BBEST Conference 2011 – Tutorials

Tutorial 7 – Sustainability I - Environment

Jeremy Woods – Imperial College (UK)

Arnaldo Walter – UNICAMP/CTBE (BRAZIL)

Proposed program based on the international bioenergy sustainability agenda:

- What does it mean bioenergy sustainability?
- Energy ratio (fossil/renewable);
- Reduction of GHG emissions due to biofuels production and use;
- Impacts due to Land Use Changes (direct and indirect);
- Impacts on water resources (availability and quality);
- Impacts on biodiversity;
- Moving forward: opportunities and challenges.

Jeremy Woods – Imperial College (UK)
(jeremy.woods@imperial.ac.uk)

Arnaldo Walter – Unicamp/CTBE (BRAZIL)
(arnaldo.walter@bioetanol.org.br)

Abstract

It is estimated that in 2008 about 13% of the world primary supply was covered by renewable energy (RE) sources, being biomass the most important contributor (slightly higher than 10%). Due to a set of reasons, but mainly due to the required reduction of greenhouse gas (GHG) emissions, it is predicted that RE will become more important in the years to come, covering almost 30% of the total primary energy supply in 2050 in a less ambitious scenario concerned to the deployment of RE, or even 45-75% in the same year (in case of the scenarios with the highest share of RE) (IPCC, 2011a).

According to a recent report published by IPCC (2011a), bioenergy should give the most important contribution among all RE, mainly in the transport and in the industrial sectors. However, modern biomass shall be also relevant for the residential sector and for electricity generation.

Sustainability has been recognized as an essential aspect for the future of bioenergy and mainly for the consolidation of bioenergy sources in the international markets. The discussion about sustainability has become even more important due to growing the production of biofuels and, in particular, gained momentum during and after the food crisis in 2007-2008. Nevertheless, biofuels accounted for only 2% of global road transport fuel demand in 2008 and nearly 3% in 2009.

The main demands regarding sustainability come from the most organized sectors of the society and have induced specific actions in Europe and in North America. The focus in US has been only on avoided GHG emissions regarding fossil fuels, while the EU Renewable Energy Directive (RED) also addresses potential impacts on biodiversity, on water resources and on food supply, besides the respect of human, labour and land use rights. These sustainability initiatives have motivated the proposition of certification schemes and it is predicted that without a certified production it won't be difficult to reach the most important markets.

One of the main conclusions of the recent IPCC (2011b) report is that besides gains on feedstock productivity and improvements of conversion technologies, expanding bioenergy production will require land and water use management and a refined understanding of the complex social, energy and environmental interactions associated with bioenergy production and use.

The topics that will be addressed in this tutorial are currently the main issues in the international bioenergy sustainability agenda, such as (a) the energy and the GHG balances, (b) the direct and the indirect impacts to land use change (LUC), (c) the impacts of feedstocks production and biomass conversion into water resources, and (d) the impacts over the biodiversity. The aim of the tutorial is giving to the participants an overview about what has been required regarding each sustainability aspect (e.g., principles, criteria and indicators), the state-of-art of the knowledge available, the methodologies mostly used, and further required actions.

As there is great expectation of bioenergy for reducing GHG emissions, currently the priority is on evaluating the avoided emissions in comparison to the energy source displaced. Most bioenergy systems result in GHG emission reductions but, in some sustainability initiatives, such as the EU-RED, minimum thresholds have been defined. The existing regulation sets that the emissions shall be evaluated along the life cycle of the energy sources and that the impacts due to land use change shall be taken into account. Despite all uncertainties about the indirect impacts of LUC (iLUC) over GHG emissions (e.g., these impacts are not directly observable, modelling is complex, results are imprecise and the difficult of attributing the impacts to a single cause) there is a tendency of taking iLUC into account.

Also regarding GHG emissions, another factor with considerable uncertainties are those of nitrous oxide emissions during feedstock production, mainly due to the application of fertilizer and to the disposal of organic residues on soil.

In addition, the energy balance of bioenergy production is an important indicator for evaluating its sustainability, first for understating the rationale of the energy conversion process and, second, because of the impact of the energy balance over the GHG balance (mainly because of the consumption of fossil energy sources along the production process). In this tutorial some of the indicators mostly used for expressing the energy balance will be presented (such as the EROEI – energy-return-on-energy-invested), and typical figures of some bioenergy carriers will be analyzed.

Recently, a priority regarding bioenergy production is the potential impacts over water resources, both considering water availability and its quality. Obvious that this relevance is due to the fact water is a critical natural resource in many regions of the world, and also due to the high water consumption in agricultural activities. However, there is still a lot to be done for improving water use efficiency in agriculture and, in addition, some of the concerns are based on a still very poor knowledge regarding impacts on water resources.

Similarly, the potential impacts of large scale biomass production over biodiversity have been a burning issue. There are still scientific uncertainties regarding the methods of impact assessment and also superficial knowledge about the biomes that shall be protected and about what should be preserved. However, based on the precautionary principle and also on the existing expertise, it is clear that large-scale monocultures and the displacement of natural areas for biomass production are practices that should be avoided. In addition, there are sensitive biomes that shall be preserved and this justifies the attempt of defining no-go areas. Moreover, the adoption of best agricultural practices, besides the definition of areas suitable for biomass production, is practices that should be disseminated.

The final part of the tutorial will be devoted for the discussion of further actions, considering required improvements in the scientific knowledge, know-how dissemination, support for the adoption of best practices and definition of public policies that would really foster sustainability improvement.

References

Chum, H., A. Faaij, J. Moreira, G. Berndes, P. Dhamija, H. Dong, B. Gabrielle, A. Goss Eng, W. Lucht, M. Mapako, O. Masera Cerutti, T. McIntyre, T. Minowa, K. Pingoud, 2011: Bioenergy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Fritsche, UR, Hennenberg, KJ, Hünecke, K, Herrera, R, Wiegmann, K: 2010. Sustainable Bioenergy: Key Criteria and Indicators. Öko-Institut, Darmstadt. Germany.

Gerbens-Leenesa, W, Hoekstraa, AY, van der Meerb, TH: 2009. The water footprint of bioenergy. PNAS (Proceedings of the National Academy of Sciences), June, vol. 106 (25), pp. 10219–10223.

Groom, MJ, LIZABETH M. Gray, EM, Townsend, PA: 2008. Biofuels and Biodiversity: Principles for Creating Better Policies for Biofuel Production. Conservation Biology.

Hiederer, R, Ramos, F, Capitani, C, Koeble, R, Blujdea, V, Gomez, O, Mulligan, D, Marelli, L: 2010. Biofuels: a New Methodology to Estimate GHG Emissions from Global Land Use Change. European Commission; Joint Research Centre.

IPCC, 2011: Summary for Policymakers. In: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Koh, LP, Ghazoul, J: 2008. Biofuels, biodiversity, and people: Understanding the conflicts and finding opportunities. Biological Conservation 141, PP. 2450-2460.

Scown, CD, Horvath, A, McKone, TE: 2011. Water Footprint of U.S. Transportation Fuels. Environmental Science & Technology, 45, pp. 2541–2553.