Abstract 4
The Promise and Challenges of Current Crop-to-Fuel Regimes and Cellulosic Ethanol

Tim Kroenke
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Over the past six years the volume of biofuels produced and consumed globally has been growing at a rate of more than 15% per annum, yet currently account for less than 2% of global transportation fuels, In this presentation Mr. Kroenke will explore the potential and challenges for current crop-to-fuel regimes around the world as well as that of cellulosic ethanol. He will also illustrate the growing role Syngenta AG is playing in this dynamic industry.

Tim Kroenke oversees global biofuels business development at Syngenta AG. In this role he is responsible for identifying, investigating, developing and launching new business opportunities in the biofuels field for Syngenta. During his career Mr. Kroenke has overseen agricultural businesses in the United States and globally for Syngenta. He has also held various positions in business development, product management and marketing. He received his B.S. in Agricultural Economics and his M.S. in Agricultural Marketing from the University of Wisconsin, Madison, U.S.A.

Abstract 5
Biofuels – Which One is the Most Economic One?

Gunter Festel
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Due to the many different influencing factors of biofuels, such as technical (*e.g.* raw material supply, conversion and engine technologies), economical (*e.g.* fuel and engine modification costs, infrastructure) and ecological/political factors (*e.g.* greenhouse gas emissions, efficient land use, reduced dependency on crude oil), there is a tendency to get lost in details when trying to identify interesting technological opportunities.

In order to carry out a quantitative comparison of the different biofuels to identify interesting technologies the complex coherences were reduced to the most important influencing factors. An analysis of customer acceptance and attitude towards biofuels showed that important to customers are prices no higher than those of fossil fuel, no engine modification costs or loss of power, high availability and easy handling. Therefore, biofuels need to meet the following criteria: competitive production costs, no additional distribution/infrastructure costs, problem-free blending with existing fuel types as well as similar chemical/physical properties. Therefore, as costs for the customer are a deciding factor for market success over the short to mid term, our comparative analysis considered only the economical factors and not the ecological aspects.

In order to identify interesting biofuel technologies for investors publicly obtainable data with regard to production costs were evaluated and included in a consistent model calculation. Besides plausibility checks, data comparability was evaluated and, if necessary, corrections were made. The results showed the costs and profit margins of the considered biofuels. As well as the raw material costs and production costs also the capital costs, blending costs and distribution costs to the filling pumps were calculated for each fuel separately. In order to reflect the various development stages and the economies of scale, realistic scenarios were calculated. In the calculation and comparison the normal mineral oil tax was considered also for biofuels. The profit margin (price at the filling station minus all costs and taxes) was the criterion for the profitability.

In the evaluation, a price of US$ 60 per barrel of oil for petrol and diesel production was taken and the results were conclusive. Both biodiesel and bioethanol produced in Europe from wheat are not profitable. The producers' high margins are only due to the current mineral oil tax concessions. At present, biomass-to-liquids (BTL) fuel can also not be produced competitively. At the taken oil price, only bioethanol and biobutanol produced on a large scale from lignocellulose-containing raw materials have the potential to be produced competitively.

It can be concluded that in Europe biobutanol produced from straw is mid term the most cost-effective biofuel, which can be produced with a reasonable profit margin also without tax exemption. The analysis of the technologies in this field shows that there are interesting new technological developments in Europe for the hydrolysis, fermentation and purification step. Our model calculation, which is the basis for the development of an integrated butanol production process, shows that it is possible to produce biobutanol with 35 Euro cent/litre (0.10 raw material, 0.15 conversion, 0.10 capital).

Gunter Festel founded at the beginning of 2003 the advisory and investment firm FESTEL CAPITAL with headquarters in the Swiss Cantone Zug. His company specializes in the commercialization of technologies in the areas of energy, environment, health, materials as well as nutrition and invests in selected companies, preferably in early stages. One focus topic is supporting buy-outs, spin-offs and start-ups from business planning through transactions up to business optimization.
Up to the end of 2002, Gunter Festel was a member of the management team and head of the consulting business for the chemical and healthcare industry with Arthur D. Little in Zurich and a consultant with McKinsey. He started his career with Bayer, where he held various management positions in R&D and marketing. Gunter Festel received his PhD in chemistry, BA in business studies and MA in economics. Furthermore, he has an Executive Master of Corporate Finance.

Abstract 6
Biofuels – Which One is the Most Ecological One?

Rainer Zah
Technology and Society Laboratory, EMPA

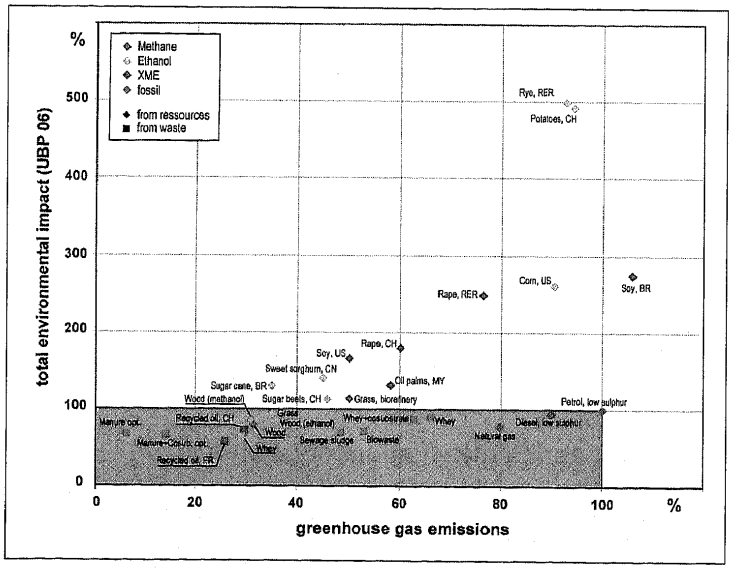
In connection with the increasing scarcity of fossil fuels and climate change the idea of using renewable energy is attracting interest both in the Swiss public eye and in industry. Fuels made from biomass – so-called biofuels – are currently the most important form of renewable energy in road transportation and could at least over the short to medium term take on a role in reducing greenhouse gases and our dependency on fossil fuels.

Although biofuels from renewable resources exist, a wider range of environmental impacts may result from their cul-

tivation and processing than those from fossil fuels. These range from excessive fertilizer use and acidification of soil to a loss of biodiversity caused by slash and burning rainforest. Besides that, one should not forget that expanding agricultural energy production may lead to land-use conflicts with other land uses such as food production or the conservation of natural areas. Therefore energy efficiency and the attainable reduction in greenhouse gases should not be taken as the sole criteria for a holistic environmental evaluation of these alternative fuels.

The objective of this presentation is to demonstrate the environmental impact of the entire production chain of various fuels made from biomass, in particular biodiesel, bioethanol, and biogas. The results are based on the Swiss database of environmental inventories *ecoinvent* and give a holistic comparison of the environmental impacts of biofuels; however neither the costs of biofuels nor the social consequences of their production are evaluated. The results refer to average values from the year 2004 in the respective production countries and are to be taken as a snapshot of factors relevant to the fuels' use in Switzerland. Thus the study cannot provide any answers to questions concerning future impacts – for instance, on food prices.

In principle, each of the fuels examined can be produced in an environmentally friendly way – it depends on what raw materials and production technologies are used. Most of the environmental impacts can be attributed to the agricultural cultivation of the respective raw materials (feedstocks). The environmental impact from fuel processing is usually much lower. The environmental impact from the transport from the production site to Swiss filling stations is even less, even when the biofuels are produced overseas. The present study shows that with most biofuels there is a trade-off between minimizing greenhouse gases (GHG emissions) and a positive environmental life cycle assessment (LCA). It is true that GHG emissions can be reduced by more than 30% with a number of biofuels. However most of these supply paths show greater impacts than petrol for various other environmental indicators.



Two-dimensional representation of GHG emissions and overall environmental impact (UBP 06). Values are relative to fossil reference petrol. The green area means both lower GHG emissions and lower overall environmental impact than petrol.

The environmental LCA was done using two different methods: one was the Swiss method of ecological scarcity (Environmental Impact Points, UBP 06, reg. Fig.), which evaluates the difference between environmental impacts and legal limits. The other one is the European Ecoindicator 99 method, which quantifies the damage done to human health and ecosystems. Both methods show the same results: in the case of tropical agriculture it is primarily the slashing and burning of rainforests that releases the largest quantities of CO_2, causes an increase in air pollution and has massive impacts on biodiversity.

In the moderate latitudes it is partly the lower crop yields, partly the intensive fertilizer use and mechanical tilling of the soil that are the causes of a bad environmental evaluation. However unlike the case of fossil fuels, the environmental impacts of biofuels can be greatly reduced by specific measures. The study shows in a sensitivity analysis how, for instance, a reduction in methane leakage can improve the LCA of biogas production or what effect a prohibition of slash and burn would have on the LCA of biodiesel made from palm oil.

Overall, the results of the study show that any promotion of biofuels by a tax break, for instance, must be done so as to target the best production paths. Not all biofuels per se can reduce environmental impacts as compared to fossil fuels. Currently, of all the production paths investigated, it is especially the use of biogenic wastes ranging from grass to wood that brings a reduction in environmental impact as compared with petrol. Since the potential of domestic bioenergy today is limited – and will be so in future – bioenergy will not solve our energy problems. However if the available biomass is transformed into energy in an efficient and environmentally friendly manner, while at the same time consumption is reduced and energy efficiency increased, these alternative energy carriers can together with other forms of renewable energy play a role in our future energy supply that should not be neglected.

Dr. ***Rainer Zah***, born in Winterthur in 1968, is deputy head of the Technology & Society Lab and head of the group Information Systems & Modelling at the Swiss Federal Laboratories for Materials Testing and Research (EMPA). As an environmental scientist and specialist for geographic information analysis and remote sensing, his main research interest is the spatial dimension of environmental problems induced by technology. Current projects include the spatial modeling of environmental emissions in Latin American cities based on environmental inventories, and the integrated assessment of bioenergy options for Switzerland.