



Renewable energy

MALI

Republic of Mali
Ministry of Energy and Water Resources
National Department of Energy



Scaling Up Renewable Energy Program
in Low Income Countries

Achievements, Challenges and Opportunities

Executive Summary



Table of Contents

Preface & Acknowledgements	ii
Abbreviations	iii
Administrative Map of Mali	iv
Introduction	1
Energy Sector: Status, Policies & Key Players	
• Overview	2
• Policy and Strategic Framework	3
• Institutional Landscape	7
Renewable Energy Technologies: Lessons Learned	
• Concrete Achievements to Date	11
• Categories of Renewable Energy Technologies	11
• Socio-Economic and Environmental Impacts	12
Key Findings in Relation to SREP	
• Strengths and Assets	14
• Main Weaknesses	14
• Major Operational Areas within the SREP Framework	16
Appendix	
Summary Table: Challenges and Priorities of Mali's Energy Sector	18–24

Preface & Acknowledgements

This paper briefly presents the key elements of an initial stocktaking exercise, “Renewable Energy in Mali: Achievements, Challenges and Opportunities,” carried out in early 2011 on behalf of the National Directorate of Energy of Mali within the framework of the Scaling Up Renewable Energy Program in Low Income Countries (SREP). The reader may consult the full document—over 140 pages of text, maps, tables and bibliographical references—for a deeper understanding of the topics covered in this executive summary.

The elements of this analysis have been examined and discussed in detail with key stakeholders during validation workshops and broad-based technical consultations. They have been fine tuned between April and October 2011, and the most relevant priority initiatives have been included in the SREP investment plan that focuses on three innovative investment projects that will stimulate transformational change in the energy sector, in general, and the renewable energy sub-sector, in particular.

This paper was prepared by Arona Coulibaly and Angelo Bonfiglioli as part of the SREP-Mali under the leadership of the National Directorate of Energy (DNE) and the African Development Bank (AfDB). The authors were supported by the members of the SREP National Commission, including Sinalou Diawara, Cheick Sanogo and Birama Diourte from DNE, Ismael Touré and Alassane Agalassou from AMADER, Hamata Ag Hantafaye and Aminata Théra Fofana from ANADEB, Sékou Traoré and Alhousseini Maiga from CNESOLER, Sékou Kone from AEDD, Béchir Simpara from DNACPN, and Tidiani Coulibaly from DNEF.

The authors also received valuable comments and guidance from multilateral development banks, including Florence Richard-Quintanilha, Nigambaye Ndoundo, Leandro Azevedo and Mafalda Duarte from the AfDB; Peggy Mischke, Koffi Ekouevi and Fabrice Bertholet from the World Bank; and Paterné Koffi and Koffi Klousseh from the International Financial Corporation (IFC). Additional contributions were received from national stakeholders during the SREP joint mission held in February 2011. The final preparation of this paper was done by Mafalda Duarte, Florence Richard-Quintanilha, Leandro Azevedo and Leslie Ashby from the AfDB.

The findings, interpretations and conclusions expressed in this paper are entirely those of the author(s) and do not necessarily represent the view of the AfDB, the World Bank, the IFC, their Boards of Directors or the countries they represent. These multilateral development banks do not guarantee the accuracy of the data included in this publication and accept no responsibility whatsoever for any consequence of their use.

AfDB	African Development Bank
AMADER	<i>Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale</i>
AMARAP	<i>Agence Malienne de Radioprotection</i>
ANADEB	<i>Agence Nationale de Développement des Biocarburants</i>
ANICT	<i>Agence Nationale des Investissements des Collectivités Territoriales</i>
API-MALI	<i>Agence pour la Promotion des Investissements au Mali</i>
APS	<i>Association des Professionnels du Solaire</i>
BOOT	Build-Own-Operate-Transfer
CIF	Climate Investment Funds
CMDT	<i>Compagnie Malienne pour le Développement du Textile</i>
CNE	<i>Commission Nationale de l'Énergie</i>
CNESOLER	<i>Centre National de l'Énergie Solaire et des Énergies Renouvelables</i>
CREE	<i>Commission de la Régulation de l'Énergie et de l'Eau du Mali</i>
DNE	<i>Direction Nationale de l'Énergie du Mali</i>
DNH	<i>Direction Nationale de l'Hydraulique</i>
EDM-SA	<i>Énergie du Mali SA</i>
FER	<i>Fonds pour l'Électrification Rurale</i>
GIZ	<i>Deutsche Gesellschaft für Internationale Zusammenarbeit</i>
GDP	Gross Domestic Product
GoM	Government of Mali
GWh	Gigawatt Hour
KfW	Kreditanstalt für Wiederaufbau
kWh	Kilowatt Hour
MW	Meggawatts
OMVS	<i>Organisation pour la Mise en Valeur du Fleuve Sénégal</i>
PEN	<i>Politique Énergétique Nationale</i>
PPP	Public-Private Partnership
PV	Photovoltaic
SOGEM	<i>Société de Gestion de l'Énergie de Manantali</i>
SREP	Scaling up Renewable Energy Program in Low Income Countries
UNDP	United Nations Development Program
USD	United States Dollars
VAT	Value Added Tax
XOF	<i>Franc CFA</i>

Abbreviations

Administrative Map of Mali



Introduction

01. The Climate Investment Funds (CIF) are a pair of funds established to provide developing countries grant and concessional financing to spur low-emissions and climate-resilient development. Under the Strategic Climate Fund (SCF), one of two CIF trust funds, three targeted programs have been designed, including the Program for Scaling Up Renewable Energy in Low Income Countries (SREP). Its aim is to pilot and demonstrate the economic, social and environmental viability of low carbon development pathways in the energy sector by creating new economic opportunities and increasing energy access through the use of renewable energy.
02. Based on the recommendations of an independent Expert Group assembled by the CIF, the SREP Sub-Committee chose Mali in July 2010 to be one of six pilot countries eligible for funding to formulate and implement an investment plan (IP) for the large-scale development of renewable energy.¹ This choice was justified by the nature of the climatic, environmental, demographic and energy challenges facing the country and by the Government of Mali's (GoM) concrete efforts to meet those challenges.
03. The main objective of the SREP-Mali is to develop renewable energies on a large scale and to effectively contribute to poverty reduction and sustainable development in Mali for the benefit of its population. Achieving this objective should help support low carbon emission development that would generate new economic opportunities and widen access to energy services.

.....
¹ The other SREP pilot countries are Ethiopia, Kenya, Honduras, Maldives and Nepal. See <http://www.climateinvestmentfunds.org/cif/srep>

Energy Sector: Status, Policies & Key Players

Overview

04. **Country:** Mali is a landlocked country in the Sahel region of West Africa. It covers an area of 1,241,248 km², 51% of which is desert. Its population is estimated at 14.5 million inhabitants and its average annual growth rate is 3.4%.² Nearly 73% of the population resides in rural areas. The urbanization rate stands at 26.8%.
05. **Economy:** Over the last decade, Mali has made significant progress in economic, political and social spheres.³ In less than 10 years, the Gross Domestic Product (GDP) tripled from 2.43 billion United States dollars (USD) in 2000 to USD 9.70 billion in 2010. Notwithstanding this progress, Mali remains one of the poorest countries in the world, ranking 160th out of 169 countries.⁴
06. **Climate:** Mali's climate is characterized by a long dry season and a rainy season that lasts on average one to five months per year, depending on the region. On the basis of rainfall levels, the country is divided into four main areas corresponding to four ecological zones whose agricultural potential is diversified. Two energy sub-sectors are particularly vulnerable to climatic variability: (i) wood fuel (firewood and charcoal) and (ii) hydroelectricity.
07. **Energy:** In 2008, the energy balance reported that biomass (firewood and charcoal) accounted for about 80% of national energy consumption, fossil fuel 16%, electricity 3%, and renewable energy (other than hydropower) 1%.
08. The energy sector comprises four main sub-sectors:(i) fossil fuel, (ii) traditional energy, (iii) renewable energy and (iv) electricity:
 - a) **Fossil fuel:** The oil and gas sub-sector is characterized by total dependence on petroleum imports.
 - b) **Traditional energy:** Fuel wood is the primary traditional energy source for households. Mali's forestry potential is estimated at roughly 33,000,000 hectares (ha), including a standing volume of about 520,000,000 m³.
 - c) **Renewable energy:** The national renewable energy inventory reveals substantial potential depending on energy source. Although these sources have never been factored into the energy mix, they may be about 3% of conventional electricity generation or 12 megawatts (MW). One of the objectives of the *Politique Énergétique Nationale* (PEN) is for renewable energies to reach 6% penetration in the country's energy mix by 2010 and 10% by 2015.
 - d) **Electricity:** The national electricity access rate was 27.1% in 2010. The demand for electricity is growing by 10% annually. The electricity access

2 Fourth General Population Census, 2009

3 According to the 2010 results of the World Bank's Country Policy and Institutional Assessment (CPIA), Mali is in the top quintile of countries.

4 United Nations Development Program - Human Development Index for 2010

rate is around 55% in urban areas, but only 14% in rural areas. The PEN projects a rise in the electrification rate from 1% in 2005 to 12% in 2010 and 55% in 2015. So far, results are consistent with goals. The average electricity generation costs are estimated at USD 0.24/kWh for the electricity supplier *Énergie du Mali SA* (EDM SA), while off-grid generation costs for private energy service companies (*SSD Koray Kurumba* and *SSD Yeleen Kura*) are estimated at about USD 0.47/kWh.

09. **Poverty reduction:** The national “*Cadre Stratégique de Croissance et de Réduction de la Pauvreté*” for 2007-2011 contains a comprehensive strategy for combating poverty and provides a coherent framework for all development partners to align their interventions. The paper has since been updated to define policies and programs that the country intends to implement at the macroeconomic level to promote growth over the 2012-2017 period. Environment and climate change issues are fully mainstreamed in the document, with renewable energy identified as part of energy sub-sector development.
10. **Decentralization:** Over the past two decades, Mali has experienced not only social and economic progress but a political evolution. This entailed the adoption of a democratic and pluralistic political system and a process of territorial decentralization⁵ regarded as crucial for citizens’ participation in the economic, social and cultural development of the country. Through the *Fonds d’Investissement des Collectivités Territoriales*, administered by the *Agence Nationale des Investissements des Collectivités Territoriales* (ANICT), the central government allocates grants to local governments to fund self-owned and managed investment projects. The allocations are determined by the size of the community’s population and by institutional performance.
11. In addition to these major policy frameworks, Mali has developed **policies that relate to the energy sector:**
 - a) “*Politique Nationale Forestière*,” developed in 1996, stresses the importance of populations participating in the integrated and sustainable management of natural resources and ensures the sustainability of natural resources in a context where biomass is the most commonly used energy source in the country.
 - b) “*Politique Nationale de Protection de l’Environnement*,” adopted in 1998, aims at contributing to the country’s sustainable economic and social development, ensuring food security and stemming the degradation of natural resources.

Overall Policy & Strategic Framework

⁵ The legal decentralization framework is part of the fundamental law or the Constitution. In addition, about a dozen organic laws and decrees (issued from the late 1990s) constitute the legal arsenal governing the life of local communities in Mali.

Policy & Strategic Framework for the Energy Sector

- c) *“Loi d’Orientation Agricole,”* adopted in 2006, promotes the use of agricultural residues and biofuels. Chapter IV underscores the fact that the energy policy specific to the agriculture sector is an integral part of Mali’s energy policy.
12. As far back as 1998, the GoM clarified its energy policy through a series of reforms and a host of legislative and statutory instruments related to various sub-sectors that redefined the role of the state in the energy sector and opened the sector to private operators.
13. The following are among the key policies directly related to the energy sector:
- a) *“Politique Énergétique Nationale”* (PEN), adopted in 2006, is a tool for balancing energy availability and national socio-economic development needs, fostering synergy between the major energy sector stakeholders, and guiding their interventions.⁶ The goals of the PEN refer to using renewable energy technologies for energy production and are fully reflected in the *“Stratégie Nationale pour le Développement des Energies Renouvelables”*.
 - b) *“Stratégie Nationale pour le Développement des Energies Renouvelables,”* adopted in 2006, aims at: (i) promoting the widespread use of renewable energy technologies and equipment to increase the share of renewable energy in national electricity generation up to 10% by 2015, (ii) developing the biofuel sub-sector for various uses (i.e., electricity generation, transportation and agricultural motorization), (iii) creating better conditions to sustain renewable energy services and (iv) searching for sustainable and suitable financing mechanisms for renewable energy.



Mali seeks to build more biofuel plants like this 3 x 100 KW unit to scale up biofuel production and use in rural and semi-urban areas.

⁶ The PEN also establishes operating and pricing schemes, distinguishing between a licensing system with a free rate-setting system and a concession scheme whose rates are subject to approval by the CREE.

- c) “*Lettre de Politique Sectorielle de l’Énergie*” for 2009-2012 is a reference and guidance framework for the GoM’s vision concerning the energy sector. The main goal is to carry out the necessary adjustments and reforms in the electricity sub-sector, such as completing the restructuring of EDM SA and tariff reforms, and taking steps to ensure its sustainable development. Its main objectives are: (i) to provide wide access to rural energy services at an affordable cost, (ii) to develop all available renewable energy sources and (iii) to promote access to finance.
- d) “*Stratégie nationale pour le Développement des Biocarburants*,” adopted in June 2008, aims to boost local energy generation by developing biofuels to meet the country’s socio-economic needs at a lower cost while reducing Mali’s high dependence on oil imports.
- e) “*Programme d’Action National d’Adaptation aux Changements climatiques*,” adopted in 2007, aims to mitigate the adverse effects of climate variability and change on the most vulnerable segments of the population for a more sustainable development. The program includes renewable energy development projects, some of which have been partially implemented.

14. The enabling environment that is available to private investors in the energy sector is marked by several mechanisms, either specific to the sector or more generic:

- a) *Fonds d’Électrification Rurale*, established by Law No. 05-019 of 30 May 2005 and managed by the *Agence Malienne pour le Développement de l’Énergie Domestique et de l’Électrification Rurale* (AMADER), partially funds studies, strengthens the management capabilities of private operators and provides co-financing for rural electrification investments.
- b) Mali’s Industrial Development Policy ensures rapid, sustainable and employment-generating industrial development.
- c) A framework for public-private partnerships (PPs) exists in the form of a build-own-operate-transfer (BOOT) concession.⁷
- d) The Investment Code establishes a preferential customs and tax scheme to promote private investment.
- e) *Agence pour la Promotion des Investissements au Mali* (API-Mali) acts as a single entry point for all formalities in creating businesses, supporting investors and issuing approvals under the Investment Code.

***Policy & Regulatory
Framework for
Private Investment***

⁷ Under a BOOT scheme, a company or a consortium of companies can design, finance, build, own and operate a new asset or system that reverts to the public authority after a pre-determined period of time.

Major Reforms in the Energy Sector

15. Additional guidance is provided in a regulatory act that guarantees free competition and organizes public electric supply.⁸ This decree addresses the roles and responsibilities of different actors in the sector, discusses conditions for the ownership of generation projects and sets the conditions under which entities are authorized to supply electricity.⁹
16. Over the past five years, the GoM has prepared and adopted a series of reforms and regulatory measures to define the main areas of energy development in support of its macro-economic strategy. Significant progress has been made in sector reforms, such as separating the water and electricity sub-sectors, restructuring the national utility EDM SA and opening the electricity sub-sector to competition. This has contributed to the energy sector's overall increased effectiveness, accelerated the public sector's withdrawal from operations and expanded service coverage.
17. The Ministry of Energy and Water have also launched initiatives to restructure the energy sector in order to increase its efficiency. They include (i) redefining the tasks and responsibilities of the *Direction Nationale de l'Énergie de Mali (DNE)*, (ii) exploring the option of establishing an *Agence Nationale pour les Energies Renouvelables (ANAER)* to replace the *Centre National de l'Énergie Solaire et des Énergies Renouvelables (CNESOLER)* and (iii) reviewing the PEN as planned every five years.
18. Other reforms and regulatory measures undertaken over the past five years include:
 - a) **Institutional reform:** Establishment of the *Commission Nationale des Energies Renouvelables (CER)* and the *Agence Nationale de Développement des Biocarburants (ANADEB)*.
 - b) **Regulatory reform:**
 - Implementation of the law suspending tax collection on imported renewable energy equipment
 - Adoption of the "*Stratégie Nationale pour le Développement des Energies Renouvelables*"
 - Adoption of the "*Stratégie Nationale pour le Développement des Biocarburants*"
 - Adoption of the "*Cadre de Référence pour les Biocarburants*"

⁸ Regulatory Act No. 00-019/P-RM of 15 March 2000 and its implementation decree, Decree No. 00-184/P-RM of 14 April 2000

⁹ In this regard, several forms of partnerships aim to create a friendlier environment for private investors (various types of agreements, including on works concessions, leasing and management).

19. Energy is a cross-cutting issue, which explains the presence of many players in the sector. It is currently managed by the Prime Minister's Office, which supervises the *Commission de la Régulation de l'Energie et de l'Eau du Mali* (CREE), five ministries,¹⁰ four national technical directorates¹¹ and three specialized services overseen by the Ministry of Energy and Water.¹² The National Directorate of Energy is responsible for defining the PEN and for coordinating and supervising technical services in charge of policy implementation at the regional and sub-regional levels.

20. Among public sector actors involved in the energy sector, some **national entities and technical services** are also involved in the development of renewable energy:

- a) *Commission de la Régulation de l'Energie et de l'Eau du Mali (CREE)*, is an independent unit set up in the Prime Minister's Office, whose objective is to support the development and ensure the quality of national water and electricity public services, protect the interests of users, promote and organize competition among private operators, and fix prices.
- b) *Énergie du Mali SA (EDM SA)*, the national state-owned utility, is subject to the provisions of the concession and its rates are governed by the CREE.



***Institutional
Landscape:
Public Sector
Actors***

More than 1,500 solar-powered water heaters like this 200 L model have been installed around the country to provide 24/7 hot water to hospitals, hotels and households. These units are durable, easy to maintain and are made of local materials for a cost of 500 XOF each.

¹⁰ Namely, the Ministry of Energy and Water, the Ministry of the Environment and Sanitation, the Ministry of Industry and Trade, the Ministry of Agriculture and the Ministry for Women's Affairs, Children and Family.

¹¹ The National Directorate of Energy and the National Directorate of Hydraulic under the authority of the Ministry of Energy and Water, the National Directorate of Agriculture under the authority of the Ministry of Agriculture, and the National Directorate of Water and Forests under the authority of the Ministry of the Environment and Sanitation.

¹² AMADER, ANADEB and AMARAP

- c) *Agence Malienne pour le Développement de l'Énergie Domestique et de l'Électrification Rurale* aims at increasing energy efficiency and at expanding access to electricity in rural and sub-urban areas. It is also responsible for implementing the *Programme Décennal d'Électrification Rurale* (PRODER) through PPPs.
- d) The mandate of *Centre National de l'Énergie Solaire et des Énergies Renouvelables* includes baseline data collection, research, development, production and marketing of appropriate technologies and equipment, training and supervision of stakeholder groups, and protection of small and medium companies.
- e) *Agence Nationale de Développement des Biocarburants* is tasked to ensure the continued availability of biofuels in the market, coordinate the interventions of national and international partners in the biofuel sub-sector, and help define standards for the dissemination of biofuels and monitor their implementation.
- f) Regarding research and training, the *École Nationale d'Ingénieurs Abderhamane Baba Touré* in Bamako designed in 1990 an energy module comprising all aspects of renewable energy. Its facilities include an applied thermal science laboratory. The Faculty of Science and Technology at the University of Bamako also carries out studies related to renewable energy technologies.

Private Sector & NGOs

- 21. Under the current framework, the GoM guarantees the free exercise of competition and organizes the electricity public service. Levels of intervention are distributed between the state, the CREE, the public utility EDM SA and private operators. PPPs exist in the form of authorization and concession schemes. In addition, Mali has a framework for PPPs under a BOOT scheme, although awareness needs to be raised among local and international private operators. The major advantage of this arrangement is that it generates additional tax benefits and streamlines approval procedures through a single window.
- 22. **Private local energy companies and local initiatives** (i.e., communities and women associations), with support from AMADER, are the drivers of Mali's rural energy access agenda. The *Fonds pour l'Électrification Rurale* has attracted almost 50 local energy service companies to the rural energy service delivery market in Mali. Most of them operate diesel-based mini-grid systems.
- 23. **Autonomous producers** are consumers who generate electricity for their own needs, either to cope with EDM SA failures to provide them with sufficient power or because they are outside the grid. They use diesel-powered generators. Major autonomous producers include mining companies (i.e., Mines SEMOS, mines in Morila, Syama, Yatela and Sadiola) and manufacturing companies (i.e., *Compagnie Malienne pour le Développement du Textile* (CMDT), HUICOMA,

BRAMALI and UMPP). Autonomous producers also include independent traditional energy producers, mainly woodcutters, charcoal sellers and those who trade, haul and retail wood and charcoal.

24. **Non-governmental organizations (NGOs)** are primarily involved in experimental activities and the promotion and dissemination of renewable energy installations as part of community development efforts (through public information and the promotion of individual or collective equipment).¹³ Professional associations are an effective network for disseminating information and building capacity.¹⁴
25. At the regional and sub-regional level, the following organizations are involved in the energy sector:
 - a) **Inter-governmental organizations**, such as the *Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS)*, the *Autorité de développement intégré de la région du Liptako-Gourma*, the *Comité permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel*, the West African Economic and Monetary Union, the Economic Community of West African States, and the African Union
 - b) **Public interest companies**, such as the *Société de Gestion de l'énergie de Manantali (SOGEM)*, the asset-holding public company established by OMVS member states (Mali, Mauritania, Senegal) to manage SOGEM; the West African Power Pool which ensures the interconnection of Mali's power grid with neighboring countries; and the ESKOM Energy Company in Manantali, a Malian subsidiary of Eskom Enterprises (South Africa) responsible, in partnership with SOGEM, for operating and maintaining the Manantali hydro power plant

Regional Organizations



Small scale solar-powered dryers are helping to improve the conservation of Mali's agricultural products and the quality of its food supply. They are inexpensive (125 XOF), easy to use and maintain, and provide additional income for women in particular. Over 1,000 are in use nationwide.

¹³ Such as GERES, a French NGO, as well as AMEDD, IC Sahel and Mali Aqua Viva, which are Malian NGOs.

¹⁴ For example, the *Association des Professionnels du Solaire*, the *Association des Femmes Ingénieurs du Mali* and the *Association du Développement des Mines et du Solaire*.

Development Partners

26. Development partners have an important role to play in promoting and disseminating renewable energy technologies. Three groups can be identified:
- a) **Multilateral development institutions** supporting the GoM in developing and implementing renewable energy projects and programs: (i) the World Bank Group, (ii) the United Nations Development Program and United Nations Environment Program, (iii) the African Development Bank and (iv) the European Union Delegation
 - b) **Bilateral development partners** operating within the framework of bilateral cooperation for financing projects and programs through public or private institutions: (i) GIZ and KfW, (ii) the United States Agency for International Development, (iii) the Danish International Development Agency, (iv) the French Development Agency, (v) the Belgian Development Cooperation, (vi) the Dutch Cooperation and (vii) the Indian Cooperation among others
 - c) **Organizations that work directly with beneficiary populations and seek funding** for renewable energy projects and programs from development partners: (i) Mali Folkcenter, (ii) SNV (Netherlands) and (iii) the *Groupe de Recherche et d'Applications Techniques*



Although its wind potential is localized, Mali has installed 150 windmills, water pumping systems and about a dozen low-power turbines to generate electricity.

27. With support from its partners, Mali has been very active in the area of renewable energy by gaining experience and promoting the use of renewable energy equipment (solar PV, thermal power, hydro power, wind power and biofuels) and building stakeholder capacity. This has allowed the expansion of renewable energy in Mali over the past two decades.
28. In terms of promotion and use of renewable energy technologies, the following major achievements have been reached over the past 20 years:
- a) Substantial experience in hydro power generation (about 156MW)
 - b) Massive dissemination of solar PV systems for lighting, audio-visual kits and water pumping in rural and semi-urban areas, as well as piloting hybrid mini-grid systems
 - c) Applications of solar thermal systems for collective heating (i.e., health centers) and food drying
 - d) Better use of biomass resources due to the dissemination of improved equipment, such as cook stoves for rural households, and the promotion of efficient equipment in agro-industrial units
 - e) Good development of jatropha-based biofuels and efforts to increase their use
 - f) Wind power systems encompassing 150 windmills, water pumping systems and about a dozen low-power turbines to generate electricity
29. Analysis of the current state of Mali's renewable energy sector highlights three technology groups, defined according to their level of adoption:
- a) **Proven technologies:** Hydro power plants; solar PV for water pumping, lighting, refrigeration and telecommunications systems; solar water heaters and food dryers; and wind pumping systems
 - b) **Technologies to be promoted/scaled-up:** Household biogas systems, industrial biogas systems using waste or agricultural residues to generate electricity, biofuel production and use of biofuel in rural and semi-urban areas for transportation, and hybrid mini-grid systems, including solar PV
 - c) **Technologies to be introduced:** Large scale solar PV on-grid systems to scale up the use of renewable energy in the country

Renewable Energy Technologies: Lessons Learned

Concrete Achievements to Date

Categorizes of Renewable Energy Technologies

***Socio-Economic
& Environmental
Impacts***

30. Some of the environmental and social impacts of Mali's current energy mix are:
- a) Deforestation of about 400,000 ha per year
 - b) Emission of 15.45 megatons of carbon dioxide, representing 94.33% of Mali's total greenhouse gas emissions in carbon equivalent¹⁵
 - c) A decrease in the population's purchasing power because of the rising price of petroleum products
31. The impact of renewable energy use has been assessed in relation to the deployment of solar PV systems and in the context of the preparation of renewable energy projects. It appears that adopting renewable energy technologies may be beneficial but also risky.
32. Some of the **benefits** of renewable energy adoption and dissemination include:
- a) **At the social level:** increased access to and improved use of basic social services, such as education and health care (lighting/heating/cooling of schools and health centers through solar panels), and increased access to water in rural areas (through solar PV pumping systems). Solar home systems also prevent health issues related to indoor use of firewood and improve household safety by decreasing domestic accidents caused by candles and kerosene lamps.
 - b) **At the economic level:** new jobs (either direct or induced) and new income-generating activities, modernization of craft activities due to electricity access, local capacity building and better living conditions for women (less domestic chores related to wood collection and water pumping), less kerosene purchased by households, less firewood used, and better processing and conservation of agricultural products
 - c) **At the environmental level:** reduction in carbon dioxide emissions and various forms of pollution, as well as less pressure on forests by using alternative energy that can reduce deforestation
33. However, renewable energy initiatives can also have **negative effects** or barriers that may prevent their large scale development. These could be reduced through appropriate corrective measures. Some potential negative impacts include:
- a) A lack of information greatly increases populations' distrust of new technologies and creates a phenomenon of rejection.

15 The Intergovernmental Panel on Climate Change's computer-assisted method was used to estimate emissions arising from energy production and consumption modes as part of the preparation of Mali's Second National Communication under the United Nations Framework Convention on Climate Change.

- b) The introduction of new technologies may destabilize certain commercial activities (i.e., kerosene) and certain sectors (e.g., firewood) that bring relatively high incomes to part of the population (i.e., the producers and sellers of improved stoves, woodcutters, charcoal sellers, wholesale carriers and truck owners).
- c) The relatively high cost of renewable energy equipment may hamper the adoption of new technologies.



This 72 KWp solar plant is one of the small-scale installations in Mali that power schools and health centers to improve access to basic social services.

Key Findings in Relation to SREP

Strengths & Assets

34. Major assets in Mali's **institutional and political framework** are: (i) the existence of key documents governing the energy sector and subsectors, notably the "*Stratégie Nationale pour le Développement des Energies Renouvelables*," (ii) measures to open the energy sector to private operators; (iii) measures to open the national electricity grid to neighboring countries through inter-connection; and (iv) demonstrated political willingness to develop the sector. The government has also made significant progress with sector reforms that aim at increasing the efficiency of the sector, speeding the withdrawal of the public sector from energy operations and extending service coverage.
35. The **investment framework** constitutes a good starting point, and the tax and customs regime currently in place for the development of renewable energy is favorable, even though it needs to be strengthened. The major advantages of the energy investments mechanism are tax benefits and approval procedures streamlined through the establishment of API-Mali.
36. An important asset is the existence and availability of significant renewable energy potential, especially solar, hydro and biomass/biofuels.
- a) **Solar potential:** Average solar radiation in Mali is well distributed over the national territory with an estimated 5-7 kWh/m²/day and a daily sun lighting duration of 7-10 hours. The global typical average is only around 4-5 kWh/m²/day.
 - b) **Hydro power potential:** An inventory of hydro power sites identified about 20 sites nationwide, with a total estimated capacity of 1,150 MW and an average annual energy production of about 5,000 GWh. Of these, only few sites are developed, representing about 22% of the potential capacity.
 - c) **Biomass potential:** This potential comes from four sources: (i) in terms of fuelwood, about 33 million hectares with a standing volume of 520 million cubic meters and a weighted productivity in the entire country of about 0.86 cubic meter/ha/year, (ii) several million tons of agricultural residues and plant waste, (iii) an annual production capacity of 2,400,000 liters of alcohol since 1997, and (iv) about 2,000 hectares of jatropha¹⁶ plantations for sustainable biofuel production.

Main Weaknesses

37. The main obstacles and weaknesses¹⁷ for the development of the sector relate to low power generation and transmission capacity and to the poor development of national energy resources. For renewable energy, the following can be highlighted:
- a) Due to wind patterns, the **wind power option** offers some potential but is localized to few sites.

¹⁶ Jatropha is a locally adopted, non-food crop that is relatively resistant to drought.

¹⁷ The main bottlenecks and weaknesses are presented in the appendix and are the result of an analysis on priority areas of intervention (and potential actions) to remove obstacles and fill gaps.

- b) The **biofuel option** could be difficult to develop because of the absence of an appropriate regulatory, fiscal and legislative framework. Logistical considerations may make it less appealing to grow jatropha, thus limiting this product in the local market. Seed production is left to farmers' organizations that lack adequate support. The government and development partners will support biofuel development only if it does not threaten food security. This option could also run counter to powerful interests behind the import of petroleum products.
38. Concerning the **institutional and political framework**, the main weaknesses relate to the large number of institutional actors, as well as inadequate material, financial and human resources. Other factors include:
- a) Weak cohesion between existing mechanisms and institutions
 - b) Poor implementation of the "*Stratégie Nationale pour le Développement des Energies Renouvelables*" due to funding constraints
 - c) The fact that the framework for evaluating and updating the PEN is yet to be operational and the *Commission Nationale de l'Energie* is not functional
 - d) The fact that EDM SA has little involvement in renewable energy
 - e) With a view to better implement the PEN, the need to redefine the general mission and functions of DNE and to reorganize the national entities responsible for energy matters
39. Concerning the **economic and fiscal framework**, several bottlenecks still remain despite efforts made in recent years to improve the investment climate:
- a) There are shortcomings in the investment code, since investors in the energy sector cannot benefit from tax free zones. Guarantees and securities for site acquisitions by foreign investors are also vague.
 - b) The actions of private operators, associations and NGOs in the renewable energy sector remain timid due to limited access to funding; weaknesses in logistics, technical and human resources; and a lack of incentives.
 - c) The mechanism to promote PPPs has many shortcomings, including those arising from conflicts of interest.
 - d) Poor people's access to renewable energy technology is limited by inadequate financial resources. These include: (i) an unattractive national banking system, (ii) limited access to external financing, (iii) lack of a financial framework to promote renewable energy and (iv) lack of information about credit mechanisms.

**Major Operational
Areas within the
SREP Framework**

40. This initial assessment suggests four strategic operational areas for Mali's SREP Investment Plan. The objective is to optimize Mali's energy sector's potential by addressing the institutional, legislative, regulatory, economic, financial and organizational constraints facing the sector.

Strategic Area 1: Institutional, legislative, regulatory and strategic framework

Energy investments will only yield lasting benefits if they are supported by measures that strengthen the energy sector's global policy environment and harmonize sectoral and multi-sectoral strategies.

Strategic Area 2: Information dissemination, training, and capacity building at the institutional, organizational and technical level

The improvement of policy and institutional mechanisms and the pursuit of sustainable investments in Mali should be preceded and supported by concrete and effective measures to strengthen the technical capacities of the parties concerned.

Strategic Area 3: Studies, research, management and knowledge sharing

A full program of studies and research should be conducted both upstream and downstream of major investments in order to improve knowledge, enhance achievements and share technological information.

Strategic Area 4: Sustainable investments in the energy sector, in general, and in proven renewable energy, in particular

Mali's SREP Investment Plan will focus on scaling up renewable energy to make renewable energy technology sufficiently attractive to public and private operators and to improve the energy access for Malian populations, especially those in the most remote rural areas.

41. By being fully consistent with SREP objectives, these strategic areas could trigger a shift from conventional energy investments to the large scale use of renewable energy technologies. The table in the appendix briefly presents these strategic areas, linking them to the main sector constraints already identified and to major possible initiatives, including those within the SREP framework.

Appendix

Summary Table: Challenges and Priorities of Mali’s Energy Sector

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
<p>Legislative Framework</p> <ul style="list-style-type: none"> ▪ Incomplete energy sector reforms <p>Regulatory Framework</p> <ul style="list-style-type: none"> ▪ Uncompetitive business environment (unattractive to investors and private operators) ▪ Legislative and financial constraints to private operator activities ▪ Weak PPPs ▪ Some uncontrolled wood markets still exist <p>Institutional Mechanisms</p> <ul style="list-style-type: none"> ▪ Weak coordination among sector institutions ▪ New CNE ineffective ▪ EDM SA’s low involvement in renewable energy ▪ Multiplicity and dispersion of actors in the energy field ▪ Ineffective assessment of the framework and updating of the PEN <p>Financial Arrangements</p> <ul style="list-style-type: none"> ▪ Inadequate financial resources, which hinder renewable energy access for the poor ▪ Lack of a tax relief system for biofuels and lack of an appropriate fiscal and normative regulatory framework ▪ Lack of a preferential fiscal and regulatory framework for renewable energy ▪ Low capacity to mobilize external funding 	<p>Legislative and regulatory framework and institutional and financial mechanisms for the energy sector</p>	<p>Legislative Framework</p> <ul style="list-style-type: none"> ▪ Review and upgrade the legislative framework based on current climatic, environmental and energy challenges and decentralization. ▪ Formulate laws and regulations on controlled logging. ▪ Establish a motivating regulatory and fiscal framework for biofuel development. ▪ Clarify the legislative and regulatory framework for implementing biofuel policy. ▪ Define and transfer jurisdiction in energy matters to local government. ▪ Ensure implementation of existing legislation (including providing guarantees to private investors). <p>Regulatory Framework</p> <ul style="list-style-type: none"> ▪ Establish a competitive business environment that is sustainable and attractive to investors and private operators. ▪ Establish tax and customs incentives. ▪ Regulate overconsumption and waste. ▪ Clarify legislation to boost private sector involvement. ▪ Clarify the principles of PPPs agreements. ▪ Establish a tax relief system for biofuels and an appropriate fiscal and normative regulatory framework. ▪ Improve the regulatory framework to enable the development of solar energy. ▪ Define a regulatory framework and a system for controlling the wood market. <p>Institutional Arrangements</p> <ul style="list-style-type: none"> ▪ Clarify the mandate of the numerous agencies operating in the energy sector and improve coordination. ▪ Redefine duties and responsibilities of DNE.

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
		<ul style="list-style-type: none"> ▪ Consider establishing the “<i>Agence Nationale pour les Energies Renouvelables</i>,” the “<i>Commission Nationale de l’Energie</i>” and a continental “<i>Centre d’Excellence pour les Energies Renouvelables</i>.” ▪ Support EDM SA in increasing its involvement in renewable energy. ▪ Develop exchanges of experiences on renewable energy with other countries and international organizations. ▪ Support Malian institutions’ participation in renewable energy-related initiatives of international agencies. <p>Strategic Framework</p> <ul style="list-style-type: none"> ▪ Support the evaluation of the implementation and revision of the PEN and the “<i>Stratégie Nationale pour le Développement des Energies Renouvelables</i>.” ▪ Formulate and implement the reforms necessary to implement the PEN. ▪ Support the implementation of priorities in the “<i>Stratégie Nationale pour le Développement des Energies Renouvelables</i>.” <p>Financial Arrangements</p> <ul style="list-style-type: none"> ▪ Define and implement targeted funding by supporting: <ul style="list-style-type: none"> - The local branches of ANICT - <i>Fonds de Développement Local et Rural</i> - FER ▪ Improve the business environment to make it more competitive and attractive to private operators. ▪ Establish special lines of credit for renewable energy in national commercial banks and strengthen banks’ capacity to meet the demands of small private investors. ▪ Establish a financial framework for promoting renewable energy in poor communities (micro-credit).

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
		<ul style="list-style-type: none"> ▪ Formulate and implement a mechanism for guaranteeing and ensuring the security of foreign investors in renewable energy by setting up an international tender mechanism for the energy sector and an appropriate framework for cooperation with the API-Mali. ▪ Conduct advocacy to attract foreign investors.
<ul style="list-style-type: none"> ▪ General lack of awareness of energy issues among consumers ▪ Poor dissemination of information on energy (resulting in popular distrust of new technology) ▪ Lack of knowledge about financial arrangements that could increase private sector involvement in the renewable energy sector ▪ Low technical, managerial and organizational capacities of public and private operators involved in the energy sector ▪ PPP mechanisms are not adapted for the energy sector ▪ Lack of appropriate mechanisms for collecting data on and monitoring energy sector investments 	<p>Information, training and strengthening of stakeholders' institutional, organizational and technical capacities</p>	<p>Communication and Awareness Raising</p> <ul style="list-style-type: none"> ▪ Develop a communication strategy and an action plan. ▪ Organize programs to raise awareness about energy issues and energy management, energy-saving habits and equipment, etc. ▪ Develop energy-related courses for schools. ▪ Establish, for the benefit of local operators, a more appropriate information-sharing system about the PPPs framework. ▪ Implement information-based initiatives enabling policy makers to adopt informed financial measures (depending on energy prices and market distortions). <p>Training and Capacity Building</p> <ul style="list-style-type: none"> ▪ Strengthen DNE's capacity to fulfill its role of coordinator. ▪ Strengthen national capacity in energy planning. ▪ Strengthen the capacities of communities (local elected officials) and associations by providing them with all necessary energy-related information. ▪ Support all actors able to operate in the renewable energy sector. ▪ Develop and implement a human resource training plan to create a critical mass of experts in renewable energy in Mali. Develop curricula for skills/specialized training in renewable energy. ▪ Support communities to better identify/target renewable energy sites and technology when preparing their development plans.

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
		<p>Private Sector Support</p> <ul style="list-style-type: none"> ▪ Develop PPPs mechanisms to improve the outreach of renewable energy services. ▪ Strengthen the capacity of private actors. ▪ Support autonomous energy-producing companies to diversify energy mix. ▪ Improve renewable energy developers' access to banking systems and other local, national and international financial institutions. ▪ Establish operational mechanisms/special financing or guarantee funds to start up renewable energy projects initiated by private and civil society actors and to reduce constraints related to hard-to-access funding and expensive bank loans. ▪ Establish a system of guaranteed preferential purchase prices for renewable energy (e.g., feed-in tariffs) to reassure parties willing to make long-term investments. ▪ Provide advisory support for local council initiatives promoting the renewable energy sub-sector. <p>Management and Information & Knowledge Sharing</p> <ul style="list-style-type: none"> ▪ Define and implement a permanent system for collecting and evaluating best practices related to the monitoring and evaluation system for SREP activities (i.e., studies, analysis of policy and regulatory frameworks, mechanisms for choosing technology, funding mechanisms, planning and implementation of renewable energy investments).

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
<ul style="list-style-type: none"> ▪ Detailed assessments of renewable energies potential to be continued (e.g., wind and solar resources assessment). Inadequate baseline data on installed renewable energy. ▪ Inadequate research on unproven renewable energy ▪ Lack of studies on solar PV, thermal power, bioconversion and wind energy ▪ Incomprehensive national renewable energy mapping ▪ Limited number of impact studies on the use of new renewable energy technology ▪ Lack of diagnostic studies on the socio-economic impacts of renewable energy technology, particularly the impacts on the poorest segments of the population 	<p>Energy-related studies, research, management and knowledge-sharing</p>	<p>Technology</p> <ul style="list-style-type: none"> ▪ Complete the inventory of national renewable energy potential (solar, wind, biomass, mini/micro hydropower). ▪ Promote research and development related to the massive extension of renewable energy technologies, especially in rural areas. ▪ Carry out a comprehensive inventory of installed renewable energy technologies. ▪ Promote research and development in unproven renewable energy technologies. ▪ Conduct thematic research and development on biofuels (recommended by SNDB). <p>Resources</p> <ul style="list-style-type: none"> ▪ Conduct comprehensive national mapping of renewable energy sources. ▪ Identify security measures (programmed hydropower production and electricity consumption). <p>Impact</p> <ul style="list-style-type: none"> ▪ Assess socio-economic and environmental impacts of renewable energy. ▪ Assess impact of replacing different proportions of hydrocarbons (gasoline, diesel) with biofuels (bioethanol, biodiesel, pure plant oil). ▪ Improve mechanisms for monitoring, evaluating and periodically reviewing energy policy related to local, sub-regional and international development requirements. <p>Markets</p> <ul style="list-style-type: none"> ▪ Conduct a market study on the renewable energy sub-sector. <p>Socioeconomic Aspects</p> <ul style="list-style-type: none"> ▪ Conduct diagnostic studies on: <ul style="list-style-type: none"> - The energy poverty of certain vulnerable segments of the population - The impact of proposed investments on the status of women and gender parity, as part of gender mainstreaming efforts - Local perceptions of energy services of public and private operators

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
<ul style="list-style-type: none"> ▪ Poor synergy between development partners in the energy sector ▪ Inadequate funding mechanisms ▪ Low levels of investment in renewable energy 	<p>Sustainable investments in the energy sector, in general, and in proven renewable energy sources, in particular</p>	<p>Partnerships</p> <ul style="list-style-type: none"> ▪ Strengthen the synergy between funding partners for investment in the renewable energy industry. ▪ Strengthen state partnerships with key multilateral institutions and donors. ▪ Establish a guarantee and security mechanism for foreign investors in the renewable energy sub-sector. <p>Funding Mechanisms</p> <ul style="list-style-type: none"> ▪ Strengthen the systems that finance renewable energy facilities (i.e., banks/financial institutions or projects with a credit component). ▪ Redefine priorities and strategies for mobilizing financial resources. <p>Monitoring and Evaluation</p> <ul style="list-style-type: none"> ▪ Revitalize and strengthen the framework for monitoring and evaluating PEN projects. <p>Investments</p> <ul style="list-style-type: none"> ▪ Increase investment in infrastructure by lowering the risks facing private investment (in the spirit of the New Partnership for Africa's Development). ▪ Set up/supervise village biofuel production units. ▪ Define and implement concessional financing mechanisms and other incentives designed to ensure the long-term sustainable cost recovery. ▪ Implement priority solar projects proposed by the national agencies working in the renewable energy sector. <p>Investments Recommended by the National Strategy for the Development of Renewable Energy</p> <ul style="list-style-type: none"> ▪ Promote widespread installation of solar energy equipment in rural community centers (i.e., health centers or schools) and installation of wind-powered water pumps and generators in the Sahel and Sahara regions of the country ▪ Develop effective systems for operating and maintaining renewable energy equipment in rural and suburban areas.

Main challenges and constraints in the energy sector	Main operational areas	Main possible initiatives (including under SREP)
		<ul style="list-style-type: none"> ▪ Stimulate efficient and sustainable use of energy from biomass in agricultural and agro-industrial zones (i.e., fuel briquettes, biogas, vegetable oil and alcohol). ▪ Initiate and support local projects for assembling and manufacturing renewable energy components. ▪ Encourage renewable energy programs to systematically provide income-generating activities.

