Sugar Cane to Fuel-Ethanol... ***to green power? clean water? recycle sludge? reclaim soils?***

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The Fuel-ethanol Programs

After the oil crisis in 1973, Brazil took the initiative of substituting oil imports by launching a vast sugar cane ethanol program for the fuelling of light gasoline vehicles. A decade later, mainly by environmental reasons, the City of Stockholm started a program of re-placing diesel in heavy vehicles for ethanol. These two fuel-ethanol programs have complemented each other, the blending and total substitution of gasoline and diesel is technically well known. Experience will benefit future initiatives. As an example in this paper, in the ethanol program announced by Colombia the goal is within 3-years 10 % of the gasoline to be will be substituted by ethanol (1). For this purpose 10 biorefineries would be installed and 150,000 ha of sugar cane will be established. The relation between cane planters' economy and energy sector should result in increased and secured steady incomes to the farmers. In accordance with the Kyoto Protocol, the economic impact of ethanol programs might in future become transnational as those open up for CO2- compensatory quotes for OECD countries (2). Ethanol programs should leverage the generation of green power, a more CO2-neutral bagasse papermaking and the turning of severe water and soil related environmental problems into assets.

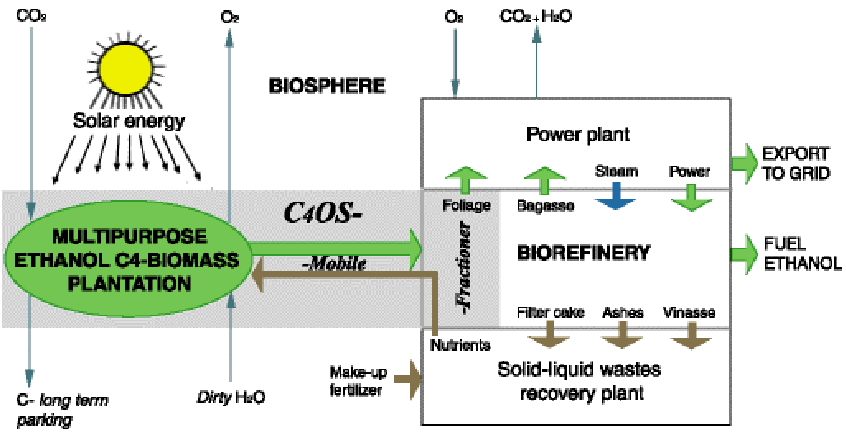
Green Dollars Going Up in Smoke

Sugar cane has the highest annual yields of biomass of all species but by ancient cultural and industrial tradition this crop, capable to produce both so-lid bio-fuels and ethanol, still is considered as a food crop. In the vast majority of the about 100 sugar cane producing countries a current agricultural operation is used: Before the harvesting and, to get rid of the foliage, farmers burn the sugar cane fields. This is understandable from the sugar producer's point of view, out of the foliage no sugar is obtained, it is just as "trash". On the other hand, cane burning is unacceptable from both the environmental and energy/economical point of view. Roughly, one ton of sugar cane biomass - based on bagasse, foliage and ethanol - has an energy content equivalent to one barrel of crude oil. As foliage is burnt on the fields, about one third of the total biomass energy is lost, also creating harmful emissions. Unimaginable*: A third of the crude oil production being burnt for nothing? Such a "luxury" the petroleum industry could hardly afford. The world sugar cane industry does exactly this!* There are exceptions, but if one third of the global crude oil production is assumed to being burnt on oil-fields: How much would the price for consumer of gasoline or diesel rise? This is the main point when costs of sugar cane fuel-ethanol are questioned and found too high compared to gasoline and diesel-oil. Burnt sugar cane cost in Colombia is 18 USD/t and considering that 18 gallons of ethanol could be obtained, the raw material cost component in the final price would be as high as 1 USD per gallon. *How much stronger in competition would fuel-ethanol be if all the potential values from sugar cane could be taken into account?* About 1.9 Mtoe/a of trash-energy is spoiled on the Colombian cane fields representing 2 % of the global sugar cane harvested area. The 2.0 Mtoe/a of bio-fuels used in district-heating system is about 235 million USD worth, excluding eco-taxes, equivalent to the value of fuel-oil in Sweden.

Globally, the quantity of lost bio-energy may correspond to as much as 5% of the OPEC's crude oil production. Additionally, about 700,000 barrels of fossil-fuels are estimated to be consumed only for the ignition of cane fields (3), generating additional green-house gases and other nocuous emissions. Today's uncontrolled combustion of foliage generates emissions of CH_4, N_2O, NO_x, CO, VOC and particles which contributes to global warming, acidification and smog. For comparison, the green-house gases emission from cane burning in Colombia corresponds to about one third of the CO_2-emission from the Stockholm City. About 10 kg of the above gas pollutants are reported released to the atmosphere per ton of sugar cane stalk (4) and in 1999, the global production was about 1.74 billion tons! Such emissions, having both a local and global harmful impact to the environment and human health, can be drastically reduced if a well-controlled combustion of clean foliage takes place in a furnace of a combined heat and power plant. Whenever bagasse is not sufficient to cover the process energy demand or, when bagasse is used for paper, board or other products the availability of cost-competitive foliage-fuel would enhance the substitution of fossil-fuels in sugar mills.

Multipurpose both, the C4-biomasses and the technology

To make this CO_2-mitigating actions technically and economically feasible and, based on the technologies and cultivation methods already developed for C3-energy crops, Salix Sphere is now focusing on C4-plants (sugar cane, sorghum, corn) as effective bioenergy crops, An operative system for the primary conversion of sugar cane into high quality to low cost raw materials for sugar and ethanol, fuels (foliage, pith, bagasse), paper and board is being developed. Historically, the cane-cultural efforts have been almost limited to optimize sugar productivity. This will improve further, trials carried out in three sugar mills in Peru, demonstrated an increase of 18 – 20% in sugar recovery and a production cost reduction of 20 %. *C4OS – C4 plants Operative System* consists of two sub-systems. *C4OS-Mobile* for harvesting whole cane biomass, includes equipment for transportation of harvested cane to the mill and biorefinery, assuring a quick delivery of cane to mills. Multiplying the benefits, it also facilitates -previous treatment- the recycling of solids and liquid wastes from sugar or ethanol processes, then significantly savings on fertilizer are achieved. The already high net energy balance of sugar cane increases further and high net CO_2-mitigation effects are reached to low cost. The other subsystem, *C4OS- Fractioner* is a stationary installation to separate foliage from the cane stalk and to prepare stalks fore juice extraction. Foliage-fuel, about 50 Koe/t of separated stalk, with a net energy balance around 1 to 115, releases bagasse for diversification and re-places fossil fuels for process steam and power surplus exportable to the grid. C4- plants to energy and environmental applications could be established even in regions outside their agricultural frontiers. During the life time of a sugar cane plantation, significant quantities of carbon are long term parked in the root-system and up to 400 m^3 of *dirty* water are cleaned per ton of dry biomass. By *Multipurpose non-food C4-plantations*, severe environmental problems could be remedied adding credits to ethanol: Remediation of soils, recycling sludge, filtering waste waters, etc. Science has not explored yet these implementations for C4-plants as much as it is done for the C3-plants. *C4OS –Technology*, the key to GHG-mitigation and diversification, will soon be fully demonstrated. Additionally, would the environmental problems holistically turned into assets, the competitiveness of fuel-ethanol against fossil fuels should be drastically reinforced.



Biosphere care will in the near future be highly profitable.

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