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LIQUID BIOFUELS IN TRANSPORT: CONCLUSIONS AND RECOMMENDATIONS OF THE SCIENTIFIC AND TECHNICAL ADVISORY PANEL (STAP) TO THE GLOBAL ENVIRONMENT FACILITY (GEF)

(Prepared by the Scientific and Technical Advisory Panel)

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Liquid Biofuels in Transport:

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Preface

Following the earlier report of the GEF-STAP Workshop on Liquid Biofuels[1], which was commissioned by the Scientific and Technical Advisory Panel (STAP) of the GEF, I am pleased to present the report "Liquid Biofuels in Transport: Conclusions and Recommendations of the STAP".

Liquid biofuels have been the subject of much debate about their potential to reduce greenhouse gas emissions through their substitution for fossil fuels. While the Workshop focused on the factual evidence for GHG reduction and on the technology aspects, this report dealing with STAP's advice to the GEF, provides a strategic overview, puts the Workshop findings into context and recommends the direction that GEF could follow.

The motivation for countries to consider using liquid biofuels for transport is primarily the desire to reduce GHG emissions and also to reduce dependency on imported fossil fuels. Liquid biofuels need to be placed in the much larger context of bioenergy, and the modernization of traditional biomass use which, for example, must consider questions of ecosystem resilience, food security and sustainable markets. The STAP workshop concluded that biofuels can offer a sustainable and lower-carbon alternative to petroleum fuels, provided that *sustainability safeguards* are put in place, which include sustainable land management.

This report from STAP, while providing clear recommendations to the GEF, clearly demonstrates that the sustainable development and use of biofuels is only one part of a larger picture involving the need for much greater efficiencies in existing transport systems. The report also cautions that where new technologies offer promise, they also need to be appropriate solutions to problems facing developing countries.

Finally, while this report offers succinct and well targeted advice to the GEF, it also identifies a number of practical next steps to take, and it is hoped that the environmentally and socially sustainable use of biofuels will result.

Yolanda Kakabadse

STAP Chair

[1] The Report of the GEF-STAP "Liquid Biofuels Workshop" was presented to GEF Council in December 2006, and can be downloaded from the STAP website at http://stapgef.unep.org

Background

1. As a result of renewed and growing interest in biofuels as a renewable energy source to substitute for petroleum-derived products in the transport sector, the GEF received a number of project proposals to support biofuels in developing countries and countries with economies in transition. Because of the potential role of biofuels in reducing greenhouse gas (GHG) emissions in the transport sector, the GEF requested STAP's advice on liquid biofuels. Specifically, STAP was asked to examine GHG emission reductions and other environmental benefits of biofuels, as well as to evaluate the potential impact of biofuels on biodiversity, land degradation, water and food production, job creation, and to provide guidance to the GEF in this area.

Process followed by STAP

2. Following discussion in the October 2004 meeting of STAP III, liquid biofuels was included in the work plan of STAP for the year 2005-06, with STAP member Anjali Shanker as the lead, and supported by Peter Hennicke, Thomas Johansson and Anand Patwardhan.

3. A workshop of experts and practitioners was organized by STAP from August 29 – September 1, 2005 in New Delhi. Two technical background papers were commissioned by STAP, to inform the workshop and to serve as the basis for discussion:

- Life Cycle Analysis of Greenhouse Gas Emissions from Biofuels; Eric Larson, Princeton University
- Technology State of the Art: From Feedstock to Energy Production within a Prospective Vision; Philipe Girard, CIRAD[2]

4. A workshop report, drawing from key discussions and the background papers, was submitted to the GEF Council in December 2006.[3] The present document contains the conclusions reached by the Panel, and the recommendations to the GEF. The conclusions are largely based on the background papers, the expert workshop organized by STAP, and subsequent discussions between STAP members involved in the activity (members appointed to STAP III (2004-2006) and STAP IV (2006- present)). The recommendations follow from the conclusions, and also reflect the thinking of the Panel that the topic of liquid biofuels ought to be placed within the larger context of bioenergy, and the modernization of traditional biomass. While the main mandate for STAP was indeed the question of liquid biofuels in transport, carrying out this activity has underscored the importance of a more comprehensive and holistic examination of biomass, and the appropriate role that the GEF could play in this space.

[2] Agricultural Research Centre for International Development, France.

[3] The background papers can be accessed through the STAP website: http://stapgef.unep.org

Conclusions

5. Biomass today provides some 10 percent of global primary energy, most of which is used in GEF recipient countries[4]. In many rural regions in the recipient countries, biomass is still the dominant source of primary energy, particularly for cooking. It is widely accepted that much more energy services could be obtained from sustainable biomass than is presently the case, and that biomass has a considerable *potential* in contributing to increased energy security, economic development, and climate change and air pollution mitigation.

6. The biofuels area is quite complex, and different combinations of *feedstocks*, *conversion routes*, *fuels* and *end-use applications* lead to a wide range of pathways for biofuels. Some of these pathways are already commercially viable at large-scale; while others are at varying stages of research, development and commercialization.

7. As regards liquid biofuels for transport, which is the issue the GEF asked STAP for advice on, the best known example in developing countries is the use of ethanol from sugarcane in Brazil as an automotive fuel, and many developing countries are looking to replicate this example.

8. A key question for GEF is the GHG mitigation potential of liquid biofuels for transport. In addition, it is perhaps equally important to consider whether biofuels can be produced without negative effects on soil, water and biodiversity as well as the satisfaction of primary human needs such as food, and whether biofuel production may also offer opportunities for positive effects in terms of environmental and developmental co-benefits. When evaluating biofuel pathways, in addition to the GHG savings, it may be important to look at the net energy ratio as well, in absolute terms, and on a per hectare basis, as land & water use efficiency are also important metrics.

9. The workshop concluded that biofuels can offer a sustainable and lower-carbon alternative to petroleum fuels, provided that *sustainability safeguards* are put in place, which include sustainable land management. This would exclude both the production of biofuels by clearing forest land for example, and the production of biofuels with negative or uncertain GHG emission balances.

10. The results of life-cycle analyses (LCA) for biofuels with respect to GHG emissions span wide ranges. Biomass yields, the efficiency of conversion of biomass to fuel, and the efficient use of the produced fuel all play a role in the extent of GHG savings possible. Despite this large variation for net GHG savings of biofuels systems in the literature, it is possible to draw a few robust conclusions.

11. 1st generation *grain- and seed-based biofuels* will provide only modest GHG mitigation benefits in the order of 20-35% reduction when compared to petroleum-based fuels[5], will

[4] Dominant in the current biomass energy use in developing countries is traditional biomass with its negative impacts on human health and the environment, under certain conditions (Karekezi 2004).

[5] Only for favorable conditions with high yields and full co-product use, GHG reductions from plant-oil-based biodiesel could be as high as 65%, as compared to fossil diesel.

have rather high costs, and will be able to provide only modest level of fossil-fuel displacement in the long term due to high land requirements. The fundamental reason for the relatively poor performance of grains and seeds is that they represent only a small portion of the above-ground biomass.

12. Among commercial biofuels today, *sugarcane ethanol* gives the highest land use efficiency for GHG mitigation, and is therefore an attractive biofuel from a GHG emissions perspective. Provided sustainable safeguards are addressed in the production, sugarcane ethanol shows 80 to 90 percent reduction potential for reducing GHG emissions when compared to fossil fuels, at favorable costs as well.

13. Biodiesel ("Straight Vegetable Oil" - SVO, Fatty Acid Methyl Esters - FAME) from *palm oil* could be a comparatively low-cost biofuel, but its GHG balance seems less favorable than that of sugarcane ethanol. Furthermore, biodiesel from palm oil is in direct competition with non-energy uses of palm oil.

14. The prospective "next" (often called 2nd) generation[6] biofuels promise advantages over 1st generation biofuels in terms of land-use efficiency, and environmental performance. High quantities of lignocellulosic feedstock from biogenic residues and wastes are already available, and can be expanded by non-food crops such as perennial grasses, and short-rotation forestry.

15. Many 2nd generation biofuels are at a pre-commercial stage, but could enter the market within 10 to 15 years if corresponding investments (R&D, infrastructure) are achieved. Their feedstock base includes a large variety of non-food biomass (perennial grasses, wood, residues, wastes), and a range of outputs (ethanol, diesel, compressed or liquefied gas).

16. From a developing country point of view, two other biofuel pathways need more attention:
    i) *Biodiesel* from low-input perennial plants like jatropha grown on *degraded or marginal land* could be a favorable option provided that low-cost inputs are available, and costs for fossil diesel is high (e.g., in rural areas, or on islands).

    ii) *Biogas* from both residues (including sewage and landfill gas), and bioenergy crops can be processed to synthetic natural gas and, hence, to compressed natural gas for vehicles, and offer the prospect also to be converted into a "green" liquid fuel in the longer-run. As experience from biogas upgrading and processing to transport fuel quality is still limited, overall costs and GHG balances need more analysis, but the existing examples indicate favorable potentials for high GHG reductions at moderate costs.

17. Further, in developing countries, GHG emission reductions from biomass use in stationary energy systems (e.g. combined heat and power) might offer higher and more cost-effective GHG abatement potentials than biofuels today. Co-generation is already present today, and in the near term, co-firing and cogeneration will be based mainly on low-cost biomass resources

[6] The term 2nd generation shows wide variation in usage – and can variably refer to feedstocks (lignocellulosic material), conversion routes (thermochemical, flash pyrolysis, enzymatic etc.) and end products (gas or liquid fuels).

(i.e., residues and wastes) which *cannot* be converted to biofuels with 1st generation technologies.

18. Workshop participants realized that in order to make the transport sector more GHG efficient, certain conditions need to be put in place first. These include the decarbonization of the transport system to ensure a globally sustainable transport system, and in that respect, increased end use *efficiency in vehicles* (airplanes, buses, cars, ships, trains, trucks), and *shifts towards low-emission transport modes* (high-occupancy vehicles, efficient logistics, public transport) which are important, relatively low-cost options

19. As regards the overall issue of the role of biofuels for GHG emission reductions in the transport sector, the workshop concluded that:

    a. sustainable biofuels are *additional* options which can have favorable costs in the long run[7], and;

    b. sustainably produced biofuels like sugarcane ethanol and jatropha-based biodiesel from marginal lands can play a role *already, under favorable conditions*.

20. Scenario analyses for industrialized countries show that *raising fuel efficiency* far beyond a business-as-usual path is the most cost-effective option to reduce GHG emissions in the transportation sector, followed by alternative fuels (i.e., biofuels, de-carbonized synfuels).

21. The relative contribution of all options depends on whether they can successfully be implemented, i.e., if efficiency strategies fail to deliver, fuel substitution will be more important. Among the biofuels options, 2nd generation biofuels may become highly interesting within a 10-15 year time horizon.

22. Furthermore, with the case of bioethanol in Brazil, the GHG reduction cost in the transport sector could become zero or even negative. The cost-effectiveness of GHG reduction options must be considered in the wider setting of biomass, though, taking into account non-GHG benefits as well, and factoring in competing uses for biomass.

24. The workshop further concluded that both small and large-scale production of biofuels can be sustainable and beneficial in terms of global and local benefits. Large-scale exploitation of biomass for energy and fuel uses requires *integrated national strategies* for all uses of biomass (energy, food, fuels, and materials) which take into account sustainability issues including biodiversity, and nature protection, as well as social impacts.

Recommendations

25. Based on the workshop conclusions and overall developments in the biofuels area, the following are the key recommendations of the Panel:

[7] Participants in the workshop pointed out that also fossil-fuel derived synfuels and/or electricity from systems using carbon capture and storage (CCS) could become attractive in the future as additional options.

Biofuels is a promising area for the GEF

26. STAP feels that the area of biofuels is promising and important for the GEF, and recommends that it be reflected in the strategy for the climate change focal area in GEF-4 and beyond. The biofuels area is quite complex, and the combination of feedstocks, conversion routes, fuels and end applications leads to a wide range of pathways for biofuels. Some of these pathways are already commercially viable at large-scale; for example ethanol from sugarcane for use as a blended auto fuel or attractive for other reasons, such as jatropha. GEF should support capacity development for proper replication of such projects. Others are at varying stages of research, development and commercialization. At the same time, biofuel production has interlinkages with other focal areas of the GEF, particularly biodiversity and land management; and these cross-focal area impacts need to be carefully examined, and addressed in any effort supporting biomass and biofuels.

Consider Interlinkages in Future GEF Biofuel Projects

27. It is likely that a broader perspective that incorporates developmental, economic and cross-focal area issues would be important for biofuel projects. For example, in many developing countries, the principal drivers for biofuels are often related to objectives such as rural development, income enhancement and marginal / wasteland development. Therefore, a challenge is to develop and support biofuel projects which deliver *multiple benefits* in the areas of climate change, biodiversity, etc. while actively contributing to sustainable rural development, and poverty alleviation. STAP recommends that GEF establish a special program for such innovative and ground-breaking projects.

Support Integrated National Biomass Strategies

28. STAP recommends that demonstration of cross-sectoral, integrated national strategies which determine sustainable land-use opportunities for biofuel developments and factor in food-versus-fuel considerations should be included in any project proposal as a prerequisite for being considered for GEF funding. To the extent that targeted research activities include scenario-based modeling for assessing the cross-sectoral impacts of biofuel production; they would also help in identifying optimal strategies for governments to adopt.

Establish Reference Procedures and Data for GHG Accounting

29. Few data exist on the life-cycle GHG emission balances of biofuels for developing countries. With the exception of some 1st generation fuels, including cane ethanol, there are very limited data at reasonable scales. Therefore, more LCA studies are needed, in particular for crops and conditions prevalent in tropical regions, to assess the GHG mitigation potential of different biofuels. STAP recommends the inclusion of the preparation of such studies in GEF targeted research activities. In that respect, the development of reference methodologies for GHG accounting that may be used by the GEF should be supported, together with the related capacity-building[8]. In this process, it will be important to consider the full range of potential biofuel pathways, including stationary as well as transport applications.

8 Ongoing work of the Clean Development Mechanism Methodology Panel within the UNFCCC should be taken into account.

Establish Sustainability Standards for GEF Biofuel Projects

30. STAP recommends that GEF should help developing *sustainability standards* for biofuel projects through targeted research, and introducing such standards to its projects, taking into account the results of the ongoing development of such standards in various fora. In that respect, GEF-financed pilot projects could help also to establish good practices, and to test monitoring, certification and verification schemes.

31. Further, project proposals should be evaluated in the two contexts outlined in the *Conclusions* section above: *(i)* biofuels in the context of modernization of bioenergy, and *(ii)* reductions of GHG emissions from the transport sector. Furthermore, projects should be evaluated in terms of energy balance, GHG reduction, land use efficiency, and competition for water use.

Demonstrate Biofuel Projects with proven and substantial GHG Reductions at moderate cost

32. To overcome current barriers such as uncertainty in technology prospects for developing countries, access to adequate small-scale biofuel conversion technologies, and investor risks associated with controversial GHG and cost balances, STAP recommends that GEF should consider funding of 1st generation biofuel projects that deliver clear and substantial life-cycle GHG reductions in a cost-competitive manner and that meet the sustainability standards mentioned earlier. Appropriate benchmarks may be set and required for parameters such as the net energy ratio and GHG reduction ratio in absolute and per hectare terms.

Support 2nd Generation Biofuels at an appropriate point in the technology cycle

33. Many 2nd generation biofuels are likely to have significant potential for GHG reduction. However, they are often at an early stage of development and commercialization. Direct co-financing support to 2nd generation biofuel projects may therefore be appropriate only as the technology matures further. However, given their potential in the coming decade, capacity building, and awareness raising and targeted research activities could be envisaged.

Support Information Access, and Knowledge Sharing

34. Last but not least, STAP recommends that GEF becomes an active supporter and – in the medium-term, as GEF biofuel projects become operational – contributor to the multilateral activities on information access, and knowledge sharing regarding sustainable biofuels. In that respect, the GEF may play an important role in enhancing the flow of information and knowledge into practice, by leveraging and supporting networks such as FAO's International Bioenergy Platform and other initiatives including public-private partnerships; and by appropriate promotion and demonstration activities.