Development and Comparison of Sustainability Indicators

POLICY BRIEF
Bioenergy and biofuels

Checking the validity of the idea of biofuels in semantic terms: current technical progress and the urban revolution are consequences of the fossil energy revolution

Agro-biofuels are being proposed as an innovative green solution to our emerging energy problems. It is unclear, however, in which sense the agro-biofuel proposal represents something new. For thousands of years, human societies relied on a metabolic pattern based on biomass energy sources that did not lead to greenhouse gas accumulation in the atmosphere. Therefore, before getting into policies aimed at jumping into the past, it would be wise to check why the wealthiest fraction of humankind stopped using biomass energy in the first place.

Looking at the historic trends shown in Figure 1, one can see that the dramatic discontinuity associated with the industrial revolution. It was generated by a strategy aimed at reducing the requirement of *land and ecological services per capita* by using increasing quantities of fossil (oil) energy to intensify the agricultural production.

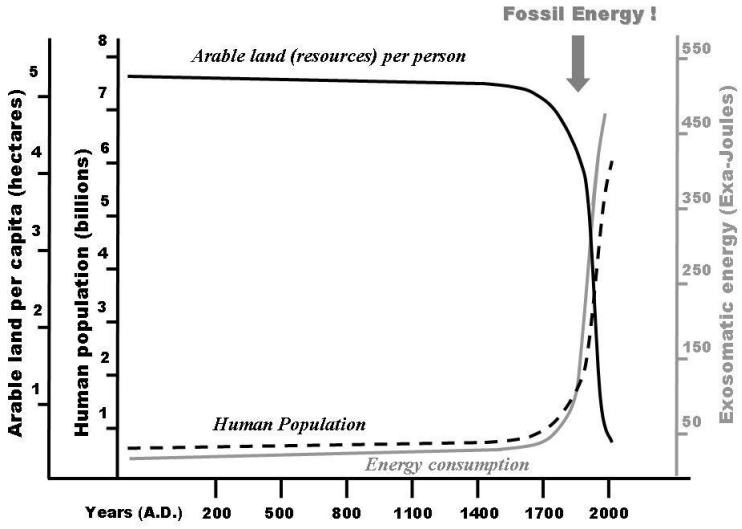

Figure 1: The trend of human population, land per capita, and energy consumption

On the contrary, the strategy proposed by those supporting the idea of replacing oil with biofuels is aimed at **reducing the use of fossil energy (oil) by using increasing amounts of land and ecological services per capita**. Looking at Figure 1, it seems that those supporting this idea must have missed what happened on this planet in the last 300 years!

Checking the idea of biofuels in quantitative terms: the heart transplant metaphor

The existing energy sector, based on fossil energy as main energy source, can be seen as the pulsing heart keeping modern societies alive. If we want to replace this heart with an alternative one (an energy sector based on agro-biofuels) we should check, before performing the transplant, **whether or not the proposed substitution is feasible**.

Such a check must necessarily involve:

- the development of a suitable database of the available biomass as well as the conversion alternatives that can be used for each typologies of biomass;
- the calculation of technical and environmental performance coefficients applicable to different biomass typologies and conversion techniques determining typical benchmarks in terms of flow intensity (per hour of required labor) and density (per hectare of required land);
- a comparison of the performance of the present system with that of the proposed alternative.

The DECOIN toolkit is able to shed light on all of the above points, when applied to the analysis of biofuels, the SUMMA and the MuSIASEM approaches provide a clear understanding of the material, energy, and environmental demand and return of the various options.
Due to the low output/input energy ratios of biofuel systems and the internal loop required for large-scale production, an energy sector based on biofuels would entail a heavy demand of land, water and labor per net GJ delivered. Therefore, when evaluated in relation to this set of criteria, biofuel does not seem to represent an alternative to the current use of oil and not even an option to replace a significant fraction of it. Biofuel systems appear unable to match the increasing demand for high quality energy input (liquid fuels) in front of a shrinking supply of land and water per capita. Even more striking is the biofuel situation in relation to the criterion of high labor productivity. In developed countries with an energy consumption of over 250 GJ/year per capita, an energy sector based on biofuel would absorb between 20 and 50 percent of the labor force, which is incompatible with the current profile of labor allocation to the various economic sectors.

Checking the correspondence between energy demand and energy supply in societies

There is no evidence that a large-scale production of biofuels can be considered an “environmental-friendly” solution for world energy security. The direct pollution (BOD in the effluents of plants, aldehydes from ethanol-fueled vehicles, pesticides released in the fields) and other kinds of environmental damage (soil erosion, destruction of natural habitats, reduction of biodiversity) related to the net delivery of biofuel indicate that a large-scale production would exact a heavy toll on the environment. Biomass (excess production, residues, waste) can, and has, to play a role in the energy security of modern society, both in developed and developing countries. However, the recognition that there is room for a more rational and efficient utilization of biomass at the rural level has nothing to do with the idea of farming for fuel per se.
The shrinking endowment of land per capita suggests that food and environmental security should be of greater concern to society than energy security for a world population that is projected to reach a plateau of about 8 to 10 billion. Heavy reliance of the world economy on bioenergy to a larger extent would make it impossible to guarantee food security because of competition for arable land and water, and would result in serious environmental impacts comparable to those currently experienced with the use of fossil energy. The economic cost of biofuel, especially in developed countries, derives mostly from the labor demand per unit of energy throughput delivered. A massive adoption of biofuel (with a much lower energy throughput per unit of labor than fossil energy) would imply reverting a basic trend induced by technological progress: that is reducing the fraction of human time that can be allocated to the service sector and leisure. We believe that innovative strategies for biomass use should not be aimed at cropping new biomass for energy. The main products of photosynthesis should be environmental services, food, wood, construction materials, fibres, chemicals, and textiles. In this framework bioenergy should be considered as an additional outcome.

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