WORLD RESOURCES INSTITUTE

EXECUTIVE SUMMARY

POWERING DEVELOPMENT IN CLIMATE VULNERABLE AREAS

The Role of Decentralized Solar Solutions in India

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FOREWORD

The year 2020 marked five years since the signing of the Paris Agreement, which aims to limit global temperature rise by 1.5°C through aggressive mitigation action. India has been making steady progress toward its commitment of reducing energy sector emissions and has set a 450 GW target for renewable energy by 2030. India also made significant progress in improving electricity access for more than 500 million people over the last two decades.

Despite the significant increase in electrification of homes, electricity access continues to be a challenge for the rural health, education, and livelihood sectors. In India, according to National Health Mission statistics of 2018, 36 percent of public schools and 24 percent of public health centers remain unelectrified. Several of the electrified centers get only an intermittent and unreliable supply of electricity and are therefore compelled to rely on expensive diesel generators. Inequitable access to reliable electricity supply impacts the socioeconomic development of vulnerable communities, particularly in rural areas, as it disrupts schooling, medical services, and livelihoods.

The 14 case studies in this report, "Powering Development in Climate Vulnerable Areas: The Role of Decentralized Solar Solutions in India," highlight how climate change affects electricity demand and debilitates the infrastructure that supplies electricity. The report is a timely analysis of the importance, and advantages, of deploying decentralized energy solutions to power remote and rural schools, healthcare, and livelihood facilities. The findings from this publication also indicate that effective decentralized energy solutions need to be climate proof and tailored to local conditions. For example, Assam, which is a flood-prone state, has developed unique solutions such as floating solar grids to reduce the risk to infrastructure during the monsoon. On the other hand, in lightning-prone areas of Jharkhand, implementers have installed lightning arresters to protect against such events. The localization and customization of clean energy solutions are not limited to technology but also include operational and financial processes.

This report aims to be a roadmap for designing, implementing, and managing clean energy solutions—especially in climate vulnerable areas. It describes how implementers, vendors, and policymakers can come together to build resilient infrastructure that can support the country in achieving its Sustainable Development Goals and climate targets.

As a developing country, India enjoys the unique advantage of being able to pursue cleaner trajectories for infrastructure that is yet to be built. As the Indian government works toward ensuring sustainable, affordable, and reliable electricity for all, it needs to ensure that the new infrastructure is climate resilient to secure mitigation and development gains. Decentralized renewable energy solutions crafted to meet developmental needs are essential to lift people out of poverty and stay below 1.5°C.

Andrew Steer

President
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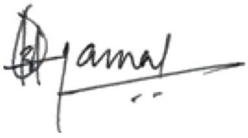

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Highlights

- In India, poor and marginalized communities face the dual challenges of low socioeconomic development and extreme vulnerability to climate change. Providing reliable access to electricity through decentralized renewable energy creates an opportunity to stimulate low-carbon socioeconomic development in climate vulnerable areas.
- India has made impressive progress in increasing the reach of its grid connectivity. Climate-related events can impact the supply of electricity, especially the distribution network of the centralized grid structure.
- Decentralized energy solutions play an essential role in supplementing grid connectivity to support basic services such as health, education, and livelihood generation during uncertain times.
- Development agencies are increasingly adopting decentralized energy solutions to provide affordable, reliable, and sustainable electricity access, which is key to building long-term adaptive capacity. Notably, these solutions can also be affected by climate-related events, thus requiring resilience planning.
- Developing climate resilient energy solutions requires working across conventional silos; incorporating climate considerations in technology, planning, and execution; and aligning organizational responsibilities and funding arrangements at each stage of the project cycle.

Many of India's most impoverished and underserved people live in the country's climate vulnerable regions. With limited access to healthcare, education, and livelihoods, the poor are among the least equipped to cope with the climate change threat despite being overrepresented in climate vulnerable areas (Diwakar et al. 2019).

Energy in Climate Vulnerable Areas

Although there have been significant improvements in India's rural household electrification, electricity availability for health centers, schools, and rural enterprises is still limited.

Electricity is one of the enablers of socioeconomic development. Access to reliable electricity can improve the working hours, staff availability, water availability, and medical and diagnostic services in hospitals; improve the learning environment, school attendance, and the quality of education delivery in schools; and enhance productivity, savings, and income for rural livelihoods (Chaudhury and Hammer 2003; World Bank IEG 2008; SEforAll 2018). In climate vulnerable areas, facilities for essential services, such as healthcare, education, and livelihoods, that are functional under all conditions can help the poor improve their socioeconomic situation and cope with the existing and new threats posed by climate change.

Decentralized solar energy solutions are increasingly considered for bringing reliable electricity to community facilities, especially in climate vulnerable areas. **Although decentralized solar solutions are not entirely immune to extreme events, they are relatively more resilient than centralized electricity systems** (IEA 2015; PGCIL 2015; WBCSD 2014; OECD 2018).

About This Report

In this report, we explore the impacts of climate-related events on electricity needs, whether decentralized solar solutions consider climate change in the lifecycle of the installation, and if not, then what factors need to be considered.

Since 2015, World Resources Institute (WRI) India's work on improving energy access in India has focused on the states of Assam, Jharkhand, and Rajasthan**.** We adopt a four-pronged approach encompassing technology, data, policy, and finance as a scaling-up strategy to ensure reliable electricity for social and production loads.

Our partners are development agencies such as public health departments, charitable hospitals, schools, local administrations, state government departments, and not-for-profit livelihood grassroots organizations. To further that work, through this report we explore the nexus between energy for development and climate change. We analyze 14 decentralized solar energy systems installed in community-level healthcare, education, and livelihood facilities in climate vulnerable regions across these three states. For this report's purposes, *decentralized solar energy solutions* refer to stand-alone or minigrid-sized installations that provide electricity supply to facilities such as schools, health centers, and communities.

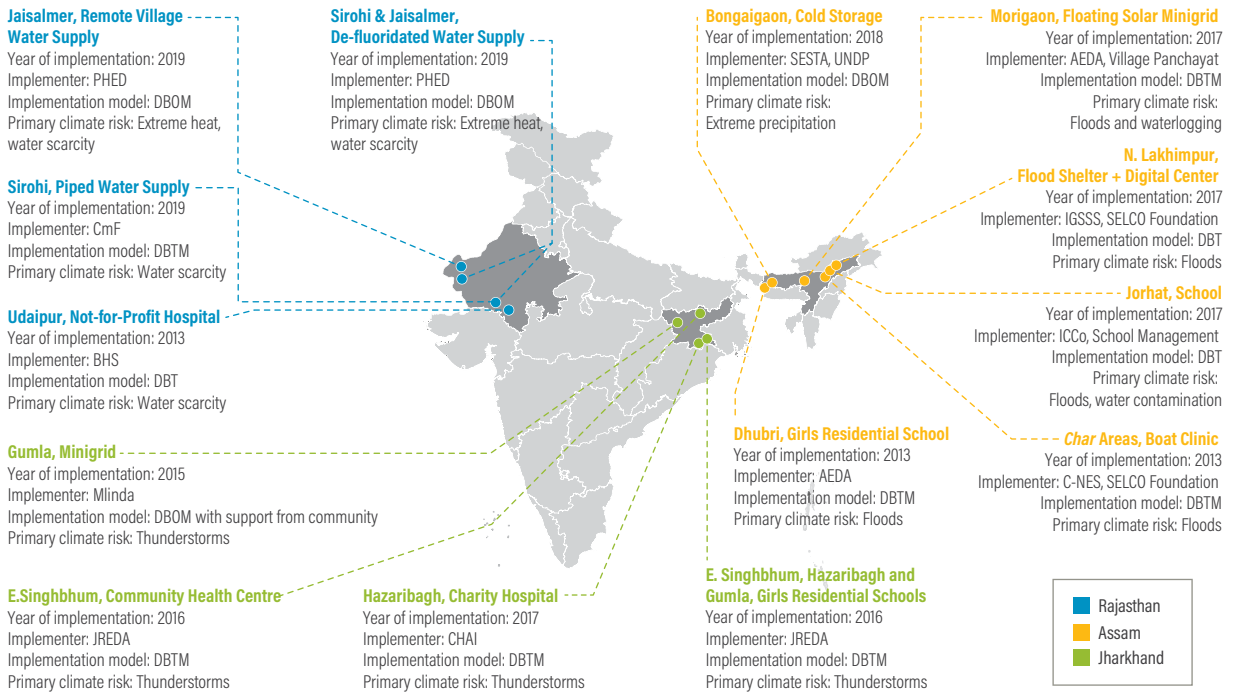
We explore whether electricity demand for healthcare, education, and livelihoods is affected by climate-related events and whether energy solutions take climate risks into account. A summary of the case studies is shown in Figure ES-1.

How to plan for energy for development in climate vulnerable areas?

Through this study we inquire about the impact of climate vulnerability on energy needs for development. By studying energy access installations, we explore how these solutions account for climate vulnerability in their design and implementation models, specifically in energy-poor states. These case studies of installations help us to arrive at the factors that should be considered for improving the sustainability of energy access solutions in climate vulnerable areas.

This study is the culmination of extensive background research, in-person interviews, state-level multi-stakeholder consultation workshops, and field visits. An initial list of decentralized renewable energy (DRE) projects was created with the help of this network. This list was then distilled to 14 case studies based on population served,

Figure ES-1 | Fourteen Case Studies of Decentralized Solar Energy Systems in India



Note: AEDA = Assam Energy Development Agency; BHS = Basic Health Care Services; CHAI = Catholic Health Association of India; CmF = Centre for Micro Finance; C-NES = Centre for North East Studies and Policy Research; DBOM = Design Build Operate Maintain; DBTM = Design Build Transfer Maintain; DBT = Design Build Transfer; ICCo = Innovative Change Collaborative; IGSSS = Indo-Global Social Service Society; JREDA = Jharkhand Renewable Energy Development Agency; PHED = Public Health Engineering Department; SeSTA = Seven Sisters Development Assistance; UNDP = United Nations Development Programme.

Source: WRI authors.

location, access to the site (permission to visit), and willingness to share information. The field visits conducted between June and November 2019 document various stakeholders' experiences at the sites. During the field visits, we interviewed implementers, donors, operators, and end users about the experience of installing and operating DRE solutions, the challenges faced, and benefits accrued. We expect our research to provide practical, usable information for government agencies, energy enterprises, financing agencies, and development organizations implementing decentralized solar energy solutions in climate vulnerable areas.

Findings

Our research indicates that electricity demand for the delivery of essential services is impacted by climate risk in three ways:

- Backup power: Electricity supply through the grid is often disconnected during thunderstorms and floods because of, or in anticipation of, damage to the grid infrastructure. As a result, the demand for backup sources of electricity, such as diesel generators, increases during these times.
- Demand surges: Electricity demand increases as people seek to cope with specific climate-change-induced events. For example, they need electricity for information and communication, medical diagnostics and treatment of diseases, or pumping and filtration of water due to contamination or scarcity.
- Service expectations: Electricity demand will increase for ongoing activities such as digital education, quality healthcare, and income and livelihood enhancements that build the long-term capacities of communities to cope with climate events.

Climate change impacts the technical, operational, and financial design of a project. Many renewable energy projects adapted their designs considering specific local conditions. For example, in Assam, to deal with waterlogging and flooding, installations are designed to withstand higher water levels, either through raised platforms or through technologies such as floating solar installations. Jharkhand is prone to thunderstorms and lightning, and a few pilot implantation projects in the state have installed lightning rods, surge protectors, and chemical earthing. In the desert state of Rajasthan, the installations are designed to withstand extreme temperatures and strong winds and include insurance of structures in project design.

However, none of the installations covered in the case studies specifically incorporate predictions of future climate change into their project design. Climate considerations are even less evident in the operational and financial design. Our research finds that only a

limited number of case study installations have operational clarity on roles and responsibilities during and after a climate-related event or have funding arrangements in place to deal with the aftermath of an event. Furthermore, the clarity that some possess stems from learning through experience and not from the project design. We expect that this report will trigger more thinking and planning for climate events in the design and operations of future projects.

Implications for Decentralized Solar Solutions in Climate Vulnerable Regions

Ensuring energy systems' resilience is vital for development agencies and is a growing area of concern for renewable energy practitioners. Building on the framework from a recent report by UN Foundation and Sustainable Energy for All (SEforAll) titled *Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education* (UN Foundation and SEforAll 2019),

we identify the following additional considerations for decentralized solar energy installations in climate vulnerable regions:

- **Technical considerations** include understanding the current and future climate risks in the region, how they affect the demand for and supply of electricity, and what technology options, codes, and guidelines exist to ensure that the energy system continues to remain useful and functional. The implementing agencies and vendors should also consider whether project timelines include climate risks through the four stages of the project life cycle and whether the technical design considers the market availability of spare parts in case disruptions occur.
- **Organizational considerations** include whether the contractual and non-contractual responsibilities of all participants are laid out in the event of climate-related disruptions and whether they have adequate capacity to execute them. Users and implementing agencies should account for local capacity building, contingency communication, or response plans under contractual obligations that can be activated during climate-related events. Energy project planning should consider the local community's expectations, including the role played by energy in the community's current and future coping mechanisms to manage climate-related risks.
- **Economic considerations** include a realistic estimate of whether finance for the project incorporates climate resilience as a critical element of project planning. Funding agencies, implementing agencies, and users should collaborate on project planning that is flexible enough to integrate innovative financing options to hedge against short- and long-term uncertainty.

Policymakers, implementing agencies, vendors, and funding agencies can build resilient structures by integrating these considerations well before the design stage. System design and operation during the lifetime of the infrastructure, when based on climate and other risk assessments, can increase the installation's lifespan and reduce downtime and avoid failures. Policies, financial instruments, and design standards can reinforce the resilient design and management of infrastructure.

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Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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