REPUBLIC OF ANGOLA

MINISTRY OF ENERGY AND WATER

NATIONAL STRATEGY

FOR THE NEW

RENEWABLE ENERGIES

FINAL VERSION

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MESSAGE FROM THE MINISTER OF ENERGY AND WATER

Renewable energies, in particular, hydro, have contributed decisively to bring power to more and more Angolans. Hydropower accounts for over 70% of electricity production in the country and, with the ongoing construction of Laúca and Cambambe II, will continue to represent the majority of grid connected generation in the country. Angola is already today one of the world's countries with greater incorporation of renewables.

However, we cannot rely only on water, which can also scarce due to natural causes, or on fossil fuels, which are nonrenewable, costly and pollute the environment. It is also necessary to diversify and invest in other energy sources and other types of projects: the new renewable energies. The new renewables are distributed more evenly across the territory, with the potential to support the electrification of the country in a more sustainable manner. The strategy that is now being approved is part of the strong commitment of the Government in the electrification of the country.

Solar power constitute a strong commitment, as Angola is a country that benefits from solar irradiation over the entire

territory for almost the whole year. The experience and success of the Solar Villages' program allows us to establish a new ambition: to reach every commune headquarters that will be off-grid until 2025. The higher irradiation in the center and south of the country and the lower costs allow to aspire for higher size projects that leverage the construction of factories and solutions to supply solar-based energy to the rural areas of Angola.

Our aim goes beyond solar energy, in particular, with regard to grid connectivity. Angola has vast forests, favorable agricultural areas for the exploitation of sugar cane, and municipal solid waste that can and should produce electricity, promoting job creation and the development of new sectors. There are countless possibilities to build small hydropower plants throughout the country, reducing costs and improving energy supply in isolated systems, in more remote areas of the network, or even in small local networks, that shall be boosted. The wind, in many upland areas of the country, from north to south, has enough quality to produce electricity in a compatible manner with the national network that we are currently building.

Angola is committed to the new renewable energies to bring more and better energy to our citizens. We are committed to targets, but above all with the desire to create the necessary conditions - legislative, regulatory, of incentives, financing, information and training - so that the public and private

investment in the new renewable energies of Angola can be a reality in a short time frame.

João Baptista Borges
Minister of Energy and Water

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ABBREVIATIONS AND ACRONYMS

CCER	Tradable Renewable Energy Certificates
CDM	Clean Development Mechanism
FiT	Feed-in Tariff (Supply Tariff)
FUNEL	National Electricity Fund
GEF	Global Environmental Facility
GHG	Greenhouse Gasses
GIS	Geographical Information Systems
IRENA	International Renewable Energy Agency
IRSE	Regulator Institute of Electricity Sector
LCOE	Levelised Cost of Electricity
LED	Light Emitting Diodes
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MINEA	Ministry of Energy and Water
MSW	Municipal Solid Waste
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NEPAD	The New Partnership for Africa's Development
NRE	New Renewable Energies
PPA	Power Purchase Agreements
PV	Photovoltaic
RE	Renewable Energies

SADC	Southern African Development Community
UNFCCC	United Nations Framework Convention on Climate Change
WRF	Weather Research Forecast

Note: In the text, when the terminology and its acronym are uncommon or known in English, it will be used the corresponding acronym in Portuguese.

EXECUTIVE SUMMARY

This document establishes the principles and national political and strategic goals for the promotion and exploitation of new sources of renewable energies in Angola - particularly energy generated from the sun, wind and biomass, as well as small hydro. Biofuels are not included in the present strategy as there is an autonomous strategy for them.

Context and Problem

The present strategy seeks to contribute to the National Energy Security Policy and Strategy, promoting the diversification of the national energy matrix, as well as for the Program of Integrated Rural Development and Poverty Combat, and for the promotion of growth and employment. On the international front, the present strategy contributes to the combat of climate change and is articulated with the participation of Angola in SADC and IRENA (International Renewable Energy Agency).

Angola fundamentally depends on its hydro resources and petroleum products to produce electricity. In rural areas, biomass remains one of the major fuels. New renewables still do not have weight.

The suppressed demand and excessive use of subsidized diesel, the geographic concentration and the long lead times for the construction of large hydropower plants, the lack of access to

modern energy sources and the unsustainable use of biomass in rural areas constitute problems that the new renewable energies will help to solve.

New Renewable Energy Resources and Potential

Angola is an endowed country in renewable resources, as with the estimates from the recent resource mappings confirm:

- *Solar Energy*: Solar radiation is high and constant throughout the territory, having been identified 55 GW of generation potential.
- *Hydropower (up to 10 MW)*: The hydroelectric potential is estimated at 18 GW, having been identified numerous rivers with adequate flows and falls to smaller projects (up to 10 MW) throughout the territory.
- *Biomass Energy:* The forests of the country, the existing forest polygons, the favorable agricultural areas for the planting of sugar cane or other crops with energy potential, the farming of livestock and municipal solid waste, all have the potential to generate energy that can overcome the 3 GW.
- *Wind Energy:* The wind resource in the Southwest and on the Atlantic slope, along to the north-south axis identified in recently completed studies, present favorable conditions to the installation of more than 3 GW of wind farms.
- *The remaining sources of energy:* geothermal signs of average enthalpy in the center of the country and an

extensive ocean coastline also constitute potential resources to be followed.

Rural Electrification with Renewable Energies

Renewables energy may in many cases play a huge role in rural electrification and provision of basic services, essential for socio-economic development of remote areas.

Once defined the areas that will benefit from the extension of the national network(s), it is important to identify the most appropriate solutions for populations that are not covered. Solar energy constitutes the most comprehensive, flexible and adjusted renewable source to supply small local networks - with batteries or in articulation with small generators - either for individual systems. Pico and micro hydro or bio digesters may be alternatives in places where resources are available in adequate conditions.

Elements for the Implementation of New Grid-Connected Renewables

Barriers to implementation of the new renewables and greater involvement of the private sector are many. Their mitigation shall take place through the creation of legislative and regulatory conditions favorable to the implementation of renewable projects, establishing incentive mechanisms and adequate funding and promoting training and communication for the new renewable energies.

Strategic Targets and Goals

Taking into consideration the above described, the Government of Angola through the present strategy sets as a target for 2025 that at least 7.5% of the electricity generated in the country will come from new renewable energies, foreseeing the installation of 800 MW.

In order to achieve this target, three strategic goals with specific targets and measures are established:

- *Goal 1 - Improve access to energy services in rural areas based on renewables:*
    - at the level of community and public services, create the National Institute for Rural Electrification (INEL) and extend the "Solar Villages" program;
    - at the level of domestic use, promote market solutions and act only in more dispersed areas with low purchasing power;
    - at the level of productive uses and entrepreneurship, invest in farming communities and in the creation of distribution networks and service providers throughout the territory.
- *Goal 2 - Develop the use of new grid-connected renewable technologies:* specific targets and guidelines for each type of renewable energy are established, promoting in the case of solar the creation of factories. The

knowledge and monitoring of technologies in various areas should be encouraged through the creation of a Center for Research in Renewable Energy in articulation and collaboration with the Ministry that oversees Science and Technology, with the university system and the involvement of Universities.

- *Goal 3 - Promote and accelerate public and private investment:* this includes, among other measures, the creation of specific legislation for renewables, a system of tariffs such as "feed-in" for projects up to 10 MW, the launch of credit lines to stimulate the private sector initiative in rural areas and the development of communication campaigns and training offers.

Institutional Framework and Transversal Aspects

The Ministry of Energy and Water through the DNER and future INEL will work with other Ministerial Departments on the strategy implementation, being the action in rural areas performed in coordination with the various Programs dedicated to the development of rural areas. The IRSE will promote appropriate regulation of the sector, in the legislative framework to be developed. The National Electricity Fund (FUNEL) will be budgeted and managed by INEL to support the financing of priority initiatives in rural areas in coordination with international financing available. Projects connected to the grid, of larger size, will be developed in conjunction with the General State Budget.

The impact on improving the living conditions of rural women, in local employment, business creation, college night school and improving safety conditions are transversal issues that the strategy will also promote.

From Strategy to Action

The strategy is committed to action and results achievement. In addition to boosting the implementation of measures by MINEA, the integration of strategy on planning and budgeting tools of the Ministry, it is foreseen the creation of an Inter-ministerial Committee for Monitoring and conducting monitoring reports every 3 years.

1. INTRODUCTION

The present document sets out the Government's vision, policy principles, strategic goals and targets for promoting and implementing the new renewable energy technologies in Angola, both in small applications as well as in large scale.

1.1 Vision for the New Renewable Energies

The strategy is aligned with the political goal of providing universal access to energy services of quality, modern, efficient and promoters of development.

The Government's vision for the new renewables lies *on delivering energy of quality to more and more citizens taking advantage of new technologies and the potential and proximity of its endogenous resources - especially water, the wind, the sun and the biomass - to meet the needs of each site with rationality, efficiency and safety, contributing to competitiveness, energy security and environmental sustainability.*

The strategy aims to contribute to the sustainable development of the Angolan economy, improving the living conditions of the population particularly of the one that does not have access to public service for electricity supply.

As stated in the Law 256/11 of 29 September the extraordinary wealth of resources in Angola allows the convergence of the three goals of an energy policy, typically conflicting, including security and energy autonomy, cost efficiency and environmental sustainability. This strategy for the new renewable energies aims to strengthen the three goals.

1.2 Definitions of New Renewable Energies

Renewable energies are those obtained from natural sources such as the sun, wind, water and biomass, capable of being regenerated, and therefore virtually inexhaustible. Them include the Solar Energy; Wind Energy, Hydropower, the Ocean Energy, Geothermal Energy and Biomass Energy in general, not forgetting Biofuels (see Annex I: Glossary of terms and definitions).

The national energy matrix already incorporates a large percentage of energy from renewable sources, the hydropower, which is developed autonomously. However, this strategy is intended to promote the use of new sources of renewable energy, in particular, small hydro, wind, solar and biomass energy.

Not included in this strategy are solar thermal energy denominated as "passive", because it is closely linked to the

construction of buildings, which are subject to autonomous regulations, as well as biofuels, for which there is a separate strategy (Resolution no. 122 / 09 of December 23, 2009) and a law (Law no. 6/10 of April 23, 2010).

1.3 Purpose of the Strategy for New Renewable Energies

The purpose of this document is to establish the Principles, Targets and Goals of the Executive in relation to new renewables.

The Strategy for the New Renewable Energies (NRE) guides the development and implementation plans of projects of use and conversion of renewable energy sources, and engages the Executive in a series of actions to ensure that the New Renewable Energies contribute significantly for the diversification of the national energy mix by 2025.

The strategy also aims to promote and facilitate the entry of the private sector in the implementation and use of these indigenous energy sources, leaving to the Government the role of political advisor, regulator, provider of incentives and oversight of its proper application to protect the consumer and create a sustainable market for RE and driven by the private sector.

1.4 Principles of the Policy for the New Renewable Energies

The Principles of the Policy are the fundamental premises that the Government will use to apply, develop and test the policy and subsequent actions, including decisions, legislation, regulation and reinforcement.

The main Principles of the Policy for the New Renewable Energies are:

Equity and sustainability: Access to basic services must be equitable to meet the needs and ensure social welfare, helping to reduce social and geographical disparities. Each generation has the duty to avoid harming the ability of future generations to ensure their well-being, both in economic and environmental terms.

Rationality and efficiency: The criteria used in the allocation of resources should take into account the rationality and efficiency in order to contribute to the gradual improvement of the competitiveness of the system. The use of more efficient technologies should be encouraged.

Comprehensive assessment of costs and benefits: The options and pricing policy will be based on the analysis of economic, social and environmental costs, on the actual costs of the alternatives including subsidies, and on the benefits of policies,

plans, programs, projects and activities of energy production and use.

Safeguard of the public interest and safety standards: The planning and operation of grids and the integration of renewables will always comply with minimum safety criteria that safeguard the functioning of the system. The diversification of resources and the proximity between production and consumption constitute contributions to the security that should be weighed in decisions. In all decisions will be given preference to the common good, the public interest and energy security.

Allocation of Functions: The Government will allocate functions in accordance with the Constitution to Government Institutions and Spheres that may, effectively, achieve the goals of the functions assigned in the context of this strategy.

Global and international cooperation and responsibilities: The Government will recognize their responsibilities in international and regional issues and act in accordance with the principles of relevant policies and relevant regional and international agreements.

2. CONTEXT AND PROBLEM

This chapter intends to establish both national and international issues related to the implementation of renewable energy technologies in Angola, as well as presenting the current situation of the energy sector in Angola and the problems that new renewables can help to solve.

2.1 National Context

2.1.1 The Constitution

The Angolan Constitution provides that the State exercises sovereign rights and jurisdiction in matters related to the conservation, exploration and exploitation of natural, biological and non-biological resources.

Accordingly, the State should establish the policies to ensure the conditions of concession, research, exploration and appropriate distribution of national resources, which include the energy ones, under the terms of the Constitution, Law and International Law, in order to meet the needs of the nation.

2.1.2 General Guidelines

The general guidelines establish the policy of the Executive on the supply and consumption of energy in the upcoming

decades, particularly the Law 256/11 of 29 September that approved the Policy and National Strategy for Energy Security.

One of the guiding principles of the Law no. 256/11 for the electricity subsector is to promote the balanced development of the society and the Angolan economy, developing options that aim to reduce the social and geographical inequities, and *"constitute a diverse energy mix that gives preference to the endogenous energy (in particular, hydro resources and natural gas), energy security and environmental sustainability."*

Given the increasing opportunities for energy trading in the Southern African region, the Executive will promote energy security by encouraging diversity in both supply sources as on the primary resources. The Energy Security should be achieved through diversity and flexibility of supply, and competition among the different players of the energy sector.

2.1.3 Strategy for Integrated Rural Development and Poverty Combat

The Government is committed on implementing the following key strategies:

- Strategy to Combat Poverty.
- National Strategy for Food and Nutrition Security.

In order to implement these strategies and achieve the established results, various plans and programs were proposed by the sectors that contain actions, projects, activities and policy measures that are reflected in the Integrated Rural Development and Poverty Combat Program.

For the Integrated Rural Development and Poverty Combat Program is urgent to ensure an efficient and integrated contribution of all sources of energy that can contribute to the national energy mix and sustainable development of the country, promoting an increased role of energy supported on natural resources and the energy self-sufficiency of Angola.

2.1.4 Growth, Employment and Macroeconomic Redistribution Strategy

The energy sector can further contribute to economic growth and well-being of the Angolan population, to the extent that encourage investment in domestic or foreign capital in energy diversification, using besides fossil fuels the biomass, solar, hydro and wind energy, among others.

It is anticipated that in the next five years Angola continues to register high growth rates (between 7 and 8% per year), based not only on increasing oil production, but also an increasing growth of the non-oil sector. Thus, the support to the economic

growth targets requires the elimination of the current deficits of electrical supply industry.

This is a point where the private, domestic and foreign capital is considered crucial, for growth, employment and macroeconomic redistribution strategy.

2.1.5 Legal Context

Law 256/11 encourages the entry of multiple players in the power generation market with the use of new renewable energies including, solar photovoltaics (PV) energy, active and passive thermal, wind energy and biomass energy. However, there is no specific legislation for the use of the new and renewable energy sources.

According to its statutes, the Regulator Institute of Electricity Sector (IRSE) has jurisdiction over all the regulatory activity of electricity generation, transmission, distribution and sale. The purpose of regulation is to ensure the supply, to protect consumers, to promote the economic and financial equilibrium of the Public Electricity System companies, to encourage competition and to ensure non-discriminatory commercial terms.

2.2 International Context

2.2.1 Climate Changes

The UN Framework Convention on Climate Change (UNFCCC) was established in 1990. This Convention was opened for signature in June 1992 at the Earth Summit in Rio de Janeiro. The fundamental goal of the UNFCCC is to reduce the emission of greenhouse gases into the atmosphere, stabilizing them to a level that can be managed by natural processes, preventing dangerous anthropogenic interference with the climate system. Angola ratified the UNFCCC in 2000.

The Kyoto Protocol was introduced in 1997 and regulates that industrialized countries (Annex I countries) would reduce their combined greenhouse gas (GHG) emissions by at least 5%, relative to 1990 emissions levels, during the period from 2008 to 2012. The Protocol entered into force after the ratification by at least 55 Parties to the UNFCCC, including Annex I countries, which account for about 55% of total GHG emissions in the group of industrialized countries. Angola ratified the Kyoto Protocol on May 8, 2007.

The Kyoto Protocol does not commit the countries of non-Annex I (developing countries), such as Angola, to any emissions targets quantified on the first agreed period (2008-2012). However, there is the possibility to offset GHG emissions in Annex I countries through projects that reduce GHG emissions, due to

lower costs of reducing emissions in these countries, the so-called Clean Development Mechanism (CDM).

In Angola there are several sources of greenhouse gases of human origin, many of which are the basis for meeting the energy needs of the population. These basic needs are mainly related to the production of electricity from fossil fuel and unsustainable use of biomass for cooking, both generating Greenhouse Gases.

2.2.2 Angola in the International Arena

In terms of participation in International Organizations, one can highlight the participation of Angola in the Southern African Development Community (SADC), of which it is a founding member. Before the creation of the current structure of SADC, Angola coordinated the energy sector where, among others, were inserted projects and programs related to the development of renewable energy technologies in the region.

The SADC Protocol on Trade provided for the creation of a free market eight years after its ratification. This may have implications on the export market for local producers of renewable energy technologies.

It is also hoped that the African Union and the New Partnership for African Development (NEPAD) help to protect natural

resources and to promote the exchange of information and transfer of technology for renewable energies.

On the other hand, Angola is a member of the International Renewable Energy Agency (IRENA) since January 2012.

2.3 Energy Context and Problems to be Solved

The current energy matrix of Angola, with regard to electric energy, is essentially based on two sources: hydro and thermal (from petroleum products) and, with regard to energy consumption in rural areas, on biomass (wood and charcoal). New renewables have no weight and represent less than 1% of the energy consumed.

The suppressed demand and excessive use of subsidized diesel, the geographic concentration and the long lead times for construction of large hydropower plants, the lack of access to modern energy sources and the unsustainable use of biomass in rural areas constitute problems that the new renewable energies can help to solve. However, several barriers that must overcome limit their implementation.

2.3.1 Oil and Natural Gas

Angola has vast oil reserves, being the second largest producer in African continent, after Nigeria. In late 2008, proven reserves

were of 13,500 million barrels, representing 21 years of production.

Angola also has considerable reserves of associated natural gas, which will be exploited by Angola LNG project. Angola has a high potential for production of natural gas, with proven reserves of 270 billion m^3.

The Angola LNG project also produces liquefied petroleum gas (LPG) - from gases associated with its oil exploration - that can replace the charcoal in urban and peri-urban areas.

Oil production has led to rapid economic growth. However, the longer lead times of infrastructures in the electricity sector and the impact of wartime on existing infrastructures, did not allow to accompany the demand growth. The suppressed demand has been offset by the generation (mostly private) from diesel at subsidized prices and with obvious damage to the national economy.

Furthermore, on the refining of oil, Angola has an inefficient and deficit production capacity resulting in higher imports of products like gasoline and diesel, making even more costly the invoice associated with these subsidies.

2.3.2 Large Hydro

Currently, Angola is a country with the world's highest penetration of renewables in the electricity sector under the weight of its hydroelectric plants. In 2013, over 70% of the electricity produced in the country was hydro-based.

The Action Plan of the Ministry of Energy and Water for the period 2013 - 2017 reinforces this investment on large hydroelectric plants, by building Laúca with 2060 MW and Cambambe II with 960 MW, whose works are already underway. To these, various other hydroelectric projects are added, especially Caculo Cabaça, Jamba-Ya-Mina, Jamba-Ya-Oma and Baynes.

Table 1 - Installed Hydroelectric Capacity (MW)

	2013	2017
North System	725.6	5,572.6
Center System	122.2	325.4
South System	40.8	346.8
Isolated Systems	58.1	76.0
Total	**948.9**	**6,614.8**

Despite the low generation costs associated with large hydro and the benefits for future generations of the country, the best projects are concentrated in the rivers with greater flows and in areas of higher slope, resulting in a high level of territorial concentration of power generation, in particular in the Kwanza river Basin and the Northern System.

This concentration, together with hydrological variability and unpredictability, implies the need to build long corridors of transport with losses, lower quality of energy in distant extremes and the need to maintain some thermal generation over the network to maintain stability and ensure production in years of lower hydrological.

Adding to this problem, it is the long lead times of hydroelectric power plants and the need to find solutions that will help to meet in the short and medium term the demand strong growth.

2.3.3 Electricity Transport and Distribution

The electrical grid of Angola is constituted by 3 independent main systems, underpinned in watersheds, in particular the North, Central and South Systems. The Province headquarters outside of these systems are supplied by isolated systems. The Action Plan 2013-2017 provides for the expansion and interconnection of the three systems and the creation of a fourth

system in the East that will unite the Provinces of Lunda Norte, Lunda Sul and Moxico.

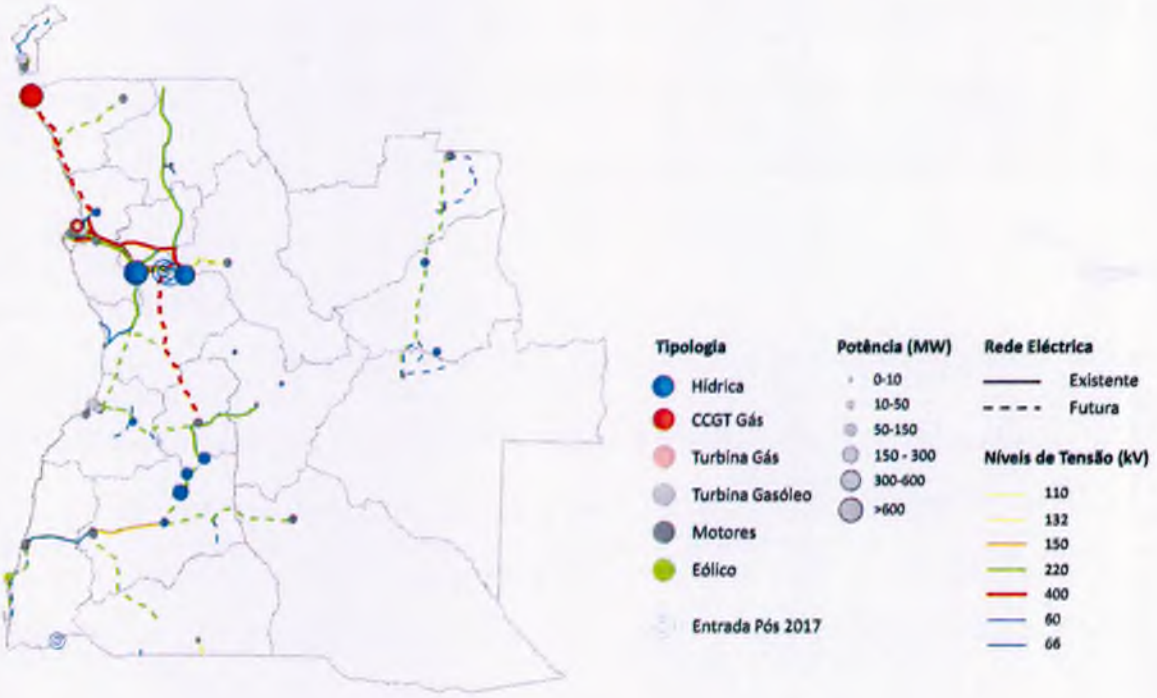

Figure 1 - Electrical Grid and Expected Generation in 2017 (Action Plan 2013-2017)

Despite high investments in the sector, the situation of the power sector continues to be characterized by a suppressed demand, by both the constant failures of supply and the low penetration of electricity in rural areas. The coverage rate of the electrical system is still only 30% of the population, of which 70% in Luanda, where most of the population lives with high purchasing power, and therefore the one that benefits more from the subsidized rates (the tariff is on average 20% of the actual cost of electricity).

Subsidized electricity prices in areas covered by the distribution networks limit the introduction of renewable energy

technologies, being an obstacle to the emergence of new markets, as the market for solar collectors for water heating in urban areas - resulting in a growing use of the electric cylinder.

Also in areas not covered by the electric grid, subsidized diesel prices limit the market for individual or community solutions for production of electricity based on renewables.

There is an ongoing program of implementation of solar photovoltaic systems for electrification of rural areas not covered by transmission and distribution network, with a focus on community building, called "Solar Village" with two phases already completed. Despite the registered progress, the number of local beneficiaries is inexpressive.

Table 2 - PV Electrified Infrastructures

Infrastructures	**1st Phase**	**2nd Phase**	**Total**
Schools	10	23	33
Clinics	16	23	39
Administrative Residences	10	29	39
Police Stations	3	7	10
Community Centers	-	7	7
Total	**39**	**89**	**128**
Streetlights	70	84	154

2.3.4 Fuel Wood and Charcoal

Most rural areas have no access to electricity and other modern energy sources. The fuel wood continues to be one of the most used forms of energy in rural areas of Angola for heating and cooking. The uncontrolled use of this resource has created some problems of deforestation, though confined to the outskirts of towns and villages in rural areas. The charcoal, which is mostly used in urban areas, is normally produced unsustainably, once felled trees are not replaced.

2.4 Barriers to Implementation of the New Renewable Energies

New renewables can help to mitigate many of the problems identified in the preceding paragraphs. However, there are significant barriers to its implementation that must be taken into account, namely:

- Many renewable energy technologies are still expensive, in terms of investment costs, compared with conventional energy for the supply of urban areas or industries. Moreover, the level of subsidy for diesel and gasoline makes this difference higher and the investment in renewables less attractive.
- The high investment required and the inadequacy of national financial resources available difficult the introduction of these energies that require special

conditions of maturity and funding for a relatively long period before they become profitable.

- Risk perception that leads commercial agents to impose excessively high margins on these technologies.
- Lack of a clear, stable and favorable legal and institutional framework.
- Lack of technical capacity at the level of planning, installation and maintenance.
- There is a lack of knowledge by the public energy consumer on the benefits and opportunities of renewable energies. There is little information available and its dissemination is not done efficiently.

The implementation of renewable energy technologies on a large scale in many countries is already cost parity with other alternatives in the supply of electricity to the grid, in particular those based on petroleum. In isolated rural areas and situations, new renewables may already be the lowest cost solution. However, in Angola this is not the case due to the barriers listed above. This strategy is therefore intended to overcome these barriers.

3. NEW RENEWABLE ENERGY RESOURCES AND POTENTIAL

In this chapter it is presented the potential approach for the development of new renewable energy resources in Angola. The Renewable Energy Atlas of Angola in mesoscale was recently completed, using satellite data, which mapped and identified the major resources and a vast number of renewable energy projects.

In some of these resources, there are already ongoing measurements to confirm on the ground the good results forecasted by the Mesoscale study. It is underway, as part of the Atlas, the creation of a database of resources and projects, including the results from all ground measurements.

3.1 Solar Energy

Angola has a high potential of solar resource, with a global annual horizontal solar radiation between 1,370 and 2,100 kWh/m^2/ year.

This is the largest renewable resource of the country, evenly distributed and in which variations on scales of tens to hundreds of kilometers are not noteworthy, except for a few specific situations such as sites along the coast or rivers where there is frequent fogs, or high locations next to mountains that causes significant shades.

Regional variability of the solar resource is known sufficiently, for instance the provinces of Central and Southern Angola have a greater solar irradiation, as can be seen in the following map. It's the most reliable and constant resource throughout the year.

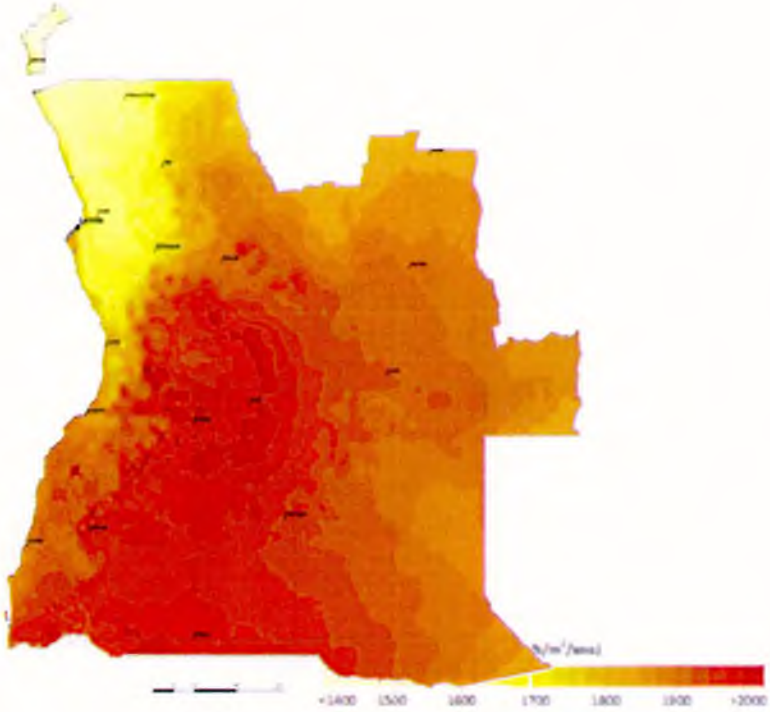

Figure 2 - Solar Radiation (GHI) Atlas of Angola

The most appropriate technology to harness the solar resource in Angola is the production of electricity through photovoltaic systems, which can range from individual small-scale systems, normally associated with batteries, to medium and large scale applications connected to the grid. Is the fastest technology installation (lead times of less than 1 year) and lower maintenance cost.

The Renewable Energy Atlas identified several sites with characteristics suitable for large and medium scale photovoltaic projects to connect to the grid, with room and conditions to install more than 55 GW of solar power. However, the solar photovoltaic energy, although predictable throughout the year, in short periods of time is intermittent and subject to rapid fluctuations, being advisable to not to exceed 20% of the installed power in each system without using batteries.

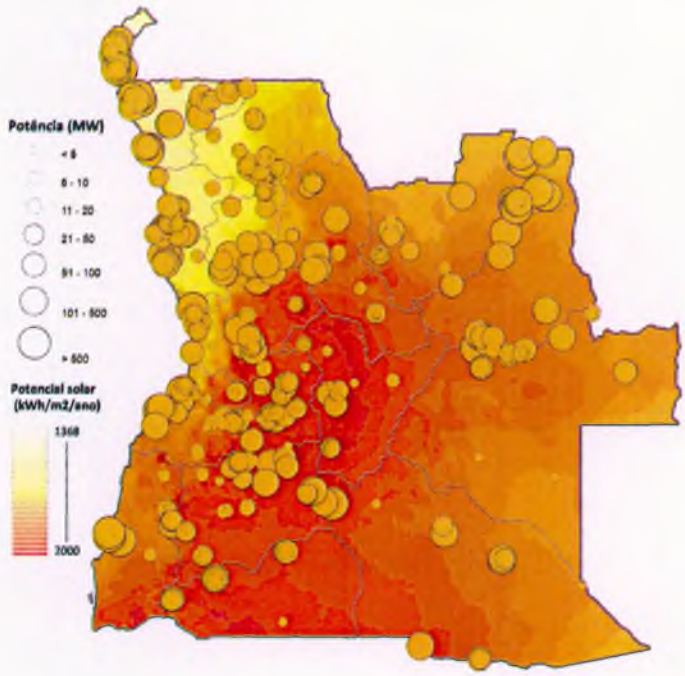

Figure 3 - Potential of Identified Solar Photovoltaic Projects

The medium and large scale solar projects in the East and in isolated systems - without batteries - present a levelised cost of less than $0.2/kWh, constituting already economic alternatives to replace diesel. In the Centre and South, you can even achieve costs below

$0.15/kWh and, if during the first 3 years these projects are remunerated at the cost of the diesel that they are replacing during that period, than the levelised cost can drop to less than $0.1/kWh after the 3rd year. Additionally, is expected that the costs of technology will continue to decrease, meaning that these values could drop even more in the near future.

The potential for rural electrification projects based on photovoltaic solar energy is vast but costly due to the need to use batteries. This will be discussed in the next chapter.

Adding to the production of electricity is a great number of possibilities and applications of solar energy, such as:

- Air and water solar heaters for household, commercial and industrial use;
- Solar dryers for drying, among other foods, grains, fish and fruits.
- Solar water pumping systems for irrigation.
- Construction of residential, commercial and industrial buildings taking into account the passive solar energy to minimize the consumption of thermal energy.
- Solar stoves as an alternative to wood-burning stoves in rural areas.
- Solar desalinization of salt water to produce drinking water, with little interest to Angola.

3.2 Hydropower (up to 10 MW)

The hydro resources of Angola are estimated at 18 GW which means an annual production of 72 TWh.

The Hydroelectric Atlas of Angola shows that, in addition to the high potential located in the river basins of Kwanza, Cunene and Catumbela, Queve (that represent 86% of the estimated potential), innumerous rivers throughout the territory have conditions for smaller size projects.

Figure 4 - Hydroelectric Atlas of Angola

Similar to the wind resource, hydropower is a much localized resource: essentially depends on the flow and fall available or viable in each location. The National Direction of Electrification (DNE) has been developing a database of favorable potential

locations for small hydropower plants (SHP), having those locations been assessed in the Hydroelectric Atlas (see Figure 5). Several, from more than 100 potential identified sites, exceed 10 MW, being estimated a total of at least 0.8 GW on the identified sites.

About 14 sites, that represent globally 60 MW, are considered economically attractive due to the scale and proximity to large municipalities' headquarters, enabling the supply at a competitive energy cost. Some of these sites have already been the object of tender procedures.

Other locations, by themselves, have sufficient economic attractiveness and grid proximity to justify the grid connection.

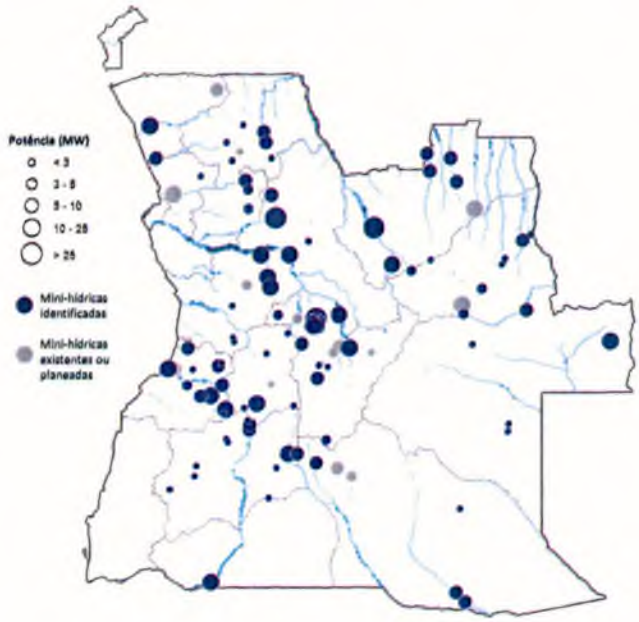

Figure 5 - Dimension and Location of the Mini-hydro Potential Inventoried by DNEL

Nevertheless, the existing information represents only a small part of the hydroelectric potential of the country in terms of small hydropower. That said, it's important to identify and map the mini-hydro potential and projects in the country followed by measurement campaigns to confirm the resource and minimize the hydrological risk.

The small-hydro are the most low cost alternatives among various renewable technologies studied in the Atlas, however, with a significant variation between projects.

3.3 Biomass Energy

The biomass definition applies to all the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

All plant biomass is formed during the photosynthetic process, producing carbohydrates, meaning, the solar energy is stored in the chemical bonds of the structural components of the biomass. The energy production with biomass does not entail the release of any molecules of CO_2 as the carbon cycle is considered zero - it is a cyclical process of atmospheric CO_2 consumption and release after combustion – considered therefore as a renewable resource.

Biomass can be achieved through various types of remains that can be used to produce energy. There are essentially four different types of residues coming from biomass, with the greatest potential concentrated in the first two:

- Forest residues and energy crops;
- Agro-food industry residues (especially the sugar cane);
- Agricultural and livestock waste;
- Urban and Industrial biodegradable waste.

The conjunction of the map of the electric potential of forest residues resulting from the operation of wood from natural growth forests and the map of the potential associated with the sugar industry (see picture below) shows the geographical distribution of the biomass potential, which in some places can reach 170 MW.

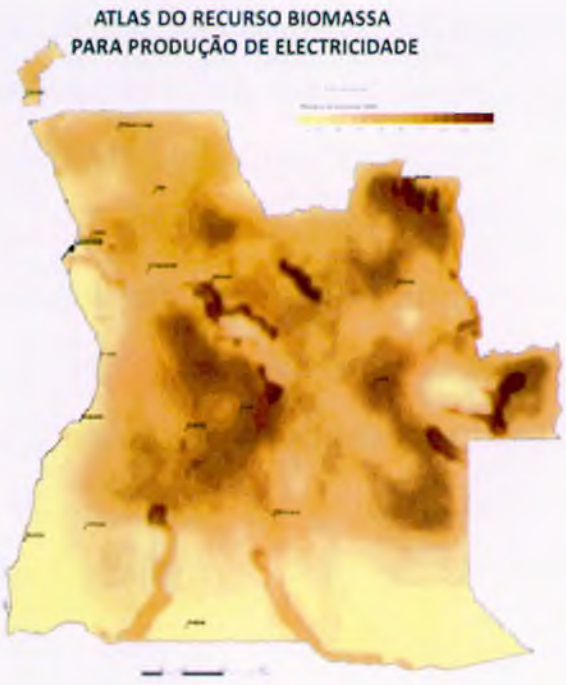

Figure 6 - Biomass Resource Atlas for Electricity Generation

The Central Region (Provinces of Huambo, Bie and Benguela) and the Eastern Region (Provinces of Moxico, Lunda Sul and Lunda Norte) are the most favorable zones in terms of resource (forestry and agro-industry). In the remaining regions there is enough potential except in Namibe province.

The potential for electricity production using livestock residues is significantly lower than that of the forests and sugar plantations. In the case of agriculture, the largest resource is the cassava although dispersed in innumerous familiar plantations dedicated to food supply. In the case of livestock residues, the provinces of Cunene, Namibe and Huila record high numbers of cattle, but not normally stabled, which limits the potential. Nevertheless, there could be projects associated with the ongoing investment in the agricultural sector.

Municipal Solid Waste (MSW) presents a relevant potential but it is concentrated in the largest urban agglomerations such as Luanda and the Alto Catumbela – Benguela – Lobito axis. There are two different energy potentials with MSW: sanitary landfilling gas production and combustion or, alternatively, incineration / direct combustion of MSW with or without physical-chemical pretreatment. The Strategic Plan for Municipal Waste Management (PESGRU) foresees a strong growth of waste treatment and gives preference to its treatment. Therefore, the priority in the main urban centers should be the treatment, recovery and subsequent incineration of "waste-derived fuels" and, in other urban centers, the municipal waste disposal after treatment and recovery in landfills can later be used to produce energy through the use of biogas. In the latter case, the potential energy will be limited to the organic component - 250kW to 1 MW projects – that can be materialized in a wider horizon (after 2020) associated to the times of maturation of these landfills.

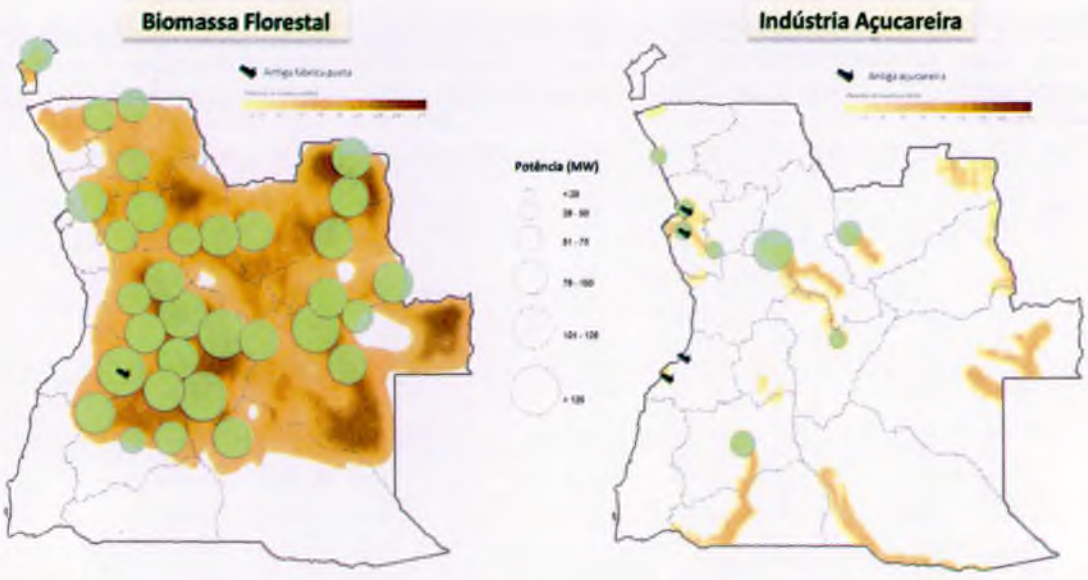

Figure 7 - Potential of Biomass Projects

There were identified 42 potential biomass projects with a global power potential of 3.7 GW (3.3 GW of which associated with the forest sector).

In terms of forest, it stands out for the lower cost associated with the existence of large forest areas - leading to a levelised cost of around $0.13/kWh - 3 locations in the central region have a potential that can reach the 300 MW. In the Eastern region, despite higher costs - around the $0.18/kWh - the biomass generation can replace other thermal generation with economic benefits. In any of these locations, the resumption of the exploration can streamline the creation of new forestry clusters.

Regarding the sugar industry, although Angola has had in the past 4 explorations along the coast in the province of Malange,

where the Biocom project is being developed, it benefits from the vast flat areas, the water of the river Kwanza and logistical conditions associated with the railroad. 8 favorable locations were identified with a global biomass energy power in excess of 350MW at a level costs that can vary between $0.15 and 0.20/kWh. The sugar cane energy potential can vary between 1.1 and 2, 9 kW per cultivated hectare, depending on the technology used.

In regards to the Municipal Solid waste (MSW), a potential of "waste-derived fuels" of at least 120 MW were identified, associated with major urban areas, with levelised costs around $0.11/kWh.

3.4 Wind Energy

The wind resource of Angola was evaluated through a Mesoscale mapping with a 3 km resolution - presented in Picture 8. This map enables the identification of the potential for wind electricity generation in the Atlantic slope, along a North-South axis associated with the places of higher altitude, and in the southwest region of the country, where the wind reaches high average speeds exceeding 6 meters per second at 80 agl. In the rest of the country, the wind resource is between 3.5 and 5.5 meters per second, offering a limited potential for electricity generation at competitive costs.

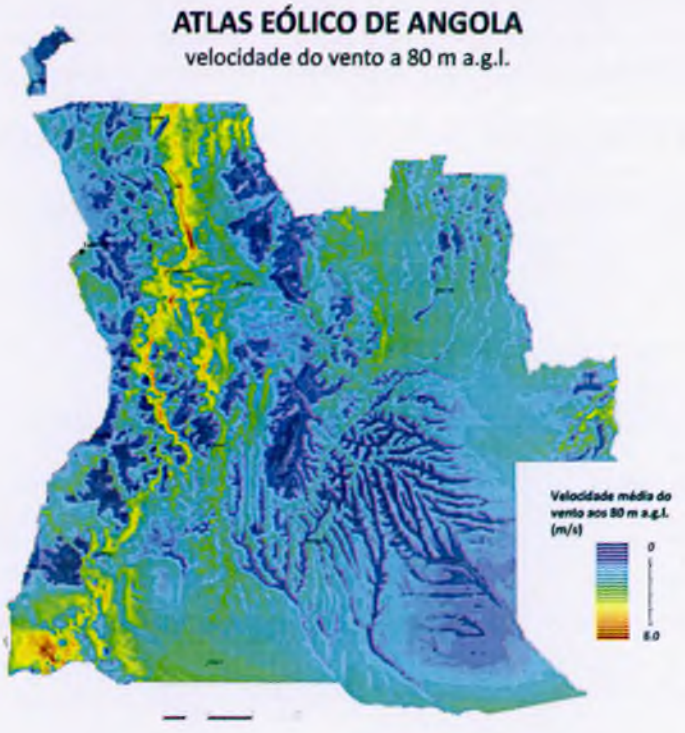

Figure 8 - Wind Potential Atlas at 80 Meters above Ground Level

The wind resource is much located and depends not only on atmospheric phenomena but also on phenomena linked to the orography, surrounding vegetation, among others. Based on the Mesoscale mapping presented, MINEA is currently producing a detailed mapping of the 12 sites with the higher potential throughout the installation of 80m measurement stations in the territory.

These measurements were firstly conducted in the Namibe province between June 2009 and June 2010. The 40m meet mast registered 5.2 m / s - enough for the production of electricity. Despite not completing a full year, other measurements in the North of Angola have identified/confirmed

new areas in line with the information presented in the Wind Atlas.

In Figure 9 are presented the size and locations of the 12 new possible projects which were identified based on the Wind Atlas and confirmed with in field surveys, with conditions to install up to 3.9 GW. Several of these sites are close to both the substations and grid with ability to absorb up to 400 MW without significant technical restrictions.

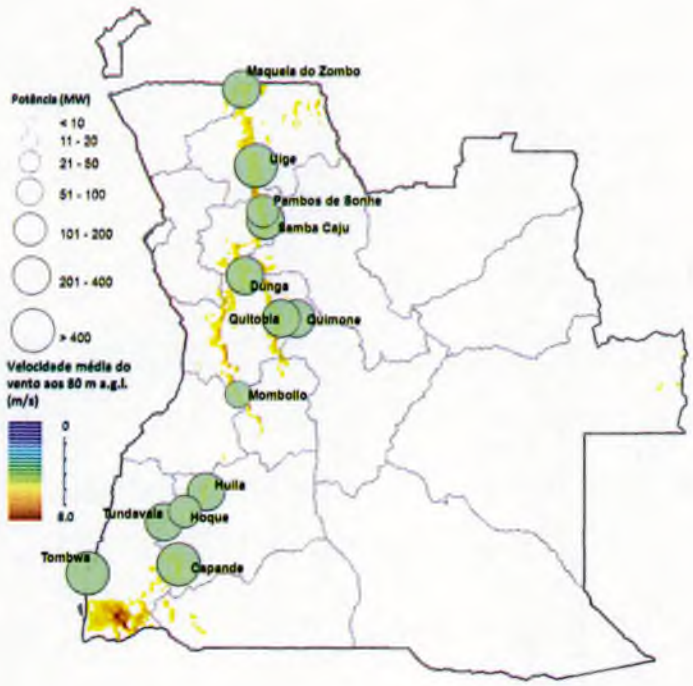

Figure 9 - Mapping and Size of the Most Promising Wind Sites in Angola

The levelised costs of wind generation may vary between $0.1 and $0.27/kWh. They are significantly dependent on the resource (that is confirmed) and on the grid availability and stability required to dispatch that energy. The latest studies point

towards a higher feasibility and benefits when developing several intermediate size wind farms, in line with the capacity of dispatch of the existing or the planned (until 2017) infrastructures.

3.5 Other Renewable Energies

Ocean Energy

Nothing is known about the potential of this type of renewable energy in Angola, however, due to the abundance of other renewable resources, and to the fact that this technology is not yet mature, and therefor with high costs and technology risks, this should not be a priority for the country, and may be only exploited in the future.

Geothermal Energy

Geothermal energy can be characterized into two types: high enthalpy and medium / low enthalpy. The first refers to temperatures above 140 ° C, normally associated with recent volcanism (and can be used for electricity generation). The second refers to temperatures below 100 ° C and is normally used for thermal purposes or for heating of greenhouses or spas, among other uses.

Although Angola does not show recent volcanism in geological terms, there are a few medium temperature geothermal manifestations in the provinces of Huambo (Alto Hama) and

Kwanza Sul (Conda) which could have some geothermal potential.

4. RURAL ELECTRIFICATION BASED ON RENEWABLE ENERGIES

This chapter discusses the criteria to define the locations where to consider mini-grids or individual systems and evaluates several aspects that should be considered as the strategy to choose the type of renewable energy to use.

4.1 Extension of the Network or Isolated Systems vs. Mini-grids or Individual Systems

4.1.1 Extension of the Network or Isolated Systems

As support to sector planning on the 2025 horizon, it was performed a study of the network extension based on economic criteria and geographic information systems. The maintenance of certain service levels in rural areas and the current costs of decentralized alternatives make appropriate in the long run to interconnect the vast majority of the population (about 90%) to the national grid. However, the means to bring electricity to many mini-grids and to produce enough energy require many years of implementation, making it necessary to establish priorities and segment service levels. For a successful rural electrification many factors must be considered.

In first place, it is necessary to clearly define which areas of the country will not be connected to the national grid (which includes the isolated systems) in a predefined horizon, taking into account that the extent of the network by 2025 will be concentrated in urban areas where concentration of

population is higher, particularly in the Province and Municipality headquarters, as well as the main productive centers, largely rural, that include areas of agricultural development. Some communal headquarters and rural villages nearby the network to be developed may benefited.

The exercise indicated above would result in a properly geo-referenced map and would serve as a basis for rural electrification in the country. This map should be based on the following criteria:

- In the expansion plans of the national grid in the 2017 horizon (in accordance with the Action Plan of the Energy and Water Sector 2013-2017), and the 2025 horizon;
- In economic parameters, i.e. an analysis of costs / benefits, the extent of the network to supply electricity to villages, considering minimum load criteria (kW) per km of network and customer and buffer zones ("buffer ") for each side of the network that would give priority to the extension. Criteria and levels of service to rural areas through power limits for home, only to return to the ground conductor or "ready-boards" to reduce investments can be established.

Some of the urban areas are to be electrified are far from the main network, so it will be more economical to develop isolated systems, which in many cases can be supplied by hybrid solutions with solar or hydro. The extent of these isolates to adjacent rural areas should also be analyzed.

4.1.2 Mini-grids or Individual Systems

In locations not covered by the national grid or by isolated systems, rural electrification should be completed through mini-grids or individual systems with different service levels and different levels of involvement of the public sector in order to maximize the number of beneficiaries.

The remote rural areas far from the grid may be subdivided into two main categories:

- **The zones of influence**: the communal headquarters, the larger villages (more than 2000 inhabitants) and the ones along the main roads;
- **Scattered areas**: the smaller villages and settlements isolated and away from main roads, where often farming communities with some organizational and trade skills may be found.

The conducted study of network extension identified about 500 areas of influence throughout the country, most being commune headquarters.

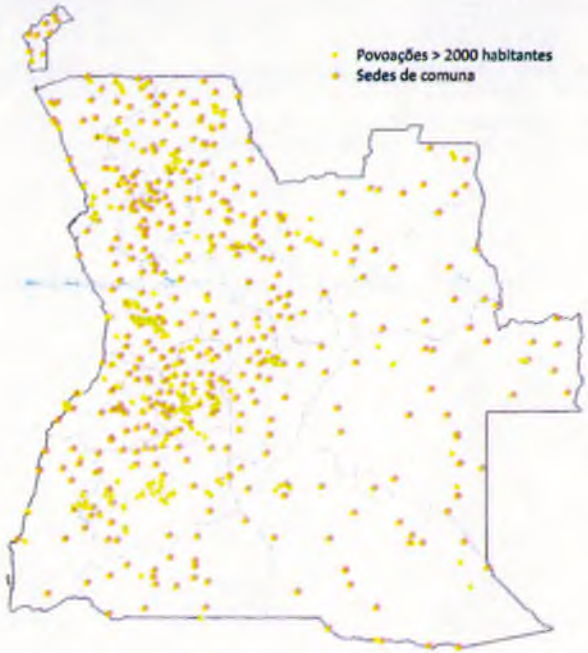

Figure 10 – Identified Rural Zones of Influence

The level of concentration of the population in each of these areas justify different approaches in which mini-grids should be favored in the areas of influence and individual systems in dispersed areas. Both mini-grids and individual systems in rural areas can and should benefit from renewable energy technologies, being fundamental to tailor the technologies to the needs and available resources.

4.2 Renewable Energy Alternatives for Mini-grids and Individual Systems

4.2.1 Resources and Location

The existence and characteristics of the various resources in each site are the starting point for the selection of the renewable source to be selected for each location.

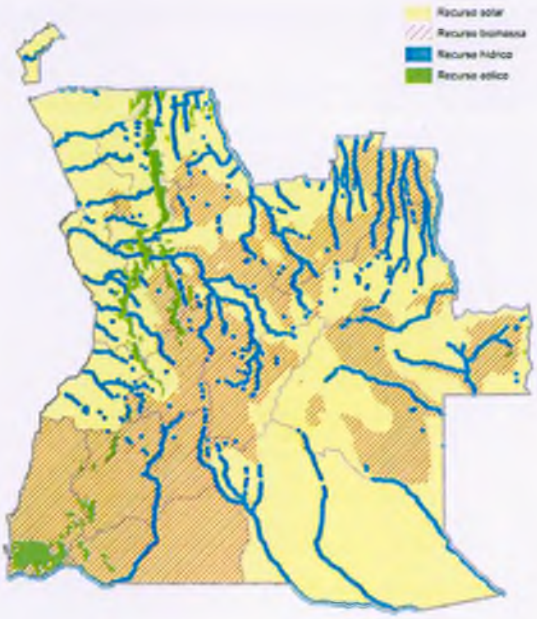

Figure 11- Preferred Regions by Type of Resource for Local Networks

Hydropower

For the design of a small hydropower plant, it is required to have a knowledge of the flow for several years. One of the limitations to the development of hydropower projects relates to the hydrological risk associated to the project, which can be reduced if the hydrological records series is long and with assured quality - good practices recommend the use of consecutive time series not less than 15 years. Therefore, it is important to strengthen the existing network of hydrometric stations and follow the best practices.

In small-scale projects of up to 500 kW (pico and micro-hydro) - more suited to mini-grids – it is possible to mitigate the risk by choosing the design flow as small fraction of the estimated mean annual runoff (i.e. high capacity factors) or establishing

compensation mechanisms as a function of measured runoff. Using high capacity factors also minimizes the risk during drought periods and the need for hybrid solutions with diesel generators.

Using hydropower in a mini-grid will always depend on: (i) the existence and location of the resource, (ii) the distance to consumption, (iii) the volume of demand. In this sense, this renewable energy is highly localized.

Wind Energy

Although in principle it is possible to place a wind turbine nearest to the load area, by the effect of topography, this renewable source is the most variable and difficult to predict both in local scale and timescale.

Mesoscale mappings, while enabling a first resource zoning, are too generic to allow wind projects dimensioning for mini-grids. Also taking into account the low power supply in isolated locations, the towers will obviously be lower than the mapping altitude usually selected for such wind mapping, which usually considers wind turbines for higher capacity. For an appropriate sizing and configuration that can assess the feasibility, a time series with several years of wind speed and wind directions at the height of the project should be available.

Wind is also the most inconstant and intermittent renewable resource, and there may be periods of several days with very

limited use. In mini-grids, the wind resource can be combined with diesel engines or used in production applications. The batteries will be less recommended due to intermittency of the resource and solution cost.

Solar Energy

The solar resource is the source of endogenous energy more evenly distributed in Angola. It is also the most reliable and constant renewable resource throughout the year, enabling a very stable dimensioning of the associated batteries system.

The resource mapping based on satellite data, calibrated by various weather stations on the ground, constitutes a good forecast for the design of small photovoltaic systems which permit to assess the potential of rural electrification and the estimated cost of decentralized generation.

The 100% renewable solutions with batteries will be appropriate for individual systems. For mini-grids, some cases may compensate to reduce battery capacity by introducing solutions with diesel generation - to cope with prolonged periods of reduced solar irradiance, being necessary to perform a cost-benefit analysis for each case.

Biomass Energy

At biomass resource level for mini-grids, small engines and bio digesters associated with livestock is the technology with the

greatest application. Conventional power plants are poorly suited for mini-grids or isolated systems due to the inertia of the vapor cycle. The gasification technology of forest biomass could provide an interesting alternative for small applications in the future, but these solutions are still not consolidated.

The potential for biodigesters focuses on areas with higher livestock activity, i.e. the provinces of Huila, Cunene and Namibe. However, the potential will be limited to a few larger farms as at the other cattle should not be stabled and there is limited information on its location and potential.

4.2.2 Costs by technology

Regarding investment costs, the various alternatives for rural electrification should take into account the origin of the necessary equipment and guarantees to ensure its regular operation.

Hydropower

In rural electrification, hydro power often means more tens of kW than megawatts, and the unit costs can be very high for the smaller capacities.

The large hydropower in Angola has an average cost of around $ 2,000 / kW. However the cost of hydropower between 1 and 10 MW is typically much higher.

In some Southern African countries the average cost of hydropower (up to 1 MW) is greater than $9,000/kW, reaching values of $32,000/kW in lower outputs and low-fall applications (60 kW). The investment level will depend heavily on the characteristics of each site (flow, fit and fall) and its location (accessibility, availability of borrow pit in the vicinity in case of landfill).

The levelised cost of electricity (Levelized Cost of Electricity - LCOE) for large hydropower projects can range from $0.02 to 0.1/kWh assuming a cost of capital of 10%, reaching higher values in the case of regularization dams. For mini-hydro power output between 1 and 10 MW is possible to obtain lower costs down to $0.1/kWh. In the case of pico and micro hydro costs can vary between $0.2 and $0.5/kWh constituting in many cases the most economical alternative for mini-grids.

Wind Energy

The costs of wind turbines for grid connected projects can vary between $1,500 and $2,500/kW, which are added to the costs associated with the necessary network to ensure the production dispatch in safety.

Wind energy has significant "economies of scale". Wind turbines of less than 100 kW capacity cost between $3,000 and $8,000/kW. A small wind turbine with an appropriate output for

rural electrification, i.e. 10 kW, can have an installation cost between $5,000 and $8,000/kW depending on the type of tower height and transport logistics and installation.

The cost of grid-connected wind generation in Angola may lie between $0.1/kWh and $0.26/kWh, depending on the resource and investment grid connection. For smaller systems, the costs are higher, which may exceed the $2/ kWh in case of solutions with batteries.

In Angola, taking into consideration the costs of the different technologies and the mappings performed, the solar resource should always be more competitive for mini-grids than the wind resource - which should be considered only for grid connection.

Solar Energy

In early 2012, the price of PV modules (excluding works) fell below $1/Watt-peak (Wp). The modularity of PV systems and reduced economies of scale allow its application in small scale economic rationality.

However, in cases where energy storage is required, usually through batteries, the rest of the equipment (especially the batteries) and installation costs comprise the large majority of the cost, making it very costly solutions.

Despite impressive reductions in the cost of PV systems, the LCOE of PV remains high. The LCOE for residential systems without storage assuming a cost of capital of 10% was between $0.25 and 0.65/kWh in 2011 and when electricity storage is added, the cost increases to the range between $0, 36 and 0.71/kWh.

Biomass Energy

The investment in biomass projects varies between US $1,880 and US $6800/kW, depending on the technology employed, which depends mainly on the type of waste used. In some cases investment in boilers and equipment for removing particles from air is required. The levelised cost for these projects can range between $0.06 and $0.2/kWh, with a greater weight of the operation costs. For small projects with biodigesters more affordable costs can be achieved.

4.2.3 Maintenance

This is the crucial aspect that is often neglected and in some technologies is more important than the technical quality of the facilities.

Hydropower

Hydropower is a technology with low maintenance requirements and exists in the country capacity and experience. A hydropower plant usually has one or more unique operators, so

this aspect is normally provided. It is however essential to ensure that spare equipment is available when needed.

Wind Energy

High maintenance costs. A wind turbine, being a mechanical-electrical system subject to violent fluctuations, normally requires skilled labor for its maintenance.

Solar Energy

Compared to the two previous options, it presents lower maintenance costs. However, it is noted that most photovoltaic systems fail because their maintenance is not done, and not by poor quality components or installation.

If the installation is centralized, and more importantly if commercially managed, their operators are trained to efficiently perform maintenance. In isolated (PV) systems (see definition) users have to be trained. In these cases, it is recommended that the supplier and installer pass guarantees of equipment that are usual, and there is a contract of technical service of at least two years.

For isolated systems, a key factor relates to the use of batteries that does not require maintenance (sealed or equivalent), although the batteries with electrolyte present some technical advantages.

Biomass Energy

The maintenance of energy production systems from biomass is highly associated with the technology employed.

4.2.4 Over-sizing and Over-specification

The over-sizing is an aspect to consider which affects any of the technologies discussed. It is important to note that the use of renewable energy is related to the efficient use of energy, but that energy is also a factor of development – being expected consumption growth.

Over-specification means imposing technical standards for installations in homes that make prohibitive installation in the residential sector (becoming in some cases the installation more expensive than the value of the home), or in the case of being non-refundable, greatly limit the number of installation. Without diminishing energy security, too stringent standards should not be imposed for their intended context, allowing for the use - for example, "ready-boards", prepaid meters, or single conductors with return by land - solutions that reduce cost of connecting a particular customer.

4.2.5 Grid or Individual Systems

In the case of wind and hydro power, when not devoted to productive purposes, there must be a mini-grid.

In the case of solar and biomass energy, the decision to install a mini-grid in a settlement or install individual systems or individual service must depend on a cost / benefit analysis.

4.2.6 Direct or Alternating Current

The use of DC is advantageous for making the system cheaper, has less components which reduces the probability of defects and losses, so that the system can be better sized. The alternating current has the advantage of the higher availability of equipment using this type of current.

For individual systems and due to the advent of LED lamps with high efficiency and very long duration, the choice of DC is the best solution, as stated above when needs are only lighting and there is no mini-grid.

4.2.7 Productive activities

Hydropower

The range of capacity available in this case is usually sufficient to feed productive activities. Given that productive activities with higher loads usually take place during the day (some productive activities that happen at night are related to small businesses, usually only lighting) and the rest of the load is mainly for lighting, the financial feasibility of hydropower increases considerably, by having a distributed load throughout a longer period.

Wind Energy

Wind energy is also typically implemented in a capacity range that is sufficient to feed economic activities. However this energy is totally inadvisable in this case due to the unpredictability of the resource.

Solar Energy

For very large capacity, photovoltaic technology must be combined with other resources to avoid the high cost of energy storage. However, considering the sharp decline in the cost of photovoltaic panels and that economic activities usually take place during the day, reducing the need to accumulate energy, since the energy generated can be used immediately, the cost of this technology can be competitive. Thus, the batteries would be dimensioned so as to satisfy the nocturnal consumption, normally related to illumination. Water pumping for productive activities is an example where the photovoltaic conversion technology has obvious advantages, provided that the system, subject to available water storage properly sized, does not requires batteries.

Biomass Energy

The use of biomass can transform waste, contributing to the emergence of new economic activities.

Table 3 - Strategic Choices for Rural Electrification

	Hydro	Wind	Solar	Biomass
Resource	• Very specific and localized, requires specific measurements • Season variability • Characterization of the resource with some uncertainties due to lack of hydrological data	• Very specific and localized, requires specific measurements • Highly variable and unpredictable	• Uniform and well distributed throughout the country • Solar resource is well known and can be extrapolated without many mistakes	• Very specific, dependent on the local activities
Investment	• For mini-hydro costs can be high depending on the characteristics of each site	• Small wind farm are proportionally much more expensive	• High cost per kW, very dependent on the need for storage • The cost of the panels (not the battery) has been declining.	• Relatively low costs
Maintenance	• Easy maintenance requires	• Very difficult and very intensive.	• With almost no maintenanc	

	specialized personnel, capacity exists in Angola, although for more serious flaws is not available locally	Requires highly skilled personnel and components that are not available locally. • Greater risk of being long periods waiting for maintenance	e	• Depending on the technology used.
Over-sizing	• Difficult to adapt	• Difficult to adapt	• Very easy to adapt to the energy needs	
Grid connected	• Yes	• Yes	• Not necessarily	• Not necessarily
DC	• No	• No	• To be considered	• No
Productive activities	• Yes	• No. Solar is more competitive	• Yes, possibility of hybrid systems • Yes, water pumping	• Yes

5. ELEMENTS FOR THE IMPLEMENTATION IN THE GRID OF NEW RENEWABLE ENERGIES

In this chapter an analysis of the essential elements to take into account to promote the development of new renewable energies will be conducted at regulations, incentives and financing as well as the training and communication level.

5.1 Regulating the Access to the Activity, Land and the Electric Network

Attracting private investment for the new renewables will depends on the following factors of regulation:

- Existence of a regime for granting the concessions with rules and decision levels appropriate to the size/complexity of the projects and with time predictability and criteria to obtain it.
- Existence of a clear licensing procedure with a sole interlocutor from the State side that manages network access and requests for advice to other entities (already provided in Decree 47/01).
- Existence of an environmental licensing regime with clear procedures and predictability in the time spent in obtaining permits.

- Existence of a legal framework that allows access to land and expropriations or servitudes that reveal to be indispensable (already provided in Decree 47/01).
- Access to the national grid and energy dispatch guarantee, or of compensation, if it delivery is not possible for reasons beyond the promoter.
- Existence of a regulatory framework that provides for network access, trade relations between the parties, forecasts and information exchange management as well as of any deviations.

The Decree 47/01 of July 20 defines the purpose, allocation process, public utility regime, the duration and the goods and means relating to the concessions for producing electricity, not establishing specific arrangements for the renewable energies or local networks. It is ongoing in Angola the establishment of specific laws that govern concession and licensing of renewable energy production.

The creation of a regulatory platform adequate to the reality of the national market is recommended. This requires:

- To develop, implement, maintain and continually improve an efficient legislative system to promote the implementation of renewable energy projects.

- In terms of the regulation, develop or update Regulations and codes, namely the network code or network access regulation, the regulation of trade relations, among others.

The simplification of procedures associated with environmental licensing is also a key factor for the development of renewable energy projects. In this sense, current Angolan legislation of environmental impact assessment could integrate procedures that aimed to accelerate the environmental licensing procedure, without prejudice to the respect for the values of protection and nature conservation.

The integration of a simplified environmental impact assessment regime on the current legislative framework, as the figure of a Study of Environmental Issues, could be applied whenever a new renewable energy project was developed outside of natural protected areas, similarly to what already happens today in many European countries.

This procedure would bring innumerous advantages, from the point of view of both promoters, and environmental protection. From the point of view of the developer/investor, the reduction of the licensing time, as well as the possible reduction of the costs associated with environmental studies and consultancy are value-added and a factor of encouragement for the development of renewable energy projects.

Regarding the preservation of the environmental value, the fact that there is a positive discrimination by the use of areas outside the protected areas, will encourage developers/investors to use areas of lower environmental value and hence to significantly reduce the likelihood of significant environmental impacts.

Thus, the simplification of the Environmental Assessment procedure through a study of environmental incidents will not mean a reduction in requirements and/or rigor necessary for the environmental impact assessment process, but rather an assessment tool faster and more assertive aimed at protecting the environment and, simultaneously, creating mechanisms to encourage investment in renewable energies.

5.2 Financing and Incentive Mechanisms

Renewable energies are characterized by high initial investment costs and low variable costs of operation that implies recovering the investment over several years of operation. These projects, when grid-connected, are typically associated with very stable remuneration schemes that enable high levels of debt - allowing adequate compensation to investors without high costs for the electrical system. The lower the financing cost, the lower the price of energy demanded by the investors.

At the level of incentives and financing, the important factors for project implementation are:

- The selling price of energy, its evolution, duration and currency;
- The entity responsible for energy payment (the so-called "off taker"), guarantees given to these payments under the predicted horizon, as well as the risk of "convertibility" of such payments;
- The mechanisms for mitigation of risks, namely the existence of an adequate supply of insurances, among others;
- The capital structure, financing costs, and the presence or absence of public entities that enable concessional financing for projects;
- The tax treatment of renewables;
- The availability of international financing of support, bilateral and/or multilateral, which will accelerate the implementation;
- The use of international mechanisms for the reduction of Greenhouse Gases (GHG) ;
- Other incentives provided from government funds.

A large number of developed or developing countries use various mechanisms to stimulate the application of RE technologies. Some types of incentives:

Subsidies, Investment Credits and Tax Benefits

To reduce the high initial cost many countries extend investment subsidies, or provide financial products tailored to the needs of RE financing. Other countries have introduced tax benefits in the form of discounts on the tax burden for investors in RE. However, the popularity of these instruments is declining because they do not encourage production, but are still required for specific types of RE.

Incentives to Production ("Feed-In-Tariff" and "Power Purchase Agreements")

The electricity distributor is required by law to buy, at a certain minimum (c/kWh, higher than the existing rate) tariff (feed-in tariff), the electricity of each generator of renewable energy connected to the grid. Sources of funding to enable the distributor to buy at the grid producer tariff are: direct subsidies and/or cross-subsidies from the electricity consumer (through prices). These tariffs are diverse depending on the renewable energy technology.

The Power Purchase Agreements (PPA) are Energy Supply Contracts that may regulate the sale of energy based on feed-in tariffs pre-established by law, or make provision for specific tariffs and negotiated for each project. Law 256/11 establishes that the remuneration of production is adjusted to the different types of assets, providing for large scale projects the PPA with negotiated tariffs.

Set-aside or "Standard Renewable Portfolio"

A set-aside is an energy supply block that is marketed by law for renewable energy capacities. The potential producers of renewable energy compete to make available the renewable energy supply block. Winning projects receive financial support, for example subsidy per kWh or the guarantee of a fixed tariff for electricity. The choice can be made based on an auction of blocks in which it will assign outputs to be provided, starting from the lowest generation cost, and then if the offer is still not satisfied, it will successively assign those offering higher prices.

Concessions

The concession system assigns to a concessionaire an exclusive right to distribute and bill electricity in a given area. Sometimes the concession also includes electrical power generation. In this particular case, it would be a concession for generation through renewable energy (or imposing a minimum) and distribution. The concession is given to those who obey to all the necessary conditions and guarantee a minimum price for the supply of energy for a predetermined number of years. In the case that a uniform tariff is required (as the case is in Angola) and while it is not sufficiently high to have a viable business, the implementation of such models is more complex due to the need for subsidies and the difficulty to control the energy actually delivered. The Production and Distribution Concession Model, using mechanisms and focalization entities, may be the alternative.

GHG Reduction Credits and Similar

The GHG reduction credits in the form of "certified emission reductions" (CER) can be found on the official market or the so-called voluntary market. However without setting targets for post-Kyoto, the value of these credits has been declining.

The Tradable Renewable Energy Certificates (CCER) or carbon credits, which can be traded both nationally and internationally with users who want "green" attribute, also have the possibility to finance the production of renewable energy. A research of the "green" market indicates that there is, although still small, a growing demand from consumers (domestic and commercial) willing to pay a premium for the benefits of receiving "green" electricity. This "green" premium will therefore accelerate the commercialization of renewable energy technologies, thereby reducing the need for financial assistance from the Government, for which a Designated National Authority (DNA) of Angola was already constituted and will coordinate the issuance of the Certificates with the United Nations.

At the present stage of development of renewable energy in Angola, an incentive in the form of FiT, specific for each type of renewable energy, is the most advisable. For sizes smaller or equal to 10 MW, the mechanism (according to Law 256/11) would be the FiT and PPA with negotiated tariff for sizes larger

than 10 MW, with both specific and more favorable terms for the supply of renewable energy.

For rural electrification with renewable energies, the concessions system separating the production and distribution could have a significant role.

Legislation to be developed should give special attention to rules that do not allow the accumulation of benefits in order to obtain rates of return out of the ordinary. For example, it should not be possible to get the benefits of FiT while getting CCER. In this case, the CCER would have to be passed to the property of the Government, which could negotiate autonomously, or mixed regimes where it decreases the benefits obtained by the FiT or PPA in the proportion of other benefits.

5.3 Training and Communication

Training and Education

In order to Angola achieve the desired scale in the future in RE, technicians, nationwide, both basic, secondary and higher level, are needed, ensuring the project's design, installation, operation and maintenance.

Efforts should be initiated in the area of Education, under the National Program for Teacher Training, to inform and prepare future technicians in renewable energy, developing specific

training programs in Educational Institutions. It is also fundamental to promote Innovation and Research with the participation of the Angolan Universities.

Communication

The successful penetration and exploitation of renewable energy technologies in Angola depends fundamentally on the increasing demand in various energy sectors. However, current awareness about the existence of renewable energy and its economic, environmental and social benefits have been little known. There is the need to provide comprehensive independent and comparative information, relative to products and renewable energy services, to consumers.

The responsibility to prepare realistic information and training strategies to encourage the participation of the RE public – private sector in the energy market should be of the Administrative Bodies of the State that have under his department the electric energy.

The general population, and national, provincial and local authorities also need to be informed about the benefits and opportunities of the RE.

6. TARGET, GOALS AND MEASURES

6.1 Target for the New Renewable Energies

The government is strongly engaged with renewable energies and with the goal of keeping the renewable energies as a support of the electric system of Angola, in specific through a strong investment in the hydroelectric potential of the country. The Development Plan for the Energy and Water Sector for the period of 2013-2017 foresees the installation of 5,000 MW mainly of hydroelectric energy. This investment not only enhances the competitiveness of the system but also represents the commitment with future generations.

The main goal of the present strategy is to diversify the investment in renewable energies through a growing role of the new renewable energies, including small hydropower plants. It is expected that by 2025 energy consumption may reach 39 TWh meaning that it is necessary to go further than 9 GW of installed energy capacity to meet the hydrological variability and also to guarantee the safety of energy supply.

Upon the necessity of reinforcing the installed energy capacity by 2025 and the Government commitment with the introduction of the new renewable energies, the Government of Angola establishes to 2025 that the energy generated by new

renewables exceed 7.5% of the energy produced, about 3 TWh, being expected for that the installation of 800 MW.

6.2 The Strategic Goals for the New Renewable Energies

Three strategic goals are set forth for the new renewable energies in order to meet the main challenges identified:

1. **Improving the access to energy services in rural areas based on renewable sources:** The goal for off-grid situation is to ease the accomplishment of several activities that support the rural development and that relieve them from poverty, as well as to guarantee that communities living in non-electrified areas may access to safer and better quality energy sources.

2. **Develop the use of the new renewable technologies connected to the grid, enhancing the establishment of new markets and reduction of regional asymmetries:** The goal for grid-connected renewable energies is to develop the national renewable resources for generating electric energy, taking advantage of opportunities for replacing fossil fuels, avoiding investments in grids or enhancing new sectors that will generate wealth and employment.

3. **Promote and accelerate the private and public investment in the new renewable energies:** The goal is to generate effective conditions of investment in the new renewable energies that mitigate the distortion introduced by the subsidies to the fossil fuels, offering a suitable payback to the investment, an appropriate mitigation of risks and a regulation, procedures and communication that ease the implementation and commit investors.

Table 4 – Specific Goals of RE Strategy by 2025

Strategic Goals	Action field	Specific Goals
Improve the access to energy services in the rural areas based on renewable sources	**Public and community services**	• Establishment of the National Institute for Rural Electrification (INEL) • "Solar or renewable villages" in 500 sites, with more than 10 MW of solar energy and 50 systems based on micro or pico-hydro
	Domestic use	• Private domestic market of 1 MW/year in individual solar systems • Distribution of 100,000 improved ovens and 500,000 solar flashlights in the most remote rural areas with few buying power
	Productive uses of energy and entrepreneurship	• 200 agricultural communities with renewable solutions for productive purposes • 200 new companies focused on the new renewables in rural areas
Develop the technology of use and conversion of the sources of renewable energies	**Solar energy**	• Implementation of 100 MW of solar energy plants, of which 10 MW are off-grid • Building 1 factory for photovoltaic panels production
	Hydropower (<= 10 MW)	• Implementation of 100 MW of mini-hydro, including at least 60 MW for electrification of municipalities' headquarters integrated in the isolated grids

connected to the grid	**Biomass energy**	• Implementation of 450 MW of forest and agro-industrial biomass projects • Implementation of 50 MW with urban waste
	Wind energy	• Implementation of 100 MW distributed by 2 to 3 wind farms across the territory
	Other sources and Investigation & Development	• Establishment of a Research Center for Renewable Energy
Promote and accelerate the private and public investment in the new renewable energies	**Regulation**	• To approve specific legislation for renewable energies, including rules for grid connection
	Incentives and financing	• To approve subsidized tariffs (FiT) for renewables up to 10 MW and to review taxation • To provide 1,000 million of Kz per year to FUNEL and establishment of micro, mini and small scale credit mechanisms
	Capacity building and communication	• Establishment of at least one Training Center dedicated to renewable energies • Launch a communication campaign on renewable energies

6.3 Strategic Goal: Improve the Access to Energy Services in Rural Areas based on Renewable Energies

6.3.1 Framework and Specific Goals

Energy is a development factor not only in urban areas but also in rural areas. Rural areas are defined by a low population density, high dispersion of population and low energy consumption. The rural areas far from the grid may be divided in two areas: rural areas of influence – commune headquarters and others – and dispersed rural areas (chapter 4.1).

In the rural areas of influence, it is possible to guarantee the supply of electric energy through small local grids or systems of renewable energies, mainly solar and pico/micro hydro plants, associated with public or commune infra-structures. It is possible to foresee solutions of incentive to the installation of "Individual Solar Systems" (thermal or photovoltaic) or to the establishment of energy stores through private initiative. The incentives to private initiative and the financing solutions are fundamental as the investments to be made are heavy and, most times, not much attractive in comparison with the alternative of diesel or gasoline generator with a subsidized price that represents a cost for the country.

In disperse rural areas the systems or single solutions based on solar energy are the most suitable solution for providing basic services of energy. The use of wood or charcoal will remain as the most used solution for cooking, giving priority to the spread of efficient or improved ovens. The higher dispersion and lower economic capacity may justify a higher level of subsidy associated with simpler energy services and of lower investment. The productive use of renewable energies in agricultural communities regarding water pumping, drying and milling may be defined as an area of high priority in these areas.

An integrated management of several interventions regarding rural electrification is important to optimize the allocation of resources and guarantee the quality, coherence and regional balance of on-going initiatives. Quality is one of the important issues because often the low purchasing power compels consumers to opt for solutions of low quality and with reduced duration, which will result in increased spending and a throwback to traditional solutions.

The specific goals, by 2025, in the area of energy services for off-grid rural areas are:

a) Establishment of the National Institute for Rural Electrification;

b) Broadening the program of "solar village" to every commune headquarters and populations with more than

2,000 inhabitants that are not connected to the national grid by 2025, with the target of connecting at least 500 sites, implementing more than 10 MW of solar photovoltaic energy and installing 50 systems based on pico and micro-hydro;

c) Promote the private domestic market of at least 1 MW per year of individual solar systems produced in Angola;

d) Distribute at least 100,000 improved stoves and 500,000 solar flashlights, to the most remote populations and with low purchasing power, and create distribution and training teams within the scope of the National Institute for Rural Electrification;

e) Implement in more than 200 agricultural communities, systems for productive uses (irrigation, drying and milling) based on renewable energies;

f) Promote the establishment of at least 200 new companies or businesses dedicated to manufacturing, maintenance and distribution or commercialization of renewable energetic solutions for rural areas.

To reach the above mentioned goals the following measures were identified. This measures should be aligned with the economic development programs defined by the Government.

6.3.2 Measures within the Scope of the Communitarian and Public services

- Establishment of the National Institute for the Rural Electrification (NIRE) which will be responsible for managing the National Fund for Electricity and, in the most rural areas, for managing every initiatives of the Ministry of Energy and Water, guaranteeing the engagement with Provincial Governments and drive the allocation of concessions for distribution or production/distribution to private parties for extending the grid or for the establishment of new local grids.

- Establishing parameters to define when the energy services will beneficiate from a local grid, individual system or service, as well as communitarian or public energy services which may be available in each type of site. Based on those parameters a new map of the national territory will be developed that identifies the proposed areas for electrification by grid extension, by means of isolated systems, local grids or individual services by 2025, as well as the level of "energy" services on a public and communitarian level in each site.

- Launch public tenders, in articulation with the Provincial Governments, for the installation of local grids (known as "solar or renewable villages") based on systems of solar photovoltaic energy in the rural commune headquarters and populations with more than 2,000 inhabitants, with no access to the grid until 2025, benefiting social infra-structures, namely: public illumination, water pumping, health centers, schools, administrative buildings, police stations and communitarian centers.

- Promote the development of communitarian local grids also based on pico and micro-hydro ("renewable villages"), through mapping, identification and research on

sites with potential on the territory, and through the launch of tenders for its deployment.

- Over-sizing "solar or renewable villages" in order to establish a concession of energy services in each site conceded to the private sector that carries out individual services to communities and that guarantees a maintenance of both communitarian and local individual systems.

- In addition to "solar or renewable villages", promote the installation of solar thermal systems in community buildings and, in more dispersed and less populous areas, to promote the installation of streetlights from photovoltaic systems.

6.3.3 Measures within the Scope of Domestic Use

- Promote the installation of photovoltaic systems of illumination on houses located in off-grid areas and where there are no more economically favorable alternative through, among others:

    - Programs and campaigns of divulgation and training;
    - Credit lines with low-interest (subsidized) to be established through banks;
    - Tax benefits to equipment manufactured in national territory and to commercial solutions of renting or payment per use.

- Ease the access to solar photovoltaic energy systems, in particular in disperse areas, with low consumption and low purchasing power, through a program of incentives to the

establishment of distribution and retail networks of these equipment.

- Establishment of a system for certifying equipment traded in the area of renewable energies for rural electrification in order to guarantee the regularly specified quality standards.

- Promote the construction of small bio digesters for individual use, in the agricultural areas, through an incentive and training program to be developed in coordination with the Ministry of Agriculture.

- Promote, in articulation with the Provincial Governments, the distribution of efficient or improved stoves and solar flashlights, manufactured in Angola and also the training for final users.

6.3.4 Measures in the Area of Productive Activities and Stimulus to Entrepreneurial Initiative

- Promote close to agricultural communities, in articulation with the Ministry of Agriculture, a program of incentive to the productive use of renewable energies for agriculture, including the incentive to installation of:

    - Systems of water pumping for agricultural and cattle raising use;
    - Bio digesters, with the ultimate purpose to produce electric energy;
    - Electric mill systems based on renewable energies;
    - Solar systems for drying food.

- Launch a program of training, accreditation and distribution of raw materials for the manufacturing by local artisans of low cost solar dryers for food.

- Support and ease the establishment of small private local grids based on renewable energies, energy stores and companies of installation and technical assistance in the area of the new renewable energies, through a program of training, incentives and a simplified licensing regime.

- Enhance the establishment of factories for equipment oriented to the off-grid rural electrification associated with "solar or renewable villages", with the individual solar systems, with the improved stoves and solar flashlights, as well as with the productive uses in order to to provide knowledge, employment and decrease the cost of these solutions.

6.4 Strategic Goal: Develop the Use of New Renewable Technologies Connected to the Grid, Enhancing the Establishment of New Markets and Reduction of the Regional Asymmetries

6.4.1 Framework and Specific Goals

It is important to develop with logical reasoning the grid connection of each of the priority new renewable energies: solar energy, small hydropower plants up to 10 MW, biomass energy and wind energy.

Regarding solar energy, there were identified several opportunities for connecting to the grid, in particular in the South System and Eastern System that is important to carry out together with the establishment of at least one modern factory that enhances a real market of solar solutions also for the rural areas. The thermal solar, despite not producing electricity, may decrease its consumption, with particular interest in the sites where the production of electric energy is based on diesel.

Regarding hydropower, it is fundamental to implement the projects assigned, prepare the launch of tenders for the remaining identified potential and carry out a detailed mapping in order to identify additional opportunities, for the electrification of isolated urban areas and also for the small hydroelectric projects for connecting to the grid.

Regarding biomass energy, it is important to implement the opportunities identified with potential for enhancing agricultural and forestry initiatives, in particular in the North, Center and East. The cogeneration or the energy use of waste from agricultural and/or livestock activities may help enhancing new entrepreneurial realities in the agro-livestock that is important to support through the acquisition of exceeding energy, always that its prices are suitable. Finally, it is important to establish incentives, in cooperation with the Ministry of the Environment, for the construction of 1 or 2 incineration units based on waste

fuels (up to 50 MW) and in order to the landfills be prepared for using the gas that will generate to produce energy.

Regarding wind energy, the confirmed resources in Tombwa together with the heavy investments required in terms of the grid suggest a phased project – meaning that it is possible to reach the target of 100 MW by 2025 with a first phase of 20 MW in Tombwa and several other projects across the territory. It is also important to take advantage of the first 100 MW to obtain knowledge, train people with the needed skills to maintain the equipment and create competencies in the area of renewable energies, promoting the link to the universities and the launch of training offers in this area.

Regarding other sources of energy and investigation and development, it is important to follow technological evolution, trying to understand its consequences and application in the Angolan context.

The specific goals for grid connection of renewable energy technologies by 2025 are:

a) Regarding solar generation, to reach 100 MW of installed capacity, including 10 MW off-grid, establishing a factory unit of solar photovoltaic panels and the associated cluster.

b) Regarding generation based on small hydropower plants, to reach 100 MW with at least 60 MW oriented to the electrification of municipalities headquarters based on isolated systems.

c) Regarding generation based on biomass, to reach 500 MW of installed capacity, supporting the establishment and development of new livestock and agriculture ranks, with a particular interest for sugarcane, of new forestry businesses in the eastern and center of the country, and of the establishment of incineration units of waste fuels.

d) Regarding wind power, to reach 100 MW of installed capacity, with a specific focus on a broader regional diversity and a taking better advantage of the current infra-structures.

e) Regarding other sources of renewable energies and research and development, to establish a center of research and development for the new renewable energies in Angola.

To implement the above mentioned goals the following measures were identified:

6.4.2 Measures in the Area of Solar Energy

- Launch tender to concede licenses for the construction of photovoltaic power plants connected to the grid, under the regime of Independent Power Producer, with a total capacity of 100 MW - 10 MW per year over 10 years - associated with the installation of a modern factory unit

and of distribution networks and trade of individual systems at competitive prices for rural areas.

- Study and dimensioning of solar systems to replace diesel fuel in thermal power plants of isolated system to be included in the tender to be launched.

- Promote the establishment of a market for solar photovoltaic and solar thermal energy disseminating information to the general public by means of great impact, such as on television and radio. Moreover, technical, commercial, economic and legal information should be disseminated for the private sector through official websites.

- Launch a pioneer program to encourage the use of solar collectors for heating water in the interior Provinces headquarters supplied with electricity generated from diesel, in order to launching a national program.

6.4.3 Measures in the Area of Small Hydropower Plants

- Promote the study of projects and launch tenders for the construction of at least 60 MW of projects for competitive small hydroelectric power plants oriented for the electrification of municipalities' headquarters away from the network.

- Establish a system of concession of production/distribution and remuneration of isolated systems based on small hydropower plants that limit the risks and create the

appropriate incentives to the optimization of projects, namely through power purchase agreement of the type that "receive or pay" and independent remuneration by type of asset. A system of certification/inspection of the energy produced and distributed to safeguard any subsidies to be awarded will be created.

- Conduct a thorough mapping of the hydroelectric potential and national projects to boost the private sector or promote new tenders.

- Promote the allocation of concessions and construction of small hydroelectric power projects connected to the grid at competitive costs.

6.4.4 Measures in the Area of Biomass Energy

- Promote and encourage the interconnection to the National Grid and sale of energy surplus from units of electricity co-generation, from sugarcane bagasse and agro-livestock waste, providing for the installation of at least 110 MW by 2025.

- Promote the implementation of hydro-thermal phased projects in the central region and associated with the establishment of a forestry industry in the region, providing for the installation of 300 MW of biomass power plants and equivalent additional capacity of medium and large-size hydro by 2025 (power capacity greater than 10 MW).

- Promote the construction of at least 2 forestry biomass power plants close to large cities in the east of the country with a total power capacity of 40 MW, associated to the development of the forestry industry.

- Promote, in close cooperation with the Ministry of Environment, the construction of 1 or 2 incineration units based on waste fuels in the main urban centers of the country, totaling 50 MW, and the establishment of incentives for preparing landfills to collect and value biogas energy.

6.4.5 Measures in the Area of Wind Energy

- Promote the construction of the Tombwa Wind Farm with an initial capacity of 20 MW and a 60kV connection to Namibe, taking advantage of existing and planned grid infrastructures to meet the consumption needs of the Southern System.

- Complete the wind resource measurements at the 12 identified sites with potential for the construction of wind farms.

- Promote the construction and operation of new wind farms across the territory with a total power capacity of 80 MW by 2025, giving preference to the link with universities and the launch of training courses in the area of renewable energies.

- Ease the establishment of wind turbine maintenance systems and their respective spare equipment, to feed the domestic market.

6.4.6 Measures in the Area of the Remaining Sources of Energy and Research and Development

- Promote the establishment of a Research Centre for Renewable Energies in close cooperation with the Ministry of Science and Technology.

- Promote the establishment of protocols with national leading universities for research and development in the area of renewable energies, as well as for equipment certification.

6.5 Strategic Goal: Promote and Accelerate Public and Private Investments in New Renewable Energies

6.5.1 Framework and Specific Goals

In order to accelerate the investment in new renewable energies it is important to set clear rules in terms of regulation, incentives and favorable tax regimes for investment and also develop human skills regarding qualification and information.

Regarding regulation, it is important to establish appropriate procedures to private initiatives in the allocation of concessions, clear rules and deadlines defined in the access to the grid and in the licensing of projects, as well as clear and simple rules to entities acting at the level of rural electrification.

Regarding financing and incentive mechanisms, the establishment of subsidized tariffs for new renewable energies connected to the grid ("Feed in tariffs") are an important component, therefore the establishment of tariffs should take into consideration the applicable tax system, the type of financing and respective interest rates and maturities, and the CDM - variables that must be optimized to the RE. In addition to the tariff, the developers should obtain a payment guarantee from the Ministry of Finance.

The National Electricity Fund (FUNEL) plays an important role in this strategy, particularly in supporting rural areas and in raising/channeling concessional financing and assistance. FUNEL, through INEL, will also keep cooperation with the Sovereign Fund that may be a minor shareholder of the projects to be developed.

Regarding skills training and communication, it is important to promote conditions for staff and skills training and increasing knowledge regarding the potential and benefits of renewable energies, particularly in rural areas.

The specific goals to promote investment in renewable energies by 2025 are:

a) Approve specific laws for new renewable energies.

b) Approve pre-defined subsidized tariffs (FiT) for renewable projects to be grid-connected of up to 10 MW and review the tax system.

c) Allocate an amount of at least 1,000 million Kz per year to the National Electricity Fund (FUNEL) by 2025 to support rural electrification programs based on renewable energies and to the establishment of subsidized credit lines for the purchase of individual systems or launch of productive activities.

d) Ensure the establishment of at least one training center for renewable energies.

e) Launch a media campaign about renewable energies and its advantages, particularly as a means of bringing basic energy services to rural areas and boost solar thermal.

In order to implement the above mentioned goals the following measures have been identified:

6.5.2 Measures in the Area of Regulation

- Approve and publish specific legislation for attribution of concessions and licensing of RE projects, including procedures for the private sector, the allocation of power

blocks - regardless of locations - for promotion of tenders with industrial counterparts, and a simplified and integrated regime for the attribution of joint concession for production and use of water resources for small hydropower plants of up to 10 MW.

- Define, in the laws to be approved relative to RE, the principles and rules for grid connection and supply from the new renewable energies. Given its specificity, among other aspects, the rules should establish the principle of "receive or pay" and provide total priority in the hierarchy of dispatch to energy generated by RE.

- Review of the environmental impact assessment legislation in order to establish a simplified procedure based on Environmental Incident Studies whenever renewable energy projects are developed outside protected natural areas and exemption of license and environmental impact assessment in the case of solar PV projects and mini-hydro of up to 10 MW.

- Adopt specific laws and regulations for the exercise of off-grid generation activity, considering the particularities of the technologies associated with the new renewable energies, as well as for the licensing of off-grid operators, either for generation and trade, or for the provision of energy and/or maintenance services, ensuring that technical standards are

met, that the service quality is also met, that the licensing and monitoring of the activities are simple and eased, and that the activity is profitable, in terms of the licenses provided.

6.5.3 Measures in the Area of Financing and Incentive Mechanisms

- Establish and promulgate subsidized tariffs for the supply of electrical energy to the grid based on new renewables of up to 10 MW. Accommodate, whenever possible, the regime of decreasing tariffs to ensure the sustainability and competitiveness of renewable energies in the future. For more than 10 MW, provide for a negotiated tariff regime based on Power Purchase Agreement ("PPA").

- Establish specific calculation rules or standards for specific situations in case of concessions for the supply of electricity in isolated systems based on renewable energies. For local grids prioritize subsidy investment and initial installation through pre-determined amounts per client connected and installed kW.

- Establish the concession of sovereign guarantees during the initial 15 years of operation for all new renewable energy projects over 1 MW and ensure, through the Ministry

of Finance, concessional financing for investments in approved renewable energy projects, which management and retrocession of their responsibilities will be guaranteed by the National Energy Fund.

- Review fiscal policy applicable to new renewable energies, namely at the consumption tax level applicable to investments in renewable energies, to the purchase of individual solutions and systems and to power purchase in local grids, as well as at the level of the exemptions to be applied to the custom levels and industrial tax in the early years.

- Establish appropriations, rules and management of the National Energy Fund (FUNEL) by the National Institute for Rural Electrification. The Fund should make provision for, among others:

    - Obtaining and channeling concessional financing, guaranteed by the Angolan State, in favor of new renewable energy projects connected to the grid, assuming the retrocession of their responsibilities and channeling capital gains to financing rural electrification.
    - A suitable engagement with the Angolan Sovereign Fund, which will seek to take minority share in large

projects (greater than 10 MW) to support its financing and feasibility.

- The subsidy for the installation of "solar or renewable villages".
- The support, through pre-established subsidies per customer and installed kW, to an initial investment in local networks, allocated by a tendering procedure.
- Support the distribution of improved stoves and solar flashlights, manufactured in Angola, or "renewable vouchers" for rural and dispersed areas in Angola.
- The promotion, along with local banks, of credit lines to purchase individual solar systems and to support entrepreneurship and the creation of businesses for distribution of solutions and energy stores.
- International cooperation in order to maximize the raising of non-refundable financing for rural electrification projects in Angola.
- The realization of the CDM procedures reverting its benefits for the financing of rural electrification.

6.5.4 Measures in the Area of Capacity Building and Communication

- Promote, in conjunction with the Ministry of Education and the university system, the creation of RE training centers that contribute to the technical development of the country in the RE.

- Promote and disseminate this strategy of RE development together with the financing institutions, at various levels in the country (through lectures, seminars and workshops) and internationally in active countries in renewable energy matters.

- Promote and stimulate the RE market, through the diffusion of information related to the economic, environmental, social and commercial benefits of renewable energy technologies and its applications, in particular in rural areas. Launch the communication campaign and spread the knowledge of the technologies use and conversion of renewable resources, in particular through:

    - Regular information and education programs in communities and schools.
    - Bilingual brochures (in official and local languages) with the divulgation of RE.
    - Information about RE on the website of the Ministry of Energy and Water.

- Promote the communication and interaction between national, provincial and local governmental institutions in the RE policies. Empowering provincial institutions to

serve as a link between communities and the central strategy and ensure that both are continuously aligned.

7. INSTITUTIONAL AND TRANVERSAL ASPECTS

7.1 Institutional Aspects

The use of renewable energy sources is still on an initial phase in Angola. Unlike other energy sectors, as large hydropower or oil, renewable energies require institutional arrangements in order to strengthen themselves.

The Energy Security Policy and Strategy (Law 256/11) provides for a restructuration of the electricity subsector in particular in the production, transport and distribution with the possible introduction of the public-private participation model and assuming in the future the emergence of one or more distributors.

The Regulator Institute of Electricity Sector (IRSE) shall, after review of the General Electricity Law, have jurisdiction over the entire industry and market access regulation through attribution of licenses to producers, distributors and traders of electricity.

All electricity tariffs should be adopted with the participation of the IRSE, and also should regulate the quality of supply and mediate disputes and customer complaints. A regulatory

framework is being prepared to govern the implementation of the renewable energy development plan.

The Ministry of Energy and Water (MINEA) will assume the overall responsibility for the coordination of an energy policy in Angola, working in close coordination with key Ministerial departments and institutions.

7.1.1 Government

MINEA shall work with the remaining government agencies in establishing an appropriate environment to ensure that activities carried out by other partners are coordinated, uniform and effective. Moreover, this body shall facilitate the implementation of this policy in cooperation with other key ministerial departments including those related to the environment, tourism, national treasury, commerce, industry, arts, science and technology, housing, education, higher education, provincial and local governments, forest, agriculture and transport.

Ministry of Energy and Water

This Ministry established the National Directorate of Renewable Energy, which will have responsibility for the design, promotion, evaluation, implementation and monitoring of policies for renewable energy connected to the grid to be developed by this executive body.

Through this strategy the National Institute for Rural Electrification is created, which will be in charge of the design, promotion, evaluation, implementation and monitoring of all policies relating to rural electrification, whether through renewable energy systems, whether through extension of the network. This institute will also be responsible for managing the National Electricity Fund and the raising of international co-financing to enable the maximization of the management and the impact of available funding

Moreover MINEA will undertake the following functions within its jurisdiction and financial constraints related to renewable energy policies and policy implementation:

- Policy development, strategic, action plans, legislation, regulation and control;
- Coordination;
- Dissemination of information;
- Monitoring, audit and review;
- Monitoring the development of research funded by the public sector;
- Promotion of capacity training and responsibility.

Regulator Institute of Electricity Sector (IRSE)

Created by Decree No. 4/2002, of March 12, the Regulator Institute of Electricity Sector (IRSE) is the entity responsible for regulating the electricity sector.

In its regulatory role, IRSE shall establish the rules of the public electricity system operation and the relationship between this and the electricity system not bound, which will take place through the Tariff Regulation, Regulation of Access to Networks and Interconnections, Regulation of Service Quality, Regulation of Commercial Relations, Regulation of Dispatch.

The main purposes of the regulation are:

- Ensuring supply.
- Protect consumers.
- Favor the economic-financial equilibrium of the Public Electricity System companies.
- Enhance competition.
- Ensure non-discriminatory commercial terms.

All public electricity companies are subject to regulation by the IRSE. In addition, IRSE advises MINEA on all matters relating to the electricity supply industry.

IRSE shall carry out the following functions related to the implementation of renewable energies:

- Implement regulations requiring electricity distributors to purchase power (output) according to the national renewable energy policy.
- Produce regulations forcing the managing entity of the national transmission grid to ensure non-discriminatory access to electricity networks to promote the participation of small producers and consumers in electricity production.
- License or register renewable energy producers.
- Regulate access to the electricity market through licenses to all producers (greater than 5 MWh/year), distributors and electricity traders.
- Regulate prices at which energy is purchased from producers, both state and independent producers.
- Approve electricity tariffs for renewable energies.
- Regulate supply quality and mediate disputes and consumer complaints.

Provincial Governments

Provincial Governments already have in their structure Provincial Directorate of Energy and Water that accompanies and streamline the investment projects of the sector in their respective areas of intervention. It's important to promote the articulation of the new National Institute for Rural Electrification with Provincial Governments, aiming for supporting rural

electrification. It's also important to ensure proper coordination between the Ministry of Energy and Water and Provincial Governments in licensing and feasibility of grid connected projects that may be selected as priority.

National Institute for Rural Electrification and National Electricity Fund (FUNEL)

The National Electricity Fund (FUNEL) is a legal entity under public law with legal personality, with administrative, financial and patrimonial autonomy, created under the provisions in the General Electricity Law in paragraph 1 of Art. 4 of Law No. 14-A / 96 of 31 May. The National Electricity Fund will be managed by the National Institute for Rural Electrification (INEL).

The National Electricity Fund whose purpose is the management of financial resources for the implementation of measures and actions supporting and encouraging the progressive electrification of the entire national territory and the permanent supply of electricity, to suit the needs of consumers and the national development.

Angolan Sovereign Fund

The Angolan Sovereign Fund was created in 2011. This fund may partially invest in the capital of the new RE projects to be launched, facilitating their financing.

7.1.2 Partnerships

According to the Presidential Decree on National Energy Security Policy and Strategy, the model of public and private participation should be implemented whenever possible.

The financial sector institutions will also have an important role in involving the private sector, being important to develop partnerships with these institutions in articulation with the National Electricity Fund (FUNEL).

7.2 Transversal Aspects

7.2.1 Impact on Health

The lack of infrastructure and adequate living conditions in many regions of Angola means that millions of people are subject to the use of fuels that emit several harmful gases to health and that can be deadly. National statistics show that acute respiratory infections associated with exposure to smoke is the second leading cause of infant mortality in children under 5 years.

The medium-term priorities of the Energy Policy should include the mitigation of negative effects, both environmental and health, of air pollution by the use of coal and wood fuel in

residential environments. Create an Action Plan for biomass that should propose specific actions to deal with these aspects.

7.2.2 Energy and Gender

In rural areas are generally women who make use of energy. Despite the wider use be for activities related to heating and cooking, being energy a factor of development, we believe that with the massification of these technologies, women's tasks will be facilitated.

Sustainable energy development can have a positive impact on women and therefore to society. To this end, it should be considered the following:

- Involvement of women in policy formulation and planning for renewable energies.
- Availability of more information related to alternative energy sources and technology.
- Assistance to women for developing skills through the use of renewable energy technologies.

7.2.3 Job Creation

One of the fundamental requirements that renewable energy projects should have for receiving assistance from the Executive is the creation of new jobs.

Job creation in the renewable energy industry is linked both to the manufacturing of such technologies as the operation and maintenance. This can be ascertained in countries where renewables have been promoted.

In such cases it can be observed that when the technology is locally-developed the number of jobs for unit of energy is much higher than compared to conventional energy technologies.

However, for local production to become viable, there must be an economy of scale with significant demand.

To empower the workforce, the entity responsible for the training of the electricity sector should be mandated to ensure, with the support of the renewable energy industry, that appropriate and nationally recognized training sessions in renewable energies should be developed and recorded.

This will ensure the expertise required to draft blueprints, installation, operation and maintenance of technologies and renewable energy equipment, offering simultaneously new careers.

8. FROM STRATEGY TO ACTION

The strategy defines the principles, targets and key measures, as well as the role of various institutional partners. It should also establish mechanisms for implementation and monitoring of the strategy which is now being approved.

The Ministry of Energy and Water will promote, through its National Directorates, the National Institute for Rural Electrification to be created and through tutored companies, the implementation of this strategy, which will be reflected in the Activity Plans and annual budgets as well as in the future Action Plans to be approved.

It will be constituted an inter-ministerial Commission for monitoring the Strategy for new renewable energies to be chaired by the Ministry of Energy and Water and will include the Ministry of Environment, the Ministry of Agriculture, the Ministry of Education, Science and Technology, and the Ministry of Planning and Territorial Development as well as representatives of the Provincial Governments. This Commission will meet annually.

It will be conducted and published a monitoring report of this strategy every 3 years that will be presented to the Commission

on a national seminar to be held at the same periodicity. This seminar will provide a space for reflection on the results of the strategy and new measures to be implemented.

We hereby present a budgetary impact estimate of the proposed strategy in the overall period 2015-2025 and the yearly average, expressed in USD millions:

Measures and objectives	Period 2015-2025	Avg. anual cost
Objective 1. Improve access in rural areas	**404,6**	**36,8**
Serviços comunitários e públicos	336,3	30,6
Utilização doméstica	51,6	4,7
Usos produtivos e iniciativa empresarial	16,7	1,5
Objective 2. Develop grid connected and renewable Energy	**718,4**	**156,2**
Energia Solar	59,9	5,4
Energia hídrica (<= 10 MW)	51,9	4,7
Energia da biomassa	446,5	131,5
Energia Eólica	245,7	22,3
Outras fontes e Investigação & Desenvolvimento	18,2	1,7
Objective 3. Promote and accelerate investment	**126,0**	**11,5**
Regulamentação	3,0	0,3
Incentivos e financiamento	110,0	10,0
Capacitação e comunicação	13,0	1,2
		-
TOTAL	**248,9**	**204,4**

ANNEX I - GLOSSARY OF TERMS AND DEFINITIONS

Anthropogenic: Caused by human activity.

Biomass: Non-fossil material, biodegradable derived from organic material naturally occurring or on cultivated plants, animals and micro-organisms, including products from agriculture (including vegetal and animal substances), forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste.

Specific forms of biomass:

Wood fuel is the largest source of biomass, usually derived from trees. However, wood fuel can be used in a non-sustainable manner, when there is no replacement of trees, whereby the wood fuel obtained in this manner cannot be considered as renewable. Other types of biomass are plants, forest and agricultural waste and organic components in municipal and industrial waste.

Coal (vegetable) is a fuel obtained by partial carbonization of wood. Usually is not produced in a sustainable manner.

Biogas is a fuel gas from biomass and / or from the biodegradable fraction of solid or liquid waste, or excreta from animals, obtained by anaerobic fermentation processes.

Syngas, synthetic gas or wood gas is a gas obtained by other processes than fermentation, such as carbonization.

Biofuels in liquid form can be produced from the conversion of biomass and used for example for transportation, and can also be used to replace the wood or charcoal for cooking. The two most common types of biofuels are ethanol and biodiesel.

Ethanol is obtained by fermenting any biomass that is rich in carbohydrates such as corn, cassava and sugar cane.

Biodiesel is produced from vegetable oils, animal fat and micro-algae by an extraction process which is normally

Renewable Energies: sun, wind, biomass, water (hydro), waves, ocean currents, tides, ocean thermal gradient, geothermal and other natural phenomena that are cyclical and regenerative.

Solar Energy can be used for generating electricity or heating. Depending on the end use, solar energy is called:

- Solar Photovoltaic Energy, when electricity production is from solar radiation absorbed in solar panels, through the photovoltaic effect.
- Solar thermal energy from high temperature, which is based on heating a fluid from the concentration of radiation through collecting concentrators provided with complex systems of focal radiation reflection. There are currently three geometries concentrators to obtain energy from high temperature: parabolic trough collectors, tower type collectors and Fresnel type collectors. The fluid high temperature allows to generate steam and move a turbine coupled to a generator.
- Solar thermal energy from low temperature, resulting from the thermal conversion through collectors that capture sunlight, turning it into heat and transmitting it to the water. It is to be used in houses and buildings, either for domestic hot water, heating swimming pools or air conditioning systems. Solar thermal energy from low temperature systems can be distinguished by two types of technologies: thermo syphon systems and forced circulation systems.
- Passive solar thermal energy refers to the utilization of solar energy through the sunlight for heating buildings through constructive ideas and strategies. A passive solar system for heating or cooling can be defined as one in which the exchange of thermal energy is made by natural means.

Wind Energy: Energy derived from wind, used to produce mechanical energy or to produce electricity when coupled to generators, in this case called "wind turbine" or aero generators. When several turbines are placed in a limited area, are referred to as "wind farm".

Geothermal Energy: Energy obtained from the heat derived from the Earth's interior.

Hydro Energy: Energy obtained from the movement of water under gravity to produce mechanical or electrical energy.

There is a great international variation in the sub categorization of hydro. In this strategy the definitions for small hydropower (SHP) will be the following:

- **Pico**-hydro: up to and including 10 kW.
- **Micro**-hydro: greater than 10 kW to and including 500 kW.
- **Mini**-hydro: greater than 500 kW to and including 10 MW.

Ocean Energy: Energy generated from waves, the difference in tide level or from the vertical temperature gradient of the oceans.

Wave Energy

Takes advantage on strong ripple that occurs at specific sites of the coast. There are many systems under development but none has reached commercial production.

Tidal Energy

In order to obtain energy from tidal it is necessary that they be strong with an increase in the water level of at least 5.5 meters from low to high tide. There are few places in the world where there is such a difference in tides. The operation of the turbines in this case is similar to a hydroelectric power station.

Oceans Temperature Difference

The vertical temperature difference of the oceans may be used when there is a difference of about 3° C between the surface and the ocean bottom. This source of energy is being used in Japan and Hawaii, but only as a demonstration and experience.

Externalities: Impacts on the environment, health, quality of life, etc., with no costs included in the market prices of manufactured products and services. In practice it is difficult to

measure the prices/costs and often the impacts are not all included.

Photovoltaic: the photovoltaic effect refers to photons that excite the electrons in a material by inducing them to a higher energy level, thus enhancing the establishment of an electrical current. The **photovoltaic energy** (PV) is a method of generating electric energy by converting solar radiation into electricity (direct current) using semiconductor materials that exhibit photovoltaic effect.

Greenhouse Gases (GHG): Gases that absorb part of the infrared radiation, emitted mainly by land surface, and hinder their escape into space. This impedes the loss of heat into space, while maintaining the heated earth. The main greenhouse gases are Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O).

GWh (Gigawatt hour): A unit of energy used to measure the consumption of electricity (1 GWh = 3,600 GJ (Gigajoule) (Joule, energy unit).

Levelised Costs of Electricity (LCOE): It is the total discounted costs over the life of the project divided by generation during the life of the project, also discounted.

Clean Development Mechanism (CDM): The CDM was developed from a Brazilian proposal which envisaged the creation of a Clean Development Fund. The CDM allows countries present in Annex I (industrialized, large emitters of GHG) to finance reduction projects or buy the GHG emissions reduction volumes resulting from initiatives developed in non-industrialized countries (not present in Annex I).

Mtpe (Million Tons of Oil Equivalent): Universal unit of comparison by which energy can to measured. (1 Tpe = 42 GJ = 0.042 TJ = 0.0116 GWh).

New Renewable Energies (NRE): All sources of renewable energies, excluding hydro, with a capacity greater than 10 MW.

Independent Power Producers (IPP): Legal entity or consortium of companies holding concession, permission or authorization to produce energy for trade of all or part of the energy produced by their own risk.

Electrical network/grid: A generic term used to define an electrical system consisting of transmission lines, buses, transformers, etc.

On-grid and off-grid

In Angola due to the national system not being interconnected, it is used the notion of on-grid or off-grid, whose size does not match what in this strategy is considered isolated grid. To enhance clarity, this strategy considers the term local network. The following concepts are used.

Network/grid: The current national system of networks, consisting in the three major networks and other networks called isolated.

Local Network/Mini-Grid: A local small local network isolated of any of the above-defined networks, of electricity distribution in low voltage (although there may be a line of medium voltage between the point of generation and load, which supplies electricity to one or more communities or a small village. It's usually fueled by a diesel generator, a PV installation, a small hydroelectric facility, etc. or a combination of these options. Also, this network may only serve part of a village, as hospital, school, administrative post, etc.

Individual Systems: Systems that provide power to a house, clinic, school, etc.

Individual Service: The lowest level of supply, which only serves a specific need for energy services such as lighting.

The last three categories are what is commonly internationally considered as off-grid.

Environmental Sustainability: The ability of an activity to continue indefinitely at current or projected levels, without affecting the social, cultural and natural resources to current and future needs.

Renewable Technologies: Technologies that are used to convert the primary source of renewable energy or energy resource to the desired form of energy service.

Tcf (trillion cubic feet): Standard term used to measure the volume of natural gas.

Watt (W): 1 Joule per second of energy consumed or dissipated (MW = 1 000 000 W)

ANNEX II - ENERGY UNITS AND CONVERSION

Here are presented some of the energy units used in the text and some frequently used conversions.

Table 5 – Unit Prefixes

Prefix	Symbol	Value	Short scale	Long scale
kilo	k	10^3	Thousand	Thousand
Mega	M	10^6	Million	Million
Giga	G	10^9	Billion	Thousand Million
Tera	T	10^{12}	Trillion	Billion
Peta	P	10^{15}	Quadrillion	Thousand Billion

Table 6 – Conversion of Energy Units

Original Unit	Conversion
kWh	$3,6 * 10^6$ Joule
kWh	$86 * 10^{-6}$ tpe (tons of oil equivalent)
Joule	$2,78 * 10^{-7}$ kWh
Joule	$24 * 10^{-12}$ tpe
tpe	$42 * 10^9$ Joule
tpe	$12 * 10^3$ kWh