

Derisking Renewable Energy Investment: Off-Grid Electrification

A Framework to Support Policymakers
in Selecting Public Instruments to Promote
Private Investment in Solar PV-Battery
Mini-Grids in Developing Countries

EXECUTIVE SUMMARY & DERISKING TABLE



Empowered lives.
Resilient nations.

UNDP partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. On the ground in nearly 170 countries and territories, we offer global perspective and local insight to help empower lives and build resilient nations.

United Nations Development Programme
304 East 45th Street
New York, NY 10017 USA
www.undp.org

ETH zürich

Founded in 1855, today ETH Zurich is one of the world's leading research universities. ETH Zurich has more than 20,000 students from over 120 countries, including 4,000 doctoral students. About 500 professors currently teach and conduct research in engineering, architecture, mathematics, natural sciences, system-oriented sciences, as well as management and social sciences. The Energy Politics Group (EPG) forms part of ETH Zurich's Department of Humanities, Social and Political Sciences and in its research centres on questions related to the governance of technological change in the energy sector.

ETH Zurich, Energy Politics Group
Haldeneggsteig 4
CH-8092 Zurich, Switzerland
www.epg.ethz.ch

Authors (UNDP): Oliver Waissbein, Hande Bayraktar and Christoph Henrich.

Authors (ETH Zurich): Tobias S. Schmidt and Abhishek Malhotra.

Contributors: Marcel Alers (UNDP), Léonore Haelg (ETH), Claire Jin (UNDP, intern) and Usha Rao (UNDP).

External reviewers: Subhes Bhattacharyya, Courtney Blodgett, Sagar Gubbi and Hisham Zerriffi.

Acknowledgments: UNDP and ETH Zurich would like to thank the mini-grid developers and investors, and other stakeholders, in Uttar Pradesh, India and Kenya who participated in structured and informational interviews for the illustrative case studies. The authors would also like to thank the external reviewers for their valuable comments and inputs.

This publication builds on the original *Derisking Renewable Energy Investment* (UNDP, 2013) report, which established the methodology which has now been tailored to solar PV-battery mini-grids in this publication. For further information, please visit undp.org/DREI

Disclaimer: The views expressed in this publication are those of the authors and do not necessarily represent those of the UN, including UNDP, or UN Member States.

This report should be referenced as: UNDP & ETH Zurich (2018). *Derisking Renewable Energy Investment: Off-Grid Electrification*. United Nations Development Programme, New York, NY and ETH Zurich, Energy Politics Group, Zurich, Switzerland.

Design: Camilo J. Salomon (camilo.salomon@optonline.net, www.cjsalomon.com)

December 2018, New York & Zurich



This document is an abbreviated version of the full report, and is composed of the following:

- Acronyms
- Executive Summary
- Derisking Table for Solar Mini-Grids

The full report is available at www.undp.org/DREI

Acronyms

ARPU	Average revenue per user
BAU	Business-as-usual
BDA	Business development advisor
BNEF	Bloomberg New Energy Finance
BOO	Build-own-operate
CAPEX	Capital expenditure
CO₂	Carbon dioxide
DC	Direct current
DFI	Development finance institution
DREI	Derisking Renewable Energy Investment
ECN	Energy Research Centre of the Netherlands
EPC	Engineering, procurement and construction
ESMAP	Energy Sector Management Assistance Program
F/X	Foreign exchange
FDI	Foreign direct investment
FY	Financial year
GDP	Gross domestic product
GCF	Green Climate Fund
GEF	Global Environment Facility
GIS	Geographic Information System
GHG	Greenhouse gas
GTF	Global Tracking Framework
GW	Gigawatt
HDI	Human Development Index
ICT	Information and communication technology
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPP	Independent power producer
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LCOE	Levelised cost of electricity

LCD	Liquid crystal display
LED	Light-emitting diode
LIC	Low-income country
MECE	Mutually Exclusive, Collectively Exhaustive
MG	Mini-grid
MTF	Multi Tier Framework (on electricity access)
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NREL	National Renewable Energy Laboratory
O&M	Operations and maintenance
ONSSET	Open Source Spatial Electrification Toolkit
OM	Operating margin
OPEX	Operational expenditure
PAYG	Pay-as-you-go
PPA	Power purchase agreement
PPP	Purchasing power parity
PRI	Political risk insurance
PV	Photovoltaic
RE	Renewable energy
SDG	Sustainable Development Goal
SEforAll	Sustainable Energy for All
SHS	Solar home system
TPO	Third party ownership
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UP	Uttar Pradesh
USD	United States Dollar
VAT	Value-Added Tax

Executive Summary

The objective of this report is to support policymakers in identifying cost-effective public instruments to promote private investment in solar PV-battery mini-grids in developing countries.

This report expands UNDP's existing *Derisking Renewable Energy Investment* (DREI) framework (UNDP, 2013) to solar mini-grids. The report introduces methodological concepts and tools, including an open source Excel-based LCOE tool, and then sets out the results of two illustrative case studies in Uttar Pradesh, India and in Kenya. This report has been prepared by UNDP in collaboration with ETH Zurich.

Opportunity for off-grid renewable energy

Worldwide, around 1 billion people currently lack access to electricity as of 2016 (WB, 2018; IEA, 2017), of which 87% live in rural areas (WB, 2018). Electrifying this population can pay huge dividends in terms of human development.

A real opportunity exists in the coming years to meet this challenge with private sector solutions for off-grid renewable energy, either via solar photovoltaic (PV)-battery mini-grids (solar mini-grids) or solar home systems (SHS). Three key trends are converging behind this opportunity: first, continued reductions in hardware costs – in solar modules, batteries and energy efficient appliances; second, a digital revolution, with mobile communication technology facilitating payments and monitoring, as well as new fintech solutions (for example, end-user credit assessment); and third, innovation in business models, such as pay-as-you go (PAYG) and third-party ownership for solar home systems, which offer energy as a service, and can remove previously prohibitive up-front costs for households.

A remaining challenge is to increase investment from current levels. If universal electrification is to be achieved by 2030, it is estimated that USD 52 billion in annual investment will be needed (IEA, 2017). In solar mini-grids, nearly all current investment is financed through grants and non-commercial, patient equity. In PAYG solar home systems, financing is further advanced, and tier 1 companies are now beginning to access debt, albeit often at favourable, not fully commercial terms. If off-grid electrification is to truly scale, there is a need to access commercial debt financing at large volumes. In the longer term, developing domestic, local-currency sources of financing – to avoid foreign exchange risk – will also be key.

In a private-sector led, fast-moving context, government efforts to support such off-grid renewable energy solutions have often, to date, been lagging. Private sector actors often express indifference with current regulations, and point to burdensome or poorly-formulated public measures. This report seeks to specifically address this policy gap for solar mini-grids, providing policymakers with guidance on implementing systematic, well-designed public instruments – seeking to intelligently support and grow the sector as it evolves into a mature market.

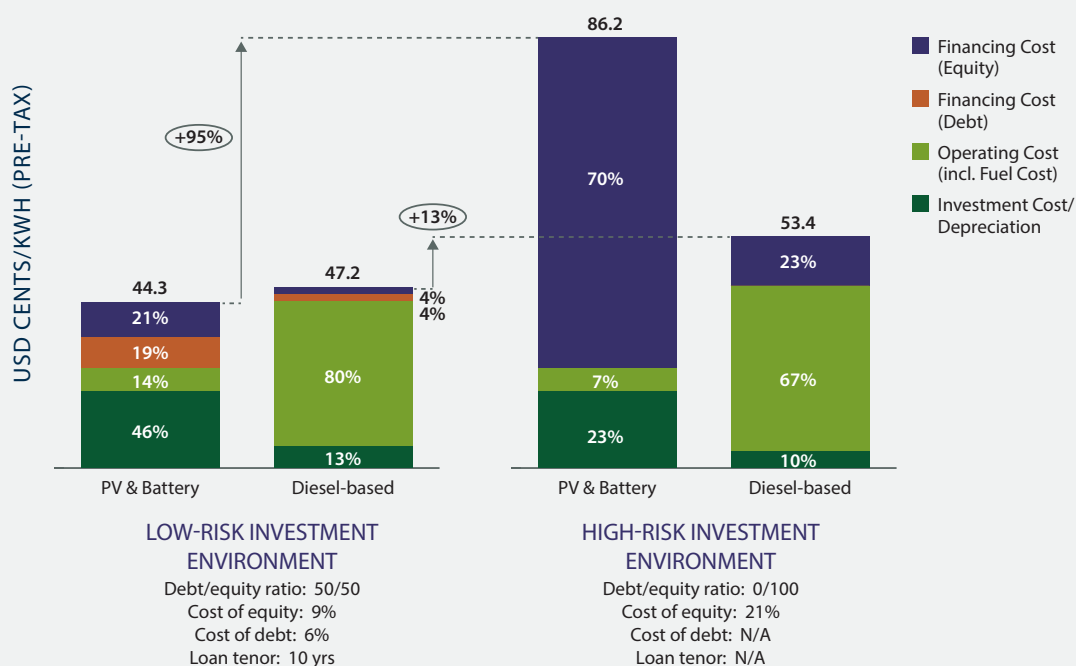
“If universal electrification is to be achieved by 2030, it is estimated that USD 52 billion in annual investment will be needed.”

DREI framework for solar mini-grids

A central focus of the *Derisking Renewable Energy Investment* (DREI) framework described in this report is on private sector financing costs – an investment's capital structure, and investors' required return on equity and debt. As illustrated in Figure E.1, due to their capital intensity, solar mini-grids are penalized in high financing cost environments. Developing countries often exhibit high financing costs for renewable energy due to investment risks that can exist in early-stage markets. An opportunity is for policymakers to systematically address these investment risks, lowering financing costs and leading to competitive investment.

“Due to their capital intensity, solar mini-grids are penalized in high financing cost environments.”

Figure E.1: Impact of financing costs on solar PV-battery and diesel-powered mini-grids' generation cost in low and high-risk investment environments¹



Source: Authors' modelling.

There are both public and private strategies to address investment risks. The DREI framework is concerned with public strategies, and identifies three central ways – often used in combination – that the public sector can improve the risk-return profile of private sector investment opportunities:

“Public instruments

预览已结束，完整报告链接和二维码如下：

https://www.yunbaogao.cn/report/index/report?reportId=5_11804

