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# Energy Perspective for a Sustainable World

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**Abstract:** Energy has been one of the most important resources for the development of mankind. In the beginning it was mainly used for survival; however, since the industrial age the intensive use of fossil fuels as well as the increase of animal production for food has driven urban and rural areas to consequent greenhouses emissions that may compromise Earth's fragile ecological balance. According to the Intergovernmental Panel on Climate (IPCC, 2005) gas emissions are affecting significantly the planet's climate, and ultimately may induce natural disasters. Even though uncertainties are a key issue in all climate change scenarios one way of dealing with them is to take into account the feedbacks between the past, and build up the capacity to adapt and mitigate the future. A society seeking both sustainable rural and urban development ideally needs to use energy resources which cause no environmental impact. However, since all energy resources somehow lead to various environmental impact, it is reasonable to suggest that some of the concerns regarding the limitations imposed on sustainable development by environmental emissions and their negative impacts can be in part overcome through the increase of energy efficiency. A strong relation clearly exists between energy efficiency and environmental impact even though less resource utilization and consequent pollution is normally associated with higher efficiency processes. Under this scenario this presentation brings up possible perspectives of energy use for sustainable development with focus on the agricultural engineering approach.
**Key words:** Energy, renewable energy, agricultural production

## INTRODUCTION

Since the beginning of the industrial era human civilization learned a different meaning of quality of life, that both interfere in the planet environment and in the structural social outcome. The results are known today as the global warming and the increasing dispute for political leadership worldwide.

Due to excessive greenhouse gas emissions, the world does not face a bright future. Following a request of the G8 (group the eight most powerful countries in today's economy) at the summit at Gleneagles in July 2005, the International Energy Agency published a report that outlines energy technology perspectives for the near future, and proposes scenarios and strategies for 2050 to turn back the trend (Krewitt et al., 2007). The remaining hope is that the alarming outlook seen today can still be changed in medium term. It would require significant but not inconsistent efforts which work out various technology scenarios to bring back carbon dioxide emissions to the current value by 2050, moderating significantly the growth of fossil fuel demand. The technologies forecasted in these scenarios are expected to have an incremental cost; however, it is low when compared to the benefit towards the fragile mankind survival in the planet. In all of the proposed scenarios, from the most pessimistic to the most optimistic, a portfolio of available technologies is applied. Technologies to lower carbon emissions exist, but none of them will be able to make a difference on its own. Energy efficiency gains, biofuels, and partially decarbonised electricity generated by nuclear, renewable, natural gas, or clean coal energy will be called to contribution. And, startling enough in all the proposed scenarios, fossil fuels will still supply most of the world's energy by 2050.

Problems with energy supply and use are related not only to global warming, but also to environmental concerns such as air pollution, ozone depletion, forest destruction, and emission of radioactive substances. These issues must be taken into consideration simultaneously if a bright energy future with minimal environmental impacts in humanity is to be achieved. There has been enough evidence suggesting that the future will be negatively impacted if humans keep continuously degrading the environment. There is an

intimate connection between energy, the environment and sustainable development (Watson et al., 2000). Some solutions to current environmental issues in terms of energy conservation and renewable energy technologies are identified by the current literature (Dincer & Rosen, 1998; Zervos, 2006; Krewitt. et al., 2007) where some theoretical and practical limitations on increased energy efficiency are explained, as well as several issues relating to energy, environment and sustainable development are examined from both current and future perspectives.

Facing one of the IPCC and by the United Nations Environment Program -UNEP) forecasted scenario (global temperature increase in 2°C), an European team of scientists created a target-oriented setting which explores energy supply options that comply with the global warming (Krewitt et al., 2007). The proposed scenarios were created in close collaboration with stake holders in order to be technically feasible where nuclear options were excluded, setting aside all power supply technology that might not satisfy the sustainability criteria. Global energy demand was modeled using a cluster approach of ten world's regions, population and GDP growth being taken as the main drivers. Energy prices and CO2 emissions costs were projected in order to include economic drivers. The main results were as follows:

1. Renewable energy could provide as much as half of the world's energy needs by 2050, wind, solar and hydrological plants being the main renewable energy sources. However, the shift towards renewable requires strong effort to increase its productivity and market uptake;
2. By increasing energy efficiency and choosing renewable energy, developing countries could stabilize their CO2 emissions without compromising economic growth while the Organization for Economic Co-operation and Development (OECD) countries could reduce their emissions by up to 80%;
3. The increase in the global temperature by the forecasted scenario not only complies with environmental objectives, but also helps to stabilize energy prices and to relieve economic pressure on societies; and
4. Compared with a "business like" scenario, this scenario is preferable, considering that average electrical energy costs will decrease by one third by 2050.

The authors highlighted this target-oriented scenario as a benchmark for future policy decisions rather than the traditional business reference due to the strong evidence that the "business like" approach taken before would lead to an environmental and socio-economic collapse. As current real world trends partly deviate from the development pathway described by the IPCC scenario, there is clearly a strong need for policy intervention to close the gap between climate policy commitments and the actual development of the world energy system. This content put together some thoughts of the renewable energy grid perspective for the world's sustainable development.

## WORLD'S ENERGY NEEDS

It is said that the Stone Age did not end because of the lack of stones, thus it is comprehensible that today's energy dependent society is going to find its way out of the ongoing energy increasing crisis, probably adapting sustainable energy use policies.

The nation's development nowadays is highly dependent on fossil fuel technology for several actions such as agricultural production and processing, household and personal needs, health and transportation. The increase in world's population associated to the lack of cultivated areas for expansion of food crops and extensive animal production leads the food yield to search for optimizing space, and consequently to the adequate use of life support systems (EC, 2007). However, when increasing both crop and animal stoking densities, the emission of effluents and gases may drive sustainability into its limits. The increase in crop yields achieved today was only possible through the use of technological innovations and it seems logical to conclude that in future the increase in the optimization of both animal and crop production can also be achieved in this same way.

The developed world has reached its maximum food production, while the lack of sustainable use of agricultural practices limits the raise in production by increasing the loss of agricultural land and pollution of water reservoirs in developing countries. The main question raised nowadays is related to the Earth's

potential of absorbing the amount of residues left by the industrial food production.

Economic growth in developing countries is projected at about a 5% annual rate in 2006-15, according to USDA (2005) and FAO (2006). Developing countries play an increasingly important role in global growth in food demand and become a more important destination for goods producing countries exports, and growth rate increase is normally followed by large energy demand.

Brazil's national ethanol program dates back to 1975, when the Brazilian government first introduced the policy as a measure to reduce its dependence on petrol imports as well as to enable the country to produce renewable and environmentally friendly energy (Cortez et al, 2001; MME, 2006). From 1985 to 1990 nearly 90% of all automobiles manufactured in Brazil were powered by ethanol. Today Brazilian fleet has more than six million ethanol and flexible fuel vehicles, and the country became the leader in producing and economically using biofuels in the so-called hybrid or flexible vehicles (cars that can run either on pure ethanol or gasoline). It is a curiosity that the term "gasoline" as used in the country, actually refers to a mixture of 78% gasoline and 22% sugar cane ethanol (Program, 2007). Brazil has led the use of this technology in the world at the present time, mostly due to the sugarcane production since the 1500s and the natural efficiency in turning this product into ethanol.

Considering recent international debates the question to be answered by all nations concerns the agricultural land use for energy rather than for food production.

## RENEWABLE ENERGY SOURCES OVERVIEW

Several definitions are found for renewable energy sources. Green power sources can include solar (photovoltaic and thermal), wind power, new hydro on existing dams, biomass, wave energy, etc.

Bioenergy technologies use renewable biomass resources to produce an array of energy related products including electricity, liquid, solid, and gaseous fuels, heat, chemicals, and other materials. Biomass energy is derived from plant and animal material, such as wood from forests, residues from agricultural and forestry processes, and industrial, human or animal wastes, and it can be used directly for electricity generation, steam for industrial uses, heating, cooking or indirectly by converting it into a liquid or gaseous fuel (e.g. ethanol from sugar crops or biogas from animal waste). An example of biomass used for renewable energy generation in both Brazil and Australia is the use of sugar cane waste for electricity production in sugar mills. Biodiesel is a biodegradable fuel derived from renewable sources such as vegetable oils and animal fats, chemically combined with alcohol or methanol in the presence of a catalyst. This fuel can be a total or partial substitute for petroleum diesel to power diesel engines in trucks, tractors, pickups, and passenger cars, as well as motors that generate power and heat. With the new development of hybrid cars and tractors, the use of bioenergy for transportation and agricultural field operations can become sustainable.

Hydropower uses water - that is not reduced or used up in the process - to power machinery or make electricity. There are several types of hydroelectric facilities; they are all powered by the kinetic energy of flowing water as it moves downstream. Turbines and generators convert the energy into electricity, which is then fed into the electrical grid to be used in homes, businesses, and by industry. However, the environmental impact may be an important restriction in the construction of large dams to produce electricity.

The recent agricultural use of windmills to generate power began in the late 19th century, when settlers used the technology to pump water for farms and ranches, and later, to generate electricity for homes and industry. The industrialization era, first in Europe and later in America, led to a gradual decline in the use of windmills (Reeves & Beck, 2003), when the steam engine replaced water-pumping windmills. Wind turbines convert the kinetic energy in the wind into mechanical power, that can be used for specific tasks (such as grinding grain or pumping water) or yet a generator can convert this mechanical power into electricity. In the whole world there is approximately 30,000 MW installed capacity, and a large amount of it is in rural area (Rosenbloom, 2006).

A typical solar water-heating system reduces the need for conventional water heating by about two-thirds (depending on the latitude) minimizing the use of electricity or fossil fuel to heat the water and reduces the associated environmental impacts. Solar

water heaters use the sun to heat either water or a heat-transfer fluid in the collector being held in storage tanks ready for use, with a conventional system providing additional heating as necessary. Mediterranean countries intensively uses solar heating in urban areas, however, it yet lacks the use in agricultural procedures.

The first geothermal power plant was built in 1904, in Lardarello, Italy. The use of geothermal energy can greatly minimize the environmental impacts, resulting in benefits for local communities with growing energy needs. Geothermal energy is clean and sustainable, and reservoirs of low-to moderate-temperature water - 20°C to 150°C - may provide direct heat for rural, residential, industrial, and commercial uses. Steam and hot water reservoirs are just a small part of the geothermal resource.

## ENERGY USE IN AGRICULTURAL PRODUCTION

Agriculture energy use includes all kinds of farming facilities and equipment applied for growing crops and raising animals, including the farmhouse. In most countries these facilities use energy mainly for equipment such as water heaters, milk coolers, vacuum pumps, lighting, irrigation pumps, crop dryers and ventilation. Table 1 shows the agricultural renewable energy alternatives.

**Table 1. Agricultural renewable energy application alternatives**

| Technology | Application |
|---|---|
| Bio fuels | Combustion engines, electricity, turbines, heating and cooling processes |
| Solar | Natural lighting, photovoltaic use, heating and cooling |
| Wind | Electricity, mechanical power |
| Hydro | Electricity, mechanical power |
| Geothermal | Heating processes |

Field crop operations utilize intensively diesel fuels'; however, the most important indirect use of petroleum energy is due to the use of fertilizers mainly nitrogen (N) based products (up to 90% of the cost of production), phosphate (P) and potassium (K) (up to 30% and 15% of the cost of production, respectively). The direct use of energy in farm operations is mainly towards the following actions:

- Operation of large farm machinery (field work and delivery)
- Operation of small equipments (animal housing, irrigation and processing)
- Custom operations and farm overhead (power for farm house appliances, lighting , etc)

In the field operations as well as in the application of small equipments there is an intense use of petroleum energy that can be modified to renewable energy sources, as well as to some extent, the customs operations.

Figure 1 show, for instance, a way to interact the overall demands for meat production in a sustainable way, achieving market's demands.

Also another way to reduce the energy cost in buildings in rural areas is the adequate use of adobe brick for building both houses and animal shelters, which need to be improved (Figure 2).

In an analysis of the social impacts of food and energy technologies, Peemans (1987) pointed several recommendations for future work in this field from which few were selected here:

1. Developing a maximum number of synergies between food crops, livestock, fish production, and new sources of renewable energy (biodigestion of wastes, biomass production and treatment) in order to increase the local energy potential for household purposes, irrigation, biofertilization, and transport;
2. Focusing greater attention on the role of small-scale rural industries oriented towards the processing of local goods for bringing to urban consumers;
3. Assessing the institutional framework, including the feasibility of a network of rural and urban cooperatives to support community-based integrated development schemes; and
4. Promoting the participation of local authorities and central agencies in such a network, in which they could take initiatives and give support.

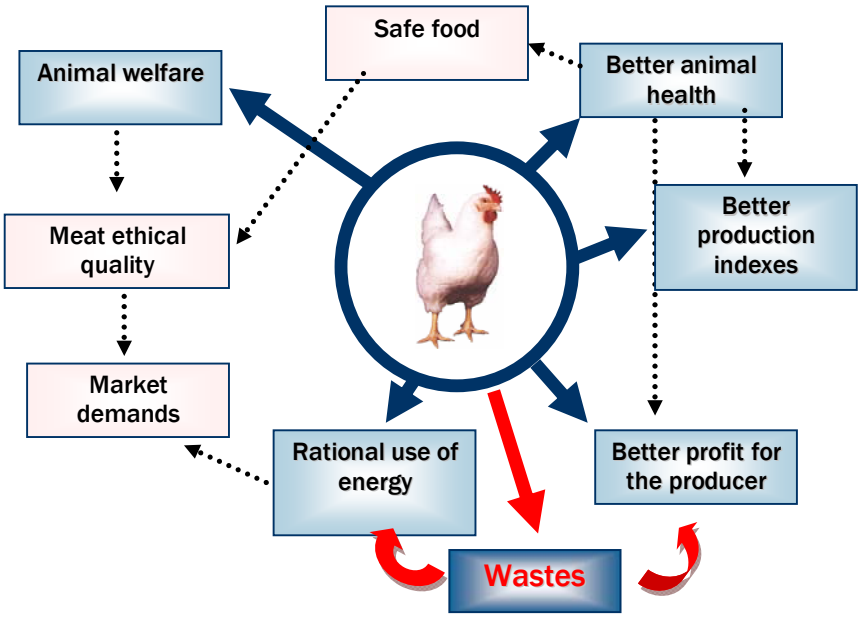


**Figure 1. Overall balance to be reached in animal production cycle.**

**Figure 2. Adobe brick for rural building purposes.**

## FINAL REMARKS

The need to reduce gases emissions and restrain the increase of cost in food production, will normally lead to the reduction of the use of fossil fuels in agricultural operations.

Renewable energy sources will play a decisive role in our future energy grid. The energy demand in a modernized grid tends to reduce the need for new generation and probably will cut costs to consumers, besides creating new economic opportunities that are unpredictable today. Instead of relying only on a few, traditional power plants, utilities will be able to get electricity from a network of clean power providers, which would not only make clean energy widely available to consumers, but also make its supply more stable and secure. The trend of renewable energy use is practically the only solution for the oil crisis today, as it has the technological potential to replace fossil fuels as mainstream energy source, besides its tangible economic, ecological and social benefit. However, the land competition for food production in

the case of bio fuels needs to be solved, as well as the establishment of a predictable, supportive political and legal framework for renewable energy production and distribution worldwide.

Climate change and oil dependence are pushing the nations toward an efficient energy future. There is not a single answer to this complex array of problems that need to balance demand and supply in a proper, logical and, most of all, ethical way.

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