Renewable energy options in developing countries

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With global energy consumption set to surge, greenhouse gas emissions increasing, and stocks of fossil fuels dwindling, José Goldemberg and Oswaldo Lucon look at the alternatives.

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In 2009 the world energy consumption was 11.3 billion tonnes of oil equivalent (toe). Energy consumption in industrialized countries has basically been stable in the last 10 years, but in the rest of the world it has been growing at approximately 5% per year. At this rate and based on present technologies, the world's annual energy consumption could reach 20 billion toe by the year 2020. The consequences of such growth – approximately 80% of it originating from fossil fuels – could be disastrous for three reasons:

- the depletion of fossil fuel resources;
- geopolitical problems caused by access to such fuels; and,
- environmental problems, notably global warming

Developing countries are witnessing a substantial growth in their greenhouse gas emissions, mostly due to rapid industrialization and transport growth, but also due to the unsustainable use of fuelwood and subsequent deforestation.

Solving these problems implies tackling their causes: a huge effort that encompasses basically complementary actions and policies in terms of energy efficiency (or energy conservation) in order to obtain an equivalent well-being by using fewer natural resources; renewable energies, which can be used instead of fossil fuels; and new technological advances to improve energy efficiency and utilize renewable energy.

Energy efficiency extends the life of finite resources, reduces environmental impacts, secures supplies for the long-term, and frequently offers attractive economic returns. However, increasing access to energy services really depends on an enhanced supply. Fortunately, this can be safely achieved by using a wide variety of renewable sources, some of

which, such as hydropower and biomass, are already well-developed. Most developing countries are located in tropical areas where the existence of rivers and rain-fed, arable land provide the conditions for these energy sectors to flourish. While competition with food production and multiple water uses are important issues, more often than not the problems may be overestimated, and can be dealt with through appropriate logistical and land-use planning.

Photo: KieselUndStein/istock

Attractive biomass options already exist. Sugar cane ethanol production (and associated bagasse cogeneration) in Brazil, geothermal energy in the Philippines, agricultural waste-to energy in India, thermal solar energy in China, and improved wood-fuel cook stoves in some African countries are some successful examples.

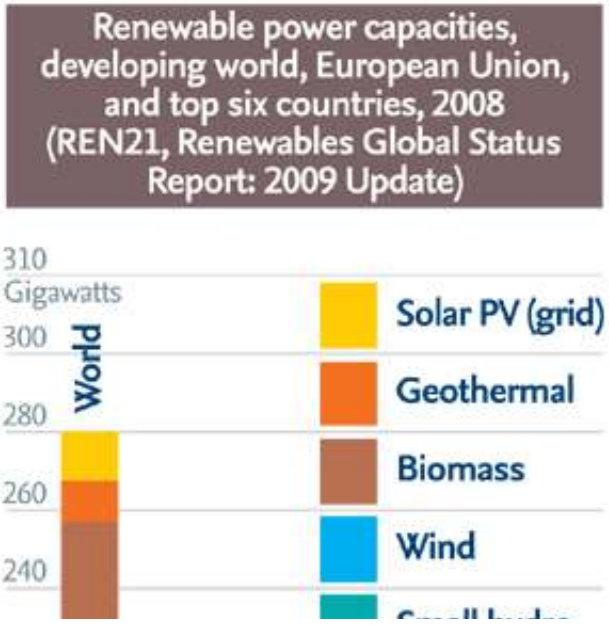
There are also newer renewable technologies under development, with biomass having good prospects for rapid technological advances, particularly in relation to improved use of agricultural wastes, municipal solid waste incineration, and the production of several types of biodiesel. Several bioenergy transformation routes using diverse types of biomass are possible, from simple boilers for domestic heating to integrated energy farms.

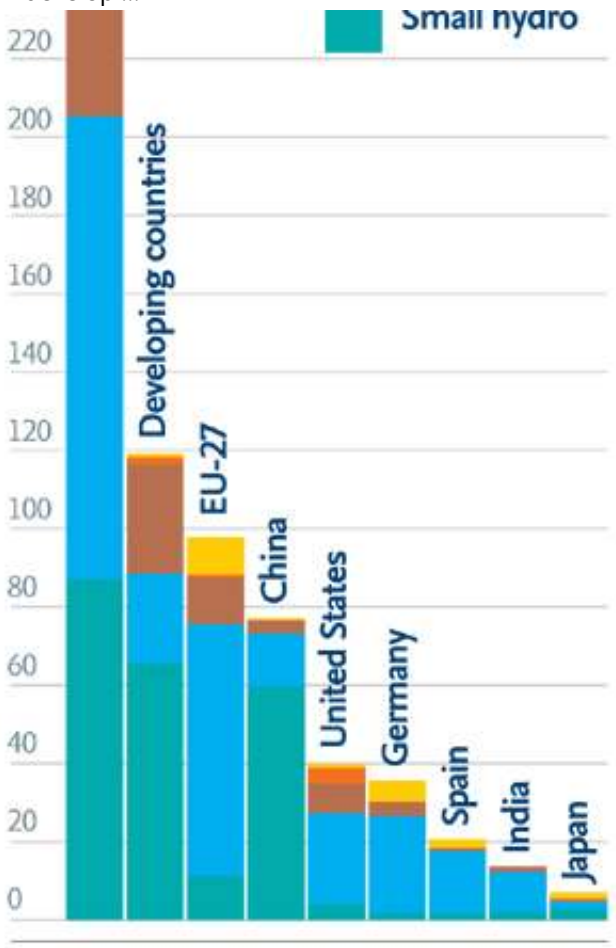
Although still in the research phase, second generation biofuels, and advanced solar, marine and geothermal applications, may become economically viable in certain circumstances.

Wind and solar

Wind power production technology has become highly sophisticated, with important developments in the areas of control, aerodynamics, and materials. Large systems can have hundreds of high-tech, large generators, each with a generation capacity of 5MW and blades spanning more than 80 metres. Wind power machinery costs have recently dropped significantly, mainly because manufacturers in developed countries have benefited from government support policies. As a consequence, the price of wind turbines for customers in developing countries is also coming down.

Solar thermal energy has huge potential in the developing world, but the relatively high start-up costs, and the subsidies provided to conventional fossil-based sources, are barriers to a more rapid deployment. Simple applications such as plastic solar collectors or cook stoves are initial steps frequently used in demonstration projects, especially in poorer countries. However, their take up has often been very limited, and the user regularly reverts to traditional sources of energy. More positively, China has moved steps ahead by subsidizing the use of solar panels for water heating, while in Brazil, the use of solar panels may negate the need for large investments in the additional power production now required to supply the electricity used at peak times. For example, solar power can be used to produce electricity for water heaters and other small appliances.





For small islands, mountain villages and other more remote communities, solar photovoltaic systems offer good prospects. The technology is ideal for small applications and certain niches, as the power produced is enough to refrigerate vaccines and medicines; preserve food and fishing products; make small and micro businesses viable; light houses, schools and medical centres; extract and pump water from wells; and power communication and entertainment systems. Solar may be one of the main technologies for future integration of decentralized energy systems.

Biofuels

So far, bioethanol and biodiesel are the best biofuel options, followed in some cases by vegetable oils. The Brazilian sugarcane ethanol programme produces fuel that is cost competitive in a free market, and has a positive energy balance of up to ten outputs to one unit of input. For these reasons alone, it could be promoted as a fuel alternative in other countries in the world. Concerns about the environmental and social impacts of biofuels are being addressed in a responsible manner – a response driven by the threat that technical trade barriers will be imposed as a result of consumer pressure. Meanwhile, there are high expectations for second-generation biofuels, especially cellulosic ethanol (produced from wood, grasses, or the non-edible parts of plants), which could promote a real clean energy revolution when achieving competitive costs.

Decoupling

The energy crisis of the late 1970s led to an energy revolution when new technologies that became commercially available at that time made it possible to provide energy services with a smaller energy input than would have been possible with the technologies then in widespread use. This meant there could be a decoupling between GDP growth and energy growth, and this did in fact take place in the industrialized countries in the 1970s and 1980s. Using energy more efficiently, and switching from fossil fuels to renewable energy sources, meant that economic growth, as measured by GDP growth rates, could continue, even though the growth in energy consumption slowed. For example, the energy consumption of the European Union is today 50% lower than it would have been if the measures taken in response to the 1973 oil crisis had not been implemented. Another more recent example is provided by China, which since 1990 has enacted bold energy efficiency measures. While GDP has increased almost nine-fold, in the same period, carbon emissions are only two and half times greater.

In this context, developing countries can today take advantage of a great opportunity. Rather than replicating the economic development process of industrialized nations, which went through a phase that was dirty and wasteful, and created an enormous legacy of environmental pollution, developing countries can leapfrog ahead by incorporating currently available, modern, and efficient technologies in the early stages of their development process.

The use of renewable energy resources is progressing rapidly, and will probably represent a very significant contribution to energy consumption in the next few decades. A combination of energy efficiency, and renewable and emerging new technologies using biomass, wind, and solar energies, could sustain development for the majority of the human population over the course of the 21st century.

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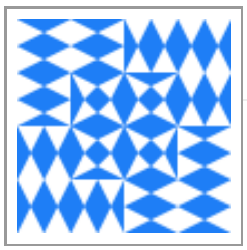

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