CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

iied
International Institute for Environment and Development

POLICIES TO SPUR ENERGY ACCESS: VOLUME 2

CASE STUDIES OF PUBLIC-PRIVATE MODELS TO FINANCE DECENTRALIZED ELECTRICITY ACCESS

Neha Rai, International Institute for Environment and Development (IIED)
Terri Walters, National Renewable Energy Laboratory (NREL)
Sean Esterly, NREL
Sadie Cox, NREL
Maliha Muzammil, University of Oxford
Tasfiq Mahmood, International Centre for Climate Change and Development
Nanki Kaur, IIED
Lidya Tesfaye, Echnoserve Consulting
Simret Mamuye, Echnoserve Consulting
James Knuckles, Cass Business School
Ellen Morris, Columbia University
Merijn de Been, Delft University of Technology
Dave Steinbach, IIED
Sunil Acharya, Digo Bikas Institute
Raju Pandit Chhetri, independent policy researcher
Ramesh Bhushal, independent policy researcher

Technical Report
NREL/TP-7A40-64460
September 2015

Executive Summary PDF	Volume 1 PDF	Volume 2 PDF

CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

iied
International Institute for Environment and Development

POLICIES TO SPUR ENERGY ACCESS: VOLUME 2

CASE STUDIES OF PUBLIC-PRIVATE MODELS TO FINANCE DECENTRALIZED ELECTRICITY ACCESS

Neha Rai, International Institute for Environment and Development (IIED)
Terri Walters, National Renewable Energy Laboratory (NREL)
Sean Esterly, NREL
Sadie Cox, , NREL
Maliha Muzammil, University of Oxford
Tasfiq Mahmood, International Centre for Climate Change and Development
Nanki Kaur, IIED
Lidya Tesfaye, Echnoserve Consulting
Simret Mamuye, Echnoserve Consulting
James Knuckles, Cass Business School
Ellen Morris, Columbia University
Merijn de Been, Delft University of Technology
Dave Steinbach, IIED
Sunil Acharya, Digo Bikas Institute
Raju Pandit Chhetri, independent policy researcher
Ramesh Bhushal, independent policy researcher

Technical Report
NREL/TP-7A40-64460
September 2015

NOTICE

This manuscript has been authored by employees of the Alliance for Sustainable Energy, LLC ("Alliance") under Contract No. DE-AC36-08GO28308 with the U.S. Department of Energy ("DOE").

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Available electronically at SciTech Connect http:/www.osti.gov/scitech

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
OSTI http://www.osti.gov
Phone: 865.576.8401
Fax: 865.576.5728
Email: reports@osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
NTIS http://www.ntis.gov
Phone: 800.553.6847 or 703.605.6000
Fax: 703.605.6900
Email: orders@ntis.gov

Authors

This report was produced jointly by the Clean Energy Solutions Center through staff at the National Renewable Energy Laboratory (NREL) and the International Institute for Environment and Development (IIED) with additional contributions by many international experts. The following were instrumental in the development of this report:

Report Authors

Terri Walters (NREL), Neha Rai (IIED), Sean Esterly (NREL), Sadie Cox (NREL), and Tim Reber (NREL)

Case Study Authors

Bangladesh	Neha Rai (IIED), Maliha Muzammil (University of Oxford), Tasfiq Mahmood (International Centre for Climate Change and Development)
Ethiopia	Nanki Kaur (IIED), Lidya Tesfaye and Simret Mamuye (Echnoserve Consulting)
Mali	James Knuckles (Cass Business School)
Mexico	Ellen Morris, Ph.D. (Columbia University, School of International and Public Affairs and Sustainable Energy Solutions), and Merijn de Been (Industrial Design Engineering, Delft University of Technology)
Nepal	Dave Steinbach (IIED), Sunil Acharya (Digo Bikas Institute), Raju Pandit Chhetri (independent policy researcher), Ramesh Bhushal (independent policy researcher)

Contributing Authors

Yasemin Erboy Ruff and Jem Porcaro (United Nations Foundation), Boris Lopicich (NGO Innovation, Development & Equity) for India information, David Lovullo (NREL)

Acknowledgments

The authors would like to acknowledge the support and reviews from Emma Wilson (IIED), Christine Eibs-Singer (SE4ALL), Philip LaRocco (Columbia University), Ron Benioff (NREL), Victoria Healey, (NREL), Ian Lloyd (U.S. Department of Energy [DOE]), Caroline McGregor (DOE), Rose Mutiso (DOE), and Sam Booth (NREL). UK Aid was instrumental in funding and making available over 80 interviews in Nepal, Ethiopia, and Bangladesh for use in the case studies in this report.

Suggested Citations

Entire Report

Terri Walters, Neha Rai, Sean Esterly, Sadie Cox, and Tim Reber. 2015. "Policies to Spur Energy Access." Golden, CO: National Renewable Energy Laboratory.

Volume 2

Rai, Neha, Terri Walters, Sean Esterly, Sadie Cox, Maliha Muzammil, Tasfiq Mahmood, Nanki Kaur, Lidya Tesfaye, Simret Mamuye, James Knuckles, Ellen Morris, Merijn de Been, Dave Steinbach, Sunil Acharya, Raju Pandit Chhetri, and Ramesh Bhushal. 2015. "Policies to Spur Energy Access: Volume 2: Case Studies of Public-Private Models to Finance Decentralized Electricity Access." Golden, CO: National Renewable Energy Laboratory.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

About this Report

This report was written to support policymakers who want to accelerate energy access by engaging private sector participants in developing countries or regions. It focuses on **electricity access**; for the purposes of this report, the term "energy access" refers to access to electricity and related services rather than cooking fuels or technologies. The report focuses on the use of **distributed** (or decentralized) electricity options rather than grid extension. While its primary focus is off-grid energy access, it also offers policy information for including distributed electricity as part of the grid.

These policy issues are complicated and many issues are interrelated. The authors would like to remind readers that the Clean Energy Solutions Center offers governments access to expert assistance on these and other clean energy policy issues at no cost. More information is available at cleanenergysolutions.org/expert.

The report consists of an executive summary and two volumes that cover three types of information. The volumes can be read in conjunction with each other, or they can be read separately. The executive summary covers both Volume 1 and Volume 2.

Volume 1: Engaging the Private Sector in Expanding Access to Electricity

Section 1—Basics of Distributed Electricity Access
Intended to provide background to those new to off-grid energy access, Section 1 of this volume provides a brief rationale for why governments should consider prioritizing distributed electricity access. It discusses the benefits of accelerating access and the role that small and medium-sized enterprises (SMEs) can play in providing those services. After highlighting barriers that SMEs face in engaging in energy access, this section introduces the role of government in opening these markets.

Section 2—Policies for Decentralized Energy Access Markets
Drawing from a wide range of existing programs and reports, this overview describes the key policies that countries are using to enable the development of the off-grid energy access market. Experience has shown that a holistic policy approach is most successful in fostering small and medium-sized enterprises to provide energy services to rural customers. This section addresses the government's role in each element of the market—from energy regulations to finance options and from business support to worker training. It also discusses the role of various ministries in expanding energy access and approaches for integrated actions across agencies and levels of government. Policies in this section are highlighted with real-world examples and emerging good practices, drawing on the case studies presented in Volume 2 and other examples from the literature.

Volume 2: Case Studies of Public-Private Models to Finance Decentralized Electricity Access

Volume 2 uses case studies to examine five different models for off-grid energy access around the world, including Bangladesh, Ethiopia, Mali, Mexico, and Nepal. Each study examines a program, policy, or innovations in a market, and each case study assesses the policy decisions that led to the current market and their impact on SMEs in distributed energy access.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
AEPC	Alternative Energy Promotion Centre (Nepal)
AMADER	Malian Agency for the Development of Domestic Energy and Rural Electrification
BCCRF	Bangladesh Climate Change Resilience Fund
CFE	Federal Electricity Commission (Mexico)
CGRE	climate resilient green economy strategy (Ethiopia)
CONACYT	National Council of Science and Technology (Mexico)
COPLADE	Planning Commission for Social and Economic Development of Oaxaca (Mexico)
CREE	Regulatory Commission for Electricity and Water (Mali)
CREF	Central Renewable Energy Fund (Nepal)
CSR	corporate social responsibility
DBE	Development Bank of Ethiopia
DDC	District Development Committee (Nepal)
DFID	Department for International Development (United Kingdom)
DNE	National Energy Directorate (Mali)
ECAE	Ethiopian Conformity Assurance Enterprise
EDM	Énergie de Mali (Mali state-owned utility)
EE	energy efficiency
EEA	Ethiopian Energy Authority
EEP	energy efficient program (Ethiopia)
EEPCo	Ethiopian Electric Power Cooperation
FI	financial institution
GEF	Global Environmental Facility
GIZ	German Technical Cooperation Agency
GPOBA	Global Partnership on Output Based Aid
GTP	Growth and Transformation Plan (Ethiopia)
ICS	improved cook stove
ICS	inter-connected transmission system
IDB	Islamic Development Bank
IDCOL	Infrastructure Development Company Limited (Bangladesh)
IPP	independent power producer
JICA	Japan International Cooperation Agency
kWp	kilowatt peak
LAERFTE	Law for the Development of Renewable Energy and Energy Transition Financing (Mexico)
MDRE&EEP	Market Development for Renewable Energy and Energy Efficiency Programme (Ethiopia)
MFI	microfinance institution
MoFED	Ministry of Finance and Economic Development (Ethiopia)
MoSTE	Ministry of Science, Technology and Environment (Nepal)
MoU	memorandum of understanding
MoWIE	Ministry of Water, Irrigation and Energy (Ethiopia)

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

NEP	National Energy Plan (Ethiopia)
NGO	nongovernmental organization
NRECA	National Rural Electric Cooperative Association (United States)
NRREP	National Rural Renewable Energy Programme (Nepal)
OBWME	Oromia Bureau of Water, Mines and Energy (Ethiopia)
OCSSCO	Oromia Credit and Saving Share Company (Ethiopia)
OECD	Organization for Economic Cooperation and Development
PCASER	spontaneous project application for rural electrification (Mali)
PEA	political economy analysis
PFEA	Public Financial Enterprises Agency (Ethiopia)
PSE	private sector enterprise
PV	photovoltaics
RE	renewable energy
REDA	Renewable Energy Development Agency (Bangladesh)
RSP	regional service provider
S&T	science and technology
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (Mexico)
SCS	self-contained systems
SE4All	Sustainable Energy for All initiative (United Nations)
SEDESOH	Oaxaca State Department of Social Development (Mexico)
SEMARNAT	Secretariat of Environment and Natural Resources (Mexico)
SENER	Secretariat of Energy (Mexico)
SHCP	Secretariat of Finance and Public Credit (Mexico)
SHS	solar home system
SIP	solar irrigation pump
SME	small and medium enterprises
SRBO	Senegal River Basin Organization
SREDA	Sustainable and Renewable Energy Development Authority (Bangladesh)
SREP	Scaling Up Renewable Energy Programme (Nepal)
STyDE	Secretary of Tourism and Development (Mexico)
TSC	Technical Standards Committee (Bangladesh)
TWh	terawatt-hour
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VDC	Village Development Committee (Nepal)
Wp	watt-peak
ZEM	multisectoral electrification zones (Mali)

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table of Contents

1 Introduction ... 1
2 Bangladesh: A Case of the Infrastructure Development Company Limited ... 2
2.1 Country Context ... 4
2.2 Key Agencies and Actors ... 7
2.3 Program Overview: IDCOL's Delivery Model ... 8
2.4 Policies and Actions to Support Energy Access ... 13
2.5 Challenges ... 20
2.6 Lessons Learned ... 20
2.7 Additional Information: Central Bank of Bangladesh's Green Financing Scheme ... 22
2.8 References ... 25
3 Ethiopia: Financing of Inclusive Investment in Off-Grid Renewable Energy ... 26
3.1 Country Context ... 28
3.2 Key Agencies and Actors ... 29
3.3 Program Summary ... 32
3.4 Policies and Actions to Support Energy Access ... 39
3.5 Challenges ... 41
3.6 Lessons Learned ... 41
3.7 References ... 43
4 Mali: Programs to Support Private Minigrids for Rural Electrification ... 44
4.1 Country Context ... 47
4.2 Key Agencies and Actors ... 50
4.3 Program Overview ... 50
4.4 Policies and Actions to Support Energy Access ... 53
4.5 Challenges ... 59
4.6 Lessons Learned ... 60
4.7 References ... 61
5 Mexico: Provision of Solar Power for Households in Rural Communities Through Iluméxico ... 65
5.1 Country Context ... 67
5.2 Key Agencies and Actors ... 67
5.3 Project Summary ... 68
5.4 Policies and Actions to Support Energy Access ... 71
5.5 Challenges ... 76
5.6 Lessons Learned ... 76
5.7 References ... 78
6 Nepal: The Experience of the Alternative Energy Promotion Centre and the National Rural Renewable Energy Programme ... 79
6.1 Country Context ... 82
6.2 Key Agencies and Actors ... 82
6.3 Program Summary ... 83
6.4 Policies and Actions to Support Energy Access ... 86
6.5 Lessons Learned ... 90
6.6 Additional Information: Interview Findings for Key Energy Access Topics ... 93
6.7 References ... 96
7 Conclusion ... 97

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

List of Figures

Figure 1. Key policies and actions in the context of the energy access framework 3
Figure 2. Renewable energy policy context 6
Figure 3. Actors in the renewable energy landscape of Bangladesh 8
Figure 4. Actors in IDCOL's financing supply chain 9
Figure 5. Implementation arrangement of SHS program 11
Figure 6. Credit wholesaling through NGO linkage..... 23
Figure 7. Use of Central Bank's refinancing funds for green investments, by category from 2009 to 2014 24
Figure 8. Key policies and actions in the context of the energy access framework 27
Figure 9. Actors in the RE landscape in Ethiopia..... 32
Figure 10. Key policies and actions in the context of the energy access framework 44
Figure 11. Map of Mali 47
Figure 12. Timeline of energy sector milestones in Mali..... 49
Figure 13. Key policies and actions in the context of the energy access framework 66
Figure 14. Evolution of Iluméxico 69
Figure 15. ILUCentros Locations..... 70
Figure 16. Key policies and actions in the context of the energy access framework 80
Figure 17. Political economy analysis..... 81
Figure 18. Financial flows under the NRREP 85
Figure 19. The climate finance landscape of RE investment in Nepal..... 86

List of Tables

Table 1. Summary of Case Studies by Program Type..... 1
Table 2. Mode of Financing Example 12
Table 3. Phase-Out Subsidy (USD)[a]..... 13
Table 4. Drivers of Investment in Decentralized Energy in Bangladesh, by Stakeholder Category.... 15
Table 5. Drivers for Selecting Specific Intermediaries and Instruments..... 17
Table 6. Actors' Views on how the Public Sector is Effective in Enabling Energy Access for Poor in Bangladesh..... 19
Table 7. The Development Bank of Ethiopia 34
Table 8. Financial and Market Development Needs of Actors in the RE Investment Landscape..... 35
Table 9. Policy Choices in the Financial Landscape 37
Table 10. Incentives Shaping Choices in the Financial Landscape..... 40
Table 11. Costs of Grid Extension in Mali Compared to Kenya and Senegal 48
Table 12. Financial and Market Development Needs to Encourage Rural Energy Access..... 93
Table 13. Drivers of Investment in Rural Energy 94
Table 14. Effectiveness of the NRREP in Promoting Rural Energy Access..... 95

List of Text Boxes

Text Box 1. Mali—An Overview of Minigrids..... 46

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

1 Introduction

Access to energy continues to remain a challenge for many, as a large portion of the developing world resides in rural and remote areas where supplies of grid-based electricity remain a challenge. The public sector has played a crucial role in expanding energy services in areas that the private sector may find less commercially viable. In some cases, this role is facilitated by creating opportunities for the private sector to engage in decentralized energy distribution. Such opportunities include policy reforms that enable a foundation for decentralized energy, establish dedicated institutions that can effectively deliver finance, or develop business models and incentives that can catalyze new players to engage in decentralized energy markets.

This is the second part of a two-volume report on "policies to spur energy access" in developing countries. Drawing from a wide range of literature and case studies, the first volume summarizes a range of policy options that are instrumental in expanding energy access markets. This volume identifies a number of public sector innovations for financing decentralized energy through case studies of five different models for off-grid energy access in developing countries. Each case analyzes an innovative policy, program, or entity that has been instrumental in spurring energy access through small and medium-sized enterprises (SMEs). These cases also analyze policy drivers and programs that catalyzed financing to various actors in these distributed energy access markets. The cases are summarized in Table 1.

Table 1. Summary of Case Studies by Program Type

Country	Type of Program
Bangladesh	Infrastructure Development Company Limited providing decentralized energy through solar home systems and solar irrigation pumps
Ethiopia	Development Bank of Ethiopia financing inclusive investment in off-grid renewable energy
Mali	Programs to support private mini-grids in rural electrification
Mexico	Provision of solar power for households in rural off-grid communities
Nepal	Experience of Alternative Energy Promotion Centre and the National Renewable Energy Programme in Nepal

Our analysis show that across the case studies, developing country governments have deployed a wide range of policies, actors, instruments, and financing modalities to catalyze private sector investments in decentralized energy. Each country has established a strong policy foundation to plan, coordinate, and regulate decentralized energy. For example, Bangladesh and Ethiopia have focused on aligning electrification goals with renewable energy and climate related targets. Regulations in Mali and Mexico have encouraged tariff design that enables cost-effective distributed energy. Besides policy support, countries have strengthened capacities of players in a relatively new space. Governments have played a major role in developing entrepreneurial markets around decentralized energy in Mexico, Ethiopia, and Bangladesh. While governments continue to play an important role in incentivizing energy access markets in developing countries, the examined programs also emphasize a need for stable and continued public support to catalyze a long-term impact in access to electricity services. This volume further analyzes these barriers and constraints in each of the programs examined in the five countries.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2 Bangladesh: A Case of the Infrastructure Development Company Limited

Case study prepared and written by Neha Rai, Maliha Muzammil, and Tasfiq Mahmood

Nearly 40% of Bangladesh's population does not have access to the electricity grid and almost 15 million rural households still use kerosene lamps to light their homes. As a government owned financial institution, the Infrastructure Development Company Limited (IDCOL) was set up to encourage private investment in infrastructure and renewable energy in Bangladesh (Nazmul Haque, pers. comm. 2014). Some of IDCOL's initiatives include a solar home system (SHS) program, domestic biogas program, solar irrigation pump (SIP) program, solar minigrid, solar powered telecom, biogas based electricity project, biomass gasification project, and the improved cook stove program (Islam 2014).

This case study explores how IDCOL's SHS program leverages donor and public funds to engage private stakeholders and households in expanding energy access. In Bangladesh, there has been a rapid increase in the uptake of solar home systems in recent years. The SHS program has grown to be one of the largest off-grid electrification initiatives in the world (Khandker et al. 2014). Starting in 2003, the SHS program quickly outpaced its target of 50,000 units, to be achieved in 5 years, within a month, and it had installed three million units by 2014 (Khandker et al. 2014).

IDCOL's business model for the SHS program has been particularly successful because it combines price support with quality assurance, installation, and after-sales support (Khandker et al. 2014). It relies heavily on the private sector to manage projects and ensure access to and maintenance of solar home systems.

Having learned from the success of the SHS program, the government of Bangladesh also launched a Solar Irrigation Pump program through IDCOL to expand access to solar powered irrigation in off-grid areas (BCCRF 2013). The SIP program is closely linked to the government's objectives for food security and climate change mitigation, and it has set an initial target to install 1,550 solar irrigation pumps by 2017.

A final section of this case study (Section 2.7) contains a separate examination of the Bangladesh Bank regulations that channel finance for renewable energy investments. The Bangladesh Bank, a central bank, was established to manage the country's monetary and credit system. The bank plays a regulatory role and a licensing role with all financial intermediaries, commercial banks, and financial institutions within the country, including the regulation of IDCOL.

Actions and policies implemented by the government of Bangladesh and the Central Bank of Bangladesh also align with the key policy areas for energy access presented in Volume 1, Section 2 of this report, and they are highlighted in Figure 1.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Figure 1. Key policies and actions in the context of the energy access framework

The Bangladesh case study also provides a number of key lessons that can be applied to energy access efforts in other countries, including:

- **A strong policy foundation can result in incentives for stakeholders along the value chain**. Policy incentives at a higher level will trigger incentives and interests at the intermediary level, at the private small and medium enterprises (SMEs) and microfinance institutions (MFIs) levels, and finally at the beneficiary level.
- **An innovative, integrated, and holistic financing model can create win-win opportunities for all stakeholders in the value chain**. For example, IDCOL offers an entire SHS package that incentivizes market creation, creating delivery networks, access to capital, quality assurance, after-sales service, training and institutional strengthening support for partnering organizations, and SMEs.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- **Knowledge of the demand of SHS in off-grid areas has been a key reason for the exponential increase in supply of the systems**. Funders were made aware of the large demand for SHS, as well as the benefits, helping to reduce perceived risks.
- **IDCOL's transparent and accountable system,** enhanced by its Technical Standards Committee (which provides approval to suppliers), the partner organization (PO) selection committee responsible for selecting partnering organizations, and the monitoring and inspection team that reviews the reports from the PO, has been essential in gaining increased support from the donors over the years.
- **Increased support from donors can help with outreach to the poor, market development, and catalyzing finance for smaller players**. Grants and subsidized credit have been crucial within the IDCOL model to make the renewable products affordable for the poorer beneficiaries. Grants, low-interest loans, and microcredit arrangements also unlock finance for small-scale enterprises that have difficulty accessing finance from commercial markets.
- **Financing instruments used in a sequential model can help in developing a long-term sustainable financing structure that remains viable**. A phase-out subsidy model and a concessionary to semi-commercial credit have helped in the transition to a more sustainable financing arrangement once the market is developed.

This case study uses the Climate Finance Landscape Framework (adapted from Climate Policy Initiative) to analyze design choices aimed at delivering appropriate finance for investment in energy access for the poor (Buchner et al. 2013). This framework focuses on the role of financial intermediaries, financial instruments, and financial planning systems in mobilizing and channeling appropriate finance for inclusive investment in energy access.

A case study approach is used to understand the role of IDCOL in delivering appropriate finance for investment in renewable energy for the poor. This report specifically studies the IDCOL Solar Home System program. The data for this case draws from nearly 25 interviews conducted in Bangladesh and a document review.[1]

This case study is based on a political economy analysis (PEA) to understand the financial needs, design choices, and incentive structures that shape policy articulation and delivery of off-grid renewable energy technology in Bangladesh (Rai et al. 2015a).

2.1 Country Context

Bangladesh has developed a diverse set of policies to encourage energy access, the most recent of which is the government of Bangladesh's vision to ensure 'Electricity for all by 2021' (Power Division 2013). Only 62% of the total population has access to electricity and

[1] The evidence for this study is generated from a wider study on "Financing Inclusive Low-Carbon Resilient Development" in Bangladesh, Ethiopia, Nepal, and Rwanda. The Bangladesh case study draws evidence from approximately 25 interviews with a wide range of actors engaged in the value stream of financing decentralized energy in the country (Rai et al. 2015b).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

generation per capita is one of the lowest in the world (321 kWh per annum) (Islam 2014). Up to 70% of Bangladesh's total commercial energy is provided by natural gas and the remainder by imported oil. Natural gas is in short supply, which is another reason the government is keen to push the renewable energy agenda. Access to electricity is a major input in trying to achieve the Millennium Development Goals for Bangladesh (Khandker et al. 2014).

Renewable Energy Policy Objectives

- Harness the potential of renewable energy resources and encourage spread of renewable energy technologies in rural, peri-urban, and urban areas
- Enable, encourage, and facilitate both public and private sector investment in renewable energy projects
- Develop sustainable energy supplies to substitute indigenous non-renewable energy supplies
- Scale up contributions of renewable energy both to electricity and to heat energy
- Promote appropriate, efficient, and environmentally friendly use of renewable energy
- Create enabling environment and legal support to encourage the use of renewable energy
- Promote development of local technology in the field of renewable energy
- Promote clean energy for Clean Development Mechanism.

Source: Government of Bangladesh 2008

Bangladesh Policy Interventions

- Target is to generate 5% of electricity from RE sources by 2015 and 10% by 2020
- Fiscal incentives for investment in RE sector:
  - Tax holiday for 20 years
  - Reduced levies on import of RE technologies
  - Reduced taxes on local manufacturing/assembling of RE equipment's
- Private sector allowed generating electricity from RE sources and selling to utilities.

Targets for renewable technologies

- Target to finance 1,550 solar irrigation pumps by 2017
- Target set up in 2003 to install 50,000 units of SHS in five years

Source: Islam 2014

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

A dedicated renewable energy policy has been in place since 2009 (see Figure 2). The policy sets targets to generate 5% of electricity (800 MW) by end of 2015 and 10% of electricity by end of 2020 from renewable energy sources (Power Division 2013; Christian Aid 2014). Solar energy is expected to contribute about 500 MW of renewable electricity in order to achieve the 800 MW target by 2015.

Figure 2. Renewable energy policy context

The government of Bangladesh has prioritized efforts in the power sector according to the pledge of the election manifesto by the ruling party Awami League. Priority targets have been set for specific programs such as the solar home system program and a program to replace about 150,000 diesel and conventional electricity-run irrigation pumps with solar-powered pumps. In 2011, a Sustainable Energy Development Act was passed, which led to the creation of a policy institution to promote renewable energy within the country: the Sustainable and Renewable Energy Development Authority (SREDA).

The government has also created several financial incentives for investment in the renewable energy sector in Bangladesh, including tax holidays for 20 years, reduced duties and levies on import of renewable energy technologies, and reduced taxes on local manufacturing and assembling of renewable energy equipment (Islam 2014).

Feed-in tariffs and other incentives to attract foreign investments are being considered to encourage purchase of electricity from renewable energy sources. The government has permitted the private sector to generate electricity for short-term contracts from renewable sources and sell to chosen customers at a preferential tariff (Islam 2014). Concessional financing and capital buy-down grants are also available to promote renewable energy (Section 2.3.2 provides details on these financing mechanisms).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2.2 Key Agencies and Actors

Ministry of Power, Energy and Mineral Resource is mandated to manage all actions relating to rural and renewable energy.

In 1995, the National Energy Policy proposed that the government would set up a Renewable Energy Development Agency (REDA), but no progress was made before 2005. In 2005, the government changed its plans slightly and established the **Sustainable Renewable Energy Development Authority (SREDA)**, which focuses on increasing the generation and use of renewable energy (Uddin 2006).

Since its establishment, SREDA has provided support through capacity building and advisory services for public and private stakeholders. The SREDA Act was introduced to encourage consumers in Bangladesh to increase their use of energy efficient equipment (Power Division 2013). In addition to engaging suppliers and consumers, SREDA also supports the government by monitoring and accreting entities which promote and finance energy projects and supports public-private partnerships (PPP) (Power Division 2013:32).

SREDA is supported by the **Ministry of Power, Energy and Mineral Resources** as well as the **Ministry of Finance**. Administrative oversight and support to SREDA is provided by the energy ministry. The Ministry of Finance ensures SREDA has a sufficient budget by managing a "Pool Fund" that is supported by international co-operation. The Ministry of Finance also establishes renewable energy tax incentives and provides capacity building to financial institutions.

Bangladesh Central Bank is the primary regulator that manages the country's monetary and credit system. It regulates all financial and non-financial institutions within the country.

IDCOL is a non-banking financial institution established to catalyze the private sector within the renewable industry of Bangladesh. The agency is hosted within the Ministry of Finance although governed by independent boards of directors from the Ministry of Finance, the Ministry of Information and Communication Technology, and the Ministry of Power, Energy and Mineral Resources. Although IDCOL is regulated by the Central Bank of Bangladesh, it has long-standing experience of financing decentralized energy from donor-funded support that began long before the Central Bank introduced its green investment policies. Key actors in the Bangladesh renewable energy market are depicted in Figure 3.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

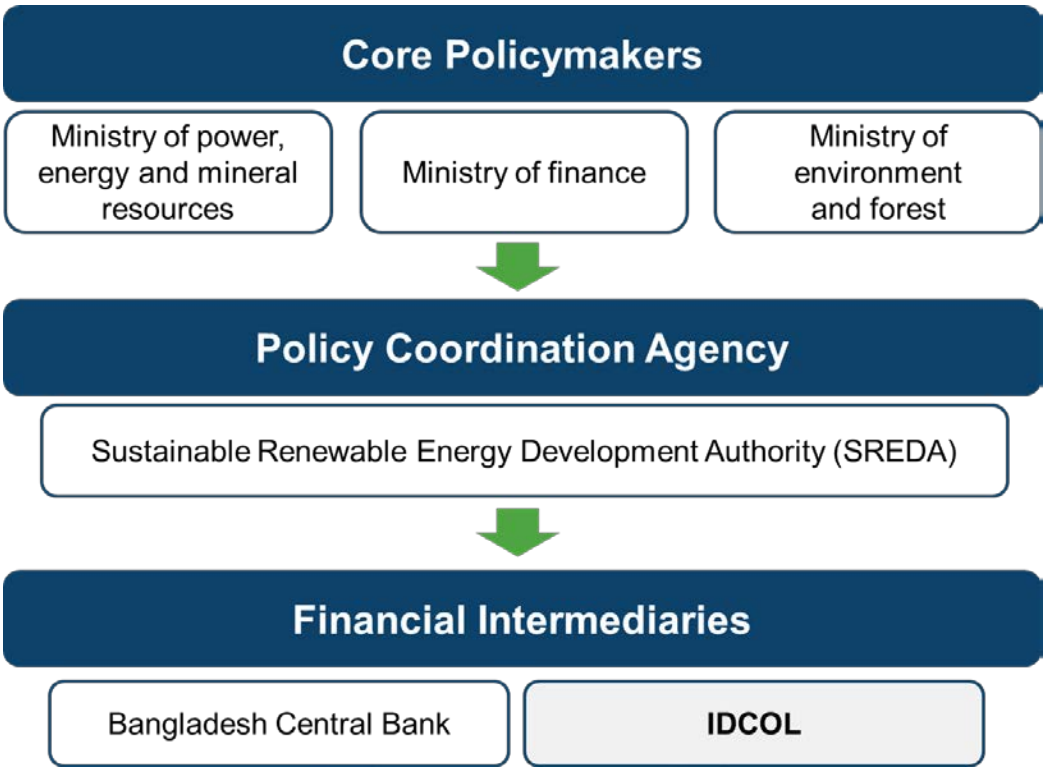

Figure 3. Actors in the renewable energy landscape of Bangladesh

This case study focuses on how the non-banking financial institution IDCOL played an important part in shaping the renewable energy landscape in Bangladesh by catalyzing investment in energy access projects. See Section 2.7 for a brief discussion of the emerging role of the Central Bank of Bangladesh in green investments and the green lending sector in Bangladesh.

2.3 Program Overview: IDCOL's Delivery Model

IDCOL is a government-owned financial intermediary mandated to provide long-term financing for private infrastructure projects. It works with development partners, suppliers of solar home systems, SMEs, and participating MFIs, which are considered partner organizations. IDCOL sets technical specifications, certifies products and components, and selects partner organizations (POs) based on clear eligibility criteria.

Vital factors contributing to the success of IDCOL's SHS Program are its delivery model and the availability and access to finance from the donors. By using a microcredit financing mechanism, poor households are able to access affordable energy services because they do not have to come up with upfront costs or pay for the operation and maintenance on their own.

Below we discuss IDCOLs role, funding sources and delivery models particularly in reference to the SHS program.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2.3.1 Intermediaries and Institutional Arrangement for Delivering IDCOL Projects

The supply chain through which IDCOL finances renewable energy (see Figure 4) involves bilateral and multilateral funding agencies providing loans and grants to the government of Bangladesh (for example, the Bangladesh Climate Change Resilience Fund [BCCRF]), which in turn provides loans and grants to IDCOL.

IDCOL is funded by multiple agencies, including the World Bank, the Asian Development Bank (ADB), the Islamic Development Bank (IDB), the Department for International Development (DFID), the Japan International Cooperation Agency (JICA), the KfW Group, Gesellschaft für Internationale Zusammenarbeit (GIZ), the Global Environmental Facility (GEF), United States Agency for International Development (USAID), and Global Partnership on Output Based Aid (GPOBA) (Islam 2014; IDCOL 2014).

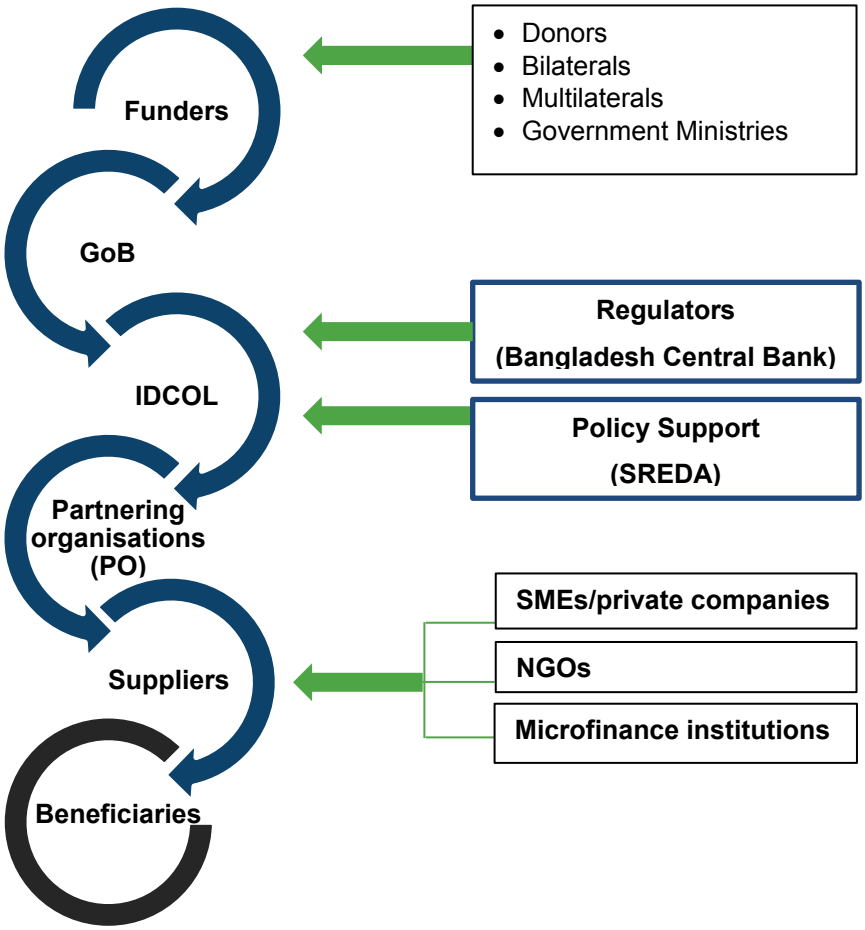

Figure 4. Actors in IDCOL's financing supply chain

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

IDCOL has a selection of 47 POs all over the country that are responsible for selling and installing solar home systems. POs include private SMEs, MFIs, and NGOs. POs, which have coverage and offices set up in rural areas along with experience in microcredit programs, have enabled wider energy access for the poor. Partnering organizations that have better coverage in rural areas can also ensure credit disbursement, credit collection, and after sales services.

IDCOL began as an urban financial institution with previous experience working on large-scale projects. When it diversified to off-grid renewable energy, it needed intermediaries to reach its largely rural target group for the solar home systems and irrigation pumps. Because Bangladesh has a good record and experience with the microcredit program and many of the MFIs have substantial coverage in rural areas, IDCOL chose the MFIs as intermediaries at the beginning of the project (Khandker et al. 2014). The MFIs are trained by IDCOL to conduct household assessments of energy needs and affordability, install the systems, and provide after sales services.

IDCOL recruits the POs, which are responsible for selecting potential SHS and SIP buyers in the off-grid areas, installing the systems, providing after sales service and maintenance, and developing a robust market chain (Khandker et al. 2014, 12). Another reason for success is the stringent screening by IDCOL's PO selection committee responsible for assessing the POs against the eligibility criteria for inclusion in the IDCOL program. IDCOL also sets the technical specifications of the products and certifies products and components (Khandker et al. 2014). IDCOL has a technical standards committee that approves the suppliers and the SHS equipment to be used (refer to Figure 4). IDCOL has developed an innovative and partially subsidized SHS delivery and financing system, which has proven to be very effective in unlocking credit for households and working capital for small-scale enterprises and suppliers all over Bangladesh. The SHS program has made systems affordable through a combination of consumer credit and (declining) subsidies (Khandker et al. 2014).

In order to keep the system process affordable, IDCOL provides the POs with capital buy-down grants; through market competition, the grants are passed on to household buyers in the form of a lower price. Buyers are also offered microcredit to make SHSs more affordable. All these incentives work together to create a market chain that ensures quality products that are affordable and locally serviceable (Khandker et al. 2014, 13).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

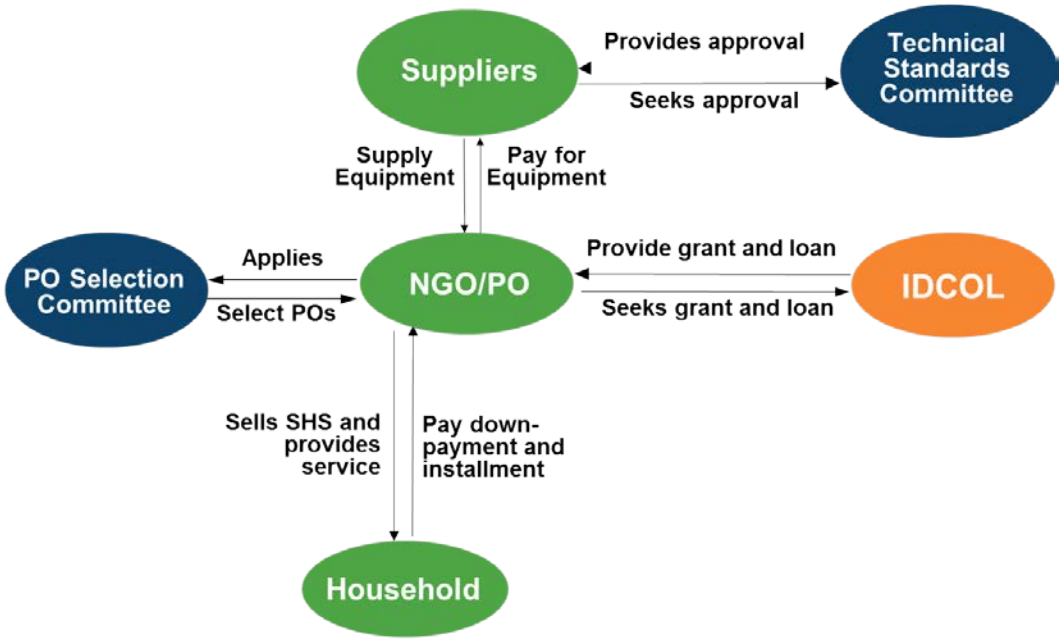

Figure 5. Implementation arrangement of SHS program

Source: Haque 2015

2.3.2 Financing Modality

IDCOL's financing model is a partial subsidy model and a refinancing model. The output-based subsidy and credit support seeks to ensure effective outreach and uptake on the ground. The delivery model works in a manner where households receive grants indirectly in the form of reduced unit price, as discussed in the steps below:

- **Households pay upfront cost:** If a household is interested in purchasing a SHS, they are required to make a minimum down payment of 10% of the system cost. The remaining 90% is financed by loan.
- **Households take microcredit from POs:** The 90% loan is available at the rate of 15%–20% per annum from the partnering organization.
- **POs sell and install the equipment:** On receipt of the down payment for the SHS, the POs enter into a sale/lease agreement and install the system furnished by the supplier. The systems must meet the specifications approved by the independent Technical Standards Committee (TSC) formed by IDCOL to approve quality equipment for the program.
- **PO creates an application for an output based subsidy or the refinancing scheme:** After the installation, the PO applies to IDCOL to receive refinancing of their loan as well as an applicable grant. IDCOL inspectors then carry out physical verification of the SHS installed. Based on satisfactory verification, IDCOL provides a grant to the POs and refinances 70%-80% of the loan amount extended to the households at a lower interest rate (Asaduzzaman et al. 2013).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- **IDCOL claims for loans from funders**: IDCOL then claims the loan funds used for refinancing from the World Bank, ADB, IDB, or JICA and the grant from GPOBA, GIZ, KfW, USAID, or DFID.
- **POs pays to the suppliers**: On receiving the funds from IDCOL, the PO pays back the suppliers.
- **The households receive after sales services once the system is installed:** Suppliers are expected to provide 20-year warranty for the panel, 5-year warranty for battery and 3-year for the charge controller. POs provide 3-year free after sales service and enter into yearly maintenance agreements with households. Quality assurance inspectors of IDCOL monitor the quality of SHS components and after sales service of POs.
- **Households become sole owners:** After the households pay off the loan, they become the sole owner of the system.

Table 2 provides an example of how the cost of one solar home system is distributed between IDCOL, PO (MFI), and the household.

Table 2. Mode of Financing Example

Financing for a Sample SHS	Terms
A) Market price of 20Wp SHS	USD 193
B) Buy-down grant	USD 20
C) System price for household [(A)-(B)]	USD 173
D) Down payment from households to PO [10% of (C)]	USD 17
E) PO loan to household [(C)-(D)]	USD 156
Loan tenor	3 years
Interest rate	15%–20% per annum
Monthly instalment amount	USD 5.40
F) IDCOL refinance [70%-80% of (E)]	USD 109-125
Loan tenor	5-7 years
Interest rate	6%-9% per annum

Source: Haque 2015

The subsidy has a positive impact on the price of the systems. Even though the subsidy is not directly given to the buyers, the purchasing households still receive part of the subsidy in the form of a lower price per unit (refer to Table 3 for figures on capital buy down subsidy, which has reduced over the years). Thus, subsidy trickles down making renewable energy affordable for the rural poor (Asaduzzaman et al. 2013).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 3. Phase-Out Subsidy (USD)[a]

	2003	2004–2005	2006–2007	2008–2009	2010–2011	2012	2013–2014
Capital buy-down grant	$70	$55	$40	$40	$25	$25	$20*
Institutional development grant	$20	$15	$10	$5	$3	-	-

[a] for small SHS (up to 30 Wp) only

Source: Haque 2015

Lack of financial services to cover SHS purchase is a serious holdup to adoption of SHS for the poorer rural households. The availability of the microcredit financing scheme along with the government's mandate to provide access to electricity for all by 2021 have allowed the system to grow.

Many banks are either unwilling to lend to the poor, perceiving them as high-risk, or charge exorbitant interest rates with a large down payment. Having IDCOL's support has allowed the MFIs to access the loans and in turn provide the poor with credit to buy the system and make payments over three years (Khandker et al. 2014, 20).

2.4 Policies and Actions to Support Energy Access

A wide range of incentives underpins the decisions to invest in decentralized renewable energy. Incentives, which can include policy, economic, and knowledge-based factors, can provide the support needed to invest. In this section, we explored what incentives drive investments in energy access projects, as well as the incentives that drive deployment of specific instruments and modalities. Our findings show how incentives at a higher policy level indirectly help create policy, economic, or other types of incentives for actors lower down the value chain.

2.4.1 Drivers to Invest in Renewable Energy Access Projects

The main driver for IDCOL to start investing in renewable projects was for commercial and developmental benefits. As a government-owned financial institution, IDCOL sought to achieve countrywide goals of rural electrification and meet the energy demand of the country. At the time when IDCOL was established, 60% of the country was out of the grid area. The commercial drivers included a large off-grid market for solar energy and available finance from donors who were keen to fund the programs.

IDCOL benefitted from concessional financing sources and technical assistance from the development partners. The agency was originally set up as a large-scale infrastructure development company, but as a developing country, most of the large infrastructure was still subsidized by the government. The government had limited subsidies to provide and, therefore, instead of going for highly subsidized, countrywide grid extension and reaching only a small number of people, the government decided to direct its subsidies to small-scale infrastructure so that it could reach the maximum number of people. Low carbon energy was not the purpose for any of these initiatives in the beginning, rather it was rural electrification

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

to meet the energy demand, and renewable development came about as a by-product (Nazmul Haque, pers. comm. 2014).

Public finance is also being used to invest in newer technologies such as solar irrigation pumps to reduce import costs of fuel used for traditional diesel-powered irrigation pumps. The government spends a significant amount on subsidies in the agriculture sector. It also spends about $100 on a barrel of diesel; reduced diesel imports would benefit the economy along with reduced carbon emissions and increased irrigation.

Most donors are now contributing to IDCOL's SHS program. The Global Environmental Facility (GEF) has been supporting the program since 2002 continues to support it. The funds from GPOBA, USAID, and KfW are pooled into the climate change funds such as the BCCRF, which IDCOL is able to access.

Different actors also had wide ranging incentives to invest in renewable energy (refer to Table 4):

- **Policymakers:** The primary objective of the government of Bangladesh was to increase access to electricity. It was therefore imperative for the government to invest in increasing access to electricity particularly in the rural areas. The government was also eager to reduce expensive diesel imports, subsidies in the agriculture sector, as well as reliance on expensive natural gas, which acted as a primary driver to shift to other diversified renewable sources. The policies and mandates acted as drivers for the government to encourage more widespread dissemination of the SHS and SIP systems. Energy targets set in the renewable energy policy were solidified by establishing more incentives that would have a knock-on effect in incentivizing other players in the value chain. A focal coordinating agency was therefore established to promote and develop renewable programs in the country. Fiscal incentives were introduced including reduced import tariffs as well as taxes on renewable energy products. Policies were established to encourage private sector investment in the power sector using the independent power producer (IPP) model.
- **Partnering Organizations:** POs include SMEs, NGOs, and MFIs that receive IDCOL support to invest in decentralized renewable energy markets. Grameen Shakti is one of the oldest success stories of SME financing under the IDCOL programs. The improved cook stove (ICS) programs is also a strong example where IDCOL and POs are working with 3900 SMEs who produce and sell ICS to households. The financing model of IDCOL provides some concrete incentives that drive SMEs, MFIs, and NGOs to invest in the renewables industry. Most of these are economic incentives that help POs to access low cost capital and an institutional grant that incentivizes them to deliver services in rural areas. For example, capital buy down grants and institutional grants helps them extend their lending reach in remote decentralized customers. Institutional development grant at the rate of $3 per system allows new POs to develop institutional capacity. The refinancing scheme with subsidized interest rates (6%) and long-term repayment tenure offers a strong commercial incentive for the POs to invest.
- **Suppliers**: Suppliers have an incentive to engage in the renewable energy market because of a package of incentives offered within the IDCOL delivery model. The

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

program helps in market creation by establishing a network of dealers. Policy and fiscal incentives such as tax holidays, exemptions, reduced duties and levies on import, and local production of renewable energy technologies also incentivize new suppliers and players to join the renewables industry.

- **Beneficiaries:** Access to the microcredit facility and buy down grants for small SHS products is the primary incentive for households and customers to invest. Beneficiaries have access to 90% of the cost of the SHS as finance through a microcredit facility. The credit terms help to keep the monthly instalments within the affordability range of rural consumers. The capital buy-down grant helps in reducing the cost of products (currently by US$20 per unit for system capacities below 30 watt-peak [Wp]).

Table 4. Drivers of Investment in Decentralized Energy in Bangladesh, by Stakeholder Category

Core Actors	Drivers to invest in energy access projects
Policymakers	**Social development incentive:** More than 40% people do not have access to grid electricity. 15 million use kerosene lamps for lighting their homes. Government objectives: to address carbon emission Economic incentives: reduce diesel imports and subsidies in the agriculture sector; reduce dependence on gas **Policy incentive:** Vision to ensure access to electricity for all by 2021 Target to generate 5% of total electricity using RE by 2015 and 10% by 2030
Source Funders	**Policy incentive:** To support country objectives and IDCOL targets by 2017. Knowledge incentive: knowledge of huge demand of SHS and its benefits such as reduces fuel wood, fossil fuel consumption directly.
Core: Financial Intermediary IDCOL	**Development incentives:** Rural electrification and meeting the energy demand. Provide affordable and reliable energy supply for the rural people Economic incentives: tap market for solar. Tap available finance from donors. Change in IDCOLs mandate: from large scale to small scale.
Partnering Organizations—SMEs/MFIs/NGOs	**Economic incentives:** Access low cost capital Institutional grant which incentivizes them to deliver services in rural areas. The refinancing scheme with subsidized interest rates (6%) and long-term repayment tenure offers a strong commercial incentive for the POs to invest.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2.4.2 Drivers for Choosing Specific Delivery Models and Implementation Channels

Incentives can also influence decisions around the type of actors, their implementation channels, funding instruments and delivery models that intermediaries would choose for investing in energy access markets.

2.4.2.1 Drivers for Choosing Specific Institutions for Delivering Energy Access Projects

- IDCOL engages with multiple partnering organizations to deliver SHS and SIP projects. For example, IDCOL began working with **MFIs and NGOs** because they have the coverage and office set up in rural areas in Bangladesh, and their experience in microcredit program is beneficial for this project with regard to credit disbursement, credit collection, and after sales services.
- Over the years, many **private sector entities including SMEs** and private suppliers have been involved in the project purely for business purposes (Nazmul Haque, pers. comm. 2014). SMEs and private companies are skilled in marketing, willing to sell their products, and can provide engineering support.

2.4.2.2 Drivers for Using Specific Financing Instruments

The upfront grant portion was needed in the beginning for market creation to make investments more lucrative and reduce the price of the system for the end user. Originally conceived as market-development tools, subsidies were designed to help POs market the systems by making them more affordable while also covering the costs that new POs incurred in setting up a new business line in solar home systems (Sadeque et al. 2014, 4). Table 5 indicates the decision points faced by end users in determining which intermediaries and financing instruments to choose.

End users are required to make a down payment of 10% to establish ownership. MFIs did not have the money to pay to the suppliers immediately, so IDCOL provided a refinance credit so that they could immediately pay the suppliers. But, some sort of ownership was needed to develop buy-in from the MFIs to make it a sustainable business model, so the MFIs retain a 10% equity stake in the project (with the household owning the other 10% equity) and IDCOL provides 80% in the form of a refinancing credit. The availability of refinance credit and long tenure period allowed small business to access affordable, flexible, and long-term capital to invest in decentralized energy.

The upfront grant portion was targeting the poor because the initial system price would be too high for them, but even including the upfront grant portion, marginalized populations could not afford it.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 5. Drivers for Selecting Specific Intermediaries and Instruments

Decision	Drivers

Choice of intermediaries	Engages with multiple partnering organizations to deliver projects. For example:
	• Knowledge/capacity incentives:
	  • MFIs have good coverage and office set, experienced in microcredit program: credit disbursement, credit collection, and after sales services. Vendors are assured payments if MFIs are engaged.
	  • SMEs and private companies are skilled in marketing, willing to sell their products, and can provide engineering support.

Choice of instruments	IDCOL used different types of financial instruments, including grants and loans: • Grants: In developing markets to enabling access to capital and make products affordable. • Loans: For commercial viability so that funding continues to revolve. • Bank Guarantees: Experienced defaults in the past and therefore guarantees were needed. • Subsidized interest rates (6%) and long-term repayment tenure incentivizes the MFIs and SMEs to invest

2.4.3 How Effective is the IDCOL Model in Enabling Decentralized Energy Access for Poor Populations?

The choices made in the financial landscape can be instrumental in effective delivery and outreach of energy access project. In this case study, we explored the extent to which public investments in energy access through IDCOL have been instrumental in targeting the poor, creating renewable energy markets for decentralized energy access, as well as in reaching out to the most vulnerable by helping them access affordable finance. Table 6 summarizes interviews with market actors on how effective IDCOL is at providing energy access for the poor.

Targeting the Poor

According to IDCOL officials, IDCOL programs, by default, target the poor and vulnerable by investing in off-grid areas (Nazmul Haque, pers. comm. 2014). As grid electricity is already subsidized, the focus on off-grid avoids duplication of subsidy schemes. The initial range of SHSs supported was 30–130 Wp, however, later 10–20Wp was also introduced to serve the lower income segment. Fixed subsidies for all system sizes mean a larger percentage of subsidy for smaller systems, usually availed by the poorer segment of the society. As subsidies phase out, capital buy down grant will only be available to low income segments for purchasing smaller systems that are less than 30wp.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Market Creation and Catalyzing the Private Sector

IDCOLs financing scheme has catalyzed the private sector by unlocking working capital for small-scale enterprises.

- **Refinancing scheme** offers commercial viability for partnering organizations
- **Develops domestic support industries:** Fiscal support by the government as well as the semi-concessional credit facilities offered by IDCOL to local support industries encourages new domestic manufacturers or partnering organizations (POs).
- **Prices are determined by the market:** Multiple suppliers for each SHS component allow POs to procure SHSs at competitive prices. Presence of multiple POs ensures healthy competition and customers are free to purchase from their chosen PO based on price and quality of service.

Meeting Energy Access Goals

Universal access to electricity by 2021 is a stated goal of Bangladesh's national strategy; grid electrification alone has been unable to achieve this target. Solar power using photovoltaic technology, such as SHSs, has been effective in rural electrification in remote rural areas that would not receive a grid connection in the foreseeable future (Khandker et al. 2014, 87).

Since its inception in 2003, Bangladesh's solar home system (SHS) program has installed household electrification systems in three million rural households, two-thirds of them from 2011–2014. In the same period, the country's rural electricity cooperatives have extended access to the national electrical grid to about 1.3 million households.

The program has made systems affordable through a combination of consumer credit and (declining) subsidies. The idea was to bring monthly expenditures as close as possible to existing household spending on kerosene and dry cells.

Reaching Out to the Poor and Vulnerable by Unlocking Affordable Finance

Buy down grants, long term and flexible repayment tenure, and flexible installments enable low-income groups to access affordable credit. However, the initial subsidy was $70 per system and has since been reduced to only $20 and going forward it might be removed altogether. Withdrawing subsidies at a time when poor people are becoming able to afford these systems may have implications on the model.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 6. Actors' Views on how the Public Sector is Effective in Enabling Energy Access for Poor in Bangladesh

Core Actors	Targeting	Co-Benefits	Appropriateness of Finance for Poor	Leveraging
Sources-funders	No specific targeting Nature of projects: pro-poor by default; Rural, off-grid, remote areas	Better living status Better health, education and communication No specific gender benefits.	Funds should reach poor but first priority is viability and increased energy access Repayment ability is important Doesn't provide cheaper capital to poor population But provide diversified portfolio of products with smaller products for the poor.	Revolving fund Household contribute through upfront capital MFIs/POs: equity sharing.
IDCOL	Upfront grant to target the poor Donors' sometime earmark-more on a project basis Targeted subsidies Off grid Smaller and cheaper products Fixed subsidy for all sizes-implies larger percentage of subsidies for poor.	Reduced expenditure, time spent, employment, education Reduced cost of energy compared to burning fossil fuel or wood More available work hours at night Women's safety.	Upfront grant and adequate repayment periods Instalment is set comparing to repayment ability and fuel costs In practice, SHS hasn't reached the most marginalized or ultra-poor Do not have the purchasing power.	Initially the World Bank and GEF program for rural electricity. Later GIZ, KfW, ADB, JICA, USAID, DFID came forward with additional financial support for the expansion of SHS program.
PO- SMEs	Not designed for poorest. For those with minimum affordability Assesses income levels and provides different options No subsidy for products that may be affordable to rich >30 watt.	Reduced fuel cost from diesel Impacts earnings and livelihoods Empowers women and children.	Both SHS, SIP still quite expensive Not reaching the poorest. Subsidy less and costs high for SIP; SHS phasing out subsidy Fewer subsidies needed for gas.	
PO- MFIs	By nature target the poor but also seek for viability	Mobile phone Improved quality of life The extension of working hours Household income.	Down payment and monthly installments difficult to pay although costs remain lower than the cost of kerosene used monthly in a household (Asaduzzaman et al. 2013).	

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2.5 Challenges

The Bangladesh experience and case study highlight a number of key success and lessons learned, as well as some challenges. The main challenges to be extracted are described below.

- Although Bangladesh Bank's low cost fund has been effective in reach out to rural populations, the poorest sections are not entirely catered. Different market segments require customized support to ensure energy access for all.
- Under the incentive based financing scheme of IDCOL, the FI receives a grant from the government and donor's pool fund. This allows them to provide funds for renewable investments at a lower rate. Other FIs and banks cannot compete with the price, even with the help of refinancing. This dilemma is crowding out the potential investment opportunity of commercial FIs.
- The initial subsidy was US$70 per system, and has since been reduced to only US$20. Going forward, the subsidy will be removed altogether. Withdrawing subsidies at a time when poor people are becoming able to afford these systems may have implications on the model.
- Both the IDCOL SHS and SIP programs are by default targeting the poor and vulnerable by investing in off-grid areas and there is a trickle-down effect from the grants provided by the donors; however, targeting the ultra-poor more specifically could provide them with more benefits and increased access to these services.
- The current model of IDCOL may be a viable and sustainable option but the upfront costs, as well as the interest rates, may still be unaffordable for the ultra-poor that constitute nearly 18% of the total population, while those living below the poverty line are nearly 32%. A better market segmentation would allow governments to target the ultra-poor by innovative social protection measures or community based investments.

2.6 Lessons Learned

IDCOL's feat in providing decentralized energy access in off-grid areas can be largely credited to the creation of effective working partnerships with different actors in the supply chain. IDCOL realized very early on that it is a large urban financial institution and lacks the ability for widespread dissemination that the MFIs and SMEs were capable of and designed its program accordingly. The widespread presence and past experience of the use of microcredit in Bangladesh also aided the reliability of process. The programs have been able to unlock finance in the form of long-term soft loans and equity and in turn enabled the partner organizations to provide the SHS and SIP services to the off-grid areas. Knowledge of the demand of SHSs in off-grid areas has been a key reason for the exponential increase in supply of the systems. IDCOL's transparent and accountable system, enhanced by their Technical Standards Committee, which provides approval to suppliers; PO selection committee responsible for selecting partnering organizations and Monitoring and Inspection team, which review the reports from the PO, have been essential in gaining increased support from the donors over the years. Working in tandem with the government's vision for energy access in the future also helped catalyze the widespread uptake of solar projects.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

A number of success factors in Bangladesh can inform other energy access programs. Below we summarize some key policy lessons from this case that may be transferrable to other countries:

- **A strong policy foundation can result in incentives for actors along the value chain**. Enabling decentralized renewable energy access would require strong political will, policy measures, targets, and fiscal measures that will indirectly create incentives for different actors along the different scales of value chain. It means that policy incentives at a higher level will trigger incentives and interests at the intermediary level, at the private SME and MFI level, and finally at the beneficiary level. For example, the government's vision for universal energy access to all and a target to generate a proportion of electricity from renewables in the future also helped public policymakers to catalyze actors along the renewables value chain by establishing incentives such as tax holidays, reduced import duties, reduced levy for domestic suppliers, leverage concessional and grant based financing from donors and government, dedicated policy coordination agency for catalyzing the renewables industry.
- **An innovative, integrated, and holistic financing model can create win-win opportunities for all actors in the value chain**. For example, IDCOLs business model for SHS offers an entire package that incentivizes market creation, creating delivery networks, access to capital, quality assurance, after sales service, training, and institutional strengthening support for partnering organizations, and SMEs.
- **Increased support from donors can help in reaching out to the poor, market development, and catalyzing finance for smaller players**. Grants and subsidized credit have been crucial within the IDCOL model to make the renewable products affordable for the poorer beneficiaries. Grants, low interest loans, risk guarantees, and microcredit arrangements also unlock finance for small-scale enterprises that have difficulties accessing finance from commercial markets. Grants provide opportunities to enhance institutional capacities of partnering organizations and SMEs that want to invest in decentralized energy access, creating an enabling environment for the small market players to invest in decentralized renewable energy.
- **Flexibly tailored instruments can help with outreach to weaker segments of the population**. Tailoring products for different economic segments of the population has helped low income sections of the population access finance (although not always for the ultra-poor). Original solar home systems were 30–130Wp; however, later 10–20Wp was also introduced to serve the lower income segment. Fixed subsidies for all system sizes ensures a large proportion of subsidy for smaller systems availed by the poorer segment of the society.
- **A sequential reinforcing model can help in developing a long-term sustainable financing structure that remains viable**. A phase out subsidy model and a concessionary to semi-commercial credit has helped transition to a more sustainable financing arrangement, once the market is developed. The down payment of 10%–15% of the remainder creates ownership for the end users. MFIs did not have the money to pay to the suppliers immediately, so IDCOL provided a re-finance credit so that they can immediately pay to the suppliers. But, the MFIs needed to retain some

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

sort of ownership for business sustainability, so 80% was re-financing credit and 20% was equity sharing.

2.7 Additional Information: Central Bank of Bangladesh's Green Financing Scheme

Over the years, core agencies such as the **Central Bank of Bangladesh** have also begun to regulate and channel bank and non-banking finance for renewable energy investments, which includes regulating the non-bank institution IDCOL. Bangladesh Bank is a Central Bank established to manage the monetary and credit system of Bangladesh. It plays a regulatory and licensing role over all financial intermediaries, commercial banks, and financial institutions within the country.

It is the first federal bank in the world that has taken a definitive interest in providing dedicated resources toward a sustainable development agenda. Starting in 2005, Bangladesh Bank set up a refinancing scheme advising commercial banks wishing to finance green energy projects, including solar, and biogas. In 2010, it introduced a US$26 million facility for the refinance of bank loans for investments in green energy and effluent treatment plants. The 2010 refinance scheme was in line with the government's overarching goal of generating enough renewable electricity to meet 5% of total demand by 2015 and 10% by 2020. The refinancing scheme made it possible for commercial banks to access capital from the Bangladesh Bank at lower rates, thereby increasing the profitability of green lending. The 'policy guidelines for green banking,' introduced by Bangladesh Bank in 2011, encourage phased steps to develop green banking practices in the banking sector of the country.

- *In phase one,* banks are required to allocate a specific budget for green finance. This includes direct financing in projects such as renewable energy, clean water supply, wastewater treatment plants, solid and hazardous waste disposal plants, biogas plants, and bio-fertilizer plants.
- *In phase two*, banks are expected to set achievable targets and strategies and disclose these in their annual reports and websites. Banks are also required to establish a green branch. Compliant banks receive preferential treatment through a refinancing model that provides access to low-cost financing.
- *In phase three*, banks are expected to do independent reporting of their green banking practices

In a 2014 circular, the Central Bank of Bangladesh announced direct green financing targets for all the banks and non-banking financial institutions to ensure financing for environment friendly products. Banks that have been operational in the market since 2013 are expected to disburse 5% of their loans toward financing green products. New banks are expected to disburse 3% of their loan portfolio, and non-banking institutions are expected to disburse 4% toward lending finance for green products, which include renewable energy.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2.7.1 Central Bank's Financial Model

Funds from the Bangladesh Bank are allocated to commercial banks based on three financing mechanisms:

- Refinancing mechanism
- Spontaneous financing mechanism
- Incentive-based (discussed in detail in Section 2.3)

Refinancing Mechanism

Banking financial institutions (FIs) and non-banking financial institutions, such as IDCOL, invest in renewable energy markets with the help of a low-cost fund provided by Bangladesh Bank's refinancing facility. These funds can be lent through two different channels:

- Direct credit lending through commercial banks
- Credit wholesale lending through NGO/MFI linkage.

FIs come into a participatory agreement with Bangladesh Bank to utilize the refinancing facility. Under this agreement, FIs disburse loans to SMEs or direct investors and then apply to Bangladesh Bank for refinancing. The FI can directly lend to the borrower or through a credit linkage facility by credit wholesaling. The difference will be in the interest rate. Figure 6 shows the credit wholesale lending model.

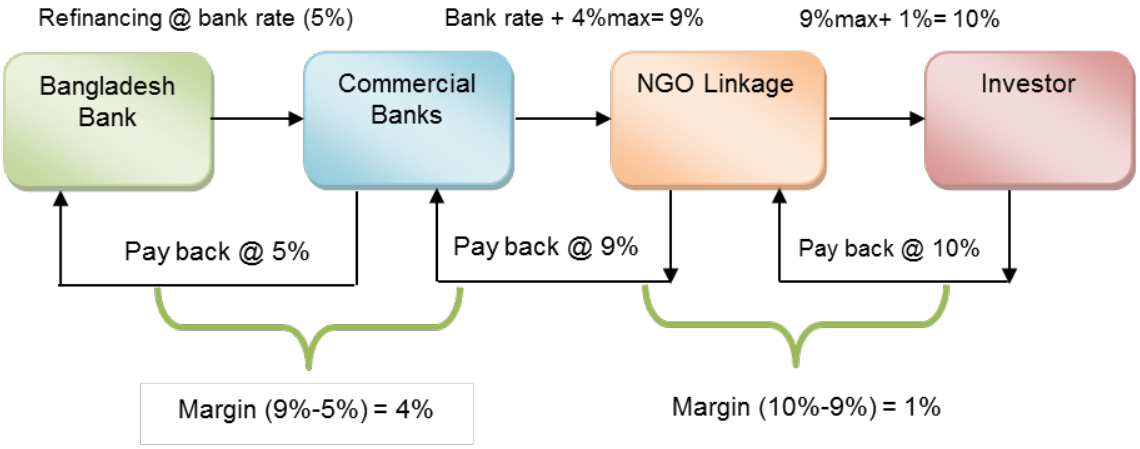

Figure 6. Credit wholesaling through NGO linkage

Source: Rahman 2013

If the bank lends directly, banks receive a concessional loan of 5%, which they can lend directly to the borrower at the rate of 9%. This helps the lender earn a profit margin of 4%. The second mode is through credit linkage or wholesale lending through financial intermediaries (Figure 6) where the FIs work in collaboration with MFIs, NGOs, and suppliers or manufacturers. Many banks feel comfortable providing large amounts of credits to the MFIs that are better at lending and collection from the rural off-grid borrowers. The Central Bank of Bangladesh has allowed participating FIs with limited rural branches to use NGO or MFI linkages to increase rural renewable finance through microcredit. With minimum or no documentation and often no collateral required, microcredits are also easier

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

to access for rural poor. Borrowers do not have to go the bank branches for availing credit, and NGO/MFI staff can visit the prospective borrower's house to provide the loan and collect the small weekly recoveries. However, there are concerns around the growing interest rate for microcredit. The government of Bangladesh is trying to put a cap on how much interest can be charged for microcredit to ensure it is within reach for low-income populations.

Spontaneous Financing Mechanism

Some banks and non-banking financial institutions may not sign the agreement for the refinancing mechanism. They may want to invest in solar energy as part of their regular credit as spontaneous finance. Initially, this type of financing would have been done under the FIs corporate social responsibility (CSR). FIs and banks themselves calculate the risk and premium to coverage. However, these banks do not receive the same concessional finance and their final interest rate to end investors differs from 9% (as in the case of refinancing facility) to 18%.

Outcomes of the Green Banking Policy

As of October 2014, more than US$37 million (original allocation of US$26 million) under the refinancing facility has been allocated to green projects. Figure 7 shows the funding for the different types of project up to 2014 (Asif Iqbal, pers. comm., 2015). In the third quarter of 2014, investment in renewable energy was nearly 24% of total green lending portfolio.

Figure 7. Use of Central Bank's refinancing funds for green investments, by category from 2009 to 2014

Source: Rai et al. 2015a, Iqbal 2015

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

2.8 References

Asaduzzaman, M., Mohammad Yunus, A. K. Enamul Haque, AKM Abdul Malek Azad, Sharmind Neelormi, and Md Amir Hossain. 2013. *Power from the Sun: An Evaluation of Institutional Effectiveness and Impact of Solar Home Systems in Bangladesh*. Report submitted to the World Bank. Dhaka, Bangladesh: Bangladesh Institute of Development Studies.

Buchner, Barbara, Morgan Herve-Mignucci, Chiara Trabacchi, Jane Wilkinson, Martin Stadelmann, Rodney Boyd, Federico Mazza, Angela Falconer, and Valerio Micale. 2013. *The Global Landscape of Climate Finance 2013*. Climate Policy Initiative. http://climatepolicyinitiative .org/wp-content/uploads/2013/10/The-Global-Landscape-of-Climate-Finance-2013.pdf.

Haque, Nazmul. 2015. "IDCOL's Contribution to Low Carbon Climate Resilient Development in Bangladesh." Presentation in a workshop on financing inclusive investments held in Kathmandu, March 30–31, 2015.

Government of Bangladesh. 2008. *Renewable Energy Policy of Bangladesh*. Power Division, Government of Bangladesh.

Islam, S. M. Formanul. 2014. "Financing Renewable Energy in Bangladesh" Presentation by Deputy CEO of Infrastructure Development Company Limited (IDCOL) at the West African Power Industry Convention, Lagos, November 2014.

Khandker, Shahidur R., Hussain A. Samad, Zubair K. M. Sadeque, Mohammed Asaduzzaman, Mohammad Yunus, and A. K. Enamul Haque. 2014. *Surge in Solar-Powered Homes: Experience in Off-Grid Rural Bangladesh*. Directions in Development. Washington, D.C.: The World Bank.

Rai, Neha, Sunil Acharya, Ramesh Bhusal, Raju Chettri, Md Shamshudoha, Misgana Elias Kallore, Nanki Kaur, Sumanta Neupane, Lidya Tesfaye. 2015a. *Political Economy of International Climate Finance: Navigating Decisions in PPCR and SREP*. Working Paper. April 2015. London: International Institute for Environment and Development.

Rai, Neha, Asif Iqbal, Asif Iqbal, Antara Zareen, Tasfiq Mahmood, Maliha Muzammil, Saqib Huq, Noor Elahi. 2015b. *Financing Inclusive Low-Carbon Resilient Development: Role of Central Bank of Bangladesh and Infrastructure Development Company Limited, Country Report*. London: International Institute for Environment and Development. http://pubs.iied.org/10139IIED.html.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

3 Ethiopia: Financing of Inclusive Investment in Off-Grid Renewable Energy

Case study prepared and written by Nanki Kaur, Lidya Tesfaye, Simret Mamuye,

Policymakers in Ethiopia are promoting public and private sector investment in grid connected and off-grid energy production and distribution to address the growing demand for energy and to enhance access to clean and sustainable sources of energy.

This case study looks at how unlocking appropriate finance for investment in off-grid renewable energy (RE) production and distribution can enhance access to energy. The study focuses specifically on how the Development Bank of Ethiopia (DBE) mobilizes and delivers finance under the Market Development for Renewable Energy and Energy Efficient Products (MDRE&EEP) program to support investment by households, microfinance institutions and private sector enterprise's in off-grid energy.

The case study is based on a political economy analysis to understand stakeholder choices and incentives that shape the financial landscape supporting investment in off-grid RE. It identifies financial intermediaries, financial instruments, and financial planning systems that deliver appropriate finance for private sector investment in off-grid RE. It concludes by identifying incentives that deliver appropriate finance for investment in energy.

Actions and policies implemented by the government of Ethiopia and the Development Bank of Ethiopia also align with the key policy themes presented in Volume 1, Section 2 of this report, and they are summarized in Figure 8.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

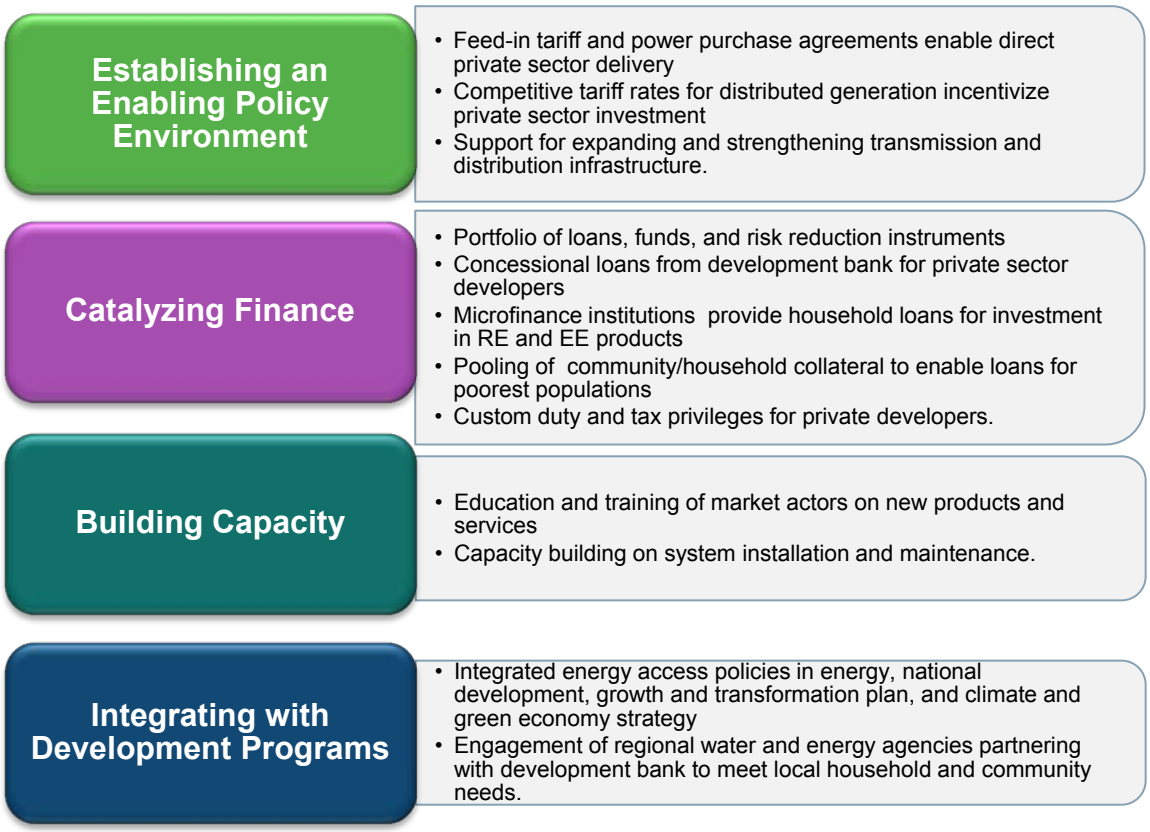

Figure 8. Key policies and actions in the context of the energy access framework

The Ethiopia case study also provides a number of key lessons that can be applied to energy access efforts in other countries, including:

- Promoting private sector enterprise (PSE) and household investment in renewable energy (RE) and energy efficiency (EE) products is more successful if policymakers address the following investment needs: access to concessional and long-term credit, access to credit without collateral, and access to credit in the form of foreign currency
- Market development needs should be addressed, including promotion of new products through awareness raising and quality assurance, and the need for actors in the investment landscape to have sufficient capacity to carry out their roles
- The findings of the case study indicate that national development finance institutions like the DBE and microfinance institutions (MFIs) are important financial intermediaries as they are able to mobilize and deliver finance to households and PSEs for investment in RE and EE products.
- Financial instruments such as loans (concessional and market rate loans), revolving funds, and risk management instruments (guarantees) are able to deliver scaled up and long-term finance for investment in RE and EE products. These financial instruments can also provide socio-economic returns on investments in RE and EE

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- Financial planning systems like policy frameworks that govern the flow of finance toward pro-poor investment in RE and EE products will promote inclusive investment. Similarly, risk management systems such as group collateral requirements enable the poorest populations to access credit for investment in RE and EE products.
- Policymakers can use policy incentives to promote financial investment in RE and EE products. Ethiopian policy examples include a mandate to enhance access to energy, policy frameworks that guide investment in RE, and the use of specific financial intermediaries and instruments for investment in RE and EE.
- Working with established finance and business networks can expand investment in RE and EE products. In Ethiopia, development finance institutions have the capacity to mobilize and deliver finance to households and SMEs for investment in RE and EE products.

This case study uses the Climate Finance Landscape Framework (adapted from Climate Policy Initiative) to analyze design choices aimed at delivering appropriate finance for investment in energy access for the poor (Buchner et al. 2013). This framework focuses on the role of financial intermediaries, financial instruments, and financial planning systems in mobilizing and channeling appropriate finance for inclusive investment in energy access.

3.1 Country Context

Enhancing access to energy by scaling up public and private sector investment in grid connected and off-grid energy production and distribution is a key policy agenda in Ethiopia. This section of the case study provides a snap shot of Ethiopia's policy and institutional framework that shapes financial investment in the energy sector.

3.1.1 Energy Demand and Supply

Demand for energy is growing rapidly in Ethiopia. The demand forecast made for the climate resilient green economy (CRGE) strategy reflects that total power demand is projected to grow from 4 terawatt-hours (TWh) in 2010 to nearly 70 TWh in 2030. This increase results from both growing electrification of the country and rapid growth of electricity-intensive industries (FDRE 2011). Electricity consumption on the national grid has grown at more than 12% annually. However, the annual per capita consumption of electricity is less than 100kWh, while sub-Saharan Africa consumes on average 521kWh per capita (NEP 2012). The industrial sector has had the most rapid increase in its demand for electricity since 2000. The household sector, consuming 89% of the energy supply, accounts for the largest share of sectoral energy consumption. Of the total, 74% is consumed by rural households and 15% is consumed by urban households (MoWIE 2012).

Only 10% of the total energy consumption in Ethiopia is supplied by electric power and the rest is from biomass, such as wood fuel and dung. The total capacity of electricity generation of the country is about 730 MW, 86% of which is from hydropower, 13% diesel and 1% geothermal. The inter-connected transmission system generates more than 98% of the total energy supply through the national grid. This comes mainly from a set of large hydropower systems with some thermal back up. There are currently about 8 hydropower plants (662.60MW), 12 diesel power plants (113.44MW) and one geothermal plant (7.3MW) that provide power to 1,643 villages and towns. Self-contained systems (SCS) are used for energy

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

supply in off-grid areas. These rely on small-scale power plants (hydropower, solar energy, and wind energy plants).

3.1.2 Policy Framework

The key policy direction in the energy sector is to deliver secure, accessible, and affordable modern energy supply to the entire country to accelerate and sustain social and economic development (NEP 2013). The main policy objectives are stated in the national development plan, the Growth and Transformation Plan (GTP), the national energy policy and the CRGE strategy (MoFED 2010). Policy objectives focus on addressing issues of energy access, the quality and supply of energy, and the productive use of energy.

Interventions aimed at achieving policy objectives include:

- Accelerating and completing the construction of hydroelectric power and other RE generation projects
- Expanding and strengthening the existing transmission and distribution lines to provide improved access to rural villages
- Modernizing the distribution system to reduce power losses to meet international benchmark levels.

Providing the necessary support and incentives for the private sector to participate in the energy sector is a key policy goal in Ethiopia. The draft feed-in tariff proclamation allows the international and national private sector to supply power to the national grid system. The draft proclamation sets competitive tariff rates to incentivize private sector investment in RE production.

3.1.3 Financing Inclusive Investment in RE

In order to meet the rapidly growing domestic demand and to become an energy hub in East Africa, the government of Ethiopia is actively seeking additional investment for the energy sector. The main objective is to leverage investments for expanding the energy supply. Financial resources come from government equity, multilateral banks, development partners, and local banks and from revenue earned from the export of power (EEPCo 2009).

In 2013, the government opened the sector for foreign direct investment in the production of hydropower, wind, solar and thermal energy (Draft energy proclamation 2013). Private sector project developers investing in the energy sector will have custom duty and tax privileges (Investment code 2003). Finance enhancing regulatory instruments like feed-in tariffs and power purchase agreements have also been introduced to incentivize private financing investment in the energy sector.

3.2 Key Agencies and Actors

The key agencies involved in the MDRE&EEP include, the **Development Bank of Ethiopia**, which is the financial intermediary for the program and the **Ministry of Water, Irrigation and Energy (MoWIE)**, which is the technical intermediary for the program. It is responsible for shaping policies related to the development and expansion of the energy sector.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Key agencies in the broader energy investment landscape include the **Ethiopian Electric Power Cooperation (EEPCo)**, responsible for the generation, transmission, distribution, and sale of electricity. The **Ethiopian Energy Authority (EEA)** is responsible for investment in the energy sector and for setting the tariffs and regulating and supervising access by private operators to the electricity grid, which includes the approval of power purchase agreements.

Other institutions that play a key role in the energy sector include: **Ministry of Finance and Economics Development (MoFED)** which oversees of public finances; Ministry of Trade which is involved in the petroleum pricing system; National Strategic Petroleum Reserve Administration which manages and administers strategic fuel reserve depots located throughout the country to ensure sustained supply at times of sudden shocks; Ministry of Mines which is charge of upstream hydrocarbon and geothermal resources exploration; and, Ministry of Environmental Protection and Forestry (MEPF) which regulates the environment aspects of energy development activities.

3.2.1 Actors Shaping Investment in RE

A number of actors with a specific set of functions are involved in the investment landscape for the *Market Development for Renewable Energy and Energy Efficient Programme (MDRE&EEP)* (Figure 9). They include regulators, financial intermediaries, technical providers, and end users comprising of households and private entities.

3.2.1.1 Regulatory Bodies

The national bank, the Public Financial Enterprises Agency (PFEA), the Ethiopian Conformity Assurance Enterprise (ECAE), and Lighting Africa regulate investment in the MDRE&EEP landscape.

The national bank regulates the Development Bank of Ethiopia (DBE) and MFIs. The DBE is also regulated by the PFEA. Lighting Africa and the ECAE regulate the quality of solar energy products provided by private companies.

3.2.1.2 Financial Providers

In the MDRE&EEP case, the flow of financial resources starts with the World Bank, which has provided a US$40 million long-term concessional loan to enable private sector investment in RE production and distribution. Of the US$40 million, US$20 million has been allocated in the first tranche (2012-2017). Of this amount, loans worth US$18.8 million have been approved by the DBE, of which US$10.3 million have been disbursed to MFIs (US$ 6.6m) and to PSEs (US$ 3.7m) (Rahul Kitchlu, World Bank, pers. comm., 2015). Funds from the bank flow to the Ministry of Finance and Economic Development (MoFED), which in turn transfers the funds to the DBE. The DBE channels the funds for investment in RE production and distribution of energy efficient products through two credit lines:

1. Credit line to support working capital of project developers (e.g., PSE for investment in RE and energy efficient products.
2. Credit line to provide on-lending support to MFIs to lend to small households for investment in RE and energy efficient products. To date two MFIs have acquired concessional loans from the MDB. These are Oromia Credit and Saving Share Company (OCSSCO) and Wassassa Micro Finance Institution. Both operate in the

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Oromia Regional State. Three MFIs in the regional states of Amhara, Tigray, and Southern Nations, Nationalities, and People's (SNNP) are in the pipeline to access credit from the DBE. Each MFI in these regions expects to access about 50 million Birr (roughly US$2.5 million credit).

3.2.2 Technical Providers

There are a number of technical providers in the MDRE&EEP investment landscape—each plays a specific role in the promotion, distribution, and uptake of investment in RE and EE products.

Technical service provision includes:

1. **Technical assistance to identify credit-worthy households and develop credit-worthy applications**: The MoWIE provides technical assistance to the DBE and to the private companies accessing credit from the DBE. It appraises credit applications, including the energy product that is being proposed for importation. The Oromia Bureau of Water, Mines and Energy (OBWME) provides similar assistance to the MFIs. It helps them identify households that are eligible to access credit for investment in RE and EE products. In the case of investment in biogas digesters, households that own livestock are eligible to access credit. In the case of investment in solar lanterns, households need to provide group collateral to access credit.
2. **Technical assistance to develop market linkages**: NGOs play an important role in linking MFIs to private sector service providers.
3. **Technical assistance to distribute, implement, and maintain investment in RE and EE products**: Private entities are responsible for distributing, implementing, and maintaining investment in RE and EE products. The OBWME also supports MFIs by providing material, at a concessional price, to households for the construction of biogas digesters.

3.2.3 End Users

For purposes of this case study, the term "end user" refers to the end users of finance rather than the end users of energy access services. The end users in this financial value chain include:

1. **Households** that access finance from the MFIs for investment in renewable energy and energy efficient products. To date households have invested in biogas digesters, improved fuel saving stoves, electric stoves, and in different types of solar systems like solar lanterns
2. **Private sector enterprises** that access finance from the DBE to purchase and distribute energy efficient products and to invest in RE production. To date, six private companies have accessed credit to purchase and distribute RE and EE products. To date PSEs have invested in solar lanterns and energy saving lamps. MFIs also work with PSEs to install and maintain RE and EE products for households.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

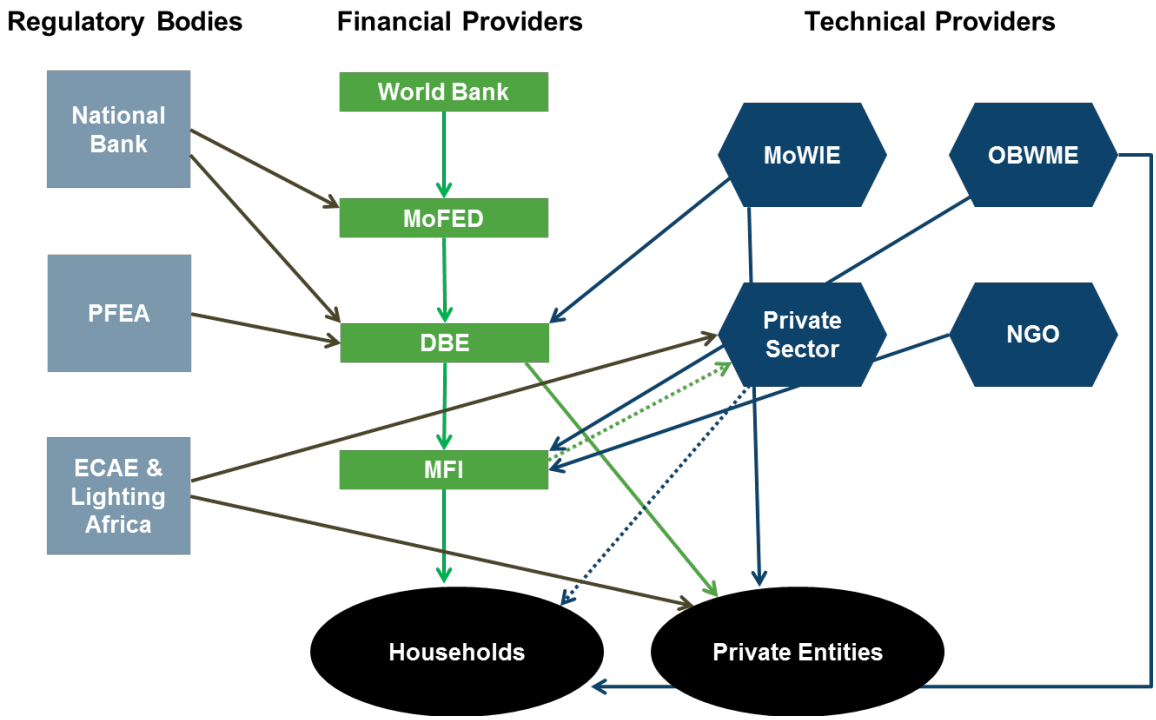

Figure 9. Actors in the RE landscape in Ethiopia

3.3 Program Summary

The DBE has a significant role in mobilizing and delivering finance for inclusive investment in RE and EE products. The DBE is an example of a national development finance institution (Table 7).It can contribute to financing inclusive investment in RE and EE because:

- DBE has the ability to mobilize scaled up, long-term, and flexible finance by:
  - Accessing national and international sources of public, private and carbon finance
  - Pooling/blending different sources of finance
  - Deploying a range of financial instruments, including long-term loans and guarantees
- DBE has the ability to finance inclusive investment in CRGE because it is mandated to invest in sectors and products that are akin to CRGE investments and to lend to risky households and enterprises.

The DBE finances investment in energy production and distribution in two ways:

- Trust Agent: As a trust agent, the DBE administers funds on behalf of another entity. As a trust agent, the Bank receives a commission for its administrative services and does not share risks related to the investment portfolio.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- Credit Line: The Bank also manages its own credit line. In such cases, it has a share in the investment risk and accrues income from the interest charged.

This case study focuses on how DBE channels finance through its credit line for investment in off-grid energy production and distribution. The study specifically focuses on the MDRE&EEP. The overall goal of the program is to promote private sector led development of RE and EE products. The program aims to enable the private sector to expand operations to rural areas by removing financial barriers to private investment. The program uses appropriate financial intermediaries and financial instruments to enhance access to credit, including access to foreign currency and collateral. As described above, the MDRE&EEP is financed by a $40 million concessional loan from the World Bank to the DBE, with $20 million allocated as part of the first tranche.

The MDRE&EEP builds on previous programs that have aimed to enhance energy access to off-grid communities by moving from public approaches to private and market-led approaches for investment. These include the universal access program led by EEPCo that aimed to subsidize investment in off-grid RE production and the RE fund program (REF) that aims to procure RE products and services based on specifications provided by rural cooperatives. These programs have been unable to scale up investment due to procurement barriers (Rahul Kitchlu, World Bank, pers. comm., 2015).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 7. The Development Bank of Ethiopia

Source	Intermediary	Instrument	Financial Planning System	Use and Users
National Public Finance from GOE Debt finance (bonds) International Financial institutions (World Bank, CDB, EIB) Carbon finance (DEB is working with the World Bank to tap into this source) *2012: Authorized capital 3 billion br. Paid-up capital 1.8 br.*	As a financial intermediary, DBE mobilizes, manages and channels finance in two ways: **Trust Agent**: It administers funds; receives services commissions; does not share the risk. **Credit Line:** It manages its own credit line; shares the risk has an income from the interest charged DBE can channel finance to public agencies, MFI & private sector	A range of financial instruments tailored to suit the investment type: Guarantee Concessional and market rate loans Co-finance Debt finance (bond sale	**Policy**: Credit Policy **Institutional Arrangement:** DBE is supervised by the Public Finance Enterprises Supervising Agency. Board of Management administers the Bank Bank President Vice President Process Managers of three Divisions Branch offices	**Use** Manufacturing and Extractive Industry Agro-processing Commercial agriculture Special programs, including energy, rural electrification, export, credit & guarantee **Users** Private Ltd. companies Sole proprietorship Share companies MFI

Source: Case study interviews[2] 2015

[2] The evidence for this case study is generated from a wider study on 'Financing Inclusive Low-Carbon Resilient Development' in Bangladesh, Ethiopia, Nepal, and Rwanda. The Ethiopia case study draws evidence from around 25 interviews conducted in 2015 with a wide range of actors engaged in the value stream of financing decentralized energy in the country (Rai et al. 2015).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

3.3.1 Financial and Market Development Needs to Support Investment in RE and Energy Efficient Products

The MDRE&EEP has been designed to address the specific financial and market development needs of private sector investment in RE and EE products in rural off-grid markets (Table 8).

Table 8. Financial and Market Development Needs of Actors in the RE Investment Landscape

Actor in the Investment Landscape	Financial Needs	Market Development Needs
Development Bank of Ethiopia	Access to long-term concessional credit to promote and sustain investment in RE and EE	Promotion of new technology. Sufficient capacity of actors in the investment landscape to be able to carry out their roles. Division of labour and coordination in the investment landscape to enable all elements of the investment landscape to function.
Microfinance Institutions	Access to long-term concessional credit to promote and sustain investment in RE and EE. Access to larger amount of credit to finance start up investment costs (RE and EE is a new investment area with many start-up costs—like training of RE and EE providers.	
Households	Access to larger amount of concessional credit to scale up investment in RE and EE products.	
Private sector enterprises	Access to foreign currency to import RE and EE products. Access to credit with low collateral to enable start up investment in RE. Access to concessional credit to enable investment in EE products.	

Source: Case study interviews 2015

In terms of financial needs, the program aims to remove barriers to private investment. These include barriers related to access to credit, foreign currency, and collateral requirements. Actors in the investment landscape reiterated the need for appropriate finance to enable private sector investment in RE and EE products, including access to:

- **Concessional Credit:** Required to enable households and private sector enterprises to access finance for investment in RE and EE products.
- **Long-Term Credit:** Required to promote and sustain investment in RE and EE. Long-term credit, disbursed through a revolving fund, enables MFIs to deliver finance to a greater number of investors. Long-term credit also enables investors to engage with the different phases of the investment cycle associated with new products. These phases include feasibility assessment, promotion, development, deployment, and maintenance. The uptake and financial viability of investment in RE and EE products will depend on how well they are promoted. This requires investment in raising awareness, and training of RE and EE suppliers.
- **Collateral-Free Credit:** Required to incentivize investment in RE and EE products by transferring the risk of investment away from the investor.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- **Credit in Foreign Currency:** Required to import RE and EE products.

In terms of market development needs, the program aims to build the capacity of actors in the investment chain to promote and maintain investment in RE and energy efficient products. Access to finance to invest in RE and EE is seen as incomplete without the development of a market that will promote the uptake of RE and EE products. Actors in the investment landscape indicated that promotion of the new products through raising awareness and quality assurance is essential for market development. Along with promotion, actors in the investment landscape need to have sufficient capacity to carry out their roles. This includes technical capacity to implement and maintain RE and EE products and financial capacity to pick up the up-front costs of investment in this area. Finally, actors indicated that division of labor between the actors in the investment landscape and effective coordination between actors to ensure delivery of all functions in the investment landscape is essential to ensure uptake of RE and EE products.

3.3.2 Choices in the Financial Landscape to Support Investment in RE and EE Products

Actors in the RE and EE investment landscape work with specific financial intermediaries, financial instruments, and financial planning systems to address the specific financial needs of private sector investment in RE and EE. Table 9 provides an overview of these choices and the extent to which they address the financial needs of investing in RE and EE.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 9. Policy Choices in the Financial Landscape

Actor in the Investment Landscape	Choices in the Financial Landscape	Addressing Financial Needs of RE and EE Investment
Development Bank of Ethiopia	*Financial intermediary*: MFI and PSE	Access to credit
	Financial instrument: Long-term concessional loan and provision of foreign currency	Access to credit Access to long-term credit Access to credit in foreign currency
	Financial planning system: Policy framework	Access to credit
Microfinance institutions	*Financial intermediary*: DBE	Access to credit Access to long-term credit
	Financial instrument: Short-term market rate loan and revolving fund	Access to credit Access to long-term credit
	Financial planning system: Policy framework and risk management systems	Policy framework and Risk management systems enhance access to credit
Households	*Financial intermediary*: MFI and private lenders	Access to credit
	Financial instrument: short-term market rate loan; *long-term concessional loan*	Access to credit Access to long-term credit
Private sector enterprise (PSE)	*Financial intermediary*: DBE and private lenders	Access to credit
	Financial instrument: short term concessional loan; **risk transfer instruments**	Access to credit Access to collateral free credit

Source: Case study interviews 2015
Underlined text refers to proposed financial instruments.

Financial Intermediary

The DBE and MFI are the financial intermediaries used to mobilize and deliver finance for private sector investment in RE and EE products (Kaur et al. 2014). The DBE is a development finance institution and has a mandate to deliver finance to households and private sector enterprises for investment in RE and EE products. Investment in off-grid RE and EE products is expected to improve energy access and its productive use thereby contributing to the country's aim of achieving inclusive low carbon climate resilient development by 2025. MFIs are also development finance institutions. They are able to mobilize finance from public and private sources of domestic finance, including household savings. In terms of delivering finance, MFIs have a mandate and the capacity to deliver credit in rural areas to households and SMEs.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Financial Instrument

Loans (concessional and market rate) and revolving funds are the main financial instruments being used to finance investment in RE and EE products.

- **Concessional Loans**: The DBE provides concessional loans to project developers to promote investment in RE and EE products. The Bank provides 70% working capital loans at an interest rate of 8.5% with a 5-year repayment period. Project developers are required to provide 30% of the total project cost in the form of equity contribution and collateral in the form of fixed asset for movable projects. The DBE provides concessional loans for on-lending to MFIs. These are provided at an interest rate of 6% with a 10-year repayment period. MFIs are not required to provide collateral. The DBE bears the full risk of the loans to MFIs. Concessional loans, which are below the market rate, enable households and private sector enterprises to access credit for investment in RE and EE products in rural off-grid areas. Concessional loans have a long repayment period enable access to long-term finance, which promotes and sustains investment in RE and EE products.
- **Market Rate Loans**: MFIs use market rate loans to deliver finance to households for investment in RE and EE products. MFIs are free to set their own lending rates and repayment period based on market conditions and are not bound by interest rate caps. For investment in biogas, MFI provide a maximum of $2500 per household at a rate of 15% with a two-year repayment period. Households are not required to provide collateral; however, they do make an equity contribution in the form of either part payment or labor for the installation of biogas digesters. For investment in solar lanterns, MFIs provide credit to households at a rate of 18% with a one-year repayment period. Households are required to make an equity contribution in the form of part payment and provide group collateral. Market rate loans enable households to access credit for investment in RE and EE products in rural off-grid areas.
- **Revolving Funds**: MFIs manage the 10-year concessional loan from the DBE as a revolving fund. They provide short-term loans to households. This enables MFIs to scale out finance for investment in RE and EE products by a large number of investors.

In addition to the financial instruments in use, end users highlighted the need to introduce **risk management instruments like guarantees**, which transfer the risk of investment in RE and EE products from the investor to the financial supplier. According to PSEs, guarantees will remove the collateral requirement for accessing credit for investment in RE and EE products. In the current investment landscape, PSEs have not borrowed project capital for investment in RE due to the high collateral requirement.

Households have also highlighted the need to introduce **long-term concessional loans of greater amounts** to enable scaled up investment in RE and EE products. This includes scaling up investment from solar lanterns to solar home systems.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Financial Planning Systems

Policy frameworks and risk management tools are being used to govern the flow of finance to the private sector for investment in RE and EE products.

1. **Policy Frameworks**: The DBE relies on its credit policy and program documents to govern the flow of finance to the private sector for investment in RE and EE. The credit policy provides a mandate to the DBE to provide finance for inclusive investment in RE and EE products in rural and off-grid areas.
2. **Risk Management Systems**: MFIs rely on group collateral to manage risks related to financial default. Group collateral enables MFIs to provide finance to individual households for investment in RE and EE products.

3.4 Policies and Actions to Support Energy Access

3.4.1 Drivers for Financial Investment in RE and EE Products

The government of Ethiopia has developed policy documents to promote investment in RE and EE products. These include the GTP, the National Energy Plan (NEP), and the CRGE strategy. All three policy documents promote investment in enhancing access to and the production of RE. The government has also introduced finance enhancing regulatory instruments such as feed-in tariffs and power purchase agreements to incentivize private sector RE investment.

Investment in RE and EE products by households and SMEs in rural and off-grid areas will require access to appropriate finance. This includes access to concessional credit, long-term credit, credit without collateral, and credit in the form of foreign currency. Actors work with specific financial intermediaries and financial instruments to deliver appropriate finance. These choices are shaped by a range of political, policy, economic, and capacity-based incentives (Table 10).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 10. Incentives Shaping Choices in the Financial Landscape

Choices in Financial Landscape	Drivers
Financial Intermediary	
DBE	Capacity—to mobilize and deliver finance for investment in RE and EE Policy—to deliver finance to PSEs for investment in RE and EE
MFI	Capacity—to deliver finance to rural households for investment in RE and EE products Policy—Reform in financial service industry
Financial Instrument	
Concessional loan	Policy Economic
Market rate loan	Policy—allowed to set its own lending rate Economic—market demand for credit
Revolving fund	Economic—market demand for credit Political—scale up access to credit
Risk management instruments (guarantee)	Economic—enable project investment in RE and EE products Policy—New CRGE Facility promotes the use of risk management instruments to incentivize investment in climate resilient green economy interventions

1. **Political mandates** deliver inclusive growth, including access to energy for productive use. MFIs use revolving funds to manage and deliver finance to households. The revolving fund enables MFIs to provide credit to a greater number of households—a political mandate of development finance institutions.
2. **Policy and regulatory frameworks** can guide financial investment in RE and EE products. The World Bank works with the DBE in response to policy direction provided by the government of Ethiopia to work with national development finance institutions to deliver finance for investment in key sectors. The DBE works with MFIs in response to the policy direction provided by the financial service industry reform in the 1990s. These reforms restructured government-owned financial institutions and led to the establishment of MFIs. Policy-based incentives are also shaping the choice of financial instruments. For instance, MFIs use market rate instruments in response to policy direction that allows MFIs to set their own lending rate. PSEs and the DBE are considering the use of risk management instruments like guarantees in response to the CRGE facility operational manual, which enables the CRGE facility to deliver finance using risk management and other instruments. The DBE is able to provide loans in foreign currency due to a memorandum of understanding (MoU) signed between the World Bank and the Central Bank for lending in USD (Rahul Kitchlu, World Bank, pers. comm., 2015).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

3. **Economic incentives** provide an economic return on investment. The choice of financial instruments is shaped largely by economic incentives. For instance, the DBE uses concessional loans to leverage private sector investment in RE and EE products. The bank provides 70% working capital loans to PSEs, which in turn unlocks 30% equity contributions from PSEs. MFIs use market rate loans to deliver finance to rural households. They borrow finance from the DBE at a 6% interest rate and lend this money out to households at a rate of 15–18%. PSEs request the introduction of risk management instruments like guarantees to address the collateral required to access project finance for investment in RE and EE products.
4. **Capacity** to mobilize, manage, and deliver appropriate finance to the private sector is crucial for investment in RE and EE products. The World Bank works with the DBE because the DBE has the capacity to deliver finance to PSEs investing in RE and EE products in rural areas. The DBE works with MFIs because they have the capacity to deliver financing to rural households.

3.5 Challenges

The Ethiopia case study provides a number of key lessons and best practices. It also highlights some challenges that arose. For example, neither the universal access program led by EPCO (that aimed to subsidize investment in off-grid RE production) nor the RE fund program (REF) (that aimed to procure RE products and services based on specifications provided by rural cooperatives) was able to scale up investment due to procurement barriers. Removing or reducing procurement barriers would increase the ability of the programs in acquiring various RE products and services.

3.6 Lessons Learned

This case study focuses on outlining how access to appropriate finance can enable private sector actors like households and SMEs to invest RE and energy efficient products that enhance access to energy for productive use in rural areas.

Our findings highlight that to promote investment in RE and EE products by households and PSEs, policymakers will need to address specific investment needs including financial and market development needs. Financial needs to support investment in RE and EE include **access to concessional and long-term credit, access to credit without collateral, and access to credit in the form of foreign currency**. Market development needs include **promotion of the new products** through awareness raising and quality assurance and the need for actors in the investment landscape to have **sufficient capacity** to carry out their roles. Sufficient capacity includes technical capacity to implement and maintain RE and EE products and financial capacity to cover the up-front costs of investment in this area. Finally, actors indicated that **division of labor** between the actors in the investment landscape and **effective coordination** to ensure delivery of all functions in the investment landscape is essential to ensure uptake of RE and EE products.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Choices in the financial landscape play an important role in mobilizing and delivering appropriate finance for investment in RE and EE.

1. **Financial intermediaries**: Our findings indicate that national development finance institutions like the DBE and MFIs are important financial intermediaries because they are able to mobilize and deliver finance to households and PSEs for investment in RE and EE products.
2. **Financial instruments**: Instruments like loans (concessional and market rate loans), revolving funds, and risk management instruments (guarantees) are able to deliver scaled up and long-term finance for investment in RE and EE products. For instance, loans have leveraged equity contributions from households and PSEs for investment in RE and EE products. Guarantees can deliver collateral-free credit to enable PSEs to invest in production and/or assembly of RE and EE products as opposed to their import with the use of working capital loans.
3. **Financial planning systems** like policy frameworks that govern the flow of finance toward pro-poor investment in RE and EE products will promote inclusive investment. Similarly, risk management systems like group collateral requirements enable the most poor to access credit for investment in RE and EE products.

Political, policy, economic, and capacity-based incentives drive investment in RE and EE products and the choice of financial intermediaries and instruments to finance investment in this area by households and SMEs.

1. **Political Mandates**: Policymakers could consider replicating political incentives used in Ethiopia to promote investment in RE and EE products in rural areas. These include a political mandate to enhance access to energy and a mandate to work with national development finance institutions to deliver finance for investment in priority development sectors.
2. **Policy Frameworks**: Policymakers could consider using policy incentives to promote financial investment in RE and EE products. Examples include the use of policy frameworks that guide investment in RE and the use of specific financial intermediaries and instruments. In Ethiopia, the government uses policies to promote the use of national development finance institutions for financing inclusive investment in RE and EE.
3. **Economic Incentives**: Policymakers could consider promoting economic incentives that will provide socio-economic returns on investments in RE and EE. For instance, financial instruments like concessional loans leverage additional equity investment from households and PSEs. Risk management instruments like guarantees incentivize invest in the production and/or assembly of RE and EE products.
4. **Capacity**: Policymakers could consider building on capacity based incentives to finance inclusive investment in RE and EE products. For instance, in Ethiopia actors work with development finance institutions because they have the capacity to mobilize and deliver finance to households and SMEs for investment in RE and EE products.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

3.7 References

Buchner, Barbara , Morgan Herve-Mignucci, Chiara Trabacchi, Jane Wilkinson, Martin Stadelmann, Rodney Boyd, Federico Mazza, Angela Falconer, and Valerio Micale. 2013. *The Global Landscape of Climate Finance 2013*. Climate Policy Initiative. http://climatepolicyinitiative .org/wp-content/uploads/2013/10/The-Global-Landscape-of-Climate-Finance-2013.pdf.

EEPCo (Ethiopian Electric Power Corporation). 2009. *Reports on Distribution of CFLs*. Addis Ababa: Ethiopian Electric Power Cooperation.

FDRE (Federal Democratic Republic of Ethiopia). 2011. *Ethiopia's Climate-Resilient Green Economy: Green Economy Strategy*. Addis Ababa: Federal Democratic Republic of Ethiopia.

Kaur, Nanki, John Rwirahira, Daniel Fikreyesus, Neha Rai, and Susannah Fisher. 2014. *Financing a Transition to Climate Resilient Green Economies*. IIED Policy Briefing. April 2014. http://pubs.iied.org/pdfs/17228IIED.pdf.

MoFED. 2010. *Growth and Transformation Plan (GTP) 2010/11-2014/15. Volume 1: Main Text*. Addis Ababa: Ministry of Finance and Economic Development, Federal Democratic Republic of Ethiopia. Addis Ababa, Ethiopia. http://www.mofed.gov.et/English/Resources/ Documents/GTP%20Policy%20Matrix%20%28English%292.pdf.

MoWIE. 2012. *National Energy Policy (Draft)*. Addis Ababa: Ministry of Water, Irrigation and Energy, Federal Democratic Republic of Ethiopia.

Rai, Neha, Asif Iqbal, Asif Iqbal, Antara Zareen, Tasfiq Mahmood, Maliha Muzammil, Saqib Huq, Noor Elahi. 2015. *Financing Inclusive Low-Carbon Resilient Development: Role of Central Bank of Bangladesh and Infrastructure Development Company Limited, Country Report*. London: International Institute for Environment and Development. http://pubs.iied.org/10139IIED.html.

Smallridge, Diana, Barbara Buchner, Chiara Trabacchi, Maria Netto, José Juan Lorenzo Gomes, and Lucila Serra. 2013. *The Role of National Development Banks in Catalyzing International Climate Finance*. Washington, D.C.: Inter-American Development Bank. IDB-MG-148.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

4 Mali: Programs to Support Private Minigrids for Rural Electrification

Case Study Prepared and Written by James Knuckles

This case study highlights actions taken in Mali to promote privately run minigrids and to hybridize systems powered by diesel generators. The country's program incorporates a variety of policy and regulatory measures that have been successful in supporting deployment of over 160 standalone minigrids—perhaps the most of any sub-Saharan African country (Stephanie Nsom, pers. comm., March 2015).

Minigrids are increasingly seen as powerful levers not only to boost rural electrification, but also to deploy renewable energy and create opportunities for raising rural standards of living (Tenenbaum et al. 2014). As a result, numerous governments have initiated and often prioritized the design of policies and regulations that support minigrids and encourage investment in these pillars of the off-grid electricity sector. Minigrids are one of the key drivers of energy access in Mali and are thus the focus of this case study.

Actions and policies implemented by the government of Mali also align with the key policy themes presented in Volume 1, Section 2 of this report. Figure 10 highlights the key policy actions presented in this case study that are related to clean energy access in Mali.

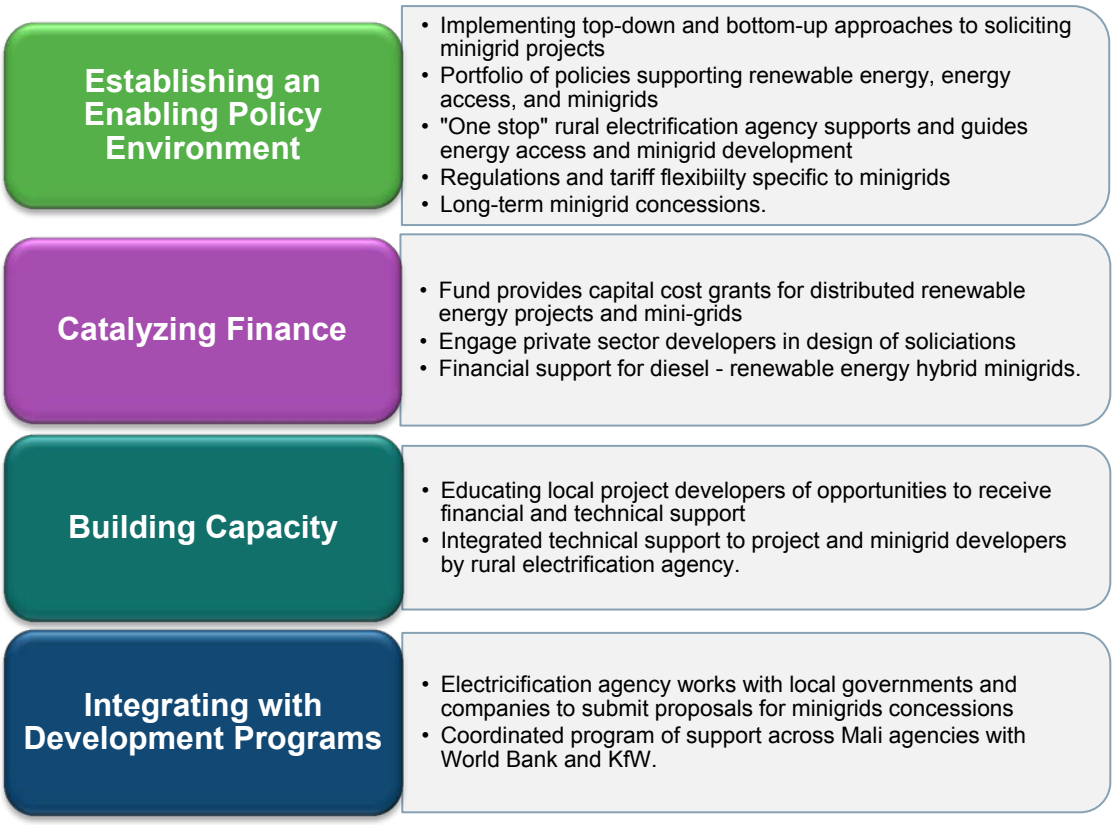

Figure 10. Key policies and actions in the context of the energy access framework

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

As detailed in this case study, a number of lessons can be drawn from Mali's minigrid experience. Key lessons, elaborated in the sections below, include:

- Opening multiple avenues to solicit projects from minigrid developers can jumpstart private investment
- Capital cost grants can support financial viability and sustainability of minigrid projects
- Designating a "one stop" agency to regulate and provide minigrid grants can increase efficiency and make private sector engagement more attractive
- Allowing minigrid developers to set their own tariffs can support minigrid deployment
- Including support for hybridization of diesel-powered minigrids can reduce their operating costs and thus lower their tariffs
- Based on key challenges identified in Mali, the following actions could support improved minigrid deployment:
    - Streamlining the regulatory review and approval process of concession agreements
    - Explicitly stating what the options are for developers when the main grid arrives
    - Requiring the utility to publish its grid expansion plans and hold it accountable to them
    - Investing in "capacity building" for the rural electrification agency
    - Building into the competitive bidding process the flexibility to assess organization skills and potential, and not just the estimated costs and tariffs
    - Considering a limited number of long-term funding agreements with donors or other agencies insulated from politics to ensure a stable baseline amount of capital. Once funds are made available to a minigrid developer, they must remain available unless the developer fails to meet the agreed upon milestones.
    - Encouraging the private developer to sign an electricity service agreement with the village(s) it intends to serve stating the rights and responsibilities of the village and of the developer.
    - Implementing education and outreach programs to communities to increase understanding about the costs and benefits of minigrid electricity.
    - Considering extending concession contracts for 10 years after completion of a minigrid's hybridization, and adjusting the terms and conditions to reflect the new cost structures of hybrid minigrids.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

This case study begins by providing background on the political and economic context for minigrid deployment in Mali. It then presents key energy access milestones and actors. The third section of the case study examines five key policy and regulatory measures to catalyze finance for minigrids. The fourth section summarizes key challenges related to these policy and regulatory measures. The case study concludes with lessons related to these measures and options for improvement as other countries consider implementing similar measures.[3] For background, Text Box 1 provides an overview of minigrids, what they are, and how they operate.

Text Box 1. Mali—An Overview of Minigrids

A minigrid is a village-level electricity system that connects one or more generation sources to local end users—typically households and small businesses, and occasionally an "anchor" customer such as a mobile phone tower or a large business. It can act as a standalone "island" system, or be connected to the main grid. It should be noted that there are significant differences—both technical and economic—between standalone mini-grids and those that are connected to the main grid, and the relevant set of policies and regulations in each country may be different, depending on whether the mini-grid is standalone or grid-connected. As the SE4All initiative points out, an inclusive definition of minigrids does not define them by exact size but instead "differentiates the sector from stand-alone household systems and grid-extension approaches" (See "High Impact Opportunity," http://www.se4all.org/flagship-programmes/high-impact-opportunities/).

Low-income countries are not the only places where minigrids operate. In fact, 66 percent of the total minigrid installed capacity around the world exists in North America, with Europe as the second largest market, and include applications ranging from commercial and industrial complexes to military installations (Asmus, Embury, and Lawrence 2014). Still, minigrids are a vital tool in providing energy services to those without access to electricity.

Minigrids are constructed, owned, operated, and maintained by a variety of actors, from independent minigrid developer-entrepreneurs and small companies to non-profit organizations, local communities, the national utility and large multi-national corporations, or some combination thereof. Often, different entities will have different responsibilities; for example, a private company might build and maintain the minigrid while a local community organization owns and runs it day-to-day including payment collection from customers.

A range of different energy sources supply power to minigrids. The most common are diesel, wind, solar, hydro, and biomass (e.g., rice husks and wood pellets). In minigrids supplied by intermittent renewable energy sources, arrays of batteries are often used to provide electricity when the renewable sources are not producing. Multiple energy sources can also be

[3] This study's aim is to provide a detailed yet clear picture of the key policies and regulations in Mali that support minigrids, bolstered by "behind the scenes" perspectives from some of the key people who helped shape them. Information came from a thorough review of original legislative and policy texts (in French), reports and documents from leading international development agencies, and peer-reviewed literature, as well as interviews with actors who helped develop and are currently implementing Mali's approach to supporting mini-grids.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

combined in what is called a hybrid system, for example where a diesel-powered generator provides backup or peaking power* in combination with one or more renewable generation sources (Bhattacharyya and Palit 2014).

The World Bank and the International Energy Agency have calculated that only 40 percent of the electricity required to supply off-grid individuals around the world can feasibly come from extensions of main grids (World Bank and IEA 2014, 115). The remaining 60 percent of the required electricity must come from "minigrid and stand-alone off-grid solutions." It is not surprising, therefore, that minigrids are emerging as a solution to provide electricity to off-grid communities. Minigrids enable higher levels of electricity-based services at lower costs than solar home systems (Chaurey and Kandpal 2010; Palit and Chaurey 2011). In addition, as Ulsrud et al. (2011) assert, "minigrid systems may also facilitate the set-up of commercial organizations with incentives to keep the system in good working order," which makes minigrids important drivers of economic development.

*Backup power refers to power generated by the diesel generator when the renewable energy systems are not producing electricity and batteries cannot meet the grid demand. Peaking power refers to the power needed when there is a surge in demand from customers on the minigrid. In hybrid minigrids, a diesel generator would generate the additional power that the renewable sources could not provide.

4.1 Country Context

Mali is a landlocked country in West Africa with a population of about 15.3 million, over 70% of which live in rural areas.

Figure 11. Map of Mali

Source: UN Department of Field Support, March 2013

The country remains one of the poorest in the world, with about half of the population living on less than US$1.25 per day and an average life expectancy of around 55 years (World Bank data, accessed March 3, 2015). Mali's economy is highly dependent on commodity exports, of which cotton and gold comprise around 80%. As in many sub-Saharan African countries, Mali's electrification rates differ significantly between urban and rural areas. Today, an estimated 55% of people in urban areas have access to electricity compared to just 15% in rural areas (up from just 1% in the early 2000s) (World Bank 2014). This means that a large

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

majority of rural households still rely on kerosene and batteries for lighting and electricity (World Bank 2014). The biggest threats to the economy are political insecurity, violent conflict, and environmental change (e.g., drought) (AfDB/OECD/UNDP 2014). Poverty remains the country's primary underlying structural weakness. Subsequently, rural electrification plays an important part in the government's and international donors' strategies for growth.

Electricity provision to urban areas in Mali is the responsibility of the state-owned utility, Énergie de Mali (EDM). From the early 2000s to 2012, EDM steadily brought new urban customers online, but it has been unable to provide reliable electricity in rural areas as a result of financial and technical viability crises (World Bank 2014). In addition, extending the main grid to rural areas is expensive in Mali due to the high cost of materials. As the World Bank and the National Rural Electric Cooperative Association (NRECA) calculated in a study of grid extension costs in developing countries, grid extension in Mali costs over US$19,000 per kilometer (see Table 11). The material costs in Mali are particularly high because of the high cost of transmission and distribution poles and the pole-top assembly (NRECA 2000).

Table 11. Costs of Grid Extension in Mali Compared to Kenya and Senegal

	Kenya	Senegal	Mali
Labor and Other Costs	$6,590	$5,150	$2,590
Materials	$5,960	$10,810	$15,170
Total	$12,550	$15,960	$19,070

Source: NRECA 2000 (All figures are in 2000 US$/km.)

As a result of the financial and technical difficulties that face EDM as well as the high costs of extending the main grid to rural areas coupled with the large geography across which rural populations are sparsely dispersed, minigrids became a founding pillar of Mali's rural electrification efforts. The following sections detail the evolution and critical components of Mali's reliance on and support of minigrids.

In the early 2000s, a market for minigrids did not yet exist in Mali. Yet by March 2015, there were over 160 standalone minigrids in operation throughout Mali under the direct supervision of the Malian Agency for the Development of Domestic Energy and Rural Electrification (AMADER) (Mamadou Ouattara, pers. comm., March 17, 2015), serving an average of 500 connections each (Fabrice Bertholet, pers. comm., June 13, 2013). Figure 12 outlines some of the key events and policies that shaped the political and regulatory landscape in which a minigrids market would grow. It serves as a reminder that Mali's path to a vibrant minigrid market was not created through a single "silver bullet" policy or regulation.[4]

[4] Full text of all energy-related legislation from the government of Mali (in French) is available at http://dne.energie.gouv.ml/documentation/textes%20l%C3%A9gislatifs%20doc.pdf from http://dne.energie.gouv.ml/.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

1990

- **Launch of the UN Development Programme's Multifunctional Platform Program**
- 450 7.5kW "multifunctional platforms" installed; likely the first manifestations of rural micro/minigrids in Mali. The project has since ended (UNDP 2004).

1999

- **Creation of National Energy Directorate (DNE)**
- DNE officially took control of the energy sector within the Ministry for Mines, Energy and Water. This began to streamline oversight of the electricity sector (République du Mali 1999).

- **Korayé Kurumba Begins Operations**
- Likely the first private minigrid operator to exist in Mali. As of 2012, it served about 4,000 households with diesel-powered minigrids (Bardouille 2012).

2000

- **Creation of CREE (Regulatory Commission for Electricity and Water)**
- CREE is the official regulator of the energy sector, giving electric power producers a single point of contact for most major regulatory matters (République du Mali 2000a).

- **Signing of the Energy Sector Organization Law**
- This law would set the stage for minigrid market by: allowing private operators to supply electricity; launching a rural electrification program; and eliminating the nationwide monopoly of EDM (République du Mali 2000b).

2001

- **Granting 12-year licenses to Yéelen Kura and Senegal River Basin Organization (SRBO)**
- Yéelen Kura and the SRBO were the first private operators to be granted concessions in areas that had previously been restricted to EDM's service area (iED 2013 & Yéelen Kura 2013).

2003

- **Creation of AMADER**
- By creating AMADER, the Government of Mali began to designate regulatory control of rural electrification to a separate entity (external to CREE). AMADER would become the primary agency for regulating and supporting minigrids (République du Mali 2003a & b).

2005

- **Creation of the Rural Electrification Fund**
- Within two years of creating AMADER, the Malian government established a special Rural Electrification Fund to be managed by AMADER (République du Mali 2005).

2006

- **Enactment of the National Energy Policy**
- This is a guiding policy that still underpins the government's energy sector today. It recognizes minigrids as important components in rural electrification plans (Ministère des Mines de L'Energie et de l'Eau 2006).

2009

- **Elimination of Value Added Tax (VAT) on renewable energy component imports**
- This helped reduce costs and promote renewable energy for minigrids, EDM, and other electricity producers (République du Mali 2009).

- **Signing of the Energy Sector Policy Letter**
- Guided Mali's energy policy from 2009–2012 and still serves as an important directive. Among its provisions are adjusting EDM's tariffs toward cost-recovering levels thus reducing the difference between utility and minigrid tariffs.[a]

Figure 12. Timeline of energy sector milestones in Mali

[a] See "Mali (2012)," http://www.reegle.info/policy-and-regulatory-overviews/ML.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

4.2 Key Agencies and Actors

A number of key agencies and actors presented below were critical in supporting minigrid energy access efforts in Mali.

- Malian Agency for the Development of Domestic Energy and Rural Electrification (AMADER): AMADER is the pivotal entity for the development of minigrids in Mali. It acts as the funder and regulator for minigrids. It serves as the "one stop" agency for all matters related to household energy and rural electrification in the country.[5] It is legally responsible for: tariff oversight and periodic adjustments (in coordination with the developers), minimum quality-of-service standards, analyzing and approving or rejecting the initial business plans of prospective developers, monitoring developers' progress, preparing and updating periodically the rural electrification master plan, providing technical assistance, and generally promoting rural electrification (World Bank 2014). Under its charter, AMADER must coordinate its activities with CREE and the Ministry of Mines, Energy and Water (World Bank 2003).
- The National Energy Directorate (DNE), within the Ministry of Mines, Energy & Water: Defines and implements national energy policy
- Commission de Régulation de l'Electricité et de l'Eau (CREE): The Regulatory Commission for Electricity and Water serves as the primary regulatory body for electricity
- Énergie de Mali (EDM): The state-owned utility responsible for electricity provision to urban areas in Mali
- World Bank: A key AMADER partner in implementing energy access and minigrid efforts.
- Kreditanstalt für Wiederaufbau (KfW): The German government's development bank is a key AMADER partner in implementing energy access and minigrid efforts

4.3 Program Overview

The government of Mali, acting through AMADER with assistance from the World Bank and KfW, implemented a bidirectional strategy for rural electrification to jumpstart a private sector market for minigrids. Program options for minigrid developers included a bottom-up and a top-down development approach to participating in the AMADER programs. This section examines each approach in more detail.

"Spontaneous" Entrepreneurship: PCASER

Under this "bottom-up" approach, private developers submit a "spontaneous project application for rural electrification," known as PCASER, to AMADER for the development of one or more minigrids serving a couple hundred to a few thousand customers per minigrid.

---

[5] See "Mali: Household Energy and Universal Access. Increasing Access to Basic Energy Services in Mali: What a Little Light Can Do for Social and Economic Development." http://go.worldbank.org/6XEAVQYIZ0.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

AMADER reviews the project proposals and if it accepts the application and the project is greater than 50 kW, the developer signs a concession agreement that sets the terms and conditions the developer must follow while granting the developer a renewable 15-year license to sell electricity within the specified service area. For installations smaller than 50 kW, the developer needs only to register with AMADER. The first two companies that gained PCASER concessions for large service areas were Yéelen Kura and SRBO.

The concession agreement includes the following provisions:

- Minimum quantity (seven hours every day) and quality (voltage and frequency) of electricity
- Activity reports sent to AMADER every six months with a more detailed report annually
- Developers may set their own tariffs, including cross-subsidizing different customer groups, described below, subject to the approval of AMADER
- AMADER serves as the arbiter of last resort in disputes between customers and developers, thereby reducing the number of disputes AMADER must mediate, saving the agency precious time and money (AMADER, n.d.[a]).

In addition, some developers of larger minigrids may want to purchase an existing minigrid. In this case, the concession agreement explicitly states, "the operator will have the possibility to purchase the non-amortized part of the PCASER developer's non-subsidized investments," leaving it up to the private developers to work out the details of the sale (AMADER 2010).

Competitive Bidding: ZEM

For the "top-down" approach, the government of Mali identified ten "multisectoral electrification zones" (ZEM) in which one private operator (which could be the national utility) would have a renewable 15-year monopoly to serve clients within the zone. To win a service monopoly, a developer would submit a detailed proposal to a competitive bidding process orchestrated by AMADER and CREE (Rolland and Glania 2011). AMADER would select the project with the strongest proposal and lowest tariff. In very low-income rural areas, which attract little interest from private sector developers, AMADER would leverage the Rural Electrification Fund to pay for feasibility studies and would advertise these projects in the competitive bidding process (iED 2013a). Developers of ZEM projects would have been able to purchase existing minigrids within their service area according to the concession agreement described above.

PCASER Takes Over ZEM

Today, AMADER regulates and supports only PCASER projects (Mamadou Ouattara, pers. comm., March 17, 2015). Whereas the PCASER approach has been quite successful—serving over 70,000 customers (iED 2013b)—AMADER was unable to attract any projects under the ZEM approach (Alassane Agalassou, pers. comm., March 17, 2015). Prospective developers found the ZEM approach to be too cumbersome and preferred instead to submit their projects under the PCASER approach. However, it has been noted that the ZEM approach, while not directly successful in attracting projects, helped to generate interest from national and international developers, even though they ultimately opted to apply under the

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

PCASER scheme. In fact, some of the larger developers manage multiple PCASER projects, and are therefore able to serve an area that is equivalent in size to a ZEM project (Alassane Agalassou, pers. comm., March 17, 2015).

Drivers

Three key factors motivated the initial implementation of this bidirectional strategy. First, Malian society is very entrepreneurial (Fabrice Bertholet, pers. comm., June 13, 2013). The success of the PCASER approach would not be possible without the decisions of local private entrepreneurs to want to construct and operate minigrids in rural areas based on their perception of the local market (World Bank 2014). Second, the Malian government has decentralized the governance of rural areas. In 1999, the government created rural municipalities, comprised of communes and villages, and held mayoral elections. By 2000, the municipalities had autonomous budgets and the government directed significant national tax revenues to the communes, villages, and municipalities to support community needs (e.g., improved water supply, access to energy services, improved health services). The decentralization of decision-making, financial resources, and budgetary autonomy changed the mindset from one of waiting for national-level action to one of stimulating local-level initiatives (World Bank 2003). Finally, Malian government officials set ambitious goals for rural electrification rates—by some accounts as high as 55% by 2015 (World Bank 2014)—but recognized that a bottom-up spontaneous approach would not guarantee results fast enough. The top-down concession approach was meant to exist alongside the bottom-up approach, and it was hoped that it would account for the majority of progress toward rural electrification goals (Fabrice Bertholet, pers. comm., June 13, 2013).

Program Challenges and Opportunities

The largest challenge that AMADER faced was a lack of interest in the private sector for ZEM projects. According to project managers at KfW—the German development institution that worked with Malian officials on the ZEM and PCASER approaches—the competitive bidding process "is a very long and complex process with high transaction costs" (Rolland and Glania 2011). As a result, interest from larger private companies was lacking even though the basic market opportunity existed.

Rural electrification agencies facing a similar challenge could streamline the concession review and approval process, which would include transparency in decision-making criteria; a clear sequence of approvals; timely decisions made by regulators who are held accountable for the process; and an external review of the process every 2–3 years (Tenenbaum et al. 2014). A streamlined review and approval process for concession applications would likely have made market entry through the ZEM approach more attractive for the private sector.

Some of the PCASER projects find themselves in the path of EDM's expansion. When this happens, EDM simply takes over the developer's minigrid and reimburses the developer the non-amortized portion of the developer's investments that were not subsidized by AMADER (Stephanie Nsom, pers. comm., March 2015). The lack of possibility to remain in business after the main grid arrives can be a deterrent to private investment. To resolve this problem, regulators could explicitly state what the business model options are for developers when the main grid arrives (Tenenbaum et al. 2014). In addition, regulators could require national

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

utilities to publish their grid expansion plans and timeline and hold them accountable to these plans (Tenenbaum et al. 2014).

Another challenge has been the failure of some PCASER projects due to lack of developer skills or low profitability of operators. Developers, in order to have their project accepted by AMADER, often initially set tariffs too low to allow cost recovery. As a result, AMADER has had to provide additional funds to these minigrids to keep them operating (iED 2013b).

With funding from international donors, other countries can invest in "capacity building" within the regulatory and rural electrification agencies, as the World Bank is doing with AMADER in Mali (Stephanie Nsom, pers. comm., March 2015; Tenenbaum et al. 2014). The rural electrification agency could also carefully assess the developer's management capabilities and profitability claims when evaluating developers' business plans. One option here would be to outsource due diligence to a third party or establish an expert team that focuses just on due diligence of potential projects (Stephanie Nsom, pers. comm., March 2015). Finally, it is important to consider building into the competitive bidding process the flexibility to assess organization skills and potential and not just the estimated costs and tariffs.

4.4 Policies and Actions to Support Energy Access

The following section describes several key policies implemented in Mali to support AMADER and the minigrid program. These include the use of capital cost grants, allowing AMADER to take responsibility for regulation of minigrids and allowing minigrid developers to set their own tariffs. This section will describe each policy as well as the drivers behind it and the challenges and opportunities presented by each.

4.4.1 Capital Cost Grants

To accelerate private sector engagement in developing minigrids, Mali has made funds available to minigrid developers to cover a percentage of the initial capital costs, including those associated with connecting new customers to the minigrid.[6] This funding is credited with being a major factor in triggering—and sustaining—the market for private sector minigrids in Mali. The following section examines this strategy further.

AMADER will give a capital cost grant to minigrid developers to cover up to 80 percent of the costs associated with the generator(s), wiring and equipment, and connecting customers to the grid, to a maximum of US$500,000, during the first two years (Mamadou Ouattara, pers. comm., March 17, 2015). These grants are available to all approved minigrid developers under the PCASER scheme, irrespective of generator type, and are calculated according to:

1. The total projected costs for constructing the grid and connecting customers who live within 15 meters of the minigrid's distribution lines. If a customer lives further than 15 meters from the minigrid's distribution lines, he or she pays the difference

[6] Connection costs include extending wiring, installing a meter, and conducting installations and inspections of equipment and appliances in the homes of prospective customers.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

between what the capital cost grant covers per connection and what it costs the developer to extend the line beyond 15 meters (Tenenbaum et al. 2014).

2. The number of customers projected to be connected during the first two years (note that the type of customer does not matter)
3. The projected average tariff across all customer types (Agalassou 2011; Alassane Agalassou, pers. comm., March 17, 2015).

AMADER pays the developer the grant based on the developer reaching certain milestones, the most important of which is the number of connections to the minigrid. This creates an important connection-based incentive for the developer. In addition, because each project has a unique revenue and cost structure and target for number of customers to connect to the minigrid during the first two years, AMADER calculates each capital cost grant on a project-by-project basis (Alassane Agalassou, pers. comm., March 17, 2015).

The developer is expected to contribute cash or "in kind" contributions to cover the remaining costs of developing the minigrid within 60 days of the start of construction. For its part, AMADER disburses the first 25% of the grant when the developer has made its contribution. It pays the remaining 75% according to pre-established construction and connection milestones (AMADER, n.d.[b]).

To supplement AMADER's capital cost grant, most developers obtain loans from domestic banks, although these are typically offered with short payback periods and high interest rates (Mamadou Ouattara, pers. comm., March 17, 2015). Others leverage funding from Malians living abroad in the form of donations or equity. As Bardouille (2012) explains, "as a 'stakeholder' of unelectrified rural communities to which they still have family ties, the Malian Diaspora community has helped to cover the unviable portion of the Korayé Kurumbu and Yéelen Kura [definition of RESCO] capital costs."

To fund the capital cost grants, the government of Mali established a Rural Electrification Fund, to be administered by AMADER, in 2003. The Rural Electrification Fund is the primary funding vehicle for private sector minigrid developers under the PCASER approach described above. In theory, the fund is to be supported by money from the Malian government, international donors, donations from Malians living abroad, (re)application fees from prospective (or existing) PCASER project developers, fines levied on project developers, a tax on project developer income, an annual fee imposed on project developers, and contributions from local authorities from their autonomous budgets. In practice, however, it is likely that nearly all funding comes from international donors (Stephanie Nsom, pers. comm., March 2015). In addition to funding capital cost and connection cost grants, the Rural Electrification Fund also financially supports feasibility studies and pilot projects, capacity development for project developers, awareness campaigns, and other AMADER activities (République du Mali 2005).

Policy Drivers

Malian officials knew that in order to jumpstart the market for minigrids, they would have to inject capital to attract private investors. They also knew that subsidizing consumers directly on their electricity usage or minigrid developers directly on their operations (e.g., fuel costs), would create a market distorted by financially unviable projects. However, in their

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

conversations with prospective private sector developers—and given the experiences of Korayé Kurumba, Yéelen Kura, and the SRBO—Malian officials understood that grants or subsidies were necessary. Capital cost grants emerged as the best option because they do not artificially support minigrid operations but instead enable financially sound projects to get off the ground (World Bank 2014).

In addition, Malian officials wanted to balance the fact that minigrid developers could charge cost-recovering tariffs (described below) with the fact that these tariffs would be higher than EDM's tariff. Capital cost grants were chosen because they can help make minigrid tariffs affordable by reducing the developer's costs without directly subsidizing tariffs, which would represent an ongoing and untenable cost for AMADER (World Bank 2014).

Challenges and Opportunities

Minigrid developers have reported some dissatisfaction with the capital cost grants they receive: some of the grants were not arriving by the agreed-upon date, and there was some concern that the Rural Electrification Fund was not reliable as a result of a number of factors, including politically motivated appointments at AMADER and changing top management at AMADER (Stephanie Nsom, pers. comm., March 2015). This has led to uncertainty for potential developers that had factored in a large capital cost grant in their business plan.

Once funds are made available to a minigrid developer, it is important that they remain available unless the developer fails to meet the agreed upon milestones. Funding can also be insulated from political and regulatory changes as a further safeguard. Governments could also consider providing long-term, sustainable support to rural electrification agencies through designated funds similar to Mali's Rural Electrification Fund, recognizing that these funds are one of the key tools that rural electrification agencies have to support minigrids and rural electrification more broadly.

4.4.2 Shifting Regulatory Responsibilities for Minigrids to AMADER

Delegating regulatory and grant-giving responsibilities to AMADER for the minigrid market has can be recognized as a key strategy behind Mali's success with minigrids (Franz, Peterschmidt, and Kondev 2014). Nevertheless, while developers and international donors prefer to deal with just one agency, the separation of responsibilities between AMADER and CREE is sometimes unclear (Stephanie Nsom, pers. comm., March 2015). Still, delegating responsibilities to AMADER has enabled AMADER to develop expertise on minigrids, which helps it make informed decisions.

Policy Drivers

The primary driver behind the creation of AMADER was the World Bank, which, based on its experience in other countries, recognized that creating a so-called one stop government agency to regulate and grant funds to the rural electrification sector was a "cleaner" and "easier to implement" approach than "assigning regulatory responsibilities over isolated minigrids to the national electricity regulator" (Tenenbaum et al. 2014). Malian government officials agreed, and established AMADER as the specialized rural electrification agency under the oversight of the previously created CREE and DNE.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Challenges and Opportunities

Granting rural electrification responsibilities to AMADER created some coordination problems with EDM. In particular, EDM and AMADER could not agree on how best to handle situations in which a PCASER project wanted to sell electricity also to the main grid. EDM was not prepared to phase in new distributed generation, even if it counted toward EDM's goals of grid extension. After extensive negotiations, DNE decided to transfer management of the 10 grid-connected PCASER projects from the developer to EDM, and EDM compensated the developers for the non-subsidized investments. (Alassane Agalassou, pers. comm., March 17, 2015).

To avoid this problem, rural electrification agencies could explicitly state what the business model options are for connecting a minigrid to the main grid—or for when the main grid arrives in the service area of a minigrid.

One of the primary problems surrounding the delegation of regulatory power to AMADER that Malian policymakers and regulators now face was initially unexpected. After the establishment of a decentralized approach to governance, as described earlier, villages in Mali began to feel like AMADER was bypassing their authority when it granted licenses and concessions to private minigrid developers. For example, in the village Badinko, committee members requested detailed information on contracts and terms after a private minigrid operator received grants from AMADER to serve the village (Hughes et al. 2013).

One solution here could be to encourage the private developer to sign an electricity service agreement with the village(s) it intends to serve stating the rights and responsibilities of the village and of the developer. This approach has been successfully implemented in Cambodia. To avoid excessive burdens or delays for developers, the rural electrification agency could develop a model version of such a contract; in this way, the village, the developer, and the agency all agree on what is expected. The developer would then show that the agreement was publicized and discussed in the village as a condition for receiving grant money or a concession (Tenenbaum et al. 2014).

Another solution could be to implement education and outreach programs in rural communities as part of the rural electrification agency's market awareness programs to build understanding of the costs and benefits associated with minigrid electricity.

4.4.3 Allowing Minigrid Developers to Set Their Own Tariffs

AMADER allows minigrid developers to set their own tariffs. The concession contract states, "the concession holder shall be free to set the rates in the contracts it signs with customers." However, it must submit these rates and supporting documentation to AMADER for approval: "The concession holder shall produce all the evidence and documents necessary, including its operating accounts," with its semi-annual report to AMADER. The contract also allows rates to be adjusted annually at the request of AMADER or the concession holder. To evaluate and adjust tariffs, AMADER uses a formula detailed in the concession contract that includes costs of raw materials, wages, inflation rate, and diesel prices, as well as costs incurred for "pre-financing by the operator of the cost of connection, customer interface (e.g., circuit breaker and energy meter) for interior installations, and electrical equipment such as

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

lighting units" (AMADER, n.d.[a]). In this way, AMADER differentiates between types of minigrids reflecting their different cost structures (Bardouille 2012).

In 2011, the average minigrid electricity tariff for households was about US$0.48/kWh—high compared to the ~ US$0.12/kWh tariff for grid-connected customers (Eberhard et al. 2011). In 2013, minigrid tariffs for households averaged around US$0.50/kWh (Fabrice Bertholet, pers. comm., June 13, 2013; Bardouille 2012).

It is noteworthy that the tariff levels are this high because developers receive such a significant capital cost grant. The data are not available to understand exactly what the cost and revenue breakdown is behind the average tariff levels. Most of the mini-grids in Mali are diesel-powered, which have higher operating costs than ones that use hybrid or renewable energy power. This may partly explain elevated tariffs. In addition, the role of capital cost grants is to promote the overall sustainability of the mini-grids sector, which entails not only ensuring the financial viability of individual mini-grids but also promoting interest in the sector from prospective private developers. Thus, even when tariff levels are high in Mali, donors and government officials may be reluctant to reduce or eliminate the capital cost grants because of the repercussions it would have on the sector's overall growth.

Allowing minigrid developers to set their own tariffs has also enabled the creative use of technology in several minigrid developers' business models. For example, Shared Solar has developed a pay-as-you-go model that allows customers to purchase small amounts of electricity "on demand" by purchasing scratch cards from local vendors and sending a text message with a single-use code to the network operator. Customers are willing to pay as high as US$3 for the first kWh each month, which is high enough for Shared Solar to recover its costs (Bardouille 2012). These minigrids have led to new local small businesses, a new local radio station, and improved hospital services in some of the pilot villages (Harper 2013). In another example, Columbia University's Earth Institute has constructed a series of minigrids that deploy prepaid meters and "smart controls" that limit overuse at the customer and minigrid level to ensure a stable supply (CEM 2013).

Policy Drivers

Several factors motivated and enabled AMADER's decision to allow minigrid developers to set their own tariffs. First, officials at AMADER knew that in order to attract private sector investment, they had to set conditions that allowed companies to achieve financial sustainability. Allowing developers to set their own tariffs, subject to the approval of AMADER, was a key part of this strategy, complementing the capital and connection cost grants described above. Second, the officials at AMADER likely recognized that they would not have sufficient funds or administrative capacity to subsidize tariffs for every customer of every minigrid (and it could not subsidize certain customers while not subsidizing others). Third, the World Bank's experience from working with AMADER since the early 2000s has demonstrated that AMADER has an in-depth understanding of the cost structure and operating conditions of rural electricity suppliers and an incentive to maintain their financial viability. AMADER is therefore well positioned to balance the competing considerations of consumer interests and long-term financial viability of minigrid developers.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Challenges and Opportunities

The difference between higher minigrid tariffs and the low tariffs charged by EDM on the main grid—sometimes twice as high—inevitably creates "tariff envy," especially when the minigrid serves a village located near another village served by EDM. It also creates political tension between local representatives and energy sector regulators at CREE and AMADER. For example, in 2011, the Malian government ordered EDM to connect to seven isolated minigrids located close to the national grid, effectively putting the minigrid out of business (after an unspecified compensation to the developer) (Tenenbaum et al. 2014).

Mitigating this challenge is difficult. For minigrid developers to operate in a financially sustainable way in the absence of tariff or other operating cost (e.g., fuel) subsidies, they need to be able to charge cost-recovering tariffs. In addition, many governments cannot afford to subsidize tariffs in addition to providing capital cost grants to developers. Raising the national uniform tariffs to be on par with minigrid tariffs is also often politically untenable.

One possible solution, as mentioned earlier, is for the national utility to make its grid expansion plans available to the public and to set realistic timetables to which it is held accountable. Unelectrified communities are likely to understand that higher tariffs are better than no electricity, but if they believe that having minigrid electricity prevents or precludes them from receiving main grid electricity, tariff envy and aversion to—or outright rejection of—minigrid electricity is likely.

4.4.4 Supporting Diesel-Powered Minigrids to Include Renewable Energy

A minigrid powered by both fossil fuels and renewable energy is called a hybrid minigrid, and the process of incorporating renewable energy is called hybridization. In Mali, the most common configuration of hybrid minigrids is solar power and batteries to offset generation from a diesel generator. Financial support to minigrid developers for hybridization comes in the form of capital cost grants for the purchase and installation of renewable energy equipment and components. Funds come primarily from outside donors and/or the minigrid developers themselves. Further support for hybridization came when the Malian government eliminated the VAT on imported and purchased renewable energy components and equipment.

To date, over 30 hybrid minigrids operate in Mali (Mamadou Ouattara, pers. comm., March 17, 2015). Examples of recent hybridization projects include:

- The World Bank funding a project to install photovoltaic (PV) arrays in existing diesel-powered minigrids in up to 50 locations, comprising a total of 5 MW of PV and a total investment budget of US$58 million (US$11,600 per kilowatt peak [kWp] PV), including: Kama SA (300 kWp); Yéelen Kura (300 kWp) planned in addition to an existing 72 kWp hybrid minigrid; and Tilgaz (22 kWp)
- An AMADER-led program to hybridize 17 minigrids for a planned total of 1 MW of PV funded by international donors (Léna 2013).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Under AMADER's rules, the developer—not AMADER—decides how to optimize electricity production on the hybridized minigrid. This hands-off approach has appealed to minigrid developers and AMADER officials alike.

Drivers

Economics was the initial motivating factor behind both AMADER and minigrid developers calling for support to hybridize diesel-powered minigrids. Most private-run minigrids are powered by diesel generators, and most developers pay the full retail price for diesel including VAT (iED 2013b). As mentioned earlier, this leads to minigrid tariffs that are considerably higher than tariffs on the national grid. Offsetting diesel generation with renewable energy reduces operating costs but greatly increases capital costs since renewable energy components are more expensive than those for diesel generators.

How, then, should hybridization be financed? The priority—and legal mandate—for AMADER and the Rural Electrification Fund is rural electrification, not renewable energy (Tenenbaum 2014). Indeed, many new PCASER projects are diesel-powered while others are hybrids (Mamadou Ouattara, pers. comm., March 17, 2015). As a result, AMADER and Malian government officials did not want to take away funding from the Rural Electrification Fund to support hybridization. Instead, they sought financial support from international donors including the World Bank while also encouraging private developers to seek their own funding (and contribute in-kind, such as installation of the renewable energy equipment) for hybridizing diesel-powered minigrids. Appetite from the international donor community for supporting renewable energy in developing countries meant that funding was available.

Challenges and Opportunities

One of the primary challenges with the hybridization projects is the legal implications for the concession contracts of minigrid developers who might want to hybridize but are well into their 15-year contract with AMADER. Their concession contract and grant terms are based on the original cost structure of a diesel-powered generator. Developers fear that any new concession contract based on a hybrid system will be less favorable than the one they currently have. (Stephanie Nsom, pers. comm., March 2015).

AMADER is considering extending concession contracts for 10 years after completion of a minigrid's hybridization and adjusting the terms and conditions to reflect the new cost structures of hybrid minigrids – a consideration that merits the attention of other rural electrification agencies seeking to support minigrid hybridization. Important questions to address when considering this option might include how the process would be administered and which minigrid developers will have priority. (Stephanie Nsom, pers. comm., March 2015).

4.5 Challenges

Although the Malian example presents a number of key lessons and successes, challenges to minigrid deployment remain. Key challenges, elaborated in the sections above include:

- Long and complex competitive bidding processes with large transaction costs impacted private sector interest.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- Lack of possibility to remain in business after the main grid arrives can be a deterrent to private investment, despite reimbursements.
- Lack of developer skills or low profitability of operators has led to failure of some PCASER projects.
- Delays in receiving capital cost grants led to uncertainty for potential developers that had factored in a large capital cost grant in their business plan.
- Poor coordination and planning between EDM and AMADER impacted program deployment.
- Village-level concerns relating to AMADER bypassing their local authority when licenses and concessions are granted to private sector minigrid developers can lead to conflicts with village leaders.
- Higher mini-grid tariffs as compared to tariffs charged for main grid connection can create "tariff envy" and political tension, but unelectrified communities are likely to understand that higher tariffs are better than no electricity if they are assured that access to relatively expensive mini-grid electricity now does not preclude them from receiving grid-based electricity from the main utility at some future point.
- Legal issues associated with hybrid system concession contracts and developer fear that any new concession contract based on a hybrid system will be less favorable than current contracts.

4.6 Lessons Learned

Reflecting on Mali's path to minigrids, we can see an important and immediate takeaway: there was no "silver bullet" that led to the development of the minigrid market throughout Mali today. Still, while Mali's path toward minigrids evolved more or less organically, other countries can learn from the key policy and regulatory elements described in detail in this case study:

- Offering multiple avenues for private sector participation in the mini-grid sector provides flexibility and may provide unanticipated opportunities for expanded participation Capital cost grants to support the developer's financial viability and sustainability
- A designated "one stop" agency to regulate and give grants to minigrid developers
- Allowing minigrid developers to set their own tariffs
- Support for diesel-powered minigrids to hybridize, reducing their operating costs and thus lowering their tariffs

The combination of these measures has resulted in over 160 minigrids currently in operation, over 30 of which are hybrids, each serving on average 500 customers with good quality electricity for at least 7 hours per day every day (Mamadou Ouattara, pers. comm., March 17, 2015). From the private sector minigrid developer's perspective, the market in Mali looks relatively attractive compared to other markets in Sub-Saharan Africa and AMADER has a large pipeline of business plans from prospective minigrid developers, awaiting approval and financing from the Rural Electrification Fund (World Bank 2014).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

The measures described in this case fit together in what we might call the "Mali Model." While not perfect, they are certainly worth consideration by policymakers and regulators looking to support a private sector market for minigrids in their own countries. Suggestions for how to improve upon the model include:

1. Streamline the regulatory review and approval process of concession agreements.
2. Explicitly state what the options are for developers when the main grid arrives.
3. Require the utility to publish its grid expansion plans and hold it accountable to them.
4. Invest in "capacity building" for the rural electrification agency.
5. Build into the competitive bidding process the flexibility to assess organization skills and potential, and not just the estimated costs and tariffs.
6. Consider a limited number of long-term funding agreements with donors or other agencies insulated from politics to ensure a stable baseline amount of capital. Once funds are made available to a minigrid developer, they must remain available unless the developer fails to meet the agreed upon milestones.
7. Encourage the private developer to sign an electricity service agreement with the village(s) it intends to serve stating the rights and responsibilities of the village and of the developer.
8. Implement education and outreach programs to communities to increase understanding about the costs and benefits of minigrid electricity.
9. Consider extending concession contracts for 10 years after completion of a minigrid's hybridization, and adjusting the terms and conditions to reflect the new cost structures of hybrid minigrids.

4.7 References

AfDB/OECD/UNDP (African Development Bank/Organization for Economic Co-operation and Development/United Nations Development Programme). 2014. *African Economic Outlook 2014: Global Value Chains and Africa's Industrialisation*. Paris: OECD Publishing.

Agalassou, Alassane. 2011. "Rural Electrification and Opportunities for Gender Integration in Mali." Presentation at the ESMAP Knowledge Exchange Forum, March 17.

AMADER. 2010. "Avis de Pre-Qualification: Realisation de Projets d'Electrification Rurale." *Journal du Mali*. http://www.journaldumali.com/files/appels/35.pdf.

AMADER. n.d.(a). "Specifications Annexed to Concession Order." Unofficial English translation. Washington, D.C.: The World Bank. http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Mali0Specifications.pdf.

AMADER. n.d.(b). "Financing Agreement N°……../AMADER/DG/DAF for the Electrification Of……" http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Mali1Model0Financing0Agreement.pdf.

Asmus, Peter, Taylor Embury, and Mackinnon Lawrence. 2014. *Microgrid Deployment Tracker 2Q14*. Boulder, Colorado: Navigant Research.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Bardouille, Pepukaye. 2012. *From Gap to Opportunity: Business Models for Scaling Up Energy Access.* Washington, D.C.: International Finance Corporation.

Bhattacharyya, Subhes C. and Debajit Palit, eds. 2014. *Mini-Grids for Rural Electrification of Developing Countries: Analysis and Case Studies from South Asia*. New York: Springer.

CEM (Clean Energy Ministerial). 2013. "Mini-Grids: Pre-Read for Public-Private Roundtable." Presentation at the Clean Energy Ministerial Roundtable 6: Mini-Grid Development, New Delhi, India, April 17.

Chaurey, A. and T.C. Kandpal. 2010. "A Techno-Economic Comparison of Rural Electrification Based on Solar Home Systems and PV Microgrids." *Energy Policy* 38(6):3118–29.

Eberhard, Anton, Orvika Rosnes, Maria Shkaratan, and Haakon Vennemo. 2011. *Africa's Power Infrastructure: Investment, Integration, Efficiency*. Washington, D.C.: The World Bank. http://www.ppiaf.org/sites/ppiaf.org/files/publication/Africas-Power-Infrastructure-2011.pdf.

Franz, Michael, Nico Peterschmidt, and Bozhil Kondev. 2014. *Mini-Grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-Grid Roll-Outs*. Eschborn, Germany: European Union Energy Initiative, Partnership Dialogue Facility.

Harper, Meg. 2013. *Review of Strategies and Technologies for Demand-Side Management on Isolated Mini-Grids.* Berkeley, California: Lawrence Berkeley National Laboratory and Arcata, California: Schatz Energy Research Center.

Hughes, Wendy, Vanessa Lopes Janik, and Yvette Bossman. 2013. *Integrating Gender Considerations into Energy Operations.* Knowledge Series 014/13 Report No. 76571. Washington, DC: The World Bank.

iED (Innovation Energie Développement). 2013a. *Feasibility Study for Rural Electrification Projects in Senegal River Basin*. Francheville, France: Innovation Energie Développement.

iED. 2013b. *Low Carbon Mini Grids: Identifying the Gaps; Building the Evidence Base*. Support Study for DFID. Francheville, France: Innovation Energie Développement.

Léna, Grégoire. 2013. *Rural Electrification with PV Hybrid Systems: Overview and Recommendations for Further Development*. Paris: International Energy Agency and the Club of African National Agencies and Structures in Charge of Rural Electrification.

Ministère des Mines de L'Energie et de l'Eau. 2006. *La Politique Energetique Nationale*.

NRECA (National Rural Electric Cooperative Association). 2000. *Reducing the Cost of Grid Extension for Rural Electrification*. Report for the Energy Sector Management Assistance Programme. Washington, D.C.: The World Bank. https://www.esmap.org/sites/esmap.org/files/Rpt_gridextensionesm227.pdf.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Palit, Debajit, and Akanksha Chaurey. 2011. "Off-Grid Rural Electrification Experiences from South Asia: Status and Best Practices." *Energy for Sustainable Development* 15(3): 266–76.

République du Mali. 1999. "Fixant l'Organisation et Les Modalites de Fonctionnement de La Direction Nationale de l'Energie, vol. Decree No. 99–186/P-RM."

République du Mali. 2000a. *Portant Creation et Organisation de La Commission de Regulation de l'Electricite et de l'Eau*.

République du Mali. 2000b. *Portant Organisation Du Secteur de l'Electricite*.

République du Mali. 2003a. *Fixant l'Organisation et Les Modalites de Fonctionnement de l'Agence Malienne Pour Le Developpement de l'Energie Domestique et de l'Electrification Rurale*.

République du Mali. 2003b. *Portant Creation de l'Agence Malienne Pour Le Developpement de l'Energie Domestique et de l'Electrification Rurale*.

République du Mali. 2005. *Portant Modification de l'Ordonnance N. 00-019/P-RM Du 15 Mars 2000 Portant Organisation Du Secteur de l'Electricite*.

République du Mali. 2009. *Portant Suspension de La Perception de La Taxe Sur La Valeur Ajoutee, Des Droits et Taxes Sur Les Equipements d'Energies Renouvelables a l'Importation, vol. Decree No. 09–503/P-RM*.

Rolland, Simon, and Guido Glania. 2011. *Hybrid Mini-Grids for Rural Electrification: Lessons Learned*. Brussels, Belgium: Alliance for Rural Electrification.

SE4All (Sustainable Energy for All). 2014. *High Impact Opportunity: Clean Energy Mini-Grids*. Vienna: Sustainable Energy for All.

Tenenbaum, Bernard, Chris Greacen, Tilak Siyambalapitiya, and James Knuckles. 2014. *From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa*. Directions in Development. Washington, D.C.: The World Bank.

Ulsrud, Kristen, Tanja Winther, Debajit Palit, Harald Rohracher, Jonas Sandgren. 2011. "The Solar Transitions Research on Solar Mini-Grids in India: Learning from Local Cases of Innovative Socio-Technical Systems." *Energy for Sustainable Development* 15(3): 293–303.

UNDP (United Nations Development Programme). 2004. *Reducing Rural Poverty through Increased Access to Energy Services: A Review of the Multifunctional Platform Project in Mali*. Bamako, Mali: United Nations.

World Bank. 2003. *Project Appraisal Document on a Proposed Credit from the International Development Association in the Amount of SDR 25.20 Million (US$35.65 Equivalent) and Proposed Grant from the Global Environment Facility Trust Fund in the Amount of US$3.5*

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Million to the Republic of Mali for a Household Energy and Universal Access Project. Washington, D.C.: The World Bank.

World Bank. 2013. *Project Appraisal Document on a Proposed IDA Credit in the Amount of SDR 16.3 Million (US$25 Million Equivalent) and a Proposed SCF-SREP Grant in the Amount of US$14.9 Million and a Proposed GPOBA Grant in the Amount of US$5.0 Million to the Republic of Mali for a Rural Electrification Hybrid System Project*. Washington, D.C.: The World Bank.

World Bank. 2014. *Project Concept Note 131084: Mali Rural Electrification Hybrid System Project.* Washington, D.C.: The World Bank.

World Bank and IEA (International Energy Agency). 2014. *Sustainable Energy for All 2013-2014: Global Tracking Framework Report*. Washington, D.C.: The World Bank, 2014.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

5 Mexico: Provision of Solar Power for Households in Rural Communities Through Iluméxico

Case study prepared and written prepared by Ellen Morris and Merijn de Been

Lack of access to electricity is a significant challenge faced by approximately three million people[7] in Mexico, often located in rural communities.[8] Iluméxico, a program focused on deployment of solar home systems in rural Mexico, presents an innovative public-private partnership model to address this electrification challenge, alleviate energy poverty, and support sustainable market outcomes.

In alignment with key policy themes for energy access described in Volume 1, Section 2 of this report, the success of Iluméxico was supported by several government policies and actions presented in Figure 13. Policies and actions that were instrumental in supporting Iluméxico in expanding access to energy recognize the connection between energy and development, clear and transparent regulations, openness to private sector approaches, and access to early-stage capital. This case study presents key elements of Iluméxico's business model as well as government policies that have supported Iluméxico in addressing crucial energy access needs in rural Mexico.

This case study begins by providing the country context for energy access efforts in Mexico. It then presents primary energy access actors and provides a high-level overview of the Iluméxico project. The next section of the case study examines key policy and regulatory measures to support energy access in Mexico. The final two sections summarize key challenges and lessons learned related to the Iluméxico model. [9]

---

[7] Approximately 2.3% of the total population

[8] See the Federal Electricity Commission website: http://www.cfe.gob.mx/ingles/Pages/Home.aspx. Globally, four out of five households that lack access to electricity are located in rural areas (IEA 2012).

[9] Information in the case study was drawn primarily from interviews with the Iluméxico founders and internal company reports relating to the business strategy, financing sources, and growth of the company since 2009. Research by the Delft University of Technology in the Netherlands (de Been, 2014) related to development of a scale-up strategy for Iluméxico was also included in the case study. In addition, the case study is supported by data collected from interviews with Iluméxico customers in 2014.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

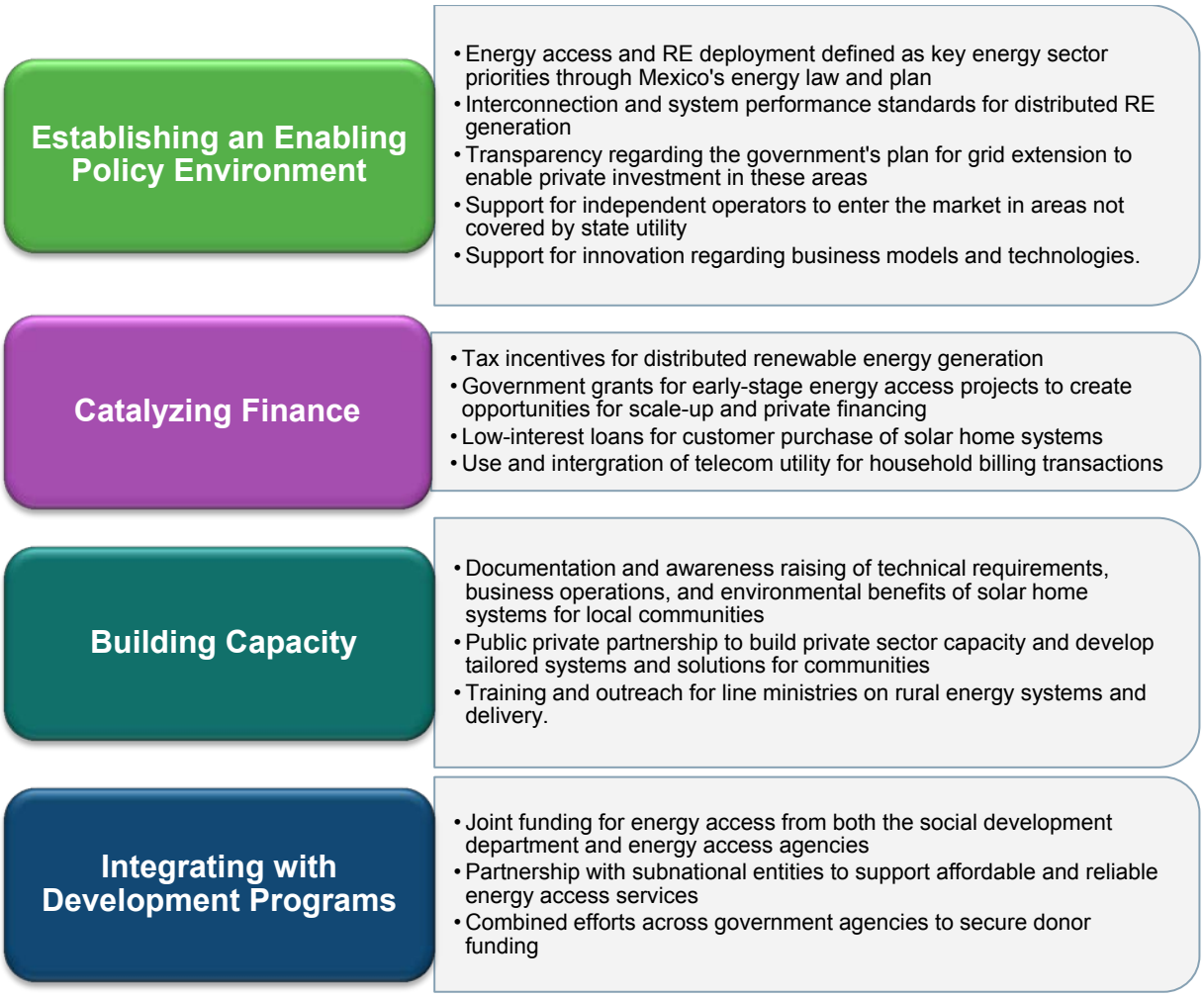

Figure 13. Key policies and actions in the context of the energy access framework

Building on the actions highlighted above, the Iluméxico case study provides a number of lessons that can inform energy access efforts globally. Key lessons, elaborated in the sections below, include:

- As evidenced through various collaborative actions described in the case study, public-private partnership is critical to support successful energy access outcomes.
- Provision of transparent information on grid extension plans can send a crucial signal for private investment in rural energy access.
- Service and maintenance plans are necessary to ensure long-term system sustainability and successful energy access business models.
- Collaborating with development agencies and subnational governments can provide an opportunity for diversified funding while also leveraging successes and experience gained from work funded by traditional energy entities.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

5.1 Country Context

Approximately three million people in Mexico, or 2.3% of the population, lack access to electricity.[10] . Exacerbating this issue, these communities are often difficult to access due to rough, mountainous, and densely vegetated terrain. Great distances often separate communities and even houses within communities.

Given the remoteness and difficult terrain of many rural communities in Mexico, grid extension is often cost prohibitive. While a number of NGOs and energy access programs have tried to support rural electrification in these areas, lack of long-term engagement and training of communities on use of technologies as well as limited service and maintenance has led to less than optimal outcomes. In a number of cases, rural communities have grown accustomed to receiving free products from government-subsidized and other programs without local buy-in or commitment.

Lighting and energy options for communities without electricity are extremely limited and often expensive in rural areas of Mexico. Options include diesel/gas lanterns and candles for lighting, dry cell batteries for radios, and, for the few who can afford it, diesel fuel and diesel generator sets. Because lighting is a major priority for many people, they are often willing to spend a relatively large portion of their income on available lighting fuels and technologies. Each month, the majority of farmers in rural Mexico spend around US$15 on candles and kerosene for fuel lamps, about 10% of their monthly income of US$150–US$200.[11] Kerosene and candles are costly lighting options for poor communities, often provide poor lighting, and can lead to negative health and environmental impacts (IEA 2010; Pode 2009; Adkins et al. 2010; Chilcott 2006; Jacobson et al. 2013).

Within the context of these geographic and economic challenges, Iluméxico's business model provides a unique approach to support energy access and is one of the few examples of a commercial enterprise that has successfully leveraged public support for rural electrification in Mexico.

5.2 Key Agencies and Actors

A number of key agencies and actors were integral in supporting the launch and growth of Iluméxico. Government agencies focused on the energy sector, social development, and housing not only provided the foundational public policy framework to address energy infrastructure and access needs in Mexico, but also supported community engagement and implementation of energy access strategies. Diverse support from various ministries and programs also allowed for a more sustainable initiative. Key Iluméxico partner agencies and programs are outlined below.

- Ministry of Energy (SENER): Federal agency responsible for production and regulation of the energy sector in Mexico. Iluméxico received funding from SENER for electrification projects aimed to increase energy access in rural areas.
- Federal Electricity Commission (CFE): State-owned electric utility of Mexico. Transparently communicated grid extension plans with Iluméxico to help guide business strategy. This information was critical in supporting energy access in rural areas.

---

[10] See the Federal Electricity Commission website: http://www.cfe.gob.mx/ingles/Pages/Home.aspx.
[11] Iluméxico. 2013. Internal survey.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- Oaxaca State Department of Social Development (SEDESOH): State agency responsible for social development in Oaxaca. Iluméxico received funding to promote the sale of solar home systems in underdeveloped regions in rural Oaxaca.
- National Council of Science and Technology (CONACYT): Government agency promoting innovation in science and technology by Mexican companies. Iluméxico has received research and development grants from CONACYT to develop innovative charge controllers integrated in their solar home systems.

5.3 Project Summary

Launched in 2009, Iluméxico is a social enterprise that aims to improve the lives of Mexico's rural poor by increasing access to affordable solar products. Since Iluméxico's first small pilot project in 2009, the company has grown significantly, now operating in four Mexican states and serving more than 18,500 people. Figure 14 presents the evolution of Iluméxico from 2010 to 2014. In addition to key business model elements described below, the case of Iluméxico provides a number of interesting insights into public policy to support private investment for energy access in Mexico.

Iluméxico is a social enterprise that aims to generate profits while achieving social and environmental benefits. The company has received a combination of government grants and subsidies that were important in the early success of the projects, but it operates independently of any government or political entity. Iluméxico has also received investment from the private sector, which will be described in detail in Section 5.4.

Iluméxico's business model focuses on the sale of small-scale solar home systems at a range of sizes. The most basic and affordable system—a 15-W solar panel, a charge controller, battery, and two 3.5-W LEDs—provides electric lighting and includes a USB port to charge phones, among other uses (de Been 2014). In addition to the basic system, larger sized systems with 20-W, 50-W, 100-W, 150-W, and 200-W panels are available, as well as an option for large grid-connected systems for residents or commercial businesses in urban areas. The larger systems include enhanced lighting systems and support additional electronic devices by providing an inverter. Iluméxico also sells water pumps, refrigerators, public lighting, and electric fences, each with corresponding solar panels and batteries.

Iluméxico employs a community-oriented, holistic approach that incorporates all elements of the energy access value chain, including technology, installation, service, and financing. Another key aspect of the business model is ensuring communities have a stake in the project through charging a nominal fee for the service. This approach has proven to increase the adoption and maintenance of the systems and generated profits, which are reinvested in other regions and communities.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

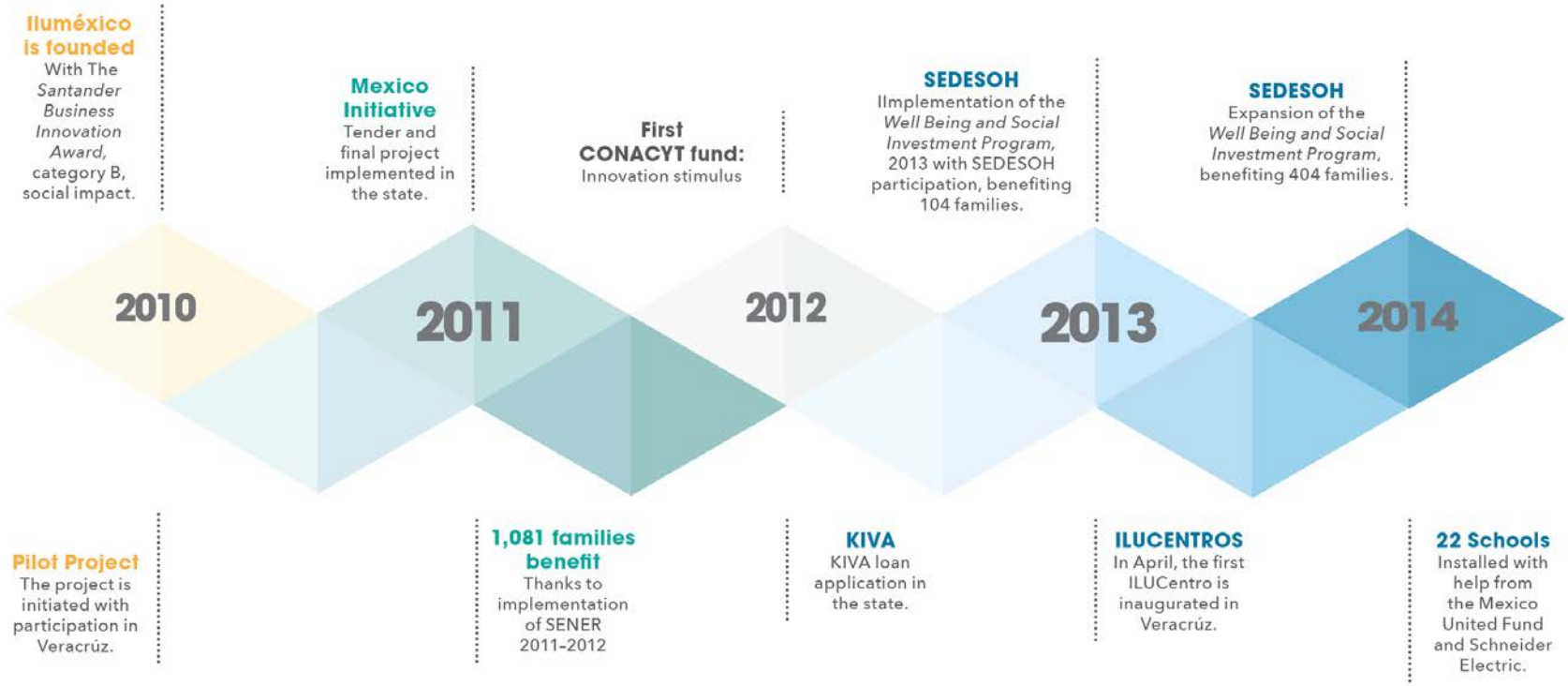

Figure 14. Evolution of Iluméxico

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Local stakeholders are engaged to support sustainability of Iluméxico operations on the ground. This includes partnerships with the private sector to mobilize resources and NGOs to support Iluméxico's community development activities. Iluméxico also works closely with local and federal governments to identify the needs of rural communities. One such valuable partnership with CFE resulted in plans to develop technical procedure regulations for social and technological transfer programs to ensure safety and wellbeing of highly disadvantaged populations of Mexico.

To support sustainability of the initiative, Iluméxico depends on local branches, called ILUCentros, to provide customer service and troubleshooting in rural areas. After solar home systems (SHSs) are purchased, local ILUCentros technicians provide an installation check to support optimal installation and usage. In addition to providing technical assistance, spare parts, and other services such as battery replacement, the ILUCentros serve as hubs for community development (e.g., offering workshops in local schools on workforce skills, sustainability, community empowerment, and gender equality). The ILUCentros are funded through the sale of complementary products/replacements for SHSs and a maintenance plan that users renew each year for access to these services. To incentivize renewal of the plan, customers receive a free replacement battery after three to four years of subscription. The ILUCentros also provide local employment opportunities with two to three employees per center. To build local capacity, Iluméxico demonstrates installation and operation of systems at the community level. Figure 15 presents the location of ILUCentros in various rural areas of Mexico.

Figure 15. ILUCentros Locations

Iluméxico customers can provide full up-front payment for SHSs or use a low-interest payment plan (a total annualized cost of 35%-50%) over the period of one year. The majority of purchases use the low-interest payment plan (de Been 2014). Consumer finance is offered through Telecomm-Telégrafos, a decentralized government telecommunications agency that provides several communication services and basic financial services such as remittances. It administers the monthly loan payments for rural customers using an existing nation-wide network of local branches, often closely located to Iluméxico's rural customers.

The following illustrates a typical Iluméxico transaction for the purchase of a basic household SHS. When a family decides to purchase a system, they first sign a contract with Iluméxico describing the

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

transaction and the payment plan to repay the loan for the system. Immediately after signing, they receive a new, ready-to-install system. Both the signing and delivery of the products takes place in the local community or nearest town. Once the product is installed, the family makes a monthly payment at a branch of Telecomm-Telégrafos for a term of one year, after which the loan is paid in full and the family owns the SHS system.

In total, Iluméxico has installed approximately 3,500 solar home systems throughout Mexico, reaching more than 18,000 people. Although Iluméxico's program comes at a small cost for the community, the organization has improved household economies by saving users between 10–15% of their income.[12] In communities where Iluméxico has implemented solar technologies, children have also gained an average additional 2–3 hours per day of education and micro-enterprises have increased revenue through longer working hours.[13] The initiative also supports environmental objectives, with pilot results of traditional oil-based lamps and candle replacement yielding a reduction of 0.225 tons of CO_2 per year per installation, totaling approximately 1800 tons as of 2015.[14]

5.4 Policies and Actions to Support Energy Access

The government of Mexico has supported a robust enabling environment to scale up private investment in energy access. As described below, key policies and actions have allowed Iluméxico to move from a primarily publicly funded initiative to leveraging a more diverse funding base.

5.4.1 High-Level Policy Framework

SENER and the Secretariat of Environment and Natural Resources (SEMARNAT) are the two key government agencies responsible for designing and implementing renewable energy, and energy policy more broadly, in Mexico. In addition, the government-owned utility CFE is a critical actor in shaping energy policy, particularly policies related to energy access described in this paper. Most notably, CFE's provision of transparent information on grid extension plans, information not commonly provided by utilities, has provided a strong signal for private investment in energy access projects in rural areas of Mexico and is detailed as one of the key lessons learned in Section 5.6.

Two key policies provide the foundation for RE deployment and energy access efforts in Mexico. First, the 2008 Law for the Development of Renewable Energy and Energy Transition Financing (LAERFTE) mandated a certain portion total energy supply to come from renewable resources, with transition and implementation led by SENER. Second, and as an outgrowth of LAERFTE, the National Energy Strategy (2013–2027) sets the foundation to support development of the energy sector with two main objectives: to drive development and economic growth, and to increase energy access and consumption. One key provision of the National Energy Strategy is a legally binding requirement that 35% of the energy mix in Mexico be generated by non-fossil fuels by the year 2024.

To increase energy coverage and diversify Mexico's energy portfolio, the National Energy Strategy aims to strengthen the energy regulatory framework and promote private investment in renewable

---

[12] Iluméxico. 2013. Internal survey.
[13] Because Iluméxico has executed several user surveys, both pre- and post-purchase, there is some data available on the social impact that users perceive after installation of a solar home system.
[14] Iluméxico website: http://www.Iluméxico.mx, accessed April 4, 2015.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

energy development. This high-level framework promotes public private collaboration and provides certainty for RE investors, thus stimulating private investment in RE projects. The National Energy Strategy also puts forth a provision to promote the development of RE projects that increase electricity access in rural areas.

Under this broader framework, rural electrification projects developed by private entities like Iluméxico will be supported and promoted over the next ten years. In particular, the government is providing funding for electrification efforts and individual agreements are being executed to support coordination between CFE and private developers to deploy energy access projects. Further, the National Energy Strategy explicitly promotes community RE schemes supported by public institutions and private sector companies, as well as the entrance of independent energy operators into regions not covered by CFE (including remote, rural locations). As noted above, CFE's provision of transparent information on grid extension plans has been a critical element in supporting successful energy access efforts in Mexico. With this information, the private sector can actively target communities not planned for grid extension and provide necessary systems and services to support electrification.

To stimulate the Mexican renewable sector, the government also offers private sector tax incentives. As such, companies may depreciate 100% of machinery and equipment used for RE generation, and custom duties have been removed for companies importing or exporting machinery, equipment, instruments, and materials for RE research or development.

Finally, to support the deployment of innovative technologies, in 1970, the federal government created CONACYT, a decentralized public agency to guide government policies related to science and technology (S&T), manage research programs, grant S&T scholarships, and provide research and development grants to industry and private sector. This agency supports local development of new technologies and innovation in order to contribute to the wellbeing of the population and increase the added value of innovative Mexican products.

5.4.2 Public Financing to Enable Private Investment

Government support was critical in supporting the transformation of Iluméxico from a small-scale project to a nationally operating private enterprise. Iluméxico began as a US$32,250 pilot project providing 40 SHSs in Los Tuxtlas, Veracruz, with prize funding from a large Mexican bank. In 2011, Iluméxico was able to leverage the successful results of this project to secure a US$375,000 grant through the government of Mexico Fund for Energy Transition and Sustainable Use of Energy. This fund is supervised by representatives from SENER, CFE, SHCP (Secretariat of Finance and Public Credit), SAGARPA (Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food), and SEMARNAT (Secretariat of Environment and Natural Resources) and supports expansion of RE through competitive solicitation of proposals.[15] With the grant, the scaled-up effort called 'Programa de Iluminación rural 2011–2012' focused on the provision of small SHSs to 1050 households in rural communities in the Mexican states of Campeche, Guerrero, and Veracruz from 2011 to 2012.

[15] Each year an amount is budgeted for the fund from the federal expenditure budget (2014: $117 million), though the fund may not publish future bids in the short term because of new energy reforms (KPMG 2014).

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Iluméxico received additional government grants including a US$123,000 grant from CONACYT used to develop an innovative new solar charge controller in 2011 and a US$57,000 grant in 2012. In 2011, Iluméxico also participated in Iniciativa México, a nationally televised program to stimulate entrepreneurial ideas with social impact. Through this initiative, Iluméxico received a grant of US$484,000 (US$323,000 funded by the national government and US$161,000 from Televisa) to support expansion. Iniciativa México involves academic institutions, social organizations and diverse opinion leaders, and it is supported by strong media promotion. This award helped raise the profile of Iluméxico and raise awareness of the initiative with other donors and partners.

The combination of the large project funded by the Fund for Energy Transition and Sustainable Use of Energy, the research and development grant from CONACYT, and the award money from Iniciativa México made it possible for Iluméxico to grow from a small-scale project to a vibrant social enterprise. This public support was instrumental in building a strong foundation for Iluméxico's energy access efforts through enabling the development of in-house solar technology, improving the distribution model, and expanding the staff and customer base.

5.4.3 Collaborating With Subnational Governments and Leveraging Local Development Programs

In Mexico, states and municipalities are responsible for planning and financing off-grid electrification and grid extension, and thus energy access. Therefore, local governments are crucial partners for Iluméxico. Local governments provide connection with communities, funding opportunities, and in some cases purchase solar home systems for public facilities and local programs. Currently, Iluméxico is collaborating with the state government of Oaxaca on energy access efforts. At the end of 2013, Iluméxico received a contract from the Oaxacan state government to partially subsidize solar home systems to unelectrified communities in rural Oaxaca. This project proved to be successful and subsequently a larger program with the Oaxacan state government was rolled out in 2014 and 2015. Specifically, the state government specifies projects for certain regions and provides subsidies for energy access efforts. Details of this partnership are presented below.

In 2011, the Oaxacan state government set an ambitious goal of advancing toward universal electricity access in all households in the state during the government administration (2010-2016). Oaxaca is a relatively poor state. More than 5% of the population—more than 48,000 households—lacks access to electricity. The initial program set up by the Planning Commission for Social and Economic Development of Oaxaca (COPLADE) aims to supply small-scale solar home systems to almost 10,000 households. The subsidy programs are funded by different entities in the government, such as the state's department for social development, SEDESOH, and the Secretary of Tourism and Development (STyDE), and are executed by the private sector.

Two private sector entities were commissioned to supply the solar systems: ACCIONA Microenergía and Iluméxico. Iluméxico was awarded the concession by building a track record based on a successful pilot project in northern Oaxaca at the end of 2013. Both companies deliver solar home systems using 25-W panels to deliver electricity used for lighting. The Oaxacan government subsidizes a little more than half of the final consumer price of electricity.

Details about the Oaxaca program shed light on how subsidies and customer financing are interrelated. The total cost of the 25-W SHS is US$250, including installation and a one-year maintenance plan. The subsidy from the Oaxacan government is US$140, making the final cost for the customer in Oaxaca US$110 (which can be paid either upfront or with a payment plan). With the payment plan, the customer can get a loan for a year. Terms are a US$30 down payment and monthly

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

payments of approximately US$8, a typically manageable payment level by the customers of Iluméxico. This program uses subsidies in concert with financing options to leverage private investment by customers.

The Oaxacan government program catalyzed the private sector in a way that complemented the work of the state utility (CFE) in order to reach the goal of universal electricity access in Oaxaca. Households in remote, rural areas that are expensive to connect to the existing grid are now being serviced by the private sector. The funding provided to subsidize system costs expands the potential market for enterprises like Iluméxico in regions that might otherwise prove too difficult and expensive to pursue. Even when the government funded programs end, Iluméxico is well positioned for the long term. The government funding was important in helping Iluméxico overcome the hurdle of initial investment that comes when entering a new region and provided it with an existing customer base and presence within the region, which could form a foundation for further expansion within that region or others.

Rather than working directly with CFE, the Oaxacan government commissioned the private sector to address these rural electrification needs because social enterprises such as Iluméxico have the experience and capacity to operate in difficult remote locations utilizing its innovative distribution and logistics model. At the same time, government-initiated programs provide an opportunity for social enterprises to expand their customer base by allowing them to sell for a lower sales price, reaching more people with lower income who could not normally afford unsubsidized systems.

Building on the experience in Oaxaca and other rural regions of Mexico, Iluméxico is collaborating with national and subnational government agencies to replicate its model across Mexico and draw from experience to support successful energy access outcomes. For example, based on its experience, Iluméxico is working with government officials to formulate technical standards for rural solar projects that will help to ensure long-term sustainability of systems. In addition, Iluméxico is leveraging support from Social Development Departments at the subnational level by setting specific electrification goals and targeting regions prioritized by the government for energy development due to extreme poverty or underdevelopment (such as the Oaxaca, Guerrero, or Chiapas regions). In this way, Iluméxico is building on the advancement and expertise gained through traditional energy ministry funding to leverage new development-focused funding and support a scaled-up business model throughout Mexico.

The government of Oaxaca recently attracted international attention when it was recognized by the Clinton Global Initiative for its goal to provide 1,500 solar systems to rural households in partnership with Iluméxico and other initiatives. It was highlighted as an innovative public private partnership supporting Mexico's National Development Plan 2011–2016 and goals associated with poverty alleviation in Oaxaca. This recognition demonstrates Iluméxico's success in aligning the initiative's business model with broader development goals and agencies.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

5.4.4 Moving Toward Further Private Investment and Market-Based Outcomes

The year 2013 represented a turning point for Iluméxico, as the larger government funded project ended and no further significant government grants were awarded to Iluméxico. In addition, with a change of government in 2012, there were major shifts in energy policies and funding, with some funding being reallocated or eliminated.[16] Thus, Iluméxico pivoted its business model to rely less on government grants, subsidies, or award funds.

To adapt to the changes that were occurring with reduced government support, Iluméxico sought to move toward a more independent, revenue driven model. Significantly, from 2013 to 2014, Iluméxico adopted a new distribution model that allowed the initiative to reach households located in remote areas of rural Mexico and provide them with solar home systems, microloans, and servicing. A key element of the newly developed distribution model was the introduction of ILUCentros, described above, which provide customer service and troubleshooting in rural areas and can serve as small showrooms. The ILUCentros require little investment, and they generally have proven to generate revenue. Under the ILUCentro business model, local staff are hired to work in the centers, while company ambassadors and promoters are recruited from within the targeted unelectrified communities to market the products.

Further, to support market-driven outcomes, Iluméxico made further adjustments to the company's business model. While initially Iluméxico subsidized up to 50% of the costs of the solar systems, the organization is gradually decreasing this percentage. Under this approach, it is expected that 80% of Iluméxico customers will pay the full price of the system and 20% of customers, such as the highly marginalized people with few resources, will receive subsidies. Although the model avoids dependency on government funds, residents can apply to reduce their personal investment if the local government or another entity offers a related subsidy. Importantly, a portion of the profits generated by Iluméxico's model is also reinvested into a community project fund in the area where the revenue is generated. The funds are sometimes used to finance community projects that meet local needs, such as public lighting or lighting in schools. For the future, Iluméxico plans to create an energy service network and provide access to new technologies for rural populations, proving a valuable rural distribution network.

Iluméxico recently secured private investment to take the next step toward growing into one of the largest off-grid solar providers in Mexico. The mixed equity/debt instrument investment of US$340,000 from an internationally operating European impact investment fund in 2015 will assure expansion into new regions, providing not only the opportunity to sell more solar systems to rural communities, but also to provide employment opportunities in often underdeveloped regions in Mexico. Social programs involving electrification of rural schools, community centers, and clinics that complement this investment will have a lasting impact on the long-term social and economic development of the local communities. Moreover, new community-based projects for solar street lighting will enhance the feeling of security in rural areas, and they will provide local entrepreneurs, such as small shop owners, with opportunities for increased revenue.

---

[16] Major reform of the energy sector was proposed and approved in mid-2014.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

5.5 Challenges

Although Iluméxico has experienced a number of successes, various challenges remain in scaling-up market-based energy access initiatives in Mexico. Two key challenges are outlined below.

- **Political transition and potential overdependence on government funding**: Initially, public funds were extremely beneficial in supporting Iluméxico's entrance in the rural energy access market and in allowing for experimentation with different delivery and end-user finance models. However, as energy access initiatives grow, Iluméxico's financial viability can potentially be at risk if government funding is greatly reduced or removed due to shifting priorities, government program adjustments, or budget cuts. This risk is often most apparent during periods of political transition. When government changes occur at the national or state levels, government funding may be redirected to different areas to reach new political goals. Under this scenario, government funded electrification projects could suddenly end, potentially undermining earlier efforts (e.g., possible faltering of system sales because of price increases when subsidies are reduced, or people's distrust of government electrification projects because there is no guaranteed continuity in the project). Changes in the organization and management of government programs due to changes in the political landscape can also jeopardize the continuity and funding of projects. To address this challenge and mitigate risk, energy access initiatives can actively diversify their financial base. As described above, Iluméxico is now working with a private impact investor to move toward a more sustainable business model.
- **Loan default and late payments**: Under the initiative, loan default has occurred in some cases, with higher default rates in the Oaxaca region (Manuel Wiechers Banuet, CEO of Iluméxico, pers. comm., March 4, 2015, Mexico City). When a default on a loan occurs, Iluméxico staff retrieves the systems directly from the customer. Reasons for default include customers not necessarily in need of systems (some had light already or are seasonal tenants), customers who were misinformed about the conditions of payment, or customers who may not value subsidized systems as much as unsubsidized systems. Iluméxico has learned from experience and is implementing measures to address these challenges.

5.6 Lessons Learned

A number of lessons, highlighted below, can inform energy access efforts around the world.

- **Public-private collaboration is critical to support successful energy access outcomes**—Iluméxico's experience demonstrates that a collaboration of national and state governments with the private sector can contribute to reaching the goal of universal electricity access. Partially government-subsidized SHS make it possible to reach the poorest households, which might not otherwise be able to afford market price systems offered by the private sector. However, although subsidies are often critical for the poorest communities, Iluméxico has also demonstrated the effectiveness of monthly payment plans to finance systems for customers. Private entities such as Iluméxico can also offer specific market knowledge, an efficient distribution network, and an informed customer base, all critical elements in supporting successful government-sponsored rural electrification projects. The government of Mexico has recognized that it can be more cost-effective in reaching rural customers through private sector collaboration and providing targeted incentives to ensure business viability.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- **Provision of transparent information on grid extension plans can send a crucial signal for private investment in rural energy access**—As discussed, the government owned public utility, CFE, controls electricity grid planning and operations in Mexico. Given this arrangement, it is essential for the private sector to understand the policies related to grid extension and the outlook of CFE's activities concerning rural electrification. CFE has demonstrated a model example of providing transparent information on grid infrastructure activities and extension plans, namely communities they will and will not serve. With this information, the private sector is able to easily understand demand for off-grid systems and services and target energy access efforts to communities the grid is not expected to reach. Provision of this information allows communities to avoid buying and companies to avoid selling solar home systems in areas where there might be plans for future grid extension. CFE's strategy seeks to avoid cost-prohibitive grid extension and sends a crucial signal to the private sector to support energy access in rural areas. Iluméxico established a strong working relationship with CFE to promote coordination and support collaborative energy access goals.
- **Service and maintenance plans are necessary to ensure long-term system sustainability and successful business models**—Private companies are shown to be crucial in providing reliable and timely service and maintenance of solar home systems and other small-scale RE technologies after purchase. It is well understood that without service and maintenance, components such as solar panels and batteries could malfunction or fail after a short period. Government provision of such services is often impractical given costs and skillsets that often align more closely with specialized private companies. Therefore, private companies such as Iluméxico are often well equipped to provide these crucial services and can benefit from ongoing service revenue models. Private companies can also consider integrating system upgrades with their business model to add an additional revenue stream, further increase access, and improve livelihoods.
- **Collaborating with development agencies and subnational governments can provide an opportunity for diversified funding, while also leveraging successes and experience gained from work funded by traditional energy entities**—Reflecting on the experience in Oaxaca, the Iluméxico approach could be used as a model for replication in other regions of Mexico. Oaxaca provides an example of an effort funded by local development agencies and focused on the socio-economic impact of energy access efforts, such as health, education, jobs, and income. By prioritizing the poorest communities, Iluméxico was able to leverage subnational development funding and collaborate with state governments at the local level. Further, concentrating these efforts on groups of neighboring communities through common distribution and marketing channels can ultimately increase the social impact while decreasing private sector operational costs. Tracking social impact can also allow for expanded funding opportunities in the future.[17]

[17] For instance, to better understand project impacts and the value-proposition for communities, Iluméxico has partnered with Schneider Electric and Fondo Unido, to carry out a Randomized Control Trial to measure the impact of energy on populations, expected to be finished by mid-2015. The impact study is executed by CAMBS, and it consists of both a quantitative and qualitative study of 500 households in northern Oaxaca before and after obtaining an Iluméxico solar system.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

5.7 References

Adkins, Edwin, Sandy Eapen, Flora Kaluwile, Gautam Nair, and Vijay Modi. 2010. "Off-Grid Energy Services for the Poor: Introducing LED Lighting in the Millennium Villages Project in Malawi." *Energy Policy* 38(5):1087–1097.

Chilcott, Robert P. 2006. *Compendium of Chemical Hazards: Kerosene (Fuel Oil)*. Chilton, UK: Health Protection Agency.

de Been, Merijn. 2014. *Building a Portfolio Expansion Strategy: Selling Solar Products in Rural Communities in Mexico*. Delft, the Netherlands: Industrial Design Engineering, TU Delft.

IEA (International Energy Agency). 2010. *Energy Poverty: How to Make Modern Energy Access Universal? Special Early Excerpt of the World Energy Outlook 2010 for the UN General Assembly on the Millennium Development Goals*. Paris: International Energy Agency/OECD.

IEA. 2012. *World Energy Outlook*. Paris: International Energy Agency.

Jacobson Arne, Nicholas L. Lam, Tami C. Bond, and Nathan Hultman. 2013. *Black Carbon and Kerosene Lighting: An Opportunity for Rapid Action on Climate Change and Clean Energy for Development*. Brookings Policy Paper, 2013-03. Washington, D.C.: The Brookings Institution.

KPMG. 2014. *Mexico Taxes and incentives for renewable energy*. New York: KPMG Global Energy & Natural Resources. http://www.kpmg.com/global/en/issuesandinsights/articlespublications/taxes-and-incentives-for-renewable-energy/pages/mexico.aspx.

Pode, Ramchandra. 2009. "Solution to Enhance the Acceptability of Solar-powered LED Lighting Technology." *Renewable and Sustainable Energy Reviews* 14:1096–1103.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

6 Nepal: The Experience of the Alternative Energy Promotion Centre and the National Rural Renewable Energy Programme

Case study prepared and written by Dave Steinbach, Sunil Acharya, Raju Pandit Chhetri, and Ramesh Bhusha[18]

This study outlines Nepal's efforts to promote renewable energy access to off-grid rural communities using new financing instruments and delivery channels. In particular it focuses on the Alternative Energy Promotion Centre (AEPC)—the lead agency for delivering off-grid renewable energy technologies in Nepal—and its flagship initiative, the National Rural Renewable Energy Programme (NRREP). The NRREP was launched in 2012 as a single program modality for promoting and delivering all off-grid renewable energy technologies of less than 10 MW in Nepal. The program has a different financing structure than past government initiatives, using a blend of both subsidy and credit instruments to finance investment in renewable energy (RE) technologies, and involving new financial actors such as commercial banks to channel this finance to rural areas. Because the NRREP represents a shift from previous government initiatives, this case study aims to explain how the program's financial delivery structure presents new opportunities for promoting rural energy access, and whether this modality is effective in delivering RE technologies to the poor.

Based on the four key policy areas presented in Volume 1, Section 2 of this report, Figure 16 highlights key actions presented in this paper to **establish a foundational policy environment** and **catalyze finance** for energy access in Nepal.

[18] Fieldwork for this case study was undertaken in February and March 2015 in Barpak VDC, Gorkha District and Babiyachaur VDC, Surkhet District. On April 25, 2015, the first of two devastating earthquakes struck Nepal. The epicenter of the first earthquake was located in Barpak VDC, and initial estimates suggest that over 90% of buildings were destroyed in this area. Following the earthquake, AEPC has estimated that micro-hydro plants serving over 60,000 households were damaged during the earthquake. This initial assessment was made on May 7, prior to the second earthquake, meaning that estimates are likely to be very low. Further, they do not capture damage to households with other RE technologies, which means that the number of AEPC-supported households who no longer have access to electricity is likely to be much higher. The case study researchers hope that this report can help highlight the importance of promoting investment in off-grid renewable energy in Nepal, and contribute evidence towards long-term sustainable (re)-development planning, as efforts to rebuild following the earthquake move forward.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

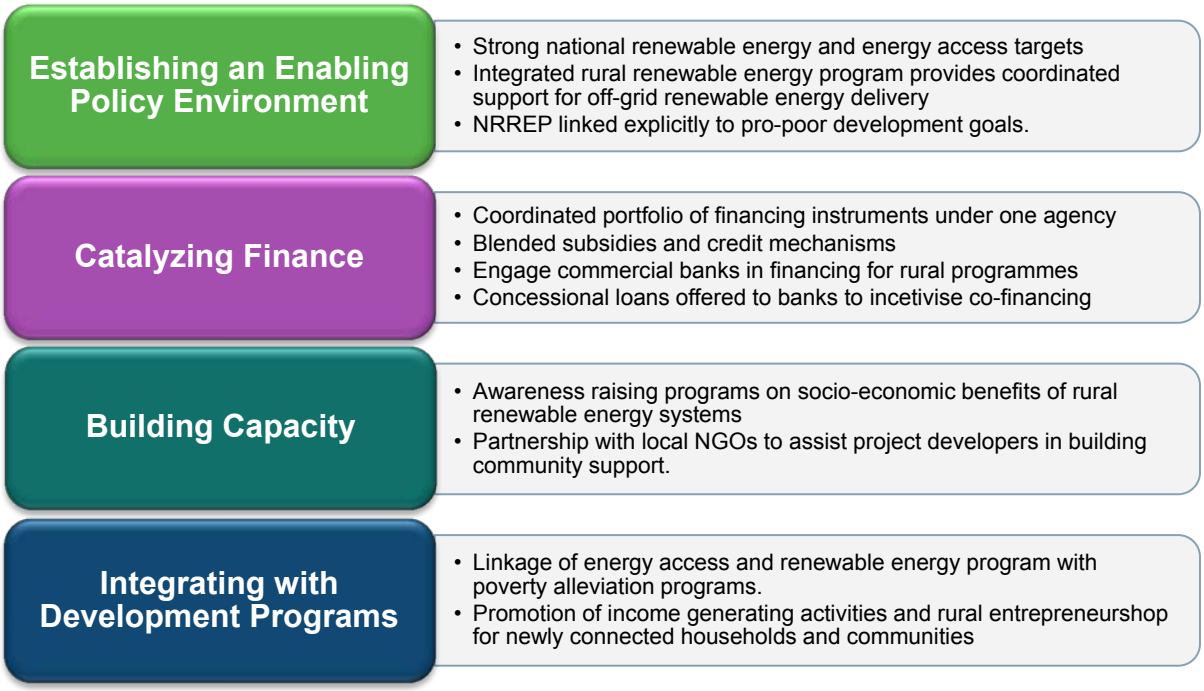

Figure 16. Key policies and actions in the context of the energy access framework

Building on the policies and measures presented above, a number of lessons can be drawn from Nepal's energy access experience. Key lessons, elaborated in the sections below, include:

- The introduction of credit-based financing under the NRREP was based on the desire to encourage the long-term sustainability of the renewable energy market in Nepal. Credit is seen as more sustainable because it can incentivize private banks to enter the renewable energy market; reduce the burden on government and donor financing; and spread more widely to target more beneficiaries.
- Despite a gradual shift toward credit financing, there is broad consensus that subsidies will continue to play an important role in enabling poor communities and households to invest in RE technologies in Nepal because the rural poor are often constrained by their inability to access credit.
- The selection of commercial banks as financial intermediaries has been driven by a number of factors, which include the perception that banks have better financial management capacity; a desire to reduce Nepal's dependence on donor financing (leading to banks leveraging their own finance); and the desire to move toward commercialization of the renewable energy sector through the promotion of banking and the private sector.
- Commercial banks are primarily driven by profit and a desire to expand their businesses into new markets. Under the NRREP, they have been given financial incentives to act as financial intermediaries in the form of concessional loans that they can pass on at higher interest rates to other banks, microfinance institutions (MFIs), and co-operatives that directly support investment in RE technologies.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- The perception that energy access leads to socio-economic benefits (income-generating activities, entrepreneurial development, and improvements in education and health) is the main driving force behind investment in off-grid RE technologies at the beneficiary level.
- For many beneficiaries, investment in RE technologies is constrained by the inability of individuals, households, or communities to access finance. With subsidies only covering 30–50% of the cost of RE technologies, the lack of rural banking services, collateral, or personal co-finance has restricted many of the rural poor from investing in new technologies and benefiting from the NRREP.

This case study uses two analytical frameworks to analyze AEPC and the NRREP.

First, the study uses the *Climate Finance Landscape Framework* to explain the design choices for the development of AEPC's NRREP modality. This framework outlines the sources, financial intermediaries, financial instruments, financial planning systems, and users involved in mobilizing and channeling finance for climate-related investment (in this case, promoting rural energy access) (Buchner 2013, Rai et al. 2015, Kaur et al. 2014). This framework is useful because it provides a snapshot of the renewable energy investment value chain and shows each actor's role in promoting the uptake of RE technologies in rural areas. During the scoping phase of the AEPC and NRREP study, researchers carried out a number of interviews with AEPC to understand the RE technology financial delivery value chain in Nepal. These interviews resulted in the mapping of the NRREP value chain.

The second analytical framework used in this case is **political economy analysis (PEA)**. Although it is important to understand each actor's role in the climate finance delivery value chain in Nepal, this information is not sufficient to understand **why** a certain financing modality was developed, the **incentives** that encourage the participation of various actors, and whether the NRREP modality will be **effective** in promoting rural energy access. PEA acknowledges that different actors have different knowledge, values, and skills, and that their actions are influenced by different incentive structures. As Figure 17 shows, a combination of these three political economy factors—actors, knowledge, and incentives—leads to decision making. For the purpose of this case study, PEA is used to understand the differing knowledge and incentives of each actor in the financial value chain for delivering RE technologies to rural communities.

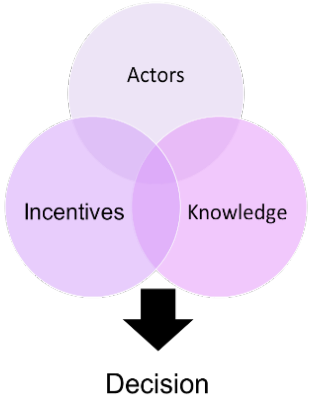

Figure 17. Political economy analysis

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

To undertake a political economy analysis of the NRREP financing modality, researchers in Nepal conducted approximately 35 interviews with a wide variety of actors, including the government of Nepal, donors, staff members from AEPC, representatives of commercial banks working with AEPC under the NRREP, district officials responsible for overseeing local development, NGOs and other service providers involved in delivering RE technologies, private sector technology providers, MFIs, and beneficiaries of financial support from AEPC under the NRREP. Each of these interviews included questions on the **financial needs** for investment in rural energy; the **incentives** leading to the design of the NRREP financing modality and more broadly on the reasons for investing in rural energy; and finally on the overall **effectiveness** of the NRREP modality in promoting rural energy access. The responses from these interviews have been aggregated across four main groups of actors and are presented in the appendix.

6.1 Country Context

Nepal's per capita energy consumption is one of the lowest in the world. The country's mountainous terrain and high levels of rainfall provides an ideal environment for hydropower generation. Yet only 56% of the population has access to electricity, and those who do have access are subject to load shedding for up to 14 hours per day. In rural areas, home to 80% of Nepal's population, access to electricity is even lower. The United Nations Development Programme (UNDP) estimates that 85% of total energy consumption in rural areas comes from traditional biomass such as fuelwood, agricultural residue, and cattle dung.[19] For many communities in rural areas, connection to the national grid is a remote possibility due to constraints that include a lack of national generating capacity, the country's mountainous geography, and a corresponding lack of appropriate grid infrastructure.

The government of Nepal has recognized that off-grid RE technologies provide one of the greatest opportunities to improve rural energy access in the country. The government has pledged to increase RE capacity from 1% of primary energy supply in 2010 to 10% by 2030 and has undertaken a number of initiatives to meet this target (Climate Investment Funds 2012).

6.2 Key Agencies and Actors

A number of public and private actors are important players in supporting energy access in Nepal. Key actors and agencies are outlined below.

- **Alternative Energy Promotion Centre (AEPC):** The lead agency for delivering off-grid RE technologies in Nepal under its flagship initiative, the National Rural Renewable Energy Programme (NRREP).
- **Ministry of Science, Technology and Environment (MoSTE**): Supports sustainable economic growth in Nepal with a focus on poverty reduction and job creation. The AEPC operates under the MoSTE.[20]

---

[19] See the Renewable Energy for Rural Livelihoods Project Background Web page: http://www.np.undp.org/content/nepal/en/home/operations/projects/environment_and_energy/rerl/background/.
[20] http://moste.gov.np/ministry/about_us

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- **Central Renewable Energy Fund (CREF)**: The single financial intermediary that manages all of the NRREP funds (both subsidy and credit). The government of Nepal and a variety of AEPC development partners provide CREF funding.
- **Global IME Bank**: A private bank that houses the Secretariat of CREF and acts as "handling bank" for all of the NRREP funding. The bank disburses subsidy-based finance under AEPC's subsidy policy and acts as a lender to seven partner banks that have been selected by AEPC to deliver credit-based finance for investment in off-grid RE technologies.

6.3 Program Summary

This section provides background on the evolution of renewable energy policy in Nepal as well as on the country's current institutional design structure for promoting renewable energy technologies to off-grid, rural communities.

Nepal has been promoting the use of small-scale renewable energy for several decades. In 1996, the AEPC was created as the lead agency in promoting off-grid renewable energy technology in Nepal. AEPC operates under the MoSTE with a specific mandate to promote technologies that generate a maximum of 10 MW. AEPC acts as a technical intermediary between government and donors (that provide policy direction and finance for renewable energy in Nepal) and the financial intermediaries (banks, micro-finance institutions, private technology providers, NGOs, and district/village development committees) that channel finance for renewable energy investment to beneficiaries. Its activities include renewable energy policy formulation, planning, and facilitating the implementation of the policies/plans.

Prior to 2012, AEPC oversaw a number of different projects funded by the government of Nepal and international donors. These projects were built around a subsidy-based model that provided targeted support to rural communities that could not afford the full commercial cost to invest in RE technologies (Government of Nepal 2013). In 2012, this approach was replaced with the establishment of the National Rural and Renewable Energy Programme. The NRREP is a five-year, US$170 million program that is jointly funded by the government of Nepal, Danish Ministry of Foreign Affairs, Norwegian Ministry of Foreign Affairs, UK Department for International Development, Kreditanstalt für Wiederaufbau (KfW), Gesellschaft für Internationale Zusammenarbeit (GIZ), the SNV Netherlands Development Organisation, UNDP, and the Scaling-Up Renewable Energy Programme (SREP). The NRREP is expected to achieve the following targets by July 2017:

- 25 MW micro/mini hydropower projects
- 600,000 solar home systems and 1,500 institutional solar power systems
- 475,000 improved cook stoves
- 130,000 household biogas plants, 200 community, and 1,000 institutional biogas plants.

There are two mains ways in which the NRREP is a departure from previous AEPC initiatives. First, the NRREP has adopted a single program modality for financing small-scale renewable energy projects—meaning that all finance for renewable energy will come through government channels and be managed under the NRREP. This responded to concerns on the part of government and donors that the previous approach was too fragmented, leading to duplication and lack of co-ordination of financial assistance to the renewable energy sector in Nepal. The second main change is that the NRREP has transitioned away from a subsidy-based model for financing off-grid RE technologies, to

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

a model that uses both subsidies and credit financing. This second design component of the NRREP is a significant evolution in renewable energy policy in Nepal, and is a critical point of discussion in this case study's political economy analysis found in Section 4.

The NRREP has a single financial intermediary that manages all of the program's funds (both subsidy and credit)—CREF. CREF is an independently managed fund with the capacity to deliver subsidies and credit financing to implement RE technology deployment at a household and community levels. It is different from AEPC's previous Rural Energy Fund in that it incorporates credit financing for the first time. Additionally, the financial management of the funds has been entrusted to a corporate bank—Global IME Bank—rather than being managed by AEPC itself. AEPC has an agreement with Global IME Bank for the bank to house the Secretariat of CREF and act as 'handling bank' for all of the NRREP funding. The handling bank has two different roles.

First, the handling bank disburses subsidy-based finance under AEPC's subsidy policy that promotes the uptake of RE technologies within targeted groups of rural Nepalese society—the poor, women, and a number of other marginalized groups. Subsidies are given to private technology providers who have agents in rural areas that promote RE technologies and try to create demand for investment. These private companies may also work with **regional service providers** (RSPs)—a group of 10 NGOs assigned a geographic area in Nepal by AEPC that are responsible for promoting the NRREP and encouraging communities and households to invest in RE technologies such as biogas, solar home systems, and microhydropower. When a beneficiary decides they want to invest in a specific technology, they purchase the product directly from the technology provider at a cost below the market rate in accordance with AEPC's subsidy guidelines (approximately 30–50% of the cost is subsidized). The technology providers, RSPs, and often the **District Development Committee** (DDC) or **Village Development Committee** (VDC) are then responsible for documenting and providing evidence that the new technology has been installed. Once this has been adequately demonstrated to AEPC, it will instruct Global IME Bank to release the subsidy to the technology provider so that it can recuperate its costs.

In addition to its role as a subsidy provider, the handling bank also acts as a lender to seven partner banks selected by AEPC to deliver credit-based finance for investment in off-grid RE technologies. Through this channel, Global IME Bank provides concessional loans to these seven banks. A certain percentage of the loan is defined in Global IME Bank's MOU with AEPC, but the loans could also include extra co-financing from Global IME Bank itself. These partner banks, in turn, provide concessional loans at a higher interest rate to co-operatives and microfinance institutions at the district and village level, which who use the money to provide market-rate loans to their members to invest in RE technologies such as village-level micro-hydropower systems. Once again, the RSPs and DDCs are involved in monitoring and reporting to AEPC.

Figure 18 provides an overview of the fund flow for RE technology investment under the NRREP. As mentioned above, this new financing modality has made important changes in the way finance is delivered from the national and international levels to the local level. Therefore, it is important to understand why these changes have been made, and what benefits they are expected to bring to improve the adoption of RE technologies in rural areas.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

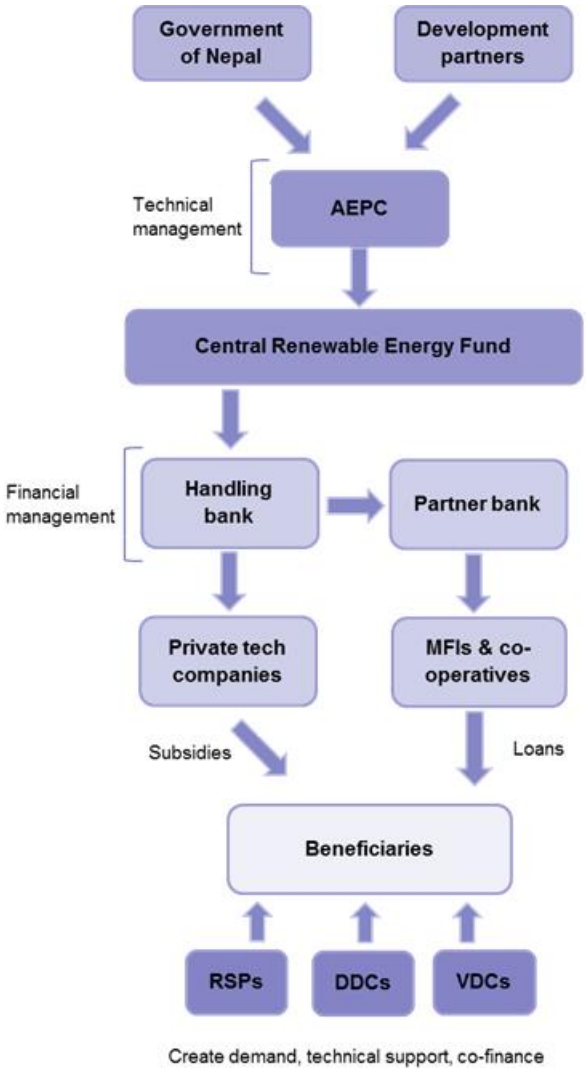

Figure 18. Financial flows under the NRREP

The following section turns to these questions and uses political economy analysis to outline the **financing needs** and **incentive structures** driving investment in RE technologies under the NRREP model. It is important to note that while the NRREP was formally launched in 2012, it was only in March 2015 that the government, donors, and AEPC were able to sign a final agreement with Global IME Bank and the seven partner banks to act as financial intermediaries under the NRREP. For the previous two years, AEPC had been delivering subsidies through its own fund management structure as a temporary arrangement. As such, discussions on the **effectiveness** of the NRREP model are limited to the effectiveness of the subsidy delivery mechanism as well as perceptions from actors on how effective or ineffective the credit financing mechanism is likely to be.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

6.4 Policies and Actions to Support Energy Access

This section provides a political economy analysis of the AEPC/NRREP financing modality for investing in off-grid renewable energy in Nepal. The main goal of this analysis is to understand the investment needs for RE technologies in Nepal, the knowledge and incentives that have led to specific choices in the financial landscape of the NRREP (particularly choices in financial intermediaries and financial instruments—the first two yellow sections in Figure 19) and how effective these choices are in promoting investment for energy access in Nepal. Findings in this section are based on detailed interviews with actors across the NRREP financial value chain. Detailed responses from different groups of actors in the financial value chain are provided in the appendices of this case study.

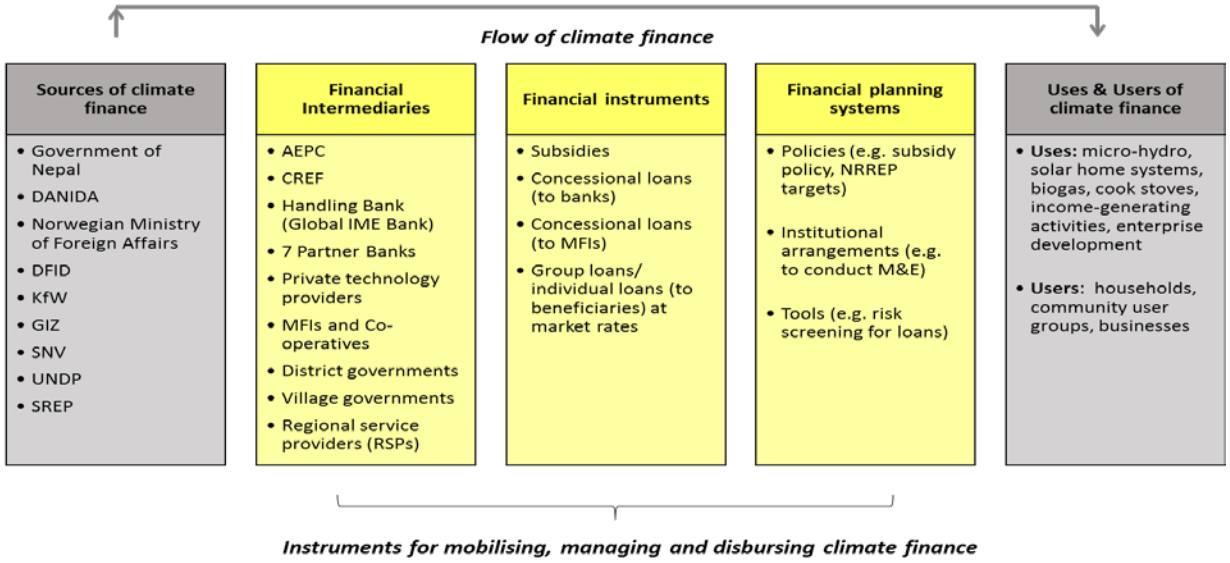

Figure 19. The climate finance landscape of RE investment in Nepal

6.4.1 Financial and Market Development Needs to Encourage Rural Energy Access

This section provides information on financial and market needs to support energy access. Two important similarities can be noted across nearly all actor groups in the NRREP value chain. First, respondents agreed there is a need to address the constraints that the rural poor face in accessing finance to invest in RE technologies.[21] Interviewees highlighted a number of ways that these barriers could be addressed, such as increasing subsidies for the poor, improving the targeting mechanism of subsidies to ensure they reach those with the most need, and improving access to credit in rural areas. Second, all actors believe there are still a number of market barriers to investing in RE technologies, though these barriers differ according to actor group. Some of the market development needs that

[21] Note that the original fieldwork for this study was based on an IIED project on how new financial instruments and intermediaries can improve the delivery of finance for investment in technology and services that benefit the poor. There may therefore be some bias toward responses that focus on pro-poor outcomes and targeting of the poor rather than simply increasing energy access. However, these responses are still important because they highlight potential barriers of financing models that promote energy access without an explicit understanding of how to foster *inclusive* energy access.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

were identified included the need to improve rural infrastructure, the need to extend banking services to rural areas, and the need to raise awareness about AEPC's support for RE technologies in order to increase demand in rural areas.

An overview of the key findings on financing and market development needs for investing in RE technologies in Nepal are presented in the subsections below.

Financial Needs

- Subsidies are seen as the main financial instrument to target the poor, and most actors believe that targeted subsidies for the poor must remain a component of the NRREP even as the program moves toward credit financing and commercialization. Banks have not emphasized instruments to target the poor because their primary focus is profit. This means that they are likely to emphasize wider technology distribution (i.e., increases in overall energy access) rather than focus on issues of equity.
- There is broad consensus on the need to make credit more accessible to rural communities—for instance, through the extension of banking services to rural areas, encouraging MFIs to provide finance for investing in RE technologies, and flexible collateral agreements to enable the poor to access credit.
- Private companies see long-term concessional loans as necessary to incentivize their investment, particularly if they are likely to provide co-financing to increase investment in RE technologies.

Market Development Needs

- Government and commercial banks outlined how banking institutions need to enhance their knowledge and capacity in order to enter the renewable energy market, which is a new area for many banks that have recently signed MOUs to participate as handling and partner banks under CREF.
- Almost all actors agree on the need to extend banking services to rural areas where communities struggle to access finance (particularly credit). Many banks have branches in district capitals, but these are often not readily accessible for rural residents, which limits their ability to access loans and demonstrate their creditworthiness in terms of capital and collateral.
- Some actors emphasized the need to improve rural infrastructure. Nepal's mountainous terrain makes it difficult to access many rural communities, and this is seen as a significant barrier to the ability of technology providers to supply their products (e.g., solar panels, turbines) to market.
- Beneficiaries and those who work directly with beneficiaries to promote RE technologies (RSPs, DDCs) emphasized the need to reduce the red tape involved in approving community-level projects (e.g., community hydropower projects), and for AEPC to speed up the subsidy application procedures, both of which are seen as barriers to the uptake of RE technologies in rural areas.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

6.4.2 Drivers of investment in rural energy in Nepal

This section provides insights on the drivers that have shaped the design of the NRREP and CREF investment model for rural energy access in Nepal, and the drivers that are shaping investment in RE technologies. Key findings that explain both the rationale for the shift from a subsidy model to a credit-based model and why different actors are investing in RE technologies are outlined the subsections below.

Drivers Behind the Design of the NRREP and CREF Investment Models[22]

- Actors agreed that the financial design choices of the NRREP—the introduction of credit-based **instruments** and commercial banks as new **financial intermediaries**—were based on a desire to encourage the long-term sustainability of the renewable energy market in Nepal.

- Government officials, AEPC, and donors all agreed that the previous subsidy model for promoting off-grid RE technologies was not sustainable. Previous programming modalities for renewable energy in Nepal had been too fragmented and suffered from a lack of coordination. A significant number of RE projects were supported by foreign donors with the understanding that this support would not last indefinitely.

- The NRREP (using CREF as the main funding mechanism) was designed to incentivize private banks, through the provision of concessional loans, to enter the RE market and lead to full commercialization of the sector.

- However, most actors emphasized that there was a continued need for subsidies under the NRREP, to support poor communities and households who will be unable to access credit for investing in RE technologies.

Drivers for Investing in Off-Grid RE Technologies

- At the government and development partner levels, efforts to promote national development, poverty alleviation, and energy access were the primary drivers behind investing in renewable energy under the NRREP. A lack of financial management capacity within AEPC, along with a desire to commercialize the renewable energy sector and leverage additional private finance, all contributed to the decision to use commercial banks to deliver finance under the NRREP.
- Respondents within AEPC, government, and the donor community all highlighted the continued need to provide targeted subsidies to the poor under NRREP, acknowledging that many intended beneficiaries would not have access to credit and would otherwise be overlooked by the program.
- Commercial banks were primarily driven by profit and a desire to expand their business operations into new areas. Some actors also highlighted the desire to be leaders in new

[22] This section is based on by interviews with decision makers involved in designing the NRREP funding modality (representatives of the government of Nepal, the donor community, and AEPC) who provided input on the rationale for the NRREP's single program modality and movement away from subsidies toward credit-based financing through banks.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

sectors such as RE that promote national development. Banks were encouraged by the financial opportunities provided under the NRREP, which would enable them to receive concessional loans at very low interest rates from AEPC and lend out this money (along with their own cofinancing) to other financial institutions at higher interest rates.

- At the beneficiary level, socio-economic considerations were the main driving force behind investment in renewable energy. This includes income-generating activities, entrepreneurial development, and improvements in education and health.
- Local level intermediaries and beneficiaries all highlighted that investment in RE technologies was strongly shaped (and often constrained) by the ability of individuals, households, or communities to access sufficient finance. In many cases, rural people have been able to access subsidies from AEPC to invest in RE technologies. On the other hand, with subsidies only accounting for 30–50% of the cost of RE technologies, the lack of rural banking services, collateral, or personal co-finance has restricted many of the rural poor from investing in new technology and benefiting from the NRREP.

6.4.3 Effectiveness of the NRREP in Promoting Rural Energy Access

This section focuses on effectiveness of the NRREP's new financing modalities in promoting rural energy access. Recalling the PEA diagram in Figure 17, this section sheds light on whether the **decisions** in the financial landscape (which are shaped by the **knowledge** and **incentives** of different actors) are leading to **effective investment** in energy access in Nepal.

In this analysis, the term **effectiveness** was used to understand whether the NRREP's new financial design choices are expected to promote rural development, increase financing in RE technologies, and deliver finance that meets the financial needs of the poor. These areas of effectiveness were captured using three proxies: co-benefits, leveraging of additional finance, and the appropriateness of the finance for the poor.[23] Insights related to these areas are highlighted below.

- **Increasing energy access is the main priority articulated by all actors in the NRREP value chain**. In addition, all actors emphasized the strong co-benefits that are delivered to beneficiaries by promoting rural energy access under the NRREP. These include enterprise development, income-generating activities, education, and health. Low-carbon development, as an end in itself, is considered a secondary priority. Overall, all actors are working toward a shared vision.

[23] It is important to note that this is not a holistic review of the NRREP's performance to date. The assessment follows the same methodology as the previous sections, which means the analysis reflects the opinions of actors across the NRREP value chain, rather than independent data on how the NRREP is performing against its targets. While data measuring the performance of the program is useful, the benefits of the PEA approach is that it digs below the surface to outline *why* the NRREP will be effective or will face challenges in delivering finance for investing in RE technologies. It is also important to recall that the shift toward new financial instruments (credit) and new financial intermediaries (commercial banks) under CREF only began in March 2015. The opinions of different actors therefore only refer to how new financial instruments and intermediaries are *expected* to perform in relation to the three criteria of co-benefits, leveraging and inclusive investment.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- **Most actors believe that the use of new financial intermediaries under the NRREP will help to leverage additional funds for investment in RE technologies.** For example, respondents outlined how additional investment from banks will be incentivized through concessional interest rates, that DDCs and VDCs will increasingly co-finance NRREP projects, and that extending banking services to rural areas will increase household contributions to technology installations. On the last point, many beneficiaries dispute that they will have adequate resources to co-finance RE technology installations themselves, since they have low levels of household savings and no collateral to use to access loans from MFIs.
- Results from AEPC (2014) show that progress has been made in increasing energy access through the subsidy model (though progress has been slower than expected). Yet despite the fact that energy access is increasing overall, **the choice in financial instruments for investing in renewable energy projects in Nepal may not be appropriate for the most poor** under the new CREF model. Many community respondents highlighted the fact that they had difficulty accessing subsidies for installing RE. In particular, the poor face barriers to investing in RE technology because subsidies usually cover only 30–50% of finance and they do not have access to credit or sufficient personal capital to cover the remaining costs.
- **Most actors predict that accessing credit through the CREF will be difficult for the rural poor** because of a lack of rural bank branches, high interest rates, and lack of collateral. Banks have committed to delivering finance to rural areas through existing microfinance and co-operative institutions to meet this challenge. However, there is concern that these institutions lack the capacity (financial management and human resources) to manage and deliver these funds.
- **Targeting the poor is a top priority for all actors except the private sector**, whose focus is on increasing market access and profitmaking. Although NRREP subsidies have improved energy access for the rural poor, a number of different actors stated that **there is still no clear vision on how the poorest of the poor will be reached**. AEPC is current revising its subsidy policy, which may lead to more targeted support of marginalized groups in the future, but in the meantime, many beneficiaries are worried that the NRREP's move toward credit financing will result in less overall subsidy support to those who need it the most.

6.5 Lessons Learned

Energy access is an important national development priority in Nepal. This case study has outlined how Nepal is promoting the uptake of RE technologies in rural communities under the National Rural Renewable Energy Programme (NRREP) Through the use of political economy analysis, this case study has outlined the knowledge and incentive structures that have led to new financial design choices in the NRREP, focusing particularly on credit-based financing instruments and banks as financial intermediaries. It has also outlined the knowledge and incentive structures that are driving (and in some cases, constraining) investment in off-grid RE technologies at all levels of the NRREP value chain. Finally, this case study has analyzed whether the financial design choices are sufficiently aligned with the knowledge and incentive structures of actors across the value chain to effectively deliver finance that promotes the uptake of RE technologies.

A summary of these three analytical pillars is provided below. This summary can serve as a useful guide to policymakers, development partners, investors, technology providers, and end users who are interested in understanding how financial design choices influence investment in RE technologies.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

6.5.1 Knowledge and Incentives Influencing the NRREP's Financial Design Choices

- The introduction of credit-based financing under the NRREP was based on the desire to encourage the long-term sustainability of the renewable energy market in Nepal. Credit is seen as more sustainable because it can incentivize private banks to enter the renewable energy market; reduce the burden on government and donor financing; and spread more widely to target more beneficiaries.
- Despite this gradual shift toward credit financing, there is broad consensus that subsidies will continue to play an important role in enabling poor communities and households to invest in RE technologies in Nepal, as the rural poor are often constrained by their inability to access credit. AEPC's subsidy policy is currently being revised to improve its ability to target particularly vulnerable groups.
- The selection of commercial banks as financial intermediaries has been driven by a number of factors, which include the perception that banks have better financial management capacity; a desire to reduce Nepal's dependence on donor financing (leading to banks leveraging their own finance); and the desire to move toward commercialization of the RE sector through the promotion of banking and the private sector.

6.5.2 Knowledge and Incentives Driving Investment in Off-Grid Renewable Energy

- At the government and donor level, efforts to promote national development, poverty alleviation, and energy access are the main drivers of investment in renewable energy under the NRREP.
- Commercial banks are primarily driven by profit and a desire to expand their businesses into new markets. Under the NRREP, they have been given financial incentives to act as financial intermediaries in the form of concessional loans that they can pass on at higher interest rates to other banks, MFIs, and co-operatives who are directly supporting investment in RE technologies.
- The perception that energy access leads to socio-economic benefits (income-generating activities, entrepreneurial development, and improvements in education and health) is the main driving force behind investment in off-grid RE technologies at the beneficiary level.
- For many beneficiaries, investment in RE technologies is constrained by the inability of individuals, households, or communities to access finance. With subsidies only accounting for 30–50% of the cost of RE technologies, the lack of rural banking services, collateral, or personal co-finance has restricted many of the rural poor from investing in new technologies and benefiting from the NRREP.

6.5.3 Aligning Financial Design Choices and Incentive Structures: Effectiveness of the NRREP

- Increasing energy access is a priority that has been articulated by all actors in the NRREP value chain, which shows that there is a shared vision toward which all actors are working.
- Most actors believe that the use of new financial intermediaries under the NRREP will help to leverage additional funds for investment in RE technologies, for example by encouraging banks to provide co-financing by giving them loans at highly concessional rates.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

- AEPC has been successful in increasing rural energy access through a number of technologies in the NRREP's first two years, using subsidies as the main financial instrument.

However, many beneficiaries have difficulty accessing subsidies to invest in RE technologies. In particular, the poor face barriers because subsidies account for only 30–50% of finance, and they do not have access to credit or sufficient personal capital to cover the remaining costs.

- Targeting the poor is a top priority for all actors except the private sector, whose focus is on increasing market access and profitmaking. Yet although NRREP subsidies have improved energy access for the rural poor, many different actors stated that there is still no clear vision on how the poorest of the poor will be reached.
- AEPC is current revising their subsidy policy, which may lead to more targeted support to marginalized groups in the future, but in the meantime, many beneficiaries are worried that the NRREP's move toward credit financing will result in less overall subsidy support to those who need it the most.
- A further concern is that the rural poor will be excluded from accessing finance under the new CREF model due to the low provision of banking services in rural areas. Banks have committed to delivering finance to rural areas through existing microfinance and co-operative institutions. However there is concern that these institutions may not have the capacity (in terms of financial management and human resources) to manage and deliver these funds.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

6.6 Additional Information: Interview Findings for Key Energy Access Topics

Tables 12–14 summarize the findings of interviews conducted as part of the case study for Nepal.

Table 12. Financial and Market Development Needs to Encourage Rural Energy Access

Stakeholder Group	Financial Needs	Market Development Needs
Sources of finance (Government of Nepal, AEPC, donors)	Subsidies to help poor. Increased access to credit/soft loans for rural poor. Larger scale investment in RE. Credit to promote long-term sustainability of RE sector.	Capacity building in banks to manage rural RE projects. Market development in rural areas; de-risking for private sector; service provision from private sector (not just tech). Improved rural infrastructure; links with micro-RE and national grid. Awareness raising to target the poor.
Banks and private sector	Long-term concessional loans to incentivise the private sector	Capacity in banks to help enter into new sectors Political stability, regular policy signalling Improved infrastructure and access to raw materials in rural area
RSPs, DDCs, VDCs	Subsidies for poor Flexible provisions to help poor cover 50%-70% of investment not covered by subsidy Extension of financial institutions to rural areas: will help target poor, assess risk for MFIs	Need to catalyse private investment through CREF Demonstration of successful CREF loan modality; business guidelines Banking services in rural areas to channel funds to local level Project pipeline development; QA procedures
Beneficiaries	Need subsidy beyond 30% or 10,000 Rupees (US$94) Support accessing loans, collateral	Finance needs to be more accessible to the poor with less red tape Access to employment and income-generating activities (IGA) Mechanisms to access loans without provision of collateral Access to local banking services

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 13. Drivers of Investment in Rural Energy

Stakeholder Group	Drivers	Constraints/Dis-incentives
Sources of finance (Government of Nepal, AEPC, donors)	Political/economic: national development, energy access, sustainable development, market development Knowledge: best practice examples (e.g. Sri Lanka)	Capacity: lack of financial management capacity in AEPC led to design of CREF with banks taking fund management role Economic: instruments are not always suited for the extreme poor. AEPC is revising their subsidy policy to improve targeting of vulnerable groups
Banks and private sector	Economic: profit; desire to break into a new market; financial instruments provided by government of Nepal/AEPC (concessional loans, risk guarantees) Reputational: Desire to be seen as a market leader	Capacity: lack of risk profile of borrowers; lack of capacity in some MFIs to channel finance to rural areas; insufficient knowledge of RE sector
RSPs, DDCs, VDCs		Economic: choice of financial instruments can exclude the poor who cannot access additional credit or provide co-finance
Beneficiaries	Socio-economic: desire to access energy; start new enterprises/promote IGA; improve livelihoods; importance of co-benefits (health, education, internet access) Economic: choice of financial instruments – subsidies of 30%-50% can help poor finance investment in RE; credit available to more middle income households or those with collateral	Economic: choice of financial instruments – subsidy of 30%-50% not sufficient for poor people; struggle to access additional credit or provide co-finance; lack of collateral Capacity: Lack of business skills hinder investment in enterprises and limit IGA investment potential. Knowledge: Lack of knowledge about AEPC subsidy provision

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Table 14. Effectiveness of the NRREP in Promoting Rural Energy Access

Stakeholder Group	Co-benefits	Leveraging additional funds	Appropriateness of finance for the poor
Sources of finance (Government of Nepal, AEPC, donors)	Energy access, health, education, internet, income, reduced kerosene use, adaptation, EWS, low-carbon (lesser priority)	40%-60% of finance from AEPC. DDC/VDC will leverage funding Private sector will leverage own funds	Poor may struggle to access loans under CREF Flexibility of loan & subsidy Revision of subsidy policy to target poor
Banks and private sector	Less emphasis Some mention of energy access, health, income generation, carbon reduction, education	Banks plan to invest their own money in addition to AEPC subsidy	No pro-poor emphasis by banks Banks may have too high interest rates for poor
RSPs, DDCs, VDCs	Income generation, energy access, health, education, gender, skills training, internet, employment	DDCs will provide some co-finance. But unlocking local finance unlikely to happen in large volumes	Important that subsidy stays flexible to poor needs CREF may improve access to finance. But MFIs need more capacity to deliver
Beneficiaries	Education, IGA, enterprise development, health, increased savings, female empowerment	Unlocking local finance unlikely to happen in large volumes due to lack of collateral and low levels of household savings	Subsidy not enough. Usually 30%. Poor cannot raise additional finance No local financial institutions Only short term finance

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

6.7 References

AEPC (Alternative Energy Promotion Centre). 2014. *National Rural and Renewable Energy Programme: Annual Progress Report NFY 2070/71*. Lalitpur, Nepal: Alternative Energy Promotion Centre. http://www.aepc.gov.np/docs/resource/rescenter/20141116013903_NRREP-APR%202070%2071-Final.pdf.

Climate Investment Funds. 2012. *Scaling up Renewable Energy in Low Income Countries Program: Nepal*. Fact sheet. Washington, D.C.: Climate Investment Funds. http://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/SREP_Nepal.pdf.

Government of Nepal. 2013. *Subsidy Policy for Renewable Energy 2069 BS*. Ministry of Science and Technology. http://www.aepc.gov.np/docs/ resource/rescenter/20130818060043_RE%20 Subsidy%20Policy%202013%20-%20En0glish.pdf.

Kaur, Nanki, John Rwirahira, Daniel Fikreyesus, Neha Rai, and Susannah Fisher. 2014. *Financing a Transition to Climate Resilient Green Economies*. IIED Policy Briefing. April 2014. http://pubs.iied.org/pdfs/17228IIED.pdf.

Rai, Neha, Nanki Kaur, Samuel Greene, Bowen Wang, and Paul Steele. 2015. *Topic Guide: A Guide to National Governance of Climate Finance***.** Evidence on Demand. United Kingdom: Department for International Development. http://r4d.dfid.gov.uk/Output/200645/.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

7 Conclusion

This case study volume has shared examples of how public finance is stimulating investments in decentralized energy access in various developing countries. We looked at case studies from Bangladesh, Ethiopia, Mali, Nepal, and Mexico to understand what policy options, business models, financing instruments and financial modalities have been instrumental in catalyzing different players such as small and medium enterprises (SMEs), suppliers, entrepreneurs, commercial banks, etc. to engage in renewable energy markets.

Countries have invested in policy reforms and capacity building, mainstreamed energy access within development programs, and used various incentive-based instruments to catalyze finance for energy access markets.

Bangladesh, Nepal, and Ethiopia for example are incorporating decentralized energy into their power sector plans and enabling policies to ensure uptake. For example, Bangladesh's target of 10% electricity by renewable energy by 2020 provides a clear policy signal of energy access priorities. Mexico's private utility received clear future plans from government on areas that will be connected by grid and which one's wont, this allowed them to plan utility services and distribution more systematically.

Nepal and Ethiopia have also aligned their energy access plans with national development plans. Nepal's off-grid energy policy is linked explicitly to pro-poor development goals. The National Rural Renewable Energy Programme (NRREP) aims to increase energy access for the poor through targeted subsidies. Ethiopia's Growth and Transformational Plan (GTP) and the Climate Resilience and Green Economy (CRGE) strategy both promote investment in enhancing access to and the production of renewable energy.

Besides incentives, policy reforms have also imposed regulations that obligate investments in energy access. For example, a green banking policy of Bangladesh requires all banking and non-banking financial institutions of Bangladesh to channel 5% of its finance for green lending. Concessions can also be a useful tool to attract developers to specific areas that need energy access. Mali government has encouraged private developers to invest in mini-grids by providing concessions in clearly designated areas.

Apart from building a strong policy foundation, to ensure longevity and sustenance of off-grid energy access projects, it is equally crucial to develop domestic capacity to support the markets. Dedicated technical assistance programs can offer both business and technical support to assist businesses on an as-needed basis, navigate obstacles and continue on track. For examples IDCOLs business model for solar home systems incentivizes market creation, creating delivery networks, access to capital, quality assurance, after sales service and it provides training and institutional strengthening support for partnering organizations, including private sector businesses. In Tanzania, the Rural Energy Agency offers grants to support market research in the rural electrification sector and provides assistance with business plans and specific projects. Training programs for the financial community (MFIs, Banks) that lack understanding about complex and technical projects will help in these institutions to practically determine which projects are technically viable.

A primary barrier for businesses and projects in energy access that deal with low income remote populations is accessing affordable, patient financing to start-up and operate a new type of business. Public sector can play a key role in targeting specific financing instruments to enable investments

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

and catalyze finance. Using appropriate financing intermediaries to reach markets can be one approach. The case studies in this report for example Bangladesh, Ethiopia, Mali, and Nepal all show programs where governments have used existing organizations or created new entities to serve as financial intermediaries to translate large amounts of funding into the small-scale needs of end users. Government incentives can also ensure that the barriers to new market development are offset. For example, government subsidies in Mali and Bangladesh have been targeted to support the development of a private sector market.

When affordable financing is not available to market actors, governments can supply capital through loans administered by government financial institutions or financial intermediaries. Concessionary loans in Nepal, Bangladesh have helped meet the needs of the markets by including lower interest rates, longer terms, or reduced requirements to qualify.

These examples around the work highlight a wide range of innovations that has been instrumental in channeling finance to decentralized energy access. The case comparison show that different instruments and modalities can be mixed and matched to achieve the desired results, as a one size fits all approach may not always work. However, across cases we also observe that vision of reaching to the poorest of the poor still remains challenging. Many business models have tried to address this concern but this section of the society is left out because of lack of ability to contribute their share or inability to continue payments in the long run. There are also concerns that rural poor will further be excluded from accessing finance when there is too much focus on engaging the private sector. To ensure energy access is provided to all, a careful analysis of the financing models that can reach ultra-poor communities or of the optimal (and complementary) roles of the public and private sector would need to be clarified.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.