Chapter 2

Review of Environmental, Economic and Social Indicators

Sustainability Assessment of Biomass Utilisation in East Asia Working Group

February 2013

This chapter should be cited as
Sustainability Assessment of Biomass Utilisation in East Asia Working Group (2013), 'Review of Environmental, Economic and Social Indicators' in *Extending the ERIA WG Methodology for Sustainability Assessment of Biomass Utilization in East Asian Countries*, ERIA Research Project Report 2011-19. Available at: www.eria.org/publications/research_project_reports/FY2011/No.19/Chapter_2.pdf

CHAPTER 2

Review of Environmental, Economic and Social Indicators

Various initiatives related to the sustainability of biomass utilization have emerged in recent years. The BEFSCI Project of the Food and Agriculture Organization of the United Nations (FAO) (FAO, 2011) conducted a review of 23 of these sustainability initiatives and classified the sustainability aspects/issues addressed under the initiatives into 24 categories. Among these initiatives, the WG focused on the environmental, economic and social indicators of the Global Bioenergy Partnership (GBEP, 2011) and the Roundtable on Sustainable Biofuels (RSB, 2010). In the following sections, in addition to the review of indicators of the above two initiatives, some other initiatives were also taken up as appropriate.

1. Review of Environmental Sustainability Indicators

This section looks over the environmental impact categories and corresponding indicators taken into consideration in two well-recognized initiatives, GBEP and RSB. In addition, the issue of direct and indirect land use changes, a controversial topic in estimating life cycle GHG emissions from bioenergy, was taken up in order to look into how the GHG emissions associated with land use change are dealt with in other sustainability initiatives.

1.1. GBEP's Environmental Indicators

As indicated below, among 24 sustainability indicators of GBEP, 8 are related to environmental aspects.

- Indicator 1: Life cycle GHG emissions

Life cycle GHG emissions reported using the GBEP common methodological framework

- Indicator 2: Soil quality

  Area and percentage of land with specific soil carbon conditions

- Indicator 3: Harvest level of wood resources

  Volume and percentage of harvested wood, etc.

- Indicator 4: Emissions of non-GHG air pollutants, including air toxics

  Emissions in comparison with other energy sources

- Indicator 5: Water use and efficiency

  Volume / percentage of water withdrawn from specific water resources

- Indicator 6: Water quality

  Percentage of pollutant loadings in the watershed

- Indicator 7: Biological diversity in the landscape

  Area and percentage of land with high conservation values

- Indicator 8: Land use and land use change related to bioenergy feedstock production

  Total land area, percentage of land area with specific land conditions, net annual rates of conversion

Just as the ERIA WG methodology employs life cycle GHG emissions as an environmental sustainability indicator, it was also considered important in GBEP's framework. GBEP provides a common methodological framework for estimating GHG emissions so that it can cover fundamental emission sources step by step.

Other than GHG emissions, as reported in the ERIA WG report of the previous phase (ERIA, 2011), the WG conducted a review of several environmental impact categories (e.g. climate change, impacts on air, water and soil, and biodiversity) that were found to be important issues in the pilot studies. GBEP also includes these categories in its guideline.

In addition to these categories, it also pays particular attention to wood resources and land use change. The indicator for wood resources is intended to assess whether forests are being harvested beyond their ability to renew themselves. The indicator for land use change is to assess the impacts of bioenergy production and use on land use, and land use change that may trigger environmental, economic and social issues. This is to be reviewed, as these issues were not observed in the WG's pilot studies.

1.2. RSB's Environmental Indicators

RSB has 12 principles for sustainable biofuel production, among which six are related to environmental sustainability. These principles and corresponding indicators are as follows.

- Principle 3: GHG emissions

  Whether biofuels contribute to climate change mitigation by significantly reducing lifecycle GHG emissions, as compared to fossil fuels (average 50% lower).

- Principle 7: conservation of biodiversity and ecosystems

  Whether biofuel operations avoid negative impacts on biodiversity, ecosystems, and conservation values.

- Principle 8: soil

  Whether biofuel operations implement practices that seek to reverse soil degradation and /or maintain soil health.

- Principle 9: Water

  Whether biofuel operations maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights.

- Principle 10: Air

  Whether air pollution from biofuel operations is minimized along the supply chain.

- Principle 11: Use of technology, inputs and management of waste

  Whether the use of technologies in biofuel operations seek to maximize production efficiency and social and environmental performance, and minimize the risk of damage to the environment and people.

As RSB principles are designed for certification systems, these indicators are used to check whether or not they meet the certification requirements. The environmental indicators of RSB also cover GHG emissions in Principle 3, impacts on air, water and soil in Principles 8 to 10, and biodiversity in Principle 7. In addition to these impact categories, RSB focuses on risks associated with use of technologies including genetically engineered plants or micro-organisms.

1.3. GHG Emissions Associated with Land Use Change

1.3.1. Emissions from Direct Land Use Change (dLUC)

The pilot studies conducted in the previous WG activities did not estimate GHG emissions from direct Land Use Change (dLUC) because none of the four pilot study sites had been converted from other land use in the past few decades. However, as some studies and reports have pointed out, dLUC emissions have a large impact on the life-cycle greenhouse-gas (LC-GHG) emissions of biomass utilization for energy. The emissions greatly depend on what the previous land use was prior to biomass feedstock cultivation. There are even some cases where the dLUC emissions alone may possibly be larger than the LC-GHG emissions of fossil based energy if lands with high carbon stock were converted into croplands for biomass feedstock. As a methodology to quantify these emissions, many initiatives for bioenergy sustainability including the ERIA WG methodology refer to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines Vol.4 (IPCC, 2006). Although these guidelines are designed for compiling the National Greenhouse Gas Inventory Report (NIR), they are applicable to analyses of LC-GHG emissions of bioenergy. The Tier 1 methodology in the IPCC guidelines provides default values and methods for estimating carbon stocks for various land use types. Without directly measuring carbon stock in biomass and soil, the dLUC emissions could be computed with this method and default values with a particular uncertainty (Fritsche *et al.*, 2010). Some certification systems or legislations have simplified this methodology and prepared their own dLUC calculation methodologies and the databases necessary for the calculations. Table 1 summarizes how the dLUC emissions are dealt with or considered in selected initiatives.

The European Union (EU) Directive 2009/28/EC and some certification systems provide methods to calculate dLUC GHG emissions and the databases necessary for calculations whereas the GBEP's guideline for bioenergy sustainability provides a framework to describe how LUC was taken into account.

The ERIA WG also addressed the calculation methodology based on the IPCC guideline in a previous report (Sagisaka, 2009). The recent WG discussion concluded that the LUC GHG emissions should be counted in LC-GHG emissions analyses with the description of uncertainty.

Table 1: Selected Bioenergy Sustainability Initiatives that Deal with dLUC

	Name	How dLUC GHG emissions are dealt with
Guideline	GBEP (Global Bioenergy Partnership)	The guideline refers to the common methodological framework for GHG lifecycle analysis of bioenergy, which helps users of the guidelines describe how the dLUC emissions are taken into consideration, e.g. reference period, scenarios, system boundaries, baseline, methodological approach for estimating the emissions etc.
Certification System	RSB (Roundtable on Sustainable Biofuels)	The certification has its own GHG calculation methodology developed based on IPCC guidelines. There are some differences from the methodology of EU Renewable Energy Directive 2009/28/EC.
	ISCC (International Sustainability & Carbon Certification)	The certification requirement for the production of biomass stipulates that the biomass feedstock should not be produced (as of January 2008) from • land with high biodiversity value • highly biodiverse grassland • land with high carbon stock • land that was peatland GHG emissions from dLUC that took place after 1 January 2008 are counted with the calculation methodology of Directive 2009/28/EC.

Source: WG compilation.

1.3.2. Emissions from Indirect Land Use Change

Indirect Land Use Change (iLUC) effects indicate a variety of environmental and social impacts, which are indirectly induced by the expansion of feedstock cultivation for bioenergy. For example, even if the feedstock for biofuel were to be cultivated on land where dLUC effects might not be critical (e.g. conversion of crop land to land for an energy crop), it might result in the subsequent conversion of other lands to biofuel feedstock cultivation. iLUC is often referred to as "unintended negative impacts induced from indirectly induced land conversion, particularly increases in GHG emissions". As there is no well-established calculation methodology for iLUC GHG emissions, not all the bioenergy sustainability initiatives take account of this complicated issue, although some of them have had intensive discussions on how iLUC could be quantified in their certification system or guidelines. Table 2 shows selected initiatives that officially address the iLUC GHG emissions. Although the WG currently does not address iLUC in its methodology, GHG emissions from iLUC will be included in future if calculation models become well-established with sufficient scientific evidence.

Table 2: Selected Bioenergy Sustainability Initiatives that Deal with iLUC

	Name	How iLUC GHG emissions are dealt with
Guideline	GBEP (Global Bioenergy Partnership)	The guideline refers to the common methodological framework for GHG lifecycle analysis of bioenergy, which helps users of the guidelines describe how the iLUC emissions are taken into consideration, e.g. reference period, scenarios, system boundaries, baseline, methodological approach for estimating the emissions, etc.
Certification System	RSB (Roundtable on Sustainable Biofuels)	The RSB standard currently does not address indirect impacts. However, an expert group was formed in 2009 to examine the indirect impacts of biofuel production and has published a “Draft for Public Consultation” (RSB, 2012), which shows five potential options for dealing with the indirect impacts of biofuel. • Do nothing about indirect impacts • Add-on certification of low-risk biofuels for indirect impacts • Criteria to minimize the risk of indirect impacts • Implementation of an iLUC factor in lifecycle GHG calculations • “Indirect impacts fund” / indirect impacts mitigation outside the project boundary
Legislation	RFS-2 (US Renewable Fuel Standard)	Energy Independence and Security Act (EISA) 2007 stipulates that greenhouse gas emissions assessments must evaluate the aggregate quantity of greenhouse gas emissions, including direct emissions and significant indirect emissions such as significant emissions from land use changes. It sets GHG emissions reduction thresholds for the four biofuel categories. To determine which fuel pathways meet this threshold, EPA is preparing GHG emissions assessments (including iLUC) for different pathways of several biofuels. The calculation model of GHG emissions consists of LCA models (GREET), economic models, satellite images and carbon stock maps to estimate international and domestic land use change emissions.

Methodology	RCA (Responsible Cultivation Areas) Methodology	RCA Version 1.0 is an open methodology that is designed to be used by all interested parties to identify and certify feedstock production with a low risk of indirect effects. It explains how to set the baseline and system boundary and how to prove the “additionality” that is a key to preventing bioenergy feedstock production from displacing other provisioning services of land.

1.4. Summary of Environmental Indicators

The environmental sustainability indicators of GBEP and RSB include life cycle GHG emissions in a similar way to the ERIA WG methodology. Other than GHG emissions, RSB and GBEP include environmental impact categories that were reviewed in the previous ERIA WG report (ERIA, 2011), i.e. climate change, impacts on air, water and soil, and biodiversity. In addition to these categories, GBEP takes into consideration wood resources and land use change while RSB includes the risk of new technology use, including genetically engineered plants or micro-organisms.

GHG emissions associated with land use change were also reviewed. The GHG emissions from dLUC are taken into consideration by GBEP, RSB and other sustainability initiatives, with frameworks for estimating the GHG emissions, but concrete methodology to estimate the emissions from iLUC is addressed in only one set of legislation.

The WG is reviewing the evaluation methodologies of these impact categories suitable for East Asian countries to include them and extend the ERIA WG methodology.

2. Review of Economic Sustainability Indicators

In order to enhance the ERIA WG methodology, the economic indicators of the Global Bioenergy Partnership (GBEP) and the Roundtable on Sustainable Biofuels (RSB) have been assessed. These are well-recognized initiatives.

2.1. GBEP's Economic Indicators

The GBEP sustainability indicators for biomass utilization for energy are similar to the ERIA WG methodology and other frameworks of bioenergy sustainability, and are categorized into environmental, economic and social pillars. The following 8 indicators belong to the economic pillar:

- Productivity
- Net energy balance
- Gross value added
- Change in consumption of fossil fuels and traditional use of biomass
- Training and re-qualification of the workforce
- Energy diversity
- Infrastructure and logistics for distribution of bioenergy
- Capacity and flexibility of use of bioenergy

2.1.1. Productivity

The indicator applies to biomass utilization for energy and to all bioenergy feedstock and pathways. Increases in productivity resulting in more efficient use of all inputs, including land and other resources, would mean reduced quantities of all inputs, resulting in increased profit and reduced burden on the environment.

Productivity is another indication of economic sustainability, but the ultimate measure of economic benefit could be expressed in terms of net profit derived from the production of bioenergy feedstock and/or processing of feedstock into bioenergy. Net profit is a component of Gross Value Added (GVA), an economic indicator already used in the ERIA WG methodology. Therefore there may not be a need to include productivity as another economic indicator.

2.1.2. Net Energy Balance

GBEP describes net energy balance as the net energy ratio of the bioenergy value chain, including energy ratios of feedstock production, processing of feedstock into bioenergy, bioenergy use, and/or life cycle analysis. It applies to biomass utilization for energy, biomass conversion into energy, use of bioenergy and to all bioenergy feedstocks, end-uses, and pathways. It is generally expressed in terms of the ratio of energy output to the total energy input from all the stages of biomass utilization for energy. An energy ratio greater than one means that the energy that can be derived from the bioenergy production is more than what is needed to produce the energy. Efficient production of bioenergy will result in a higher net energy balance and hence will lead to energy savings, which in large volume may improve energy security. The energy input may be in the form of fossil fuel or renewable energy. If the energy input is from fossil fuel, a higher net energy balance indicates a reduced consumption of, and hence reduced dependence on, fossil fuel.

Net energy balance would be better expressed in terms of the difference between the energy content of bioenergy and the total energy input used in the production of feedstock and processing to bioenergy. The unit could be expressed in terms of MJ/ha, MJ/ton of feedstock or MJ/year.

Net energy balance could be included in the list of economic indicators under the ERIA WG methodology. A positive net energy balance would make the biomass utilization for energy sustainable as there will be more energy output than used in the process. If biomass utilization for energy were to be a significant quantity then this could enhance the energy security of the country concerned.

2.1.3. Gross Value Added

Gross Value Added (GVA) is one of the GBEP economic indicators, and is defined as the value of output less the value of intermediate consumption. It is a measure of the contribution to GDP made by an individual producer, industry or sector. GVA provides a monetary value for the amount of goods and services that have been produced, less the cost of all inputs and raw materials that are directly attributable to that production. GVA is equivalent to the TVA (Total Value Added) of the ERIA WG methodology.

2.1.4. Change in consumption of fossil fuels and traditional use of biomass

This is described as the substitution of fossil fuels with domestic bioenergy, measured by energy content and in annual savings of convertible currency arising from reduced purchases of fossil fuels. The former is measured in terms of MJ per year and/or MWh per year while the latter is measured in terms of USD per year.

The use of locally produced biomass for energy can displace the consumption of fossil fuels, consequently reducing a country's dependence on imported fossil fuel, and might therefore have a significant impact on energy security if large volumes were involved. The non-importation of fossil fuels would also bring about savings in dollar reserves.

This economic indicator is included in the ERIA WG methodology separately as foreign exchange savings.

2.1.5. Training and re-qualification of the workforce

This is described as the percentage of trained workers in the bioenergy sector out of the total bioenergy workforce, and the percentage of re-qualified workers out of the total number of jobs lost in the bioenergy sector.

Although this indicator can be a factor to ensure sustainable production and use of bioenergy, the WG regards it as a non-direct measure of the sustainability of bioenergy.

2.1.6. Energy diversity

This is described as the change in diversity of total primary energy supply due to bioenergy. It is measured in terms of MJ of bioenergy per year in the total primary energy supply. The indicator applies to biomass utilization for energy, and to all bioenergy feedstocks, end uses and pathways. The production and use of bioenergy improve the diversity of energy supply and can make a contribution also to the country's energy security if large volumes are involved.

Energy diversity applies only to a macro-level biomass utilization for energy, hence there may not be a need to include this as another economic indicator in the ERIA WG methodology.

2.1.7. Infrastructure and logistics for distribution of bioenergy

This is described as the number and capacity of routes for critical distribution systems, and is expressed in terms of number of infrastructure facilities and total bioenergy in MJ or volume of bioenergy safely and reliably distributed per year. Safe, reliable, cost-effective, appropriate available infrastructure will help ensure adequate and secure energy supplies, that will facilitate sustainable bioenergy development. It is not, however, a direct measure of the sustainability of biomass utilization for energy.

2.1.8. Capacity and flexibility of use of bioenergy

This is described as the ratio of capacity for using bioenergy with actual use for each significant utilization route, or the ratio of flexible capacity which can use either bioenergy or other fuel sources, to total capacity. This indicator refers primarily to energy security, and infrastructure and logistics for distribution and use.

Again, just like the other economic indicators mentioned above, this is not a direct measure of the sustainability of biomass utilization for energy.

2.2. RSB's Economic Indicators

The Roundtable on Sustainable Biofuels (RSB) sets Principles and Criteria that provide guidelines on the best practices for sustainable biofuels production.

The only economic indicator under RSB is wages, and this is reported as one of its socio-economic indicators together with employment and labor conditions.

The RSB Principles, specifically Principle 4- Human and Labor Rights- is intended to ensure that biofuel operations do not violate human or labor rights, and in fact promote decent work and the well-being of workers. This includes wages which are to be provided in cash, or some other form acceptable to farmers, at a pay rate based on the legal minimum wage or comparable regional wage, whichever is higher.

The RSB also emphasizes the importance of the principle that economic viability of biofuel operations should not entail sacrificing the social and environmental aspects of its development. However, it does not specifically mention measure(s) of economic viability.

2.3. Summary of Economic Indicators

Among the economic indicators listed under GBEP and RSB only net energy balance could be included in the list of economic indicators under the ERIA WG methodology. However, instead of being expressed as the energy ratio of the bioenergy value chain in comparison with other energy sources, it would be better expressed in terms of the difference between the energy content of bioenergy and the total energy input used in the production of feedstock and processing to bioenergy. The unit could be expressed in terms of MJ/ha, MJ/ton of feedstock or MJ/year. A positive net energy balance would make the biomass utilization for energy sustainable, as there will be more energy produced than used in the process.

3. Review of Social Sustainability Indicators

Development of bioenergy is associated with a broad range of social issues. While its benefits include accelerated rural development, increased employment, mitigation of climate change and access to modern energy services, it may also result in certain risks, including deforestation, food and fuel conflict, biodiversity loss, water scarcity, and land degradation due to increased use of agricultural inputs.

To have a broader view of the social impacts and their indicators, two of the existing sustainability guidelines, namely, the Global Bioenergy Partnership (GBEP) and the Roundtable for Sustainable Biofuels (RSB) are covered in this sub-section. The Millennium Development Goals (MDGs) are also discussed, recognizing the situation of many developing countries in Asia.

3.1. The GBEP Social Indicators

Among the 24 sustainability indicators proposed by the GBEP, eight are for the assessment of social impacts, considering various criteria such as access to land, water and other natural resources, the national food basket, labor conditions, rural and social development, access to energy, and human health and safety. The corresponding social impact indicators are

- Allocation and tenure of land for new bioenergy production
- Prices and supply of the national food basket
- Change in personal incomes
- Jobs in the bioenergy sector
- Change in unpaid time spent by women and children collecting biomass

- Bioenergy used to expand access to modern energy services
- Change in mortality and burden of disease attributable to indoor smoke
- Incidence of occupational injury, illness and fatalities.

The indicators are value-neutral, do not feature directions, thresholds or limits and do not constitute a standard, nor are they legally binding. The indicators are intended to inform policy making and facilitate the sustainable development of bioenergy, and shall not be applied so as to limit trade in bioenergy in a manner inconsistent with multilateral trade obligations. The GBEP indicators do not provide answers or correct values of sustainability, but rather present the right questions to ask in assessing the effect of modern energy, biomass utilization for energy, and use of bioenergy in meeting nationally defined goals of sustainable development.

3.2. The RSB Social Indicators

The RSB standard is built around the following 12 principles: (i) legality, (ii) planning, monitoring and continuous improvement, (iii) greenhouse gas emissions, (iv) human and labor rights, (v) rural and social development, (vi) local food security, (vii) conservation, (viii) soil, (ix) water, (x) air, (xi) use of technology, inputs and management of waste, and (xii) land rights. The social impacts are combined with economic impacts addressing the following concerns.

- Land tenure, access and displacement
- Rural and social development
- Access to water and other natural resources
- Employment, wages and labor conditions
- Human health and safety
- Energy security and access
- Good management practices and continuous improvement.

The RSB standard identifies four types of operators subject to different sustainability requirements within it. These include “feedstock producers”, “feedstock processors”, “biofuel producers” and “blenders”. Throughout the standard the requirements that apply to each of theses operators are identified. The criteria included in the RSB standard address only the direct activities that farmers and producers can undertake to prevent unintended consequences from biofuel production.

3.3. The MDG Social Indicators

The Millennium Development Goals (MDGs) were declared in 2000 and their progress was reviewed by the United Nations in 2010, when world leaders agreed that some concrete strategies and actions would be taken up to meet the eight MDGs by 2015 (United Nations, 2010). The MDGs represent human needs and the basic rights that every individual around the world should be able to enjoy. They are classified into eight categories, namely; freedom from extreme poverty and hunger; quality education; productive and decent employment; good health and shelter; the right of women to give birth without risking their lives; and a world where environmental sustainability is a priority, and women and men live in equality and develop a global partnership for development to achieve these universal objectives.

Most of the MDGs are thus related to social development, and employment and access to modern energy are built into them.

3.4. Summary of Social Indicators

The GBEP sustainability indicators provide guidance on how to promote wider production and use of bioenergy, particularly in developing countries. These indicators could be modified by country, region or community to suit their nationally or regionally defined needs and circumstances. The RSB standard, however, is a certification system for biofuels that demands strict compliance to its principles and criteria to obtain certification.

The common social concerns in the GBEP and RSB sustainability criteria and guidelines are the following:

- Resource rights and use
- Labor rights and employment conditions
- Food security
- Human health and safety
- Rural and social development
- Benefits for women, youth, indigenous and vulnerable people

- Access to modern energy services

Both GBEP and RSB have tried to consider the realities in developing countries and regions of poverty, where traditional use of biomass is still prevalent. The indicators, measured over time, could show progress towards or away from a nationally defined sustainable development path. However, it would require a huge and diverse amount of data and expertise to come up with a holistic description and context of socio-economic conditions, which may not be available at the local level.

A variety of data sources would be needed to analyze the wide range of socio-economic issues mentioned above, in a qualitative and quantitative manner. While it is preferable to be comprehensive in addressing social impacts, in the end the data challenge will dictate the necessary trade-off in prioritizing indicators which are easily observable and important to the community such as "increase in income" and "access to modern energy".

ERIA through its WG has developed its own methodology which uses various social development indicators (SDIs) to express the social aspects of bioenergy, both qualitatively and quantitatively. The WG has compared the ERIA WG methodology with the GBEP methodology and the MDGs and such comparisons raised many questions, which need to be answered. For example, many of the GBEP indicators are not included in the ERIA WG methodology and it was felt necessary to give an explanation for this.

Data for estimating employment and access to modern bioenergy were not collected in pilot studies, and these may be required in future studies through more extensive field surveys of the study regions.

Although GBEP's methodology is comprehensive, it seems difficult in implementation in developing countries. As the GBEP method has very many indicators, data collection could be difficult for researchers, and data understanding could be difficult for policy makers

The MDGs aim at halving poverty in the world's poorest countries by 2015, which is a daunting task. While some of the world's poor countries have seen tremendous success in poverty reduction over the past decades and are on track to achieve the MDGs, many others are lagging. It would be worthwhile to address the role of energy services in meeting the MDGs in the lagging countries. Energy services are essential to both social and economic development, and much wider access to energy services is critical in achieving all of the MDGs.

In view of the above comments, the ERIA WG methodology may not include some of the GBEP indicators nor some aims of the MDGs, and our methodology may not be the best available, but it could be an appropriate one to apply at the local level, particularly in East Asian countries. However, the WG is still not sure about its methodology being recognized or applied in all East Asian countries, and feels that it is necessary to disseminate the ERIA WG methodology widely in these countries. One of the future goals of the ERIA WG will thus be to establish a comprehensive database, containing the data necessary for carrying out a sustainability assessment and possibly including data and information on GBEP and MDG concepts and indicators.