official estimates, beels in Assam have a potential to produce more than 1000 kg per hectare of fish annually but the production is less than 500 kg/Ha/per year[43].

The state government has introduced several schemes for sector development

1. Matsya Jagaran-Ghare Ghare Pukhuri Ghare Ghare Maach
2. Seed Bank Programme
3. Majuli development programme
4. Selection of MatsyaMitra
5. Beneficiary training
6. Assistance to women SHGs for production of value-added fish products

The main objectives of these schemes are expansion of fish culture area, enhancing fish production, socio-economic upliftment of the rural people, promotion of value-added fish products, and entrepreneurship in post-harvest fisheries activities. In spite of significant measures taken by the state government for the development of the fishery sector, it is yet to meet its full potential. The main challenges are as follows:

- Most people engaged in fish farming are not bankable
- Initial investment for a fishpond is high
- Lack of awareness, knowledge and skill on scientific fish culture practices and management
- No institutional finance support for fishermen
- Wastage of fish due to premature harvesting, poor storage and processing facilities, inadequate market access
- Inadequate practice of fish product safety and quality control

Application of DRE in fisheries and aquaculture in Assam is in its infancy and its introduction resulting in improving livelihoods of fisher folk would require significant policy support.

2.4.2 Energy use in fishery

The energy need in fisheries is extensive. Energy is required for fishing boats, preservation and storage, fish processing / value addition and its transport to the consumer. Currently the energy need is met by electricity and diesel-powered devices. Figure 6 details the energy use across the fish value chain.

42. Assam State Fisheries and Aquaculture Draft Policy 2023
43. https://www.sentinelassam.com/editorial/assams-stake-in-indias-blue-revolution-626837

Capture/ Aquaculture	Storage	Processing	Marketing & distribution
Vessels: Diesel or batteries for running engines	**Ice making machines:** electricity, fossil fuel	**Semi-mechanized/ mechanized equipment for scaling, filleting, gutting, drying, packaging:** Electricity, diesel engine	**Portable coolers, freezers, ice-making machines:** grid electricity or fossil engines
Fishing gear: Lighting	**Portable chillers/ refrigerators:** Electricity/ batteries		
Aquaculture: Electricity for equipment, Heat (fossil-fuel/ electric) to maintain temperature	**Cold storage:** electricity	**Smoking of fish:** Fossil fuel-based kilns	**Transport:** gasoline/ diesel engines

Figure 6: Energy use at each stage of a fish value chain[44]

2.4.3 Relevant policies and schemes on fishery

GoI has focused on overall development and scaling of fishing and aquaculture in the country. **The National Fisheries Policy** was launched in 2020, with a vision to develop an ecologically healthy, economically viable and socially inclusive fisheries sector.

Pradhan Mantri Matsya Sampada Yojana (PMMSY)[45] was launched by the Central Government as an umbrella scheme. It focuses on increase in the sustainable fish production to 220 lakh metric tonnes by 2024–25 and increasing domestic fish consumption from 5 kg to 12 kg per capita/ year. Further, the scheme aims to reduce post-harvest losses from the reported 20-25% to about 10% and generate 55 lakh direct and indirect jobs across the value chain. PMMSY is being implemented in all states and union territories for the FY 2020-21 to FY 2024-25. DRE can positively contribute to the following activities in the scheme:

- Development of Inland Fisheries and Aquaculture
- Development of fisheries in North-eastern and Himalayan States/UTs
- Development of ornamental and recreational fisheries
- Technology infusion and adaptation
- Post harvest and cold chain infrastructure
- Markets and marketing infrastructure

Fisheries and Aquaculture Infrastructure Development Fund (FIDF)[46] was launched in 2018–19 to create a marine and inland fisheries infrastructure with a total fund size of around INR 7,522 crore. The projected increase in fish production was 200 lakhs tonnes by 2022–23. The FIDF provides financial support to the state governments, union territories and state entities for fisheries infrastructure development.

Assam State Fisheries and Aquaculture Policy 2023

The policy aims to increase productivity and double the fish production by 2029-30. It covers resource management, aquaculture, harvest and post-harvest infrastructure, market support and capacity building. The support for post-harvest management of fisheries in the policy is as follows:

- Encouragement to FPOs/FPCs/SHGs/NGOs to establish processing and value-addition plants
- Promoting use of solar energy in the small-scale fish processing and value-addition to fish.
- Establishment of modern hygienic fish markets with availability of ice and cold storage facility.
- Modernising landing centres by providing electricity, water, and ice.
- Establishment of high capacity ice plants, chilled rooms, and stand-alone cold storages

44. https://www.fao.org/3/cc4903en/cc4903en.pdf
45. https://pmmsy.dof.gov.in/new-download
46. https://dof.gov.in/fidf

- Developing standards and code of practice for drying, salting, smoking, and fermentation
- Training on hygienic fish handling, processing, preservation, transportation, and marketing
- Provision of a solar dryer to a group/cluster for drying of beel fish

The policy has promoted DRE at various stages of fish production and includes:

- Creating an ecosystem to attract involvement of the private sector for deployment of DRE.
- Linking DRE to existing financing schemes or through new innovative financial instruments
- Encouraging innovation for development of efficient, cost-effective DRE products for deployment in the fisheries sector.
- Creating awareness on DRE across relevant stakeholders.
- Promoting skill development for strengthening the service infrastructure at the local level
- Extending subsidy to DRE-powered aerators, pumps, cold storage, etc.
- Undertaking pilots to demonstrate usage and impact

2.4.4 Scope for DRE integration in policies and schemes

DRE technologies are the only clean or alternate energy source for electrical/ thermal energy for fishing vessels / units in areas that are either not grid-connected or where the electricity supply is unreliable and/ or expensive. Table 7 provides a list of some of the DRE based options that could be mentioned in fishery policy.

Table 7: Scope for DRE technologies in fishery and aquaculture sector

Technology/ equipment	Applications
Solar PV plant/ Micro hydro plant	To power aquaculture systems, for pumps, filters, aerators
Solar thermal/ biomass-based heat	For maintaining suitable temperature in aquaculture system
Solar PV system and batteries on vessels	To power equipment for navigation, communication, refrigeration, lighting
Liquid biofuels	To power motor engines of vessels
Biomass based furnaces/ kilns	For smoking of fish
Biomass powered cold storages	For safe storage of fish and reduction of wastage
Biomass powered dryer	For fish drying / preservation

2.5 Tourism

2.5.1 Overview

Assam, the gateway to the North-Eastern region of India has enormous tourism potential. The state is surrounded by hills, has scenic rivers (Brahmaputra, Barak, and their tributaries) and tea gardens. Assam has five National Parks – Kaziranga, Manas, Dibru – Saikhowa, Nameri and Orang. There are eighteen wildlife sanctuaries in Assam, the highest concentration in India. They are the host to 25% of India's floristic wealth and enormous faunal diversity. It is home to various ethnic tribes and groups, each having their own heritage and socio-cultural lifestyles, customs, religious beliefs, language, culture, food, songs, and festivals. There are more than 600 tea gardens in the state; 20 tea gardens have golf courses within the garden area, and a few have polo fields. Assam has the world's largest inhabited river island Majuli, which has several monasteries. Temples and monuments like Kamakhya, Nabagraha, AmbubachiMela, Basisthashram, are spread across the state.

The tourists to Assam are gradually growing as can be seen from table 8.

Table 8: Year wise tourist footfall in Assam

Year	2018	2019	2020	2021	2022
Tourists (No.)	47,10,617	54,47,805	12,66,898	14,09,161	98,30,946

2.5.2 Energy use in tourism

Tourism sector requires different forms of energy for various activities as shown below in Table 9:

Table 9: Energy needs of the Tourism sector

Electricity	**Heat / Thermal** (non-electric)	**Transport Fuels**
Indoor and outdoor lighting, decorative and street lighting, monument lighting	Hot water bathing	Transport vehicles
Lighting for camping, houseboats, playgrounds	Beauty and wellness centers	
Swimming pools filtration	Space heating	
Air conditioning / temperature management	Cooking	
Wildlife fencing	Bon fires	

2.5.3 Relevant policies and schemes on tourism

The table 10 below shows relevant policies on tourism and DRE in Assam.

Table 10: Selected policies relevant to tourism and DRE in Assam

Policy/Scheme	Ministry
Assam Tourism Policy 2022	Tourism Department, Govt of Assam
Promotion and development of Tea Tourism Infrastructure in Assam	Tourism Department, Govt of Assam
Assam Renewable Energy Policy 2022	Government of Assam

- **Assam Tourism Policy 2022** has provided for development and upgradation of infrastructure at various tourist places while taking into consideration ecological and cultural sensitivities in the state.
  - It supports purchase of equipment or technology that reduces waste, encourages green energy adoption, water conservation and community involvement in waste management.
  - Policy has extended the previous policy measures including reimbursement of 25% investment on renewable energy sources up to a maximum of INR 10 lakhs on private properties in new and existing tourism locations[47]
- **Promotion and Development of Tea Tourism Infrastructure in Assam**[48] has provided for installation of solar lights
- **Assam Renewable Energy Policy 2022** is promoting Renewable Energy based Electric Vehicle Charging Stations[49]

Power Department, Government of Assam has undertaken several solar energy-based initiatives in tourism sector[50] including

- commissioning of off-grid SPV plant & street lighting in the locations of historical importance
- commissioning of 100 kWp grid interactive roof-top/ground mounted SPV plant with net-metering arrangement in important tourist locations/wildlife sanctuaries

2.5.4 Scope for DRE integration in policies and schemes

The unique feature of the tourism sector is that the potential exists for the entire sector to become DRE enabled and off grid. DRE technologies can generate significant savings by offsetting or replacing use of diesel gensets with reliable electricity in remote areas. DRE technologies can also support branding of tourism locations assustainable tourism destinations. Some examples of DRE integration into the tourism sector are listed in Table 11 below.

Table 11: Scope for DRE integration in tourism

Tourism Type	Scope for DRE Integration
Tea Tourism and Golf Tourism	• Solar streetlight in tea estates where tourists visit • Use of battery-operated vehicles, charged by solar power
Wildlife Tourism	• Use of battery-operated vehicles for safaris, charged by solar • Powering resorts near National Parks and wildlife sanctuaries using solar, biomass and hydro energy • Use of solar powered fencing where required • Use of solar streetlights
Spiritual Tourism	• Promotion of biogas-based cooking applications using waste generated at religious site locations
Ethnic Tourism	• Exclusively DRE based energy use by ethnic communities

47. https://industries.assam.gov.in/sites/default/files/swf_utility_folder/departments/industries_com_oid_4/portlet/level_3/Tourism%20Policy.pf
48. http://www.assamtourismonline.com/pdf/tea_tourism_brochure.pdf
49. https://dpns.assam.gov.in/sites/default/files/swf_utility_folder/departments/directorate_printing_uneecopscloud_com_oid_3/menu/documen/no._715_pel_230-2021-138_dated_13-10-22.pdf
50. https://power.assam.gov.in/portlets/going-green

Tourism Type	Scope for DRE Integration
River Tourism	• Application of solar powered boats for lighting needs • Rooftop solar and solar water heater in river islands
Eco Tourism	• Showcasing DRE based livelihood applications in eco sensitive areas • Pellet fired bon fires • Biogas flares for heating lawns and open spaces, • Biogas for cooking, fuel efficient charcoal barbeques, tandoors
Cross cutting	• Use of solar energy for electricity generation, use of solar and non-solar energy for cooking needs and hot water requirements

2.6 Bamboo

2.6.1 Overview

Bamboo, a versatile group of plants can provide ecological, economic and livelihood security to the people. Statistics reveal that the north-eastern region has about 60% of the country' growing stock of bamboo[51]. The total area under bamboo in India is 1.5 crore hectares. As of 2021, the area under bamboo cultivation in Assam stood at 10.6 lakh hectares (ranked 5th amongst Indian states). The total bamboo stock in the state as of 2021 was 386 lakh tonnes, which was 9.6% of the total stock of the country[52].

Usage of bamboo is presently confined to subsistence activities. There is a great opportunity to generate employment and revenue by tapping bamboo not just for its energy but also as a sustainable, eco-friendly construction material. The demand for bamboo in India was estimated to be 280 lakhs tonnes in 2017. Although India has 19% share of world's area under bamboo cultivation, its market share in the sector is only 6%[53]. India is a net importer of bamboo as Table 12 below shows. The bamboo and rattan industry of India is worth INR 28,005 crores[54]. In the year 2017, UNIDO estimated that the bamboo business in the North-East alone had a revenue generation potential of about INR 5,000 crores in the next ten years[55].

Table 12: Contribution of bamboo to the India's import and export[56]

Year	Import in crores (INR)	Export in crores (INR)
2015-16	148.63	0.11
2016-17	213.65	0.32

51. https://pib.gov.in/PressReleasePage.aspx?PRID=1556536
52. https://www.switch-asia.eu/site/assets/files/3663/bamboo_state_profile_-_assam-v2.pdf
53. https://pib.gov.in/newsite/erelcontent.aspx?relid=173782
54. https://megsoil.gov.in/nbm/NBM_Guidelines_New.pdf
55. https://pib.gov.in/newsite/PrintRelease.aspx?relid=173782#:~:text=The%20amendment%20will%20help%20in,in%20the%20next%20ten%20years.
56. https://megsoil.gov.in/nbm/NBM_Guidelines_New.pdf

2.6.2 Relevant policies and schemes on bamboo

The restructured National Bamboo Mission was launched during 2018-19 as a centrally sponsored scheme. The nodal Ministry for NBM is Ministry of Agriculture & Farmers Welfare. The mission is implemented through the state nodal departments. The mission focuses on the development of the complete value chain of the bamboo sector from planting material, plantation, creation of facilities for collection, aggregation, processing, and marketing. All activities in the bamboo sector are covered for benefit under the agriculture infrastructure fund. The fund allocation for Assam under the NBM was INR 500 lakhs for FY 2022-23. Regarding DRE, the mission has included DRE components and activities such biomass and activated carbon pellets, bio energy extraction and establishment of bamboo based gasifiers for ethanol production. The details are provided in Table 13 below.

Table 13: DRE in National Bamboo Mission

Scheme	Activity	Indicative cost	Pattern of Assistance	DRE perspective
Scheme B: Promotion of bamboo treatment and preservation	Establishment of carbonization plants in private sector	30 lakhs (project based)	100% of cost to Govt. For Private Sector 50% of project cost subject to maximum upto indicative cost as credit linked back ended subsidy	Thermal DRE options can be recommended for carbonization of bamboo. (i.e. heating bamboo at high temperature)
Scheme C: Product development and processing - Management of bamboo waste in primary processing units and establishment of Micro/Medium processing units	Making of value-added products like pellets & activated carbon	25 lakhs (project based)		Waste bamboo can be a starting material in the preparation of biomass fuel pellets
	Bio Energy extraction	200 lakhs (project based)		Direct combustion of bamboo in co-gen plants to product heat and power, solid bio-fuel production
	Bamboo gasifier for ethanol production	500 lakhs (project based)		Biomass gasification for ethanol production

States that do not have bamboo policies follow the policy as laid out in the NBM. A few states in India, mostly in the north-east, have issued state bamboo policies in addition to NBM. Table 14 below provides information on state policies of north-east, including Assam.

The Assam bamboo policy is very meticulously conceived covering several aspects that have not been covered by other state policies. The policy considers bamboo as a source of biomass energy and mentions conversion of bamboo and bamboo waste into renewable energy products like solid bio-fuel, into biogas and into bio-ethanol.

Table 14: List of state bamboo policies

State	Year of Policy Formulation	Line Ministry in different states	Bamboo resource in state
Assam	2019	Department of Industries and Commerce	22.3 lakh hectares 900 lakh tons of bamboo
Tripura	Original 2007, revised in 2020	Department of Industries and Commerce	239,700 Ha
Manipur	2023	Dept of textiles, commerce, and industries	1,068,700 Ha with a bamboo stock of 154.69 lakh MT
Mizoram	2021	Bamboo included in the Mizoram industrial policy	57% of geographical area of Mizoram covered by bamboo forests
Nagaland	Original 2004, updated in 2018/2019	Department of Industries and Commerce	90,487 Ha

Table 15 provides a summary of approach and strategy of NBM and state bamboo policies.

Table 15: Approach and strategy of National Bamboo Mission and state bamboo policies

Approach and strategy	NBM	Assam	Manipur	Nagaland	Tripura
Bamboo as a resource and an enterprise				√	
Creation of a Board or Development Corporation					
Community and private sector participation					√
Industrial utilisation and entrepreneurship		√			√
Management information system, inventory, database development		√	√	√	√
Promotion of bamboo-based industries*		√		√	√
Development of marketing, trading plan and systems				√	
Undertaking techno economic feasibility studies, development of project profiles				√	
Bamboo as a wood substitute in construction/ housing		√	√	√	√
Develop bamboo as a source of energy			√**	√	√
Access to credit / loan for bamboo farmers			√		
Setting up of bamboo markets			√		
Advocate strong linkage between farmer and industry			√		
Development of Bamboo-Supply chain					
Setting up of Common Facility Centres (CFCs), Innovation centres, treatment plants, distribution centres					
Encouragement to bamboo entrepreneurs		√			

*Food products, medicinal, chemical products, alcohol beverages, craft, handicraft and art products, value added products and wood substitutes in housing /construction; **also set up pilots for ethanol, bioCNG, domestic biogas plants etc.

2.6.3 Scope for DRE integration

Bamboo has many environmental and economic benefits that make it an excellent sustainable energy resource. Bamboo is highly renewable as it is one of the fastest growing plants on earth. Bamboo does not need to be replanted each time.

Assam can become the hub of bamboo-based bio energy in India. Bamboo has the potential to reduce the dependence on fossil fuel by offering biomass-based power for cooking, heating, and electricity. Bamboo as a biomass source can be converted to biogas which can ultimately be processed into BioCNG. Bamboo can also be used as a raw material for production of ethanol and thus providing opportunity to support India's commitment to blending ethanol with petrol. Numaligarh Refinery Limited in eastern Assam's Golaghat district has taken steps in setting up a bio-refinery unit for producing bioethanol from 5 lakh metric tonnes of bamboo per year. The project also entails setting up a 20 MW captive power plant that would use bamboo residue as fuel[57]. Several DRE technologies are available for powering conversion bamboo or cane into useful products for housing and handicrafts.

Bamboo sequesters carbon dioxide much faster than other forest and plantation crops. A mature grove of bamboo absorbs carbon dioxide and releases 35% more oxygen than an equivalent strand of trees[58]. Thus, it is an effective carbon sink and has tremendous potential in combating climate change.

Creation of value-added products and timber alternatives from bamboo is seen as a major industry in Assam. A study on the potential for value-added products from bamboo (e.g. bamboo pipes for irrigation, identifies lack of reliable power as the major constraint[59]. It is estimated that there are 480 bamboo and cane units in the state. A review of one of the clusters points out that these areas have irregular power supply and there are frequent power cuts about 2-3 times a day[60]. Electricity is consumed primarily for lighting and using specific electric tools like a circular saw, polishing, and sanding machine. The units are running their crafting activity on domestic load line and the average monthly electricity consumption is around INR 500-700. The cluster village has a common facility centre but it is not used well. Such common facility centres can be powered by DRE and managed by the local youth.

The Assam Bamboo policy offers 100% grant from the state for manual and powered tools for making bamboo products like incense sticks and furniture. The inclusion of DRE-powered equipment within such a scheme would address the electricity gap faced by bamboo processing units.

2.7 Handloom and sericulture

2.7.1 Overview

Handloom is the second largest income generating activity in the country after agriculture. The sector is primarily rural and is almost wholly unorganized. Although fabric is hand woven in almost all states of India, the North-Eastern states have the highest concentration of handloom weavers in India with women's participation of around 88%[61]. The Indian handicrafts and handlooms industry is worth INR 24,300 crores (2021 March). Nearly 15% of cloth production in India is from the handloom sector[62]. As per the Fourth All India Handloom Census (2019-20), there are 26,73,891 handloom weavers and 8,48,621 allied workers in India. The number of handloom workers has increased by 11.5% between 2009-10 and 2019-20 and the production output has also increased correspondingly[63]. Table 16 provides the number of weavers and allied workers across Assam and four regions of India.

As the eastern region of India has a high presence of handloom weaves (74.9%) with about half of them in Assam, handloom is an important sector for stimulating livelihoods in the region. As per the Handloom Census (2019-20), more than 12.83 lakh handloom

57. https://www.sentinelassam.com/north-east-india-news/assam-news/bamboo-bonanza-numaligarh-refinery-to-use-bamboo-to-produce ethanol-614320
58. https://www.oneearth.org/the-wonders-of-bamboo-groves/
59. https://www.researchgate.net/publication/353399753_A_Study_on_Prospects_and_Challenges_of_Bamboo_Wood_Products_in_Assam
60. https://sidbi.in/files/publications/47.%20SIDBI_Chakchaka%20Cane%20and%20Bamboo%20Cluster%20,Barpeta,%20Assam.pdf
61. https://handlooms.nic.in/assets/img/Statistics/3736.pdf
62. https://www.investindia.gov.in/team-india-blogs/weaving-indias-future-investment-handloom-sector#:~:text=The%20production%20of%20handlooms%20in,handloom%20activities%20was%2031.45%20lakhs.

between 2009-10 and 2019-20 and the production output has also increased correspondingly[63]. Table 16 provides the number of weavers and allied workers across Assam and four regions of India.

As the eastern region of India has a high presence of handloom weavers (74.9%) with about half of them in Assam, handloom is an important sector for stimulating livelihoods in the region. As per the Handloom Census (2019-20), more than 12.83 lakh handloom weavers (including allied workers) and 12.46 lakh handlooms are available in the state. The raw materials used in the handloom industry of Assam mainly include cotton, muga, mulberry and eri silk. Assam produced 160 MT of muga and 3834 MT of eri silk during 2020-21[65].

Table 16: Number of weavers and allied weavers across four regions of India and Assam[64]

Region	No. of allied workers	No. of weavers	% of total
Assam	**1,76,453**	**11,07,428**	**36.4**
Total East Zone	5,95,697	20,44,245	74.9
Total West Zone	13,746	39,965	1.5
Total North Zone	86,712	1,94,708	8.0
Total South Zone	1,52,466	3,94,973	15.5
Grand Total	8,48,621	26,73,891	

2.7.2 Energy use in handloom/ sericulture

Handloom weaving is an intricate process. The Jacquard machine in handloom has traditionally been handheld or pedal operated. Being manually operated and used often in poorly lit and ventilated areas, health problems are common among handloom weavers. There is also an adverse impact on the productivity of the sector and consequently on the price / affordability of the finished products. The process of matching designs, checking the weave pattern, etc., require the weaving area to be lit. Weavers use filament lamps or fluorescent tubes which can easily be replaced by solar lights. Handloom processes also require heat for operations such as drying of yarn, dyeing, scouring, soaping, etc. This need is currently being met by burning wood / charcoal and other fossil fuels. The energy consuming processes in sericulture include:

- stifling (done using hot air or steam) and sorting
- de-flossing
- reeling of cocoon into silk yarn (done by automated machines or by hand)
- twisting and dyeing of silk yarn

2.7.3 Relevant policies and schemes on handloom/ sericulture

Government of Assam had issued the state handloom policy in the year 2017-18 which was effective till November 2022. The policy has not been renewed till date. The objective of the policy was to make handloom sector a sustainable source of employment for people of the state, promote handloom products as cultural heritage, find solutions to sector challenges, build capacity of weavers, strengthen production base, among others.

63. https://handlooms.nic.in/assets/img/Statistics/3736.pdf
64. https://handlooms.nic.in/assets/img/Statistics/3736.pdf
65. https://dht.assam.gov.in/about-us/detail/state-profile-0

The policy has not mentioned any DRE technologies for handloom sector[66]. In harmony with the concept of 'Minimum government and maximum governance', the All-India Handloom Board was abolished in July 2020. However, institutional frameworks and schemes implemented by the office of the Development Commissioner for Handlooms exist. The schemes that pertain to the handloom weavers are presented in Table 17 below:

Table 17: Major policies and schemes for handlooms

Policy framework	Support provided
National Handloom Development Programme	Provides concessional credit at interest rate of 6%, margin financial assistance up to INR 10,000, marketing assistance, and logistical support
Comprehensive Handloom Cluster Development Scheme	Develops mega handloom clusters and provides relief to MSMEs as a grant
Yarn Supply Scheme	Increases availability of yarns to eligible handloom weavers
Handloom Weaver's Comprehensive Welfare Scheme	Assists weavers in availing social security benefits
Hathkargha Samvardhan Sahayata	Provides looms / accessories to weavers to improve productivity and quality. 90% of the cost of loom/accessory is borne by the Government of India

A Block level cluster (BLC) scheme was introduced into the **National Handloom Development Programme** in 2015-16. This provides financial assistance upto INR 2 crore per BLC for various interventions such as skill upgradation, Hathkargha Samvardhan Sahayata, product development, construction of work shed, project management cost, design development, setting up of common facility centre, etc. Besides, financial assistance upto INR 50 lakh is also available for setting up of one dye house at district level. National Handloom Development Programme has unspent balance of up to 5 to 15 crores year on year.

Comprehensive Handloom Cluster Development Scheme (CHCDS) is being implemented for development of Mega Handloom Clusters covering at least 15,000 to 25,000 handlooms. The scheme is providing financial assistance as GoI share from INR 40 to INR 70 crores in a period of 5 years. Under the scheme, diagnostic studies, engaging designers, product development, corpus for raw material, construction of work sheds, skill up-gradation etc. are fully funded by GoI.

2.7.4 Scope for DRE integration in policies and schemes

Given the very distributed presence of handlooms and sericulture units, DRE is very obviously a natural ally. There is enormous need and scope for integrating DRE into the sector. The details of DRE equipment supported under different state policies and national policy is presented in Table 18.

66. The policy does not mention energy either. However, a reinterpretation of the clause 7.7 might be useful. The clause states "One time capital subsidy to the extent of 10% of the working capital for the year and not exceeding Rs 5 lakhs will be eligible for units using local resources for production and marketing." So DRE can be interpreted as a local resource.

Table 18: DRE in central and state level handloom policies

State	Line Ministry/ policy or scheme	Policy duration/ date	DRE details in policy
National	Ministry of Textiles– National Handloom Development Programme	Ministry of textiles – National Handloom Development (2021-22 to 2025-26)	• Solar lighting for individual work shed: 75-90% funding • Solar lighting for common work shed: 90% funding • Solar/ electric powered Silk Reeling and Twisting Machine (2 spindles/4 spindles): 90% from GoI • Solar operated winding machine (inc. solar system) • Solar system for manual jacquard lifting mechanism • Solar power system for operating electronic jacquard • Solar power system for operating warping machine
North-eastern region	Ministry of Textiles		• Solar lighting in group work shed: INR 50,000 per work shed, GoI contribution 90%
Integrated Sericulture Development Program in NE states	Ministry of Textiles - North-Eastern Textile Promotion Scheme		• Pre cocoon irrigation facilities @ INR 0.75 lakhs / acre for all four types of silk 90% GoI contribution • Solar operated spinning machine (Cost per unit): INR 20,000, 90% GoI contribution for muga only
Silk Samagra Schemes	Central Silk Board	2022	• Solar lighting system in rearing houses • Solar lantern in Rearing and mounting quipment for muga silkworm rearers
Haryana	Industries and Commerce	2022	Subsidy for solar roof top @ 30% to 50% for a maximum investment of INR 20 to 50 lakhs
Uttar Pradesh			Solarizing handlooms & power looms in a phased manner. Provision of solar inverters. Linking weavers to banks for solar loans / SIDBI on board
Odisha	Apparels and textiles	2022	Solar lanterns to weavers in an earlier policy though OREDA for 10,000 families. Current policy does not mention this
Telangana		2017-18	Assistance of up to 40% of cost of equipment with a limit of INR 50 lakhs applicable for energy, water, and environmental conservation infrastructure separately
Tamil Nadu	Handloom / Handicraft/ Textiles/Khadi	2019	Infrastructure facilities as mentioned in GoI handloom policy. Capital subsidy of INR 2.23-8.55 lakh to small power loom units (upto 8 looms), for installation of solar PV Plant

Besides lighting products at the individual and common work sheds, the GoI policy also mentions funding for other solar products like solar powered silk reeling and twisting machine (2 & 4 spindles), solar power operated winding machine (including solar power system), solar power system for operating jacquard lifting mechanism for manual and electronic jacquard and warping machines. The GoI policy has attempted to integrate DRE into textile policy, especially in the provision of solar lighting and other products but the opportunity exists for integration of more DRE products. It is suggested that the Government of Assam follow this framework and incorporate these products into the State scheme that is due for a revamp.

Based on various processes involved in the handloom and sericulture, several options for DRE integration which are not yet mentioned in the policy are provided in Table 19 below.

Table 19: DRE products that can be integrated in textile policies of Assam and GoI

DRE product	Sector	Type	Utility / impact
Solar sprinkler, Solar irrigation pump	Sericulture (pre-cocoon)	Solar PV	Irrigation for Mulberry silk (policy mentions electrical / diesel pumps). This would increase yield of the feedstock for silkworm
Solar water heaters	Handloom / sericulture (post cocoon)	Solar thermal	For pre-heating water for fabric/ yarn dyeing/ dye preparation. Fuel conservation for dye houses. This would result in better air quality and so better respiratory health for workers, and arrest deforestation.
Biomass fired baby boilers / improved biomass stoves for dye houses	Handloom / sericulture (post cocoon)	Solar thermal	For steam generation for fabric / yarn dyeing/ dye preparation. Fuel conservation for dye houses. This would result in better air quality and so better respiratory health for workers, arrest deforestation,
Solar water heaters /improved biomass fired stoves	Handloom / sericulture (post cocoon)	Solar / biomass thermal	Generation of hot water for washing / bleaching of yarn and fabric.
Solar / biomass fired hot air generators for cocoon stifling	Sericulture (post cocoon)	Solar / biomass thermal	For stifling the pupa inside the cocoon and increasing the shelf life of the cocoon. This will reduce wastage of cocoons and improve profitability for the silk reeler
Solar charkha	Handloom / sericulture (post cocoon)	Solar PV	For spinning, to convert fibre into yarn. This would improve productivity and reduce drudgery for the labour (eliminates manual labour, can spin yarn in a larger capacity)
Solar powered motorized handlooms*	Handloom / sericulture (post cocoon)	Solar PV	For faster weaving and improving the quality of the weave

*Assam has a policy to protect the handloom sector from the power loom. So, it needs to be investigated whether a solar powered motorized handloom would be permitted

The handloom processing industry creates enormous quantities of solid and liquid waste, and it is a big polluter. More than 90% of the emissions are created from five major activities - bleaching, dyeing, finishing, weaving and fibre. DRE can also be incorporated into processes like effluent treatment mandated for sustainable handloom. Consumption of non-renewables sources of energy can be reduced using DRE.

2.8 Tea industry

2.8.1 Overview

Assam is the single largest tea-growing region in the world. It produced over 7,150 lakhs kgs of tea during the year 2019, which accounted for 51% of India's total tea production. The small tea growers in Assam are now an economic force for the state. In 2019, 45% of tea production came from small tea growers[67]. According to a survey conducted by the Industries & Commerce Department, the total numbers of small growers in 14 surveyed districts of Brahmaputra Valley were found to be 68,465. The small tea growers sell the leaves to the nearby big plantations and Bought Leaf Factories where it is processed[68].

2.8.2 Energy use in tea sector

From plucking tea leaves to packaging, tea production & processing goes through a series of steps, many of which are energy intensive. In plantations, electricity is needed for several agricultural practices, mainly irrigation, mechanised pruning, tractor-mounted spraying, power spraying, and plucking. In tea production, electricity is necessary to operate machines. Thermal energy (heat) aids moisture removal from the tea leaves during withering and drying.

2.8.3 Relevant policies and schemes for tea sector

Table 20 below presents a list of relevant policies and schemes on tea sector in Assam.

Table 20: List of relevant policies/ schemes on tea sector

Policy / Scheme	Objective	Features with likely energy use
Tea Development & Promotion Scheme - Tea Board of India		
Plantation development (small growers)	To increase production, field productivity and quality of tea	• Irrigation • Mechanization • Setting up of new and mini factories (for small growers)
Quality Upgradation and Product Diversification	To set up specialty tea units like orthodox, green tea, instant tea	Creation of infrastructure (excluding civil works)
Market Promotion–Domestic and International	Covering broad areas of market development and export promotion	No energy use expected
Research and Development	Grants for tea research and extension activities	Grants to tea research and other research institutes. Grants for research in sustainable energy use could qualify

67. Report on the tea industry of Assam – In the backdrop of Covid 19 pandemic, SITA, Government of Assam, May 2020
68. https://industries.assam.gov.in/portlet-innerpage/about-tea-industries

Policy / Scheme	Objective	Features with likely energy use
Human Resource Development Component	Grants for health, education, training, and studies on tea industry	Not applicable for energy use
National Programme for Tea Regulation	Monitoring and regulation of the activities of tea stakeholders	Not applicable for energy use
Establishment Expenses	Cost of human resources for the schemes	Not applicable

The components of above relevant policies/schemes that support energy/ power systems have been discussed in Table 21 below.

Table 21: Components of relevant policies/ schemes supporting energy/ power

Scheme/ sub-scheme	Equipment requiring energy mentioned	Extent of support
Component 1: Plantation development (small growers)		
Irrigation	Sprinkler equipment, motors, pump sets with electric line connection, electricals including transformers, accessories	25% of the actual cost subject to the maximum ceiling limits
Farm mechanization	Pruning machine, mechanical harvester, pitting augur, mounted power sprayer, soil injector and soil augur	25% of the cost, subject to the maximum ceiling limits
Setting up of new tea factories by FPOs	Nothing mentioned but factories will include powered equipment	40% of the cost subject to a ceiling of INR 2 crores / factory. Only 4 large tea factories to be supported in the scheme
Setting up of mini tea factories	Nothing mentioned but factories will include powered equipment	50% of cost with ceiling limit of INR 33 lakhs/factory. Only 10 mini tea factories to be supported
Component 2: Quality upgradation and product diversification (QU&PD)		
Tea factory infrastructure	Additional infrastructure for cleaning, blending, colour sorting, packaging of tea	40% on the cost, provided the min. investment on modernization is between INR 25 Lakhs and INR 150 Lakhs/ factory
Setting up of specialty tea units for production of green tea, orthodox tea, and instant tea	Withering troughs with air heating unit, withering trough fan with motor, steam roaster w/wo boiler, fan for leaf cooling, electronic room humidification system, dryers, instant tea processing machine	40% of the cost of plant and machinery (except land cost) subject to a ceiling of INR 200 lakhs/factory

2.8.4 Scope for DRE integration in policies and schemes

Northeast India's tea gardens have the scope to adopt renewable energy systems which will be beneficial both for the tea estates and the environment. Renewable energy will help the energy-intensive estates cut costs and reduce greenhouse gas emissions. A feasibility study on the scope of adoption of renewable energy in tea estates in north-east India was conducted by Vandita Kumari et. al at the Indian Council of Agricultural Research (ICAR) – Indian Agricultural Statistics Research Institute (IASRI) and published in the Indian Journal of Agricultural Sciences in Jan 2021. It collected data on eight tea gardens (four from Assam and four from the northern area of West Bengal) and seven tea processing industries[69]. Study showed that solar is a popular clean energy option in tea estates in Assam. All the tea gardens in the survey agreed that the installation of large solar panels within the garden would not impact the growth of tea plants. Table 22 below shows a list of DRE technologies for integration in the tea industry.

Table 22: DRE technology and products relevant to the tea industry

Product name	State of technology	How it can impact the sector
Solar roof top	mature	For powering crucial equipment in case of power outages
Solar pumps	mature	For irrigation in locations where there is no grid power
Solar sprinklers	evolving	For irrigating young plants and in nurseries
Small hydro/ solar mini grids	mature	For powering crucial equipment in case of power outages
Biomass briquettes/ pellets	mature	Can replace coal/ PNG /PNG for drying/withering

The tea sector which is often handicapped by absence of reliable power can be enriched by the adoption of DRE technologies. While Table 22 above lists DRE products that are mature and ready to use, more DRE products specific to the tea industry can be developed. The R&D grant can be used to develop and demonstrate new products required by the sector.

Electrically powered equipment, especially for use in tea gardens, that are already eligible for subsidy can be converted into standalone solar products. Some of these are solar sprinklers, battery operated tea plucker (solar charged), solar powered pruning machines, solar powered harvesters, and solar powered DC motors for power sprayers, soil injectors, augers.

The sectoral analysis has shown that Assam has tremendous potential to be a front-runner in livelihoods sectors analysed (agriculture/ horticulture, fisheries, livestock, tourism, handloom/ sericulture, tea, and bamboo). DRE can address the challenge of energy gaps which hinders technology adoption and mechanisation to strengthen livelihoods and increase productivity.

69. https://www.researchgate.net/publication/357672628_Feasibility_study_on_renewable_energy_system_in_tea_Camellia_sinensis_estates_o_North-East_India

03

Pathways for DRE interventions in livelihood sectors

The pathways proposed for DRE integration have emerged from the detailed policy analysis and are proposed as a two-step process (i) DRE intervention options in the immediate or short term and (ii) DRE intervention options in the medium term (say two to three years). In the short term, the objective would be to include as many mature DRE technologies into the existing schemes as possible. Depending on how the policies are worded, this could be done through a revised interpretation of the powered equipment supported under the schemes. Some schemes are very flexible and offer policy support for infrastructure augmentation etc. It could be possible to re-interpret the wording of the scheme and with a clarification, enable a quick inclusion of DRE technologies. Conversations with policy makers who have bought into the idea of DRE could throw up more options for DRE inclusion into existing schemes.

3.1 Pathways- immediate to short term

The thought process for the immediate, short term DRE interventions has emerged from a scrutiny of the state level policy measures of relevant departments. An opportunity to catalyse the adoption of DRE effectively and systematically can be foreseen. Table 23 below offers some suggestions for DRE inclusion in the policies of the different sectors / departments in the short term without any significant change in the existing institutional mechanisms, release of subsidy, identification of beneficiary etc.

3.2 Pathways-medium term (two to three years)

The medium-term objective visualized is to completely power all rural level energy consuming activities in four livelihood sectors – livestock, eco-tourism, homestays (tourism), fisheries, handloom and all farm level energy needs of the tea and the agriculture / horticulture sectors, by decentralized renewable energy. Options for DRE inclusion in the medium term are given in the Table 23 below.

Table 23: Pro-DRE sectoral policy suggestions for the immediate/ short and medium term

Sector/ Department	Relevant state-level policy that can be the entry point	DRE equipment/ interventions mentioned in the policy	Suggestion for DRE inclusion in the policy in the immediate / short term	Suggestion for DRE inclusion in the policy in the medium term
Multiple sectors: state-wide	Chief Minister Samagra Gramya Unnayan Yojana - ambitious scheme launched by the Government of Assam with the aim of doubling farmer's income	• DRE, solar powered pumps being supported under the scheme	Subsidies and incentives for relevant DRE technologies across agriculture, fisheries, livestock, sericulture can be extended to include: • Solar powered micro irrigation system • Solar pumps for fodder cultivation	Subsidies and incentives for relevant DRE technologies across agriculture, fisheries, livestock, sericulture can be extended: • Solar rice milling, solar and biomass-based appliances for powering equipment to make puffed rice, flattened rice (poha) • R&D of solar powered combined harvester Solar aerators, solar ice boxes, solar power plant to power aquaculture
Agriculture / horticulture	Mukhya Mantri ka Sajuli Yojana	• Provides financial assistance to farmers to procure farm tools/ farm implements (not powered equipment)	As the amount covered under the scheme is only Rs 5000 per farmer, it is proposed that the scheme be modified to allow farmers to contribute to co-owned equipment to allow use of this scheme for mechanisation	Gradually expanding the current scheme to include support for DRE appliances
Livelihoods focussed on cattle-rearing, piggery, backyard poultry	Livestock policies based largely on national policies – National Livestock Mission	NLM support powered equipment for breeding and fodder cultivation that are available as solar powered Dairy Sahakar Policy mentions support for renewable energy plants • GOBARdhan scheme provides financial assistance for cluster/community level • biogas plants	Support for following DRE- powered equipment could be provided • DRE-powered sheds (lighting, ventilation), • DRE for milk chilling, milk collection centres, milk processing • Biogas generation from animal waste	Support for following DRE-powered equipment could be provided • DRE powered egg incubators • Solar pumps for fodder cultivation • Improved cook stoves for animal feed preparation Solar powered semen/ vaccines stations; Solar freezers for semen storage
Fisheries	Assam Fisheries and Aquaculture Policy 2023	• Encourages use of renewable energy (solar) especially in small fishing units for at various stages of fish production and supply chain, including post-harvest management and value addition	Specific DRE (solar as well as biomass) technologies may be suggested: • Solar PV to power aquaculture equipment • Biomass based dryers and cold storage • Solar powered freezers on-boat • Solar PV on boats • Solar ice-making plants • Solar lights and ventilation	Any new DRE technology for post harvest management and value addition

Sector/ Department	Relevant state-level policy that can be the entry point	DRE equipment/ interventions mentioned in the policy	Suggestion for DRE inclusion in the policy in the immediate / short term	Suggestion for DRE inclusion in the policy in the medium term
Tourism	Tourism Policy of Assam 2022	• Focuses on sustainable, inclusive tourism. Supports purchase of equipment or technology that reduces waste, encourages green energy adoption • Reimbursement of 25% • investment on renewable energy available, but program on subsidies needs review	• Continued subsidy to tourism units installing renewable energy systems should continue Reimbursement of 25% investment on renewable energy can be extended to cover • Solar rooftop solar, small wind, • small hydro • Biomass-based thermal systems for cooking and heating • Use of solar energy for electricity generation, cooking needs and hot water requirements	Reimbursement of 25% investment on renewable energy can be extended to additionally cover • Use of battery-operated vehicles charged by solar, solar powered boats; biomass pellet fired bon fires
Bamboo	The Assam Bamboo and Cane Policy	• Policy has provision for 50% capital investment subsidy on electrical equipment. There are references to ethanol production • NBM include activities such as making of pellets and activated carbon, bio energy extraction and establishment of ethanol gasifier	• Policy provision on electrical equipment can be modified to include DRE-powered equipment • Bamboo and cane waste to produce biomass pellets can be suggested and incentivised	• Incentives for ethanol production may be considered under policy • Suggestion to use bamboo waste and/ or solar to power bamboo processing centres
Handloom/ Sericulture	Assam Handloom Policy has not been extended; Assam Textile and Apparel policy was operational till 2022; National Handloom Development Programme in operation	• NHDP mentions funding for other solar products like solar lighting, solar powered silk reeling and twisting machine, solar operated winding machine, solar power system for operating jacquard lifting mechanism	Several options for DRE integration can be suggested: • Solar sprinkler, solar irrigation pump • Solar water heaters • Solar/ biomass fired hot air generators for cocoon stifling • Solar charkha, Solar powered motorized handlooms	Several options for DRE integration can be suggested: • Biomass fired baby boilers/ improved biomass stoves for dye houses • Solar powered motorized handlooms DRE can also be incorporated into processes like effluent treatment mandated for sustainable handloom
Tea industry	Tea Development & Promotion Scheme of Tea Board of India Component 1: Plantation Development for Small Tea Growers Component 2: Quality Upgradation and Product Diversification	• Supports electrical equipment for irrigation (sprinkler equipment, motors, pump sets, etc.), mechanization (pruning machine, mechanical harvester, etc.), setting up of new and mini factories through subsidy extension	• Electrically powered equipment that are already eligible for subsidy can be converted into standalone solar products • Other DRE technologies for integration in the tea industry that can be suggested including: · Solar roof top – powering crucial equipment · Solar pumps, Solar sprinklers – Irrigation · Small hydro/ solar mini grids - powering crucial equipment	• Biomass briquettes/ pellets - Can replace coal/ Piped Natural Gas for drying/ withering

Some enabling actions would be required if the above suggestions have to be recommended for inclusion / modification / re-interpretation of the existing policy. These actions are discussed in detail in Section 4.

Post-harvest value addition to farm produce at the farm was considered for inclusion into the medium-term objectives. But this was rejected as rural, farm level value addition is at a very nascent stage at present and it would be premature to project a way forward through DRE at this stage. Ambitious targets for the same would also be difficult to achieve. Lack of availability of mature, robust DRE technology would also be a barrier.

A different approach to greening the bamboo sector would be required. It is a fast-growing species and can aim to be net carbon positive because while bamboo processing is a consumer of energy, bamboo itself is an energy resource. When used in housing and non-residential application, it can replace not just wood, but also energy intensive materials such as plastic, steel, cement, and composite materials in structural and product applications. There are also enormous co benefits of harvesting and using bamboo.

The major co-benefit in use of bamboo is additional income generation at various stages such as planting, harvesting, processing, product conservation, and marketing. The bamboo sector is labour intensive. Many products and processes where bamboo can be used have a high employment intensity, which can lead to increased employment in the formal and informal sectors.

A similar opportunity exists across agriculture and livestock sectors for waste-to-energy generation by converting waste to liquid, gaseous or solid fuels – the most common being biogas from cow dung. Other conversion possibilities are agri-waste to ethanol and agri-waste to biomass pellets that can replace fossil fuels (petrol and coal respectively).

The policy analysis has visualized an opportunity for technology leapfrogging by Assam in its transition to a low carbon economy. It is ideally positioned to demonstrate DRE enabled sustainable development. Assam is a power deficient, resource rich, agrarian state, with 85 per cent of the population residing in rural areas. DRE can offer to Assam an opportunity to convert its weakness into strength. A spin off of the approach would be replication of the Assam model by the other north-eastern states.

04

DRE for Livelihoods Policy Framework for Assam

MNRE formalised a Framework for Decentralised Renewable Energy Livelihood Applications in February 2022 which seeks to create a favourable pan-India ecosystem for these applications. The Framework document outlines the importance of integrating DRE within the schemes of various departments and agencies that are working with livelihoods sectors such as agriculture, textiles, MSME etc. Among the ways to scale up DRE for livelihoods, the Framework mentions the involvement of State Nodal agencies for Renewable Energy, State Rural Livelihoods Missions, state departments, State Development Agencies, State-level Bankers' Committees, and points to the possibilities arising out of setting up a State Implementation Cell for DRE. The Framework lays the ground for an enabling ecosystem to promote, adopt and scale DRE-based livelihood applications in India. It projects that DRE has the potential of being an important constituent of the 500 GW target by focusing on rural development. The draft Framework goes beyond agriculture with which rural livelihoods are generally associated. The experience of the KUSUM scheme for solarizing pumps has provided a model to scale other DRE livelihood technologies. The DRE powered cold chain is poised to follow the trend of solar pumps and the impact of the same on reduction of post-harvest farm losses is expected to be very significant.

Against this backdrop of the impetus provided by MNRE Framework, a DRE for livelihoods framework is being proposed for the state of Assam with an aim to realise the benefits of DRE integration across several livelihoods sectors as discussed in previous sections on this Roadmap.

The DRE for livelihoods framework for Assam has three components:

1. **Policy interventions -** in key state level policies on supply side (i.e. renewable energy) and demand side (i.e. end-use sectors, which have been summarised in previous Section 3.)
2. **Fostering policy convergence -** addressing policy dis-synergies and disconnects
3. **Ecosystem enablers-** required to support the mainstreaming of DRE for livelihoods

4.1 Assam Renewable Energy Policy: front-runner for mainstreaming DRE

The front-runner for mainstreaming DRE in the state is the Assam Renewable Energy Policy 2022 which has been notified in the State Gazette on 13 October 2022. The policy is encouraging in its general push for solar on-grid and off-grid by various customer categories, in the promotion of RE-based power generation as well as in the provision of irrigation through solar pumps. A few amendments in the Policy, as described below in Table 24, would ensure that DRE is at the centre-stage of energy planning for livelihoods sectors.

Table 24: Suggested amendments in Assam Renewable Energy Policy 2022

Para number	Suggested amendments
Para 5- Objectives	Signal a clear focus on DRE by including among the objectives the following: To promote the use of DRE in MSMEs, rural enterprises and livelihood applications
Para 10.7.2- Decentralised Ground/ Stilt Mounted Grid Connected Solar Power Plant at Barren/ uncultivable land/ agricultural land – items iii), v) & vi)	This para gives an opportunity to rural population for additional income by sale of electricity from their uncultivable land, even though it is not a direct and in-situ use of DRE for livelihood generation. Mention of how such power plants can also be strategically located and planned to power on-or near-farm livelihoods activities or for solarisation of agri feeders would be an important addition.
Para 10.9 – Promotion of other Renewable Energy sources	The para mentions pumped storage, biomass, and solid waste management, as examples. This can be strengthened by mentioning specific products/ systems/ appliances such as mobile solar cold storage units, biomass stoves that need to be promoted under the Policy
Para 14 - Decentralised & off-grid applications	Eligible projects under this para are solar PV pumps, mini/micro grids for un-electrified villages, other solar applications i.e. SHS, solar streetlights, etc. However, the other solar applications is limited to government and certain other institutional buildings i.e. hospitals, schools. This may be modified to clearly include the possibility of including mini-micro grids for MSME and livelihood clusters in electrified as well as unelectrified areas
Para 14.3 item (iii)	May be expanded to include buildings that are used by panchayats, FPOs, NGOs, CBOs, R&D institutions in rural areas that are engaged in income generating and livelihood activities
Para 14.3 item (iv)	May be modified as -State will also provide support to local entrepreneur/ users associations, NGOs, personnel from tourism, horticulture sectors etc. on the use and benefits of DRE in their sectors as per the capacity building program
Para 18.2 - Nodal Agency	May consider Assam Energy Development Agency (AEDA) as the Nodal Agency for implementation of DRE projects in the state. Further, the role of Nodal Agency for DRE may include- Coordinate with other departments such as horticulture, tourism, rural development, MSME etc. to facilitate and promote the use of DRE in their respective programmes and schemes

4.2 Fostering policy synergy

DRE policy is most effective when it originates in the policy documents of the departments that are DRE users / adopters. The role of the energy ministry is important in terms of facilitating the adoption by way of technology provisioning, quality control, financial incentives, awareness, and knowledge creation etc. However, policy commitments to DRE must be anchored around user-departments.

A review of sectoral / departmental policies in the above section, points to the following categories of policy changes that may be considered:

- Where mechanisation can help increase productivity and there is no provision in policy to support the same, this may be included with specific mention of relevant DRE-powered equipment
- Wherever incentives are there for mechanisation or energisation or electrification, these incentives can be reviewed and revised to clearly include DRE integration in the form of DRE- powered appliances / equipment and / or powering a unit / centre with RE
- Policies that provide subsidy on grid electricity connections or grid electricity usage may be modified to include electricity from DRE; in fact, a higher subsidy may be extended to such clean and decentralised electricity for captive generation and use.
- Inter-departmental linkages already exist, for instance, between food processing and horticulture – these linkages are important more generally for value chain strengthening but also for DRE integration. While DRE in a horticulture value chain may fit in well with the Department of Horticulture, higher scales of processing and DRE integration within them may be better suited under the Department of Food Processing.
- At the policy level, this translates into a critical need for departments to work together as this can create important synergies and avoid disconnects. It is encouraging that sectoral policies are already connected with each other in several cases. For instance, the Assam Agarwood Policy refers to incentives extended in The Industrial and Investment Policy of Assam, 2019. However, the Industrial Policy offers power subsidy of Rs. 2.00/unit of electricity consumed from APDCL and excludes captive generation. This can be counter-productive in the sense that deliberately lowering grid electricity tariff will dis-incentivise the adoption of DRE, whose strength lies in providing reliable and low / no-cost energy. Such policy disconnects need to be looked into as part of inter-Departmental co-ordination.

4.3 Ecosystem enablers for mainstreaming DRE in livelihoods sectors

Apart from favourable policies, other enablers are also required to strengthen the ecosystem within which DREs would be integrated and adopted in livelihoods sectors. These ecosystem enablers would span across financing, technological innovations, institutional strengthening among others.

4.3.1 Technology development & customisation

DRE technologies are at different levels of development. Solar PV in grid-connected, off-grid and distributed mode, is fully commercial and deployed at scale. However, several other DRE technologies are at stages of market-ready, prototype demonstration or even lower level of Technology Readiness Index (TRL)[70]. Besides, even the market ready technologies often need inputs for customisation as per specific end-use application, e.g. DRE equipment for value addition to pig and cattle meat. Therefore in anticipation of a long term need for transition to sustainable energy, partnerships should be forged with academic / R & D institutions, partners of the Atal Community Innovation Missions, FPOs, industry associations etc. to develop new DRE technologies and products for boosting livelihoods in rural Assam. The State and the Central budgets of different ministries should provide R & D budgets and stimulate student projects in different universities. Installation of more demo units at strategic locations in livestock, fisheries, eco-tourism and handloom and their performance evaluation would also help in product customisation.

70. https://www.iea.org/reports/innovation-gaps

4.3.2 Fostering innovations in delivery/business models

Barriers for adoption of DRE technologies often revolve around their high upfront cost and unreliable maintenance support. Some of these barriers can be resolved through innovations in the business model. One example is the "Pay-per-Use" model wherein a community-based model that finances, delivers and installs solar farming services to small-farm-holders is offered by Oorja Development Solutions[71]. "Energy-As-A-Service" or EaaS model offered by Schneider Electric[72] gives users access to energy services without having to bear the upfront cost. Delivery model innovations are found in community services also. Solar powered boat for health care managed by Karuna Trust offers reliable and affordable basic healthcare at the doorstep of Msihing tribes, an indigenous community residing along Brahmaputra River[73].

Deployment of market- ready technologies and their applications through innovative delivery/business models require an innovation supportive ecosystem with adequate technical and financial resources. Creating such a facility for fostering innovations in delivery/ business models would help in the uptake of DRE technologies.

4.3.3 Financing opportunities

An oft-discussed barrier to scaling-up of DRE is the lack of financing opportunities for the sector. Current financial framework of MNRE subsidies and CSR grants is insufficient to scale-up DRE applications.

MFIs can play an important role in financing DRE technologies as MFIs typically lend for purposes of income generation such as micro business, agriculture, or livestock. However, engaging with MFIs is relatively simpler for loans for well-demonstrated products. It is also possible that some MFIs can be roped in for 'third party sell' or cross-selling of DRE products (where they partner with vendors of products to bundle these products to their existing clients/customers along with micro credit.[74]

At the state level, there are several financing options that can be considered for financing DRE projects. Examples include:

- Rural Infrastructure Development Fund (RIDF) of National Bank for Agriculture and Rural Development (NABARD)
- NABARD Infrastructure Development Assistance (NIDA)
- NABARD's Rural Innovation Fund for more experimental work around DRE

At the state level, Public-Private-Partnership (PPP) model can be the workhorse of facilitating DRE uptake. A good example is the APART project which aims to ""add value and improve resilience of selected agriculture value chains, focusing on smallholder farmers and agro- entrepreneurs in targeted districts of the State of Assam". The project focusses on increasing private sector participation in the development of agriculture supply chains and markets and, improving public sector capacity in delivering climate resilient technology transfer and related support services. Under APART, there is a focus on common service centres (CSCs) and custom hiring centres (CHCs) – both of these are good entry points for integration of DRE as the source of energy.

It has often been voiced that financing of new technologies such as DRE can be eased if risks can be covered. In Assam, the Credit Guarantee Scheme for agriculture has been operated by Small Farmers Agri-Business Consortium (SFAC) through lending institutions for the last ten years. Its objective is to provide a Credit Guarantee Cover for loans to FPOs so that Eligible Lending Institutions (ELIS).[75]

In a similar move this year, the Assam Government has also decided to approve the collaboration between Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) under SIDBI and state government for providing additional guarantee coverage for loans given by lending institutions to Micro

71. https://www.startup-energy-transition.com/energy-frontrunners-23-oorja-is-helping-developing-communities-access-their-own-clean-cheap-energy/#:~:text=Oorja%20is%20pioneering%20a%20community,a%20managed%20and%20durable%20way.
72. https://www.se.com/us/en/work/services/energy-as-a-service/
73. State of Decentralised Renewable Energy (DRE) Sector in India, Clean Access Energy Network (CLEAN), Shakti Sustainable Energy Foundation, 2021
74. CLEAN (2023)- How the Green Tech Sector Can Work with MFIs: Observations and Experiences from the DRE Sector
75. https://asfac.assam.gov.in/schemes/credit-guarantee-fund-scheme

and Small Units in Assam and creation of a Corpus Fund of Rs 100 Crore – 80% from CGTMSE & 20% from Assam Government.[76]

Both of these schemes can be tapped to ensure that eligible lending institutions extend collateral free credit to FPOs and MSMEs coming forward to adopt new technologies like DRE. These opportunities have a potential to support DRE projects. However, specific directives/ amendments may be required to ensure DRE are not left-out from getting benefits of these initiatives. In some specific cases, a customised scheme can also be initiated to serve the above purpose. For instance, senior NABARD officials, during the stakeholder consultation on DRE integration conducted in Shillong suggested design of a Fund specifically to support DRE-powered livelihoods clusters in a state.

4.3.4 Knowledge creation and capacity building

There are a sizeable number of DRE projects in the state which has created general awareness among communities and officials about the use of DRE. However, a deeper understanding and knowledge, necessary to make informed decisions about selection of DRE is low, particularly among officials of user-departments. An awareness creation on benefits of DRE inclusion (reliable power supply in regions where the grid is weak, improvement in farm productivity, reduction in losses of harvested farm produce, additional employment creation, contribution of DRE to climate resilience, poverty reduction, wastage reduction, increase in state's GSDP, reduction of stress on the grid etc.) would have a favourable impact.

Further, issue-based or thematic knowledge dissemination (i.e. procurement procedures, system performance and maintenance aspects, quality and safety issues, national level RE schemes, etc.) and exposure visits for officials from the state and the national departments dealing with schemes relating to animal husbandry, drinking water, sanitation, NABARD, Khadi and Village Industries Commission (KVIC) etc. would help in strengthening the capacities of user-departments aiming at deriving the maximum benefits from DRE integration.

Departmental level partnerships with skilling programme such as those offered by Skill Council for Green Jobs (SCGJ)[77] would be beneficial in capacity building of officials from user-departments. Consultations with state government officials about the support that they would require for this transition and provision of the same should be an integral part of capacity building initiative.

4.3.5 Monitoring, Evaluation, Reporting (MER)

Systematic integration of any new technology including DRE, calls for good databases around demand, potential, lessons, impacts, and other facets needed for system and programme design and improvement. It has been observed that data availability is limited in DRE sector. Data collection, collation, analysing and reporting should be institutionalised at the state level. District officers under the DRE hubs or through the SRLM network could be employed for such data collection. More importantly, there should be a single entity responsible for MER activities to ensure consistency, regularity, and accountability.

A discussion on policy interventions and ecosystem strengthening is incomplete without identifying an institutional mechanism that should own, implement and be responsible for taking forward the initiative of DRE integration in Assam rural livelihoods sector. This Roadmap recommends setting up an exclusive facility within a state government entity/ department for this purpose, as elaborated in next section.

76. https://www.northeasttoday.in/2022/09/19/assam-government-signs-mou-with-cgtmse-sidbi-to-facilitate-rapid-industrialization-revamp-msme-sector/
77. SCGJ is an initiative of the GoI aligned to the National Skill Development Mission. It is promoted by the MNRE and CII and covers all aspects of renewable energy, environment & climate change, and sustainable development. https://sscgj.in/

05

DRE Implementation and Upscaling Facility

The MNRE's DRE policy framework recommends an integrated approach towards planning and administration through the formation of the Inter-ministerial Coordination Committee. It also lays emphasis on working with non-government stakeholders like NGOs, and CSOs. It is aware that livelihood recommendations will be region-specific, or value chain specific. If Assam pioneers DRE enabled livelihood improvement, then policy and other enablers is only the first step. An "integrated and inclusive approach" as recommended by the national level policy Framework, and inter-departmental coordination should be of prime importance for maximising socio-economic impact while keeping carbon emissions low through DRE-energised livelihoods

Currently, DRE projects are conceptualised and implemented by several departments in the state using their internal financial, technical, and human resources. While this decentralised approach has merits in terms of quick decision making and fast execution of projects, they often encounter challenges related to poor technical design, sub-optimal performance, high procurement costs, inadequate O&M arrangements among others. These challenges arise due to inadequate exposure and access to knowledge and poor understanding of DRE facets (i.e. technologies, equipment, suppliers, quality aspects, promotional schemes, lessons, and best practices etc.) within these departments.

Considering the vast and diverse spread of livelihoods sector and sub-sectors, DRE integration in them needs to be facilitated in a coordinated, coherent, and competent manner. Such a requirement calls for a dedicated facility/ mechanism which is tasked with the role and responsibility to bring DRE at the centre stage of state level planning and execution of livelihoods programmes. Specific purpose for creating such a facility would be:

- to coordinate across several end-use sectors and projects for integrating DRE technologies
- to upscale DRE planning, design, implementation, adoption, monitoring capacities across several end-use sectors
- to provide technical support to all DRE projects in terms of guidance in system designs and specifications, procurement, selection of vendors, quality control, inspection, and completion approvals etc.
- to facilitate MNRE financial assistance and other financing mechanisms for DRE projects
- to create and maintain a Monitoring, Verification & Reporting (MVR) mechanism covering all DRE projects

AEDA is a potential candidate for anchoring a "DRE Implementation and Upscaling facility" on account of its mandate, experience, and expertise of managing renewable energy projects in the state. A directive/ notification from the highest decision-making body (i.e. Chief Minister's Office (CMO)), communicating the purpose, role, and function of such a facility to all concerned departments/ offices in the state would facilitate its creation and planning for operationalisation, including generating funding and human resources.

List of participants of roundtable discussion on November 09, 2023 at Guwahati, Assam

Participants
Roundtable Discussion on
'Strengthening Rural Livelihoods in Assam Through Decentralised Renewable Energy Interventions'
on November 09, 2023 at Hotel Shoolin Grand, Guwahati, Assam

Sl No	Name	Organization
1	Mrinal Krishna Choudhury	Consultant (CLEAN)
2	G Sarkar	Directorate of Handloom and Textile, Government of Assam
3	Masfick Hazarika	WRI India
4	Jnandeep Saikia	Assam State Rural Livelihoods Mission
5	Arijit Purkayastha	Koyeli Travels
6	Sanjay Sarma	Assam Rural Infrastructure and Agricultural Services (ARIAS) Society
7	Nandita Hazarika	Independent Consultant
8	Kabyashree Dutta	Assam Energy Development Agency
9	Mridusmita Borah	Assam State Disaster Management Authority
10	Ritusmita Goswami	Tata Institute of Social Sciences, Guwahati
11	Simanta Kalita	AIC SELCO Foundation
12	Duleswar Baruah	Assam Energy Development Agency
13	Pradip Goswami	Assam Power Distribution Corporation Limited
14	Tauseef Ahmed	Consultant, WEFT
15	Bishal Choudhury	CLEAN
16	Vishal Toro	CLEAN

Images of roundtable discussion on November 09, 2023 at Guwahati, Assam

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