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A Strategy for Introducing Renewable Energy Technologies in Angola

Creating a centre of excellence in renewable energy technologies

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A STRATEGY FOR INTRODUCING RENEWABLE ENERGY TECHNOLOGIES IN ANGOLA

CREATING A CENTRE OF EXCELLENCE IN RENEWABLE ENERGY TECHNOLOGIES

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1 INTRODUCTION

This report focuses on the opportunities and challenges in promoting the greater use of renewable energy sources in Angola as a key factor in the country's drive towards sustainable development. It aims to identify opportunities for coordinated action to match renewable energy technologies and sources to modern energy service needs. At the same time, it is important for Angola to assume a larger role in this area, keeping up with developments in technologies and taking part in global efforts to promote these new renewable-source technologies.

The purpose of this report is to present the Angolan Ministry of Science and Technology (MINCIT) with ideas to promote renewable energies in Angola and to discuss with other relevant agents[2] the strategies for their development.

At the end of the report, the ways in which MINCIT can make itself an attractive, proactive partner for the development of renewable energy technologies in Angola are set out, including the creation of a centre of excellence in renewable energy technologies.

This initiative should not be seen as separate to the wider Angolan energy sector. On the contrary, it will only make sense if it is integrated with other existing planning and investment programmes in Angola's energy service infrastructure and if it is consistent with the country's socioeconomic development programme.

This think piece proposes more action in the short, medium and long term by the Angolan Ministry of Science and Technology in renewable energies and serves as a platform for discussion with the other key stakeholders.

1.1 SCOPE OF THE STUDY

The renewable energy sources addressed in this report are: *solar* (thermal and photovoltaic), *biomass* (fuels for cooking, thermal uses and microgeneration), *wind energy* (electricity generation and mechanical energy) and *small hydroelectric plants (*SHPs*)*. Angola is currently studying its substantial renewable resources, such as hydroelectricity, and projects are underway to develop major power systems and centralised generation[3] [4]. Biofuels are also plentiful in Angola and a large-scale production initiative and dedicated Biofuels working group are already in place. This report does not cover these two areas.

2 WHY RENEWABLE ENERGIES IN ANGOLA?

Angola has major oil reserves and water resources, and oil is an important source of revenue for the government. Its existing generating capacity is approximately 1 GW, 60% of which comes from hydroelectric sources.

The huge demand for energy in Angola is well known and a large part of the population has no access to cleaner, more modern fuels or electricity. In addition, major projects for improving infrastructure, housing and industrialisation require rapid growth and investment in conventional energy generation. A particular issue is that conventional electricity distribution systems cannot easily serve Angola's dispersed rural population, even over the medium term. In order to meet this growing demand, a combined effort is required to increase energy efficiency, especially in end uses, and to introduce renewable technologies.

[2] First National Conference on Science and Technology, ENAD, Luanda. 20-21 October 2009

[3] Eggington, A. et al., 2007. *Angola: Towards an Energy Strategy*, International Energy Agency

[4] Republic of Angola, Ministry of Energy, 2009. Plano Nacional 2009: Programa Executivo Sectorial

The main reasons for introducing renewable energy technologies are that:

- There is huge demand for energy services in the country and in certain areas conventional technologies are very costly to develop and take a long time to reach the population[5] [6].
- Angola is building its infrastructure. This is the right time to identify opportunities to design and build energy efficient schemes that maximise solar gain, are suited to the local climate, have wastewater-to-energy systems, and so on.
- There are opportunities for these technologies to be deployed and developed locally, creating new jobs and business for small enterprises.
- Access to modern forms of energy improves quality of life and offers business opportunities for poor rural populations[7] [8].
- Cleaner cooking fuels impact greatly on domestic pollution and reduce health problems, especially among women, children and the elderly[9].
- Although there are substantial differences between renewable energy technologies, they are modular and can be customised for particular contexts where investments in (centralised) conventional technologies are costly[10].
- There is a global transition from centralised, fossil-fuel-based energy systems to distribution systems that combine efficient technologies and renewable sources[11].
- When developing renewable energy projects that do not emit greenhouse gases, Angola will also gain carbon credits[12].

3 THE INTERNATIONAL SITUATION

Renewable energy technologies are moving forward apace with some becoming commercially competitive in a host of contexts in both industrialised and developing countries. They increasingly represent a safe, modern alternative means of power generation and help to

[5] Eggington, A. et al, 2007. Angola: Towards an Energy Strategy, International Energy Agency

[6] Republic of Angola, Ministry of Energy, 2009. Plano Nacional 2009: Programa Executivo Sectorial

[7] GESNED org. 2007. Renewable Energy Technologies and Poverty Alleviation: Overcoming Barriers and Unlocking Potentials.

[8] Karekezi, S., 2002. Renewables in Africa—meeting the energy needs of the poor. *Energy Policy*, 30(11-12), 1059-1069.

[9] See for example: Smith, K., 1994. Health, energy, and greenhouse-gas impacts of biomass combustion in household stoves. *Energy for Sustainable Development*, I, 23-29. Kilabuko, J. & Nakai, S., 2007. Effects of cooking fuels on acute respiratory infections in children in Tanzania. *Int. J. Environ. Res. Public Health*, 4 (4), 283-288. REN21 Renewable Energy Policy Network., 2005. *Energy for Development: The Potential Role of Renewable Energy in Meeting the Millennium Development Goals*, Washington DC: Worldwatch Institute. Available at: http://www.ren21.net/ [Accessed March 17, 2008]. Word Health Organization, 2007. *Indoor air pollution: national burden of disease estimates (revised)*, Available at: http://www.who.int/ [Accessed May 24, 2008]. Partnership for Clean Indoor Air. Available at: http://www.pciaonline.org/ [Accessed March 17, 2008]

[10] Dincer, I., 2000. Renewable energy and sustainable development: a crucial review. *Renewable and Sustainable Energy Reviews*, 4(2), 157-175

[11] Intergovernmental Panel on Climate Change, 2007. *Fourth Assessment Report Climate Change 2007: Synthesis Report, Summary for Policymakers*, IPCC

[12] Karani, P. & Gantsho, M., 2007. The Role of Development Finance Institutions (DFIs) in Promoting the Clean Development Mechanism (CDM) in Africa. *Environment, Development and Sustainability*, 9(3), 203-228

reduce carbon emissions and other problems associated with fossil fuels and conventional sources. With increased innovation and levels of production, costs are falling significantly. This is particularly true in the case of photovoltaics and wind farming over the last decade (see Figure 1), and the costs of these technologies are likely to fall further in the next few years.

Although there is a predominance of – even preference for – fossil energy, interest in renewable energy technologies is growing globally. The 2009 Unites Nations Environment Programme report, *Global Trends in Sustainable Energy Investment* [13], shows a five percent increase in investment in renewables and that they exceeded those in the coal and natural gas sector in that year, in spite of the global financial crisis. Investments in renewable energies totalled US$ 140 billion in 2008. China has been the biggest investor in thermal solar energy (water heating), the second biggest wind farmer and third biggest biofuel producer. China has more recently also made a name for itself in the production and marketing of photovoltaic panels.

Several scoping studies highlight the importance of renewable energies and energy efficiency in the replacement of fossil-based energies[14].

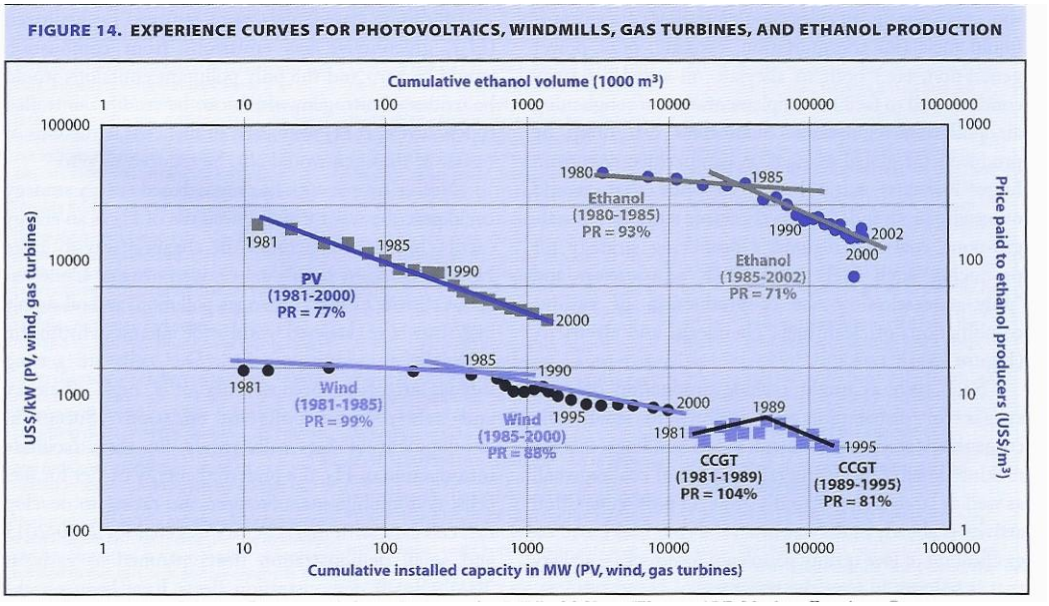


Figure 1: Experience curves for some renewable energy technologies

Source: WEA (2004).

In developing countries like Angola, the initial challenge is to identify potential renewable sources and how they can help meet basic energy needs, particularly in rural and peri-urban areas[15] which lie beyond the reach of conventional services. There are also opportunities for

[13] UNEP, 2009. Global Trends in Sustainable Energy Investment 2009 Report

[14] Gielen, D. org., 2008. Energy Technologies Perspectives 2008: Scenarios & Strategies to 2050, International Energy Agency. See also footnote 11

[15] Cornelio, F. S.M. 2009. Energy-Poverty and its Impacts on Peri-urban Zones of Huambo City, Angola. M.Sc., Lund University

renewable energy (RE) technologies to help to improve users' quality of life[16], generate income and reduce poverty[17].

The technical and financial feasibility of renewable energy technologies are borne out by the wealth of experiences in many other developing countries. Examples include: wind-powered water-pumping systems in Namibia and South Africa; programmes providing stoves to burn wood, charcoal, ethanol gel and liquid ethanol in Kenya, Mali, Ethiopia, Tanzania, India, China and many other countries[18]; and, solar water heating systems in South Africa[19]. There has been success in expanding rural electrification using decentralised systems in south and southeast Asia[20] [21] [22]. Biomass gasification trials using agricultural waste have been conducted successfully with systems outputting from 5 kW to 1 MWe. Countries like Malaysia and Indonesia have managed to develop programmes for the production of biodiesel, thereby creating opportunities for new jobs and income streams[23].

To ensure the effective incorporation of renewable sources in a country's energy grid and to make sure renewables contribute to widening access to modern energy services, the push for change must come not from the public and consumers but rather the government, energy companies and industries. Better information about renewables sources and technologies is necessary if expectations are to be met.

The promotion of renewable energy technologies requires a series of coordinated actions ranging from changes in legislation and regulations to technical capacity-building programmes, financing schemes and new institutional arrangements.

4 FEATURES OF A NATIONAL STRATEGY FOR RENEWABLE SOURCES

In this section, we take an in-depth look at the key elements for a national strategy for renewable technologies in Angola and at how this should be structured (Figure 2).

Given that we are in the first stage of developing the strategy, these elements will need further working up. The intention is to demonstrate how cooperation between different public (including legislative powers) and private agencies, universities and technical schools, departments and ministries is needed for a programme to succeed.

These stakeholders' can promote renewable energy technologies in two ways, neither of which are mutually exclusive: a) through public policies in the areas of energy, the environment and

[16] Kilabuko, James and Satoshi Nakai. 2007. Effects of cooking fuels on acute respiratory infections in children in Tanzania. *Int. J. Environ. Res. Public Health*. See also, for example, Word Health Organization. 2007. *Indoor air pollution: national burden of disease estimates (revised)* http://www.who.int/indoorair/publications/nationalburden/en/index.html.

[17] GESNED, org. 2007. Renewable Energy Technologies and Poverty Alleviation: Overcoming Barriers and Unlocking Potentials. www.gnesd.org . *See also:* Anon. *Access of the Poor to Clean Household Fuels in India*. South Asia Environment and Social Development Department, World Bank http://siteresources.worldbank.org/INDIAEXTN/Resources/Reports-Publications/Access-Of-Poor/FullReport.pdf. [Accessed 29 September 2009]

[18] For example: Zuzarte, Fiona. 2007. Ethanol for cooking: feasibility of small scale ethanol supply and its demand as a cooking fuel: Tanzania case study. M.Sc., KTH School of Energy and Environmental Technology, Stokes, Harry and Bengt Ebbeson. 2005. Project Gaia: Commercializing a new stove and new fuel in Africa. *Boiling Point*

[19] Brew-Hammond, A. 2008. "Renewable Energy Technology in Africa" presented at the International Conference on Regional Energy in Africa, Dakar, Senegal

[20] Chaurey, A., K. Lata, P. Mohanty, A. Kumar and M. Shrestha. RETs theme Renewable energy in South East Asia for improving access to energy (With focus on India and Nepal)

[21] Asian Institute of Technology. 2003. Successful Electrification Programmes in South and Southeast Asia

[22] Shrestha,, R., S. Kumar, M. J. Todoc, and S. Sharma. 2004. Institutional Reforms and their Impact on Rural electrification: Case studies in South and Southeast Asia. GNESD

[23] See footnote19.

economic and social development; b) through specific programmes with defined deadlines and parameters. In any case, this institutional cooperation is essential in establishing a sustainable market for renewable technologies.

Figure 2 shows the main components of the suggested strategy and the following sections describe the concepts and key activities for each of these components.

Funding	Understanding energy demand	Understanding RE supply
	Strategy for RE technologies	
Institutional and regulatory aspects	Local adoption of technologies	Capacity-building and training

Figure 2: Features of a national RE technologies strategy

4.1 GENERAL ISSUES

Energy is a basic infrastructure service for all sectors of a modern economy and it is a core element of any national development plan. An energy infrastructure based on major centralised generation, transmission and distribution systems using conventional technologies is very capital intensive and requires time between studies and installation. On the other hand, many renewable energy technologies are modular, decentralised and quick to install. Nonetheless, they require solutions to make them technically and economically feasible.

Efforts to introduce and promote renewable energy technologies in Angola should correspond with the country's proposed development targets. Figure 3 sets out schematically how the goals fit with the strategy to promote renewable energy technologies and the country's existing economic and social development plans. However, for RE technologies to be successful and for markets to be created for them, they must be integrated into the country's wider development activities.

Official targets for the electrification of homes for 2013 are: 100% for the urban population, 60% for peri-urban regions and 30% for the rural population[24]. Renewable energy technologies will certainly be of use in meeting some of this rural need. The Ministry of Energy (MINEN) has two

[24] Republic of Angola, Ministry of Energy. 2009. Plano Nacional 2009: Programa Executivo Sectorial

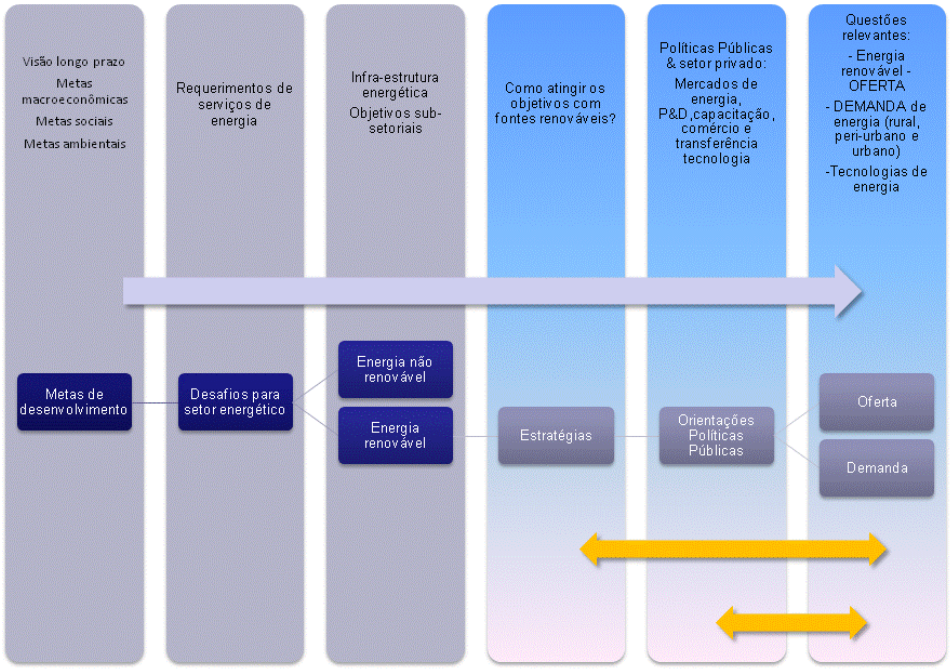
programmes for renewable sources: small hydroelectric plants[25] and photovoltaic solar energy. In addition, the ministry recently set up the Renewable Energy Office to implement these programmes.

A major national programme currently underway to build one million homes across the country is an ideal opportunity to embed a programme promoting renewable energy technologies. It is necessary to determine in more detail the energy demand of the schemes (cooking, lighting, water heating) so that technically and economically viable renewable energy projects can be devised.

These energy programmes and the above-mentioned housing project opportunity[26] may help to create a market for RE technologies through government purchasing power. The scale of government procurement is such that it can engender additional benefits: local adoption of technologies and services that support the local economy; capacity building and human resource development; and, helping the country meet its broader economic development goals.

[25] Mini-hydroelectric plant opened in Minconge. http://www.governo.gov.ao/NoticiaD.aspx?Codigo=8084 (23/09/09)

[26] It was not possible to inventory all the government initiatives that might benefit from renewable energy programmes. The examples given were collected in interviews during our visit to Luanda (8 to 17 September 2009). We have been informed that the Renewable Energy Office is taking stock of these initiatives at different ministries and public bodies.



Long-term vision Macroeconomic targets Social targets Environmental targets	Energy service requirements	Energy infrastructure Sub-sectoral goals	How to achieve goals with renewable energies	Public policies and the private sector: Energy markets R&D, capacity building, trade and technological transfer	Relevant questions: -Renewable energy – SUPPLY -Energy DEMAND (rural, peri-urban and urban) -Energy technologies
Development targets	Challenges to the energy sector	Non-renewable energy Renewable energy	Strategies	Public / political tendencies	Supply Demand

Figure 3: General framework for the introduction of energy services based on renewables and the national development plan

4.2 GOALS AND TARGETS

A strategy must have clear goals and targets. This means that the identified sources and technologies must be regarded systematically and complement conventional technologies to meet the population's requirements. Listed below are suggested strategy goals for discussion and approval by national stakeholders.

To produce clear targets, greater detail and definition by the agents involved (especially the MINCIT) is required. Targets are important for calculating finances and serve as important indicators for monitoring and assessing activities over time.

4.2.1 GOALS

To create in Angola a system capable of:

- Keeping up with international development in RE technologies
- Keeping up with international policies, legislation, regulations and mechanisms used to promote RE technologies and integrate them into national energy systems
- Promoting the technically feasible and economically competitive deployment of RE technologies to meet the energy needs of the population and production units
- Linking up Angola's private enterprise and public bodies to develop and use RE technologies
- Creating funding mechanisms to ensure financial resources are available to promote RE technologies[27]
- Creating a sustainable market[28] for these technologies so they do not depend on incentives or public funding in the medium and long term
- Developing, where possible, local labour forces skilled in adapting and producing RE technology hardware and components
- Developing technicians skilled in RE maintenance, installation and projects
- Setting up an institutional and regulatory apparatus to coordinate, implement and monitor activities related to the above goals.

These goals are grouped in activities, which are detailed in sections 4.3 to 4.7 and are part of the structural features of the strategy for introducing renewable energy technologies in Angola.

4.2.2 TARGETS

In order to achieve its goals, the strategy should create programmes (or specific projects grouped under broad, medium-term visions) with targets.

The targets must be revised periodically to adapt them to the developing programme, taking into account needs that arise after the start of activities and knowledge acquired as the programme progresses.

Programmes should be defined in accordance with the priorities set by the MINCIT and its partners.

4.3 SUPPLY OF RENEWABLE ENERGY SOURCES

It is necessary to catalogue and quantify the technical and economic potential of desired renewable sources: solar, biomass, wind and SHPs. This information should be made available

[27] For example, in some countries a small charge is taken from fossil-based energy for investment in renewable energies.

[28] This means initially having a strategy for prices, charges, subsidies, micro-credit and dissemination programmes and creating the right conditions over time for greater participation by private enterprise and consumers in investments and maintenance services.

on a geographical (GIS) basis and is fundamental for the organisation and prioritisation of RE technology promotion programmes[29].

This information should be held in the public domain and should also facilitate the participation of the private-sector in any future auctions or concession systems for renewable energy activities.

To date, this does not seem to have happened and should be prioritised in the strategy.

4.4 ENERGY DEMAND

It is also necessary to find out more about consumer demand in order to plan the RE strategy's constituent programmes.

Solid biomass is the dominant form of energy in Angola and it is used unsustainably[30]. Traditional, inefficient uses of biomass for cooking should be replaced by viable and cleaner alternatives like liquid and gas biofuels or the new-type efficient wood-burners[31]. Studies are required to answer questions like:

What technologies are currently used for cooking in Angola? Do they vary much from one region to another? What is the typical consumption of firewood, charcoal and other fuels? What equipment is used, how energy efficiency is it and what are gas and particle emissions like? Have health problems been detected due to this use of biomass?

Table 1 shows different end uses and types of energy source (fuels and electricity) and rates energy sources for each end use. A diagnostic study should be conducted on energy uses in Angola in order to identify the areas requiring improvement (introduction of cleaner, more efficient energies) and areas requiring greater inclusion of renewable sources. The study should express energy demands regionally (using GIS if possible) in order to identify the most appropriate available renewable sources.

[29] For example, see the publications *Atlas de Energia Elétrica*, *Atlas do Potencial Solar* and *Atlas do Potencial Eólico* on www.aneel.gov.br and www.cresesb.cepel.br, Agência Nacional de Energia Elétrica and Centro de Referência para Energia Solar e Eólica Sérgio de Salvo Brito respectively.

[30] Information collected in interviews with the MINCIT and MME. See also Kreidler, Corinna. 2001. *The provision of household energy: Coping mechanisms of internally displaced people in Benguela Province*, Angola. *Boiling Point*

[31] There is plenty of literature on the subject and substantial experience in a number of African countries. See, for example, Goldemberg, J. et al., 2004. A global clean cooking fuel initiative. Energy for Sustainable Development, VIII, 5-12. Modi, V. et al., 2005. Energy Services for the Millennium Development Goals, New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank. Zuzarte, F., 2007. Ethanol for cooking: feasibility of small scale ethanol supply and its demand as a cooking fuel: Tanzania case study. M.Sc. KTH School of Energy and Environmental Technology. Word Health Organization, 2007. Indoor air pollution: national burden of disease estimates (revised), Available on http://www.who.int/indoorair/publications/nationalburden/en/index.html [accessed May 24, 2008].Stokes, H. & Ebbeson, B., 2005. Project Gaia: Commercializing a new stove and new fuel in Africa. Boiling Point, 50, 31-33

Table 1: Types of energy and their suitability for end uses

	Fuels			Mechanical energy	Solar (direct)	Electricity
	Solid (wood, charcoal)	Liquid	Gas			
Cooking	XXX	XX	XXX		X	XX
Heating	XXX	XXX	XXX		XXX[1]	XX
Lighting	X	XX	XX	aaa		XXX
Refrigeration	X	XX	XX			XXX
Communication etc						XXX
Mobility	X	XXX	X	XX		X
Social services				XX		XXX
Production	XX	XX	XX	XXX	XXX[2]	XXX

Notes: X: possible, but not preferable; XX: applicable but limited; XXX: appropriate (1) water heating (2) grain drying, for example

4.5 CREATION OF A MARKET FOR RENEWABLE ENERGY TECHNOLOGIES

In the medium term, a sustainable market for RE technologies is needed. It is therefore necessary to understand the whole energy supply chain for each technology considered[32].

For the strategy to succeed, it is important to plan for private sector engagement at the outset. Depending on the technology, it may be possible to begin local production of parts for maintenance and repair. The strategy should envisage a network of suppliers, installers and technicians able to define, plan, specify and install the renewable energy systems considered[33].

As the technologies are very different (solar, wind, biomass, SHPs), it is essential to establish criteria and priorities. This will require an initial – and perhaps preliminary – inventory of their potential.

Public- or donor-funded programmes must be planned and coordinated consistently for the next few years in order to consolidate the market and create new businesses, income and jobs in renewable sources.

4.5.1 PUBLIC POLICIES

In general, RE programmes have been designed and delivered on the basis of *resource acquisition,* i.e. they introduce equipment and technologies into production processes as well as existing buildings and facilities. Public funding or international donor resources are generally used for these first-stage programmes. This does not, however, guarantee that the maintenance and replacement of equipment in the future will be done along the same lines. It is therefore necessary to be creative and devise ways to access funding, information and technology as an integral part of these initial programmes.

The RE strategy should establish market transformation programmes aimed at overcoming existing barriers[34] in the market with the measures set out in the programmes. In the medium term, the private sector will be able to offer technologies and services in planning, marketing and installing RE technologies for consumers. During strategy implementation, we expect

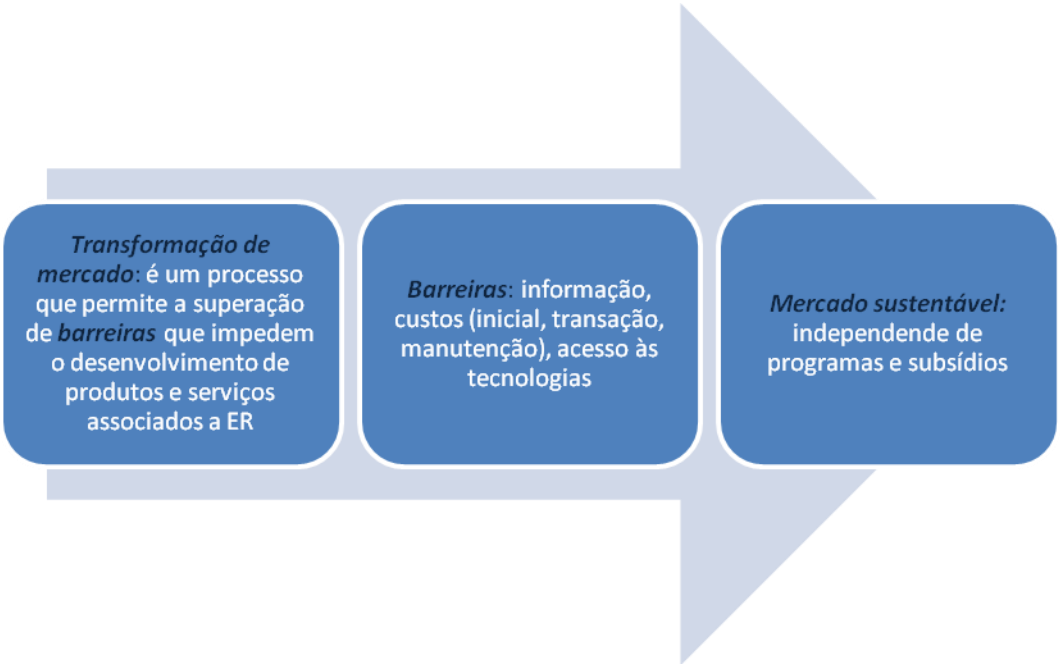
[32] This applies to efficient stoves, better charcoal production, photovoltaic panels, solar collectors, biogas use and production systems, etc.

[33] Take, for example, the trial of a seal of quality (QualiSol) for solar water heating systems in Brazil . Work was undertaken with suppliers, installers and sellers of the systems. Available on http://www.qualisol.org.br/ [accessed October 18, 2009].

[34] Identification of obstacles is in integral part of the proposed strategy.

supply and demand for RE products and services to gradually become a sustainable market in its own right, thereby rendering the programme unnecessary.

The most common obstacles are a lack of information on RE technologies, transaction costs, maintenance and the fact that energy costs do not include environmental costs. These obstacles inhibit the RE technology market. It is necessary to understand in more detail the greatest obstacles to promoting RE technologies in Angola in order to provide clearer direction for medium- and long-term activities.



Market transformation is a process for overcoming obstacles to the development of RE products and services	Obstacles: information, costs (initial, transaction, maintenance), access to technologies	Sustainable market: independent from programmes and subsidies

Figure 4: Market transformation programmes

4.5.2 PUBLIC-PRIVATE PARTNERSHIPS (PPP)

Public-private partnerships (PPPs) can be very useful in engaging with companies or agencies who can rapidly respond to opportunities in project development programmes. They can be a way of attracting more financial resources and facilitating the creation of a sustainable market for RE technologies[35].

It is possible to obtain international funds[36] to promote this type of partnership. The inclusion of private sector agents should be encouraged from the start to ensure the successful promotion of these technologies.

[35] Brazil has interesting experience in bringing together private sector agents and companies for two major energy market transformations, such as the transition from wood to LPG (V. Lucon, O., Coelho, S. & Goldemberg, J., 2004. LPG in Brazil: lessons and challenges. *Energy for Sustainable Development*, VIII[3], 82-90 and Jannuzzi, G.M. & Sanga, G.A., 2004. 'LPG subsidies in Brazil: an estimate. *Energy for Sustainable Development*, VIII[3], 127-129) and the introduction of ethanol into a market dominated by petroleum products.

[36] See for example GTZ. Public-Private Partnership, available on: http://www.gtz.de/en/unternehmen/2362.htm [accessed October 22, 2009]

4.5.3 INCENTIVES AND SUBSIDIES

Incentives and subsidies form part of market transformation programmes and they are usually always needed when new renewable energy technologies are first introduced in industrialised and developing countries. These are provided through public resources and international donor support. These mechanisms form part of RE introduction strategies but it is important to have exit strategies in place so that this type of support can be withdrawn when the market no longer requires it.

4.5.4 REGULATION AND INSTITUTIONAL ISSUES

An important characteristic of the renewable sources discussed herein is that they are dispersed and decentralised. They require a very different management model from electricity or oil companies.

It will therefore be necessary to bring forward a series of legal and regulatory reforms to allow decentralised RE systems to be able to take root and compete in the market. There is considerable and diverse international experience in this area to refer to when considering regulatory incentives for consumers and potential investors in renewable energies.

At the institutional level, it is essential to coordinate the implementation of an RE promotional strategy. RE-related activities require the input of a variety of actors from different ministries and state-owned and private companies.

It will therefore be necessary to understand the current institutional set up of agencies responsible for energy services and assess how to manage renewable sources in this context.

4.5.5 CAPACITY BUILDING

It is necessary to develop human resources if RE technologies are to be delivered at the desired scale. Unlike conventional sources, which need a small but highly qualified team for their installation, operation and maintenance, most RE technologies require a larger number of personnel with mid-range technical skills.

Training a large number of people, ensuring access to machine parts and setting up new structures for maintenance and replacement services may all require substantial upfront effort.

4.6 LOCAL ADOPTION

Local adoption is about creating a market for renewable technologies. The strategy should include actions for setting up commercial outlets, maintenance services and eventually manufacture of these technologies, where feasible.

4.6.1 TRADE

Technological development in RE has been very fast in recent years, particularly in photovoltaics (PVs) and wind energy. Many of these technologies are protected by patents, commercial agreements and intellectual property rights. There has been international concern, particularly within the scope of the climate change treaty negotiations, for facilitating the transfer of these technologies to developing countries, as has already been the case with certain medications. This could help the commercialisation of certain technologies in Angola.

4.6.2 INDUSTRIALISATION

Some RE technologies are quite sophisticated and require a highly complex industrial infrastructure while others do not, like the new-type wood or charcoal burners.

It is necessary to assess each selected technology in terms of the technical and economic possibilities of local manufacture.

4.6.3 MAINTENANCE AND TECHNICAL ASSISTANCE

As with conventional sources of energy, many different experts are needed to develop renewables, for example: chemical, electrical and mechanical engineers; managers; anthropologists and social scientists. However, because of the dispersed nature of energy sources, RE requires many medium-level technicians. For some source types, even members of the local community require training to be able to conduct routine maintenance.

4.7 FUNDING FOR RENEWABLE ENERGY TECHNOLOGIES

An obstacle to adoption of RE technologies in countries like Angola is the high upfront set up costs and funding is needed to open up the technologies to consumers and entrepreneurs.

Renewable energy initiatives require innovative policy making and more resources to fund improved user access to modern energy services.

International experience has shown the positive role that micro-credit can play in solar photovoltaic energy in rural areas (UNDP 2006). Many countries have successfully created funds for rural electrification.

5 RECOMMENDATIONS: A CENTRE OF EXCELLENCE IN RENEWABLE ENERGY TECHNOLOGIES

The development of the detailed strategy depends on close cooperation between ministries, and especially the Ministry of Energy (MINEN). The creation of a market for renewable technologies, as explained above, will require substantial government support through its ministries and state-owned corporations. Regulatory changes, incentives, capacity building for local personnel and the identification of opportunities for local technology and component production all require the formation of an interdisciplinary group that convenes or communicates regularly.

In this section, we make recommendations to the MINCIT to develop its role as a driving force for RE technologies and to enable it to set up a partnership with other key agents, including the MINEN and MINAM, to implement this strategy.

We suggest the creation of a **centre of excellence in renewable energy technologies** under the supervision of the MINCIT. This centre will be able to play a vital role in the introduction and large-scale dissemination of RE technologies, as well as in building the country's RE capacity. Many of the items suggested in the previous sections can be supported and developed by this kind of centre.

5.1 WHAT WOULD A CENTRE OF EXCELLENCE IN RENEWABLE ENERGY BE LIKE?

The main concept is that of a small, multidisciplinary institution with a diverse, qualified technical team working mainly in areas of applied research and project management.

As a centre of engineering and applied science, its members will be able to meet the specific demands of organisations[37] interested in RE technologies. It should take forward capacity building in project management and familiarisation with economic, social and regional factors and should not be regarded as an academic institution[38].

In Angola it is quite feasible to recruit a small group of professionals with solid and diverse disciplinary backgrounds who will serve as the centre's core team.

The main activities suggested for the centre are as follows and are detailed briefly in the subsequent sections:

- Evaluation of the potential of renewable sources
- Assessment of the renewable energy market
- Technological development
- Capacity building and training
- Technological transfer
- Information services.

Some suggestions for the initial setup of the centre are made below.

5.1.1 ORGANISATION

There are different ways of creating this kind of centre, depending on available time, manpower and financial resources.

The centre could be initially set up using a research unit or university group, along with a theme-based network (for example by source/technology, energy end use or region or a combination of these) to include other institutions or agencies directly related and committed to renewables. Modern information and communication technologies facilitate these types of networks, however, it is important that the centre's goals and each participant's role and activities in the network are clear and agreed.

It is essential the centre's coordinating body is prestigious and has an ethos of technical excellence.

5.2 EVALUATION OF THE POTENTIAL OF RENEWABLE ENERGY SOURCES

- Support the creation of a network of weather stations and other instruments to identify and chart indicative zones where solar and wind power, biomass and SHPs have potential.

[37] For example, we suggest that the centre should have a management committee consisting of representatives of other ministries, energy companies and other interested parties. Its main function would be to oversee and assess the centre's work.

[38] However, it is important for the members to be willing to give presentations at technical conferences and seminars and to write articles for academic publications.

- Develop this information in the form of wind atlases, solar atlases, etc. These would be useful tools to facilitate the exploitation by the public and private sectors of these energy resources, and would play an effective role in Angola's national energy planning.

Important international initiatives, such as the SWERA (Solar and Wind Energy Resource Assessment) programme funded by the Global Environment Facility and managed by the United Nations Environment Programme can be instrumental in this activity[39]. Greater contact and collaboration with other centres and drawing on the experience of others internationally would be valuable in structuring evaluation of RE potential in Angola[40].

5.3 THE ENERGY MARKET

- Diagnostic and scoping studies will help define the energy market and its technologies, such as market segment and demographic studies, and comparative analyses of RE business models, especially in rural settings.

- Concessions could be created to develop energy services and/or a combination of services including RE.

- Support the implementation of effective technological solutions by participating in national RE projects.

- Reference international experience and practice in creating programmes and incentivisation schemes for promoting RE technologies.

5.4 TECHNOLOGICAL DEVELOPMENT

- Keep up to date with international technological developments in RE. Analyse the technical performance of RE technologies to be used in Angola to ensure the technical quality of equipment. Study the possibility of meteorological laboratories granting seals or certificates of approval for technologies.

- Develop a database of national technical skills in RE and of companies involved in the different areas of RE technology.

- Set up cooperation agreements with national and international bodies for the sharing of knowledge and practice and to identify opportunities for developing and applying these technologies.

- Establish standardised criteria for evaluating the performance of systems, equipment, costs, benefits and opportunities.

- Interact with regulatory bodies and specialists to establish technical recommendations.

5.5 CAPACITY BUILDING AND TRAINING

- The centre could be tasked with communicating and sharing relevant professional information and could set up exchange programmes with other institutions, especially those abroad.

[39] For more information, see SWERA - Data for Solar and Wind Renewable Energy, http://swera.unep.net/.

[40] At the end, we suggest some centres in Brazil that could help in with this.

- Build skills and capacities for planning Angolan RE projects using software and measurements[41].

5.6 TRANSFER OF TECHNOLOGIES

- The centre should be able to subsidise technical negotiations for the transfer of required technologies to Angola which it can then manufacture itself.
- These negotiations may include licensing and commercial or intellectual property rights to RE technologies and processes.

5.7 INFORMATION

- Collect, systematise, circulate and distribute scientific, technological, economic, commercial, social and environmental information, studies and programmes.
- Develop and operate electronic and communications media and integrate them with major national and international networks.
- Set up technology exhibition centres and a specialised library on renewable energies to facilitate education and research.
- Promote and participate in national and regional events.
- Promote the publication of journals, books, manuals, catalogues, newsletters, technical and scientific content, videos and media.
- Assist teaching institutions to develop new methods and technologies to exploit renewables.

6 ANNEXES

6.1 CONTACTS AND ORGANISATIONS CONSULTED

1) Ministry of Science and Technology

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      Deputy Minister

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   c) Manoel Lopes Francisco

[41] See for example the Canadian government programme, RETScreen International. http://www.retscreen.net/pt/home.php.

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e) Mateus Manoel Neto

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2) Ministry of the Environment

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3) Ministry of Energy

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6.2 BRAZILIAN REFERENCE CENTRES FOR RENEWABLE ENERGIES

6.2.1 CENBIO – CENTRO DE REFERÊNCIA EM BIOMASSA

Homepage: www.cenbio.org

The *Centro Nacional de Referência de Biomassa* (National Biomass Reference Centre) was set up on 31 December 1996. As a centre of excellence, its purpose is to share experiences with different national and international research and development groups in all areas of biomass energy production.

6.2.2 CRESESB – CENTRO DE REFERÊNCIA PARA ENERGIA SOLAR E EÓLICA SÉRGIO DE SALVO BRITO (SÉRGIO DE SALVO BRITO REFERENCE CENTRE FOR SOLAR AND WIND ENERGY)

Homepage: www.cepel.br/crese/creseb.html

This centre's purpose is to promote the development of solar and wind energies by sharing knowledge, creating dialogue between stakeholder bodies and encouraging the implementation of studies and projects.

6.2.3 LABSOLAR – LABORATÓRIO DE ENERGIA SOLAR (SOLAR ENERGY LABORATORY)

Homepage: www.labsolar.ufsc.br

This laboratory of the Department of Mechanical Engineering at Santa Catarina Federal University is a national reference point in solarimetrics. It has gained national and international recognition for its in research into models for estimating solar radiation.

LABSOLAR has focused its efforts on implementing a surface solarimetrics network that supplies continuous, reliable radiation data from five stations in the state of Santa Catarina and one in Amazonia. In partnership with the National Space Research Institute (INPE), they are developing computational models to determine the intensity of surface solar radiation from satellite images and are analysing the performance of freestanding photovoltaic facilities in remote locations and those connected to the electricity grid. LABSOLAR also conducts research on compact solar collectors for water tanks and solar powered air conditioning systems.

6.2.4 GREEN SOLAR – CENTRO BRASILEIRO PARA DESENVOLVIMENTO DA ENERGIA SOLAR TÉRMICA (BRAZILIAN CENTRE FOR THE DEVELOPMENT OF SOLAR THERMAL ENERGY)

Homepage: www.green.pucmg.br

The centre was set up in 1997 and is based in the Pontifical Catholic University of Minas Gerais (PUC Minas). It is an interdisciplinary study group that currently comprises lecturers and students from the departments of mechanical, civil and electronic engineering and control and automation, as well as the PUC MINAS postgraduate programme in space information processing. GREEN SOLAR also fosters collaboration with universities and technology and research centres working in the field of applied solar energy in Brazil and abroad. It offers a distance learning course in thermal solar energy and has around 300 students enrolled. It also acts as an advisor on energy efficiency postgraduate programmes.

6.2.5 GEDAE – GRUPO DE ESTUDOS E DESENVOLVIMENTO DE ALTERNATIVAS ENERGÉTICAS (ALTERNATIVE ENERGY RESEARCH AND DEVELOPMENT GROUP)

Homepage: www.ufpa.br/gedae

Founded in 1994, GEDAE has been recognised by the Fórum Permanente de Energias Renováveis (Permanent Forum on Renewable Energies) as a reference centre for hybrid systems in Amazonia. Its scientific and technological activities mainly focus on regional issues and, although a university venture, on integrating its activities with the wider community.

Its goals are to:

- Undertake studies that explore the consolidation of low-cost technologies in solar and wind energy and in microwave applications
- Run pilot projects for meeting small energy demands
- Develop software for photovoltaic, wind, hybrid and microwave system projects
- Interact with the community and government bodies to identify local potential
- Interact with other education and research institutions at home and abroad with a view to securing technical and scientific cooperation
- Act in conjunction with energy concession holders on technical cooperation
- Share knowledge by working with undergraduate and postgraduate programmes on organising lectures and seminars, advising on end-of-course assignments and masters degree theses, etc.

6.2.6 CERPCH – CENTRO NACIONAL DE REFERÊNCIA EM PEQUENOS CENTRAIS HIDROENERGÉTICOS (NATIONAL REFERENCE CENTRE FOR SMALL HYDROELECTRIC PLANTS)

Homepage: www.cerpch.efei.br

This centre was set up in July 1998 and its aim is to share information through its network on programmes, projects, research, and scientific and technological developments of small hydroelectric plants. They also promote capacity building, training and research in this area.

6.2.7 CENEH – CENTRO NACIONAL DE REFERÊNCIA EM ENERGIA DO HIDROGÊNIO (NATIONAL REFERENCE CENTRE FOR HYDROGEN-BASED ENERGY)

Homepage: www.ifi.unicamp.br.lh2

This centre was founded in December 1999 and its executive secretariat is located at UNICAMP. Its aim is to promote and share via its network information on programmes, projects, research and scientific and technological developments in hydrogen fuel technologies. It also proposes and conducts scientific and technological research carried out corporately or in cooperation with other bodies to foster strategic alliances and promote capacity building.

6.2.8 INFOHAB - CENTRO DE REFERÊNCIA E INFORMAÇÃO EM HABITAÇÃO (REFERENCE AND INFORMATION CENTRE FOR HOUSING)

Homepage: www.infohab.org.br

This project is headed by the Associaçaõ Nacional de Technologia do Ambiente Construído (National Association for Built Environment Technologies), which was created in response to recommendations by the HABITARE housing technology programme and FINEP (Brazil's national research and project funding body), and supported by CNPq - Programa RHAE (a technology research and skills programme), the Caixa Econômica Federal bank and the Ministry of Science and Technology.

Seven universities participate in INFOHAB as bound units and four as an associate group, which guarantees the robustness of its information and the excellence of its services.

INFOHAB provides access to technical information on all built environment areas and disciplines.

6.3 ABBREVIATION GLOSSARY

MINCIT – Ministry of Science and Technology

PPP – public-private partnership

MINEN – Ministry of Energy

RE – renewable energy

SHP – small hydroelectric plant