Ashden India
Renewable Energy Collective

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Briefing paper series on decentralised renewable energy for sustainable energy access

DRE for Rural Development: The Way Forward

In the course of this briefing paper series prepared by the Ashden India Renewable Energy Collective and supported by the Shakti Sustainable Energy Foundation, numerous issues have been covered and several gaps have been flagged. The overarching concerns stem from the lack of a systematic approach to mainstream decentralised renewable energy (DRE) in India's energy mix and several misconceptions surrounding this group of technologies.

A summary of the briefing paper series provided in the introductory paper is reproduced here also. The introductory paper introduced the concept of DRE and its constituents, explained the issues around it, and provided some dos and don'ts that sector practitioners offer to new entrants.

Six of the papers in this series were devoted to five critical DRE segments or subsectors:

- Solar pumps are turning out to be game changers. With India expected to launch 26 million solar pumps, they could turn out to be the country's single largest solar application.
- Clean cooking energy for all, an issue that the country has been grappling with for many decades. With 75% of rural Indian households still cooking with traditional fuels in inefficient and smoke-emitting stoves, this is by far India's largest though most ignored energy poverty problem.
- Bio-energy is the single largest source of energy for Indian households. Mainstreaming of bio-energy in the 'new and renewable' category has important implications for the energy source itself as well as for the millions who depend on it for their energy and livelihoods.
- Off-grid solar lighting is the most happening renewable energy segment. Solar lanterns and solar home systems are now widespread but are also subject to many misconceptions and much misuse.
- Renewable energy-powered micro grids have tremendous potential but are ridden with problems. Given the vastness of this topic, two papers dealt with two specific interventions—hybridisation and grid interactivity—that touch upon critical concerns around reliability and post-grid sustainability of these systems.

Four papers in the series focus on cross-cutting issues that plague the ecosystem for DRE:

- The manpower void is viewed as an important impediment for scaling up DRE. This is a double-edged sword because the sector that is seen as a creator of many 'green jobs' constantly complains of the lack of skilled manpower, so the challenge is to match the jobs with the skills.
- Financing including subsidies are ridden with issues. Criticised as being highly subsidised, the DRE sector is constantly faced with the misperception that DRE is high risk and high cost with low viability. This myth must be busted.
- Institutional transitions are required to take DRE out of the confines of a single ministry and a few other agencies. Institutional preparedness is necessary to tap the tremendous potential for DRE to be deployed for numerous multisectoral applications.
- Regulatory frameworks for scaling up DRE. The sector needs regulations that foster rather than thwart DRE, and systems that improve reliability but are not cumbersome.

This paper, the concluding one in the series, is an attempt to stitch together the earlier papers and highlight some of the key take-aways. The endeavour in the course of the series has been to present practitioner perspectives, but to also shed light on the socio-economic and policy contexts. The papers are to be seen as thinking and working papers, as works in progress that will take shape with feedback and further follow-up work.

This briefing paper series has been conceptualised and prepared by the Ashden India Renewable Energy Collective (AIREC) with support from the Shakti Sustainable Energy Foundation. AIREC is a not-for-profit company set up by a group of India-based winners of the Ashden Awards for Sustainable Energy. Shakti Sustainable Energy Foundation works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage energy efficiency as well as renewable energy. For more information, please visit <http://www.shaktifoundation.in>

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Organisation of briefing paper series on DRE	
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Clarifying common misconceptions around DRE

At the outset, it is useful to reiterate and clarify some important misconceptions and views that DRE is a small boutique sector that it is only to be employed as a stop-gap arrangement until other conventional energy is made available, or at the other extreme, that it is the panacea for India's energy problems. Following are some points that are important to bear in mind about DRE.

Myth: DRE is a simple single sector

DRE is not a single sector, but comprises a range of devices and systems that differ vastly in terms of technology, renewable energy resources involved, scale, size, cost, and application. There are at least three very distinct subsectors within DRE: renewable energy-powered micro grids, renewable energy-based clean cooking energy systems, and renewable energy-powered stand-alone devices for lighting, pumping, etc. Thus, alongside a macro vision to mainstream DRE (as defined in the introductory briefing paper), a nuanced approach will be necessary to factor in the features of specific systems. As an example, while regulations for micro grids need to be stringent (in fact, renewable energy-powered micro grids themselves will need to be categorised) in terms of standards for components, systems, operations, and service delivery, regulations for renewable energy devices could be light-handed and based on functionality and output, rather than on technology or design aspects.

This also means that holistic DRE planning and policy-making is rather complex and cannot be left to a few people to handle. This forms the basis for the suggestion made in Briefing Paper # 10 on the need for a competent Sustainable Energy Access Advisory to work with multiple agencies to mainstream DRE for sustainable energy access (SEA). There is a need for DRE to break out of its institutional confinement of small groups and in one ministry, namely, the Ministry of New and Renewable Energy (MNRE) and the State Nodal Agencies (SNAs).

Myth: DRE offers just interim solutions to meet tiny energy needs

There is a tendency to view DRE solutions as interim solutions and as being reserved for certain situations like remote locations. When solar lanterns are handed out, in many instances, there is little commitment towards maintenance and replacement of parts and batteries. As a result, these systems often (estimated at more than 35%) are discarded within their lifespan (discussed in detail in Briefing Paper # 8). Solar home systems and renewable energy-powered micro grids are often provided with little thought as to how these will function once the area gets connected to the grid. Once again, systems are discarded and resources are wasted. Lack of enforcement of reliability-based standards has also resulted in substandard products flooding the market.

In short, DRE suffers from short-sightedness. Service providers can lose sight of the growing needs of the communities they are intended to serve. Micro grids often provide for basic lighting and mobile charging, but as energy demands grow, they are incapable of scaling up to meet the communities' aspirations. This has created the impression that DRE solutions are unreliable or have limited potential.

Myth: DRE is more expensive than conventional energy

Where DRE systems are considered to replace inefficient or environmentally damaging conventional energy, there is hesitation because typically the upfront costs are higher. However, it is now well established that the switch to DRE pays for itself within a short period. For instance, based on the kerosene or diesel cost savings that would be possible, the payback periods are 1–2 years for solar lanterns, 2–3 years for a solar home system, and 3–5 years for a solar pump. However, this payback period is in reality much shorter if we factor out the subsidy of kerosene and also consider the intangible costs associated with kerosene lamps, including less lighting, emission of fine particulate matter, and the risks of fire and explosions. In fact, kerosene-related risks and costs have been the principle driver for the development and dissemination of solar-powered lighting devices in unelectrified or under-electrified areas (see Briefing Paper # 8). In the context of the economics of renewable energy-powered micro grids, the costs have been compared to grid extension expenses. However, grid extension costs seldom include the full costs of transmission and

distribution infrastructure as well as the costs of power generation. It is estimated that at some locations, the real cost of grid extension may be as high as Rs 50 or even Rs 100 per unit. It must also be pointed out that micro grids offer flexible connections (to power just 1–2 lights), whereas the minimum for connecting to the grid is 200 watts. This means that grid extension increases costs because of the higher energy consumption and infrastructure than may be required due to the inherently low flexibility in grid electricity.

Yet, DRE suffers from a belief that it is more expensive but this is largely because conventional energy continues to enjoy subsidies and is not made to pay for the risks and intangible environment and health costs that it imposes (as discussed in Briefing Paper # 6). This is a policy failure that is widely acknowledged but politically (and methodologically) difficult to address.

Myth: DRE is unreliable

Some of the false perception around the unreliability of DRE stems from the short-sighted approach, as mentioned above, that has resulted in the market being invaded by substandard devices or systems that do not fully and reliably meet the needs of the people. It is a fact that some renewable energy resources, by their very nature are intermittent, like solar and wind, and this further compounds the view that DRE is not able to provide reliable 24/7 energy services. However, hybrid systems can address this limitation, provided they are planned well (as argued in detail in Briefing Paper # 4).

Myth: DRE can solve ALL of India's energy problems

Some DRE proponents hold the view that DRE solutions can solve all of India's energy problems. This lack of pragmatism has adversely affected the performance and acceptance of DRE. DRE is not the panacea to India's energy problems. India's energy requirements are so large and diverse that no single energy source or group of energy sources can bridge the gap. DRE is an important part of India's energy access solution and must be used where it is most suited. All DRE solutions have limitations and it is important to acknowledge and address them. It is also important to highlight the benefits of DRE. Decision support tools to facilitate choices of size, scale, technology, location, and other features of mini grids will help to optimise DRE to derive maximum benefits.

Lacunae in DRE planning and a call for a shift in approach

Due to the perpetuation of myths and misconceptions around DRE, the planning of DRE by both government and private agencies has been ineffective and damaging on several fronts. Through this briefing paper series, AIREC, backed by the knowledge of ground realities provided by practitioners and users, has made several recommendations. Some of the key recommendations, entailing a shift in approach towards DRE are tabulated below. While several of the recommendations are at the macro level and seek to address a number of gaps, others are targeted at specific issues or pertain to specific technologies or resources.

Table 1. Lacunae and limitations in current approach towards DRE

Limitation of current approach	Suggested strategy	Interlinked recommendations	Examples from Shakti Foundation – AIREC briefing papers
DRE is not a single technology, so one size does not fit all	Careful planning by sub-sector, resource, application	Decision support tools	■ Techno-economic feasibility of renewable energy micro grids compared to grid extension ■ Tool to mainstream user priorities in cooking energy solutions design and decisions
DRE considered an interim solution; only token energy access provided	View DRE as part of energy solutions over several plan horizons	Technological innovations	■ Hybrid renewable energy systems (RE-RE and RE-fossil fuel) ■ Product innovations (e.g., solar-powered hands-free head lamp for health workers)
Limited stakeholder orientation; confined to renewable energy technology	Weave DRE into energy access and rural development	Social and institutional interventions	■ Establish national level Sustainable Energy Access Advisory ■ Stronger local and inter-sectoral connections to be forged
Lack of pragmatism; unrealistic expectations set	Constructively recognise and address limitations of DRE	Policy and regulatory interventions	■ Performance-linked subsidy, e.g., Renewable Energy Incentive Deposit ■ Regulations for various segments of DRE

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Mainstream user priorities and adopt 'energy service' orientation

Energy is a derived need; it is never demanded for itself, but to meet a certain service. For instance, LPG is only demanded for the cooking energy service that it provides. This has two implications. First, there will almost always be competing energy fuels that can meet the same energy service with varying degrees of effectiveness and efficiency. Second, consumers' expectations or definitions of that energy service will play an important role in energy choices. In this context, cooking energy is particularly complex because cooking is a complex process that may involve steaming, boiling, broiling, roasting, toasting, etc. and will vary according to local dietary and cooking habits.

The concept of energy service delivery and the centrality of user priorities requires a shift away from supply-centric product offerings to demand-centred services. This approach is reflected in several recommendations by AIREC, including the following:

- Develop portable solar pumps as users have expressed a clear need for portability.
- Develop a range of standards for cooking energy devices that allow for some flexibility to accommodate various cooking habits and payment capacities.
- Provide flexible financing options that factor in the quantum and timing of borrowers' income streams.
- Develop pay-per-use schemes for solar home systems that allow consumers to use these systems flexibly rather than owning them.
- Develop micro grids that can be expanded in a modular fashion to meet the growing needs of consumers.

Focus on financial sustainability

DRE systems have been viewed as expensive due to the high upfront costs and because the costs of conventional energy has been kept artificially low (through subsidies and unaccounted for costs, as mentioned above). Financial viability has been a key concern for DRE entrepreneurs for a number of reasons. Typically they cater to rural low-income communities and affordability for these users is a serious concern. Also, reaching out to scattered remote locations raises logistics and transaction costs. The recommendations in the briefing papers, therefore, touch upon ways to improve the economics of DRE in several ways:

- Aggregate users with micro-finance agencies, self-help groups, or regional rural banks acting as intermediaries to help reduce transaction costs.
- Provide performance-based subsidies through schemes like the Renewable Energy Incentive Deposit (REID) so that dependence on subsidies is streamlined and delivery-oriented business models evolve.
- Grid interactive micro grids should improve reliability, permit the setting up of higher capacities, and reduce the need to look for anchor loads.
- Sensitise financiers who tend to overestimate risks around DRE.
- Tap carbon financing to capture the low-carbon features of DRE.
- Monetise the benefits of DRE, including the environmental and health benefits, averted transmission losses in the case of micro grids (as opposed to grid connected power where nearly 30% of power generated is lost in the transmission and distribution stage), and energy security benefits (reduced dependence on imported fuels).

An important step towards improving the financial sustainability of the sector would be to create a pro-DRE ecosystem by installing full-scale projects that not only demonstrate the effectiveness and reliability of DRE but also generate demand for DRE, and foster the development of strong networks of suppliers and service providers. Such programmes may be led by the government or by non-government agencies.

Involve practitioners

An important gap in the DRE efforts thus far has been the disconnect between the government and practitioners in the field. State programmes and policies have seldom sought to work with enterprises and NGOs that often have similar goals but end up working at cross purposes due to lack of a dialogue between them. Also, in the past, policy-making has been divorced from ground realities due to lack of such dialogues. In recent years, some of the members of AIREC, as well as other practitioners, have been engaging with MNRE and other ministries to help identify ways to scale up DRE in a meaningful way. Several of the recommendations of AIREC (set up by a network of Ashden award winning practitioners) highlight the need to engage with sector players more constructively. Practitioners can contribute immensely in the following areas:

- Provide opportunities for hands-on training to policy-makers and future entrepreneurs, and help develop training modules that reflect ground realities.
- Get involved in the development of standards and benchmarks.
- Contribute to the design and testing of decision support tools such as for cooking energy assessment (preliminary work is underway with AIREC), hybridisation, and grid-connectivity of micro grids.

- Get involved in setting up and working with the suggested Sustainable Energy Access Advisory.
- Help identify priorities for research, development, and design.
- Sensitise financiers, investors, and rating agencies by showcasing the benefits of DRE, building correct risk perceptions, and helping to develop instruments for de-risking or risk guarantees.
- Facilitate the identification of areas where DRE is best suited and can provide maximum socio-economic benefits.
- Help forge linkages across ministries, agencies, and sectors.

Addressing critical knowledge/data gaps

Closely linked with recommendations for a change in approach, are large knowledge and information gaps that need to be bridged. This briefing paper series pin-pointed a number of areas that need further study so that policy-making and business model development can be better informed. Some of the most critical areas for study are listed here:

- In-depth India-specific, and in some cases location-specific, understanding of the employment prospects and workforce requirements in the sector (Briefing Paper # 2).
- A decision support system that integrates local priorities at the level of an agro-ecological zone for enabling policy, business, and technology decisions around clean cooking energy (Briefing Paper # 3).
- A decision-making guide for project developers to determine when and how to hybridise a renewable energy-powered micro grid, and to what extent (Briefing Paper # 4).
- A detailed and systematic study on biomass potential and availability factoring in the need to minimise adverse social and environmental impacts (Briefing Paper # 5).
- Assess and monetise the benefits of DRE, with specific examples, to enable the incorporation of these benefits into financial incentives and to inform the understanding of risks associated with DRE (Briefing Paper # 6).
- Technical research on solar pumping with a focus on increasing the efficiency of pumps, reducing the cost of balance of systems, and improving the portability of pumps (Briefing Paper # 7).
- Options for a kerosene-free India emphasising the role of solar off-grid lighting (Briefing Paper # 8).
- Study of functioning renewable energy-powered micro grids of various categories to understand the factors that influence reliability, safety, cost, and grid compatibility. Also conduct performance evaluationsforfrequency and voltage under various operational modes (Briefing Paper # 9).
- Strategy document for strengthening SNAs and for the establishment of a national-level Sustainable Energy Access Advisory to lead and inform the development of DRE for sustainable energy access (Briefing Paper # 10).

Most of these studies can be conducted by agencies like AIREC, which have a strong practitioner-led policy analysis capability, but some will need expertise in specific areas. While some of these may be conducted as consultative policy research studies, others will need field surveys to gather a wide range of perspectives from various stakeholders.

Dovetailing DRE with rural development, creating a favourable ecosystem

For DRE to be mainstreamed, it is essential to create an ecosystem where DRE technologies are viewed as reliable energy solutions. AIREC believes DRE has the potential to be an integral part of energy provision for rural development and rural livelihoods. For some situations, renewable energy resource availability permitting, DRE may in fact be the best solution. For instance, where settlements are remote and scattered, areas that are prone to natural disasters (which can cause significant damage to the transmission infrastructure required for DRE), and where traditional institutional arrangements are strong and have a history of managing development projects.

DRE applications in multiple sectors and for community services

Thus far the focus of DRE efforts—especially in government programmes—has been confined to basic energy for households by promoting solar lanterns and solar home systems, renewable energy-powered micro grids, solar water heaters, improved biomass cookstoves, biogas plants, solar cookers, and more recently, solar pumps. However, DRE technologies have the potential to meet a very wide range of electric, thermal, and mechanical energy needs of not just households but also of a number of community services and livelihoods. An indicative list of such renewable energy technology applications is tabulated below (Table 2). It is suggested that for renewable energy to reach its full potential, these applications and devices must be brought into the mainstream through intensive government efforts. Effective demand would then be created, allowing the applications to take off on significant scales.

Table 2: Renewable energy applications for rural community services and rural livelihoods

Community services and livelihoods sectors	Renewable energy technology/application
Health	Solar-powered ice packs for vaccines, medicines, etc.; renewable energy-powered primary health centres
Education	Renewable energy-powered schools, classrooms, school toilets
Water	Solar pumps for irrigation and drinking water
Sanitation	Solar-powered running water and lights for toilets; toilet-linked biogas plants
Community kitchens in schools for mid-day meals, tribal hostels, tea stalls, sweet shops	Community-sized solar cookers; biogas plants; improved large biomass cookstoves
Poultry	Solar-power packs for lighting and ventilation of backyard poultry farms; biogas generation based on poultry litter; briquetting of poultry bedding material for use as fuel
Dairy	Solar-power packs for lighting and for small equipment such as testing equipment; renewable energy-powered milk chillers; biogas generation based on cattle dung
Horticulture / agriculture	Solar pumps; renewable energy-powered cold rooms for storage of fruits and vegetables; renewable energy-powered dryers for spices, ginger, garlic, herbs
Small-scale industries (e.g., khadi, bamboo)	Solar lanterns; solar packs for powering small equipment; energy generation from waste material like cane dust
Cross-sectoral electricity requirements	Electricity micro grids based on solar, biomass, small hydro or bio-diesel generators

Integrating renewable energy with rural development and rural livelihoods enhances local quality of life, improve incomes, and facilitates waste management. It also creates awareness about the potential for renewable energy and creates a demand for these technologies. Such demand is critical for creating a pro-renewable energy ecosystem in the state.

Even as AIREC propagates the concept of right to basic or lifeline energy access, it recommends that renewable energy adoption be part of this mandate. Programmes of various ministries and departments should promote (through mandates and incentives) adoption of DRE solutions, as indicated in Briefing Paper # 11.

Job creation through DRE

Another aspect of integrating renewable energy into local development plans is the tremendous job creation potential of this sector. Fuel-free technologies like wind power and solar photovoltaics create many jobs during the manufacturing and construction phases (with limited openings also during the operations phase for jobs such as cleaning the power plant). And fuel-based technologies such as biomass-based plants require maximum labour for feedstock production. For instance, a 10 MW biomass power project can create employment for 100 workers during the 18-month construction phase, 25 full-time workers in the operation of the facility, and 35 workers in the collection, processing, and transportation of biomass material. Tapping the employment potential of the renewable energy sector will require a planned approach towards development and deployment of skills, as outlined in Briefing Paper # 2.

DRE projects for unelectrified villages

There are about 25,000 unelectrified villages in India, many of which may not be connected to the grid for a number of reasons (very remote, small villages with populations less than 100, etc.), They will have to be powered by decentralised energy from diesel or renewable energy. These villages represent an energy challenge, but they are also an opportunity to demonstrate renewables-based electricity generation in a small-scale decentralised mode.

Several pilot projects have been announced by the MNRE. These typically entail electrification of some of these villages/ hamlets using individual household-scale solar systems. While it is heartening to note that in several of the recently announced pilot projects, renewable energy (solar) is being used to power

more than just lights, it would be useful to consider the huge possibilities of deploying solar as well as non-solar renewable energy applications to power a range of energy needs in not only households but also in community services and livelihoods activities. A model that is working well in the hilly states of northern India involves the setting up of a community solar water purification and heating facility. Development of such projects will demonstrate the reliability of DRE and will also provide hands-on training on how simple systems (particularly solar photovoltaic-based) can be readily installed to meet some critical needs, such as lighting and water purification. In remote unelectrified locations, such projects can be life changing.

India now has a wide network of practitioners, entrepreneurs, researchers, and financiers who make up the powerful knowledge resource that is needed to accelerate the DRE sector beyond field trials. This is the right time for DRE to be adopted by various sectors. Many DRE technologies have now been demonstrated for various applications in different situations and are well poised to transition into the mainstream to capture a growing share in India's energy mix.