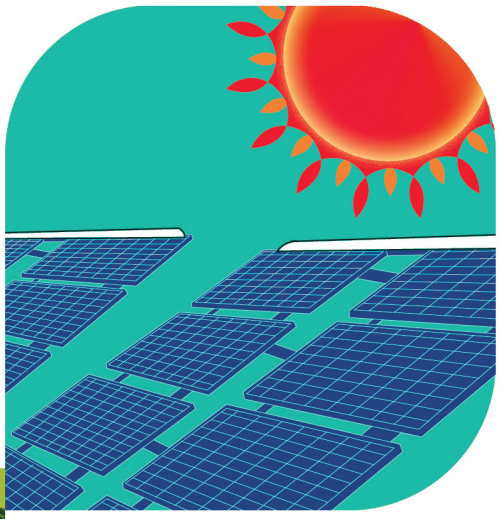
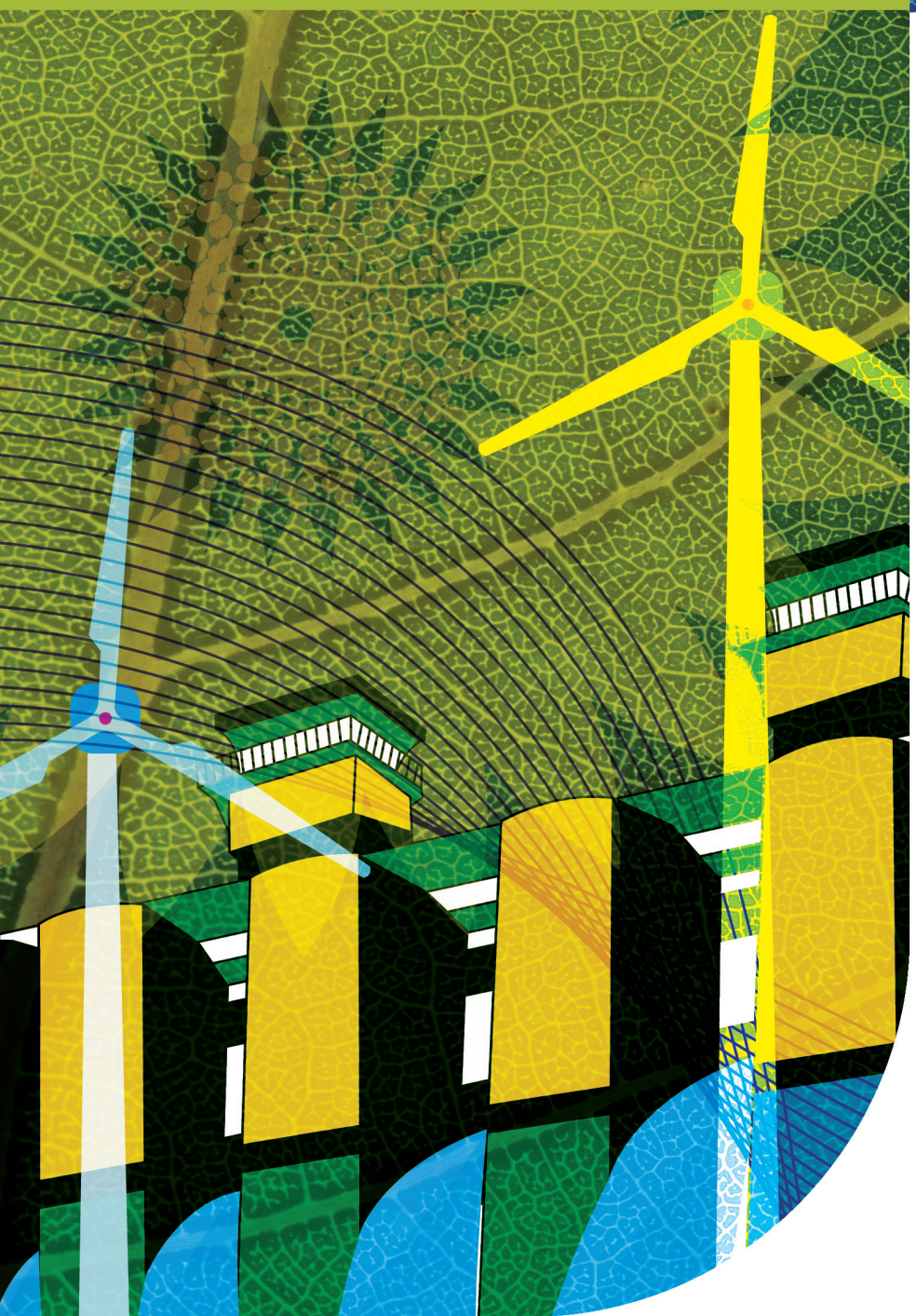
IRENA
International Renewable Energy Agency



SENEGAL

RENEWABLES READINESS ASSESSMENT 2012



About IRENA

The International Renewable Energy Agency (IRENA) promotes the accelerated adoption and sustainable use of all forms of renewable energy. IRENA's founding members were inspired by the opportunities offered by renewable energy to enable sustainable development while addressing issues of energy access, security and volatility. Established in 2009, the inter-governmental organisation provides a global networking hub, advisory resource and unified voice for renewable energy.

www.irena.org

SENEGAL

RENEWABLES READINESS ASSESSMENT 2012

Table of Contents

List of Acronyms

AfDB	African Development Bank
ANCs	National Rural Councillors Association
ANDES	National Agency for Solar Energy Development
APANPP	Association for African Non-Oil Producer Countries
APIX	Agency for Investment Promotion
ASER	Rural Electrification Agency
ASN	Senegalese Association for Standardisation
BOO	Build Own Operate
CERER	Centre for Research and Studies on Renewable Energy
CF	Carbon Fund
CIER	Interministerial Committee on Renewable Energy
CIMES	Intersectorial Committee for the Implementation of Synergies between Energy and other Strategic Sectors
CNB	National Biofuel Committee
CRSE	Commission de régulation du secteur de l'électricité
CSS	Senegalese Sugar Company
DGIS	Netherlands Directorate-General for International Cooperation
DSRP	Document of the Strategy for Poverty Alleviation
ECOWAS	Economic Commission of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
ERIL	Rural Electrification through Local Initiatives
FABER-ABERF	African Biofuels and Renewable Energy Fund
FIT	Feed-in Tariff
GOANA	Great Agricultural Offensive for Food and Agriculture
GW	Gigawatt
HV/MV/LV	High Voltage/ Medium Voltage/Low voltage
ICS	Industries Chimiques du Sénégal
IEA	International Energy Agency
IPP	Independent Power Producer
ISRA	Senegalese Institute for Agricultural Research
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
kV	Kilovolt
kW	Kilowatt

LPDSE	Lettre de Développement du Secteur de l'Energie
LPG	Liquefied Petroleum Gas
MC	Ministry of Commerce
MDG	Millennium Development Goal
MER	Ministry of Renewable Energy
MEF	Ministry of Economy and Finance
MoE	Ministry of Energy
MW	Megawatt
NBC	National Committee for Biofuels
NGO	Non-Governmental Organisation
O and M	Operations and Maintenance
OMVG	Organisation for the Development of the Gambia River Basin
OMVS	Organisation for the Development of the Senegal River
PASER	Rural Electrification Action Plan
PERACOD	Programme to Promote Rural Electrification and a Sustainable Supply of Domestic Fuel
PPP	Public Private Partnership
PREDAS	Regional Programme for Households and Alternative Energies in the Sahel
PRS	Regional Solar Programme
RE	Renewable Energy
REF	Rural Electrification Fund
REVA	Retour Vers l'Agriculture
RRA	Renewables Readiness Assessment
SAR	Société Africaine de Raffinage
SENELEC	Senegalese National Electricity Company
SPEC	Sustainable Power Electric Company
TPES	Total Primary Energy Supply
WAEMU	West African Economic and Monetary Union
VAT	Value Added Tax
WAPP	West African Power Pool
WMO	World Meteorological Organization
Wp	Watt Peak

LIST OF FIGURES

LIST OF TABLES

LIST OF IMAGES

Acknowledgements

This Renewables Readiness Assessment report was prepared by the International Renewable Energy Agency (IRENA) working in close collaboration with the Government of Senegal. The International Institute for Sustainable Development (IISD) provided valuable support. SEMIS Consult facilitated the groundwork. H.E. Louis Seck, former Minister of Renewable Energy, Senegal, was involved from the outset of the project and continued to provide helpful insights.

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Karmic Design provided the design and layout.

Comments or questions about this Renewable Readiness Assessment report can be sent to SAlzouma@irena.org, MSokona@irena.org, or to secretariat@irena.org.

Foreword

THE RENEWABLE ENERGY SECTOR occupies an important place in the economic development strategy of Senegal. Our energy policy aims primarily at diversifying and reducing dependence on imported petroleum products by increasing the share of renewable energy and biofuels in the country's energy mix by at least 15% by 2020.

That is why for nearly two years now Senegal has been reviewing the technically and economically exploitable potential of renewable energy sources for electricity production, and also determining the technical, economic and financial factors that can ensure people's access to modern energy services.

This study has led to the establishment of a legislative and regulatory framework conducive to the development of electricity production from renewable energy sources. Institutional reform has been in progress since March 2012 with the creation of an agency dedicated exclusively to the promotion of renewable energy.

It is expected that this new structure will lead to important activities including the development of synergies necessary to allow more effective collaboration between public sector research actors and the private sector; the establishment of appropriate incentives to make equipment and the purchase of green electricity more accessible; the stimulation of self-generation of renewable-based electricity by households; the identification of internal resources and financial mechanisms that can support alternative energies; and supporting the development of small- and medium-sized enterprises (SMEs) and industries (SMIs) in the local production of components specific to renewable energy technologies (RETs).

The execution of this vast project requires multilateral as well as bilateral cooperation. Therefore we welcome the initiative of the International Renewable Energy Agency (IRENA), which in November 2011 enabled Senegal to host the pilot phase of the Renewables Readiness Assessment.

This project has enabled us to highlight our country's strengths, as well as its weaknesses, concerning the rapid deployment of renewable energy across the various network options, off-grid applications and the use of biofuels. The actions identified in this evaluation will make, I believe, a significant contribution to the deployment of renewable energy. Putting all the measures identified into practice could lead our country to effective diversification of its sources of energy.

The Government of Senegal is confident that, with international cooperation, particularly with IRENA, our country will soon reach its goals of promoting renewable energies to become a model in the ECOWAS region.

Finally, I reiterate here, that all our national experts are available to assist other countries in the conduct of their own RRAs and confirm my continued support for IRENA's mission.

Aly Ngouille NDIAYE

Minister of Energy and Mines, Senegal

Preface

The First Renewables Readiness Assessment (RRA) – presented here by Senegal – is an important milestone for IRENA, whose mission is to promote the widespread and increased adoption and sustainable use of all forms of renewable energy.

The RRA is a central pillar of IRENA's work and is a country-driven process supported by IRENA providing an opportunity for countries to engage in a national dialogue with all relevant stakeholders in order to pinpoint renewable energy drivers, comparative advantages as well as areas of improvement to set concerted actions needed to be taken to enable the development and scale-up of renewables.

This will allow IRENA to identify and provide country-specific support and advice to the participating countries. More broadly, it will also generate knowledge of good practices and cooperation between countries, which are essential to increasing deployment.

Senegal, in keeping with its strong and consistent support of IRENA's mission, kindly volunteered to host the first country pilot study. The process and details of RRAs will necessarily evolve with experience. We thank Senegal for its generosity in hosting this first study. The country's engagement and input have gone beyond what we could have expected and IRENA is grateful for this important contribution.

In common with all countries, the RRA found areas where Senegal had examples of good practice that could be shared with others, areas where readiness was high and other areas where readiness could be improved in the short- to medium-term, under initiatives led by Senegal. The report now presented focuses on these actions and examples of good practice.

IRENA hopes that the RRA will enable Senegal to increase its deployment of renewables. We offer our continuing support, across all our functions and work programmes, to Senegal in implementing the actions identified.

Adnan Z. Amin

Director General, IRENA

Executive Summary

BACKGROUND

Senegal is a West African country with a population of 12.6 million, a GDP of USD 14.3 billion, and an estimated economic growth rate of 4% in 2011. The country's energy sector is characterised by a growing demand for modern energy services and a lack of reliable electricity supply. The electric system is based on inefficient oil-based power plants, now operating beyond their initial design life span, and suffers recurring power outages. Traditional biomass accounts for 54% of Senegal's primary energy supply, oil products for 40% and other resources, including coal and hydro power, for the remaining 6%. All oil products are imported, making Senegal's trade balance very vulnerable to oil price volatility.

Senegal has actively pursued reform policies in the energy sector, with a strong focus on promoting renewable energy. The current energy policy is reflected in the "Lettre de Développement du Secteur de l'Energie (LPDSE 2008)," a government strategy document building on the lessons learned from previous energy policies. The emphasis on renewable energy has resulted in the adoption of two laws aiming at increasing the cumulative share of renewable energy and biofuels to at least 15% energy mix by 2020.

As a further commitment to renewable energy, Senegal joined hands with the international community and signed the statute of the International Renewable Energy Agency (IRENA) during its founding conference in 2009. Resulting from IRENA's engagement with African governments, the Renewables Readiness Assessment was identified as a crucial step for a better understanding of the opportunities and constraints in Africa, and as a collaborative process that will provide a

The Renewables Readiness Assessment was identified as a crucial step for a better understanding of the opportunities and constraints in Africa, and as a collaborative process that will provide a rapid, objective assessment of the status of renewable energy opportunities and identify pathways to address gaps.

Senegal hosted the first country Renewables Readiness Assessment pilot study.

rapid, objective assessment of the status of renewable energy opportunities and identify pathways to address gaps. Senegal hosted the first country Renewable Readiness Assessment pilot study.

RRA IN SENEGAL

The Renewables Readiness Assessment in Senegal revealed that many steps have been taken towards liberalising the national electricity market. Although SENELEC, the national utility, still enjoys a monopoly for transmission and distribution, generation has been opened up to independent power producers and conditions for self-generation have been simplified. The only renewable-based electricity injected into the grid is from the Manantali hydro power plant in Mali, as part of the Western African Power Pool project.

Funding for research and development in the renewable energy sector remains insignificant despite the presence of research centres and institutes dedicated to renewables and the creation of the first West African solar PV assembler. Senegal could, therefore, build on these assets to accelerate the assessment of the technical renewable energy potential in order to facilitate investment and involvement of the private sector in specific projects.

In 2011, Senegal's national access to electricity was estimated at 40%, with an urban electrification rate of 70% and rural electrification of 22%. The objective is to increase national access rate to 75% by the end of 2012. All the necessary conditions for the rapid expansion of rural electrification are in place, with the adoption of a concerted programme of rural electrification (PASER) and the creation of a dedicated national rural electrification agency (ASER). In addition, concessions for rural electrification have been successfully tendered and awarded to national and international bidders and are being complemented by small local projects. Both approaches include renewables as one of the most appropriate solutions.

Significant experience with Independent Power Producers (IPPs) generating electricity for the national grid (from conventional sources) and the opening of the power-generating sector to renewable sources through the LPDSE 2008 should have increased the involvement of renewable-based IPPs. However, no mechanism exists yet to set appropriate feed-in tariffs (FiTs) and Power Purchase Agreements (PPAs) from renewable-based electricity generation for the grid. The promulgation of the Renewable Energy Law's implementing decrees, which provide "must run" status to renewables, and the design of suitable FiTs constitutes

an important milestone to expand on-grid renewable-based electricity generation.

Licensing, operation and sales of electricity are regulated by the Regulatory Commission of the Electricity Sector, which is also mandated to approve tariffs for electricity supply, regardless of the installation's size. This process is time-consuming and acts as a barrier to the implementation of small local projects, thus limiting their expansion. A measure to alleviate this constraint could include exempting installations below a certain capacity (e.g., below 100 kW) from requiring regulatory body approval for proposed tariffs, and instead allow approval at the local and community level. The decentralisation of regulatory powers, following decentralisation at governmental level, and associated capacity building at the local level to respond to tariff proposals, could also assist the process.

The biofuels sector, although relatively recent in Senegal, is carried by a strong political will to expand feedstock production from both sugarcane and jatropha in order to partially meet domestic fuel demand. However, the complex system of land tenure and the lack of agro-ecological zoning assessments for feedstock production could present significant barriers for the development of biofuels feedstock if not carefully integrated into the biofuel policy and regulatory framework.

KEY RECOMMENDATIONS

As a result of the Renewables Readiness Assessment process in Senegal, the Government of Senegal identified the following key recommendations to stimulate the deployment of renewable energy in the country. The Government of Senegal should:

- Detail out a comprehensive strategy for mapping renewable energy potentials in key areas including their techno-economic feasibility.
- Facilitate grid integration of electricity generated from renewable sources by enacting the Renewable Energy Law, implementing decrees that provide the necessary conditions, guidelines and tariffs to incorporate renewable-based electricity to the grid.
- Consider restructuring the institutional, legal and regulatory framework for utilising land for biofuels production and adapt the rules of intervention of the regulator in off-grid small-scale renewable energy projects.
- Identify the conditions needed to increase private sector involvement, especially for operation and maintenance, in the renewable energy sector.

SENEGAL

196722

km^2

GEOGRAPHICAL AREA

Dakar

CAPITAL CITY

12.6

million

POPULATION

2.6%

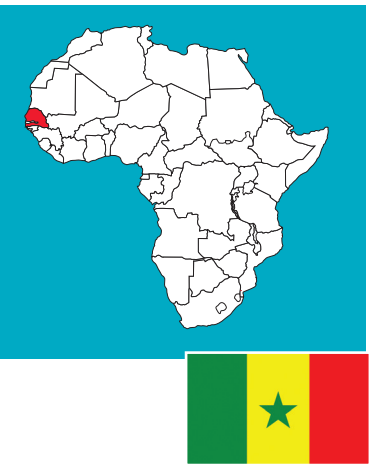
POPULATION GROWTH RATE

(ANSD,2011)

>35%

OF FOREIGN EXCHANGE

EARNINGS USED FOR OIL IMPORT



1. Introduction

BACKGROUND

Senegal is a country in Western Africa, bordered by the Atlantic Ocean and Mauritania, Mali, Guinea, Guinea-Bissau and Gambia. Senegal's economy grew at an average rate of 4% in 2011, with nearly 77.5% of the population employed in the primary sector, and is expected to grow by 4.2% and 4.7% respectively in 2012 and 2013 (ANSD, 2011).

Senegal currently uses more than 35% of its foreign exchange earnings for oil imports, making it highly vulnerable to oil price fluctuations (Ministere des Energies Renouvelables, 2011). In 2008, Senegal decided to promote the use of other energy sources and has restructured the country's national energy policy by considering the development of renewable energy as a major focus area. Institutional, legislative and regulatory structures were therefore strengthened to support the objectives laid out in the National Energy Policy. This high political commitment to institutional reform and policy positioned Senegal as the leader in renewable energy promotion in the Economic Commission of Western Africa [ECOWAS] region and the country was tasked to develop solar energy projects in the sub-region by Heads of State and Government in the ECOWAS Summit held in July 2010[1]. In 2009, Senegal also joined hands with the international community to support the foundation of the International Renewable Energy Agency (IRENA).

Because of Senegal's strong commitment to renewable energy, ECOWAS proposed that it should be chosen as one of the pilot countries to field-test the methodology being developed by IRENA for the Renewables Readiness Assessment (RRA) process. Senegal hosted the first pilot study from 14-18 November 2011 and this document, the final report from that study, contains the insights gained from interviews and workshop sessions with key stakeholders, together with findings from the published literature to summarise the status of the country's policy and institutional framework before proposing short- and medium-term actions for Senegal.

1 The 38th Summit of the Authority of Heads of State and Government of ECOWAS, held on 2 July in Sal, Cape Verde, adopted a Special Resolution establishing the ECOWAS Solar Commission (ESC) with the objective to develop large-scale solar plants to complement the region's energy needs. Under the Chairmanship of H.E. Me Abdoulaye Wade, President of the Republic of Senegal, ECREEE has been designated the implementing agency for the ESC.

IRENA
INTERNATIONAL RENEWABLE ENERGY AGENCY

AS OF NOVEMBER 2012

104
Members of the Agency

55
Signatories/applicants for membership

159
Total participation
(158 states plus the European Union)

48
Participating states in Africa

RRA
RENEWABLES READINESS ASSESSMENT

- Rapid assessment of the conditions necessary for the installation and ongoing operation of renewable energy facilities in a country.
- Covers all RE sources and services of preference to the country's national product.
- The RRA report is a product of the country, and the actions and insights in it come from a country-owned process.

IRENA became a full-fledged international organisation in April 2011, with a mandate to promote increased adoption and sustainable use of all forms of renewable energy. With 104 Members in the Agency, 48 signatories and 7 applicants for membership, IRENA has the global reach to act as the focal point for international cooperation and to underpin the effort to increase the deployment of renewables in the energy mix of countries around the world. Through its work programme, IRENA aims to position itself as an inclusive global platform to stimulate policy dialogue, and develop strategies to assist countries for their necessary transition to a renewables-based energy future.

In July 2011, more than 25 Ministers of Energy and Heads of Delegation attended the IRENA High-Level African Consultative Forum on Partnership on Accelerating Renewable Energy Uptake for Africa's Sustainable Development, where they discussed the vision and direction for IRENA's work in Africa. The communique issued at the end of the forum urged IRENA to *inter alia* "better understand the opportunities and constraints in our countries and regions by mapping 'Renewable Energy Readiness', a collaborative process that will provide a rapid, objective assessment of the status of renewable energy opportunities, and identify pathways to address gaps."

RRAs are now an integral component of the IRENA Work Programme and are included in the "Promotion of regional consensus to adopt renewable energy through strategic intervention". The RRA process is designed to provide input to national and regional renewable energy action plans and bring together partners who can support the implementation of action plans, including providing solutions to energy access.

The Renewables Readiness Assessment (RRA) is designed to define a detailed list of criteria considered necessary for the installation and ongoing operation of renewable energy facilities. Application of this framework to individual countries will provide a comprehensive analysis of the presence, or otherwise, of enabling conditions for the development of renewables. Crucially, this analysis should take into account how the renewables policy of the country in question contributes to its other policy objectives.

THE RENEWABLES READINESS ASSESSMENT

The RRA is a country-driven process that facilitates dialogue between stakeholders. It aims to help IRENA Member States achieve their aspirational goals through adopting the appropriate renewable energy technologies by assessing the current situation and identifying the gaps, and drawing concrete and prioritised action plans to be implemented within a determined timeframe, while specifying the responsible stakeholders and clarifying their roles. The process also facilitates comparisons and case studies, and enables the useful matching of attributes of renewable energy, with opportunities for its deployment.

The RRA comprises a process and a methodology that includes completing a set of templates and a final report. The RRA methodology covers all forms of energy services (transport, heat, electricity and motive power), and all renewable energy sources, with countries selecting those of particular relevance. The RRA also brings in strong country stakeholding as the processes designed to be conducted by national governments, allowing countries to obtain a comprehensive overview of the conditions for renewable energy from their own national perspective. All processes and documentation are led by the country and derive inputs from discussions with stakeholders, facilitated by the country focal point with the assistance of IRENA. The resulting report is therefore a national one, developed and owned by the country. This sets the process and methodology of the RRA apart from other assessment processes led by international organisations. IRENA offers its support during the RRA, but it is the actions and insights developed through a country-owned process that provide the key to rapid deployment.

RRAs facilitate a coordinated approach and the setting of priorities that can inform discussion with bilateral and multilateral cooperation agencies, financial institutions and the private sector regarding the implementation of actions and initiatives emerging out of the RRA. IRENA's backing of the RRA process offers countries access to a global network with the capacity to follow up on actions and facilitate an exchange of experiences. IRENA can also facilitate implementation of the follow-up actions, where necessary, after specific requests from the country or regional entity.

SENEGALESE RRA MISSION

- Introductory meeting with MER and affiliated institutions
- Site visit to small wind-solar-diesel hybrid power plant in Sine Moussa
- Fact-finding interviews with key stakeholders
- Working sessions to fill RRA templates with employees of MER and other stakeholders
- Final workshop with stakeholders to present findings, obtain feedback and to develop a set of actions

OBJECTIVES

- Assess and review the status of energy and RE in Senegal
- Approaches for developing institutional structures for RE
- Framework for providing access to RE
- Technology and Infrastructure for delivering energy and RE
- Opportunities and Barriers for viable business models for RE
- Recommend a Set of Actions to address identified issues

THE RRA METHODOLOGY

The methodology adopted for the country-level RRA has a number of distinct stages as shown in the RRA methodology chart.

TESTING THE METHODOLOGY IN SENEGAL

The pilot study in Senegal was undertaken to field-test the draft methodology for the RRA, obtain feedback from key stakeholders in Senegal on the criteria being used to assess the readiness, and further improve the methodology. An extensive literature review of recent relevant studies was also undertaken.

Stakeholder mapping identified key stakeholders in government departments and public sector bodies, financial institutions, research bodies, NGOs and the private sector. These key stakeholders are highlighted in Section 2.4. This research set the stage for a mission to Senegal to complete the on-ground assessment process. The mission comprised the following activities:

1. An introductory meeting with the Ministry of Renewable Energy (MER) and affiliated institutions provided an introduction to the project and opportunities to share knowledge with key stakeholders.

2. A site visit to Sine Moussa, a village three hours' drive from Dakar, where a hybrid power plant of 20 kW (solar 5 kW, wind 5 kW and diesel 10 kW) has been used to electrify village dwellings and provide street lighting.

3. A series of fact-finding interviews with stakeholders from the renewable energy sector.

4. Working sessions with employees from the MER and other stakeholders to fill in RRA templates for different renewable energy resources and services.

5. A final workshop with stakeholders held on the final day of the mission, aimed at presenting findings from the week, eliciting further feedback on these findings, and developing the set of actions that form the last stage of an RRA.

As stated in the introduction, the experience gained from the pilot RRA assessment conducted in Senegal will assist further regional and country level assessments, and other work in partner countries.

Renewable Readiness Assessment Methodology

1 Scoping

STEP 1A PREPARATORY WORK

- Setting up of the RRA team initiated and led by National Government
- Contextualisation of RRA
- Identification of key stakeholders, RE projects and programmes
- Roadmap and timeline for assessment

STEP 1B PLANNING THE PROCESS

- Identification of appropriate service–resource pairs
- Preparation of list of interviewees, appointments and tentative questionnaire for bilateral meetings

2 Assessing

STEP 2A INITIAL PLENARY SESSION

- Introductory session led by high-level government official (e.g., Minister of RE)
- Discussion on status, potential and barriers to scale up RE
- Description of how to conduct the RRA
- Refining and selection of key renewables applications

STEP 2B ASSESSMENT

- Filling out of RRA templates with regards to:
  - Policy and strategy
  - Business models
  - Institutional, regulatory and market structure
  - Resources, technologies and infrastructure
  - Finance, building, operations and maintenance

STEP 2C VALIDATION WORKSHOP

- National workshop to present and validate preliminary findings

3 Finalising

STEP 3A FINAL REPORT

- Final report-writing drawn on preparatory materials, completed RRA templates and list of actions
- RRA Director comments and approves work on behalf of the country

STEP 3B FOLLOW UP ACTIONS

- Working with IRENA
- RRA Director and Government Focal Point identify areas for subsequent collaboration and action

OBJECTIVES

This report aims to foster understanding and debate around the renewable energy sector in Senegal and provide an introduction to the issues facing the country. It also offers a broad summary of the experiences of the energy market development and the deployment of renewables. The key objectives for this report are:

1. To assess the energy issues facing Senegal and review the current status of energy policy, specifically regarding renewable energy, at a regional and national levels.

2. To critically review employed and planned approaches to developing institutional structures for renewables.

3. To review the framework for providing access to modern energy services using renewable energy as well as the current status of technology and infrastructure to deliver it.

4. To critically assess the opportunities and barriers for developing viable business models for renewable energy projects.

5. To suggest a set of actions to address the identified barriers.

The experience gained from the pilot RRA assessment conducted in Senegal will assist further regional and country level assessments

This report aims to conclude the pilot stage of the RRA process for Senegal and to highlight an action framework that would enhance the deployment of renewable energy. The analysis presented here is intended to put the issues and proposed actions in the context of regional and international experience.

II. Energy and Renewable Energy Context

THE REGIONAL CONTEXT

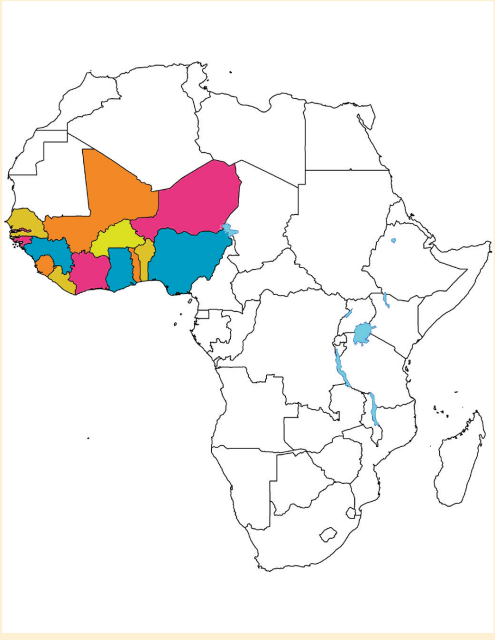
The ECOWAS region is characterised by a growing demand for modern energy and low levels of access and reliability of modern energy services[2]. According to the African Development Bank one-third of Africans are now "middle-class" (defined as having between USD 2 and USD 20 to spend daily); while improvements in governance, better access to technology, and better use of natural resources have begun to raise millions out of dire poverty (AfDB, 2011). However, the improving economic growth experienced by African countries is being stunted by poor performance of the energy sector, especially in Sub-Saharan Africa. Taking the electricity sector for example, the low growth in generation capacity is unable to keep pace with the growth in the demand for electricity and has resulted in a current supply/demand gap of about 40% (GTZ, 2009). This situation is general for the whole continent. Bazilian et al. (2011) suggest that if Africa is to meet the goal of universal energy access by 2030, electricity generation capacity needs to grow at an annual rate of 13%, compared to the 2% annual growth recorded over the past two decades. Current spending in the energy sector is much less than required, even for conventional development and energy-use patterns. For example, Sub-Saharan Africa countries spend on average less than 3% of their GDP on their power sector with about 75% of this spending used as operating costs (Eberhard et al., 2008), suggesting that a mere 0.75% of GDP is used to expand power infrastructure.

2 The International Energy Agency (IEA) defines Universal Modern Energy Access as "a household having reliable and affordable access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time to reach the regional average". The Asian Development Bank (ADB) also defines Energy Access as any or a combination of the following: (1) provision of electricity and motive power to households, (2) improvement in the supply and delivery of energy services to households, (3) provision of modern fuels and/or efficient devices for cooking and/or heating to households and (4) provision of finance to households to access energy (Sokona et al. Widening energy access in Africa, 2012).

ECOWAS

MEMBER COUNTRIES

BENIN
BURKINA FASO
CABO VERDE
COTE D'IVOIRE
GAMBIA
GHANA
GUINEA
GUINEA BISSAU
LIBERIA
MALI
NIGER
NIGERIA
SENEGAL
SIERRA LEONE
TOGOLESE Republic



<0.75% of GDP

of Sub-Saharan African countries is used for expanding power infrastructure

Households with electricity access in the ECOWAS region

<30%

in 9 out of 15 countries

15%

in remaining countries
(Guinea, Guinea Bissau, Liberia, Niger and Sierra Leone)

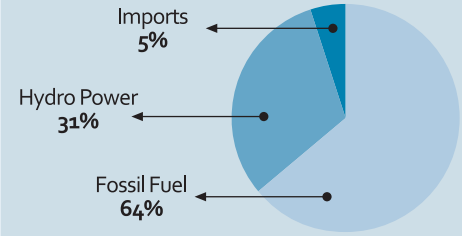
20%

for the whole ECOWAS region

Traditional biomass dominates primary energy supply in the ECOWAS region of electricity generated, 64% is from fossil fuels, 31% from hydro power and the rest is from imports.

Primary energy supply in the ECOWAS region

Sectorwise share in %



West African Power Pool (WAPP) set up in 2006 by ECOWAS to address power supply deficiency in the region.

ECOWAS Regional Electricity Regulatory Authority set up to harmonise the regulations governing trans-border electricity trade.

ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE), set up by the ECOWAS Commission in collaboration with the various partners, as a regional response to address specific issues relating to catalysing markets for renewable energy and energy efficiency technologies.

Public-private partnerships

The setting up of these will cover technical aspects, management systems, fundraising and financial risk-taking.

ECOWAS has drawn up multiple energy access goals to address the supply/demand gap. The countries in the region have decided to implement an ambitious regional energy policy (ECOWAS, 2006) in order to increase access to modern energy services. The region aims to provide access to modern energy services to at least half of the population by the year 2015. This would mean bringing 36 million additional households within the ambit of modern energy services (ECOWAS, 2006) and is proposed to be implemented by strengthening regional integration (pooling of knowledge, cross-border cooperation and capacity building), harmonisation of political and institutional frameworks, and the development of coherent energy policies based on poverty reduction in rural and peri-urban areas.

During the implementation of the energy programmes designed to achieve these goals, priority should be given to public-private partnerships (PPPs). It is most important that public actors (state, public institutions, local authorities, etc.) and private actors (national and local entrepreneurs, financial institutions, associations and cooperatives, NGOs, etc.) are mobilised.

One key regional initiative was the establishment of the West African Power Pool (WAPP) as a specialised ECOWAS institution in 2006[3]. WAPP is now working to harmonise the regulatory framework that governs the electricity sector in each member country. The first phase of its work involved engaging with countries that are already interconnected, including Nigeria, Benin, Burkina Faso, Cote d'Ivoire, Ghana, Niger and Togo, although some critical gaps in grid infrastructure still need to be addressed. WAPP has also begun to engage with countries which do not yet have interconnection facilities, including Guinea, Guinea-Bissau, Liberia, Mali, Senegal and Gambia. Other key initiatives include the ECOWAS Regional Electricity Regulatory Authority and the ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE).

Although the generation, transmission and distribution of electricity are mainly provided by publicly-owned, vertically-integrated national utilities, efforts are being made by a number of countries to mobilise private sector finance through IPPs with varying levels of success[4]. These efforts continue to be hampered by perception of investor risks, regulatory concerns with competition between public and private generation assets and difficulties in developing bankable business models.

The Total Primary Energy Supply (TPES) of Senegal in 2010 was 141.6 PJ. Biomass accounts for about 47% of the country's energy supply with oil products accounting for about 48% (Figure 2). Coal, hydro, natural gas and solar (whose combined share has greatly increased since 2000) are the other energy sources used (Figure 3).

3 WAPP was created by Decision A/DEC.5/12/99 during the 22nd Summit of the Authority of ECOWAS Heads of State and Government. WAPP was guided by a Steering Committee comprising Energy Ministers of ECOWAS Member States, supported by a Project Implementation Committee, comprising Managing Directors of Members States' Utilities and Technical and Institutional Working Groups. The 29th Summit of the Heads of State and Government of the ECOWAS Member States held in Niamey in January 2006 adopted the Articles of Agreement establishing the new WAPP organisation by Decision A/DEC.18/01/06 on 12 January 2006. The same meeting granted the status of a Specialised Institution of ECOWAS to WAPP, by Decision A/DEC.20/01/06.

4 Successful cases are CIPREL and Azito in Côte d'Ivoire; Global Electrical Group (GEG) in Gambia; Takoradi II, Sunon Asogli and Bui Hydro, in Ghana; AES Barge, Okpai , Afam VI and Aba Integrated, in Nigeria; GTi Dakar, and Kounoune I, in Senegal; and Centrale Thermique de Lome in Togo.

Senegal Energy Profile

Figure 1. Senegal Energy Profile

157.9 PJ
Total Primary Energy Supply
2,858 GWh

86.8 PJ
Share of renewables in TPES
(54.8% of TPES)

2,858 GWH
Electricity generation

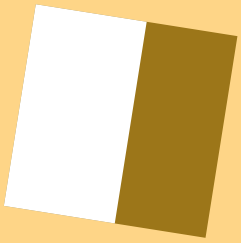
292.0 GWH
Share of RE in electricity generated
(10.2 % of total)

548 MW
Electrical capacity (2008)

2 MW
Share of RE in electrical capacity
(0.4% of total)

189 KWH
Electricity use per capita

55.5%
Senegal's Energy
Self-sufficiency



US $1.2 BILLION
Senegal's fuel imports
(23.2% of total imports)

Approximately 25%
Share of population
using solid fuels

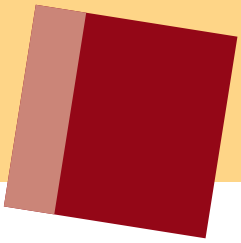
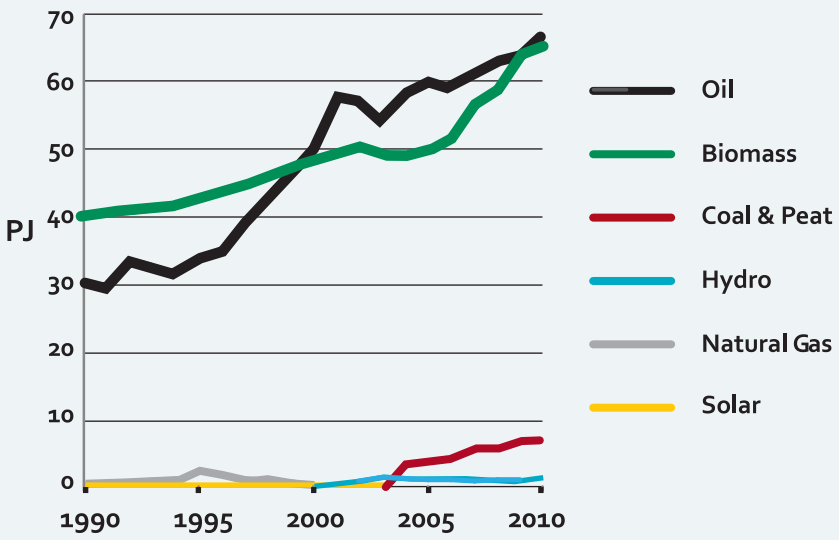
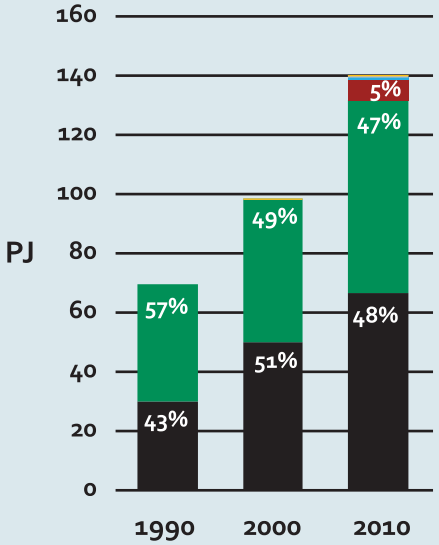


Figure 2.
Total Primary Energy Supply by Fuel





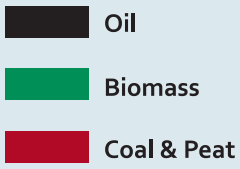


Figure 3. Energy Sources Used

Source: IEA, 2011

All the fossil fuels consumed in the country are imported – in particular the oil products that are used for transport and electricity generation – and make a significant contribution to the country's imports bill with an estimated CFA 620 billion (approx. USD 1.2 billion)[5] in 2009 corresponding to 23.3% of total imports (Figure 4). This leaves Senegal very vulnerable to increases in the price of oil products. Households account for 52% of the total energy consumption, followed by the transportation sector (30%), and the industrial sector (14%). Agriculture and public services consume the remaining 4%.

Both the biomass and oil products used in Senegal are sources of concern: the use of traditional fuels – wood and charcoal – is putting great pressure on forests and contributing to a degradation of the environment. In order to decrease

5. USD 1 = CFA 532

traditional biomass consumption, Senegal has had a policy of subsidising liquefied petroleum gas (LPG) supplies for more than two decades.

About 40% of the households in Senegal have access to electricity, principally through SENELEC's interconnected grid. SENELEC shares generation with ESKOM-Manantali[6], GTI-DAKAR[7] and Kounoune I[8] to power the interconnected grid, while there are small independent and self-power producers such as Cim-Sahel Energy, CSS, SONACOS, SOCOCIM and ICS. The rate of electrification is progressing through new connections to this main grid and through small off-grid projects. However, consumers and businesses connected to the grid still have to contend with a highly unstable and unreliable electricity supply, leading to revenue and productivity losses to firms and the economy.

Modernisation of Senegal's power generation infrastructure is lagging behind demand. This is reflected in increased power generation costs – the current average wholesale cost of power in Senegal is about CFA 70/kWh (USD 0.14/kWh) (SENELEC, 2012) compared with USD 0.13/kWh in the Sub-Saharan region's larger power systems (AfDB, 2011). The existing high cost of electricity to consumers means that it is impossible to finance further new connections through increased consumer tariffs and the scarcity of capital available to the government means that investments have to rely heavily on donors.

Figure 4.
Senegal Oil Bill
in billion CFA Francs

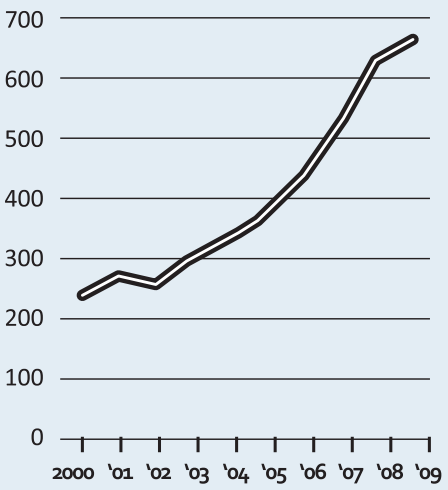


Image 1: Traditional Biomass in Senegal
© www.beershebaproject.org

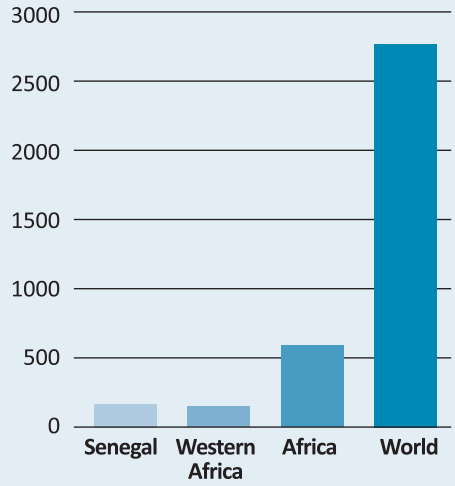
Senegal has a proven reserve of oil estimated at 100 million m3 in the south (Casamance area) but as yet, neither

6 ESKOM-Manantali is in charge of running the Manantali dam (a joint venture between Mali, Mauritania and Senegal), in the frame of the OMVS with a 200 MW installed capacity with Senegal receiving 32% of the power generated.

7 GTI-DAKAR signed a 15-year exclusive contract for electricity supply with SENELEC in 1996 and has installed a capacity of 53 MW (natural gas 37 MW and 16 MW from a steam turbine).

8 Kounoune I signed a 15-year exclusive BOO contract for electricity supply with SENELEC in 2008 and has installed a capacity of 68 MW (HFO diesel).

Figure 5: Per Capita Electricity Use
kWh per capita



Source: IRENA 2011b

189 KWH
Per capita electricity use in Senegal – fourth among west African countries.

579 KWH
Average for Africa

2777 KWH
Average for world

COST COMPARISON

CFA 110/KWH

or

US$ 0.22/KWH
Average cost to customer for electricity in Senegal

US$ 0.04/KWH
Average for South Asia

US$ 0.07/KWH
Average for East Asia

upstream nor downstream production capacity has been developed (Enda-Energie, 2006; Enefebio, 2007). Imported crude oil is refined at Societe Africaine de Raffinage (SAR) which has an annual capacity of 1.2 million tons (SAR, 2010). Gas reserves, estimated to be 30.4 billion m^3 in the Gadiaga area as of 2011, are used exclusively for running four gas turbines with a total output of 88 GWh (8% of the total electricity production within the country) (SENELEC, 2012). Table 1 presents the estimated energy potentials in Senegal by resources.

RENEWABLE ENERGY IN SENEGAL

Senegal is endowed with a large solar energy resource. Over most of country's territory, the solar irradiation is above 2 000 kWh /m^2/year for Global Horizontal Irradiation and above 1 800 kWh/m^2/year for Direct Normal Irradiation (Ministere des Energies Renouvelables, 2011). This provides good prospects for photovoltaic solar power projects. The falling prices of photovoltaic panels and system components make solar a very attractive solution, particularly when the costs of the alternatives – imported oil products – are high.

There is also significant wind energy potential along Senegal's coast between Dakar and Saint Louis with an average speed estimated around 4 m/sat 10 metres height. Recent measurements performed at 30-40 metres revealed the existence of speeds above 6 m/s (Ibid).

The total potential for large hydro power in Senegal is estimated to be approximately 1 400 MW on the Senegal and Gambia Rivers (Ibid).

Solid biomass (agricultural and agri-business by-products) and liquid biofuels also have potential in parts of the country. As mentioned earlier, biomass is the dominant source of energy in Senegal providing more than 50% of the national energy balance. Biomass resources, such as agricultural byproducts (approximately 3.3 million dry tons of agricultural residues) agribusiness (rice husk, bagasse, peanut shells, cotton stalks, etc.), also have the potential for grid-distributed and off-grid electricity generation (Ibid). Plant species (plant oil, jatropha curcas, cat-tails, sunflower, cotton, castor, sweet sorghum etc.) also have potential for biofuel production. Image 2 is a geographical representation of Senegal's renewable energy potential in relation with the existing power grid.

KEY ENERGY STAKEHOLDERS

A wide range of stakeholders was identified to participate in the workshops and discussions in order to support the RRA process. The stakeholders were primarily technical staff drawn from government departments and public sector agencies, but also came from the private sector, civil society, dev-elopment and cooperation agencies as well as financial institutions, since they all play an important role in building a renewable energy sector. In addition, bilateral meetings and interviews were conducted with key senior officials of these different institutions. It is because so many people were able to give their inputs that the Renewables Readiness Assessment is meaningful in building national consensus on renewable energy in the country. On the following pages is a list and description of these institutions.

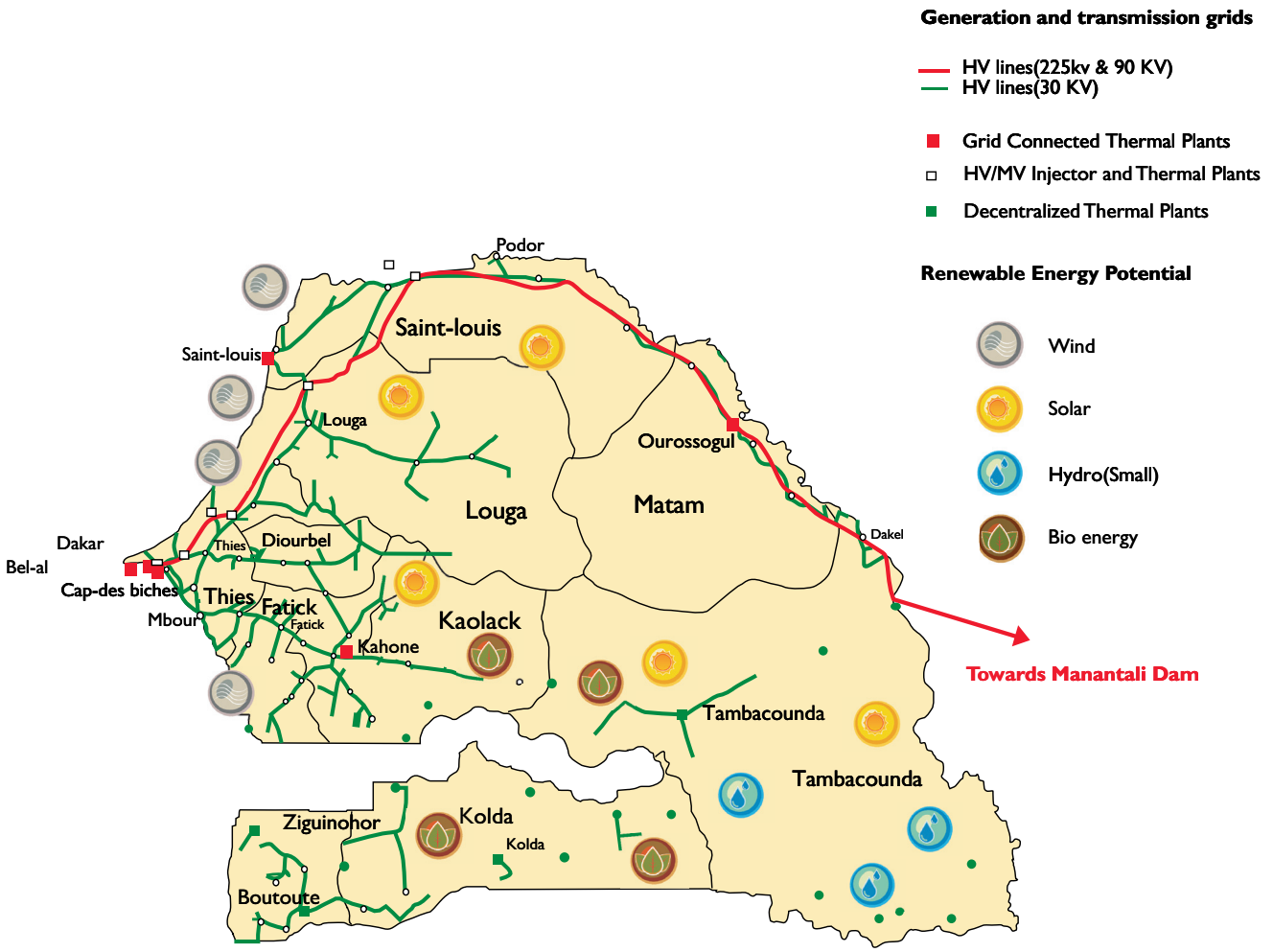
Table 1: **Types, location and potentials of energy resources**
(Enda-Energie, 2006; Enefebio, 2007)

Resources	Sites	Potential
Oil	Casamance (heavy oil)	100 million m^3
Peats	Niayes	390 million m^3
Natural Gas	Diamiadio	400 billion m^3 (reserve 30.4 billion m^3)
Biomass	Tambacounda Kolda, Ziguinchor	331.3 million m^3
Hydro	Senegal and Gambia rivers	1 400 MW
Solar	Countrywide	1 800 kWh/m^2/year, Direct Normal Irradiation 2 000 kWh/ m^2/year, Global Horizontal Irradiation
Wind	Great coast areas	4- 6 m/s

National Electricity Grids and RE Potential

(Author and Senelec, 2012)

Image 2



Key Energy Stakeholders

Council of Ministers

The Council of Ministers takes the major decisions related to energy, especially on-grid electricity.

Inter-Ministerial Committee on Renewable Energy

However, in order to coordinate and facilitate the integration of electricity from renewables into the grid, all matters relating to renewable energy need to be discussed and finalised in consultation with the key actors (MoE, MER, CRSE, ASER, SENELEC) in the Inter-ministerial Committee on Renewable Energy (Comité Interministériel sur les Energies Renouvelables, or CIER) before taking them for decision to the Council of Ministers.

Ministry of Energy (MoE)

MoE is in charge of on-grid electricity policy and closely monitors its implementation.

Ministry of Renewable Energy (MER)

MER is responsible for framing policies for the promotion of electricity generation from renewable energy sources and thus plays a key role in formulating policies and monitoring decisions taken in consultation with the MoE and other relevant stakeholders for promoting decentralised renewable energy applications.

The Regulatory Commission for the Electricity Sector (CRSE)

CRSE has the role of promoting competition, efficiency and economy in bulk power markets, regulating electricity tariffs, improving the quality of supply, advising the government on the removal of institutional barriers to bridge the demand supply gap, thus safeguarding the interests of consumers.

Senegalese Agency for Rural Electrification (ASER)

ASER is responsible for much of Senegal's off-grid rural electrification and power generation although some projects still fall under SENELEC's authority. ASER, which was established in 2000 but only became fully operational in 2005, has been given the responsibility of implementing the strategy for rural electrification (PASER).

SENELEC: The national electricity utility

SENELEC is one of the pillars of the economic and social development of Senegal and is its main electricity generator.

SENELEC is the concessionaire for the transmission and distribution network in Senegal (with the exception of Manantali interconnection) and operates in a monopoly condition for the purchase and sale of wholesale power.

SENELEC has been through several phases of privatisation but its priority now is to strengthen the capacity of power generation and implement organisational restructuring.

Intersectorial Committee for the Implentation of Synergies between Energy and other Strategic Sectors (CIMES)

CIMES is a multi-sectorial group comprising, among others, the relevant ministries, civil society, private sector and donors. The group worked towards including energy issues within the National Poverty Reduction Strategy and is considering the energy gaps to meet development goals, and the contribution of renewable energy to these goals.

National Agency for Solar Energy (ANDES)

ANDES is a new agency set up by Senegal in response to the 2010 mandate it received from the heads of states of ECOWAS countries to promote solar energy in the sub-region.

University Cheikh Anta Diop de Dakar and its subsidiaries

The University Cheikh Anta Diop of Dakar focuses on research in renewable energies in Senegal through its Research and Study Centre for Renewable Energy (CERER). Activities covered include studies into the renewable energy potential of the country, as well as pilot projects in wind and solar thermal energy.

The Polytechnic School (ESP) has been integrating renewable energy content into its curriculum for a long time, but no dedicated programme exists. Each department in the ESP has a liaison teacher to the private sector.

Enda-Energy

Enda-Energy is a branch of the Enda-Tiers Monde organisation; its work focuses on energy use and management in the African context, with an emphasis on the linkages between energy and development.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

GIZ develops capacities for sustainable development of the energy sector in Senegal through the Programme to Promote Rural Electrification and a Sustainable Supply of Domestic Fuel (PERACOD).

CMS and Sen Finance

CMS and Sen Finance are local micro-finance institutions with a good, well spread network of local branch offices. However, renewable energy is missing from their portfolios due to a lack of understanding of renewable energy technologies, industry standards and business models.

Refer to footnotes for more information on CRSE[9] , ASER[10] , ANDES[11] and PERACOD[12] .

9. The CRSE was created by the Law of 98-29 of 14 April 1998.

10 Villages close to the grid and the ones electrified before 2000 are under SENELEC control while all remaining rural localities are under ASER responsibility.

11 ANDES was established by Decree No. 2011-634 of 17 May 2011, but it is yet to become operational.

12 PERACOD is funded by the EU Energy Facility, the DGIS and the French Development Cooperation. The main activities of PERACOD are off-grid rural electrification, improving cook stoves, and training communities and the private sector in implementing these measures. PERACOD activities began in 2003 and will end in 2015.

ENERGY POLICY AND REGULATORY FRAMEWORK

Senegal initiated its comprehensive energy planning more than a decade ago with the "Lettre de Developpement du Secteur de l'Energie (LPDSE)," in 1997. This policy articulated the goals of the country to eliminate inefficiencies, decrease supply costs to consumers and mobilise funding for energy sector development. In 1998, the energy sector, through the enactment of the Law of 98-29[13], opened up for private sector investment in electricity generation and the Regulatory Commission for the Electricity Sector (CRSE) was formed in order to ensure fair and equitable treatment for all players. The CRSE became fully functional with a chairman and technical members, and worked to promote competition, efficiency and economy in bulk power markets, improve the quality of supply, promote investments and advise government on the removal of institutional barriers to bridging the supply/demand gap and foster the interests of consumers. The Law of 98-29 was further amended in 2002 in order to provide a greater level of transparency to the procedures for inviting private sector tenders.

However, all the objectives which were laid out for LPDSE in 1997 could not be achieved during the five-year implementation period and LPDSE 2003 was formulated with the aim of completing the necessary sector reforms. New measures were designed to promote development, enhance the involvement of the private sector and reduce the cost of supply to consumers.

ENERGY PLANNING

- 1997: Creation of LPDSE.
- 1998: Law of 98-29. Setting up of CRSE.
- 2003: LPDSE 2003 to complete reforms.
- 2008: LPDSE 2008. MER set up, Laws on Renewable Energy and Biofuels enacted.
- Current: National Strategy for Renewable Energy under discussion. To set a target of 20% renewables in electricity mix by 2020.

RURAL ELECTRIFICATION

Senegalese Rural Electrification Action Plan(PASER)

8%
Electricity access to rural households in 2000

62%
Electricity access to rural households in 2022
LPDSE 2008

50%
Rural electrification target for 2012

Improved access to energy services was identified as a key objective of Senegal's national poverty reduction strategy and strong linkages to this goal were incorporated into grid infrastructure planning.

In order to further the framework for energy policy, LPDSE 2008 was formulated. LPDSE 2008 builds on the experience gained and has a strong focus on promoting renewable energy as a measure for reducing the vulnerability of the country to external factors including oil

13 The Law of 98-29, enacted as part of the reform of the electricity sector, aims to promote private investment and eventually to introduce competition in production, wholesale and bulk purchase.This law was amended in 2002 and systems of launching and control of tenders for the production of electricity and the concept of ownership of the facilities of production, transportation and distribution were introduced.

BIOFUELS

National Biofuels Strategy 2006

320,000 ha

Target for land area to be planted with Jatropha by 2012

1.2 billion litres

Target forJatropha oil to be produced by 2012

Comité National des Biocarburants (CNB)

Set up to coordinate across relevant institutions in the biofuels sector

Law No. 2010-22

To create favourable conditions for the development of the biofuels sector

price volatility. The role of renewable energy in providing access to modern energy services and transport fuels was first highlighted in LPDSE 2008. The Ministry for Renewable Energy (MER) was created and the Law on Renewable Energy and Law on Biofuels were enacted to give further effect to the political intent stated in LPDSE 2008 which defines the framework for renewable energy deployment in the country and a law for promoting biofuels.

A renewable energy development policy (National Strategy for Renewable Energy), which draws on the tenets enunciated in the law, is under discussion in Senegal. When this policy is approved by the Council of Ministers, Senegal will have a renewable energy target of 10% of electricity from renewable resources in its electricity mix by 2020 (Ministere des Energies Renouvelables, 2011). The policy also envisages the development of a master plan to develop flagship projects and identify funding sources while emphasising the need to strengthen both training and research and development in renewable energy[14].

In terms of decentralised application, rural electrification has been made a national priority and clear linkages with strategies for poverty reduction have been established in the policy framework. Senegal has an ambitious multi-year programme (2002-2022) for rural electrification, the "Plan d'Action Senegalais d'Electrification Rurale" (PASER – Senegalese Rural Electrification Plan of Action), which aims to increase the rate of rural electrification (in terms of rural household connections) from about 8% in 2000 to 62% in 2022.

Many ministries have recognised the role that renewable energy can play in the achievement of the MDGs. The Ministry of Health has stressed the importance of renewable energy for maintaining the cold

14 Senegal plans to reinforce the installed capacity connected to the grid by producing 400 MW from clean energy resources by 2020 (200 MW in 2015 and an additional 200 MW by 2020), (http://fr.allafrica.com/stories/201106240575.html)

chain for vaccine distribution. In their sectorial policies, the Ministries of Water and Agriculture have similarly stated the importance of using renewable energy for pumping to provide safe drinking water and irrigation. The Ministry of Construction has made the usage of solar water heaters mandatory in government buildings and those of various institutions. The National Strategy for Poverty Alleviation – DSRP 2006-10 – built on these sectorial policies, placed a high priority on strengthening the infrastructure for providing access to electricity in rural and peri-urban households as well as electrification for social infrastructure and providing energy for mechanising motive applications[15].

The agenda set by the National Strategy for Poverty Alleviation is well-reflected in LPDSE 2008 which set a goal of 50% rural electrification by 2012 (Ministere de l'Energie, 2008). The National Strategy for Renewable Energy, currently under discussion, identifies a key role that the private sector will be required to play in the generation of electricity through the installation of decentralised applications and also in developing the market for solar photovoltaic applications, small wind turbines and biofuel engines (e.g., multifunctional platforms). It recognises the role of renewable energy for both generation of electricity and mechanisation of motive applications for rural areas.

With regard to biofuels, following the meeting convened in Dakar for the establishment of the Pan-African Non-Petroleum Producers Association (PANPPA) in November 2006, many African countries, including Senegal, have reflected on the role of biofuels in their agricultural and energy policies. Therefore, when Senegal established its National Bioenergy Strategy in 2006, one of its aims was to contribute to national energy security through the production of bioenergy. This included developing jatropha for biodiesel production and sugarcane for ethanol production. The fuels produced were to be used not only for transport, but also for blending with diesel for power generation. The government aimed to plant a total of 320 000 ha of jatropha by 2012, by providing each of 320 rural communities with 1 000 ha of jatropha seedlings, which would be used to produce a total of 1.2 billion litres of jatropha oil to meet annual petrol and diesel needs. However, implementation of this project is currently lagging behind.

Policy measures for biofuels are also included in agricultural policies and programmes such as Retour Versl' Agriculture – Going Back to Agriculture – (REVA) and

FINANCING RENEWABLE ENERGY

THE SOURCE

- Bilateral and multilateral Banks
- Donors
- Rural Electrification Fund (operated by ASER)
- Carbon Fund (set up by Government of Senegal)
- Local banks and private sector are reluctant to invest in energy due to risk perception
- National Agency for promotion of Investment (APIX) set up to implement the investment code adopted by Senegal and to create favourable conditions for investments

15 The Document of the Strategy for Poverty Alleviation (DSRP) targeted the electrification of basic rural infrastructure for rural and peri-urban areas in order to facilitate the operationalisation of basic infrastructures (health centres, schools, etc.), the access to electricity for 66% of households (30% from rural areas) by 2015, and the access to motive power for rural women, as priorities for achieving the MDGs.

Photo Courtesy: INENSUS West Africa S.A.R.L

Grande Offensive Agricole pour la Nourriture et l' Abondance – the Great Agricultural Offensive for Food and Agriculture (GOANA).

Law No. 2010-22[16], a law on the orientation of the biofuels sector, was adopted in 2010 with the aim of creating favourable conditions for the development of the biofuels sector and providing answers to the problems of economic growth, based on a policy of energy self-sufficiency through the development of biofuels. The law therefore covers all components of the biofuels sector including production, processing, storage, transport, marketing and distribution. It determines the operating environment for all forms of biofuels and the conditions and standards for their production and exploitation on Senegal's national territory and/or through international cooperation.

Implementing decrees are currently being drafted and will determine incentives for production, tax and customs treatment, marketing and other arrangements. The Ministry of Renewable Energy has a mandate to cover both biomass (under the Directorate of Renewable Energy) and biofuels (under the Directorate of Biofuels).

A national technical committee, the "Comité National des Biocarburants" (CNB), has also been established under the aegis of the National Bioenergy Strategy to facilitate coordination across relevant institutions. The CNB comprises members from the Ministries of Renewable Energy, Energy and Agriculture, Investment Promotion Agencies, and reports to the Director of Biofuels and Biomass in the Ministry of Renewable Energy. The government also appointed the Senegalese Institute for Agricultural Research (ISRA) under the

16 Law No. 2010-22 of 15 December 2010 of the biofuel sector.

National Bioenergy Strategy to take charge of monitoring biodiesel and bioethanol production. To raise awareness of the need for jatropha plantation, rural communities have been involved using the decentralised framework of the National Rural Councillors Association (ANCS).

A range of research institutions are active in the biofuels sector, including universities, CERER and ISRA[17]; and there are several training institutes across the country. Quality control of biodiesel and bioethanol products falls under the responsibility of the Societe Africaine de Raffinage (SAR– the Senegalese Refinery).

The regulatory framework in Senegal comes in the form of decrees promulgated from time to time. The two most important and recent decrees for implementing the Law on Renewable Energy were issued in December 2011. They lay down the conditions of purchase and remuneration for electricity generated by renewable energy plants, the conditions for the connection of these plants to the grid, and the conditions for purchase and remuneration of surplus electricity from captive power plants generating electricity from renewables. However, reduced taxes and customs duties applicable to renewable energy equipment are only considered on a case-by-case basis. The decrees are therefore aimed at eliminating inefficiencies, decreasing the cost of supply to consumers, and promoting development funding for the energy sector.

FINANCING AND INVESTMENT

In Senegal, investment and finances in the energy sector largely rely on funding from multi and bilateral banks or donors, but rarely from the private sector. In renewable energy, electrification projects are jointly funded by the private sector and the Rural Electrification Fund (REF) while other applications, such as motive and thermal projects, are being implemented through donor-funded programmes.

As in many other developing countries, public investments in the energy sector fall short of the requirements for funds needed to strengthen and modernise the infrastructure. The government has placed a levy on the selling of hydrocarbons and created a Carbon Fund (CF). This fund is being used to create additional capacity and to provide subsidies to consumers in the form of lower electricity costs. The government has also set up funds to promote renewable energy and biofuels, and raise awareness about these resources.

However, there is still a strong reliance on external funding (from donors) for the implementation of energy programmes and projects. Local banks and the private sector remain reluctant to invest in the energy sector due to risk perception.

Senegal is making a clear thrust towards rural electrification. A Rural Electrification Fund (REF) operated by ASER has been established and is responsible for financing

17 The ISRA is a research institute in applied science and technology created in 1974 to design, organise and carry out all research on the rural sector in Senegal. Its mission is to generate knowledge and appropriate technologies that would support the country's socio-economic development by stimulating job creation, increasing food security among other things.

Photo Courtesy: INENSUS West Africa S.A.R.L

sustainable development of rural electrification. Through the REF, ASER supports investments by granting subsidies to operators, financing credit lines and guaranteeing funds to banks, micro-finance institutions and other programme partners.

Senegal has also adopted a National Investment Code designed to create favourable investment conditions. The code provides protection against expropriation and nationalisation, as well as guidelines for repatriation of the investment and its returns. A special agency, "Agence Nationale chargée de la Promotion de l'Investissement et des Grands Travaux" (APIX - National Agency for the Promotion of Investment) has been formed to oversee the code. National treatment for foreign direct investment is also ensured which has provided an atmosphere conducive to stimulating business initiatives. Although energy is not specifically mentioned in the investment code, and is not therefore currently an eligible sector, if investments creating a new enterprise also create jobs and are located in underdeveloped areas of the country, the enterprise would receive all the preferential tax benefits under the investment code.

Fiscal incentives for promoting cropping and harvesting feedstock for biofuels and producing biofuels on a commercial scale are provided in the regulations. The National Investment Code provides that the activities on agricultural production, processing and storage will be eligible to receive benefits while farm incomes from biofuels will be exempt from income tax for a period of five years.

The development of affordable energy in sufficient quantities is crucial to achieving Senegal's economic development goals. Renewables therefore need to be exploited. Fortunately, the current political and institutional context is favourable to a step change in their deployment.

RENEWABLE ENERGY HAS A HIGH LEVEL OF POLITICAL SUPPORT, WHICH SHOULD HELP OVERCOME SOME OF THE CHALLENGES TO ITS SCALE-UP. INDEED, SENEGAL HAS ALREADY ADOPTED A RENEWABLE ENERGY LAW FROM WHICH A RENEWABLE ENERGY STRATEGY HAS BEEN OUTLINED.

III. Market Development by Sector

A. ON-GRID ELECTRICITY

Hydropower is the only renewable energy resource connected to the grid through the 200 MW Manantali hydro project[18] of which 64 MW is dedicated to Senegal.

The electricity produced by SENELEC and private companies is insufficient to cope with the growth in demand. Growing infrastructure obsolescence is leading to frequent shut-downs and transmission losses are estimated at around 21% (Ministere de l'Energie –Direction National de l'Energie, 2007) and the installed capacity has been reduced to an effective capacity of around 548.7 MW, of which 429.7 MW is connected to the grid (SENELEC, 2012). As mentioned earlier, even those who have access to electricity suffer from shortages and poor quality of supply. Unscheduled outages, load shedding, fluctuating voltage and erratic frequencies are common. Consumers and the economy bear a large burden of this poor quality of supply.

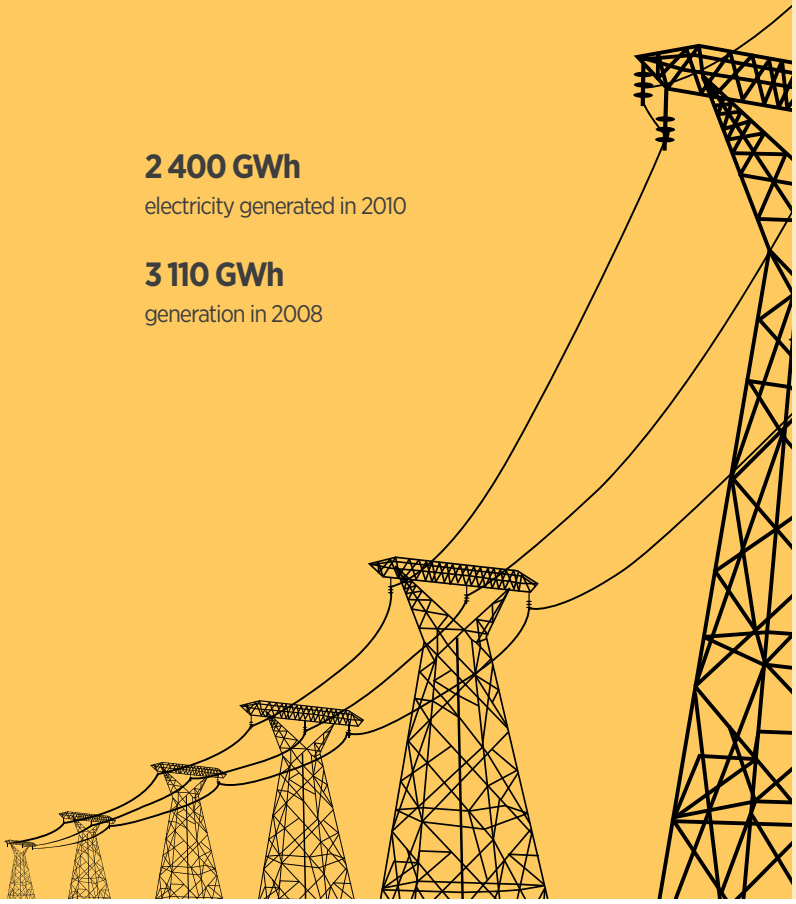
SENELEC enjoys a monopoly position in the distribution of electricity in Senegal. The electricity distribution system of SENELEC as of 2008 was comprised of:

1. An MV network at 6.6 kV and 30 kV with a total length of 7 627 km;

18 The Organisation for the Development of the Senegal River (OMVS), which consists of Mali, Mauritania and Senegal, has constructed the Manantali dam on the Bafing River, the main tributary of the Senegal River in Mali, in 1987. The Manantali project includes a 200 MW power station and a 1 300 km grid of transmission lines to the capitals of Mali (Bamako), Mauritania (Nouakchott) and Senegal (Dakar).

2 400 GWh
electricity generated in 2010

3 110 GWh
generation in 2008



SENEGALESE HIGH VOLTAGE TRANSMISSION GRID

1,262.5 km
Power line
[Senelec, 2012]

National component owned and operated by
SENELEC

Supranational component owned and operated by the Manantali hydro project.

21%
Transmission losses due to obsolescence of infrastructure

548 MW
Installed capacity

429.7 MW
Connected to grid

2. A LV network with a total length of 6 761 km;

3. 13 HV/HV substations and 3 511 MV/LV(30/6.6 kV) substations.

Senegal signed the WAPP agreement in 2000 as mentioned earlier, where it was decided to develop energy production facilities and interconnect the respective electricity grids. Senegal has been actively participating in the planning, decision-making and implementation of the WAPP in order to develop interconnection between existing and future hydro power projects in the Senegal and Gambia river basins. Projected commissioning of the project was scheduled for 2012 but delays in implementation have postponed it to 2015.

In 2010, electricity generation in Senegal was estimated at 2 400 GWh, jointly produced by SENELEC and private companies. (SENELEC, 2012; IEA, 2009). It was mainly consumed by the residential sector followed by the commercial and public services sector. This figure is lower than the 3 110 GWh generated in 2008 (SENELEC, 2012; IEA, 2009). The decline in generation is due to switching disruptions and outages linked to system malfunctions and the decline in the quantity of imported oil due to high prices.

Senegal has good potential to promote biomass, solar and wind to generate grid electricity through both the public and private sector (mainly independent power producers). Although most of the dominant market players have not started considering renewable power as a serious investment option, feasibility studies for various projects by new actors are under way.

For example, a typha-based[19] power plant, has identified a cost of sale to SENELEC of CFA 66/kWh (USD 0.13/kWh), which is below the average wholesale cost of current generation of CFA 70/kWh (USD 0.14/kWh).

Similarly for solar projects to become commercially viable, the required costs of sale are in the range of CFA 120-130/kWh (USA 0.24-0.26/kWh).

Wind projects are only viable[20] if a sale cost of CFA 85-95/kWh (USD 0.17-19/kWh) can be negotiated with SENELEC. At present, no feed-in tariff has been announced for renewable energy by the regulator.

As with wind, there is currently no solar grid-connected power generation in Senegal, despite the existence of a very good solar potential uniformly distributed across the country. However, an encouraging development in this area has been the 2010 greenfield investment by a private consortium of investors in a photovoltaic module assembly plant in Senegal. With an annual capacity of 25 MW, the facility is geared for producing high-quality modules of 50-300 Wp (SPEC (Sustainable Power Electric Company), 2012). It also has the requisite capacity to function as a system integrator for grid-connected systems. Strong local content and trained personnel should provide a strong impetus for government to support on-grid plants by fixing an attractive feed-in tariff.

Findings from the RRA

Renewable energy has a high level of political support, which should help overcome some of the challenges to its scale-up. Indeed, Senegal has already adopted a Renewable Energy Law from which a Renewable Energy Strategy has been outlined. The implementing decrees of the Renewable Energy Law are as follow:

- **Decree No. 2011-2013** provides conditions of power purchase and remuneration for electricity generated by renewable energy plants and the conditions of their connection to

CFA 70/kWh
Wholesale power purchase price of SENELEC

Identified wholesale prices from RE projects:

Biomass
CFA 66/kWh

Solar
CFA 120-130/kWh

Wind
CFA 85-95/kWh

USD 1 = approx. CFA 532

PV module assembly plant in Dakar (SPEC)
50-300 Wp

High quality modules to be produced
at the facility for up to

25 MW
annual capacity

Invested in by private consortium comprising of:
AREVA, Schneider Electric, African Fund for Biofuels and Renewable Energy (FABER-ABERF), Peacecock, Enersaf Energy Solutions

19 Typha is an invasive species growing in the Senegal River

20 A feasibility study for a wind power plant project of 15 MW to be connected to the grid was initiated in the Saint Louis area by Midi-Pyrénées (France), C3E (Dakar) company and CEGELEC (Toulouse).

Image 3: Work in progress at SPEC's solar modules mounting facility (©www.spec-solar.com)

the grid[21]. It also provides the formula for the avoided cost[22] which serves as a reference for calculating the power purchase price cap. It also contains elaboration on renewable power purchase obli-gation and feed-in tariffs for different renewable energy technologies.

- **Decree No. 2011-2014** provides the conditions of power purchase of surplus renewable energy-based electricity from self-producers[23]. It has fixed the maximum intake from renewable energy sources (variable power), determined the purchase price, conditions of purchase of surplus energy and connection to the grid, and other conditions.

The effectiveness of these decrees will depend on how investors respond to the incentives for renewable energy. The availability of funds to support deployment in the form of feed-in tariffs (and any other fiscal incentives) will also be crucial and will depend in part on continued engagement with donors.

Electricity tariffs regulation aims to minimise consumers' charges while maintaining the financial viability of SENELEC and the quality of the supply by fixing a five-year price cap. However, tariffs currently appear quite disadvantageous, particularly for SENELEC, which does not have any control over its investment programme from the perspective of funding mobilisation. A study could be undertaken for the grid integration to define the modality and to identify where money will come from (as the government has committed to pay the difference between the feed-in tariff and average cost of diesel energy). Furthermore, the CRSE should be strengthened, particularly in view of unbundling SENELEC activities, encouraging the active participation of the private sector in production and distribution, and investigating the possibility of

21 Decree No. 2011-2013 related to the conditions of purchase and compensation of electricity produced by renewable energy power plants and the conditions of their connection to the grid.

22 Capital and operating costs saved by the grid operator when electricity from conventional energy source is substituted with electricity from renewables in the frame of electricity purchase obligations prescribed by law and regulations.

23 In Decree No 2011-2014, "self-producers" means any company or household producing electricity for their own consumption and usage.

Image 4: Senegalese Sugar Production Company in Richard-Toll. © www.css.sn

opening up the renewable grid-connected sector.

Since CIER is responsible for reaching an agreement on integration of renewable energy into the grid, one of its main tasks in the near future will be determining the technical feasibility of absorbing renewable electricity into the centralised grid and approving the grid code amendments that are necessary to integrate renewables into the system. Currently the grid operator (SENELEC) has no experience in integrating variable energy sources into the grid, so capacity-building measures in terms of how to technically manage these sources will be required.

IPPs have more than 10 years of experience in Senegal with diesel-powered generation. This suggests a relatively stable relationship between independent providers and

2 MW
Total installed solar power in2007

2.5 MW
Capacity in 2010

SENELEC which could be capitalised on so that the practical experience gained with diesel generation can benefit renewable energy deployment. However, in the past IPPs have generally had government guarantees to back commercial contracts to offset the risks.

In biomass projects, costs will often depend on the boundary of the project (e.g., for typha, it must be determined who bears the costs of clearing the river). To date, there has been limited private sector participation in bioenergy. However, there are key areas where biomass could play a role, particularly where agricultural residues could provide a low-cost fuel for power generation in rural areas, although mechanisms for collection and storage would need to be worked out meticulously and the costs built into the tariff regime. Costs would vary, depending on the particular technology under consideration, but there is evidence that biomass production could be commercially viable.

One of the key issues in large-scale renewable energy projects is the ownership of the land needed for project development. In Senegal, most land is owned by local communities and, therefore, to protect the project's viability, mechanisms must be developed that involve landowners throughout the project life cycle.

Another issue is Senegal's limited experience with the installation, operation and

maintenance of large-scale renewable energy power plants. However, the government does have the capacity to assess and select proposed projects, thereby ensuring that developers with sufficient experience in this sector get preference.

Overall, the main issue for grid-connected renewable-based electricity is almost always related to the fact that proposed selling prices to SENELEC are always above its electricity purchase price (CFA 70/kWh – USA 0.14kWh). Senegal needs to capitalise on existing experience with IPPs to build business models for renewable energy operators and to explore the potential role of public-private partnerships. Power purchase agreements which focus on variable power and keep the issues of grid connection at the forefront need to be designed in order to give certainty to investors.

B. OFF-GRID APPLICATIONS

DECENTRALISED RURAL ELECTRIFICATION

This section deals with decentralised electrification, motive power for productive uses and thermal applications (cooling and heating).

Senegal already has a great deal of experience in implementing national and regional projects and programmes to promote off-grid applications of renewable energy (PRS/CILSS, PREDAS/CILSS, PERACOD, PROGEDE, etc.).

Solar PV technology has been variously adapted to provide solutions for electrifying health centres, schools, households and extending communication networks. The total installed capacity of solar power in the country increased from 2 MW in 2007 to 2.5 MW in 2010, although the use of small aero generators in Senegal is limited and the total installed capacity is estimated to be around 0.5 MW (Ministere des Energies Renouvelables, 2011).

CSS, a sugar factory in north Senegal, produces electricity for its own consumption with an installed capacity of up to 48 MW (EcosurAfrique, 2012). Bagasse generated from plant operations provides feedstock for a 25 MW co-generation plant which currently provides power to the plant but could also power unserved neighbouring towns and villages. The CSS 25 MW cogeneration plant is the first Senegalese-registered Clean Development Mechanism (CDM) project (Ibid).

ASER has adopted a market model for rural electrification that is technology neutral and thereby provides a framework for private operators to carry out electrification in rural areas using renewable energy along with other fuels[24].

Individuals, enterprises or communities generating electricity from renewables for self-consumption are governed by one of the decrees[25] for implementing the provisions of the Law on Renewable Energy 2011. This provides the conditions for purchase and tariff for surplus electricity, which can be fed into the grid or sold through decentralised distribution networks.

24 The rural regions of Senegal that have not yet been electrified have been divided into a total of 11 geographical concession areas of which ASER has 10. The electrification of these areas is put out to public tender by ASER and is undertaken by private sector enterprises. The concession model includes the following elements: grid expansion, isolated networks and single homes supply (mainly solar home systems). The financing of these areas is secured through the Senegalese state and international donors. ASER settled a minimum share of 10% for renewable energies in each concession.

25 The Decree 2011-2014 adopted on 21 December 2011 on the conditions for purchase and remuneration of surplus electricity from captive plants generating electricity from renewables.

Image 5: Sine Moussa Solar Wind Diesel Hybrid Power Plant © www.peracod.sn

Pilot projects for off-grid electrification have been undertaken by educational and training institutions, government agencies at the central and provincial level, as well as NGOs and institutions in the private sector. The project to supply electricity undertaken by the University Check Anta Diop of Dakar is particularly noteworthy.

In order to strengthen quality control, two laboratories have been set up under the supervision of the Senegalese Association for Standardisation (ASN)[26] with the specific task of ensuring the adoption of national standards for photovoltaic components.

Senegal has a great deal of diverse and rich experience in the area of decentralised electrification. Many non-state actors are involved in the marketing, installation and maintenance of equipment and systems.

Renewable energy is being increasingly recognised as a cost-effective option for decentralised applications in areas far from the grid, given that the cost of grid extension is also a factor of the load. In remote areas, where expected electricity load is relatively low, the transport cost of diesel is high, making renewable hybrid systems with a higher share of renewable energy technologies cost-competitive. ASER has assessed the economic viability of such options and has included the development of mini-grids for the electrification of villages in its concessions under "Electrification Rurale par des Initiatives Locales"(ERILS)[27].

The Programme for Rural Electrification and Cooking Fuel (PERACOD) is supporting the sustainable development of the energy sector in Senegal by implementing rural electrification projects through the private sector. The Sine Moussa village electrification is one illustration of PERACOD intervention. However, financing for small projects is limited and usually the involvement of local communities in terms of management and responsibility is insufficient.

MOTIVE AND THERMAL APPLICATIONS

Senegal has long-standing experience in the deployment of off-grid motive (primarily water pumping) and thermal applications (primarily water heating, also cooking and drying). Development and marketing of water pumping solutions has also been a focus of the private sector in Senegal. Government incentives include fiscal benefits for importing equipment

26 The laboratories have been set up by Order No 29/MEMI 21 April 1999.

27 ERILs are specification of Senegal and offer high chances for the implementation of renewable energies.

28 SPEC is producing currently PV modules of 50-300 Wp.

related to water pumping. Technologies for solar and wind pumping systems exist in the country and wind pump sets are also locally manufactured. With the setting up of SPEC, it is hoped that the solar applications customised for use in Senegal will be assembled by private sector operators[28].

There have been mixed experiences regarding the quality of operation and maintenance (O and M) of installations. Earlier programmes for wind pumps supported by government ran into problems with O and M[29], although recent programmes seem to have performed better. Wind pumps have higher maintenance requirements due to their large number of moving parts. Current business models work with user charges and the establishment of a fund for maintenance, administered by the community and the service provider. The model seems to be successful, with high levels of demand and significant sums of money being accrued in accounts to fund O and M as well as plant replacement at the end of life. In the water-pumping sector communities are increasingly employing service managers to take responsibility for operating and maintaining the system.

Although solar water heating has been used in urban areas and in rural hospitals for more than two decades, maintenance problems remain. Strong programmes have been initiated by government in partnership with[30] local construction firms. However, business models implemented have generally lacked incentives to provide after-sales service.

Image 6: Solar Water Heater in rural area in Senegal ©www.enersol.com

35%
Tax rebate against capital cost of solar heating equipment

Operators are responsible for the quality of installation, and in theory there is some institutional monitoring. However, there have been problems with the reliability of installations because nobody is responsible for testing heating equipment, even though standards do exist. Although research institutes are operating in this area, their findings are frequently not available to the private sector.

In order to increase the uptake of solar water heating equipment, a 35% tax rebate against capital cost policy has been adopted since the early 1980s, although this only benefits tax-paying businesses.

29 Of more than 200 wind pumping systems installed in 1983 and 1984 only 40% were operating three years later and even these fell into disrepair.

30 e.g. 1 000 homes installed with panels, and the payment was spread over the life of project, but this failed since there was no responsibility for maintenance.

Image 7
Installation of a small wind turbine
at the Univesity of Dakar ©www.eolsenegal.com

Other incentives include import tax exemptions for equipment relating to thermal heating, a low rate of VAT for local fabrication and fiscal exemptions for investors.

The use of solar thermal absorption systems for cooling buildings is becoming well-established, and is included in the National Energy Strategy. Together with good awareness at government level, this provides the basis for taking the technology forward.

Universities, institutes and technical and vocational training centres are carrying out training programmes and strong efforts are being made to involve the private sector in the ongoing Research and Development programme on small-scale aero generators at the University of Dakar.

Findings from the RRA

Senegal's RRA highlighted the lack of coordination between processes of elaboration of sectorial policies as the main issue on decentralised applications. It recommended that CIMES should play a coordinating role in the future in order to strengthen cooperation across the relevant ministries and regulatory agencies, and also between the private sector and research institutes, to achieve better harmonisation in sectoral policies and complementarity in the intervention of all stakeholders.

The need to strengthen cooperation across the relevant ministries and regulatory agencies and between private sector and research institutes was also highlighted.

One major issue that emerged from the RRA discussions was that the regulator (CRSE) is currently obliged to approve tariffs for electricity supply to the final consumer, regardless of the size of the installation. This process is time-consuming and acts as a barrier to the implementation of small concessions (ERILs), thus limiting their more general implementation. There is therefore an urgent need to decentralise the decision-making process and the means of capacity development at the CRSE (e.g., setting tariffs locally).

Measures to alleviate this constraint could include, for example, exempting installations below a certain capacity (e.g., below 50 kW) from requiring regulatory approval for the proposed tariff and allowing approval by village communities. Decentralisation of regulatory powers, following decentralisation at governmental level, and associated capacity building at the local level to respond to tariff proposals, could assist the process while advantage could also be taken from the existence of decentralised governance structures to assist local deployment of renewable energy technologies.

The understanding of legal issues

concerning renewable energy by local elected representatives, and the capacity of private operators, should be strengthened to handle the deployment of renewable energy technologies, evaluate proposals for tariffs and assist the electrification process.

The participation of micro-finance institutions in the sector should also be supported, which could be done through training and sensitisation in order to build their understanding of renewable energy.

The motive power sector offers good perspectives judging by existing experience in the use of wind turbines for pumping and the involvement of the private sector in the local manufacture of wind pumps. Water-pumping technology using wind is a mature technology and there is local expertise in producing the parts necessary for constructing and maintaining wind pumps. Improvements in solar technology are now being made which will allow pumping at the same depth as for wind. Resource availability for solar water pumping has been assessed and several companies in Senegal already supply solar pumps (e.g., Equiplus and Mattforce). There is also the potential to use multi-functional platforms based on biofuels to supply motive power; technology improvements are still being made for multi-functional platforms although this is dependent on the development of the biofuels sector. Currently these platforms are diesel-fuelled but,if and when the possibility to convert to biodiesel becomes available, it could provide a local application for local biofuel production.

There is still a need to build on existing experience with wind power (e.g., water pumping) to build expertise and skills in Senegal for O and M, and mechanisms need to be put in place to transfer skills from project developers to local communities regarding installation and maintenance.

Another required major action is the strengthening of domestic manufacturing capacity to meet poverty reduction-strategy targets. Once capacity has been strengthened an equipment testing body should be introduced to ensure that the technology meets the established standards and platforms for cooperation with the private sector and research institutes should be created. For example, meetings should be organised between suppliers and equipment manufacturers to identify the necessary requirements for further development or strengthening cooperation between the private sector and research institutes.

Targets and policy delivery concerning the inclusion of solar water heating in buildings are the responsibility of the Ministry of Construction, while responsibility for ensuring that a building has met legal requirements is split between the Ministry of Construction (which determines if the installation been done) and the Ministry of Renewable Energy (which check that the system is operating as intended). Therefore, effective cooperation across these ministries is necessary.

There is also a need to develop existing production capacity for technologies and the supply chain of components in order to minimise costs. Lessons learnt in earlier projects at the national or regional level should be used to informfuture projects.

From the RRA analyses, it is evident that the sector is offering an opportunity for government to provide a major push on this technology and provide a suitable

private-sector business model that includes service provision with necessary after-sales service. The sector also offers the opportunity to link with the government decentralisation agenda, with local government taking responsibility for water and health, and also take forward solar heating initiatives linked to local job creation and hence economic development opportunities. This could be combined with employment programmes for young people to train in maintenance and service.

C. BIOFUELS FOR TRANSPORT

The development of biofuels in Senegal is relatively recent and production is small. The CSS[31] set up a plant for the production of bioethanol from sugarcane in 2007 with a target production of 8-12 million litres of bioethanol per year (ISRA-BAME, 2009) on the premise that from 2013 the blending would be mandatory for ethanol. Production volumes are expected to be sufficient for meeting domestic production, although lack of policy support is reflected in a negligible market demand for bioethanol which has slowed down production. Exports of biofuels are restricted, despite foreign demand.

Good quality, disease-free seeds are required for biofuels. Only certified seeds are allowed for the industrial production of biofuel and their control and certification is the responsibility of the Ministry of Agriculture.

Infrastructure constraints for biodiesel centre around the storage and processing of jatropha seeds. The best storage conditions reduce the loss of oil. The emergence of modern jatropha processing units could lead to large-scale production of biodiesel in the same way that the investments done by the CSS have worked for sugarcane. ISRA is currently distributing free jatropha seedlings and a decree to allocate more funds to scale up this programme is expected. Small private farmers are able to produce biodiesel from jatropha, using currently available small-scale processing technologies,such as artisanal presses.

Image 8: Molasses lake at Senegalese Sugar Company (CSS). © D. Dia 2009

There is no currently significant private financing devoted to biofuels. This can partly be attributed to perceived risks– while micro-finance initiatives exist, they are unwilling to lend to these projects.

Findings from the RRA

It is not possible to judge the sustainability of the overall strategy because environmental impacts are not assessed at a national level. A project-by-project approach is taken instead (for all proposed large-scale projects). There is a very important need for training at all levels to raise awareness. Similarly, there is a low level of awareness among the general public.

31 CSS has had a distillery in operation for ethanol production of 60 000 litres per day since 2008.

The RRA process has highlighted land ownership issues. These issues need to be resolved in order to ensure that land is available to meet the needs of the industry and competing pressures. This is complicated in Senegal by the complex system of land ownership and allocation.

There is a real need for capacity building across the sector. Planning, communication and information provision can be implemented through the National Assembly, Senate and rural communities. It is possible to use the experience of the Ministry of Energy, regarding fuel for example, for distribution and networking. The Ministry of Renewable Energy has the capacity and tools to assess benefits, but lacks expertise in other areas. The NBC needs technical assistance.

Measures should be taken to follow-up the programmes and strategies to determine how successful production levels are, what volumes of oil are being produced, and what markets exist for jatropha farmers. The restriction on biofuels export, originally designed to ensure that Senegal benefits from the development of the industry, may also stunt the development of the market.

The lack of testing and quality control institutions has also been responsible for the lack of coordination across actors. Each institute is currently responsible for its own research, and an institute needs to be established for testing and quality control.

More work could be carried out on jatropha to understand the business model risks associated with various parts of the supply chain to help overcome barriers to the Ministry of Economy and Finance lending (e.g., for small-scale producers). The key issue is to address capacity for small-scale farmers' production, and to build a reliable supply chain for establishing a reliable price for the product so that farmers can get sufficient return to attract further production. Priority should be given to addressing perceived risks in order to facilitate financing and the transfer of technology and human skills.

Agricultural producers have been operating plants for some time and the advantages – such as employment creation in the operation stages – are well-known. For example, for the typha plant, local people are employed to harvest and handle the plants, while biogas production has the added benefit of producing fertiliser for agriculture.

IV. Recommended Actions

The following schematic identifies the recommended actions from the RRA process. These actions are not presented in any order of priority, and the list of actions from a rapid assessment is unlikely to be exhaustive. The detailed list of actions can be found in the Annex.

Elaborate a process for comprehensive mapping of renewable energy resources in key areas.	☼ Engage with existing initiatives for data collection, including observatory currently being established by ECREEE. ☼ Identify precise requirements for resource mapping, based on priority areas for RE. ☼ Establish a plan for collection of data. ☼ Explore the potential for funding ground measurement campaigns with multilateral/bilateral organisations.
Adapt the rules of intervention for the regulator in the specific case of small electricity producers (ERILs).	☼ Decentralisation of the regulatory powers according to the national decentralisation process. ☼ Capacity building for the Rural Electrification Agency to handle all off-grid tariffs. ☼ Associate capacity building at the local level to respond to tariff proposals.
Facilitate grid integration of electricity generated from renewable resources.	☼ Assess potential site infrastructure status. ☼ Conduct studies on grid capacity to uptake variable renewables sources. ☼ Strengthen SENELEC's human resources technical capacities.
Review the institutional, legal and regulatory conditions for utilising land for biofuels production.	☼ Incorpotate land tenure rights into land availability assessments. ☼ Identify potential for higher productivity through advances in technology and agriculture. ☼ Assess environmental, economic and social impacts of strategy implementation. ☼ Identify the extent and basis of private company participation.
Identification of conditions for increased private sector involvement in RE-related manufacturing.	☼ Identification of priority areas for development of manufacturing capacity, including training and education requirements to build the necessary skills. ☼ Creating a forum to support collaboration between the private and research sectors.
Identify conditions needed for Oand M (operation and maintenance) of off-grid motive and thermal power.	☼ Develop and fund training programmes to address capacity gaps. ☼ Define and formalise legal status and framework for service providers. ☼ Incentivise deployment of hybrid technologies. ☼ Introduce standards for quality control testing and service requirements.

THE DOMESTIC COMMITMENT TO RENEWABLE ENERGY IS REFLECTED IN THE ROLE THAT SENEGAL HAS ASSUMED IN REGIONAL AND INTERNATIONAL FORUMS.

V. Best Practices and Future Cooperation

Identified Examples of Good Practice

GOOD PRACTICE DEMONSTRATION 1: BUSINESS MODELS USED FOR RURAL AND OFF-GRID ELECTRIFICATION

Rural electrification, using both conventional and renewable energy resources, has been defined as a key sector to reduce poverty and increase rural living standards. Senegalese authorities plan to reach a 30% rural electrification rate by 2015, and a 60% rate by 2022. Responsibility for meeting the target is in the hands of the Senegalese Agency for Rural Electrification (ASER), an autonomous body reporting to the Ministry of Energy.

Based on an economic assessment of conditions for electrification, ASER has defined 10 concessions and has launched tenders for electrification of these areas in a competitive bidding process. Each bidder will be required to indicate the percentage funding that they will provide; the remainder will be provided by the government. Each bidder will also be required to develop a local electrification plan, defining the technologies to be used.To date, the following concessions have been awarded:

- Concession for Dagana-Podor: awarded to ONE-Maroc
- Concession for Mbour: awarded to ONE-Maroc
- Concession for Kaffrine- Tambacounda-Kédougou: awarded to EDF

Complementing these concessions are small local projects (ERILs), developed by local sponsors such as community associations and villages. These will also be funded through private/public financing. To date, the level of bilateral funding has been significant.

The case of Sine Moussa village is a successful ERIL case where a good business model has been developed by the operator. Senegal should build on such successful initiatives to develop a more attractive enabling environment for business to encourage operators to enter the market and reduce the cost of access and sustainability of rural electrification schemes.

This model offers a potential to attract the private sector with its associated finance, skills and implementing capacity into rural electrification.

While the programme is still in process, the experience of Senegal suggests a number of actions that may be useful in implementing a rural electrification programme based on a concession structure. These include:

- Definition of an agency with responsibility for rural electrification and autonomy to define the programme and method of operation for achieving objectives;
- a transparent approach to tendering and awarding concessions;
- an approach based on an understanding of economic conditions and viability;
- an extension of decentralisation at the government level into rural electrification; and
- integration of renewable energy into the implementation framework.

GOOD PRACTICE DEMONSTRATION 2: LEGAL AND INSTITUTIONAL FRAMEWORK

Senegal has shown a strong commitment to renewable energy, most notably with the establishment of a dedicated Ministry for Renewable Energy and the passing of framework laws on Renewable Energy and Biofuels at the end of 2010 (Act 2010-21 of 20December 2010 and Act 2010-22 of 15 December 2010). This commitment is currently being tested by a process of agreeing and finalising the implementing decrees for these framework laws. However, it is clear that renewable energy is viewed as both important in its own right and also as an enabler in the broader development of the energy sector, rural development and poverty reduction.

There are a number of institutions and frameworks dedicated to the further development of renewable energy, notably CERER (Centre for Studies and Research into Renewable Energy) at the University of Dakar, and the National Energy for Solar Energy. More broadly, agencies such as ASER (Agence Senegalaise d'Electrification Rurale), ASN (Association Sénégalaise de Normalisation) and CRSE (Commission de Regulation du Secteur de l' Electricite du Senegal) include renewable energy as a central part of their remit. Cross-institutional cooperation has been facilitated by the establishment of an Inter-ministerial Committee on Renewable Energy (CIER) and the National Committee of Biofuels. Maintaining and extending this

cooperation will enable ongoing success in the implementation of Senegal's vision for renewable energy. In particular, efforts could be usefully directed at ensuring the participation of civil society.

The domestic commitment to renewable energy is reflected in the role that Senegal has assumed in regional and international forums. At the project level, there are many examples of cross-Sahelian initiatives in design and implementation. At the strategic level, Senegal has taken a central role in IRENA and ECREEE (ECOWAS Regional Centre for Renewable Energy and Energy Efficiency).

FUTURE COOPERATION

This first pilot study in Senegal has identified a number of areas in which Senegal can take action to improve readiness for the deployment of renewables. Many of these actions can be taken in the near term, building on the momentum that has already been established in the country through recent institutional developments in support of renewable energy. The support of bilateral and multilateral institutions, both now and in the future, is an important element in the successful realisation of these actions. This report can serve as a basis for the development of international cooperation on country-level and regional-level programmes.

At the country level, the report opens up the possibility of piloting a multilateral initiative to support feed-in tariffs to promote renewable energy in Senegal. At the regional level, Senegal is well positioned to become an active stakeholder in the Global Solar and Wind Atlas initiative being coordinated by IRENA.

In addition to highlighting actions to further the deployment of renewable energy, the pilot study has also provided valuable inputs to the development of the RRA methodology and process. The improved methodology and process were discussed and amended during a technical workshop in April 2012 in Abu Dhabi before rollout to a number of other ECOWAS countries. It is very much hoped that Senegal will be able to continue its exemplary leadership in this process by supporting this rollout.

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VII. Annex

Action 1

Adapt the rules of intervention for the regulator
in the specific case of small electricity producers (ERILs)

Action	Adapt the rules of intervention for the regulator in the specific case of small electricity producers (ERILs).
Resource-Service pair(s)	Off-grid electricity, all resources.
Description	The regulator (La Commission de régulation du secteur de l'électricité du Sénégal, or CRSE) is currently obliged to approve tariffs for electricity supply to the final consumer, no matter what the size of the installation. This process is time-consuming and acts as a barrier to small concessions (ERILs), thus limiting their more general implementation. Measures to alleviate this constraint could include, for example, exempting installations below a certain capacity (e.g., below 50 kW) from requiring regulatory approval for the proposed tariff and allowing approval by village communities. The decentralisation of regulatory powers, following decentralisation at governmental level, and associated capacity building at the local level to respond to tariff proposals, could assist the process.
Actors	CRSE, Ministry of Energy, Ministry of Renewable Energy, private operators, SENELEC to participate in review. Educational and training institutions for capacity-building in decentralised institutions.
Timing	Mid-2012.
Keys for success	Engagement by the regulator, improved staffing in the regulator, decentralisation of power and building capacity of the regulator. Such capacity-building activities will be a focus of the future IRENA Work Programme, both in Senegal and elsewhere.

Action 2

Finalise and sign the implementing decrees of the framework laws on renewable energy

Action	Finalise and sign the implementing decrees of the framework laws on RE.
Resource-Service pair(s)	On-grid and off-grid electricity, all RE resources.
Description	The framework laws on renewable energy provide a structure for deployment, but this deployment is dependent on finalising the implementing decrees. These decrees would enhance the attractiveness of RE investment by giving certainty to: ☼ the conditions of purchase and remuneration for electricity generated from renewable energy plants and the conditions of their connection to the network; ☼ conditions for purchase and remuneration of surplus electricity from own-generation renewable electricity sources; and ☼ tax and customs duties applicable to renewable energy equipment. ☼ Implementation of decrees will require funding sources to be identified and secured, and this should also form part of the action. One particular action that could be explored is the Global Energy Transfer Feed-in Tariff (GET FiT), which seeks to use public sector (or donor) funds to create stable incentives for renewable energy, and in doing so attract private financing into the sector32. Identification of partners willing to support implementation in Senegal would provide a route for securing funding. ☼ Complementary actions could include exploring funding opportunities with multilateral and bilateral donors and with potential investors from private companies, utilities and commercial banks. Strengthening engagement with the Ministry of Economy and Finance, and awareness-building within the ministry in order to ensure budgetary provision could also be important.

32 For further details and an application to an African country, see W. Rickerson, C. Hanley, C. Laurent, and C. Greacen (2010). Implementing a Global Fund for Feed-in Tariffs in Developing Countries: A Case Study of Tanzania. World Renewable Energy Congress: 2010.

Actors	The Government of Senegal, Ministry of Energy, Ministry of Renewable Energy, Ministry of Economy and Finance , donors and other potential investors (private companies, utilities and commercial banks). IRENA could bring together donors and country representatives to investigate a global initiative.
Timing	Mid-2012.
Keys for success	Finalisation will require consensus on the terms of the text. The effectiveness of proposed decrees will depend on the extent to which they give incentives for renewable energy. The availability of funds to support deployment in the form of feed-in tariffs (and any other fiscal incentives) will also be crucial and will depend in part upon continued engagement with donors.

Action 3

Finalise Policies on the integration of electricity generated from renewable sources onto SENELEC's grid, and define the associated technical and capacity-building requirements for integration

Action	Facilitate an agreement on the integration of electricity generated from renewable sources onto SENELEC's grid, and define the associated technical and capacity-building requirements for integration.
Resource-Service pair(s)	On-grid electricity, all resources.
Description	The Inter-ministerial Committee on Renewable Energy (ComitéInterministérielsur les Energies Renouvelables, or CIER) has been charged with, among other tasks, coordinating the policies for integration of renewable energy and the grid code. Their finalisation will assure more coherence in integrating renewables onto the interconnected grid. Technical aspects of integrating variable energy sources into the grid is an area in which the grid operator, SENELEC, does not have any experience, and capacity-building measures in terms of how to manage these sources will be required.
Actors	CIER, SENELEC, Ministry of Renewable Energy, Ministry of Energy, organisations with experience of similar issues in other countries and regions (e.g., Morocco, Egypt).

Timing	End 2012.
Keys for success	Engagement of SENELEC and adequate resources within SENELEC. Establishing good links and exchanges with other countries with experience of similar issues can also be valuable – IRENA can play a coordinating role in this.

Action 4

Promote small-scale production of biodiesel

Action	Promote small-scale production of biodiesel.
Resource-Service pair(s)	Biofuels for transport (and also electricity).
Description	Plans for production of biodiesel from the jatropha plant focus on small producers, but engagement by these producers is limited by lack of market structures and supply chains. Securing further production depends, among other factors, on the production technology available to farmers for biodiesel and the ability of farmers to secure financing for projects and sell their output. Actions to address this could include: ☼ setting of the price at which farmers can sell output – this should be set with the finalisation of the implementing decrees on biofuels; ☼ establish markets for sale of output – as of 2013 this will be supported in part by domestic blending mandates; ☼ increase availability of financing for farmers wishing to invest in production – this will require better understanding of the technology and associated risks; ☼ review of technology requirements for improved production, and subsequent dissemination of the technology and best practices; and ☼ development of physical infrastructure as necessary to support distribution of biofuels.
Actors	Comité National des Biocarburants (CNB), Directorate of Biofuels and Biomass, Ministry of Energy, Ministry of Agriculture, National Rural Councillors Association (ANCR), finance institutions.

Timing	Complete action plan by mid-2012.
Keys for success	Development of better understanding and awareness of biofuels at all levels, including among farmers, government institutions and the public. ☼ Further work to understand the business model risks associated with various parts of the supply chain to help overcome barriers to micro-finance lending (e.g., for small-scale producers), and dissemination of this work to finance and micro-finance institutions. ☼ Finalisation of terms on which farmers can sell their output.

Action 5

Improve the institutional, legal and regulatory conditions and modalities for utilising land in support of the National Biofuels Strategy

Action	Improve the institutional, legal and regulatory conditions and modalities for utilising land in support of the National Biofuels Strategy.
Resource-Service pair(s)	Biofuels for transport (and also electricity).
Description	In 2006, Senegal launched a National Biofuels Strategy, focusing on the production of ethanol and biodiesel. Under the strategy, the government aims to plant a total of 320 000 hectares of jatropha by 2012, with each of 320 rural communities planting 1 000 hectares of jatropha seedlings provided by the government. These seeds will be used to produce a total of 1.2 billion litres of oil to meet petrol and diesel needs. Among other factors, realisation of these targets is dependent upon the availability of land for production, the distribution of high quality agricultural inputs and on maintaining production. In Senegal, this needs to take account of the complex structure of land rights. Associated actions are: ☼ reviewing land requirements for the successful implementation of the strategy (it will also be necessary to consider other resources, such as water); ☼ identify land tenure rights wherever possible and incorporate them into land availability assessments;

	☼ Identify the potential for increased productivity through technology advances and agricultural techniques, and how these can be secured; ☼ assess environmental, economic and social impacts of strategy implementation – such assessments are currently conducted on a project-by-project basis; and ☼ identify the extent and basis of private company participation.
Actors	Ministry of Agriculture, Ministry of Renewable Energy (Directorate of Biofuels and of Biomass), Village Community Organisations, Legal Advisor, ISRA and other agricultural research institutions, non-governmental organisations (NGOs).
Timing	Mid-2012.
Keys for success	Identification and addressing of public concern relating to land use pressures and associated conflicts; ☼ Inclusive participation of all relevant actors throughout the review; and ☼ Understanding of current status of the strategy and its implementation.

Action 6

Establishment of policy and institutional mechanisms to increase private sector involvement in RE manufacturing

Action	Establishment of policy and institutional mechanisms to increase private sector involvement in RE manufacturing.
Resource-Service pair(s)	Off-grid and on-grid services, wind and solar resources.
Description	Senegal has significant experience in the deployment of certain renewable energy technologies (e.g., small-scale solar, wind for water pumping), and some domestic manufacturing capacity has grown up around this (most recently SPEC, an assembly facility for solar panels). There is also a considerable level of research capacity regarding manufacturing (e.g., design and development of solar pumping technology at CERER, the Centre d'Etudes et de Recherchessur les Energies Renouvelables).

	These strengths could be captured to further build manufacturing capacity in the country, thereby positioning Senegal as a supplier of technologies and facilitating local industrial development. As a first step, a round table of manufacturers and suppliers of technologies would provide a forum to identify their requirements and actions to address these. Other actions include: ☼ finalising implementing decrees for renewable energy, including provisions relating to fiscal treatment of renewable energy technologies. In addition to giving financial incentives, this would also help to ensure market demand; ☼ identification of priority areas for development of manufacturing capacity; ☼ identification of training and education requirements to build the necessary skills for the development of the manufacturing sector; and ☼ creating a forum to support collaboration between private and research sectors.
Actors	Private sector manufacturers and suppliers of equipment, Ministry of Renewable Energy, Ministry of Industry, Ministry of Higher Education, Ministry of Technical Education, CERER and other research institutes, APIX, foreign investors.
Timing	2012.
Keys for success	Participation of key actors and commitment by the Government of Senegal; ☼ Engagement with foreign investors and/or donors could help to secure financing for subsequent actions; and ☼ Review of previous experience regarding manufacturing capacity and research, including success factors (e.g., regarding the closure of the Industrial Society for Applications in Solar Energy).

Action 7

Establish institutional capacity and conditions for improving
O and M (Operation and Maintenance) of renewable energy technologies

Action	Establish institutional capacity and conditions for improving O and M of off-grid renewable energy technologies.
Resource-Service pair(s)	Off-grid motive power (wind and solar); off-grid thermal power (solar).
Description	While Senegal has long-standing experience in the deployment of off-grid motive (primarily water pumping) and thermal (primarily water heating, also cooking and drying) power, the long-term lifetimes of each of these systems have been compromised by problems with O and M. In particular: ☼ **Motive Power:** Experience of solar pumping has shown that in cases where O and M services have been provided by third-party service companies and paid for by villages using funds from the sale of water, a number of weaknesses have occurred which need to be overcome to assure the viability and sustainability of systems. In particular are the absence of a legal framework, inadequate financial systems to ensure that customers honour their bills and the low competence level of maintenance staff. O and M problems are worse for wind than solar due to wind technology having more moving parts. ☼ **Thermal power:** The small current market for new equipment and small number of systems in operation make the market unattractive to private sector suppliers. The absence of standards and quality testing for equipment entering Senegal compounds the difficulties in developing these applications. There is therefore a need to implement actions to improve O and M provision. Improvements should be based on a review with the parties below and subsequent development and implementation of a plan of action. Preliminary suggestions include: ☼ **Both:** Develop and fund training programmes to address capacity gaps.

	Motive Power: ☼ Define and formalise legal status and framework for service providers ☼ Incentivise deployment of hybrid technologies.
	Thermal Power: ☼ Introduce standards for quality control testing and service requirements; ☼ Identify and enable implementation of business models for improved maintenance.
Actors	**Both:** Ministry of Renewable Energy, equipment manufacturers, training institutes. **Motive Power:** Village communities, service providers, equipment manufacturers, Ministry of Renewable Energy, Ministry of Hydrology, donors. **Thermal Power:** Private sector suppliers, equipment providers, Agency for Standards.
Timing	Mid-2013.
Keys for success	Understanding the motivation of all actors in the supply chain and providing incentives for them to act as desired; existence of sufficient organisations with the knowledge, capacity and interest to provide services; general support to the development of markets for off-grid motive and thermal power.

Action 8

Elaborate and implement a strategy for comprehensive mapping of resources in key areas

Action	Elaborate a process for comprehensive mapping of resources in key areas.
Resource-Service pair(s)	Wind, solar and bioenergy, for all applications.
Description	There is currently a broad-based understanding of resource availability and potential, but this is generally insufficient to enable project development or a comprehensive assessment of potential. Similarly, there is some data collection from actual projects, but this is neither comprehensive nor centralised. Comprehensive data will facilitate the implementation of the draft renewable energy strategy and future project development. Particular gaps exist in the areas of solar, wind and biofuels; benefits could also be gained from an assessment of bioenergy potential. Likely actions in implementing a mapping process could include: ☼ engaging with existing initiatives for data collection, including observatory currently being established by the ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE); ☼ identify precise requirements for resource mapping, based on priority areas for renewable energy development; ☼ establish a plan for collection of data; and ☼ explore the potential for funding ground measurement campaigns with multilateral/bilateral organisations .
Actors	Ministry of Energy, Ministry of Renewable Energy, ECREEE, project developers, CERER and other research institutes, donors.
Timing	Mid-2012 for definition of requirements and establishing protocol, ongoing for data collection.
Keys for success	Technical and human resources available for data collection, identifying and securing funds for data collection, establishing a protocol for sharing data.

Photo Courtesy: INENSUS West Africa S.A.R.L

THIS FIRST PILOT STUDY IN SENEGAL HAS IDENTIFIED A NUMBER OF AREAS IN WHICH SENEGAL CAN TAKE ACTION TO IMPROVE READINESS FOR THE DEPLOYMENT OF RENEWABLES.

MANY OF THESE ACTIONS CAN BE TAKEN IN THE NEAR TERM, BUILDING ON THE MOMENTUM THAT HAS ALREADY BEEN ESTABLISHED IN THE COUNTRY THROUGH RECENT INSTITUTIONAL DEVELOPMENTS IN SUPPORT OF RENEWABLE ENERGY.

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