Knowledge for Development: Capacity Building in Renewable Energies for Poverty Alleviation

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Research and Development Needs for Renewable Energies in Developing Countries

Abstract

The future for renewable energy sources ("renewables") in the developing world, if properly harnessed, looks bright and the prospects are good. There are vast reserves of and high potential for the use of different renewable energies (RE), be they solar, hydro, wind, wave, hydrogen, waste, etc. However, these remain largely unexploited due to a combination of facto; particularly economics, lack of appropriate research and development and the absence of enabling policy instruments. At the same time, access to modern, commercial energy services is usually too low to facilitate meaningful economic development in developing countries. Sub-Saharan Africa, the world's most underdeveloped region, with 17% of the world population and blessed with abundant mineral resources, consumes less than 3% of the world primary energy supply. Most of the developing world's energy needs could, theoretically, be met by the vast renewable energy potential. However, despite decades of attempts to supply modern renewable energy technologies (RETs), the energy landscape remains largely unchanged. Traditional fuels (biomass in Africa) continue to dominate the energy use patterns. There have been numerous spectacular instances of failed RETs, uncoordinated renewable energy programmes and piecemeal demonstrations or pilot projects. Even in the case of successes, these have largely remained undocumented and lessons learned are therefore lost.

This calls for a paradigm shift in R+D, particularly relating to RET solutions. There is a need for R+D which does not ONLY focus on flooding the developing world with an array of technologies that deliver short term benefits, but an R+D process that addresses the expressed needs of the users in an integrated manner. Such an approach will provide answers to the key questions: What are the energy needs specific to the users and how do they link to other development needs? How to transform the energy needs to effective demand? What is the best technology mix to meet these needs? The R+D needs of developing countries relate to challenges that address embedded socio-economic needs, identification of appropriate energy technologies that are informed by local conditions, and the need for R+D on sustainable business models to stimulate local renewable industries.

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Introduction

There is currently a global optimism regarding the future for RE and its potential role in sustainable development. While there are different justifications for the introduction of RE into the mainstream national energy economies, the potential to sustain economic development, while minimising the adverse effect on the environment, is a common rallying point. There is also a high level commitment globally to accelerate the use of renewables. This commitment is supported by the ready availability of capital from multinational agencies, national governments and the private sector to fund viable RE projects. The World Summit on Sustainable Development (WSSD) in Johannesburg provided a necessary platform to initiate unified and purposeful global efforts, known as Type II activities, towards accelerating actions designed to exploit renewables worldwide. One of the key outputs of the 2004 World Renewables Conference in Bonn is to provide concrete implementation strategies and joint RE projects.

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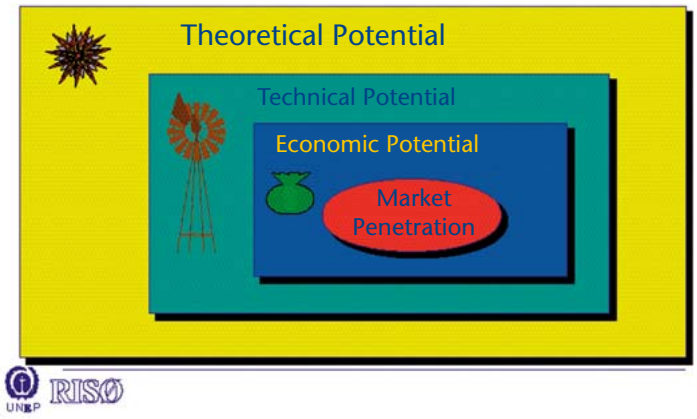

Figure 1
Potential for Renewables [1]

With respect to the developing world, the accelerated use of renewables in countries' energy mixes has important additional benefits. Access to modern fuels in many developing countries is a cause for concern. In the 'business-as-usual-scenario', more and more households, particularly in rural regions of Africa, will forever rely on dwindling biomass fuels to meet their energy needs. Estimates indicate that the current reliance on biomass (mainly woodfuel) is between 70–80 %. Providing conventional energy in the form of electricity is usually uneconomical, and the costs are beyond the reach of many households situated in rural areas. This scenario certainly does not encourage economic growth and development in these areas. Access to affordable, adequate and modern energy services is the engine for a country's development and a cornerstone in alleviating poverty. Effective introduction of renewables in developing economies could facilitate and fast-track development processes, while improving the options and quality of life available to the poor.

Despite this situations, there are many dynamic challenges to be faced in attempting to accelerate the uptake of RE in developing countries. These relate to policy frameworks that favour renewables, availability of appropriate RETs, focussed R+D on appropriate technologies and project implementation strategies, lack of baseline studies, funding, etc. Most of these barriers have largely been removed, though several critical ones still remain. This paper argues that now is the opportunity to devise effective implementation strategies that are informed by past experiences, and based on international best practices. The focus of this would be to isolate the key needs of developing countries, related to renewables, that can be addressed by innovative R+D, whilst creating and embedding local skills and expertise in the process.

The Future for Renewable Energy in the Developing World

Global Push for Renewables

The positive euphoria regarding the enormous potential of RE should be viewed against the global fear of the consequences of relying too much on fossil fuels for economic growth. A lot has been said about the negative effects of emissions from the production, transmission, distribution and consumption of fossil fuels, particularly oil and coal. Much of the global agenda on renewables (and energy efficiency) is driven by this fear, as well as the need to ensure the long-term – and diversity of – supply of environment-benign energy.

As most developing countries are net exporters of energy, as well as possessing few energy intensive industries, their emission levels are insignificant on a global scale. Therefore, the agenda for renewables in developing countries should be to satisfy the energy needs of two billion people without access to modern and clean energy sources. The question, therefore, has to be 'Can renewable energies meet the needs of developing countries?'

Theoretically, all the global energy needs / demand could be provided by RE [1]. However, currently used technologies cannot tap the current potential. Even the market penetration of RETs is below the economic potential. At the level of a developing country, penetration of RETs is least. Even the number of RETs currently in circulation remains unknown because of lack of reliable data on RE projects. The point, therefore, is that on their own, renewables cannot meet the energy demand of developing countries. At a practical level, renewables in developing countries should be introduced as one of the energy options (including non-renewables) in the context of "Energisation" (see below).

Prerequisites for Sustainable Renewables Takeoff

The global (read "developed" countries') push for renewables will not attain any sustainable level of success if developing countries are not supportive or receptive. Pro-activity is the keyword for success and developing countries must want renewables. The "want" should be determined by the policy frameworks that favour renewables and contribute to the growth of RET businesses in local economies. Unfortunately, in many instances, the push for RE comes from developed countries since there is a dearth of proactive policies in developing countries. For instance, few countries in Africa have renewables energy policies. Most attention is, understandably so, focussed on coal, gas, oil and large-scale hydropower projects. It is significant to note that the energy desk of NEPAD – a framework for Africa's economic revival – does not have a renewables mandate. The latter is located within the broader environmental desk. Most regional power pools do not prioritise renewables as they do non-renewable energy. A key prerequisite for sustainable RE takeoff is arguably harmonised regional policies and strategies. The effectiveness of projects funded by multinational agencies and intergovernmental entities will come to be well below desired levels if this prerequisite is not addressed.

However, one of the often cited barriers to formulation of realistic, informed and effective policies, particularly in Africa south of the Sahara, is lack of validated data, which in turn are determined by the absence of R+D institutions to conduct this research [2]. These facts are recognised in the WSSD Plan of Implementation, which advocates the promotion of technology development, transfer and diffusion to Africa, and the further development of technology and knowledge available to African centres of excellence [3].

Developing World: Different Contexts, Different Needs

While all developing countries share common features or indicators vis-à-vis developed countries, it is important to mention that they are definitely not a homogenous entity *(Fig. 2)*. This distinction is very significant, particularly as far as the energy landscape is concerned. The energy needs of developing countries are influenced by their varying degrees of "development", or simply the prevalence of widespread poverty. For instance, sub-Saharan Africa (SSA) is considered the least developed region in the world, well below the levels of other developing countries. The IMF projections show economic growth in all developing countries as averaging 6 % per year (2003 – 05) compared with 4 % per year in SSA. Therefore if this region has to halve poverty levels by 2015, the GDP growth must more than double from current levels of 3 % to 7 % per year [4].

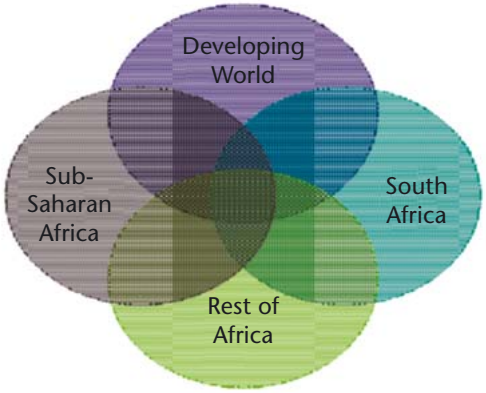

Figure 2
Heterogeneity nature of developing countries

In energy terms, this means that the poorer the region, the more different and precarious its energy needs will be, and the more complex the solutions should be. A significant number of the two billion people worldwide who do not have access to modern energy services live in SSA.

Hence, the SSA economic priorities are strongly informed by the need to alleviate poverty. With more than 500 million people currently without access to electricity and with more than 600 million people dependent on traditional biomass for survival, SSA has a dire need for safe, affordable and clean forms of energy to enable productive economic activities to generate much needed income [5]. *Tab. 1* underlines the African reliance on traditional fuels, as compared to the more affluent countries in Europe [6].

On the other hand, countries of the SSA need to develop. Owing to its developmental status, exacerbated by emigration of skilled people, Africa lacks the human capacity and technical strength to achieve the necessary progress within a ten to fifteen year time frame as required

Table 1
Energy indicators for 1999 for a selection of african & european countries, 1990 US$ (Source: International Energy Agency, Paris)

Country	Population (M)	GDP (US$B)	TPES/ Capita	TPES/ (000$)	Electr (KWh/ Capita	Electr Cons (KWh/US$)
Morocco	28.2	38.4	0.35	0.26	538	0.40
Senegal	9.3	5.5	0.32	0.54	122	0.21
Algeria	30.0	47.0	0-94	0.60	960	0.81
Egypt	62.7	74.6	0.71	0.60	960	0.81
Ethiopia	62.8	7.1	0.29	2.59	24	0.21
Nigeria	123.9	31.0	0.70	2.82	89	0.36
Kenya	29.4	9.9	0.50	1.48	127	0.38
Angola	12.4	6.4	0.61	1.18	92	0.18
Zambia	9.9	3.8	0.63	1.61	568	1.46
Zimbabwe	11.9	8.4	0.85	1.22	940	1.34
Mozambique	17.3	3.4	0.40	2.04	48	0.24
South Africa	42.1	164.4	2.60	0.67	4479	1.15
NOTE: No recent info available for Botswana, Lesotho, Swaziland						
United Kingdom	59.5	1256.0	3.87	0.18	5901	0.28
Germany	82.1	2603.0	4.11	0.13	6480	0.20
France	60.3	1698.0	4.23	0.15	7142	0.25
Sweden	8.9	267.3	5.77	0.19	15450	0.51
TPES: Total Primary energy Supply toe: tonnes of oil equivalent						

in the NEPAD position. It is almost certain that Africa would neither be able or allowed to follow the developmental pathways that brought other countries to their current position in the world. New and innovative systems-dynamic approaches are needed [6].

Therefore, the ideas and analysis presented in this paper apply to varying degrees to different regions and countries that are, by definition, considered to be "developing". However, most of the arguments presented concern the underdeveloped regions within the developing world. The bias is intentional because these are the regions that most need innovative renewable energy solutions, and these are regions that have acute energy needs. The term 'developing' is used in this sense throughout the paper.

Renewable Energy Trends in Developing Countries

The Social and Economic Dimensions of Renewables

Energy is an essential consideration in development, and choices taken in the near future will have far-reaching consequences on development, impacts on global change and the sustainable use of ecosystems and non-renewable resources.

The need for access to energy is pervasive. *Fig. 3* indicates how every facet of an economy requires access to energy services in one form or another for sustainable development [6].

It stands to reason that the most important aspect of the energy debate is the type and quality of service that energy provides to the users. Decisions as to what is the best energy source for specific needs, are determined by how an energy service comes about. With respect to developing contexts, the decision to use certain types of energy sources will be influenced by considerations such as accessibility of the fuel resource; efficacy to perform specific tasks; and the speed and reliability of service. More importantly, however, such decisions will be based on costs and affordability vis-à-vis available options. Therefore, for renewables to gain social acceptance, they need to fulfil specific criteria. The needs of developing communities are simple: they need clean water; warm houses; cooked food; to engage in agriculture and other income generating activities; easy access to health and school facilities; and so on. The energy infrastructure provided should assist in meeting these broad social and economic needs. Sadly, in many instances, renewable energy options have been introduced with scant regard to the community needs they seek to address. For example, solar PV projects have been imple-

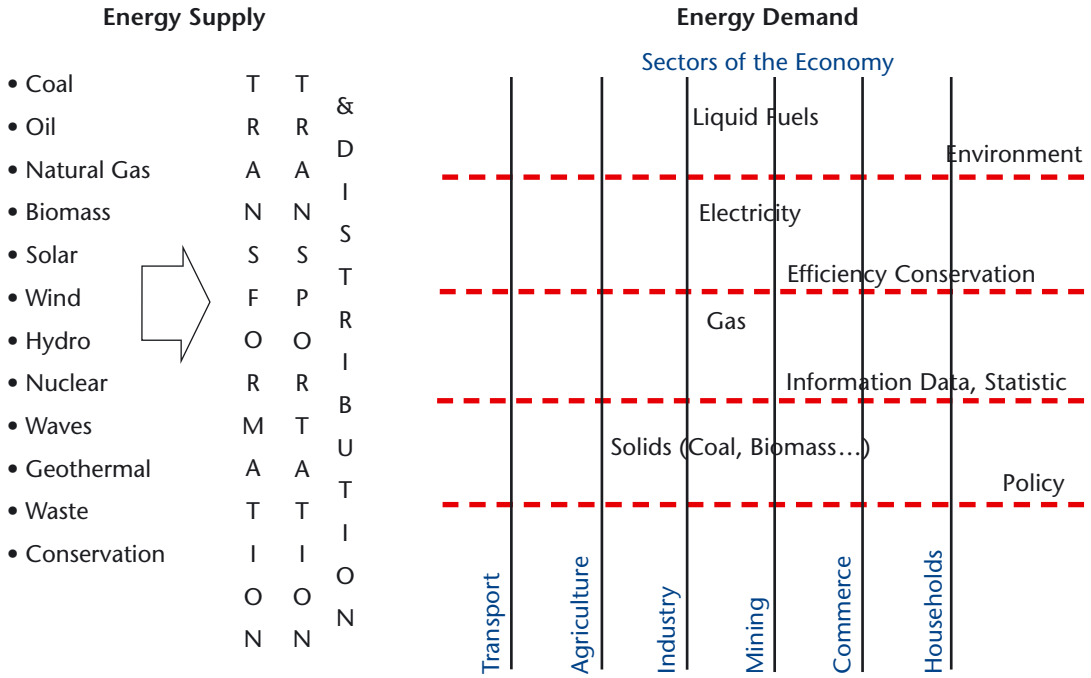

Figure 3
Energy in the economy [6]

mented in areas where the priorities of targeted communities were clearly thermal (cooking and heating).

Technology Options

Linked to the socio-economic dimensions of energy options is the question of the energy technology choice. While the potential for an array of renewable energy sources is prevalent in developing countries, the technology choices selected are, unfortunately, seldom informed by local conditions. For instance, issues such as community preferences, energy-use behaviour (e.g. cooking inside or outside; time of cooking, etc) and multiple-fuel use are often overlooked when technologies are introduced, particularly renewable energy technologies. In selecting technology options, care should be taken to consider aspects such as community fit, and cultural traits. In some communities, for instance, the use of human excreta to generate biogas goes firmly against the local culture and community etiquette.

It is also important that whatever viable technologies are selected, they should serve broad development needs – more importantly they should provide income-generating opportunities. For example, the majority of RET components are wholly imported to developing countries. This has ramifications as far as social acceptance is concerned. Where local production is non-existent, communities benefit little apart from selling the technologies. Local production of at least some components of RETs is crucial not only in providing much-needed job opportunities, but in ensuring a sustainable local production industry. Technology transfer should not be defined as indiscriminate distribution of renewables, but as skills and knowledge transfer, particularly in the manufacturing and maintenance of technology components. Most developing countries are considered as the market for ready-made, off-the-shelf RETs. Surely, this attitude needs to change.

Policies on Renewables

It is unfortunate that RE policy instruments are non-existent in many developing countries. This goes against the global pattern which prioritises renewables in countries' energy policies. How many countries in Africa, for example, have renewable energy policies? Where policies exist, how many countries have RE implementation strategies? The absence of such policy frameworks impedes the introduction of RETs as projects to accelerate renewables are often ad hoc and do not follow a strategic direction. This is a recipe for failure. To be fair to developing countries, national priorities often dictate that the focus should be on pressing and immediate needs, such as combating deadly diseases,

Figure 4 (left)
Village with renewable energy access

Figure 5 (right)
Collection of fuelwood is time-consuming and detains people from income generating productive activities

alleviating malnutrition, providing clean water, etc. Focusing on RE which is perceived (though may not be necessarily so) as small-scale, rural and therefore less important than large-scale capital projects. Also, it appears that the policy vacuum is also caused by a dearth of information that would facilitate the introduction of renewables, such as baseline studies on energy needs. The challenge this poses to RE practitioners is how to explicitly link renewable energy production, distribution and consumption patterns to national priorities.

At regional level, policies or approaches to disseminate RE are seldom harmonised. Regional institutions such as power pools and development communities exist and can be used as platforms to harmonise RE policies, as well as assisting member countries to formulate appropriate policies. All things being equal, the cornerstone to relevant and informed policies is the availability of research centres at national and regional level to provide updated baseline information as well as to develop new technology options. The developing world has fewer centres of excellence to support policy decisions, particularly on renewables. Some of the existing centres lack capacity as the best personnel emigrate to developed regions of the world due to lack of adequate resources (mainly lack of funding and institutional support) to implement appropriate R+D programmes.

A Paradigm Shift to Technology Development: Renewables and Sustainable Development

Whose Development, Whose Problem? Thinking with the People and not for the People

The above discussion suggests that perhaps one of the impediments to uptake of renewables is the manner in which solutions are conceptualised and implemented. In many instances, the energy problems of developing countries are assumed, and there is no proper research done on how such problems are viewed by the people concerned. Even when such problems are properly researched, solutions are often planned far away from the target communities. Surely, if the poor can articulate their problems and needs, solutions should also be discussed with them as well. In many instances, it may not matter so much what type of energy technology is provided, but the service that such technology provides is of crucial importance.

Thus, there is a need for a paradigm shift to development, not only in theory, but also in practice. People in developing countries should not be passive actors in their own development. Granted, they may not be aware of technological innovations, but this does not justify their exclusion in problem-solving strategies. The overriding reason for introducing RETs in developing countries should not only be driven by the need to open up new markets or to serve the concerns of the affluent about environmental issues, but by the expressed desire to complement strategies aimed at reducing poverty. For instance, the primary development problem of the developing world is poverty, not access

Figure 6
Solarhome system as example for a decentralised distributed electricity generation

to energy. The latter is the symptom of the former. RE dissemination strategies should be informed by this fact, and should be directed at poverty alleviation.

Appropriate Technology Options

The paradigm shift mentioned above suggests that education is essential before solutions can be devised. This education must be two-pronged: firstly about assuring that the developed countries understand the real needs of the developing countries and, secondly, the developing countries learning about new technologies to address energy needs. The infusion of this two-pronged education should form the basis for effective partnership in halving the levels of world poverty by 2015, as espoused by the Millennium Development Goals. Indicated above is that some wonderful technologies introduced in developing situations become spectacular flops. This may not be caused by an inferior type of technology. The failure is often due to the fact that such technology does not serve the community's expressed needs, or that the community does not understand the technology. Appropriate technology options are arrived at by understanding the developing world's priorities and the provision of technology options to match such priorities. It is therefore important not only to think of the technology, but also the downstream issues related to the use and maintenance of the technology.

Overcoming Research and Development Barriers: The Challenge for Developing Countries

The above discussion highlights that as far as developing countries are concerned, addressing energy needs is not simply the provision of technologies to meet the needs of society. Energy poverty is simply an indicator of general development challenges, which are defined by levels or degrees of impoverishment. Besides the obvious reason that most RETs that are introduced in poor rural areas are unaffordable to many people, these technologies are not used on a large scale even if they are heavily subsidised, or provided free of charge through grant funding. Does this mean that RE is 'the most expensive energy option for poor people' as it is viewed in some circles? This question can be answered by posing another question. Why, even when RETs are given for free, do they not gain widespread acceptance by people who use inferior fuels? In answering these questions, the R+D capacity in developing countries needs highest consideration. Without adequate capacity, such countries will not have the ability to develop home-grown policy frameworks, innovative technologies and processes of implementation. All things being equal, the development needs of RE can be achieved through three interlinked actions:
(a) appropriate technology;
(b) appropriate business models; and
(c) local production of RETs.
Once all these are achieved RE options would, for all intents and purposes, gain local acceptance. A brief discussion of each action plan is presented below.

R+D Focus 1: Appropriate Renewable Energy Options

At the end of the day, solutions (i. e. technology choices) have to reflect the needs and preferences of the target community. What is the community preference: do they prioritise thermal needs over lighting or vice versa? Examples abound of solar PV for lighting projects where a community's expressed need is for thermal energy services, for cooking and heating.

Figure 7 example for the utilisation of wind energy

Secondly, technology solutions mean little if they are not explicitly linked to other development needs. Does the introduction of a technology improve people's lives in terms of facilitating other important services such as the availability of vaccines, clean water, better transport, user-friendly appliances (that meet local preference), warm houses, etc? To what extent are technology sources or renewable energy choice in harmony with regional, country or government development priorities?

Thirdly, communities need to be exposed to an array of technology options available, so that they could make informed decisions as to the best option to meet their needs. Such exposure enables the users to select options that meet a variety of needs. Introducing only a technology that meets a single need may be counterproductive in promoting renewables. For instance, when a solar PV system is introduced for lighting, other solar technologies, such as solar cookers, solar water heaters, passive solar designs, should also be introduced in order to cater for most household and community energy needs.

Fourthly, education and public awareness are crucial for renewable technologies to be accepted by communities. Public perception on the quality and performance of RETs has long been identified as the key barrier to renewables in poor areas. Such perceptions – that renewables are energy supplies of second choice – are informed by past experience with low quality, fly-by-night technologies which flooded the market in the early days of renewable energy penetration. News travels fast in developing areas, particularly in Africa. Many people who have negative perceptions of the performance of renewables may not necessarily have experienced renewables first hand. These perceptions can only be addressed by a targeted public awareness and education processes that are aimed at both the users and producers of RETs.

Fifthly and related to the above, there is a widespread perception that renewables are second grade sources of energy. Such perception can be illustrated as thus:

Renewables = solar PVs = energy of 2nd choice = rural applications = poor people

This equation often results from the way in which renewables are promoted in developing countries. Renewables projects often promote a single technology (which is often solar PV or solar cookers) and promoted by people who themselves have never used this technology choice in their households. Again, the tendency is to concentrate on rural applications when grid electricity is not financially viable. Urban centres, where substantial economic activities are situated are often served with conventional energy sources. Sadly, this leads to the conclusion that renewables and its technologies are reserved only for the poor. As a starting point, it is important to ground the use of renewables firmly in developing countries. The best way to start is to focus more on urban centres where economic activities are centred and on urban households most of which could afford to pay for the new technology options. This requires (including capacity building as illustrated above) an innovative marketing strategy.

Lastly, it must be recalled that current renewable technologies may not address all the energy needs of developing countries. Therefore, RE should be promoted as one of the energy options that can perform certain tasks well. RE options can work better if introduced in a basket with other energy options, such as gas, i. e. energisation.

R+D Focus 2:
Effective Business Models to Promote Renewables

When renewables are viewed as energy options for the rural poor, the tendency is to provide these at little cost to the users. This 'developmentalist' approach was preferred especially by multilateral organisations and by other international institutions. The rural 'markets' were flooded with technology, wholly imported from the north, with little consideration to their long-term sustainability. The track record of donor programmes is poor in creating and sustaining rural enterprises for RE delivery, and has, in fact, contributed to the negative perceptions outlined above. There is a realisation now that donations (of renewables) without cost recovery actually destroy the market. Still, some donors continue to provide capital cost subsidies in order to boost the renewable energy market. There is a growing consensus that commercialising renewables could work positively for the dissemination of these energy sources in a sustainable manner. However, proper research and development on effective business models is in its infancy. Various models are being piloted across the developing world, ranging from vendor-supplied credit, micro credit, equipment rentals, etc. The bottom line is that new business models are needed with the focus on entrepreneurship and innovative finance schemes. However, the danger here could be that purely market-driven approaches may leave the very poor behind.

With respect to developing countries, there is a need for an R+D process that has the following components:
(a) as a clearing house of innovative business plans;
(b) international best practices and amplification of success stories;
(c) innovative finance which does not only provide start-up finance, but also provides for business development training; and
(d) as a source of skills to select technologies.

It should also be remembered that business models become effective if there is a market and a demand for the services provided. Unfortunately, this aspect resides outside the realm of renewables, to the broader development of the society as a whole. The market is defined here as the demand for the services and the ability of consumers to pay for them. This is different to the need for energy services. One of the downsides of renewable energy dissemination strategies is the virtual absence of viable markets. Therefore, RE strategies, including new business models can only succeed in so far as the community is developed enough to demand and afford such services. This calls for the integration of RE to other development needs, such as employment creation, increased household income, education, etc. It is often said that sustainable solutions to energy problems rely mostly on non energy interventions.

R+D Focus 3:
Local Manufacture of RETs Components

Most RETs currently in the developing markets are fully imported. Even in fairly advanced countries in the developing world, more than 50 % of renewable energy components are imported from the north. This asymmetrical situation needs to be changed if the renewables industry is to be sustainable in developing countries. There should be a long-term strategy in place for knowledge transfer. Granted, some technologies cannot be fully manufactured in developing countries and may need to be imported. However, if the rationale is to increase the share of renewables in the national energy economies, significant investments have to be made in local production of RE components. This area requires immediate intervention as it could have positive spin-offs: increased technical capacity and innovation in science and technology in developing countries, more jobs created due to the labour-intensive nature of renewable energy production, etc. Local production of RETs may be a long-term source of revenue for municipalities, and can, as well, be integrated in other municipal issues such as landfills, sewage treatment and waster disposals). [1]

Concluding Remarks

The R+D needs in developing country on renewables clearly go beyond technology solutions to encompass social and economic considerations,

i.e. the so-called "downstream" issues of technology. The above discussion highlights these broad development issues associated with technology options. Having identified these issues and needs, what is then the way forward as far as renewable energies are concerned in the developing world context? Before proposing some recommendations, it should be emphasised that energy poverty in developing countries cannot be addressed using purely market approaches, nor can they be resolved by a strictly developmentalist approach. The solutions lie somewhere in the middle. Below are value propositions on the way forward.

Regional Cooperation in Research and Development

Energy development knows no boundaries. In fact new strategies work better when they are implemented across a region, rather than only in a country-specific context. Global partnerships are a testimony to this development. Partnership is not simply about brotherhood, but a conscious strategy to mobilise scant resources and share experience across more than one country. Research and development of a technology, process of implementation or financing strategy stand more chances of success if the focus is cast wider than a single country. There is cooperation at the regional levels in many developing countries. The mandate of regional cooperation should be expanded to include research and development.

Database of Renewable Energy Technologies

It is very difficult to formulate effective policies based on insufficient and often invalid data sets. Many experts agree that lack of information on energy demand and consumption makes it near impossible to devise effective implementation and planning strategies. It is not even known how many renewable energy technologies are currently in use in developing countries. In addressing the question of data gaps, national and regional databases need to be created and periodically updated. R+D centres of excellence, such as the Global Research Alliance partners can be utilised to maintain these databases.

Innovation in Rolling Out Renewables

There is a glimmer of hope as far as innovative strategies to disseminate renewables across the developing world. In Africa, the UNEP funded programme, AREED (African Rural Energy and Enterprise Development) in partnership with E+Co is implementing an entrepreneurial approach in energy service provision. This programme is still very small-scale and also promotes other cleaner fuels such as bottled gas. In South Africa, a concession model, public-private partnership provides a fee-for-service mechanism to provide poor households with a basket of energy options including renewables. This model is, however, heavily subsidised by the national government. Across the continent and in South Asia, various ESCOs models are being piloted. These attempts provide a shift from a conventional developmentalist approach to more sustainable, profit-driven implementation strategies. Be that as it may, the impacts of these new models remain largely untested, and experiences have not been properly documented. In addition, recent experience shows that these innovative strategies do not reach the poorest sectors of the developing world.

Harmonisation for Energy Policies

Linked to the above points, an enabling environment has to be created for renewables. All developing countries have to have policy instruments to regulate renewables imports, production, dissemination and use. Moreover, as stated above, technology knows no boundaries. Therefore, policies should be harmonised so that a sustainable market for RE would be created. Prevailing policy instruments can be used and/or adopted to perform this task. Regional cooperative trade agreements between countries can be utilised to assist in the harmonisation of the renewable energy policies and assist countries that are without policy frameworks.

The discussion in this paper points to the fact that the developing world is willing and ready to take a centre stage in accelerating the use of renewables. It also argues that the best way to go about this is a formation of an effective partnership between North and South, as well as South and South. The former ensures skills and knowledge transfer and the latter ensures that best lessons are learned. The time is now!

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Capacity Building for Sustainable Energy Development and Poverty Alleviation in Sub-Saharan Africa – the Contribution of AFREPREN

About AFREPREN

African Energy Policy Research Network & Foundation for Woodstoves (AFREPREN/FWD) is an African initiative on energy, environment and sustainable development. AFREPREN/FWD brings together 97 African energy researchers and policy makers who have a long-term interest in energy research and the attendant policy-making process. AFREPREN/FWD has initiated policy research studies in 19 African countries, namely: Angola, Botswana, Burundi, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia and Zimbabwe.

AFREPREN/FWD's ultimate goal is to promote the greater use of cleaner energy options such as renewables for poverty alleviation in Africa. The near-term objective of AFREPREN/FWD is to strengthen local research capacity and to harness it in the service of energy policy making and planning. Initiated in 1987, AFREPREN is a collective regional response to the widespread concern over the weak link between energy research and the formulation and implementation of energy policy in Africa.

Since its initiation, AFREPREN has successfully implemented over 90 research projects involving 234 African researchers and policy makers in 19 countries of Eastern and Southern Africa and forged collaborative links with West, Central and North African energy researchers and policy makers. Findings of the research undertaken by AFREPREN have been published in 13 major publications, one Energy Policy special issue journal, 24 Occasional Papers, 37 journal articles, 23 book chapters and over 300 Working Papers. Since 1987, AFREPREN has had an ongoing major research programme on renewables.

The current phase due to end in 2004 also has a major programme on renewables. Entitled **"Renewables and Energy for Rural Development"** the programme is examining options for the provision of modern energy services to low-income rural areas of Africa with special emphasis on the commercial/services/productive uses of energy.

Other ongoing major programmes of AFREPREN include:

- Energy Services for the Urban Poor
- Energy Sector Reform
- Special Studies of Strategic Significance for the Energy Sector in Eastern and Southern Africa (ESA)

Additional information on these programmes is available on the AFREPREN website (www.afrepren.org).

AFREPREN's Renewable Energy Research Programmes

As mentioned earlier, AFREPREN has undertaken extensive research work on renewables in all the research phases running from 1987. The past research phases examined the fundamentals of renewable energy technologies, and the status of their dissemination in selected African countries.

In the ongoing research phase of 1999–2004, one of the core research theme groups was titled "Renewables and Energy for Rural Development". The theme-group objective is to identify options for the provision of renewable and sustainable energy services to low-income rural areas of Africa with special emphasis on commercial/ service/ productive use of energy.

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Objectives of the Theme group

- Analysing the impact of current renewables and rural energy policies.
- Assessing current rural household and community energy practices and technologies.
- Reviewing rural income generating activities and energy technologies used.
- Establishing what is hindering the removal of identified barriers in the dissemination of renewable energy technologies (e.g. absence of rural entrepreneurs, funding mechanisms, capacity building and policy).
- Assessing the gender dimension of renewables and rural energy.

Key Research Issues

- Impact of the government and utilities policies, programmes and institutional framework on the provision of renewables to rural areas.
- Analysis of existing decentralised private sector energy production and distribution activities in rural areas.
- Comparative analysis of renewables and rural energy use in rural areas.
- Analysis of components for promoting the production and deployment of renewables and rural energy by private entrepreneurs.
- Gender sensitivity of government and utilities' policies and programmes on the provision of renewables and rural energy for domestic use and for income generating activities.
- Gender analysis of energy practices in rural households and energy use in rural income generating activities.
- Impact of the gender derived and gender driven power relations at the household and community levels in the use of modern energy.

Based on the above research work, AFREPREN has over the years published a wide range of journal articles, research reports, working papers, occasional papers and major publications on renewables. These publications are distributed widely to energy sector stakeholders in Africa, as well as other parts of the world. The objective of these publications is to inform decision makers in policy making. Some of the key publications on renewables published by AFREPREN are provided in Annex 1.

AFREPREN's Energy Training and Capacity Building Programme

The number of African energy policy analysts has grown in the last few years as a result of training programs and capacity building initiatives of various training institutes, development programs and networks such as the African Energy Policy Research Network (AFREPREN). The supply of skilled energy policy analysts is, however, still insufficient. This is partially due to the difficulties faced by formal education institutions in Africa. African policy analysts have identified important constraints facing formal energy education in Africa. Key problems include the following:

- A high attrition rate of senior and experienced staff from institutions of higher learning due to the erosion of teaching and research conditions;
- Inadequate remuneration for the academic and supporting staff;
- Lack of funds for research, conference attendance and institutional attachment;
- Inadequacy in the provision of external examiners and opportunities within these institutions for staff exchanges; and
- Scarcity of funds for the purchase of textbooks, journals and equipment.

AFREPREN's training and capacity building program is designed to assist capacity building in the region and to address the above shortfalls by building on the substantial expertise and information that AFREPREN has developed over the last 10 years. AFREPREN has built substantial expertise in energy policy analysis as well as published a large body of literature on African energy issues. It has published 11 major books and over 200 Working Papers on the African energy sector as well as a diskette set and CD-ROM on African energy issues. AFREPREN has also established a substantial library of over 20,000 documents, books and journal articles covering various energy issues. It also has access to a wide range of diskettes, CD-ROMs, audiotapes and videos on energy issues. With links to over 100 African energy experts and numerous international energy agencies and experts, AFREPREN is well placed to assist in training and strengthening up

coming African energy professionals in energy policy analysis skills.

AFREPREN runs the following key training and capacity building programmes:

Masters Program:
- Support for MSc or MA research studies on energy policy
- Support for MSc or MA in energy policy subjects

In future, AFREPREN plans to launch a joint AFREPREN/Universities MSc/MA training programme in Africa.

To date, a total of 15 scholarships have been offered to candidates from Eastern and Southern Africa.

Regional Short Term Training Courses:
- Short-Courses for energy policy makers
- Research Techniques and Methodology Workshops
- IT Workshops

A total of six courses have been undertaken in the 1999–2004 research phase, and about 80 African energy researchers and stakeholders have participate in these courses.

Regional/National Policy Seminars:
Regional and national events organised by the AFREPREN Secretariat and the national focal points in AFREPREN member countries. The main objective is to disseminate research findings to national policy makers and researchers. In the 1999–2004 research phase, over 25 national and regional policy seminars have been organised in AFREPREN member countries.

The training and capacity building programmes mentioned above cover a wide range of energy subjects including renewable energy. The next section describes AFREPREN's renewable energy programmes and contribution to the international conference on renewables held in Bonn, June 1–4, 2004.

Figure 1
East and Horn of Africa: Ethiopia, Kenya, Uganda and Tanzania

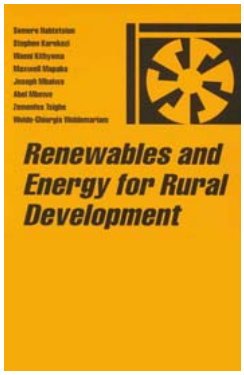
Contribution to the International Conference on Renewable Energies

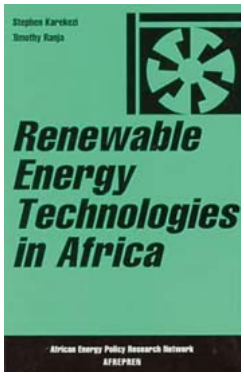
AFREPREN, with support from Sida/SAREC and the Heinrich Böll Foundation, organised a side event titled: 'What are the Benefits of Renewables in Africa?' This side event, the only one with a dedicated focus on Africa, was organised to present the findings of the study on Renewables in East and Horn of Africa, which is coordinated by AFREPREN with funding from the Heinrich Böll Foundation office for East and Horn of Africa. Approximately 50–80 people attended the side event, drawn from different geographical regions and institutional affiliations. The bulk of participants, were, however, Africans.

The study was launched by AFREPREN and HBF (Regional Office for East and Horn of Africa) and its main objectives were:
- To examine the viability of 10% renewables target proposed at the Johannesburg WSSD Summit in selected African Countries
- To assess the benefits and drawbacks of the 10% renewables target in Eastern Africa

The study was undertaken in four countries: Kenya, Uganda, Tanzania and Ethiopia *(Fig. 1)*. In parallel to the country studies, a regional study was also prepared. The study also included national level consultations in the four countries,

AFREPREN's Renewable Energy Title Series:





as well as regional consensus building and brainstorming on the regions' priorities for renewables.

One of the key outcomes of the study was the dissemination of information on renewables to policy makers in the four East and Horn of African countries participating in the study. In addition, renewable energy technologies that have a direct impact on poverty alleviation were also highlighted, and are beginning to receive attention from policy makers in the region.

Contribution to the International Action Plan – Renewables 2004 Conference

AFREPREN in conjunction with the Heinrich Böll Foundation, Regional Office for East and Horn of Africa, submitted a commitment, which was included in the International Action Plan. The International Action Plan was one of the major outcomes of the Renewables 2004 conference, and is a compilation of voluntary actions from governments, international bodies, NGOs, national and regional institutions.

The Action plan submitted by AFREPREN and HBF has a strong focus on the dissemination of small and medium scale renewables, which can alleviate poverty. The objective of the action is to develop a prioritized listing of small and medium scale renewables and cleaner energy options suitable for poverty alleviation in Africa that can be implemented in the region.

A growing number of experts within the AFREPREN Network believe that these technologies would have the greatest impact on alleviating poverty and enhancing economic development in sub-Saharan Africa. AFREPREN will continue to promote these technologies, and undertake research studies and assessments, which can be used to lobby policy makers and other stake-holders.

Other Contributions

AFREPREN participated in the conference plenary sessions, namely:
(i) Multi-stakeholder Dialogue
(ii) preparation of a summary for one of the conference ministerial sessions
(iii) participation in the Science Forum.

Annex 1: AFREPREN's Renewable Energy Title Series

Renewables and Energy for Rural Development in sub-Saharan Africa

Edited by Maxwell Mapako and Abel Mbewe (2004)

Energy supply is a key factor in economic and social development, but too little attention has been given to the needs of rural households, farmers and small businesses. Rural households in sub-Saharan Africa still derive most of their energy from biomass sources. Lack of modern energy supplies in rural areas constrains efforts to alleviate poverty and improve living standards. Renewables and Energy for Rural Development in sub-Saharan Africa addresses this situation.

The original research contained in this volume identifies the options for the provision of modern and improved energy services based on renewables to low-income rural areas, with special emphasis on the productive uses of energy. In the five countries represented – Botswana, Eritrea, Ethiopia, Zambia and Zimbabwe – the volume focuses on whether a decentralized approach to energy delivery is better than more centralized provision, the role of income-generating activities in attracting modern energy services to rural areas, and the barriers as well as opportunities that exist in the promotion of renewable energy technologies in the rural areas of sub-saharan Africa.
This latest volume is a further contribution to addressing the practical energy needs of sub-Saharan Africa.

Renewable Energy Technologies in Africa

Stephen Karekezi and Timothy Ranja (1997)

The energy sector is widely acclaimed as the heart and lungs of any programme for economic development. At the same time, energy at household level and in the rural areas is essential for everyday life. Renewable energy technologies can play a major role in both respects. This book sums up across the whole of Eastern (including the Horn) and Southern Africa (including South Africa itself) what is now

known about the innovation and deployment of renewable energy technologies in the region.

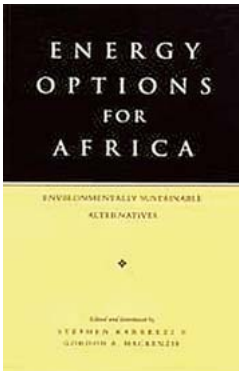
Successive chapters deal with bio-energy, solar and wind energy and small hydro technologies. The authors examine the African energy sector's overall geo-political and socio-economic setting as well as specific non-technological factors that impinge on renewable energy development, namely: financing, institutional structures for energy management, human resource development, equity and access, and environmental considerations. The book, which concludes with a special section on policy recommendation, provides an essential text for training a new generation of African energy specialists.

Energy Options for Africa: Environmentally Sustainable Alternatives.
Edited by S. Karekezi and Gordon Mackenzie. (1993).

As African economies seek to recover from what is commonly now described as the 'lost' decade of the 1980s, energy policy has become a crucial component in the region's industrial, transport and environment strategies, and in meeting household fuel needs.
This volume is a guide to policy makers and development agencies for determining environmentally sound energy options and priorities for the region. The contributors – leading energy and environment specialists from Botswana, Ethiopia, Ghana, Kenya, Nigeria, Senegal, Sierra Leone, Sudan and Uganda – identify the key requisites for such development: innovative policy instruments and institutions, and incorporation of environmental costing; mobilization of both local and external financial resources; management training and technology acquisition; energy efficiency; increased supply of environmentally benign modern fuels and energy technologies.

Energy for Rural Development.
Edited and Introduced by M.R. Bhagavan and S. Karekezi. (1992).

This book contains essays presented at a United Nations Meeting of Experts on the Role of New and Rural Development. With an introductory essay by the Swedish-based energy policy analyst Dr. M.R. Bhagavan and the Kenya Based Facilitator of the African Energy Policy Research Network (AFREPREN) Stephen Karekezi, the volume comprises national and regional studies examining the technological, economic, political, social issues concerned with energy for rural development, raising questions on productivity, income, institutions, local participation, information and assessment of resources and technologies. The studies relate to the rural situations in sub-Saharan Africa, North Africa, North Africa and the Middle East, South and East Asia, Central America and the Caribbean Eastern Europe and the Soviet Union. Each study is written either by local energy specialists and academics or by experts associated with the United Nations and its Agencies.



Energy Options for Africa

Energy for Rural Development

Annex 2: AFREPREN Journal's Articles on Renewables, Rural Energy And Poverty

[1] "Domestic Use Versus Income Generating Activities in Delivering Modern Energy to Rural Botswana." Joseph Mbaiwa and Oganne D. Gontse in Journal of Energy, Published by JESA. February 2004.

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[8] "Energy, Gender and Poverty Issues and their Linkages with Energy Policy and Planning". Abel Mbewe. In Renewable Energy, Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[9] "Rural Energy Access: Promoting Solar Home Systems in Rural Areas in Zambia – A Case Study". Oscar Kalumiana. In Renewable Energy, Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[9] "The Potentials of Wind Energy Applications in Eritrea". Semere Habtetsion. In Renewable Energy, Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[10] "The Case for De-Emphasizing PV in Renewable Energy Strategies for Rural Africa". Stephen Karekezi. In Renewable Energy, Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

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[13] "Renewables in Africa – Meeting the Energy Needs of the Poor". Stephen Karekezi. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[14] "Renewable Energy Strategies for Rural Africa: Is a PV-Led Renewable Energy Strategy the Right Approach for Providing Modern Energy to the Rural Poor of Sub-Saharan Africa?" Stephen Karekezi and Waeni Kithyoma. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[15] "Disseminating Windpumps in Rural Kenya – Meeting Rural Water Needs using Locally Manufactured Windpumps". Mike Harries. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[16] "Renewable Energy for Rural Development in Ethiopia: The Case for New Energy Policies and Institutional Reform". W. Wolde-Ghiorgis. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[17] "The Energy Sector in Eritrea – Institutional and Polity Options for Improving Rural Energy Services". Semere Habtetsion and Zemenfes Tsighe. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[18] "The Impact of Large Renewable Energy Development on the Poor: Environmental and Socio-Economic Impact of a Geothermal Power Plant on a Poor Rural Community in Kenya". Nicholas Mariita. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

[19] "Promoting Equity in Large-Scale Renewable Energy Development: The Case of Mauritius". Kassiap Deepchand. In Energy Policy, Volume 30, Nos. 11-12. Published by Elsevier Science Limited, Oxford, United Kingdom, 2002.

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Annex 3: AFREPREN's Occasional Papers on Renewables:

No. 1 AFREPREN Regional Policy Seminar on Renewables – Focus: Cogeneration
S. Karekezi, J. Kimani and J. Wangeci (eds)

No. 2 Bagasse-Based Cogeneration in Mauritius – A Model for Eastern and Southern Africa
Kassiap Deepchand

No. 3 Energy for Rural Development in Botswana – Proceedings of a National Policy Seminar
B. Mogotsi & S. Bok (eds)

No. 4 Energy for Rural Development in Zimbabwe – Proceedings of a National Policy Seminar
M. Mapako (ed)

No. 6 Energy for Rural Development in Zambia – Proceedings of a National Policy Seminar
L. Chandi, A. Mbewe & C. Mulenga (eds)

No. 9 Energy for Rural Development in Eritrea – Proceedings of a National Policy Seminar
S. Habtetsion and Z. Tsighe (eds)

No. 10 Renewable Energy Technologies in Africa – An Energy Training Course Handbook
S. Karekezi, W. Kithyoma & L. Majoro (eds)

No. 11 Energy for Rural Development in Ethiopia – Proceedings of a National Policy Seminar
M. Teferra (ed)

No. 12 The Socio-Economic and Environmental Impact of Geothermal Energy on the Rural Poor in Kenya
N. Mariita

No. 19 Cogeneration in Zimbabwe – A Utility Perspective
B. Batidzirai

No. 21 Opportunities for Cogeneration in a Reforming African Power Sector
Kassiap Deepchand (ed)

No. 22 Renewables and Rural Energy Development in Botswana: Proceedings of a National Energy Policy Seminar
J. Mbaiwa (ed)

No. 24 The Potential Contribution of Renewables in Ethiopia's Energy Sector: An Analysis of Geothermal and Cogeneration Technologies
Prof. W. Wolde-Ghiorgis

Copies of the Occasional Papers and abstracts of the journal articles can be downloaded from the AFREPREN Website (www.afrepren.org).

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Possible Cooperation between Arab and European Countries in Energy, Water and Environmental Issues

Abstract

The Arab countries, in general, lack energy and water. The average annual rain level in Arab countries is from 5 to 45 mm while in European countries it ranges from 200 to 400 mm. The total internal water reserve is only 100 km^3 for Arab countries, while in Europe it may exceed 400 km^3; bearing in mind that the world internal water reserve is 43764 km^3. Nearly more than 50 % of the Arab countries have water availability per capita less than the absolute water scarcity level (200 m^3/capita/year) while the rest, except Iraq, are in water scarcity threshold level (1000 m^3/capita/year) [1]. In Europe, the per capita water resource is as high as 85478 m^3/year (Norway). In fact among the countries with least water resources [2] we have 13 Arab countries (Kuwait, UAE, Qatar, Libya, Saudi Arabia, Jordan, Bahrain, Yemen, Oman, Algeria, Tunisia, Egypt, Morocco and Palestine) where the per capita water resource is ranging from 10 m^3/year (Kuwait) to 971 m^3 year (Egypt).

On the other hand, the electricity consumption per capita in West Europe per year has never been less than 4000 kWh in 1999 while it is as low as 46 kWh in Sudan. In the majority of the Arab countries, except Arabian Gulf countries (GCC), each person consumes annually only 1200 kWh electricity (on average)! Probably more than one million of Arab citizens (out of ~ 300 million) have no access to electricity [2].

Furthermore, the European OECD countries are emitting 3800 Mt of CO_2, which is 15.2 % of the global emissions (25000 Mt). In 2001, the share of global CO_2 emissions from Middle East is only 4.8 % – compared to North America (27.7 %), East Europe (12.6 %), West Europe (15.6 %), Africa (8.8 %), central and South America (4.1%), Far East and Oceania (31.5 %). According to latest reports, Germany has managed to reduce emissions of CO_2 by – 20 % (compared to the base year), U.K. – 12.5 %, Italy – 6.5 %, France 0 %, Russia – 6 %, USA – 7%, Japan – 6 % [4]. Moreover, according to Swiss Re [4], in its report on Natural catastrophes and man-made disasters in 2003, nearly 36 natural accidents have occurred in Europe with 424 victims wasting US$ 2173 million (11.8 % share) while in middle east Asia 178 accidents have occurred with 51894 victims costing US$ 1447 million (7.8 % share).

Therefore, cooperation for a mutual benefit between Arab and European countries in the field of energy production using the abundant solar radiation is favorable.

Clean and sustainable energy could be exported to Europe in a form of High Voltage Potential, produced in Arab countries using solar thermal or photovoltaic technology. A part of the produced energy from renewable sources can be used for water desalination in Arab countries. For 65 % of water resources are politically in debate with non Arab countries – which may ignite Water Wars.

The Arab countries are characterized and blessed with abundant direct solar radiation, i. e., ranging from 4.1 kwh/m^2/day, Mosul, Iraq to 6.7 kwh/m^2/day, Nouakchott, Mauritania [5,6]. Even more, the maximum recorded annual mean sunshine duration ranges from 7.5 hrs, Tunis, to 10.7 hrs, Egypt. These figures are larger by, at least, 3 times compared to European Countries [5].

The temporal behavior of electricity demand in Arab and European countries is found to complement each other. Therefore, this vision of cooperation, will enhance the renewable energy utilization worldwide and it will increase to be more than the current level, i. e.,13.8 % from the total primary energy supply, where 2.3 % come from hydro, 11.0 % from com-

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bustible renewable and waste, and only 0.5 % are covered by solar (0.039 %), wind (0.026 %), tide (0.004 %), and geothermal (0.440 %) sources. The solar power market is already growing, in year 2000 by 1000 MW, for instance, and is expected to be 14000 MW by 2010 and up to 70000 MW in year 2020 [3]. This, of course, will minimize the cost per watt per each renewable energy source, especially solar thermal and photovoltaic ones.

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Capacity Building in Developing Countries – Bringing Renewable Energy to the People

General

"More than half the world's population lives in rural areas, nearly 90 % of them – some 2.8 billion – in the developing countries. The vast majority of these people is dependent on the traditional fuels of wood, dung and crop residue, often using primitive and inefficient technologies. For many, this combination barely allows fulfilment of the basic human needs of nutrition, warmth and light, let alone the possibility of harnessing energy for productive uses which might begin to permit escape from the cycle of poverty" (World Energy Council 1999, p. 7).

The international postgraduate study "SESAM-Sustainable Energy Systems and Management" at Flensburg University in Germany with nearly 20 years of international experience is offering a MSc course for participants from developing countries to tackle the global challenge of using renewable energy systems. The course is partially carried out in Germany and partially with partners overseas, like United Nations Development Programme (UNDP) in Nepal, and has produced graduates in more than 50 countries worldwide and numerous international co-operations in Africa, Asia and Latin America.

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Energy and Development

Although energy is still not considered as a basic human need it is required for meeting all of the basic needs such as food and health, and in this context also agriculture, education, information, and other infrastructure services and shows clear correlation with the Human Development Index HDI.

In order to tackle the core problems of environmental degradation, diminishing natural resources and increasing poverty an important "tool" in this process is the use of sustainable energy systems which represent an essential precondition for social and economic development of a country – together with the changing of attitudes, community mobilisation and transfer of knowledge.

"Among the key lessons learned in the provision of modern energy services in the developing world (particularly in rural areas) is that the services must give rise to greater productivity if they are to be sustainable. The facilitation of new productive activities is what creates sustainable livelihoods for poor people and makes the energy projects financially viable. Productive services include a wide range of activities such agro-processing, transport provision, battery charging, and small-scale manufacturing. Very often, particularly in dry areas, power is needed for water pumping to supporting agriculture. Various options, ranging from manual and animal power to photo-voltaics or wind pumps should be considered against the dual criteria of sustainability and affordability" (Khennas 2002, p.10).

Indeed – energy and development are closely related and energy was a prerequisite two

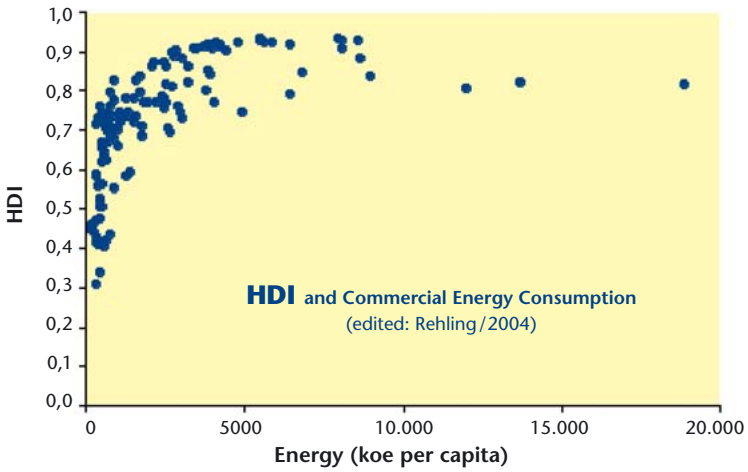


Figure1
HDI and Commercial Energy Consumption

Figure 2
Micro hydro station

centuries back for the breakthrough in economy and productivity in the nowadays industrialised countries. This interrelation of energy and development might be the base for the view that "Energy has many links with sustainable development, notably through productivity, income growth, environment, health, education, gender issues, macroeconomic stability, and governance" (Interview with Jamal Saghir, World Bank, in: Morales / Johnson 2002, p.3).

But how to make best use of that interdependancy of energy and development? What is the role of human resources? Learning lessons of various countries, organisations and projects can help to understand the mechanism….

A typical Example: Renewable Energy for Rural Electrification (SESAM 2002)

The Government in an Asian country commissioned a project in a village in 1991 and after installation it was handed over to the local Agriculture Collective to manage and operate it. The unit operated from 6 pm to 10 pm every day. Six years later in 1997 failures of the system were visible which seemed to be technology based:

- No frequency control equipment was installed on the existing system.
- Wooden poles were rotten and aluminium conductors were undersized, resulting in low voltage.
- Quality of the power was so low that the system lost paying customers and income revenue.
- Revenues from the sale of power were used to pay for projects unrelated to the operation and maintenance of the turbine system. Thus no funds were available when maintenance or repairs were required.
- The operators were insufficiently trained to do anything more than start up and shut down the plant.

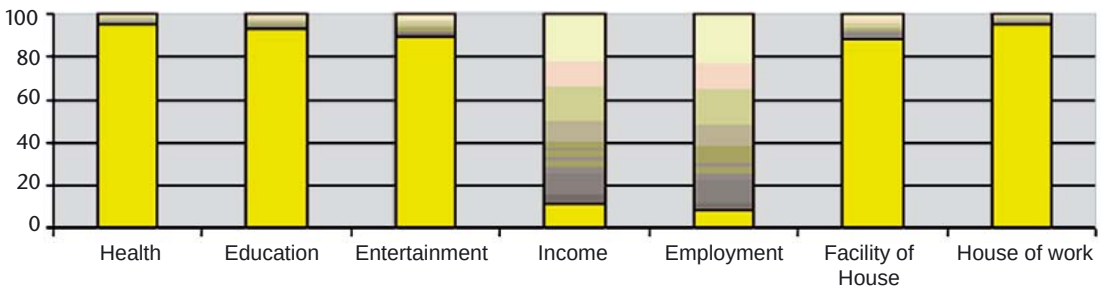
So the technical part of project was redesigned with new micro hydro station plus installation of a diesel generator, reconstruction of the electricity distribution system, and establishment of a battery charging system *(Fig. 2)*. The total budget for the project was 85,600 USD.

Running the system after re-opening for another 3 years the villagers were asked again whether positive changes had come from the project (in the graph dark colour means "no positive changes"):

The graph *(Fig. 3)* shows that improvement in income and employment as the main requirements and expectations were not fulfilled and so again the project came under financial crisis: about 50 % of the customers did not pay or could not pay because the income and employment situation had not increased.

Figure 3
Fulfillmet of requirements and expectations

= degree of fulfillment



Conclusion: latest renewable energy technology was provided but the planners had no idea of the non-technical aspects and the target group (villagers) did not participate in decisions, human resources were not trained or developed, economic situation did not improve: this kind of renewable energy project is not sustainable. In more than 100 similar case studies of SESAM in Africa, Asia and Latin America this kind of experience is (unfortunately) quite typical.

Human Resources for Renewable Energies:

To analyse, understand and solve the complexity of problems it is no longer suitable to just have a "tunnel" view which means just narrowing the view on aspects you like to see and not being capable to understand interdependancies with related aspects. Typical for tunnel views are technical solutions for development problems and under this category also falls "renewable energy for development".

Project evaluations and research studies clearly prove that the failures in implementation of energy technologies are mainly found in non-technical reasons and very often related to lack of awareness and lack of capable human resources: "In general, economic and information/awareness barriers were the most important obstacles across the countries and RETs (renewable energy technologies, author). This points to the low level of awareness and information on RETs among the potential users. Therefore, better ways to raise awareness are required… Small size of market, unfavourable policies, and subsidy to competing conventional fuels were other reasons that affected the economics of RETs further." (Painuly J.P./ Fenhann, J.V., 2002, p.37)

"A further factor that constrains the effectiveness of decentralised planning is the lack of sufficiently skilled people to carry it out. While collecting data … it is necessary, in addition, to introduce higher level training of planners." … "A further important lack of information is the one felt by rural people themselves. Although they know a great deal about traditional energy supplies and end-use options, very few of know about the potential of new technologies and modern fuels, making it difficult for them to contribute meaningfully to much of the planning process." (World Energy Council 1999, p.101)

Therefore the international MSc-course "SESAM-Sustainable Energy Systems and Management" aims to prepare participants to work in leading positions in national and international organisations as well as in businesses in order to promote sustainable development strategies and to implement energy concepts in the context of sustainable development. Of great importance in this context are key qualifications:

- ability to view problems/solutions in their entirety, i.e. a holistic approach
- creativity and openness to innovation
- inter-disciplinarily approach
- problem-solving ability
- social competencies and the ability to operate in teams.

Besides interdisciplinary study phases on technology and management with emphasis on renewable energy, project management and development strategies, environment and economy and socio-cultural aspects (10 months in Germany) participants will take part in a five months international study programme: two months with all participants as a group in an "International Classroom" and three months as individuals in field research. The international phase is in collaboration with partners like United Nations Development Programme (UNDP) in Nepal with its "Rural Energy Development Programme REDP". The partnership is to provide opportunity to apply the theoretical knowledge and skills in practical projects.

Experiences of the International Classroom with UNDP Nepal:

Every year the SESAM group went to Nepal to evaluate rural energy projects and to learn the phases of project implementation. Vice versa staff members of REDP/UNDP participated in project orientated seminars in Nepal during the Interational Classroom and staff members were

SESAM– Building Bridges between North and South

also taken for full SESAM MSc study course and within their own field research also evaluated technical, economical and socio-cultural changes, benefits and failures.

The Rural Energy Development Programme (REDP) is a joint programme of UNDP / World Bank and His Majesty's Government of Nepal which adopts a holistic approach for sustainable rural development, to enhance rural livelihoods and to preserve environment through the promotion of renewable energy systems (micro hydro, solar home systems, biogas, improved cooking stoves etc.) where possibilities of commercial energy supply do not exist. Specifically, the programme aims to have impact in the areas of

- promotion of efficient end-use technologies, including non-farm actitivies
- improved quality of life, especially for women and children
- rural capacity building and
- restoration of the natural environment.

Capacity building is a focus for REDP and SESAM: staff of both the institutions are in a continous learning process with different professional, technical and socio-economic experiences on one hand based on academic background, and on the other hand based on practical programme experience. Linking these two elements offers the chance for synergy-effects: academic training and education with application to programme identification, implementation and evaluation gives benefit to the international SESAM participants and the REDP staff likewise.

Especially the implementation of projects through community mobilization, bottom-up participatory planning and decentralized decision-making in energy development as well as producing human resources in renewable energy on national level down to grass-root level for nearly 1500 village technicians, about 4350 income generating and micro-enterprises, awareness and orientation on rural energy technologies for about 6000 people in the districts in Nepal and has successfully established more than 125 community owned micro-hydro schemes, about 3500 biogas plants and 1700 solar home systems (REDP 2003).

Main experience of the common learning process of SESAM and REDP / UNDP is:

- Renewable energy as a tool for social changes, for creating awareness and changing the role of gender is an encouraging perspective for rural development.
- Human Resource Development is an indispensable component of a country's development process: this is a must for national project and development planning and it is essential for the capacity of local groups (community members, locally elected bodies, NGOs, private sectors) to manage and operate rural energy projects in a sustainable manner.

Figure 6
Energy Wheel
Source: REDP 2002

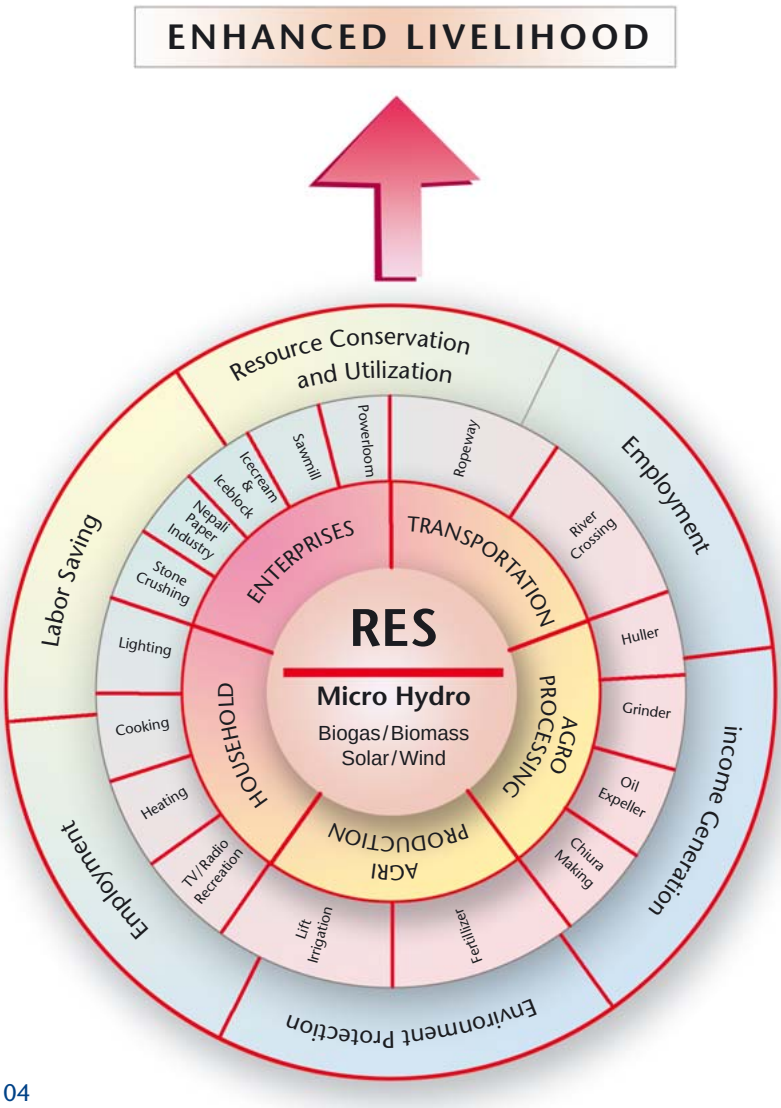


Figure 7 (left)
Practical Training for Rural Technicians (REDP 2000)

Figure 8 (right)
Awareness on rural energy in villages (REDP 2000)

- Basic energy services alone do not bring positive changes in the society: for sustainability people's participation is a must. Bringing people or mobilizing them (both men and women) into the mainstream of development process is essential before any kind of technology intervention
- Never promote energy projects in isolation: in rural and generally poor communities, the design must be essentially aiming at integrated development.
- Renewable energy projects are not auto matically sustainable: economic aspects with generating additional income is the most challenging task. Income generating activities through locally produced goods and services also depend on access to markets, number of potential customers (difficult in remote areas), diversification of products, and purchasing power in the villages.

And last not least:

- Combining university's academic education of SESAM with project implementation of UNDP/REDP as International Classroom has contributed in a significant way to the competency of the participants in both the institutions preparing them for leading positions in international projects.
- Since a number of years SESAM also uses internetbased course facilities to give more people the opportunity to participate in this global learning in the coming years.

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UNESCO's Global Renewable Energy Education and Training Program in a Latin American View

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Introduction

The Global Renewable Energy Education and Training Program (GREET) is implemented by UNESCO in the scope of the World Solar Programme with the aim to contribute to increase through education and training the capacity at national level to accomplish a sustainable energy development path.

The Latin America and Caribbean Region (LAC) are characterized by ample differences among countries in the region in relation with the energy situation, the social economic development and sustainability and capability in the society to advance in the process to meet the Millennium Development Goals.

Setting up of the GREET LAC Chapter would be a fundamental contribution to increase and consolidate the regional capacity to support the Renewable Energy development. For this reason, it is foreseen to start a consultation process that involving the key regional actors would make possible the design of the most appropriate Renewable Energy Education and Training Program for the Region. This document is a first step and its purpose is to develop a general description about how could be foreseen this program for the region.

International Commitment for a Sustainable Energy Development

The international community has expressed his commitment for a sustainable development approving the Millennium Development Goals (MDGs) during the Johannesburg World Summit on Sustainable Development (WSSD). The role of Energy for the achievement of the Millennium Goals is shown in Paragraph 19 of the World Summit on Sustainable Development (WSSD) Plan of Implementation adopted in Johannesburg. In particular request to:

> With a sense of urgency, substantially increase the global share of renewable energy sources with the objective of increasing its contribution to total energy supply, recognizing the role of national and voluntary regional targets as well as initiatives, where they exist, and ensuring that energy policies are supportive to developing countries' efforts to eradicate poverty, and regularly evaluate available data to review progress to this end.

Latin American Authorities have actively expressed their support to the conception of Sustainable Development and to meet the MDGs. Demonstration of this priority approach to the topic is the "Latin American and Caribbean Initiative for Sustainable Development", approved by the Seventh Meeting of the Inter-Sessional Committee of the Forum of Ministers of Latin America and the Caribbean on May 2002 in Sao Paulo, Brazil, that calls to adopt priority actions to address, among others, the sustainable generation of energy and the increasing participation of renewable sources. Particular significance in this context has the Brazilian Energy Initiative that called countries during the WSSD in Johannesburg to assume the compromise to "increase the use of renewable energy to 10% as a share of total by 2010".

Energy and Sustainable Development in Latin America

It is used to consider three main dimensions of the sustainable development: Environmental, Social and Economic. A brief remark about the connection of energy with every one of these dimensions in the region would be:

Environmental: Latin America is in general as for greenhouse gas emissions in particular a low emissions region. Those emissions due to burning of fuels in the region, account for less than 4% of global emissions and 7% of emissions in OECD countries (excluding Mexico). The energy system is relatively clean and emissions due to energy production, in particular, are among the lowest on the planet. However, the intense process of deforestation, overgrazing, and agricultural expansion that is seen in almost all countries in the region means carbon release, and most importantly, a decrease in the carbon sequestration capacity because of a decrease in forest coverage.

Social: In Latin America, poverty, especially rural poverty, continues to be one of the major problems assailing the region, with approximately 44% of its entire population and 64% of the rural population, living below the poverty line. The rural poor are thus generally worse off than those in the urban areas. No matter to the relative high rate of access to electricity services in the region, this fact affects significantly the affordability to theses services for greater part of the population.

Economic: In the region there is very important petroleum exporting countries like Venezuela and Mexico, 5th and 9th exporting countries in the world, and other petroleum producing countries that can satisfy a significant share of the national demand of petroleum products. Brazil, Argentina, Colombia, Ecuador and Trinidad Tobago are included in this group. But there is also an important group of countries that heavily depend of the petroleum product imports; this dependence represents a significant burden over their economies. Examples of countries included in this group are Guyana, Nicaragua, Honduras, Haiti, and Paraguay that consume 13.6, 8.3, 6.2, 5.7 and 4.2 tep/102 1995 US$ of GDP correspondingly .

Energy situation

Some remarks that could characterize the energy development in the region are:

The share of electricity in the total primary energy supply varies significantly from country to country. While there are countries with a share of electricity in the total primary energy that is higher than 30% (Argentina, Venezuela, Brazil, Uruguay, Chile), another group of countries shows figures less than 15% (Honduras, Nicaragua, Guatemala and Haiti).

The production of electricity using renewable energy has in the region outstanding examples with a share higher that 90% based mainly in the utilization of the hydropower (Paraguay, Costa Rica, Brasil and Uruguay), while in Mexico, Nicaragua, Cuba and Dominican Republic) is produced less than 25% of the electricity from renewable sources.

The electricity consumption per capita also shows a disperse distribution: A group of countries has a high electricity consumption per capita per year, higher than 1,5 MWh, (Venezuela, Uruguay, Mexico, Argentina and Chile), but also there is another group of countries with an annual consumption less than 0,5 MWh (Bolivia, Nicaragua, Guatemala and Haiti).

The annual conventional fuel consumption per capita indicator takes values higher than 0,9 tep/inhab in petroleum exporting countries like Mexico and Venezuela and in net importing countries like Chile, Dominican Republic and Cuba. On the other side, in countries like Colombia, Peru, Bolivia and Haiti the annual fuel consumption per capita is less than 0,45 tep/inhab.

Particular interest has the energy use of the forestry biomass. Despite the more or less uniform distribution of the biomass resources in the region, it can be also observed big differences in the forestry biomass consumption. The relatively higher forestry biomass consumption per capita in the region (more than 0,5 tep/inhab per year) is found in Paraguay, Honduras, Guatemala, El Salvador and Chile, while the lower consumption per capita (less than 0,2 tep/inhab) corresponds to Venezuela, Peru, Bolivia and Argentina.

The significance of the total biomass (fuel wood + sugar cane bagasse) consumption in the total direct fuel use has achieved different extent in the region. In countries like Haiti, Paraguay, Honduras Guatemala and El Salvador the biomass

consumption is determinant in the direct fuel use, consuming more than 1,3 tep of biomass per tep of oil products while in Argentina, Mexico, Venezuela, Ecuador and Dominican Republic the direct use of biomass is very low, in those countries it is consumed for direct use more than 4 tep of oil product per tep of biomass consumed.

In conclusion, it is clear that the pattern of energy use and renewable energy production and delivery has significant differences within the region. Even, the fact to be a country producing petroleum or to be a country where the electricity produced from renewable sources is significant do not prove any regularity in the whole energy picture for the specific country.

Development indicators: But the challenges to meet the Millennium Development Goals in the region also are different from country to country. Some of the basic indicators included in the Human Development Report 2001 produced by UNDP can be used to confirm this assertion. The selected indicators are the GDP per capita, live expectancy at birth and the adult literacy.

The GDP per capita has the higher values (more than 8000 US$/inhab) in Argentina, Chile, Costa Rica, Mexico and Uruguay and the lower ones (Less than 3000 US$/inhab) in Haiti, Bolivia, Honduras and Nicaragua.

There are countries with a live expectancy at birth in the rank of the developed world (more than 75 years): Chile, Costa Rica and Cuba, but also with less than 66 years: Bolivia, Guatemala and Haiti.

In the case of the adult literacy, no matter that the general figures for this indicator are positive ones, there are significant differences among countries: a group of countries have reached more than 95% of adult literacy (Argentina, Chile, Costa Rica, Cuba and Uruguay) but for another group it is under 80% in this indicator (El Salvador, Guatemala, Haiti, Honduras and Nicaragua).

Sustainable Energy Development Paradigm

The relevancy of the role that renewable energy sources are called to play in the efforts to meet the Millennium Development Goals could be briefly justified by the following reasons:

- The Climate Change mitigation only can be achieved if the share of renewable energy sources in the world energy balance would be actually significant.

- The technological development has guided a process of price reduction for the energy that is produced using renewable energy sources. While this trend should be even reinforced in the future, it is foreseen that the prices of the petroleum products will grow incessantly. These changes of pricing will contribute to create a situation where the renewable energy should be competitive with the conventional ones in market conditions. At that moment, the commercial balance of the countries where renewable energy technologies would be introduced as bulk energy will receive a great benefit.

- Poverty reduction in rural areas is closely related to the widespread use of decentralized energy systems, most of them based on renewable energy sources.

Actually, the current technological development is enough to support a more intensive expansion of applications of renewable energy sources in commercial or close to commercial conditions. The main fields of applications for renewable energy technologies could be grouped in centralized power production, renewable commercial fuels and rural energy services.

The availability of renewable energy resources is plenty in most of the countries of the Latin American and Caribbean Region. Special significance has biomass (25% of world forestry area and 40% of the world potential production of bagasse), hydropower (20% of the world technically exploitable capability), solar and wind energy resources in the region.

But no matter to this technological development and availability of renewable energy sources, the use of these technologies is very far from the potential penetration that they could have in the mix of primary energy sources. This situation habitually is explained introducing the concept of barriers that are classified as technical, economic, financial, legal and institutional ones.

But a more thorough reason to explain why it is so difficult to introduce the renewable energy technologies is the fact that the energy development paradigm that currently is applied to evaluate the goals, ways to meet these goals, and performance indicators in the energy field appeared in the world two centuries ago with the industrial revolution. The main target at that moment was to develop energy sources and technologies that could replace the low energy intensive renewable energy technologies that were used until that time. But this energy paradigm has led the world not only to the fast economic development that the developed world enjoys today, but also to the reality of the climate changes, to a life in poverty for a great portion of the humanity and to the depletion of the petroleum reserves.

But to meet the Millennium Development Goals and to facilitate to remove the barriers to a massive renewable energy deployment, it is necessary to move from an energy development conception centred mainly in the development of national economics, to a new one centred in a world wide sustainable development and it is only possible if the energy development paradigm used by the whole society is changed.

This new development energy paradigm should recognize as its main goals among others:

- Reduce drastically GHG emissions from power producer facilities as a result of the radical increasing of renewable power production and the use of cleaner technologies for power production using fossil energy sources.

- Provide access to electricity to isolated communities to guarantee services like health care, education, communication, drinking water, etc. It should be done based on a rational sustainable use of local natural resources and the most appropriate combination of available energy technologies.

- Increase the affordability of low-income population to electricity and to quality fuels.

- Extensively introduce the use of biofuels for transport, cooking and process heat improving the energy efficiency and sustainability of these services using modern technologies with enough maturity.

The Global Renewable Energy Education and Training Programme to meet Millennium Development Goals in Latin America

The role of capacity development "understood as the process of creating, mobilizing, enhancing, or upgrading, and converting skill/expertise, institutions and contexts to achieve specific desired socio-economic outcomes, …." is critical to create the conditions for a sustainable energy development. In this scope, the role of education and training, as capacity building activities that are included in any capacity development program, is widely recognised.

The Global Renewable Education and Training Programme Latin American Chapter is called to become an agent to develop the capacity in the region to transform the individuals, institutions and the overall policy framework as a force able to meet the challenges that represent to implement the new energy development paradigm and to overcome the different barriers to renewable energy technologies expansion.

The actions of the program would be directed to relevant stakeholders involved in the framework of a renewable energy development focused to meet the Millennium Development Goals. Among those stakeholders should be included not only governmental officials, representatives from the productive, academic and specialized sectors, from financing and planning systems and from the media, but also

those linked to MDGs achievement: education, health care, sanitation, water supply and environment fields.

The aim of the program is to transform the approach of those relevant stakeholders to the Energy Development Paradigm and to the role of the RETs to meet the MDGs and to the actions that should be undertaken to reinforce it.

Some of the expected outputs of the program could be formulated for some of these relevant stakeholders as:

Governmental officials: They will understand the predicted evolution of the conventional energy supply, the connection between energy and climate changes and the role of renewable energy technologies in a future sustainable energy scenario.
They will be aware about the decision making process related to energy services necessities to meet the MDGs and will conduct analysis not only using strictly techno-economic indicators.
They will recognize the priority to create an appropriate legal and regulatory framework to promote the widespread use of renewable energy.
They will accept the need to introduce the question about the sustainability of the energy development in the national political agenda.

Planning sector: The understanding of the performance of RETs and its potential to be integrated in the energy systems will be improved.

The capacity to use new planning tools will be developed to consider the introduction of renewable energy sources into the planning process to meet country energy demands and MDGs.

The personnel from the sector will be aware of the need to increase the use of specific indicators for sustainability in the planning of the energy development.

Utility personnel: They will be updated about technological development and performance of RETs.

They will be trained to evaluate integration of renewable energy technologies into the power grid.

They will have a better understanding about decentralised power systems and the use of hybrid solutions.

Specialised sector: Company staff will be trained in the design, installation and maintenance of RET facilities.
The capacity to make the renewable energy resource assessment will be developed.

Finance sector: Specialists will be aware of the specific characteristics of the renewable energy technologies.
The capacity to develop specific instruments for financing investments in the renewable energy sector will be achieved.
The skills to evaluate renewable energy project risks and revenue streams will be developed.

Science and technology sector: Science and technology people will have achieved a good understanding about the renewable energy equipment and technologies and will be ready to adapt and to develop them to the specific conditions in countries of the region.

The regional capacity will be developed to execute non-technology research and development studies of issues related to public awareness, economic and financial assessment, legal and regulatory supportive frameworks, policies to promote RETs, etc.

Some of the possible actions to be implemented to achieve expected outputs described before would be:

- Establish national training programs in vocational schools, universities and other appropriate institutions.
- Provision of specialized courses on renewable and a consensus with academic institutions to include a stronger coverage of renewable energy technologies in traditional academic courses.
- Provide information at all levels of education (from primary schools to universities) about the potential and benefits of renewable

energy, state of the technologies, and other relevant issues.
- Development of guidelines on public education and certification schemes.
- Creation of internationally recognized academic and vocational qualifications in renewable energy technology design, installation, and maintenance.
- Dissemination activities, actions and programs geared towards demonstrating the importance of the renewable energy development at policy decision-making levels and, above all, creating the awareness about the fact that to establish a new sustainable development paradigm should become a priority for the whole society.
- Training courses for local authorities to help them identify opportunities for renewables.
- Establishment of regional networks of universities and even virtual R&D institutions.
- Short courses, workshops and updating seminars directed to maintaining governmental institutions' human resources up-to-date.
- Implement courses and develop graduate programs for the technical-scientific sector.
- The promotion of academic and professional exchanges with developed countries, and between countries within the region, including capacity of experts. The development of joint international programs and networks in thematic fields

Action Plan

The aim of this action plan is to design and to make operational the GREET LAC Chapter. The main activities that have been identified are:

Activity 1: Education and training needs
- Diagnosis of priorities for sustainable energy development to meet MDGs and increase renewable energy share in the national energy balance;
- Identification of relevant stakeholders and its functions to fulfil identified priorities;
- Formulate education and training needs of relevant stakeholders to be able to perform their functions.

Activity 2: Educational and Training capacities
- Survey of training and education capacities and expertise in the region;
- Formation of clusters of countries using the criteria of the similarity of education and training needs;
- Design of activities to meet E&T needs;
- Improving of regional capacity to E&T activities.

Activity 3: Establishment of Partnerships for program implementation with
- Ongoing regional projects that include activities related to E&T;
- Regional and sub regional organizations (CEPAL, OLADE, CARICOM, etc.);
- Professional associations involved in renewable energy technology;
- International Centres of Excellences.
- National Energy Agencies.

Activity 4: Program Implementation

The first action to implement the activity 1 will be a Meeting in Havana on December 2004 with the main regional stakeholders to launch the Latin American and Caribbean Chapter of the Global Renewable Energy Education and Training Program.