UNEDITED VERSION

United Nations Conference on Trade and Development

The Biofuels Controversy

Prepared by:

Professor Ignacy Sachs

UNITED NATIONS
New York and Geneva

November 2007

NOTE

Symbols of the United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

This discussion note was prepared for the conference on "Biofuels: an option for a less carbon-intensive economy", 4-5 December 2007, Rio de Janeiro, Brazil. The views expressed in this publication are those of the author and do not necessarily reflect the views of the United Nations or its member states.

UNCTAD/DITC/TED/2007/12

Table of contents

List of boxes

Nous sommes peut-être à un tournant dans l'histoire de l'énergie. Après avoir vécu pendant deux siècles dans un monde d'énergie abondante et bon marché qui a nourri une croissance économique prodigieuse, certains signes laissent présager que nous pourrions entrer dans une phase d'énergie plus rare et plus chère. L'énergie est un bien qui est à la fois public et privé. Le soleil, le vent sont des biens publics inépuisables. Le pétrole, le gaz et le charbon, sont des biens privés épuisables dont on découvre qu'ils portent atteinte à un autre bien public, le climat. Le défi du présent siècle, c'est de produire davantage d'énergie pour alimenter le développement économique des pays émergents et des pays les plus pauvres tout en gérant de façon soutenable le changement climatique. C'est le sens du développement durable. Il ne s'agit donc pas d'un troisième choc pétrolier mais plutôt d'un changement de paysage.

(Le Cercle des économistes et Erik Orsenna, *Un monde de ressources rares*, Perrin/Descartes&Cie, Paris, 2007, pp. 76-77)

1. Biofuels Background

The coming of age of biofuels[1] is happening against the background of growing awareness of the urgent need for changing the present unsustainable pattern of energy use, characterized by a profligate (mis)use of abundant and cheap fossil fuels. It is helped by the recent sharp increase in oil prices. With oil barrel traded at 70 to 90 dollars, some biofuels become competitive. Furthermore, the imminent 'oil peak' is likely to keep the oil prices fairly high.[2]

The unsustainability of the present energy consumption trends has been put in evidence in the Reference Scenario of global energy demand to 2030, prepared by the International Energy Agency.[3] It is projected to increase by just over one-half between now and 2030 – an average annual rate of 1.6 per cent. Fossil fuels will remain the dominant source of energy, accounting for 83 per cent of the overall increase in energy demand between 2004 and 2030. The share of oil drops somehow, yet oil remains the largest single fuel in the energy mix, reaching 116 mb/d in 2030 up from 84 mb/d in 2005. Coal sees the biggest increase in demand in absolute terms driven by power generation. The share of biomass falls a bit, accounting for 10 per cent of total primary energy demand in 2030, as the traditional forms of biomass use will decrease, offsetting the growing use of biofuels and of biomass – based electrical power. The share of all other renewable energy technologies will increase from 0.5 per cent today to only 1.7 per cent in 2030. Overall, nuclear power's share of world primary energy drops from 6 per cent in 2004 to 5 per cent in 2030. Developing countries account for over three quarters of the increasing global CO_2 emissions; China will overtake the United States of America (USA) as the world's biggest emitter before 2010.

The authors of the article conclude that *'current trends in energy consumption are neither secure nor sustainable – economically, environmentally or socially. Inexorably, rising consumption of fossil fuels and related greenhouse gas emissions threaten our energy security and risk changing the global climate irreversibly.'* (p.13)

A Reference Scenario is often a scenario of impossibility. The IEA had therefore prepared an Alternative Policy Scenario in which world primary energy demand in 2030 is about 10 per cent lower than in the Reference Scenario. Global demand grows more slowly:

[1] The FAO defines biofuel as fuel produced directly or indirectly from biomass such as fuel wood, charcoal, bio-ethanol, biodiesel, biogas, or biohydrogen.

[2] There is no consensus among geologists about the timespan that separates us from the 'oil peak', many consider that it will happen within a couple of decades at most. (See e.g. WINGERT J.-L., 2005, *La vie après le pétrole – de la pénurie aux énergies nouvelles*, Autrement, Paris)

[3] For the presentation of the IEA scenarios, see Mandil C. and Birol F., "What role for biofuels in the global energy scene?" *Revue des Ingénieurs*, March/April 2007, pp. 12-14.

1.2 per cent annually. The renewables reach a 27 per cent share by 2030, compared with 22 per cent in the Reference Scenario. Global oil demand reaches 103 mb/d instead of 116 mb/d. Measures in the transport sector produce close to 60 per cent of all the oil savings, more than two-thirds coming from more efficient new vehicles.

Biofuels account for 7 per cent of the road-fuel consumption in 2030 up from 1 percent today and 4 per cent in the Reference Scenario. Biofuels' production increases from 15.5 Mtoe in 2004 to 97 Mtoe in 2030 in the Reference Scenario and to 147 Mtoe in the Alternative Scenario. Ethanol is expected to account for most of the increase in biofuel use worldwide.

However the authors consider that rising food demand, which competes with biofuels for existing arable and pasture land will constrain the potential for biofuels production, using the current technology. About 14 million hectares of land are used for the production of biofuels for transport at present, equal to about 1 percent of the currently available arable land. This share goes up to 2 per cent in the Reference Scenario and 3.5 per cent in the Alternative Policy Scenario. They recognize that second generation biofuels technologies could greatly increase the future role of biofuels, but they do not incorporate them in their Alternative Scenario.

This question is discussed by S. His and D. Babusiaux[4]. Second generation biofuels are those, which utilize ligno-cellulosic biomass, the most abundant source of renewable carbon on our planet. They estimate that worldwide at least 5 per cent of total production of biomass could be harnessed for the production of energy: 13.5 billion tons of raw material representing ca. 6 billion toe, around half of the present world consumption of energy.[5] Only 20 per cent of this potential is being used at present, mostly in the form of fuelwood (80 per cent) and only 1 per cent for transportation in 2005. This potential could reach about 18 billion tons of biomass in 2050 corresponding to 9 Gtoe of primary energy.

Only part of this potential will be transformable into biofuels and we lack at present a reliable estimate. However, a worldwide extrapolation for 2050 of a 30 per cent rate of substitution of fossil fuels by biofuels envisaged by Europe and the USA for 2030 would require 1 billion toe of biofuels. This is an ambitious, yet feasible goal, given the biomass availability.

Brazil and the United States of America lead the production of ethanol while the European Union is at present the main producer of biodiesel.

According to the *Brazilian Agroenergy Plan 2006 – 2011*, the demand for sugarcane ethanol in the country, including the prospective exports, could reach 30 billion liters by 2015. Some studies go as far as proposing a multiplication by five of the present sugarcane plantations (from 6 to 30 million hectares). M. Jank, chairman of UNICA[6] estimates nevertheless that the present area used for sugarcane will only grow from 6.3 to 14 million hectares in 2020, allowing for the increase in ethanol production from 18 to 65 billion liters

[4] His S. and Babusiaux D., "Les biocarburants : de quoi parlons-nous ?", *Revue des Ingénieurs*, March/April 2007, pp. 15-18.

[5] 2.36 Gt in forest products, 5.33 Gt in non agricultural non edible products, 3.5 Gt in agricultural residues, 2.1 Gt in wood industry residues and 0.19 Gt in other residues (animal fats), totalizing 13.5 Gt.

[6] Unica (União da agroindústria canavieira de São Paulo) is an association representing the sugarcane based agroindustries in São Paulo, wherefrom comes the bulk of Brazilian production of sugar and ethanol.

per year. After that, further increases in ethanol production will not require additional land as they will benefit from the second generation biofuel technologies and high yield varieties of sugarcane.[7] However, the need to regulate the sugarcane-based industry is urgently required.[8]

On the biodiesel front, Brazil's present capacity of production is 954 million liters per year with 25 plants functioning. Another 10 units will be inaugurated by the end of 2007, bringing the total capacity to 1.2 billion liters per year. The government is considering anticipating a 5 per cent blend of biodiesel to diesel, originally foreseen for 2013. At present 63 thousand families of small farmers are involved in the production of vegetable oils for biodiesel. But their number is expected to increase to 210 thousand in the next year.[9]

As for the United States, the US Senate approved in June 2007 the new Energy Bill, which sets the production of 136.1 billion liters of ethanol as a goal for 2022. In spite of its unfavorable energy in/energy out ratio, the US ethanol produced from maize received 9.4 billion dollars in subsidies in 2005. Hence, the criticism that the United States have only 'energy politics' not an 'energy policy' and representing 'the sum of all lobbies' and not 'the sum of best ideas'.[10]

In biodiesel, Europe is at present the leading producer. A law on biofuels will be presented by the end of 2007 following the proposal of the European Commission that all petrol and diesel used in the European Union by 2010 should have 10 per cent biofuel content. The European Union has decided to reduce by 20 per cent its emissions of greenhouse gases (GHGs) by 2020 and may be prepared to go as far as 30 per cent if other industrialized countries follow in its steps.

Much controversy surrounds the future of biofuels. Brazil aspires to play a major role in the transition from the oil to the post-oil age and to become an important exporter of

---

[7] Quoted by Romero T., "Álcool em abundância", Agência FAPESP, October 2, 2007. At present, Brazil produces 8 thousand liters of ethanol per hectare of sugarcane (compared with 3 thousand from corn in the United States). New technologies should increase the yield to 14 thousand liters per hectare.

[8] See on this point José Dirceu, "A hora da regulação", *Jornal do Brasil*, June 28, 2007. The author, a former minister-chief of President Lula's Civil House, mentions eco-economic zoning, measures to protect biodiversity and reduce pollution and calls for restricting foreign acquisition of land and biofuel industries. Government and National Congress should take the necessary steps to regulate the sugar cane-based industry in order not to transform the new opportunities arising from bioenergy into degradation of environment, destruction of small property, wealth concentration, creation of cartels, monopolies and servile labor. The need for clear rules for public-private cooperation in the field of agroenergy has also been emphasized by Roberto Rodrigues, former Minister of Agriculture and a leading authority in the subject (*Folha de São Paulo*, June 9, 2007). His successor informed the press that the government is considering the creation of an agency to deal with agroenergy. On its side, the National Institute of Colonization and Land Reform (INCRA) is considering a revision of loans, which regulate the purchase of land by foreigners (*O Estado de São Paulo*, June 10, 2007).
In a meeting at the International Labor Organization, the Brazilian Minister of Labor, Carlos Lupi, recognized the need to improve the working conditions of sugar cane cutters in Brazil (*O Estado de São Paulo*, June 11, 2007).

[9] *Carta Capital*, June 13, 2007.

[10] Friedman, T. L., "America's green bubble", *International Herald Tribune*, June 4, 2007. According to this author the elements of such a policy would be: a clear long-term price signal (carbon tax or a cap-and-trade system with binding national ceiling on carbon dioxide emissions); commitment to buy a fixed volume of solar and wind power for government buildings and Army bases for ten years; setting a norm for newly produced cars – 35 miles per gallon within ten years; establishing government loan guarantees for companies willing to build nuclear power plants; finally building a national transmission grid.
Multiplying by 8 the ethanol production will require shifting to other sources of biomass and introducing to the market cellulosic ethanol. One possibility is to extract ethanol from switch grass.

ethanol. Brazilian President, Luis Inácio Lula da Silva, is adamant that the production of biofuels can be greatly expanded without impairing food security and without endangering native forests like the Amazon forest. Brazil will give all the social and environmental guaranties to the production of biofuels. Speaking at the opening of the 62nd General-Assembly of the United Nations, he rightly observed that hunger in our planet does not come from shortage of food, but from lack of purchasing power, which affects 1 billion people. He further insists that for many Latin American, Asian and, above all, African countries, ethanol can bring energy autonomy, create employment and income and foster family agriculture.[11]

The opposite stance was taken by the Cuban *lider maximo*, Fidel Castro, who sees the boom for biofuels as a menace of hunger for many millions of people.[12] Castro's view is shared by several environmental action groups.

For instance, in an article full of flawed data, Eric Holtz-Giménez argues that biofuels are neither necessary nor desirable, as many local replacement alternatives are quite successful (but he fails to mention which and where). On the other hand, he commends the functioning of small local cooperatives producing biodiesel in the US, implying that industrialized countries should not transfer on the shoulders of the developing countries the burden of their excessive consumption of energy. As *qui pro quo*, developed countries impose protectionist barriers against developing countries, preventing these from exporting biofuels.[13]. In many quarters, fears also arise about the impact of the growing demand for biofuels on agricultural prices [14] and on water availability.[15] Other critics of biofuels argue that renewables are 'boutique fuels', they look attractive when they are quite small but if producing them on a large scale will start, the fallout is going to be horrible.[16]

Some of these articles are quoted by Jean Ziegler, United Nations Special Rapporteur on the right to food, in the report presented to the UN General-Assembly to support his plea for a five-year moratorium on the production of biofuels.[17]. The report starts by an impassionate denunciation of biofuels which may bring hunger in their wake. To him:

> *'the sudden, ill-conceived, rush to convert food – such as maize, weed, sugar and palm oil – into fuels is a recipe for disaster. There are serious risks of creating a battle between food and fuel that will leave the poor and hungry in the developing countries at the mercy of rapidly rising prices for food, land and water.'*

---

[11] See Monteiro T., "Na ONU, Lula lança cúpula sobre biocombustível e defende etanol", *O Estado de São Paulo*, September 26, 2007.
[12] Fidel Castro, *Granma* (Havana), March 27, 2007.
[13] Holtz-Gimenez E., "Les cinq mythes de la transition vers les agrocarburants" *Le Monde diplomatique* June 2007 and also *International Herald Tribune*, July 11, 2007, published under the title "Green or mean? The Biofuel myths". In Brazil, Frei Betto, former close adviser to President Lula, counts among the rare critics of the biofuel program (Paraguassú L., "Frei Betto ataca biocombustíveis", *Estadão*, July 24, 2007).
[14] See the OECD and FAO joint *Agricultural Outlook 2007-2016*, released on the very day in which President Lula was discussing the prospect for biofuels with the European Commission. Brazilian commentators played down this argument, arguing that the Report did not pay enough attention to the impact of higher oil prices on food prices.
[15] This concern was widely discussed at the 17th International Week on Water held in Stockholm in August 2007 (AFP, August 16, 2007).
[16] This is the position of Jesse Ausubel from Rockefeller University in New York. His recipe is 'if we want to minimise the rape of nature, the best energy solution is increased efficiency, natural gas with carbon capture and nuclear power.' McKenna P., "Renewable energy could 'rape' nature", *New Scientist*, July 25, 2007.
[17] Ziegler J., *Draft Report of the Special Rapporteur on the Right to Food to the General-Assembly 62/2007*. See also Chade J., "Relatório pede moratória na expansão do etanol", *O Estado de São Paulo*, September 25, 2007.

Reporting on Ziegler's presentation, the media focused mainly on these polemical remarks and on the plea for the moratorium. Yet, if one goes carefully through his recommendations, the apparent sharp contradiction between his stance and that of President Lula, to a great extent, disappears. Ziegler's main recommendations, apart from the moratorium, are:

- 'Promoting the reduction of overall energy consumption and improving energy efficiency;
- moving immediately to second generation technologies for producing biofuels so as to make complementary the production of food and biofuels;
- adopting technologies that use non-food crops, particularly those that can be grown in arid and semi-arid regions (in particular jatropha);
- ensuring that biofuel production is based on family agriculture rather than industrial models of agriculture;
- organizing cooperatives of small farmers.'

If these conditions are respected, Ziegler admits that biofuels could be an important tool to fight hunger and poverty. This opinion is not so different from the positions taken by President Lula and also by the Director General of the FAO, Jacques Diouf. In a recent article, the latter set the conditions that must be respected in order to take advantage from the enormous potential of biofuels to accelerate growth in many among the world's poorest countries, to foster agriculture and to deliver modern energy to one third of the world's population.[18] According to him:

- a fair share of bioenergy ought to be produced by farmers and rural workers in developing countries;
- small farmers should be given the opportunity and the necessary credits to organize themselves in cooperatives to produce and process biomass for fuels;
- commercial barriers imposed on ethanol imports in some OECD countries should be reduced;
- a system of socioeconomic certification of biofuels should be established; and
- finally, the debate should move beyond the substitution of fossil fuels in transportation and also focus on the importance of bioenergy for the reduction of poverty by helping 2 billion people to satisfy their daily domestic needs in energy.

In this author's opinion, instead of asking for a moratorium, Jean Ziegler would be better inspired in recommending the immediate application of the conditions set by him in order to transform biofuel production into a lever of socially inclusive and environmentally sustainable rural development.

[18] Diouf, J., "Biofuels should benefit the poor, not the rich", *The Financial Times*, August 15, 2007, see also José Graziano da Silva, "Biocombustiveis para os pobres", *Folha de São Paulo*, August 31, 2007.

2. How do we move forward?

In an important article published on the occasion of the G8 meeting, the United Nations Secretary-General, Ban Ki-moon, announced a special High-level Meeting on Climate Change to be held in the UN headquarters in September 2007. He then summarized the situation as follows: [19]

- First, the science is clear. The earth's warming is unequivocal; we humans are its principle cause.
- Second, the time for action is now. The cost of not acting will exceed the costs of acting early by several orders of magnitude.
- Third, carbon trading, new technologies, energy conservation, forestry projects and renewable fuels must all be part of a long-term strategy.
- Fourth, the most important issue is that of equity. Global warming affects us all. Rich nations possess the resources and the knowledge to adapt and people living in developing countries are much more vulnerable. Moreover, none of the Millennium Development Goals (MDGs) will be achieved unless the rhythm of its implementation is accelerated.[20]

The Stern Report[21], the three volumes of the Fourth Assessment Report recently released by the influential Intergovernmental Panel on Climate Change (IPCC)[22] and Al Gore's celebrated documentary *An Inconvenient Truth* have put climate change on top of the international agenda, which culminated with the presentation of the 2007 Nobel Peace Prize Laureates[23]. A wide consensus is emerging on the need to cut by half the GHGs by 2050 in order to avoid catastrophic and, to some extent, irreversible consequences of global warming[24].

To move in this direction, the following elements of a roadmap have been suggested in a recent United Nations Foundation publication:[25]

---

[19] Ban Ki Moon, "Hear the first victims of climate change", *International Herald Tribune*, June 5, 2007.
See on this last point, Conniff, R., "Third World to Bear Brunt of Global Warming", *Environment: Yale*, Spring 2007. The poorest nations on Earth will bear the brunt of the costs. And the wealthiest nations, which are the main source of the problem, will in some cases actually benefit.

[20] See the UN *Report on Millennium Development Goals*, New York 2007 (quoted by PNUD Brasil, *Noticias*, July 2, 2007).

[21] Stern, N., 2006, *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge.

[22] "Climate Change 2007" *IPCC Fourth Assessment Report*, 3 volumes, Cambridge University Press, Cambridge.

[23] The 2007 Nobel Peace Prize went to the Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr. "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change".

[24] This is independent from the controversy over the role played by anthropogenic action in global warming, which divides the scientific community. Whatever its causes, mitigation of climate change calls for a drastic reduction of the emission of GHGs and, therefore, to the gradual phasing out of the consumption of oil and other fossil fuels, side by side with measures aimed at capturing CO2 emitted by plants producing power from fossil fuels. A demonstration unit at Värtan coal-fired power plant in Stockholm is said to capture 95 percent of the CO2 emitted.

[25] United Nations Foundation, Sigma XI, *Confronting Climate Change: avoiding the unmanageable and managing the unavoidable*, Washington, 2007. Report of the scientific expert group prepared for the 15th session of the UN Commission on Sustainable Development. Also see "The Future in our Hands: Addressing the Leadership Challenge of Climate Change, UN Headquarters, New York, 24 September 2007, Chair's Summary, available at: http://www.un.org/climatechange/2007highlevel/summary.shtml, November 5, 2007.

1. Accelerate implementation of win-win solutions: improve efficiency in the transport sector, improve the design and efficiency of commercial and residential buildings,[26] expand the use of biofuels, promote reforestation, afforestation and improved land use practices, design and deploy only coal-fired power plants that will be capable of cost-effective and environmentally sound retrofits for capture and sequestration of their carbon emissions.

2. Implement a new global policy framework for mitigation, including mechanisms that establish a price for carbon, such as taxes or "cap-and-trade" systems and a mechanism to finance incremental costs of more efficient and lower-emitting energy technologies in low-income countries.[27]

3. Develop strategies to adapt to ongoing and future changes in climate. Create and rebuild cities to be climate resilient and GHG-friendly.[28]

4. Increase investments and cooperation in energy-technology innovation: advocating tripling to quadrupling of global investments in energy technology research, promoting a comparable increase of resources for demonstration and accelerated commercial deployment of energy technologies with large mitigation benefits, using UN institutions to promote public-private partnerships and drawing upon limited public resources to provide loan guarantees and interest rate buy-downs.

Reaching this target will require drastic changes in the use of energy. The present pattern of world economy is predicated on a profligate use of abundant and, up until the recent past, inexpensive, yet highly polluting fossil fuels – oil, gas and coal. This pattern is clearly incompatible with the goals of sustainable development.[29]

[26] José Goldenberg rightly insists on the wide array of mandatory and fiscal incentives that could be easily introduced to promote greater efficiency of the existing energy systems and newly produced equipment. In California, energy consumption *per capita* is only half of the national average and did not increase since 1980, thanks to an active policy of energy conservation. (Goldenberg, J., "Energia – outra morte anunciada", *O Estado de São Paulo*, September 17, 2007.)

[27] On August 28, 2007, the Secretary General of UNCTAD announced that UNCTAD had started its own Carbon Neutral Initiative in view of developing a carbon mitigation strategy, to be announced at the UNCTAD XII Conference.

[28] Work on eco-cities is progressing in several countries. In China, a carbon-neutral eco-city, Dongtan, is being built to house 500,000 people. The first phase of Dongtan is scheduled for completion by 2010. England is one of several countries supporting carbon-neutral urban projects. Five eco-towns, each with 10 to 20 thousand houses, are to be created. In the desert of Abu Dhabi, British architects are designing a six-million-square-meter walled complex – the world's first zero-carbon, zero-waste city. The center piece of the design is a new university that will offer programs in sustainable design. (Brass, K., *Breaking ground on eco-cities*, International Herald Tribune, June 29, 2007.)

[29] See on this point Laponche B., "L'énergie dans le monde : enjeux et prospective" in *Regards sur la terre 2007*, Jacquet P. and Tubiana L., (eds), Les Presses Sciences Po, Paris pp. 71-83. Laponche rightly observes that the most serious energy crisis is that of firewood. Two billion people worldwide depend on traditional fuels, such as wood and charcoal used for cooking and heating with serious negative implications for the environment and health. Traditional biomass makes up an astonishing 82 per cent of energy use in Africa. 1.6 million deaths per year are attributed by the WHO to indoor air pollution. (IEA, *World Energy Outlook* 2006.)

Hence, the need to moderate the demand profile for energy by changing lifestyles, consumption patterns and, above all, modes of transportation,[30] as well as the design of future cities.

Simultaneously, efforts must be made to improve the efficiency in the production and final use of energy. The challenge is to double the global output of the world economy while reducing by half the material inputs, along the lines proposed in *Factor 4.*[31]

Additionally, efforts should be focused on the substitution of fossil fuels by the full spectrum of renewable and clean energies,[32] side-by-side with efforts to evolve technologies for clean burning of coal[33] and sequestration of GHGs. Special attention should be given to co-generation of bio-electricity by sugarcane ethanol producing plants. One third of the energy from the sugarcane available in its straws and tops is at present lost because of the manual harvesting, which requires burning of the cane in the field.[34] According to a report prepared by Greenpeace and the European Council for Renewable Energy, generation of electrical energy from renewable sources has significant potential and could bring substantial savings, as compared with a scenario based on fossil and nuclear energy.[35]

Resorting to bioproducts other than biofuels may also result in indirect fossil energy substitution. Green fertilizers, bamboo and timber building materials, natural fibers, plastics and other products of green chemistry are less fossil energy intensive than cement, metals and petrochemicals. More generally, we ought to explore the whole potential of a modern, knowledge-intensive, biomass-based civilization running on solar energy captured by photosynthesis.[36]

---

[30] The data referring to distance covered by a passenger in France with one kilo of petrol equivalent are quite eloquent:
- **Urban**: tramway 193 kilometers, metro 65 to 140 kilometers, bus 36 to 47 kilometers, car 18 kilometers.
- **Intra urban**: TGV 172 kilometers, normal train 107 kilometers, bus 91 kilometers, car 39 kilometers, airplane 18 kilometers. (Dessus, B. "Changer de paradigme", *Technology Review* (édition française) n° 2 June/July 2007).

[31] Von Weizsacker, E. Lovins, A. B. and Hunter Lovins L., *Factor Four: Doubling Wealth, Halving Resource Use – The New Report to the Club of Rome*, Earthscan Publications, London 1997. See also Hawken P., Lovins A. B., and Lovins L.H., *Natural Capitalism: The Next Industrial Revolution*, Earthscan Publications 1999.

[32] Nuclear energy belongs to the latter category; however, resorting to it is a matter of controversy that will not be taken up in this report. Advocates of nuclear energy claim that it is safe and problems of disposal of nuclear waste can be properly handled. Its critics point to the conjunction of an extremely low probability of nuclear accident with the likelihood of devastating consequences, to the dangers of proliferation of nuclear energy for military purposes and to the yet unsolved problems of nuclear waste disposal.

[33] See MIT, *The Future of Coal – Options for a Carbon-constrained World, An Interdisciplinary Study*, directed by Katzer J., Cambridge, Mass., 2007.

[34] In Brazil, about 2,000 MW are generated at present, with the potential to reach 20,000 MW in 2020, about 20 per cent of the country's needs, the equivalent of two Itaipu hydro-electrical plants, at a price much lower than nuclear energy. (M. S. Jank, "Bioletricidade eficiente e sustentavel", *O Estado de São Paulo*, June 20, 2007; "Metas do açucar, etanol e bioeletricidade", *O Estado de São Paulo*, July 4, 2007). About 40 out of about 900 CDM registered projects are related to energy derived from bagasse. Such projects are largely concentrated in Brazil, China and India. However, there is not a single ethanol project registred under the CDM. Source: http://cdm.unfccc.int/Projects/projsearch.html, last visit November, 5, 2007.

[35] The report *Future Investments – A Sustainable Plan in the Electrical Sector to Save Climate*, was released on July 6, 2007. It calls for an annual investment of 22 billion dollars in renewable energy, pointing out that coal and natural gas receive at present 250 billion dollars in subsidies. (Press release from Greenpeace dated July 6, 2007)

[36] See Sachs, I., "Da civilização do petroleo a uma nova civilização verde", *Estudos Avançados 19 (55)*, 2005 p.197-214.

3. Biofuels are not a panacea

Producing biofuels is thus only a part of a comprehensive energy strategy. The addition of ethanol to gasoline and of biodiesel to diesel can reduce the consumption of oil-based liquid fuels in the near term and, for assisting in the reduction of exclusive dependency on oil-based liquid fuels at a later date. However, biofuels should not be viewed as a panacea.

For more than a hundred years we have been living in an oil-age, which is now being put on check. According to many geologists, production of oil will soon reach its peak, and will be declining afterwards. The newly discovered reserves of oil do not match the current demand prospects; hence the trend towards depletion and higher prices. These high prices and projected shortages make biofuels increasingly competitive.

The question of how to organize an orderly transition from the oil-age to the post oil-age and how to cope with the volatile and often explosive geopolitics of oil will certainly dominate the international scene throughout the 21st century.[37]

The UN-Energy Task Force recently released a comprehensive report on *Sustainable Bioenergy: A Framework for Decision Makers*,[38] which raises some important questions that need to be addressed:

- Will biofuels push out food crops, raise food prices, and threaten food security?
- Will biofuels create unexpected negative rather than positive external environmental effects?
- Could biofuels even exacerbate the impact on climate when the entire production chain is taken into account?
- How will increased investment in biofuels affect trade patterns?
- What would a sustainable approach to bioenergy look like?

Another set of queries was raised by the distinguished Brazilian environmentalist Washington Novaes:[39]

- Will the ethanol boom have an inflationary impact?
- Will Europe impose the certification of Brazilian ethanol to avoid the expansion of sugarcane plantations in the ecologically fragile regions such as Amazonia and Pantanal?
- Will the increase in land prices due to sugarcane boom expel food production and cattle breeding from São Paulo to the Amazon region?
- What ought to be done to transform the unhealthy and unjust working conditions of sugarcane cutters?

---

[37] See on this point Wingert, J. L., *La vie après le pétrole, de la pénurie aux énergies renouvelables*, Paris, Autrement 2005; Prévot, H. *Trop de pétrole, énergie fossile et réchauffement climatique*, Paris, Seuil 2007 and Sachs, I. "A revolução energética do século XXI", *Estudos Avançados 21 (59)*, 2007 p.21-38.

[38] United Nations, UN-Energy, *Sustainable Bioenergy: A Framework for Decision Makers*, New York 2007. See also among the many recent reports Garten Rothkopf, *A Blueprint for Green Energy in the Americas*, Interamerican Development Bank, Washington 2007 and Peter Hazell and R. K. Pachauri (eds), *Bioenergy and Agriculture Promises and Challenges*, 2020 Focus n°14, IFPRI/TERI, Washington/New Delhi, 2006.

[39] Washington Novaes, "O debate crucial dos proximos anos", *O Estado de São Paulo*, May 11, 2007.

The following is an attempt to answer some of the questions raised above in the context of assessing the prospect for the liquid biofuels as well as in discussing the range of policies[40] capable of ensuring that the expansion of their output will not collide with the paramount goal of food security, nor will it induce felling down of tropical native forests. It should be observed that food security can be jeopardized in two ways: by diverting prime crop lands from the production of food or by linking the prices of such goods like sugar, palm oil or corn to oil prices. A hike of the latter could result in depriving poor people of access to staple foods.[41] It is important to note that people most often starve not because of shortage of food but on account of lack of purchasing power to buy it.

Garten Rothkopf suggests that the expansion of biofuels production should rest on four pillars:

(i). innovation,
(ii). capacity expansion,
(iii). infrastructure; and
(iv). the building of a global market. [42]

It is suggested that a fifth pillar is equally relevant: (v) biofuels production should be predicated on institutional settings and production models capable of inducing a new cycle of rural development, aimed at creating a fair amount of opportunities for decent work. These would include the production and processing of biomass for fuel, productive uses of byproducts and waste, as well as technical services and transport. As for innovations required, they ought to be knowledge and labor intensive, yet land, water and capital saving.

[40] Such as economic-ecological zoning, mandatory "cap-and-trade" regulatory systems, carbon taxes, price floor on oil, fiscal incentives, tax rebates, proactive steps to spur the biofuels industry, etc. See Hayes, D., Ballentine, R. and Mazurek, G., Harvesting Fuel, *Blueprint Magazine,* April 23, 2007.
Many authors recommend carbon tax as a central tool (see e.g. Hulot, N. *Pour un pacte écologique*, Paris Calmann-Lévy, 2006), to be offset by a reduction of taxes and charges on labor, so as to be neutral from the fiscal viewpoint and, at the same time, employment creating (Hourcade, J. C.; Ghersi, F. "La taxe carbone: une bonne idée à ne pas gâcher" *Dossier pour la Science*, January-March 2007). The controversial question is how high it should be to become effective. According to Patrick Criqui, to change behavior, prices of fuels should double between now and 2050 (quoted by l'Expansion July/August 2007, n°721 "Taxe Carbone: panacée ou usine à gaz?").

[41] See on this point the already mentioned joint OECD-FAO report, which came under criticism on part of Brazilian commentators on the ground that it did not fully acknowledge the impact of rising oil prices.

[42] Rothkopf, *op.cit.*, 2007.

4. Biofuels against food?

The well known American environmentalist Lester Brown sees a dramatic conflict coming up between 800 million car owners (they will soon number more than 1 billion) and the 2 billion hungry people competing for scarce agricultural land.[43] Yet the warnings coming from neo-Malthusians are premature, least to say.

A recent FAO report on food security concluded that there is enough land to accommodate additional food crops and biomass production to be transformed in biofuels.[44] A similar conclusion was reached by a report prepared by the European Environmental Agency.[45] José Graziano da Silva, FAO's representative for Latin America has commented that the real problem is not arithmetic but social. In most cases, as already mentioned, people are not hungry on account of food scarcity, but because they lack purchasing power to buy food. There are at least five ways to reduce the competition for scarce agricultural land between biofuels and food crops:

- By concentrating the production of biomass for biofuels on waste and deforested land, leaving prime agricultural land to food crops;[46]
- By promoting integrated food-energy systems (integration of biofuels production with dairy cattle, crop association and crop rotation, agro-forestry systems) which result in higher global yields per hectare and release pastures for crop production;[47]
- By shifting, as quickly as possible, to second generation cellulosic biofuels, produced from non-edible parts of food crops, forest residues, wild grasses, tree crops, animal fat and all sorts of green residues;

---

[43] Brown, L. R., "Ethanol Could Leave the World Hungry", *Fortune Magazine*, August 16, 2006. See also Mennig M., "Haro sur les biocarburants ?", *Défis Sud*, n° 78, July-August 2007.

[44] The FAO Committee on World Food Security proceeded to an assessment of the world food security situation at a meeting held in May 2007. The resulting document concluded prudently that *"bioenergy offers both opportunities and risks for food security. The impacts will vary over space and time depending on the evolution of market forces and technological developments, both of which will be influenced by policy choices at national and international levels. It is necessary to develop an analytical framework that takes into consideration the diversity of situations and specific needs of countries."* See also the thought provoking Duisenberg Lecture, (Singapore September 17, 2006) on *Biomass for Food or Fuel: Is There a Dilemma?* by Prof. Louise O. Fresco (published by Rabobank, Amsterdam).

[45] European Environment Agency, *How much bioenergy can Europe produce without harming the environment?*, Brussels, 2007. The study concluded that *"significant amounts of biomass can technically be available to support ambitious renewable energy targets, even if strict environmental constraints are applied."* (p.6).

[46] The Indian agroenergy program is essentially based on growing Jatropha on wasteland. According to *Fortune*, ("Bright Prospects for a Poisonous Plant", September 17, 2007) about 100 thousand hectares of Jatropha are under cultivation in this country. Africa is also betting on the same source of biodiesel. In June, BP signed a 160 million dollars deal with British biodiesel producer D1 Oils. The new company aims at becoming the world's largest producer of Jatropha oil by 2011. It expects to have nearly 1.2 million hectares under cultivation within 4 years and to process 2 million tons annually – 18 percent of Europe's expected biodiesel demand. According to the UNDP 2007 Annual Report, China has launched the so-called Green Poverty Reduction project, providing poor farmers with technologies to produce Jatropha curcas trees. In 2010, the project is expected to reach 200 thousand farmers and be scaled up to nearly 1.2 million hectares.

[47] See box 1. In 1983, the United Nations University launched the Food-Energy Nexus Program addressing such issues like: more efficient use of energy in the production, processing and consumption of food, food-energy systems in diverse ecosystems, household economy in rural and urban settings and the role of women and children in the provision of food, fuel and water. See Sachs, I. and Silk, D., *Food and Energy Strategies for Sustainable Development*, United Nations University Press, Tokyo 1990, and also the work carried on the subject by EMBRAPA Florestas (Colombo, Paraná).

- By promoting further increases in yields per hectare of both food and biofuel crops, resorting to agro-ecological practices predicated on the concept of 'evergreen revolution'[48] seeking knowledge and labor-intensive, yet land, water and capital saving production functions accessible to small farmers, and characterized by low fossil energy inputs;
- Finally, by supporting research aimed at identifying new oil producing plants (with special reference to different very promising kinds of palm trees), improving the productivity of the biofuel crops already in use and expanding the spectrum of biofuels.

Box 1

Two models of integrated food energy systems

Considerable savings of land for the production of biofuels can be achieved by integrating the production of sugarcane for ethanol and vegetable oils for biodiesel with confined or semi-confined cattle breeding by using the tops of sugarcane and the residues of oil extraction as feed.

Adecoagro, an enterprise located in Santa Fé, Argentina, which owns 240,000 hectares of land in Argentina, Brazil and Uruguay proposes to extract from 500,000 tons of corn, 210 million liters of ethanol per year and produce feed for 45,000 confined cows, in order to export 50,000 tons of milk powder and cheese. 1 million tons of cow dung processed in biodigesters is projected to produce 37 million cubic meters of biogas, which is more than enough to fulfill all the electrical energy needs of the operation, and biofertilizers that will be put on the market. Adecoagro also expects to benefit from carbon credits. (*Agência Dinheiro Vivo*, São Paulo 19 April 2007)

This example of integrated food energy system is open to two criticisms. It will operate with corn, which has an unfavourable energy in/energy out ratio. Moreover, it has been designed as a large-scale capitalistic enterprise.

By contrast, Petrobras, the Brazilian state-owned oil enterprise, which is increasingly becoming an energy enterprise, is carrying out an experimental project in the State of Rio Grande do Sul, Brazil, working with a peasant cooperative and testing micro-distilleries of sugarcane ethanol (which has a very favorable energy in/energy out ratio). Each farmer will grow 2 hectares of sugarcane and engage in other agricultural activities. The sugarcane tops will be fed to milk cows.

If successful, the second model could be quickly reproduced in many rural areas of Brazil and other developing countries (*O Valor*, June 18 2007).

Serious complications may arise from linking the price of certain foods used as raw material in biofuels to the volatile price of oil. In recent months, the price of maize almost doubled on account of the US plan to expand the production of maize-based ethanol. That of *tortilla*, the staple food of Mexicans, followed suit, with severe social consequences. In the same way, price hikes of palm oil may affect the consumption patterns of poor people in many developing countries, as this vegetable oil is part of their daily diet.

[48] This term was coined by the leading Indian agronomist M. S. Swaminathan. French agronomists use instead 'doubly green revolution' to signify that both yields per hectare and respect for environment must go hand in hand.

The linkage of food prices to biofuel prices driven up by the oil price poses a serious problem, with far reaching social consequences. There are no easy solutions in sight, at least without resorting to such instruments like price controls, production quotas and taxation of windfall profits, which are currently seldom used. Of course, the problem does not arise for non-edible crops dedicated to fuel production and to the so-called second generation biofuels in so far as they will be produced from agricultural and forest waste.

Therefore, there is a need to carefully plan and organize the food and biofuel production, taking into account the linkages between the two. **Food security and energy security must be looked at simultaneously within the framework of regional and local development strategies.** To move in this direction the following policies are in order:

- Carrying out detailed economic-ecological zoning to determine which crops are more suitable for each micro-region; using, whenever possible, degraded and already deforested areas for biofuel production;
- Institutionalizing a procedure to evaluate and license new biofuels projects not merely on least-cost assessment, but taking into account criteria such as energy efficiency, environmental impacts (yield per hectare, water demand, emissions of greenhouse gases, protection of native flora and fauna), as well as social impacts (direct and indirect employment per hectare, incomes per head, human development index (HDI) and food security);
- Instituting mandatory social and environmental certification of biofuels, applicable to products both sold on the domestic and international markets, so as to be sure that they conform to a set of clearly specified norms[49];
- Assisting the farmers involved in biofuels production in getting access to carbon credits[50];
- Providing technical assistance, training, credit and fiscal incentives to small farmers willing to diversify their operations, so as to include them into integrated food-energy systems; promoting all forms of collective entrepreneurship and, above all, farmers' cooperatives; encouraging, whenever possible, the installation of local processing facilities; assisting the local

[49] European countries wish to protect themselves from importing "dirty ethanol", as *El Mundo* (July 6, 2007) put it in the article commenting on the biofuels conference held in Brussels in the presence of President Lula. On the same occasion, *La Repubblica* mentioned the existence of forced labor in sugarcane plantations in Pará (Brazil). At a public consultation organized by the European Commission, it was suggested that no tax incentives should be applied to biofuels if their production involves the emission of more GHGs than would eventually be saved. Wetlands and peatlands which are situated on high stocks of carbon would be excluded from support. This stand reflects the negative environmental consequences of palm oil grown on peatlands in Indonesia, home to endangered species like the Sumatran tiger, the Orangutan, the Sumatran rhinoceros and the Malaysian sunbear. (Cronin David, "EU Finds Green Reasons Against Biofuels", *IPS*, July 02, 2007). The European Trade Commissioner, Peter Mandelson, while recognizing that ambitious goals for biofuel use should not be an excuse to subsidize domestic farmers, declared that *"Europeans won't pay a premium for biofuels if the ethanol in their car is produced unsustainably by systematically burning fields after harvests. Or if it comes at the expense of rainforests."* (quoted by the *Financial Times*, July 5, 2007).

[50] The procedure prevailing at present, based on the Clean Development Mechanism, entails considerable costs related to CDM project's formulation and profits most to a legion of consultants. Small farmers are at lost. According to J. Kanter, carbon offsets require standardization and transparency. Other may have been sold several times which risks giving the market a reputation for shoddy practices. Effectiveness of certain offset projects has been challenged. Important banks advocate stricter credit standards and greater transparency. ("Banks seek CO_2 credit standards", *International Herald Tribune*, June 29, 2007). In another article the same author discusses the rapid emergence of carbon finance in London, raising the question whether carbon will become the world's biggest commodity market or even the world's biggest market overall ("London financiers pull gold from green", *International Herald Tribune*, June 21, 2007)

population in substituting traditional biomass fuels with environmentally-sound, locally-produced biofuels.[51]

- Disseminating agro-ecological practices for food and biofuels production, combining fair yields per hectare with low fossil energy inputs;
- Identifying new sources of biomass for biofuels with special reference to perennials producing non-edible oil-seeds and quick growing species of trees;
- Choosing the set of policy instruments most suitable to carry the tasks outlined above at the national, regional, state and local levels: taxes (first of all a carbon tax), mandatory measures, fiscal and credit incentives.

It is a challenging agenda. Still by undertaking such measures, a greatly expanded biofuels production need not collide with meeting the food production targets required to ensure the food security in the next decades. As previously mentioned, the most immediate problem is that of the detrimental linkage of food prices to those of oil.

[51] A note of caution is in order here. Localism is not always the most environmentally sound solution if more emissions are generated at other stages of the product life cycle than during transport. Scientists working on the subject reached surprising conclusions. Lamb raised in New Zealand and shipped 11 thousand miles to Britain produced 1,520 pounds of CO2 emissions per ton while British lamb produced 6,280 pounds of CO2 per ton because poorer British pastures force farmers to use feed. (McWiliams J. E., "Homegrown Isn't Always Best", *International Herald Tribune*, August7, 2007). Along the same lines, Nobel Prize winner Paul Crutzen claims that biofuels can contribute to up to twice as much as fossil fuels to the greenhouse effect because the emissions of N2O have been so far severely underestimated. Other scientists contest these findings. (Foucart S., "L'essor des agrocarburants pourrait aggraver le réchauffement climatique", *Le Monde*, September 25, 2007). As Louise O. Fresco says, as is often the case, the devil is in the detail. (op. cit.).

5. Innovations to reduce the conflict between biofuels and food

In assessing the potential conflict between biofuels and food in their competition for limited cropland, due allowance must be made for technological progress.

At the energy demand side, much can be expected from the coming of age of a new generation of ultra-light vehicles in which steel and metals are substituted by composite materials such as carbon fibers. Carbon fiber weighs one-fifth as much as steel. It is also highly shock absorbent and therefore very safe. Intelligent construction can reduce a vehicle's weight by sixty per cent leading to a reduction of fuel consumption of at least thirty per cent[52]. However, the 'retooling period' to shift from the present to the future generation of motor cars is fairly extensive – ten to fifteen years or more. Hybrid electric vehicles (in particular Toyota's Hybrid Synergy Drive), plug-in hybrid electric vehicles[53] and flex fuel cars are part of the search for fuel efficient and less polluting vehicles.[54]

Research is less advanced as far as aircrafts are concerned, but Boeing is sponsoring studies of 'green kerosene' and new models, such as the 787 *Dreamliner*, are designed with a view at reducing fuel consumption[55].

Moreover, substituting road transport by railway and individual motor car transport by collective urban and interurban transport and bicycling has to be actively pursued as a means of reducing the energy consumption.

---

[52] *UBS research focus*, January 2007 p. 51. Amory Lovins has an even more optimistic estimate of the energy savings by the new generation of vehicles. A futuristic prototype of a car designed by a German engineer weighs 450 kg and claims to get 100 km out of a meager 1.5 liter of fuel (*Time*, July 17, 2006).

[53] See Romm J. and Fox-Penner P., Electric Wheels, *Blueprint Magazine*, April 23, 2007.

[54] In Brazil, the success of flex fuel cars is the main reason for the growing demand for ethanol. By the end of 2007, 4 million flexfuel cars out of a total of 20 million will be circulating. The expectation is to reach 12 million flexi fuel cars by 2012. (Romero T., "Álcool em abundância" *Agência FAPESP*, October 10, 2007.)

[55] Boeing and NASA are sponsoring research on biokerosene derived from babaçu nuts carried out by Professor Expedito Parente from Fortaleza, Brazil, a distinguished scientist who runs a successful biodiesel industry Tecbio. Parente used biokerosene in a plane in 1984, but no attention was given to his discovery until 2005, when he received the Blue Sky Award at a UN conference. (Fernandes K., "Boeing põe em teste bioquerosene de inventor brasileiro", *Folha de São Paulo*, February 10, 2007). According to G. Bisignani, Director General of IATA ("Aviation and Global Warming", *The International Herald Tribune*, September 21, 2007), aviation today is only responsible for 2 percent of global CO_2 emisssions with a total climate change impact of 3 percent. Projections for 2050 speak of 3 percent of global CO_2 emissions with a total climate change impact of 5 to 6 per cent. With 28 per cent of costs coming directly from fuel, the airline industry has a strong incentive to keep fuel consumption low. Airlines are investing heavily in more fuel-efficient aircrafts. In the last 40 years, fuel efficiency increased by 70 percent and will improve another 25 per cent by 2020. Biofuels are part of the game. According to Bill Glower, a director at Boeing Commercial Airplanes, research is being conducted on different blends of biofuels with conventional fuels. A 50 per cent blend would reduce carbon footprint by 20 to 25 percent ("U.S. Department of Energy – Energy Efficiency and Renewable Energy Biomass Program", June 14, 2007.).

Even greater energy savings can be achieved through intelligent building construction, but here the 'retooling period' will be longer than in transport, as retrofitting of the existing housing stock poses many problems and may be quite expensive[56].

According to Amory Lovins, **if the most efficient existing technologies could be disseminated in the United States, they could potentially halve the amount of oil burnt per dollar of GNP, at an average cost of 12 dollars per barrel of saved oil[57]. Substitution of the remaining half by more efficient use of gas and large-scale production of second generation biofuels would cost 18 dollars per barrel saved, much less than the present cost of oil.**

This brings us to the second generation biofuels such as cellulosic ethanol, that can be processed from lignocellulose, using the inedible parts of food crops, wild grasses, forest residues, and trees.

Different industrial processes are being explored: enzymatic hydrolysis, thermochemical fuels obtained via gasification (Fisher-Tropsch liquids, methanol, MTBE, gasoline, dimethyl ether, mixed alcohols, hydrogen), hydrothermal upgrading oils and pyrolysis oils[58]. The first industrial plants are being set-up and it is hoped that within a few years some cellulosic biofuels will be brought to the market cost-effectively, significantly reducing, if not eliminating altogether, the conflict for land with food crops.[59]

'Treethanol' has a particular appeal in countries that have a lot of trees and import a lot of fossil fuel, such as New Zealand and Sweden[60] and, also, in tropical countries such as Brazil where several hundred thousand square kilometers of deforested areas to be reforested and suitable climatic conditions to plant quick growing species such as eucalyptus.

Research on oil-producing crops and perennials, including several varieties of palm trees beyond the oil palm is being actively pursued. A recent biotrade project of the Brazilian Ministry of Environment identified 775 species of native plants with economic potential. Brazilian researchers report that such palms like inajà (Maximiliana maripa) or pupunha (Guilielma speciosa), and babaçu (Orbignya martiana) have significant potential as sources of biodiesel.

According to Professor Parente, biodiesel can be extracted from babaçu and other nuts in very small processing units. He therefore advocates for a setting of 'energy producing

[56] EcoManor, the first certifiably green mansion built recently in Atlanta, used the following innovations: solar tubes redirecting natural light throughout the house, hidden photovoltaic panels on the roof to convert sunlight to power, high efficiency insulation underlying the roof, geothermal system using the ground temperature to heat and cool the house, rainwater and 'gray' water from sinks and showers recycled to irrigate lawn, drought-tolerant indigenous landscaping requiring less water and maintenance (*Fortune* March 19, 2007). In France, for houses built before 1970 the average domestic consumption for heating, producing hot water and lighting is estimated in 500 kWh per square meter. Recent constructions consume between 170 and 250 kWh. According to a bill voted in 2005, newly built houses will be consuming from 50 to 70 kWh per square meter (Rey-Lefebvre, "Maisons la fin du grand gaspillage", *le Monde*, January 21 and 22, 2007).

[57] Lovins A., "Getting off Oil", *The World in 2007, The Economist*, London, p. 115.

[58] See Larson E. D., "Biofuel Production Technologies: Status, Prospects, and Implications for Trade and Development", UNCTAD Biofuels Workshop, November 30, 2006, Geneva (UNCTAD/DITC/TED/2007/10).

[59] The U.S. Department of Energy is investing 385 million dollars in 6 biorefineries or the next 4 years which are expected to produce more than 130 million gallons per year of cellulosic ethanol (DOE Biomass Program, February 28, 2007).

[60] "Woodstock revisited" *The Economist Technology Quarterly*, March 10, 2007.

islands' in remote regions in order to produce biodiesel for local purposes. A recent project sponsored by Petrobras is testing micro distilleries of ethanol operated by cooperatives of small farmers, each growing 2 hectares of sugarcane.

Researchers are looking at improving the yields per hectare of sugarcane and the amount of ethanol extracted per ton of cane. At present, the average output of ethanol in São Paulo State is of 85 to 90 tons per hectare, but new varieties of *'cana-energia'* are likely to reach 200 tons per hectare[61].

Work on fuels more efficient than ethanol is also underway. A joint venture between DuPont and BP resulted in the production of biobutanol and great hopes are associated with isoprenoids that have the right characteristics to substitute for petrol and to make "biocrude".[62]

Allowance should equally be made for progress in research on food crops, whose productivity is likely to improve, offsetting in this way the pressure on cropland due to demographic increase and, hopefully, a less inequitable distribution of income leading to a higher consumption of food per capita. According to Philippe Collomb, in order to feed the population of our planet by 2050, agricultural production in Africa should be multiplied by 5.14, in Asia by 2.34 and in Latin America by 1.92[63]. Theoretically, a knowledgeable farmer having excellent seeds, a favorable climate, sufficient water, fertilizers and pesticides can feed up to 30 persons throughout the year on one hectare with vegetables, fruits, cereals and vegetable fats. If the same area is used for the production of eggs, milk or meat, the number of persons fed varies from 5 to 10[64]. But we should not forget that genetics is still a very young science. The present controversies on the genetically modified organisms show that there is an urgent need to redefine the objectives of genetic research, to establish the necessary safeguards and to thoroughly revise the agreements on intellectual property.

Let us also mention some futuristic lines of research, such as the production of biodiesel from marine micro-algae. A study carried out by the Massachusetts Institute of Technology (MIT) points to the fantastic yield of 100,000 liters per hectare![65] Furthermore, according to D. Despommier, from Columbia University, it would be possible to build vertical farms to grow vegetables using roof top solar panels to power 24-hour grow lights and NASA-like technology to capture evaporating water for irrigation, thus drastically reducing the amount of land required.[66]

Much can be expected from new ultra-thin solar panels particularly tempting for Africa, as in one hour the earth receives more energy from the sun than human beings

---

[61] Caetano M., "á Luz da Biotecnologia", *Globo Rural*, April 2007, p. 64. FAPESP has just published a book entitled *Brasil líder mundial em conhecimento e tecnologia cana e etanol – A contribuição da FAPESP* relating all the research projects on sugarcane and ethanol supported by this foundation (Agência FAPESP, São Paulo, July, 2007).

[62] "Ethanol, Schmethanol", *The Economist*, September 29, 2007.

[63] The corresponding coefficients for North America, Oceania and Europe are: 1.31; 1.61 and 0.91. Quoted from B. Parmentier *Nourrir l'Humanité – les grands problèmes de l'agriculture mondiale au XXIe siècle*, la decouverte Paris 2007 p. 29.

[64] B. Parmentier, op. cit. p. 38.

[65] *Globo Rural*, April 2007. Research is also proceeding on fertilizing oceans; cultivated algae by sprinkling micron-sized iron shavings could turn sea water into a green house absorber (*Fortune*, July 9, 2007).

[66] A 21-story vertical farm would cost 84 million dollars and rake in 18 million dollars a year (*Fortune* September 24, 2007).

consume in a year[67]. The world's biggest solar farm in California's Mojave desert, where more than 400 thousand mirrors cover 10.3 square kilometers, churns out 354 megawatts of electricity, enough for 900 thousand homes. America's south-western deserts are an abundant source of sunshine that could meet US power needs several times. According to the US energy department, 7 thousand megawatts will be available by 2020 from concentrating solar power (CSP) plants.[68]

At the same time, research is being conducted on biofuel from power plant CO_2. At the heart of the technology is a plastic cylinder full of algae, which literally sucks the CO_2 out of a power plant's exhaust. The algae can in turn be converted into biofuel.[69]

Finally, French researchers in Picardie and Champagne-Ardenne regions are working on a bio-refinery with zero-waste, using the whole plant to produce bioenergies, biomaterials, biomolecules and food[70].

[67] Norbrook N. and Mithembu-Salter, G. "Termites and Tilting at Windmills", *The Africa Report* n° 7 July 2007.
[68] *The Economist*, September 15, 2007.
[69] The project is being conducted by GreenFuel Technologies in Cambridge, Mass. (McKenna P., "Biofuel made from power plant CO2", *New Scientist*, issue 2572, October 7, 2006). "GreenFuel claims that over the course of a year, a hectare of its reactors should be able to produce 30 thousand litres of oil, which could be used as biodiesel and enough carbohydrates to be fermented into 9 thousand litres of ethanol". ("Old Clean Coal", *The Economist Technology Quarterly*, September 8, 2007).
[70] *I.N.R.A. Magazine* n° 1, June 2007 (dossier "puiser le carburant dans les plantes" coordinated by Masson B. p.VIII). A leading Brazilian petrochemical industry, Braskem, is building a plant to produce plastics from ethanol. Petrobras and Oxiteno, a subsidiary of the Ultra group, are also moving into the alcochemistry. The city of Piracicaba is planning to open a technological park to attract foreign enterprises, such as Total and BP. Morais, L. "O plástico verde da Braskem" *Isto é dinheiro*, June 27, 2007. The ultimate dream is a multiproduct biorefinery making profitable uses of all the byproducts. The challenge, however, is that the market for the fuels is like two orders of magnitude bigger than for the chemicals that could be produced alongside the fuel. (See Rosner H., "Beyond Biofuels: Scientists seek Profitable Uses for the Leftovers" *International Herald Tribune*, August 8, 2007.)

6. Mitigation of global warming? Yes, however…

Beyond energy security reasons, the main interest of biofuels as opposed to petroleum products thus lies in the reduction of CO_2 emission, and consequently air pollution. While burning gasoline is a net CO_2 emissions, burning bioethanol results in emitting CO_2 which was previously captured by the plants. [71]

Biofuels aim to be carbon neutral, that is, to provide a zero sum balance between the carbon release generated by the burning of the fuel and the carbon absorption provided by the growing of the plant which will be used for the production of fuel.

In practice, biofuels are not carbon neutral, because energy is required to grow and process crops into fuel and other adverse environmental effects have to be balanced for achieving a positive effect. The amount of energy spent during biofuel production has a large impact on the overall greenhouse gas emissions savings achieved, and attention has to be given in avoiding an increase on nitrous oxide emissions.[72]

At first sight, substitution of petrol-based liquid fuels by ethanol and biodiesel may considerably reduce the emission of GHGs. However, it is the energy in/energy out ratios that determine the amount of reduction of GHGs. As previously mentioned, this ratio is highly positive in the case of sugarcane ethanol: 1 to 8, quite satisfactory for palm-oil: 1 to 5, but deceiving for maize-ethanol: 1 to 1.4, or even less. On the other hand, the advantage pointed out above may be offset by predatory methods of land clearing to grow sugarcane or oil-seed plants. Burning of native forests in Indonesia and then draining of wetlands to start plantations of palm-oil trees resulted in a major environmental disaster, releasing vast amounts of GHGs. However, such emissions resulted in the way in which the land was cleared and can not be attributed to biofuels as such.

Needless to say, such land clearing methods should be proscribed and severely punished by the governments concerned. For that, an effective monitoring of the territory is required, the more so that land in forest areas is much cheaper than in less remote regions. Right now, pastures in the São Paulo State are being transformed in sugarcane plantations, while cattle migrate further north to Mato Grosso and other Amazon region States.[73]

In order to ascertain the actual amount of avoided GHGs emissions, it is necessary to take into account, among other things, changes on land-use to grow feedstock, raw materials (feedstock) and production technologies used, the distance and the transportation mode between the production site of biofuels and the places in which they will be consumed. In continental countries like Brazil, the pros and cons of small-scale production for local purposes should be carefully examined.

---

[71] In reality, the net emission of CO_2 when burning bioethanol is not nil, since the production of bioethanol requires energy, fertilisers, transformation, transport etc. which are CO_2 emitting activities. Nevertheless, in the case of sugar cane for instance, the net emissions of CO_2 are over 80 per cent less than emissions from fossil fuels. UNCTAD, Challenges and opportunities for developing countries in producing biofuels (UNCTAD/DITC/COM/2006/15).

[72] The carbon emissions produced by biofuels are calculated using a technique called Life Cycle Analysis (LCA), which uses various approaches to calculate the total amount of carbon dioxide and other greenhouse gases emitted during biofuel production, from the seed put in the ground to the fuel's final usage.

[73] For the devastating effects of extensive cattle breeding in the Amazon region, see Meirelles Filho, J., 2006 *O livro de ouro da Amazônia*, 5th edition, Ediouro, Rio de Janeiro, pp. 160 - .179

Other environmental criteria such as soil depletion[74], water demand and protection of biodiversity must be also taken into account.

At present, some 2 billion people depend on traditional forms of biomass-energy, such as wood, dung, agricultural residues and charcoal for cooking and heating. These products are at times acquired through devastation of native forests, not to mention widespread practices of child and precarious labor. The smoke released in closed spaces from the burning of such traditional biomass feedstocks has detrimental health effects.

Therefore, in addition to introducing modern biofuels, produced in environmentally and socially sustainable conditions, urgent measures are required in the realm of energy for domestic purposes, both at its production and end-use levels. In particular, we may mention:

- socio-environmental certification of charcoal from planted trees, agricultural residues and grasses[75];
- promotion of small-scale biodigesters producing biogas for domestic purposes from dung, human waste and other residues; and
- dissemination of improved stoves, side by side with the introduction of solar cookers to reduce the consumption of biomass energy.

[74] That is why part of agricultural waste must be returned to soil.

[75] One possibility is to move to "green charcoal". Pro-Natura International, a Paris-based NGO member of IUCN, has developed and patented a prize-winning continuous process of pyrolysis of vegetable waste (agricultural residues, wild-grown biomass) transforming them into green charcoal. This domestic fuel performs the same as charcoal made from wood at half the cost. Furthermore, it avoids the indoor air pollution that kills more than 1.6 million people each year. The process is being tested in several African countries.

7. A lever for inclusive and sustainable rural development?

Environmental considerations cannot be separated from social concerns that go beyond the question of food security. According to UN statistics, the world's population is at present equally divided between urban and rural areas. The majority of poor people still live in the countryside and 2.5 billion people, or more, survive by practicing primitive farming. Only 28 million own a tractor and 600 million use animal energy. Over 1 billion depend solely on human effort[76]. The labor productivity gap between advanced and highly mechanized agriculture and the most primitive farming methods still in use is 1 to 1000 or more. In other words, a few million modern farms could easily wipe off 2 billion small farmers, condemning them to migrate to shantytowns. Already almost 3 out of 4 urban dwellers in the Sub-Saharan Africa live in terrible slums[77].

Contrary to a strongly entrenched prejudice, conditions do not exist anymore to reproduce, on a worldwide scale, the transition from rural agricultural to urban industrial society along the path followed in the 19th and 20th centuries by industrialized countries. [78] At least, three conditions have changed. Europe could send to Americas tens of millions of peasants; today China and India would need to find a destination for a few hundred million of them. Tens of millions of Europeans were killed in the two world wars and in concentration camps and gulags; hopefully this will never happen again. Lastly, the rural migrants would in the past find jobs in labor-intensive, rapidly expanding industries; this is no longer the case. Demographically speaking, we have entered into a *deindustrialization age*, most industries grow today through labor productivity increases. Thus, we cannot afford not to discuss a new cycle of rural development if we really want to find a solution to the acute deficit of opportunities of "decent work" as defined by the ILO.[79]

[76] Attac, *Les OGM en guerre contre la société*, Mille et une nuits, Paris 2005 p.39.

[77] See Davis, M., *The Planet of Slums*, Verso London, 2006. Quite significantly this important book was published in French under the title: *Le pire des mondes possibles – de l'explosion urbaine au bidonville global* (La Découverte, Paris 2006).

[78] The UNFPA report *State of World Population 2007 – Unleashing the Potential of Urban Growth* (New York 2007) offers a good example of the illusory faith in the virtues of urbanization as a powerful tool to overcome poverty (see box 2).

[79] The concept of decent work implies not only a fair remuneration, but also reasonable work conditions and relations.

Box 2

Rural or urban bias?

In his influential book *Why Poor People Stay Poor: Urban Bias and World Development.* (Temple Smith, London and Harvard University Press, 1977), Michael Lipton showed that the bulk of investment in developing countries was going to industries and cities, to the detriment of the majority of population composed of small farmers and casual agricultural laborers, many of them living in abject poverty. The latest UNFPA report *State of World Population 2007 – Unleashing the Potential of Urban Growth* (New York 2007) took the opposite stance. Somewhat surprisingly it accuses planners in developing countries of an anti-urban bias, urging them to abandon this ineffective and often counter-productive attitude on the grounds that, historically, the statistical association between urbanization and economic growth has been strong. The report considers further rapid urbanization both as unavoidable and positive. It foresees a doubling of urban population in Asia and Africa in one generation time-span, from 2000 to 2030. It further argues that past policies to retain people in rural areas have failed.

According to the authors, people intuitively perceive the advantages of urban life. However, those who migrate to urban areas are often rural and environmental refugees, deprived of access to land and expelled from the countryside. It is true that cities also perform as a kind of 'lottery of life', with some winners and many losers. There are always people eager to try their luck and take a chance.

The term urbanization should be used in a more restrictive way to denote only those who already have a decent dwelling, a reasonable job and conditions to exercise real citizenship. This is not the case of the majority of slums' dwellers – almost 75 per cent of 'urban population' in the Sub-Saharan Africa. At best, these are candidates for urbanization still to come. For them to claim the 'right to the city' is certainly a commendable objective, but how realistic is it within the context of the emerging 'planet of slums' (Mike Davis, London, 2006)?

Slowing down the flow of rural migrants to urban areas should not be abandoned under the pretext that many policies in the past have failed. Nor can one take at face value the affirmation that cities offer a potential to improve people's lives at lower cost than rural areas, especially when one accounts for the investment necessary to create opportunities of decent work. Precarious and poorly paid activities in the informal sector in urban areas help to survive, but should not be mistaken for development.

Development will depend on the kind of policies devised for the rural areas. If concentration of land in the hands of a small minority of large landowners, agro businesses and investment funds continues concurrently with labor displacing modernization of agricultural activities, small-scale farmers will be further marginalized and expelled to urban slums. 6 to 7 per cent of economically-active population working in modern agriculture would easily feed the world population. However, another pattern of rural development is still possible if we consider farmers as the keepers of the planet (water, air, biodiversity, landscapes) and not only food producers, offering decent work, food security, social inclusion and habitat for 1 billion of them. This is the conclusion of an important book by Bruno Parmentier, (*Nourrir l'humanité - les grands problèmes de l'agriculture mondiale au XXIe siècle*, la Découverte Paris 2007). The unfinished agenda of land reforms must not be abandoned and access to land by multinationals and agricultural investment funds interested in promoting on very large scale labor-displacing agricultural techniques ought to be regulated. Biofuels and agro-energy at large may be used as levers for this socially and environmentally progressive model of rural development. At the same time, one ought to realize that agriculture is both culprit and victim when it comes to climate change. The livestock sector alone accounts for 18 percent of global GHG emissions and deforestation for 18 percent of carbon dioxide emissions. Rice is perhaps the main source of anthropogenic methane with some 50 to 100 million metric tons per year emitted (data quoted by A. Müller, FAO Assistant DG at the workshop on "Adaptation Planning and Strategies", Rome, September 10, 2007).

The challenge is daunting, given the disparities in labor productivity mentioned above. Conditions must be set to accommodate a new cycle of rural development for a fair proportion of small-scale farmers, allowing them to improve their productivity of labor, their incomes and standards of living and, at the same time, freeing them from the most painful forms of manual labor. This is certainly the case in Africa, as strongly emphasized by the former UN Secretary General, Kofi Annan, who now presides over the Alliance for a Green Revolution in Africa[80].

The emerging boom of biofuels may act as a lever for rural development, insofar as it may create many opportunities for work in the production and processing of biomass for biofuels, as well as in accompanying technical and transport services. As already mentioned, special attention should be given to integrated food and bioenergy production systems. Furthermore, modern rural development does not limit itself to purely agricultural activities. It also includes the production of environmental services. According to FAO, a growing proportion of rural family income is coming from non-farm activities of the different members of farmers' families.[81]

But progressing along these lines will depend on the capacity of governments to channel biofuels production into appropriate social models, involving small-scale farmers. This result is by no means automatic. One can imagine the expansion of biofuels production in a completely different social context. For instance, producing sugarcane on large estates dependent on casual rural labor[82] or else, the processing of biodiesel from soybeans grown in highly mechanized and very large estates requiring very little labor – according to some estimates no more than one job per 200 hectares.

The experience of Brazilian Pro-Alcool program, launched in the 1970's proved extremely successful in technical and economic terms, yet resulted in socially disruptive concentration of land and income, not to mention the casual rural labor proliferation – the *boias frias*.

The Brazilian biodiesel program addresses this issue through the use of a social label for biodiesel producers who buy the raw material from small farmers. Such producers are entitled to fiscal incentives, which are regionally differentiated. However, thus far, the social label has not been extended to sugarcane for ethanol production.

Accordingly, there is an urgent need to identify and evaluate alternative social models for the production of biofuels, so as to integrate them into socially inclusive and environmentally sustainable development strategies.

The creation of small farmer cooperatives for the production and processing of biomass into biofuels offers an interesting option, especially because circuits of fair trade might be established between producer and user cooperatives.

Quite often, small-scale biomass producers supply large biofuels producing enterprises on the basis of individual contracts. These linkages should be screened with a view to ensure

[80] See Annan K., "Pour une révolution verte en Afrique", *Le Monde* July 11, 2007.
[81] See FAO, *Rural Income Generating Activities: A Cross Country Comparison*, Rome 2007.
[82] Many sugar-cane cutters in Brazil, the so-called *boias frias*, are recruited among dwellers of urban *favelas*, having been expelled from the houses they once were allowed to occupy in the *fazendas*. As cutting of sugar-cane is being more and more mechanized, *boias frias* are in danger of losing even this temporary job.

fair conditions to the farmers. Establishing of long-term, transparent contracts, submitted to accountability rules is called for and may involve a negotiation among all the stakeholders of the rural development processes.

The most difficult challenge is posed by large-scale agricultural estates integrated with biofuels producing industries. Working conditions in these estates often do not meet the ILO standards. Other environmental risks (loss of biodiversity) are associated with large-scale monocultural plantations. Policies ought to be designed to enforce the ILO labor standards, and to encourage association (and/or rotation) of energy and food crops. Workers employed by the estates should be provided with plots of land for housing and small-scale agro-ecological food producing schemes for self-consumption and sale. The opening of ecological corridors, the restoration of native riparian vegetation and the respect for natural reserves are also indispensable. Social and environmental certification may become an important policy instrument in this respect.

8. National development strategies and international cooperation

Energy security, food security and provision of opportunities for decent work through rural development are to be viewed as paramount and closely interlinked goals. In the globalization age, national development strategies still have a crucial role to play, as envisioned by United Nations Conference on Trade and Development (UNCTAD) in several occasions.

It is up to each country to evaluate its needs and potentialities with respect to the production and/or imports of biofuels, within a strategy of gradual substitution and phasing out of oil and, possibly, other fossil fuels. Some relevant questions for the formulation of national policies are:

- What should be the ideal sequencing of a pragmatic biofuels programme that takes fully into account the economic, social, energy and sustainable development imperatives of developing countries?
- What should be the pace of import substitution in oil importing countries?
- How and where should the growing of biomass for fuel be organized with the aim of benefiting small-scale farmers and promoting inclusive and sustainable rural development?
- What policies are required to assist small-scale farmers ensuring development gains through greater access to land, technology, training, credit and markets?
- How should the production of biofuels be distributed between local level small-scale processing units and large-scale plants?
- Can the equipments required in biofuels production be domestically produced?
- What kind of research should be fostered in order to accelerate the pace of innovation?

These are questions for which there are no obvious answers. Hence, it is important to investigate how other countries have answered them, by exchanging experiences without necessarily looking for readymade models to be replicated. UN affiliated bodies – the FAO, UNEP and UNCTAD – are at present engaged in organizing a forum for such exchanges.

The potential for South-South cooperation should be actively explored in connection with technical assistance, training, exchange of students, research, purchase of equipment and trade in biofuels.

Finally, steps must be taken for the organization of the emerging international markets of ethanol and biodiesel. The world economy is entering a long transition from the oil to the post-oil age, likely to extend itself for many decades. All the efforts ought to be made to make it as orderly as possible, seeking the cooperation of all the protagonists, including oil producers.

Out of these remarks, an agenda for **UNCTAD's BioFuels Initiative** may be suggested for the years 2008-2011, for consideration at the next UNCTAD Ministerial Meeting (UNCTAD XII) in Accra, Ghana in April 2008. The UNCTAD Biofuels Initiative should concentrate its activities on three subjects:

a) Organizing the international markets for biofuels by:

- fostering the dialogue among all the stakeholders for an orderly transition from the oil age to a less carbon intensive era;
- developing guidelines for long term contracts between producers and consumers of biofuels, with special reference to cooperatives acting on both sides (fair trade);
- promoting non-discriminatory social and environmental certification at the international level; and
- simplifying the procedures for the emission of in accessing carbon credits linked with carbon reductions achieved with biofuels projects.

b) Providing technical assistance to developing countries, particularly the LDCs who wish to integrate agro-energy into their sustainable development strategies, and to use it as a lever for rural development and the improvement of income levels of small farmers.

c) Fostering South-South cooperation in scientific, technical and commercial related to the production and marketing of biofuels, as well as the development of capital goods industries necessary to produce the needed equipment, with special reference to small-scale machinery for local production.