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TWO COMPETING DEMANDS
ENERGY AND THE ENVIRONMENT

RATIONALISING ENERGY USE
> WOOD: AN OLD MATERIAL, NEW TECHNOLOGIES (NIGER)

ACCESSING SUSTAINABLE ENERGY
> POWER FROM WATER (RWANDA)
> POWER FROM WIND (MALI)

Access to energy greatly improves living conditions, creates opportunities and increases the production potential of every individual and therefore their source of income. Energy and development are intimately connected. But although the positive effect of access to energy on development is indisputable, its production unfortunately poses many environmental problems: deforestation, pollution, over-exploitation of natural resources, emission of greenhouse gases… This tension between development and the environment increases even more if the sources and/or methods of producing energy are not sustainable. There is therefore a need to promote renewable energies and improve the energy efficiency of production and consumption.

For a development agency, the energy issue appears at two levels: at the level of designing and implementing programmes related to energy (micro-electric power plants, rural electrification, etc.) and at the level of managing energy within actual initiatives, whatever the sector (supplying a hospital or school with electricity, for example).

In all cases, considerations concerning energy management are built around three aspects (the trias energetica) or a combination of them:

1. **Minimising the demand for energy** (reducing energy consumption);
2. **Using sources of renewable energy** as much as possible (reducing the use of primary fossil fuels);
3. **Using efficient energy systems**.

Applied to the context of developing countries, the trias energetica may be expressed as follows: Existing consumption (1) is often minimal or non-existent (apart from biomass), therefore reducing demand is relatively difficult. The potential for renewable energy (2) is however significant (solar, wind, water) and technical advances in the industrialised world allow better energy efficiency to be achieved (3), without passing through intermediate stages.

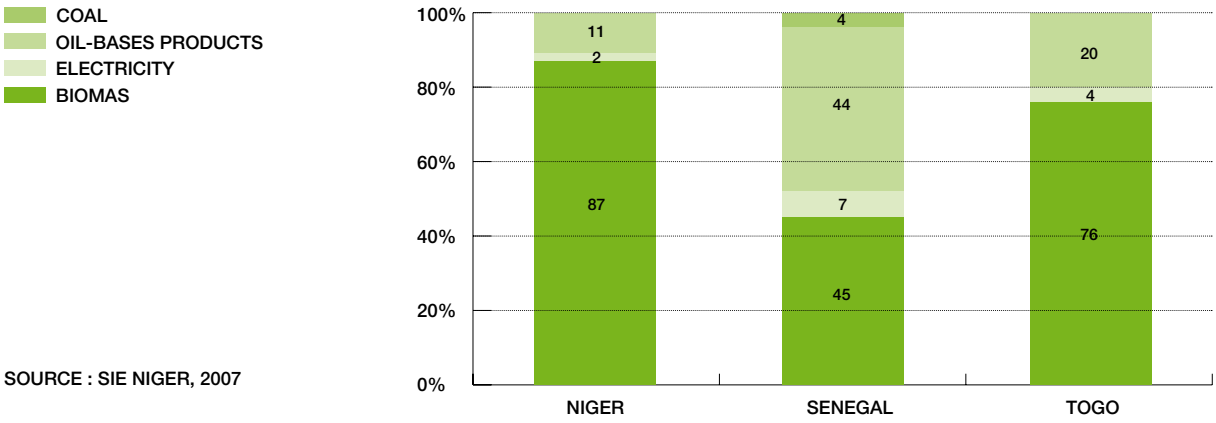
RATIONALISING ENERGY USE

Like other countries of the Sahel, Niger is subject to continuous degradation of its forest resources. Two essential factors explain this development: an increasingly dry climate and growing pressure on natural resources. This pressure is linked to the demographic growth of the country, which is one of the highest in the world (3%).

The inhabitants of Niger use wood for cooking and heating. It satisfies almost 87% of the energy requirements of the country, 89% relating to domestic consumption. This uncontrolled exploitation of wood is endangering the national forest heritage.

The government of Niger is aware of the ecological danger and concerned about the supply of wood to towns. Since the end of the 1980s the government has been implementing a forestry policy and a domestic energy strategy. The results, after 15 years of effort, are encouraging: 700,000 hectares of forests that are exploited as part of planned development are recovering and their productivity is increasing. Replanting and initiatives to rationalise consumption have also been implemented.

BREAKDOWN OF ENERGY CONSUMPTION IN CERTAIN WEST AFRICAN COUNTRIES



SOURCE : SIE NIGER, 2007

NIGER

WOOD: AN OLD MATERIAL, NEW TECHNOLOGIES

REDUCING THE CONSUMPTION OF WOOD ENERGY

REFERENCE DATA

- *Wood constitutes 87% of energy use in Niger.*
- *The coverage rate of wood energy demand in Niger should go from 57% in 1990 to 14% by 2015.*
- *The women on average spend more than 15 hours a day on domestic chores including wood gathering.*
- *The use of the improved fireplace reduced the use of wood by 50% and the women's chores by 20%.*

The project entitled *Increase in Financial Income of Women in the Region of Dosso* (ARMFD), in the south-west of Niger, is participating in this reforestation process, although it is gender-focused and without a direct environmental scope. The objective of the project is to reduce the poverty of women. To do this, it is necessary to reduce the burden of their daily household chores. These domestic occupations take up a great deal of time, almost 15 hours a day!

Among these chores: gathering wood.
In terms of both price and proximity, access to wood is becoming increasingly difficult. The women are fully aware of this due to the increasing difficulty of carrying wood as they have to go further and further to find it. Young girls perform this task, and therefore they are often deprived of a normal education.
In the Dosso region (as elsewhere in Niger and Africa), these constraints prevent women from developing virtually any income-generating activities.

The fireplace as a solution

Starting from these premises, one of the solutions for reducing the women's burden is the promotion of improved fireplaces. Traditionally, the women use a fireplace made of three stones for cooking their food. These stones are laid on the ground, surrounding the flames and supporting the pan. The fire exposes the housewives to smoke, which is very harmful to their health. In addition, the cooking time is relatively long.

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The improved "albarka" fireplace was introduced as a solution. It covers the fire with a dome of earth like an oven, retains the heat and reduces smoke emissions. It reduces the cooking time by more than half and improves preparation hygiene. It also allows cooking with half the amount of wood for the same quantity of food. Its construction requires very few resources and is technically simple. It constitutes a tool that the women can take over easily after a short technical training course.

More than 1,000 women have already been trained in its use. According to the field follow-up, almost 100% of the trained women are applying their new skill and are passing it on to other women. Today, 20,000 households are using the improved fireplaces following the project training initiative in the Dosso region.

This project was therefore a success and has reduced demographic pressure on the environment. The main arguments in favour of adopting this technique were initially remote from direct environmental concerns. However, the experiment of distributing improved fireplaces in Dosso shows that small-scale initiatives, based on simple technologies, can lead not only towards the socio-economic independence of the very poor, but can also prevent or limit environmental degradation. So, actively contributing to the fight against deforestation and to energy management is possible without necessarily resorting to complex technologies.

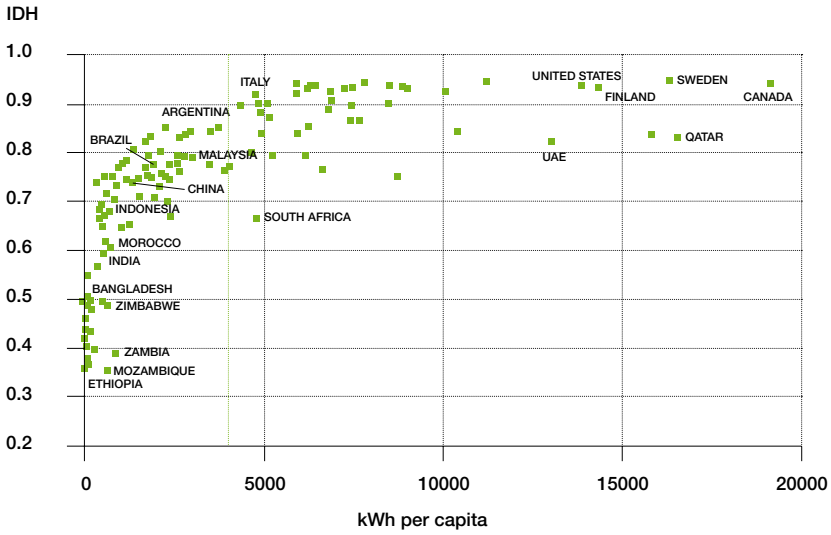
Improved standard of living…

It was in the municipality of Falwel that the success of the albarka fireplaces was the most marked. We counted more than 390 fireplaces built in three villages. The women of the village of Gardje said: "*Before, all of us had to gather wood every day. Now, we have learned how to build fireplaces at a lower cost; each household has built its own improved fireplace in the village and we've also bought a cart. With these two tools, our group takes only one day to gather enough wood for two weeks, and this has saved us two to three hours a day.*" The women of the region also welcome the safety aspect of using the improved fireplace, which protects them from burns and reduces the risks of fire. The women of Sokorbe know all about this, having lost almost everything in a fire in their village. The fire resulted from the use of a traditional "3-stone" fireplace.

An additional benefit of the process is the development of skills and the provision of services concerning fireplace construction. At Hamka Seyni (a municipality in Dosso), the trained women were asked by other villages to pass on their knowledge. They pointed out that "the earnings for women who build improved fireplaces is between FCFA 150 and 250 for each fireplace constructed (EUR 0.23 to EUR 0.38), which can amount to additional income of FCFA 2000 to 3000 (EUR3 to EUR4.5) per month. This activity gives them greater recognition from their family, the authorities and local villages. Their expertise is highly valued!

ACCESSING SUSTAINABLE ENERGY

Access to energy and development go hand-in-hand. Energy assists economic development (small and medium-sized enterprises, mechanisation, communication, etc.) and the quality of basic services (drinking water pumps, lighting in schools, improved health care, etc.). On the other hand, development creates a demand for energy (television, refrigerators, telephone chargers, computers, etc.). If we compare access to energy with the human development index[1], the correlation is striking, as shown by the following graph.



The least bit of access to energy contributes to development (left part). From a certain point onward (at about 4,000 kWh/year/person), the graph flattens out. Beyond that point, consuming more energy does not contribute to more development

SOURCE : UNDP

Electrification contributes to development, certainly, but at the same time it increases the energy needs of developing countries. Both the population and the consumption of energy per capita increase. The cumulative effect of these two increases is an exponential growth in demand for energy over the coming years and a further burden on the planet.

Due to lack of (government or private) initiatives in implementing large-scale electrification, the use of very low-power “pico” generators (1-10 kilowatts, usually running on diesel) is expanding throughout Africa. Producing electricity using these generators is accessible to most people: The initial investment is low (about 100 dollars per family) and the fuel can be found everywhere. In addition, in countries in which the electricity supply is intermittent, owning one’s own generator is a more reliable alternative. But this option is expensive! It costs 1 euro per kilowatt-hour, just for diesel, in some regions of the Democratic Republic of Congo. In comparison, a kilowatt-hour costs EUR 0.17 in Belgium. In addition, this alternative is especially polluting and its efficiency is low.

But the links between development and energy and pollution can be disconnected, if a country can meet the increasing energy demand by using renewable sources. Rwanda is trying the experiment.

1 | Human Development Report, 2007

RWANDA

POWER FROM WATER

PRODUCTION OF HYDROELECTRIC POWER

CONGOLESE ELECTRICITY PAYMENT COPIES THE PHONE

Many developing countries have electricity production and transportation infrastructures, but they are often poorly maintained through lack of investment, due to the low rate of cost recovery. In the Democratic Republic of Congo, the success of prepayment cards for the mobile telephone has inspired other sectors to follow suit. "Prepaid" meters will be installed in a hydroelectric power project (Support for Electricity Supply to Kisangani). These will allow better management of finances, through a system that has already proved itself in other countries on the continent. At the same time, the population will be made aware of the fact that electricity, although having a natural origin (solar, wind, water), does not come free. By paying for this service, it will be encouraged to reduce its consumption.

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In the Land of a Thousand Hills, with an access level of 4%, the level of rural electrification is low. More than 95% of Rwandans use wood for their domestic needs, either as they find it in the country, or in the form of charcoal in towns. Bearing in mind the number of inhabitants and the limited surface area of the country, the impact on the forests is enormous.

The government wants to diversify the sources of energy. In its strategic plan it has undertaken to triple electrical production capacity, from the current 44 megawatts to about 120 megawatts by 2011. This target will be achieved mainly through the development of hydroelectric power (50 MW), but also through the production of electricity from the methane gas contained in Lake Kivu (25 MW).

Belgian cooperation is assisting this plan with a programme of electricity distribution in rural environments on the basis of renewable energies. This programme includes the construction of mini-hydroelectric power plants and the development of other sources of renewable energy (solar power) and the installation of medium-voltage power lines to improve the access of rural populations to electricity. The overall plan is intended to increase the access level of populations to electricity from 4% in 2007 (less than 1% in the countryside) to more than 10% in 2012, which will effectively triple the number of connections (from 77,000 now to almost 200,000).

The construction of mini-hydroelectric power plants in Rwanda offers many economic and environmental advantages:

- Diversifying production sites by improving the stability of the network;
- Exploiting the hydroelectric potential of Rwanda (many rivers and streams);
- Strengthening the energy autonomy of the country;
- Reducing the use of fossil fuels by developing the potential of clean and renewable energies;
- Reducing the pressure on deforestation by progressively substituting electricity for firewood for household consumption;
- Reducing CO2 emissions.

The programme also provides for other environmental initiatives such as the establishment of an industry to compost plant waste caught in the water intake screens of the mini-power plants. The compost produced will be used to offset soil impoverishment due to erosion and reduce the use of chemical fertilisers.

As part of this programme, the *Bringing electricity to rural populations using renewable energies* (EPRER) project is designed to bring electricity to some 60 health centres in 10 districts of Rwanda by means of photovoltaic systems. In order to accurately plan the installations in proportion

to requirements and to target the initiative, two related actions were carried out:

- Energy audits in 98 health centres, to establish their exact requirements according to the size of the centres and their equipment.
- Collection of map data on the existing and proposed electrical network, to target the initiative on areas isolated from the network. Connection to the national grid is the least expensive and most sustainable solution.

Priority to concentration areas

The wide dispersion of the rural population makes the investment cost of rural electrification in Rwanda very high. Not power generation but distribution, a cost that is often neglected, is the problem. The EPRER project is therefore concentrating on electrification of imidugudu (concentrated settlements), rural centres, social infrastructure (health centres, schools) and commercial activities (welding shops, communications, engineering, sewing shops, cinemas, mills, etc.). Health centres that are not "economically connectable" to the network, will be supplied with electricity from solar panels or wind turbines. The approach is therefore a combined one and allows the best technical option to be chosen for each locality.

From the design phase onward, the construction of mini-power plants has been carried out in cooperation with Electrogaz, the national electricity and gas distribution company, thereby providing a local basis for the projects.


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ENERGY UNITS EXPLAINED FOR THE NON-INITIATED

*The **watt** is the unit of power expressing "energy per second". A kilowatt = 1,000 watts; a megawatt = 1 million watts. As an example, a good cyclist generates power of around 500 watts; he could illuminate twelve 40-watt light bulbs. A steam iron might use 1 kilowatt. A refrigerator, 100 watts. A Toyota 4x4, 127 kilowatts, in other words the energy necessary to illuminate 3,000 40-watt bulbs!*

*The **kilowatt-hour** is the unit of energy most widely used in the technical world. A kilowatt-hour corresponds to the energy necessary to supply one kilowatt for one hour, in other words to do the ironing for one hour, to illuminate a 40-watt bulb for 25 hours, or to ride a bicycle fast for two hours. The kilowatt-hour (kWh) is also the unit used for paying electricity bills.*

*A **battery** contains a certain amount of energy. Depending on the power required, its life span will vary. A 1.2 volt (rechargeable) battery of 2,000 milliampere-hours can deliver 2,000 milliamperes (or two amperes) at 1.2 volts for one hour, or 0.0024 kilowatt-hours. A human being would therefore need 2,000 of these batteries every day! Or three car batteries. This example illustrates the efficiency of our human food and biomass digestive system.*

*The old "**horse power**" unit (hp) represents the power produced by a horse: about 750 watts. Our cyclist produces 0.67 hp.*

*Other units of energy: **calories or kilocalories**. One calorie corresponds to 4,184 joules, and a joule represents the energy released to produce the power of one watt for one second. A person consumes about 2,000 calories per day, or about three kilowatt-hours. The average human being therefore corresponds to three 40-watt bulbs, a little less when resting, a little more when active.*

*At a price of 0.17 euro/kilowatt-hour, **a human being**, if he could run on electricity, **would consume 0.5 euro per day**.*

MALI

POWER FROM WIND

ANALYSIS OF WIND ENERGY POTENTIAL

In Mali, as in Rwanda, expansion of the electrification network to the rural regions, where settlements are scattered, is not profitable. In 2004, the level of electrification of the country was 13%, but did not exceed 1% in the countryside, where more than 70% of the population actually lives. This low level is explained by the enormous difficulties experienced by *Electricité du Mali* in financing the expansion of its network. On the other hand, local mini networks connected to renewable sources can be created, with the same efficiency as a connection to the main grid, at a reasonable cost and with less environmental impact.

The potential for wind energy is enormous in this country, as is that for hydroelectric power (more than 1000 megawatts, largely under-exploited) and solar energy (5 to 7 kilowatt-hour/m^2/day). This country is in one of the sunniest zones in the world. But despite these different renewable energy sources, Mali remains largely dependent on fossil fuel.

This dependence is costing the population dear, with electricity prices of EUR 0.21/ kilowatt-hour (EUR 0.17 in Belgium). It is likely therefore that the expected explosion in the price of hydrocarbons over the next few decades will force Mali to redirect its energy policy towards renewable sources.

With this in mind, BTC is coordinating the production of a feasibility study on the exploitation of wind energy in the Timbuktu region. The results are promising. The wind blows at an average speed of 6.1 m/s (22 km/h) at a height of 50 metres. In terms of energy, an Enercon 33 type wind turbine (330 kilowatts-hour) would produce 645 megawatt-hours per year. Development of a park of 6 turbines would save 50% of the oil used by the power station currently located on the site, in other words more than 3,000 litres of fuel per day and more than 2,500 tonnes of CO2 per year, while retaining the same reliability of electricity production. This fuel saving would be reflected in a reduction in electricity prices for consumers.

These detailed and costed analyses illustrate the wind potential of Mali. It therefore becomes easier to persuade investors to finance the installation of wind turbines and the political decision-makers to appreciate the benefits of “harnessing the wind” and the need to set up a legal framework that is favourable to renewable energies.

THE POTENTIAL BENEFITS OF THE AFRICAN WIND

OVER TO LUC DEWILDE, 3E

Wind technologies in Africa

As regards solar energy, the necessary technical skills and the private operators exist locally. But as regards wind power, often developed in parallel with more complex hybrid systems, the technology is not yet assimilated. But a combination of electricity generators and renewable energies makes sense in isolated areas. This is a concept that is economically viable, but technically more difficult to achieve.

In addition to training, maintenance and the funds for servicing are essential.

In fact, from the global standpoint, Africa must aim for installation of a critical mass of wind power generation. The wind power market has a two-year waiting list following the booms in the American, Canadian and Chinese markets. To set up three wind turbines in Mali would represent significant risk in terms of maintenance and guarantees. The volume of orders must therefore rise in order to ensure delivery and reduce costs.

The role of the public sector

In Europe, there are quotas for renewable energies. If a distributor cannot meet the target of a certain percentage of renewable energy, it is fined. But it is this fine that gives value to green electricity. This system is still absent in developing countries.

It is therefore essential for the local operators in these countries to establish a legal framework guaranteeing a purchase price for each kilowatt-hour produced locally with renewable energies. Development of alternative energies often lacks such a guarantee. Renewable energy projects in the implementation phase have been blocked for five years due to the absence of a legal framework.

Luc Dewilde is head of the wind power department in the company 3E, which specialises in renewable energy expertise. 3E has carried out a study of the wind power potential of the town of Timbuktu, in Mali.