Sustainable Energy Access: The DRE Way

Ashden India Renewable Energy Collective, with support from the Shakti Sustainable Energy Foundation, has prepared a series of briefing papers on decentralised renewable energy (DRE) for sustainable energy access. The papers have been organised into two groups as shown below. One group examines renewable energy (RE) resources, specific technologies, and end-uses. The other group focuses on ecosystem issues that challenge large-scale deployment of DRE, but when systematically addressed can catalyse growth in the sector. A final paper in the series summarises and knits together all the themes. It then outlines the DRE potential for rural development in India.

Organisation of briefing paper series on DRE	
ISSUES IN SPECIFIC DRE SEGMENTS	**ECOSYSTEM CHALLENGES**
Solar pumps	Manpower void
Clean cooking energy for all	Financing including subsidies
Mainstreaming bio-energy	Institutional transitions
Solar home lighting systems	Regulatory imperatives
Electricity from renewables: hybridisation	
Electricity from renewables: grid interaction	
CONCLUDING PAPER	
Potential and way forward: DRE for rural development	

Decentralised renewable energy for sustainable energy access: an overview

This paper serves as an introduction to the series, as presented above. It provides an overview of the DRE sector, the technologies it employs, the features of these solutions, and their relevance for India.

DRE has tremendous potential to address energy access gaps. There are numerous success stories of first-time access to electricity, night-lighting, and smoke-free kitchens. Unfortunately, there are also bitter experiences of projects that have failed to meet expectations in terms of community impacts and/or commercial viability. Drawing on lessons and feedback from stakeholders (summarised in AIREC, 2012), this paper attempts to provide DRE practitioners, policy makers, and researchers with the keys to ensure sustainable energy access and pathways to financial viability.

DRE refers to a range of applications providing electrical, mechanical, and thermal energy services. It includes:

- Stand-alone RE devices such as solar lanterns and home-lighting systems, solar pumps, and solar charging stations.
- Distributed generation of power from RE sources such as biomass (combustion, gasification), solar photovoltaic (PV), solar thermal, small hydro, small wind-farms, and waste-

>> Highlights

- Distributed renewable energy includes electrical power systems for remote, rural communities and household heating, cooking, and lighting devices.
- Benefits of DRE include energy access to households not served by the grid, low carbon intensity, good fit with individual community needs, and potential for employment and economic development.
- DRE projects that are integrated with existing social and economic activities have a higher probability of success than isolated ventures.
- Key issues for planning a DRE project include: engaging the community fully to ensure support and adoption; accurately identify the energy needs of the community now and estimate them in the longer term; consider clustering and hybrid systems to address affordability and intermittency; and, train and employ locals who can operate and maintain systems that have been installed.
- DRE planning needs to anticipate growth in energy demand and build in the capacity to expand as required.

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 <www.shaktifoundation.in>

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to-energy plants, and hybrid systems. These technologies may be totally off-grid or grid-interactive.

- RE devices for thermal applications such as improved biomass-stoves, biogas plants and biomass gasifiers, solar cookers, solar water heaters, and solar and biomass dryers.

DRE solutions are often misunderstood as solely household-level energy technologies. As a result, the potential of DRE for several commercial/productive and social/community applications is underutilised in India. Water purification, water pumping, cold storage or drying of vegetables, fruits and fish, milk chilling, aeration of ponds, or powering of boats are just some of the energy services that can be powered by solar, biomass, or other RE or hybrid RE systems.

Typically, the adoption of DRE has numerous positive features:

- Reduces dependence on centralised utilities such as electricity or gas grids and LPG distribution networks
- Is carbon neutral or low carbon
- Can flexibly match local demand for electricity, heat, and other energy services
- Requires less capital investment and is easier to set up through small start-ups
- Generates employment opportunities for the local community
- Provides reliable energy for critical community or economic activities

Ironically, some of the strengths of DRE also represent intrinsic limitations. For instance, because they are decentralised and small scale, DRE systems typically do not achieve the economies of scale of large or grid-scale projects. Also, as the systems are numerous and scattered, there are higher transaction costs associated with project management and coordination. Community engagement can also be a challenge, especially if the projects are not conceptualised with community involvement from the beginning.

An important limitation of some RE technologies (not limited to DRE) is their intermittency of supply, resulting in a failure to meet fluctuations in demand (such as mornings and early evenings). While biomass-based technologies are not characterised by diurnal variations, there could be seasonal issues with timely feedstock availability of suitable quality.

In addition to the inherent limitations of DRE, there are several external or ecosystem-related factors that hinder its large-scale adoption. DRE technologies tend to be costlier per unit of energy output than their centralised large-scale counterparts. In some cases, DRE operations are costlier and/or more cumbersome, too. This poses challenges on various fronts: affordability for consumers, viability of operations, and the need for entrepreneurial and end-user finance. Poor data on operations, business prospects, and lack of standards can reduce user and investor confidence in these systems.

Lack of manpower for operation, maintenance, and last mile service delivery also impeded DRE adoption. DRE practitioners must also cope with regulatory and policy uncertainty, as well as the absence of a level playing field as fossil fuel-based centralised energy continues to be subsidised.

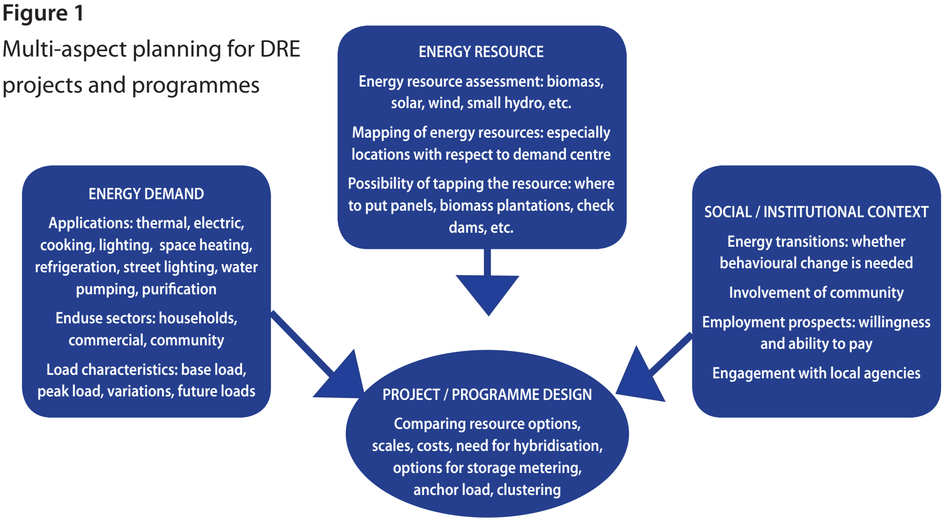
For any prospective entrant in the DRE sector there are critical success factors, some of which are outlined in the following sections, and some that appear in other briefing papers in this series.

Think and plan local

Perhaps the most important feature of a DRE project is its distributed nature, making it a local solution. Thus DRE requires us to think and plan for a specific community, integrating local energy needs and resources. The selection of DRE technology and scale is to be done systematically and in line with each local context. Conditions on the project site are critical, particularly with regard to the policy framework, community features, and RE resource availability (Figure 1). Only RE resources that are available on site can be harnessed. Feedstock sourcing must be planned thoroughly for biomass-based systems. The projects must be driven by the needs of local beneficiaries or end-users. (Mainstreaming user priorities is particularly important in the provision of

Figure 1

Multi-aspect planning for DRE projects and programmes



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clean cooking energy, a subject examined in greater detail in a separate briefing paper.)

Address intermittent supply

Power storage is usually conceded to be the weakest link in DRE, both technically and organisationally. Energy storage is an area of intense research, with various options being explored to address intermittency associated most notably with solar and wind energy.

Hybridise to improve reliability

Hybridisation within and across technologies (e.g., combining solar mini grids with solar home systems or solar mini grids with biomass gasifiers or wind turbines) can help overcome diurnal variations in energy demand and supply. It can also provide flexibility in meeting rapid growth in demand, especially in households enjoying their first time access to electricity. Micro hydro systems are susceptible to dry streams in the hot season, when solar is typically available. Similarly, during the monsoon season, when solar radiation is low, micro hydro or small wind generators could be functional in a hybrid system. Smart integration of solar with fossil fuel systems also has potential to reduce fuel costs, and such hybrids may find a ready market for this reason. (This too is a topic explored in a separate briefing paper in our series.)

Explore grid interaction to improve reliability and viability

Commercial viability of off-grid power is always a challenge, given its low levels to many rural Indians. Decentralised micro grids can also be threatened by the grid. Grid-connected (or grid-compatible) projects are better equipped to deal with this risk. Flat-rate tariffs, tiered for the poorest consumers, are usually adopted. Distribution franchisees or energy service companies may be roped in for power distribution and revenue collection.

However, grid interactivity requires a regulatory framework that accommodates three DRE options: (1) continue off-grid; (2) sell surplus power into the grid; and (3) buy from the grid a portion of the total power requirement (which could be a mix of conventional and non-conventional energy). The regulation should establish guidelines for the institutional structure, including franchisee agreement, buy-back agreement, authority of DISCOMs (distribution companies) to enter into agreement, billing, and payment mechanism for a smooth transition (AIREC, 2012). (Separate briefing papers on regulations and rooftop solar highlight the importance of the regulatory framework.)

Innovate to overcome disadvantages of small scale

Disadvantages associated with small scale, such as high transaction costs for all service and financing agencies, and the low value of projects and transactions are typical obstacles faced by DRE technologies. These obstacles are compounded by the fact that DRE applies primarily to rural markets where it faces low demand resulting from little economic activity and from low-income households. Nevertheless, some solutions have been tested and have proven to be moderately successful.

Clustering

Clustering[1] of DRE projects can achieve economies and reduce competition among rival firms. Clustering also facilitates sharing of manpower resources, technical knowledge, and both social and physical Infrastructure. Clusters (rather than individual projects) can be better suited to meet community needs and can tap funds that often involve considerable paperwork and have high transaction costs. Clustering is promoted in the programmatic CDM (clean development mechanism), whereby a single or series of inter-related measures seek a common goal of reduction in greenhouse gas emissions.

Anchor or base loads

DRE projects that are integrated with existing social and economic activities have a higher probability of success than isolated ventures. Integration facilitates establishing critical anchor loads, helps to understand the need and potential for hybridisation, and improves the possibility of clustering, which, in turn, improves viability. It is therefore important for DRE projects to identify existing energy loads from such things as small industries, mid-day meal kitchens, telecom towers, and irrigation systems.

The idea of a village community centre is not new, with initiatives focused on the use of information and communication technologies emerging, many of them in the southern states.[2] There are now plans to use such centres to provide

[1] The cluster being referred to here is conceptually very similar to the one defined by Michael Porter as a 'geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities.' In this case, the plants/projects in a cluster may or may not be owned or managed by the same parent company, but it is important that some linkages are established and documented.

[2] As discussed at the *IT for Change National Workshop on Community Information and Service Centres, 2011* http://www.itforchange.net/sites/default/files/ITfC/Community%20Information%20and%20Service%20Centres%20Workshop_Concept%20note.pdf

additional services like television set charging stations, drinking water facilities, providers of hot water, community kitchens for festivals and family functions, and so forth. Such centres could be powered by a variety of DRE technologies, or be an important base load for DRE mini grids. (Other examples are highlighted in a separate briefing paper on DRE applications for rural development and livelihoods.)

Plan realistically for the long term

Many DRE devices and some mini grids have been suggested as a quick fix for energy access gaps. Unfortunately, systems that have worked well in the short term have failed in the medium to long term to meet growing demands for energy, as people's aspirations rise. DRE planning needs to anticipate growth in energy demand and build in the capacity to expand as required. (This point is reiterated in our briefing papers on solar home lighting systems and solar pumps.)

Free solar lanterns and home-lighting systems are frequently distributed with little regard for their proper utilisation. When the batteries run out, these systems are discarded, resulting in considerable resource wastage. Continuous involvement of local agencies is critical to ensuring the upkeep of the systems, including replacement of batteries. Failure to factor battery replacement costs into the lifetime cost of DRE products keeps system costs artificially low and hampers effective utilisation.

Plan for manpower, with local youth in mind

DRE projects must seek to employ local youth who bring with them local knowledge and community connection. Where employment opportunities are part time, it makes sense to equip the existing workforce with additional DRE skills through training and support. (One of the papers in this series points out how careful matching of manpower needs with retraining of local youth can generate employment and create DRE-relevant skills. Real-life experience in DRE projects strengthens such skill development, and mentoring by entrepreneurs would also be useful.)

Network with local agencies: link projects to community needs and aspirations

Local agencies – community-based, government, and private – must be involved in planning and implementation of DRE, as they understand the features of the region. State and district agencies and relevant panchayat leaders must also be engaged.

Institutionally, DRE planning must be integrated with the responsibilities of local development agencies (akin to rural health that is now integrated with some agencies). District-level planning agencies (panchayats) may have clean energy access among their core areas of focus. ((A paper on institutional issues highlights the role of local agencies in planning DRE projects.)

Mainstreaming user priorities is key to the success of any DRE endeavour. (This is the foundation of our paper on clean cooking energy, which reports that cooking energy efforts have often failed due to a lack of understanding of what the user wants.) A focus on emissions and efficiency of cookstoves without taking into account features like ease of use or economics could lead to poor decisions about technology, product design, choice of fuel, marketing, or financing options.

Innovate in financing

Various DRE projects and devices enjoy generous government subsidies. While these are meant to lower initial costs and encourage the deployment of DRE, subsidies have been criticised for lack of timely dispatch and cumbersome procedures. As a result, many entrepreneurs now avoid subsidies and look for innovative ways to finance their projects. (This series offers a paper that covers financing and subsidies. It showcases examples of innovative financing and proposes a way of linking subsidies with performance.)

Reference

AIREC, 2012. **Scaling Up Off-Grid Renewables: Summary of Recommendations.**
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