A statement resulting from a Joint IEA Bioenergy
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SUSTAINABILITY OF BIOENERGY

The bioenergy industry is expanding rapidly around the globe in response to climate change and rising oil prices. But serious concerns about sustainability of production, off-site environmental and social impacts, and true greenhouse gas balances need to be addressed.

Some so-called “first generation” biofuel systems, such as ethanol from corn, and biodiesel from canola, deliver minor greenhouse gas mitigation benefits when the direct and indirect emissions associated with crop production, processing and transport are considered. Other biofuel systems such as oil palm grown in South East Asia for biodiesel have apparently greater greenhouse benefits due to efficient high-yielding production systems. However, when indirect impacts of offsite deforestation and loss of soil carbon, especially in peatlands, are brought into the equation the net effect can be negative compared with fossil fuel systems. In addition, expansion of bioenergy systems, involving direct or indirect land use change, can have negative impacts on other environmental attribute, such as catchment water yield and biodiversity.

Furthermore, some current biofuel systems have negative socio-economic consequences, such as increased food prices and displacement of traditional land uses.

Nonetheless, there are some bioenergy options that are environmentally-friendly, can contribute significantly to mitigation of greenhouse gas emissions, and deliver positive social and economic impacts.

Biofuels based on perennial ligno-cellulosic (woody) feedstocks generally show more promise, both in terms of net greenhouse benefit and other environmental and socio-economic impacts, than many first generation options based on starch and oilseed crops.

The systems with the greatest benefit are those that utilise residues as feedstock, and employ efficient energy conversion technologies such as combustion for heat or co-generation of heat and power.

There is an urgent need for policy development and operational guidelines to support improved sustainability in the bioenergy industry.

RECOMMENDATIONS FOR IMPROVING SUSTAINABILITY OF BIOENERGY

Improve use of existing biomass resources

Use of existing biomass resources, both products and residues from agricultural and forest industries, food processing residues and other organic wastes, should be optimised to maximise mitigation benefits. Optimal usage may involve “cascading” ; for example high value wood products can substitute for fossil -intense building products, be recycled, and finally used as feedstock in a bioenergy system. Linking bioenergy production with waste management can be particularly beneficial, reducing greenhouse gas emissions from wastes, and solving local pollution problems while providing renewable energy.

Recognise competing needs for land resources

The land resource available for bioenergy production is limited, restricting the contribution bioenergy can make to addressing the energy shortage and mitigation of climate change.

Production of liquid transport fuels based on so-called first generation systems, producing ethanol from starch and sugar crops and biodiesel from oilseed crops, competes directly with production of food and stockfeed on high productivity agricultural land. Expansion of bioenergy crops in tropical Asia and the Amazon may lead to increased deforestation, which will reduce forest carbon stocks, threaten biodiversity, and may cause social dislocation.

Intensification of agricultural practices, to increase production per unit land area, may be part of the solution, but the increased use of energy, fertilizer and pesticides will reduce the net mitigation benefits. Furthermore, intensification of inputs and extraction of a higher proportion of biomass will increase pressure on sustainability of production systems.

Focussing on bioenergy from perennial crops rather than conventional food crops, particularly if grown on lower productivity lands, will minimize competition with food production.

Acknowledge the impact of indirect land use change

Deforestation caused by indirect land use change can reduce the mitigation benefits of bioenergy. However, emissions from indirect land-use change are difficult to quantify, due to difficulties in isolating impact of biofuels from other drivers of land use change such as demand for food and fibre, and because emissions vary widely between different land use systems. Emissions from indirect land use change can be estimated by expanding the system boundary to include identifiable indirect effects, or using economic models to estimate the consequences for other land uses from increased use of biofuels.

Look for synergistic land use solutions

Land use strategies are needed that integrate production of biomass and food with delivery of environmental services whilst meeting the needs of local communities. Intercropping and agroforestry systems, that produce biomass for energy and agricultural products simultaneously, can have higher total productivity and greater resilience to drought and pests than monoculture agricultural systems.

Use biomass efficiently to deliver the services required

The focus should be on efficient utilisation of biomass energy to meet the community’s need for energy services (such as heat, transport, electrical power), rather than on production of specific energy products (such as solid or liquid fuels). Existing bioenergy technologies are likely to contribute only a part of the optimal energy conversion systems of the future.

For example, biomass may be more efficiently used as a source of heat for electricity generation used to power electricity-based transportation than as a source of liquid fuels for transportation. (However, transition to widespread use of electric transport will require technology and infrastructure development and adoption.)

Develop effective policy and operational guidelines to improve sustainability of bioenergy (and other land use)

There is an urgent need for policy measures that support improved sustainability in the bioenergy industry. Policy measures should provide incentives only for those bioenergy systems that deliver net benefit. Policy approaches may specify minimum greenhouse gas savings that must be achieved to be eligible for incentives.

Policies and operational guidelines should be developed through collaboration across all areas of government, in consultation with stakeholders and experts, recognizing the needs and impacts at the local level. Policies should be multi-dimensional rather than focussed on only one attribute (such as GHG emissions), and informed by high quality research.

Practical application of measures to increase sustainability requires the definition and acceptance of 'sustainability principles", and indicators by which sustainability is assessed.

Certification based on these sustainability principles and indicators could be encouraged to improve sustainability of individual projects with respect to on-site impacts, but it is unlikely to successfully address indirect effects such as deforestation. National or regional level monitoring programs, particularly if linked with GHG mitigation credits for avoided deforestation, will be more likely to capture such indirect effects.

Ideally, policy measures will not address sustainability of bioenergy in isolation, but consider the sustainability of all land uses.

Consider the full life cycle impacts

Environmental impacts of individual bioenergy projects can be most effectively determined using life cycle assessment (LCA), in which direct impacts as well as indirect upstream and downstream impacts resulting from the bioenergy system are included. The results are situation specific: impacts vary between different feedstocks produced by different production systems; between energy conversion systems that differ in efficiency due to technology and scale; and between locations, due to differences in productivity and transport distances.

The calculation should include emissions of the powerful greenhouse gases nitrous oxide, such as from denitrification processes in the soil, and methane, such as from anaerobic digestion. If bioenergy systems lead to changes in carbon stocks in biomass and soils, this should also be included.

Greenhouse mitigation benefits of a bioenergy system should be expressed with reference to the emissions from the fossil fuel system that it displaces.

Because LCA results are situation specific it is necessary to conduct these analyses for each system under consideration. This can be facilitated by the development of readily-available Life Cycle Inventory databases, guidelines for conducting such studies, and conservative locally-relevant default data. Meta-analyses of results of individual cases can identify those locations, feedstocks and energy conversion and distribution systems that deliver greater benefits.

Allow for a flexible definition of sustainability

Sustainability is not an absolute concept; the definition will vary, dependent on scale and situation. While universal 'sustainability principles' can be identified, the measures by which sustainability is assessed need to be adapted to the local context, recognising the objectives and priorities of local communities.

Facilitate international trade in sustainable bioenergy to allow potential to be realised

Current policies in Western countries, mandating renewable energy, have led to growing international trade in bioenergy, including transport to Europe of wood pellets from Canada, palm oil from Malaysia and ethanol from Brazil. Sustainability must be considered at each level of the supply chain. Concerns over sustainability of production systems in some developing countries, and the negative impact on GHG balance of long distance transport, have led to the suggestion that bioenergy should be produced and consumed locally. However, those countries with greatest potential to produce biomass tend not to be those with the greatest demand for energy. While it will clearly be challenging, it is important to implement policies and programs that facilitate development of sustainable bioenergy systems in developing countries, and trade of sustainably produced bioenergy, to allow the global potential for bioenergy production to be utilised to meet growing global demand for energy, and to allow the producing countries to benefit from development of industries that utilise their capacity to meet this demand.

Implement solutions at a scale relevant to the situation

The optimal scale of bioenergy projects varies depending on the spatial distribution of biomass resources and demand. While small-scale local projects will minimise transport distances and may deliver higher social benefits, large scale feedstock production and industrial-scale bioenergy plants tend to have higher efficiencies than small-scale solutions. Thus it is important to evaluate the trade-offs in terms of GHG savings and other social and economic outcomes.

Learn from existing examples

We can confidently state that certain biofuel feedstocks and technologies lead to sustainable bioenergy production in some locations.

In Sweden, the combination of industrial potential, social interest and consumer demand has led to successful use of bioenergy. Discussion began in the 1980s about the use of arable land for the production of food or biomass for energy. The Swedes improved the use of residuals and developed efficient technologies for handling forest biomass; they passed legislation requiring return of ash to the forest to minimise loss of soil fertility. The increase of taxes on fossil fuels created the market for biomass utilization. They had the advantage of high potential, willing community and strong governance.

While the experience of Sweden may not be attainable in other countries due to their different circumstances, useful lessons can be learned from their success.

Improve understanding of bioenergy

The acceptance and uptake of bioenergy can be increased through education, conveying accurate data about positive and negative impacts of bioenergy, promoting success stories and demonstration projects. Promotion should focus on the systems, both existing and developing technologies, that can have a big impact, as well as niche applications where bioenergy is the obvious solution (eg gasification in paper mills). Materials substitution, that is, use of bioproducts to displace more greenhouse-intensive alternatives, should not be overlooked. Factors that encourage successful implementation of bioenergy include: local stakeholder involvement, influential spokespersons, trust among all parties, understanding of full costs of fossil fuels, and effective promotion.