

# Forests, bioenergy and climate change mitigation

Report of a workshop held 19-20 May 2014,  
Copenhagen



Report of the workshop held 19-20 May 2014, in Copenhagen, co-organized by the Joint Research Centre of the European Commission (JRC), the International Energy Agency (IEA) Bioenergy Tasks 38, 40 and 43, the European Environment Agency (EEA) and the International Institute for Sustainability Analysis and Strategy (IINAS).

## IEA Bioenergy

IEA Bioenergy: Task 38, Task 40, Task 43

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The workshop was supported by the Joint Research Centre of the European Commission (JRC), the International Energy Agency (IEA) Bioenergy Tasks 38, 40 and 43, the European Environment Agency (EEA) and the International Institute for Sustainability Analysis and Strategy (IINAS). We thank Annemarie Bastrup-Birk, Jan-Erik Petersen, Luisa Marelli, Jacopo Giuntoli and Alessandro Agostini for their contribution to planning and running the workshop.

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## Summary

Many countries have introduced policies that promote bioenergy as a climate change mitigation measure. However, critics of such policies have suggested that the greenhouse gas savings associated with bioenergy are over-stated, or may take many decades to eventuate. There is a debate in the scientific literature about the climate effects of forest-based bioenergy, with some studies showing limited or even negative contributions to climate change mitigation at least in the short term, while other studies contradict these results, finding positive contribution also in the short term for apparently similar systems.

IEA Bioenergy Tasks 38, 40 and 43 joined the European Commission's Joint Research Centre (JRC), the European Environment Agency (EEA) and the International Institute for Sustainability Analysis and Strategy (IINAS) to devise and present a workshop which brought together researchers with a range of views on the role of forest-based bioenergy in climate change mitigation. The workshop aimed to facilitate dialogue between scientists on the topic of climate effects of forest-based bioenergy, to advance understanding of the topic and to determine the bases of divergent views.

The workshop identified points of convergence and divergence. Points of convergence related to the appropriate approaches for assessing the climate effects of bioenergy, and priorities for research. Areas of divergence related to both objective and subjective aspects of research approaches, and different perspectives were explained mainly by different worldviews or reference points, rather than scientific aspects.

Participants agreed that

- (i) information and knowledge from many scientific disciplines, applying a range of different methodologies, are needed to guide development of policy for forest bioenergy;
- (ii) studies that quantify greenhouse gas balances should adopt a full life cycle, comprehensive system view and preferably use information and data from biophysical and socio-economic modelling studies that consider market effects in parallel sectors and employ several alternative scenarios concerning critical factors, including policy options and energy technology pathways;
- (iii) achieving GHG emissions reduction goals will need a combination of enabling policy, market mechanisms driven by policy incentives, and effective sustainability standards. Simplified approaches for policy development such as a "risk matrix" were suggested, but not supported by all. The workshop concluded that there is a need for multi-disciplinary research to translate the insights from scenario modelling into policy guidance for governance of land use and energy systems.

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## Workshop Statement

This statement is an outcome of the workshop on "Forests, bioenergy and climate change mitigation", held May 19-20, 2014 in Copenhagen, which had the following objectives:

- to facilitate dialogue between scientists on the topic of climate effects of forest -based bioenergy, in order to advance scientific understanding of the topic and to clarify divergent views on the role of forest-based bioenergy in climate change mitigation, and
- to identify knowledge gaps and priorities for future research and data collection, in order to improve scientific understanding and support policy development for forest-based bioenergy.

### FRAMING THE ISSUE

Concerns regarding global climate change led to the adoption of the long-term target to limit global warming to 2°C. Current scientific understanding indicates that peak warming is insensitive to CO<sub>2</sub> emission trajectories; that is, timing of emissions is not critical in relation to the 2°C target. On the other hand, policymakers may judge that additional climate targets are needed to facilitate climate change mitigation, such as short-term national emission reduction targets. Such targets constrain the possible emission trajectory profile and shift focus toward gases with shorter atmospheric lifetimes; thus, timing of GHG emissions is relevant for such policy targets.

As noted in the IPCC AR5 report "...scenarios reaching atmospheric concentration levels of about 450 ppm CO<sub>2</sub>eq by 2100 (consistent with a likely chance to keep temperature change below 2 °C relative to pre-industrial levels) include substantial cuts in anthropogenic GHG emissions by mid-century through large-scale changes in energy systems ... [and that] bioenergy can play a critical role for mitigation, but there are issues to consider, such as the sustainability of practices and the efficiency of bioenergy systems". It is further noted that: "the scientific debate about the overall climate impact related to land-use competition effects of specific bioenergy pathways remains unresolved. Fossil fuel use transfers carbon from the slow domain of the carbon cycle, where turnover times exceed 10,000 years, to the fast domain (the atmosphere, ocean, vegetation and soil); bioenergy systems operate within the fast domain, where vegetation and soil carbon have turnover times of 1-100 and 10-500 years, respectively. A reduction of deforestation and more efficient use of forest biomass for wood-based products and energy, maximising GHG mitigation per unit biomass, are needed in parallel.

Policies frame markets for bioenergy and the broader bioeconomy, and forest management will react to that, as well as forest product markets. Forest management often has a long-term focus, which presents a challenge for development of policies intending to support near-term climate targets.

Forest management influences the dynamics of forest carbon stocks. In many countries, forest carbon stocks have increased over recent decades, but deforestation has reduced carbon stocks in other regions (sub-Saharan Africa, Latin America, South-East Asia). Currently, the vast majority of forest managers receive no revenue from maintaining or increasing forest C stocks.

Forest governance differs between countries and regions, which is relevant when considering the implications of the increasing trade in bioenergy.

## MODELLING: SCOPE, DATA AND LIMITATIONS

### Treatment of bioenergy under the UNFCCC and in Life Cycle Assessment (LCA)

The estimation of carbon fluxes from forest bioenergy in national inventories under the United Nations Framework Convention on Climate Change (UNFCCC) follows IPCC guidelines for national GHG reporting. This means that annual forest carbon releases or sinks are allocated to the land use, land use change and forestry (LULUCF) sector, and CO<sub>2</sub> emissions from biomass use are excluded<sup>1</sup> in the energy sector to avoid double counting. This is different from GHG accounting in life cycle assessment (LCA), which has a cross-sectoral and cross-border view and sums GHG emissions over the life cycle of a specific product or service to which the impact of those emissions is attributed.

Both approaches ask different questions, and different actors apply them with different scopes. When IPCC “tier 1” data<sup>2</sup> are used in LCA studies to obtain estimates of biomass and soil carbon fluxes, caution and transparency are needed as these data were intended for national level reporting and may not be appropriate at finer scales.

Various metrics have been proposed for quantifying climate change effects. Depending on the purpose of the assessment, different metrics may be preferred. Global Warming Potential (GWP)<sup>3</sup> is the most commonly used metric but, the Global Temperature Change Potential (GTP) may be a more appropriate metric in some circumstances. Application of more than one metric is informative for policy development.

### Modelling and LCA approaches for assessing Forest Bioenergy

Information and knowledge from many scientific disciplines, applying a range of different methodologies, are needed to guide development of policy for forest bioenergy. For policy assessment, a landscape perspective, rather than the forest stand level, would in general be the appropriate scope. In any case, the geographical scale, and time scale, should reflect the aim of the assessment or the scope of the (policy) instrument to be evaluated.

The workshop participants agreed that a combination of biophysical, climate and socio-economic models is required to understand the climate effects of bioenergy, including effects on parallel industries (wood products, agriculture and energy), and to inform policy development. The earth climate system is altered not only by CO<sub>2</sub>, but also by changes in the atmospheric concentration of other gases and aerosols (directly emitted or precursors), in solar radiation and in land surface albedo. Therefore, the effects of all climate forcers influenced by forest cover and forest management should ideally be included. In addition, impacts on biodiversity and ecosystem services need to be considered in policy development.

While attributional LCA (ALCA) may be applicable for some purposes (such as identifying hotspots in the supply chain or implementing a policy decision, as it reflects those aspects under control of the project manager or economic operator), it is not appropriate for evaluating the consequences of the introduction of a new policy, because it does not consider effects on other sectors of the economy. Therefore, consequential approaches, such as consequential LCA (CLCA) are required in developing policy, to conduct due diligence of new policy alternatives. One significant drawback of

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<sup>1</sup>Reported in the energy sector for information only

<sup>2</sup>For example, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>

<sup>3</sup>GWP expresses the cumulative radiative forcing of a unit emission of GHG to that of CO<sub>2</sub> over a specified period, commonly 100 years. In contrast, GTP quantifies the effect of a unit emission of GHG on the global mean surface temperature at a specified point in the future, relative to that of CO<sub>2</sub>.



CLCA is the inevitable uncertainty associated with modelling complex systems, so analysts, stakeholders and policy makers need to exercise appropriate caution and be transparent about the uncertainty associated with CLCA estimates, and pragmatic in choosing among policy alternatives that have high degrees of uncertainty.

Consequential comparative assessments addressing forest bioenergy policies need to compare the biomass and soil carbon pools, product pools, etc. in the bioenergy policy scenarios with counterfactual scenarios. Because the future is uncertain, for both the reference “business as usual” (BAU) situation and the “with bioenergy” case, it is preferable to model several scenarios to inform policy-making. BAU scenarios should reflect commonly accepted practice in forest management and land use, anticipated trends in both, and include different developments in forest product markets (sawnwood and pulpwood markets, new bio-based materials) and also energy markets.

## **POLICY GUIDANCE**

Decisions by government and the private sector should be informed by scientific understanding of climate change impacts of forest bioenergy. Such input should be based on comprehensive analysis of complex systems in the context of alternative policy options and energy technology pathways.

Decision-makers are looking for near-term policy solutions while more sound scientific assessments are being developed. Given the complex nature of the issue, some have questioned whether decision makers should use categories of bioenergy feedstock production systems based on simplified system descriptions (e.g. sustainable forest management plus maintaining forest carbon stock) to identify acceptable bioenergy systems to support and implement.

Such approaches (including “go/no-go” lists) must be seen as very crude first-order estimates and are subject to significant uncertainty, and so caution should be used if such proxies are applied. It was agreed that risk-based approaches are preferable. For example:

- Multidimensional risk matrices covering spatial aspects, forest management, forest product types, downstream/upstream markets effects and energy substitution could be used to assess specific cases.
- Consequential modelling approaches should be applied for policy development, and large-scale projects as part of due diligence. Such planning processes require transparency, including stakeholder involvement.
- Methodological frameworks (guidance and rules) for risk-based approaches should be developed.

## **RESEARCH NEEDS**

The scientific base to inform decision-makers should be expanded beyond product-based LCA, considering the role of integrated models, global monitoring systems and publicly available databases.

The following specific research needs were identified:

- Studies clarifying how the energy sector, forest industry and forest management planning respond to changing forest product markets, including bioenergy markets;
- Good empirical data on forest product supply and demand and land use, at scales of resolution that enable comprehensive analyses of alternative scenarios;

- development of stronger links between the forest/bioenergy systems modelling and the earth systems/ climate science/ integrated assessment modelling efforts;
- Multi-disciplinary research into the interpretation and translation of insights from scenario modelling into policy guidance for management of land use and energy systems.

As bioenergy policy is currently being developed, for example in Belgium, Denmark, the Netherlands, the UK and the USA at national and state levels, the international community (including scientists and policy-makers from government and industry) should prioritise allocation of resources to conduct the necessary research and risk-analyses that would lead to deployment of sustainable bioenergy systems.

Developed by the workshop participants in Copenhagen, May 20, 2014 and edited for clarity by the Organizing Committee, August 2014

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## Abbreviations

ALCA	Attributional life cycle assessment
CLCA	Consequential life cycle assessment
EEA	European Environment Agency
EU	European Union
dLUC	Direct land use change
GTP	Global temperature change potential
GWP	Global warming potential
IEA	International Energy Agency
IINAS	International Institute for Sustainability Analysis and Strategy
iLUC	Indirect land use change
JRC	Joint Research Centre of the European Commission
LCA	Life cycle assessment
LUC	Land use change

# Introduction

## BACKGROUND

Forests provide many different ecosystem services to society, ranging from timber and food provision over regulating functions, such as carbon storage or flood attenuation, to opportunities for recreation, and protection and enhancement of biodiversity. Managing forests for any purpose has an influence on these functions which shows the importance of reviewing wider environmental considerations when using wood from forests for bioenergy.

Woody biomass for bioenergy is being promoted as one of the main renewable, low-carbon sources to achieve climate and energy policy targets for 2020 and beyond.

Currently, woody biomass represents the biggest proportion of installed capacity of renewable heat and power plants in the EU (>50% for electricity generation and >75% of heat generation). The use of woody bioenergy is also expected to further increase in the future.

The promotion of biomass use for energy offers considerable opportunities for the agriculture and forestry sectors, which can find new markets for their products. At the same time, concerns have been growing that increased biomass mobilization for energy use, such as in the EU, may result in unintended negative environmental impacts both in the EU and in third countries.

There has been considerable effort spent on defining sustainable land use in forestry and agriculture. For example, the countries involved in what came to be known as the Montreal Process, agreed upon seven criteria of sustainable forest management in 1993. This agreement was significant globally, since the member countries represent about 90 per cent of the world's temperate and boreal forests in the northern and southern hemispheres. The seven criteria upon which the Montreal Process is based have been broadly accepted internationally and are similar to the foundation principles for essentially all sustainability standards developed since that time.

While originally conceived with forest management in mind, the criteria have also been adapted to ensure sustainable trade in forest products, including bioenergy feedstocks, so that it is possible to verify whether wood products purchased by consumers were produced from timber or biomass harvested from sustainably managed forests.

Yet, important questions remain about the sustainability of forest bioenergy use, and require careful consideration of benefits and costs with a view on multiple aspects (CO<sub>2</sub> emissions, other climate forcers like albedo and black carbon, biodiversity, water use, local air pollution, social and economic criteria etc.). Discussions about how to include biospheric carbon fluxes in LCA, and develop sustainability criteria and methodology that take into account forest management, site conditions, biomass types, cascading use of biomass etc. are still on-going.

## PURPOSE OF THE MEETING

Given this background, the JRC, IEA Bioenergy Tasks 38, 40 and 43, the EEA and IINAS, organized a series of workshops to discuss the main issues underpinning the use of forest bioenergy and its impacts on climate change.

Discussions at previous meetings, and previously published documents such as the IEA Bioenergy ExCo report "Bioenergy, Land Use Change, and Climate Change Mitigation", "IEA Bioenergy ExCo statement on timing", or the JRC report on "carbon accounting of forest bioenergy", helped to build consensus around some relevant topics, and gave evidence that several open issues need

further discussions to reach scientific consensus. This expert meeting was organised to continue these discussions, building on points on which some agreement was made in previous meetings. The workshop agenda is presented in Appendix A.

The goals for the workshop were:

- to facilitate dialogue between scientists on the topic of climate effects of forest-based bioenergy,
- to advance scientific understanding of the topic and
- to clarify divergent views on the role of forest-based bioenergy in climate change mitigation.

The workshop was intended to focus on scientific and technical issues and data needs in modelling and C accounting methodology, rather than debating policy options, though some discussion on implications of research for policy formulation occurred.

The workshop had the following objectives:

- To present the outcomes of a survey circulated before the workshop, and discuss identified points of divergence.
- To discuss and to improve shared understanding and agreement on the way forward regarding the scientific basis, the policy implications (e.g. necessity or otherwise to promote/discourage different bioenergy options), and the possible measures and implementation methods.
- To identify research needs and develop ideas for collaborative research and other joint activities to foster scientific understanding and investigate contradictory claims with regard to climate mitigation effects of using forest biomass for energy.
- To propose a priority list for developing data sets and other information sources that allow a better assessment of the climate change effects of forest bioenergy.

## **PRELIMINARY SURVEY**

The meeting aimed to clarify issues raised during previous meetings, with particular attention to methodological aspects. A survey (Appendix B) was circulated prior to the meeting to help identify areas of overall agreement, and dissent, to guide the planning of workshop discussions. To learn about the views of participants with regard to key statements, the invited experts were asked to express their level of agreement on each of the statements on climate impacts of bioenergy (see Survey in Appendix B).

In case of disagreement the experts were invited to substantiate the scientific basis underpinning their views.

## **TOPIC AREAS DISCUSSED**

### **Forest bioenergy, climate impacts and GHG reduction targets (policy framework):**

- GHG emission reduction targets, such as proposed by EU legislation: definition of a methodology (including metrics) to assess net GHG savings (biogenic carbon stocks included) and associated net climate effects for a series of feedstocks.
- Data and information sources available and how to improve them, for instance on type of feedstock used (now and in future), their availability (now and in future) and consequences of their use (now and in the future).
- Trade of bioenergy products: imports to EU, how to account for non-EU context of global supply chains (e.g. geographical origin, type of biomass (e.g. logs, logging residues, stumps), ecological community of origin (e.g. wetlands).
- Certification schemes for bioenergy products, and traceability.

- How to determine whether forest bioenergy feedstocks contribute to 2020-2030 GHG emission reduction targets (as determined by the specific performance criteria and associated quantification framework to be agreed upon).
- How to determine complementary performance criteria and an associated quantification framework for forest bioenergy options that inform about climate change mitigation benefits in the longer term (not restricted to GHG balances).

### **Resource competition and synergies between forest fuels production and other production in the forest sector, and interaction between the forest sector and other industrial sectors:**

- How to account for resource competition and synergies in different sectors? What are the biomass uses that, currently or in perspective, are more likely to benefit or suffer competition from the bioenergy sector?
- How to assess the forest management and feedstock-supply response to an additional demand for bioenergy / the bio-based economy (modelling?)
- How to link agro-forest-energy models and manage uncertainties?
- Which additional primary data collection is needed (e.g., on prices, material/energy flows, uses, availability etc.).

### **Long-term climate impacts modelling and policy:**

- Definition of the appropriate climate and other metrics to be used for the analysis.
- Definition of baseline/counterfactual(s) for the analysis, taking into account likely future development of energy and land use systems.
- Inclusion of biospheric carbon flows and non-GHG climate forcers in setting-up climate modelling.

### **Research needs and opportunity to create research consortia in this context**

- What other (non-climate) environmental issues should be recognised, and how to consider these in policy development?
- Which primary data are needed (e.g., on prices, flows, uses, availability etc.), and where can we get reliable data?
- What research could be undertaken to address identified knowledge gaps and investigate divergent claims with regard to climate effects of forest bioenergy?

## Summary of points arising from each session

The workshop was structured around small group discussions. Each session commenced with several short presentations in plenary, to provide context, followed by discussion in small groups that focused on questions developed in advance, and concluded with summary discussion in plenary. The discussion questions, based on the survey responses, were designed to prompt discussion. Discussion groups were not asked to compose answers to the individual questions – these were intended to serve as food for thought – however, the questions provide a convenient structure for reporting the points that arose in small group and plenary sessions. The following summary of the discussions includes statement(s) of agreed positions where there was consensus; and where the groups did not reach consensus, the different points of view have been described.

### SESSION 1: HOW TO ASSESS CLIMATE IMPACTS OF FOREST-BASED BIOENERGY?

The survey included a number of statements that addressed LCA and its use to support decision-making and policy implementation and planning. There were diverging views among respondents concerning LCA-based decision support or assessments. Contentious issues include definition of spatial and temporal system boundaries, treatment of time, when ALCA vs. CLCA is most appropriate to use, and what other complementary analyses are needed. This session intended to follow up these questionnaire statements and clarify the different standpoints.

- *What methodologies can be applied in assessing climate effects of forest-based bioenergy?*
- *What methods are suitable for different purposes (e.g. national GHG inventory, product environmental labelling, sustainability certification, emissions trading, policy planning, policy implementation...)?*
- *How can ALCA/CLCA be used to assess forest-based bioenergy, and for what purposes?*
  - *What is the appropriate system boundary for each purpose?*
  - *Should we deal explicitly with uncertainty?*

Key points raised:

- The appropriate method depends on the purpose. Therefore, flexibility is needed to apply the right method to suit the situation.
- C-accounting for GHG inventory has a finite temporal boundary – e.g. 1 or 4 years – whereas LCA considers the whole life cycle of a product.
- Life cycle approaches are needed to assess the climate effects of bioenergy.
- LCA is a framework tool for quantifying the environmental impacts of a product or service, and can be used to assess the climate effects of bioenergy.

LCA is commonly applied to product-based analyses, where the functional unit (FU) is a unit of product (e.g. 1 MJ biofuel) or the service provided by a product (e.g. 100 km travelled by standard passenger vehicle). Nevertheless, one participant noted that LCA can also be applied more broadly, where the FU could be output from a whole industry sector or a policy target to promote the use of biofuels. The essential features that define an assessment as LCA are the consideration of the whole life cycle (i.e. from cradle to grave), and the comparison of alternatives based on an equivalent functional unit. LCA is intended to consider a comprehensive set of impacts (e.g. climate change, land use, resource depletion); when we apply LCA methods to assess climate change alone this is more accurately described as LCA for a single impact category climate change or more simply assessing the carbon footprint.

- Attributional LCA (ALCA) focuses on describing the relevant physical flows to and from a product or process, quantifying the emissions and removals along the product supply chain, using static models and average data for the system studied. Projected/proposed future data can be used for assessing impacts associated with products in future situations.
- Limitations of ALCA: this approach does not recognise that land resource is limited, it doesn't handle non-linearity and dynamic effects, it is sensitive to assumptions on allocation, and cannot appropriately consider system changes.
- Consequential LCA (CLCA) describes how relevant flows will change in response to possible decisions/actions. System boundaries in CLCA typically include the activities contributing to the consequences of the changes, which can take place within or outside of the cradle-to-grave system. Thus, system expansion, to avoid allocation in multi-product systems, is an inherent part of CLCA. CLCA has higher conceptual complexity, requiring consideration of aspects such as marginal production costs, elasticity of supply and demand, dynamic models. CLCA is sensitive to assumptions about substituted products. CLCA studies of potential effects of increasing use of bioenergy have placed emphasis on market-mediated effects, especially indirect land use change (LUC) arising from increased biomass demand for energy products. Competition has received more attention than complementarity between bioenergy and other biomass uses; in the case of forest bioenergy, primarily competition with pulp production. However, demand for bioenergy also creates incentives to enhance forest productivity and to implement silvicultural operations such as thinning that can increase output of both pulpwood and bioenergy feedstock.
- Considering that forest biomass production for energy is implicitly part of the forestry sector as much as of the energy sector, to fully understand the climate effects of forest-based bioenergy it is necessary to consider the whole forestry sector, energy sector and land use impacts, which requires consideration of economic relationships. Broad-scale climate and earth-system models are also needed to understand the forest carbon and atmospheric responses to changed management, climate change and disturbance regimes. Climate models and additional tools apply to impact assessment, rather than to inventory modelling. Some may call the method CLCA when it uses CGE models and IAMs, though others say that these models are used in conjunction with LCA to assess the whole system effects of bioenergy, rather than being part of CLCA. This is largely an issue of semantics; it is sufficient to call it a 'consequential' approach. We do not need to become engaged in the debate over definitions of ALCA/CLCA in order to find appropriate methods for assessing climate impacts of forest-based bioenergy.
- Some think that CLCA is too complex, particularly for routine application. Some think that there are insufficient data to run the models, though others assert we have the required tools and data. Several participants commented that the forest production data for many European (and other) countries are not accurate.
- Modelling, supporting CLCA relies on historic data for calibration – but the past may not be a good predictor of the future, e.g., innovations in land use and changes in legislation, trade patterns and policies can make future conditions drastically different to historic conditions.
- Standards are available for LCA (i.e. ISO 14040-44 series). There are several guidelines available for ALCA (that are not entirely consistent with one another), but there is little guidance on CLCA. Despite no explicit mentioning of the two alternative approaches to LCA modelling in the ISO standards, CLCA is arguably favoured, as system expansion is preferred over allocation as the method to deal with co-products. Market-mediated effects are typically excluded in ALCA (as it takes a static view), which limits the applicability of ALCA in supporting policy development. The European Commission's Renewable Energy



- Directive, however, adopts an ALCA approach.
- There is a tension between comprehensive modelling - that aims at a more detailed representation of the modelled reality - and simplified modelling frameworks that are more practical for people to undertake.
  - Socio-economic factors should not be neglected.
  - Some consider that ALCA is typically more precise than CLCA but also more inaccurate, as it excludes market-mediated effects. Others assert that, while uncertainty is greater for CLCA, "it is better to be approximately right than exactly wrong" particularly in policy development and in research studies. However, some propose that ALCA is adequate for many purposes, including policy development, and that ALCA and CLCA have different purposes that can be complementary.
  - ALCA may be relevant for the implementation of a renewable energy scheme, or for product labelling, as part of a policy that has been designed on the basis of more comprehensive (consequential) analysis, including assessment of flow-on indirect effects of the proposed scenario(s).
  - Adding an iLUC factor to account for GHG emissions from indirect land use changes is viewed as mixing ALCA and CLCA by some of the participants, and they maintain that this is inappropriate. The reasoning is that it violates the logic of ALCA, in which the sum of all product LCAs will give the total global impacts. In such a global analysis all ILUC would be accounted as dLUC for another product system. Thus, it results in double-counting if the same LUC is accounted for iLUC of one product system and dLUC of another product system at the same time. Participants did not agree whether this is, however, better than omitting iLUC in calculating impacts of bioenergy. Nevertheless, some considered that in (sectoral) policy applications, where it is clear that indirect emissions are not being counted elsewhere, it may be appropriate to include an iLUC factor.
  - There was strong agreement that consequential modelling should be used as the basis for assessing the climate effects of a proposed policy which would change the studied system.
  - Global models have inherent simplifications and high uncertainty. Regional models can be useful as they may be more accurate.
  - Uncertainty is important and should be explicitly quantified.
  - We should apply LCA with land as the functional unit to assess the best use of the land for climate change mitigation, including the alternative scenario of not harvesting forests.
  - Climate change needs urgent action. Policymakers need advice from scientists now. Policymakers need scientists to make judgements from available knowledge as to the best course of action now. Some considered that it is not helpful to say that we need more modelling and that uncertainty is high. However, some others considered that as available knowledge is subject to many uncertainties and there is incomplete understanding, it is not appropriate to advise policymakers to pursue bioenergy.
- *What metrics can be used to quantify climate effects of bioenergy?*
    - GWP and GTP (see footnote 3) give different information, and both may be useful. GTP is more readily understood and linked to climate change effects, but it gives information only for a specific point in time and for one facet of climate change, whereas GWP gives information on the absorbed energy accumulated into the climate system over the studied time horizon. Thus, the choice of the more appropriate metric depends on the purpose of the study. An example of a modified GWP metric is  $GWP_{bio}$  that has been proposed for assessing bioenergy.
  - *What reference system/baseline/counterfactual should be considered?*
    - Many agree that bioenergy should be compared with reference system to quantify the effects of bioenergy, but some do not support need for comparison with a counterfactual

scenario (no-bioenergy forward projection), as they believe the historical situation is the appropriate baseline.

- *Should the forest reference system include expectations of management responses, and/or natural regeneration, with/without natural disturbance?*
  - Counterfactual reference land use systems are required for CLCA. There is no consistency between ALCA guidelines with respect to inclusion of a reference land use. It is debated whether a counterfactual baseline is required for ALCA; many ALCA studies have excluded a counterfactual baseline.
  - When comparing forest bioenergy to a situation in which the studied bioenergy is not produced, reference scenarios may include energy system, land use, and building materials. It should be noted that in some cases, bioenergy may replace other renewables instead of fossil fuels.
  - The counterfactual land use reference should consider the forgone future growth of the forest within the given time horizon (dynamic baseline)
  - A no-disturbance counterfactual should acknowledge the issue of saturation, and impacts of climate change on productivity and incidence of disturbance events.
  - Several reference scenarios should be considered, as we cannot be 100% sure of the future. Presenting several scenarios avoids interpretation that modelled results are "right".
- *At what scale should the analysis be applied (spatial and temporal)? (Stand, product, combustion facility, policy/program, forest estate, region, nation, globe; product life cycle, scheme life?)*
  - The relevant scale depends on the purpose of the assessment.
  - Consequential modelling to inform policy may require global or at least regional scale models.
  - Amongst the workshop participants there was general agreement that a long-term perspective (at least several rotations) and broad geographic scale is required to comprehensively understand the impacts of forest bioenergy utilisation, to inform policy development. Regional differentiation is significant and should be captured.
  - There is difference of opinion on the significance of stand vs estate scale assessment.
    - One point of view is that if a forest stand is managed as part of an estate, comprising stands of different ages, then the carbon stock change across the whole estate is the relevant figure for assessing the land use emissions or removals due to the bioenergy system. (Commonly, harvest of the stands is scheduled to provide a continuous supply of wood, and the annual cut is equal to or less than the growth across the whole estate, thus the absolute carbon stock across the estate is constant. The growth in other stands balances the loss of carbon when a stand is harvested and vice-versa.) The product system includes the entire estate. The carbon in the biomass harvested is sequestered again within a year.
    - The alternative perspective is that the growth in one stand cannot be considered to balance the carbon loss associated with harvest of another stand, as that growth is attributed to that stand. Each individual stand harvested should be considered separately. The product system includes only the harvested stand. The carbon in the biomass harvested is sequestered over the rotation cycle.
  - For assessment related to a particular product or actor, the scale should relate to the associated area of influence.
  - For temporal analysis, inventory should state the timing of emissions and removals so that the impact assessment phase can quantify the influence of this timing on climate

impact. But note that a standard method to assess effect of time has not been agreed upon (amongst workshop participants, nor in the broader scientific community).

#### **Summary of Session 1 discussion:**

- The most appropriate method depends on the purpose (eg product label, national policy development).
- A consequential approach (including indirect flow-on effects) is required if the purpose is to support policy development, or research aiming to assess the consequences of changing the use of bioenergy.
  - Need to take market and climate processes and land use systems into consideration.
- Need to consider multiple reference scenarios – not just one counterfactual.

## **SESSION 2: INTERACTION BETWEEN BIOENERGY AND OTHER WOOD PRODUCTS MARKETS, INCLUDING CONSEQUENCES FOR FOREST CARBON STOCKS AND FLOWS**

The survey included statements about interactions between bioenergy and other wood products markets and sizes of different markets, which elicited mixed comments.

Some propose that bioenergy feedstocks should be restricted to residues and end-of-life wood products due to perceived higher GHG savings per unit biomass, or that forest products that deliver higher GHG savings should be prioritized.

The current use of biomass for energy is about half as large as the industrial roundwood production (in the order of 10 and 20 EJ/yr, respectively). Current 'modern' bioenergy thus is one order of magnitude smaller than future possible bioenergy demand, as estimated in energy system scenarios exploring pathways to achieve ambitious climate targets, e.g., 2 °C target (e.g. IPCC AR5, Global Energy Assessment). This potential 10-fold increase in biomass demand is used as an argument against restricting forest biomass use for energy to residue/waste flows and cascading uses, since it would limit the contribution of forest biomass to future primary energy supply to an almost insignificant level in most countries.

The argumentation of some goes on to say that policies should incentivize forest management planning towards supplying much larger biomass volumes in the future, and that this will have as one consequence that forest carbon stocks in general become larger (because additional forests will be planted) and that the critical question is not forest carbon balances but soil, water resources and wider ecological concerns.

Under the alternative perspective, that proposes limiting feedstocks, forest bioenergy supply will remain small compared to prospective bioenergy demand; other biomass sources (e.g. short-rotation coppice, perennial energy grasses) need to be developed, and more non-biomass renewable energy technologies will need to be implemented. Forests would be managed to maximise carbon stocks, using less intensive harvesting compared to management maximizing biomass yields. This perspective emphasises a trade-off between these two management strategies.

- *Should policy prescribe which forest biomass categories should be used for bioenergy? What criteria would be used as the basis for such a prescription?*
  - Most groups felt that policy should not prescribe categories of forest biomass that are acceptable for bioenergy; but it was agreed that there needed to be an objective, scientific basis for determining sustainable harvest utilization levels. The preferred approach was policy that would define the sustainability criteria (e.g. GHG balances, soil, water, biodiversity, social and economic values) that forest bioenergy systems must satisfy, and allow feedstock systems to develop to achieve those values using whatever mix of forest components that are appropriate in a local and regional and operational- and market-specific context.
  - It was generally agreed that it is uncertain whether society can sustainably reach a global bioenergy deployment target of 200 EJ. However, workshop participants agreed that research should continue to determine the sustainable limits to forest bioenergy deployment according to generally agreed sustainability standards, and focus effort on energy system reform to replace fossil fuels.
  - Deployment of forest bioenergy to achieve, for example, a 200 EJ scale, has

unknown consequences for land use and land use change, which need to be better considered in sustainability criteria.

- *Should we instead let the market decide? Is it a problem if "stemwood" is used as biomass feedstock? How would "problematic stemwood" be defined? Is the problem a climate problem or is it rather the general problem of market distortion and economic inefficiency?*
  - It was generally agreed that markets are not perfect systems to satisfy multiple goals, and that the policy approach mentioned above (set standards for sustainable bioenergy systems and monitor and enforce the desired outcomes) is preferable. It was agreed that GHG emissions and associated climate change is THE problem, and that reduction in fossil fuel use will need various forms of policy-driven incentives, but that because incentives can distort markets and result in unintended consequences it is better to focus on the desired outcomes and allow entrepreneurs to find solutions. This multiple approach – allowing markets to do what they do best, coupled with policy incentives and effective sustainability standards – appropriately builds a diversity of tools to achieve the desired multiple outcomes.
- *Do diverging answers above (importance of regulation vs market) result from diverging expectations about the effectiveness of different governance (e.g., legislation, best management practices, certification systems, standards) in promoting optimal outcomes?*
  - The workshop discussions were effective in identifying the basis for diverging values and preferred solutions. It became clear that the views on overall amount of forest bioenergy "needed" in the future (e.g., to meet a 2 °C target) and the time perspective (short-term GHG reductions vs. mid- to long-term) are key. Common ground was found in recognizing that multiple approaches are necessary, as noted above.
- *How are forest carbon stocks affected by an increase in use of forest biomass for energy, and what are the most important determining factors?*
  - It was generally agreed that there is no simple, single answer to this question; the relationship between forest bioenergy production systems and carbon stocks, and resulting climatic effects, are site- and operational system-specific; they need to be quantified at the landscape scale and over long enough periods of time to determine when, if ever, the system is sustainable and adequate to reduce GHG emissions relative to the reference fossil fuel system it is designed to replace. It was acknowledged that management practices can enhance forest C stocks. Some suggested that this could overcome the impact of harvest on C stocks. Others doubted the magnitude of this effect, and questioned the validity of including it in the modelling of climate effects of bioenergy.

### SESSION 3: ROLE OF BIOENERGY IN NEAR-TERM CLIMATE TARGETS

The pre-workshop survey included statements on approaches to deal with bioenergy in respect of near-term climate targets, recognising that some bioenergy systems may not contribute to GHG reduction in the short term. The survey raised the possibility of applying a risk-based approach to distinguish bioenergy systems that give greater contribution to the specific policy objective, e.g., near-term net GHG emission reductions. These concepts received mixed reactions.

- *If bioenergy systems use biomass from managed forest landscapes where harvest does not exceed the annual increments<sup>4</sup>, can one, for simplicity, exclude biogenic carbon in LCA studies?*
  - Some participants tended to agree with this approach, but most further agreed that this could be applied only in limited circumstances: biogenic carbon fluxes can be omitted from (A)LCA only where sustainable forest management (SFM)<sup>5</sup> is applied, and only “for information”, not for policy development (which would require CLCA), only as a first-order approach, and most importantly, only for analyses where a counterfactual scenario is not considered. It was pointed out that although a “growth to drain” ratio (GDR)<sup>6</sup> above 1 indicates that absolute C sequestration exceeds removals, this approach ignores possible “forgone sequestration” in comparison to a counterfactual forest management scenario.
  - Other participants pointed out that it would be insufficient just to look at the forest side: competition for wood for energy vs. other material uses and market effects need to be evaluated. In other words, not only C stocks in the forest but also flows of C in materials need to be accounted for; but these interactions are still poorly understood, and good data are not available.
  - In cases where co-production needs to be handled (e.g., when quantifying environmental effects of residues that are co-produced with sawlogs) exclusion of biogenic C fluxes is essentially equivalent to allocating the C flux according to the C content. This would introduce an inconsistency in method, if a different approach to dealing with co-production is applied in the study for other flows.

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<sup>4</sup> Annual increment is defined as “the average growth per year of a tree or stand of trees at a specified age”. The term used to refer to a sustainable harvest level is Annual Allowable Cut (AAC). In many countries over the world, especially those with high shares of state-owned forests, the AAC is determined during development of a management plan by e.g. a department of natural resources and is legally binding. Its aim is to ensure the long-term sustainability and productivity of forests.

<sup>5</sup> Some people define Sustainable Forest Management (SFM) to include maintenance of C stocks, thereby ensuring that forest products are “C neutral” because there is no loss of forest C. However, maintenance of C stocks is not a universal requirement of SFM, and some accept that C stock changes are possible in a sustainably-managed forest, for example when forest management changes, such as changing rotation length.

<sup>6</sup> The growth to drain ratio (GDR) is the ratio between the annual increment and the annual removals from a forest. It is typically measured on a landscape level (e.g. a county, state or province). A GDR above one generally only refers to merchantable volume of crop trees, but here is meant to imply a net sequestration of carbon.



- *Should near term targets focus on reducing emissions or encouraging expansion of renewable energy technologies?*
  - *What are the effects of near- term climate targets (GHG reduction with/without accounting for forest carbon, renewable energy policies, etc.) on the development of the bioenergy industry?*
  - Participants in several groups pointed out that it is hard to differentiate between near term and long term, but that in any case near-term targets should not compromise long-term targets. To some participants, this implied the recognition that establishing a bioenergy system may incur up-front emissions, but that this “GHG investment” may be a justified use of “emissions space”<sup>7</sup>. However, others argued that one should not invest in biomass to achieve short-term renewable energy targets, as it may later be found that it does not contribute even to long-term climate targets. Therefore, some participants favoured an approach in which policies stimulated the use of woody biomass, even if there was a risk of forgone sequestration for the next decade or so; others argued that policies should not incentivise biomass for energy at all until the GHG effects are fully understood.
  - The rebound effect was mentioned: by stimulating bioenergy, the price of fossil fuels might drop, leading to increased demand, and ultimately cause additional GHG emissions, but these may then also be mitigated by additional policies (e.g. taxes on fossil fuels, CO<sub>2</sub> certificate prices in emission trading).
  - In two groups the GTP and GWP (see footnote 3) were compared (see also sessions 1 and 4). The general consensus was that both are useful and more than one metric should be applied. GTP is further along the cause-effect chain for climate-change impacts as it measures temperature changes instead of radiative forcing which is the basis for GWP. However, unlike GWP, GTP captures impacts at a specific point in time and thus is less closely related to cumulative impacts, such as sea-level rise, compared with instantaneous or direct impacts, such as heat waves and other extreme weather events.

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<sup>7</sup> Berndes et al. proposed “GHG emissions space” as a concept to encourage consideration emissions management in the context of longer-term temperature targets. Focusing on the accumulated emissions up to a given year, society may decide to invest a portion of the emission space, allowed within the GHG target, on the establishment of renewable energy systems. Short term emissions resulting from the establishment of bioenergy systems may be justified as investment in creating a low-carbon energy system. <http://www.ieabioenergy.com/publications/bioenergy-land-use-change-and-climate-change-mitigation/>

- *How should we consider bioenergy in GHG accounting for near-term targets?*
  - *Should we count (some) forest bioenergy as carbon neutral?*
  - *Does sustainable forest management (SFM) alone (i.e. without any GHG accounting) address the concern about forest carbon losses? If yes, should SFM be voluntary (encouraged by guidelines, standards, certification) or mandatory? Do we need traceability?*
  - No consensus was reached whether some types of forest bioenergy could (as a simplification) be counted as carbon neutral. However, most participants tended to agree that SFM certification alone (without GHG accounting or the additional AAC/GDR**Error! Bookmark not defined.** criterion, see footnotes 4 and 6) cannot assure carbon neutrality. In addition, only a very small share of the world's forest are SFM certified, and as SFM certification can never be driven by bioenergy alone, a mandatory SFM requirement for biomass would be hard to implement in practice.
- *Acknowledging uncertainties and knowledge gaps, is it useful to develop a "risk-based" approach to identify feedstocks that are compatible with short term targets?*
  - *If YES: how to define a methodology to "categorize" feedstock with lower/higher climate benefit? Should criteria relate to near term and/or long term climate effects?*
    - *Considering long term total ecological effects or just climate effects?*
    - *Can this methodology be based on ALCA? What data or lookup variables would be integrated in the methodology?*
  - *If NO: what alternative approach should be used to encourage adoption/ avoid disincentives to systems that offer benefits in long term but not short term?*
  - Several groups found that a "traffic light" for distinguishing "good" bioenergy systems has some appeal, but they also raised limitations and draw-backs:
    - 1. There is a risk that simplifications may give incentive to a system that is found not to be beneficial to climate when more knowledge becomes available and complete assessment is undertaken. Thus, a risk-based approach should have a clear time horizon, and it should be designed to allow for learning and be flexible, i.e. include the possibility to be adapted based on new insights;
    - 2. Spatial-scale disaggregated / regional differentiation would be needed;
    - 3. Implementation of such a system may be difficult due to disagreement by NGOs and/or industry;
    - 4. Such a risk-based approach should not only consider climate effects but also consider other environmental concerns (e.g. water, soils, biodiversity, etc.);
    - 5. In several groups, it was pointed out that natural disasters (especially fires and insect infestations) have a significant effect on forest GHG emissions, but it was unclear if and how this would be covered by a risk-based approach.
  - Other participants thought that a risk-based approach was not possible, or should at least also include indirect effects, e.g. response from markets to additional biomass demand.

## SESSION 4: CONTRIBUTION OF BIOENERGY TO LONG-TERM CLIMATE OUTCOMES

This session discussed long-term climate impacts of bioenergy. The issue was raised also in the survey distributed to participants: modifying the current energy system while focusing only on near-term policy goals may block solutions that could be beneficial in the longer term. This is an important issue for policy makers, whose decisions on short and long-term policy objectives have strong influence on future investments.

The IPCC concept of slow (mainly fossil fuel pools) and fast (e.g. biomass growth and decomposition or combustion) carbon cycles was introduced at the beginning of the session. According to the science presented in the latest IPCC AR5 report, the main problem of climate change lies in the continuous shift of carbon from slow cycle pools to the fast cycle, mainly via fossil fuel combustion. However, deforestation and permanent land-use changes are also contributing to this process, with significant impact on climate change. On the other hand, forests have an important role in removing significant amounts of C from the fast cycle of the biosphere and storing it in slow cycle pools (such as humus and biochar).

The first discussion point proposed in the workshop background paper dealt with the long-term climate benefits associated to bioenergy:

- *If a bioenergy system delivers a benefit only in the longer term, is this a reason to discourage its implementation?*
  - *How long is an appropriate pay-back time?*
  - *Is 20 years too short, too long, or is payback irrelevant?*
- *If long payback is acceptable (or irrelevant), how would you explain this point of view?*
  - There was general agreement that bioenergy, if it replaces fossil fuels, may be an “investment” for the long-term future as a complementary strategy to reduce long-term climate change impacts. However, some experts also pointed to the significance of short term emission reduction targets (in parallel to investments in future energy systems), which may discourage bioenergy implementation. It was noted that long- and short-term assessments should not be mutually exclusive, and the timeframe of the assessment will influence which strategy appears preferable.
  - According to the IPCC AR5, the climate system response is influenced mainly by the cumulative carbon emissions, largely independently from the trajectory of such emissions. However, it was noted that achievement of ambitious mitigation targets, such as 2 °C target, requires deep cuts in emissions within a few decades, and some participants suggested that bioenergy with relatively long pay-back time is not consistent with reaching this target. In addition, timing of emissions affects the timing of temperature change, which is important for adaptation of human and natural ecosystems. And, further, the inertia of economic and energy systems necessitates short-term emission reduction targets, as well as meaningful trajectories for ongoing reduction.
  - Delaying emissions (through temporary storage in wood products, for example) could be beneficial for climate change, “buying time” for energy system transformation, and facilitating adaptation. However, background concentrations

in the future might be higher and ocean uptake mechanisms weaker, so that future emissions have greater impacts than emissions today - thus implying a negative discount rate.

- Some noted that it could be risky to overlook short term effects on emissions because some of the effects of rapid mobilisation of biospheric biomass for energy might be irreversible (e.g. biodiversity losses due to sharp temperature increase).
  - Some commented that natural perturbations and disturbances mobilize the carbon in forests and biosphere even when humans do not utilize the forest.
  - Some suggested that it may be more effective in terms of climate-change mitigation to actively manage forests to produce products and fuels rather than conserving forests for sequestration alone, because sequestration is finite (equilibrium will be reached), sequestered carbon is vulnerable to loss through natural disturbances, and the use of wood for materials typically replaces more GHG-intensive materials.
  - Even within the fast cycle, temporary storage and delayed emissions (i.e. cascaded use), compared with immediate biomass combustion, need to be taken into account and assessed appropriately.
  - Furthermore, most IPCC scenarios forecast an overshoot of the carbon budget before the end of the century which would mean that carbon-negative technologies will be necessary to meet the target. The only two options suggested as viable and cost-effective at large scale in the near term are afforestation and bio-CCS.
- *Metrics: is it possible (or appropriate) to apply different metrics (e.g., GWP, GTP) in the analysis?*
    - Experts agreed that both GTP and GWP metrics are useful. Some argued that GTP seems more appropriate for climate change assessment in LCA than GWP. All agreed that more than one metric should be utilized, as no single metric captures all the important aspects of climate change.
    - Responding to the preparatory survey, one expert underlined that, according to a recent publication, the use of GTP100 might lead to significantly higher costs for reaching the 2°C target, when compared to the use of GWP100<sup>8</sup>.
    - The use of multiple metrics may offer advantages in reflecting different perspectives.
    - In the IPCC AR5 report, new metrics, namely GWP<sub>bio</sub> and GTP<sub>bio</sub> developed and applied to CO<sub>2</sub> emissions from bioenergy are presented.

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<sup>8</sup> Ekholm et al. 2013: Robustness of climate metrics under climate policy ambiguity. Environmental Science & Policy. Volume 31, August 2013, Pages 44–52

- One participant argued that when bioenergy is used for climate change mitigation, the same metric should be applied for fossil fuels and bioenergy. Fundamentally, the emissions and climate impacts from bioenergy and reference energy system should be assessed consistently.
  - Some experts argued that payback time is not a useful concept in addressing mitigation effects, and the main relevant issue is how to reverse forest degradation and deforestation trends in some countries, preserve C stocks, and consider also other ecosystem services.
- *What baseline/counterfactuals are relevant?*
  - This was not discussed in detail during the workshop, but the topic was presented for consideration in the preparatory survey. According to the survey, most respondents agreed that changes in forest carbon stocks and the full range of forest products should be compared between bioenergy and counterfactual scenarios, in order to understand the climate effects of forest bioenergy. It is acknowledged that this could be challenging due to uncertainties related to identifying the counterfactual scenario in consequential modelling (cf. Session 1 summary). However, several respondents voiced the opinion that counterfactual scenarios are not needed to assess climate effects for forest bioenergy. These experts assert that analysis of the absolute emissions and removals from an individual bioenergy system is important, and that it is not necessary to compare the bioenergy system with a situation in which bioenergy is not produced, in order to assess the climate effects of bioenergy. They acknowledge that comparative analysis of different scenarios is also of interest.
  - Some experts agreed that the present BAU counterfactual energy scenario (especially for electricity) is coal, and bioenergy compares favourably. However, future energy mixes are uncertain and it is difficult to define an appropriate counterfactual for long term analysis. In the future, other renewables might provide even better solutions, and the climate change effects of bioenergy are uncertain. But even in this case, forests will continue to be an important source of raw materials for other purposes, with bioenergy as a by-product continuing to provide part of the energy mix.
  - Several counterfactual scenarios should be considered in modelling, and the “no-harvest” option should also be included, to provide complete understanding of the climate effects of alternative forest management scenarios and the use of forest products.
- *How to consider time, and uncertainty of development pathways (e.g., energy systems)?*
- *How to include non-GHG climate forcers in the analysis?*
  - These questions were not addressed in detail during workshop discussions. Many of the responses to the survey agreed that other non-GHG climate forcers should be addressed, while recognising lack of data, uncertainties and difficulties in assessing their impact in climate models. More research is needed before implementing them in analyses.

#### **Additional discussion points:**

- *Forest management strategies*
  - The discussions about slow and fast carbon cycles pointed to an important question about the optimal management of forests and sequestration vs substitution. Is it better to reduce emissions in the slow cycle by using bioenergy, or maximise the uptake of the CO<sub>2</sub> in the fast cycle of the terrestrial biosphere?
    - The answer probably depends on what energy source is used if biomass is not included. The experts agreed that, ideally, a forest management strategy that maximizes carbon accumulation in the forest and at the same time optimizes extraction of wood should be identified and promoted. Sustainable Forest Management alone does not necessarily guarantee “constant or increasing carbon stocks”, and the optimal solution would be to have a mix of optimal forest management and afforestation (and increased efforts to curb deforestation).
    - The use of wood products which generate residues for bioenergy during manufacture, substitute for energy-intensive materials, and may be used for bioenergy at the end-of-life (cascading), should be promoted.

### **SESSION 5: KEY MESSAGES, GOVERNANCE, OTHER ENVIRONMENTAL SUSTAINABILITY CONSIDERATIONS, RESEARCH/DATA NEEDS, AND OPEN ISSUES**

- *What other (non-climate) environmental issues should be recognised, and how should these be considered in policy development?*
- *What are the key messages for policymakers, from the earlier sessions?*
- *Which primary data are needed (e.g., on prices, flows, uses, availability etc.), and where can we get reliable data (updates on recent studies/databases/statistics etc.).*
- *What research could be undertaken to address identified knowledge gaps and investigate divergent claims with regard to climate effects of forest bioenergy?*
- *What are the priority needs for developing statistical data sets and other information sources to allow a better assessment of the climate effects of forest bioenergy?*
  - Most of the discussion focussed on the research needs, as previous discussion had demonstrated that there was limited agreement on key messages. Those points on which there was consensus are highlighted in the “workshop statement”.
  - The scientific base to inform decision-makers should be expanded beyond product-based LCA, considering the role of integrated modelling, global monitoring systems and publicly available databases.
  - The following specific research needs were identified:



- Studies clarifying how the energy sector, forest industry and forest management planning respond to changing forest product markets, including bioenergy markets;
  - Good empirical data on forest product supply and demand and land use, at scales of resolution that enable comprehensive analyses of alternative scenarios;
  - development of stronger links between the forest/bioenergy systems modelling and the earth systems/ climate science/ integrated assessment modelling efforts;
  - multi-disciplinary research into the interpretation and translation of insights from scenario modelling into policy guidance for management of land use and energy systems.
- As bioenergy policy is currently being developed, for example in Belgium, Denmark, Germany, the Netherlands, the UK and the USA at national and state levels, the international community (including scientists, NGOs and policy-makers from government and industry) should prioritise allocation of resources to conduct the necessary research and risk-analyses that would lead to deployment of sustainable bioenergy systems.

## **Summary of different perspectives on the role of forest-based bioenergy in climate change mitigation**

Areas of divergence identified included:

- the appropriate scale of bioenergy;
- acceptable bioenergy feedstocks (restrict to wastes? and residues?; include purpose-grown biomass?);
- the relevant time scale over which to evaluate the effects of bioenergy (is short payback time necessary?); and
- whether it is appropriate to use simplified assessment approaches to identify acceptable bioenergy systems that should be supported by policy incentives, in the inevitable absence of complete scientific understanding.

Discussions identified the following as some of the considerations leading to divergent perspectives:

- Differing world views on the importance of conserving biodiversity, and the risks to biodiversity from promotion of bioenergy;
- Differing expectations that effective technological solutions to climate change will be found and deployed;
- Different views on the effectiveness of governance mechanisms (regulation or voluntary approaches) in managing the broader environmental and social impacts of bioenergy;
- Different perceptions of the adequacy and accuracy of models used to inform our understanding of the effects of bioenergy, particularly with respect to economics and impacts of policy.

Interestingly, there were totally divergent views on the application of the precautionary principle to forest bioenergy: Some participants thought that action on climate change is such an urgent need that bioenergy should be expedited, despite uncertainties in our knowledge of the exact climate effects of bioenergy. Others expressed the opposite view that, due to our incomplete understanding of the climate effects of bioenergy, it is too risky to promote it.

## Appendix A Workshop Agenda

### DAY 1

09:30 – 10:00 Welcome and roundtable with brief introductions of participants

10:00-11:00 Outcomes of the survey distributed to participants (main points of agreements vs. divergence)

11:00 – 12:00 “World café” session on climate impacts (focusing on statements with diverging views from the survey)

12:00 -12:15 coffee

12:15 – 12:45 Report back in plenary

### LUNCH BREAK

13:45 – 15:15 “World café” session on GHG reduction targets

Coffee break

15:30 – 16:15 Report back in plenary

16:15 – 17:00 Discussions on Session 1

17:00 – 18:00 “World café” session on resource competition and interactions between forest sector and other industrial sectors

Conference Dinner

### DAY 2

09:00 – 10:00 Report back in plenary on “resource competition”

10:00 – 10:30 Discussions

Coffee Break

10:45 – 12:30 “World café” session on long term climate policy

Lunch break

13:45 – 14:15 Report back in plenary

14:15 – 15:30 “World café” session on remaining open issues identified via the survey (including discussions on wider environmental issues, led by EEA)

Coffee break

15:45 – 17:00 Report back in plenary, final discussions, wrap-up and end of the meeting

## Appendix B Survey of participant views on key statements

This workshop on climate effects of forest-based bioenergy (see background document) builds upon a series of previous expert meetings and the resulting agreements and statements<sup>9</sup>. These meetings underlined that the rapid growth in the use of bioenergy - and in particular wood energy - necessitates an *improved* understanding of

- (i) how forest carbon stocks are affected when increasing volumes of forest biomass are used for bioenergy, and
- (ii) how changes in forest carbon stocks in turn affect the contribution of forest bioenergy to short and long term climate policy objectives.

However, previous meetings also highlighted areas where participants diverge in their views.

The objectives for the workshop are to *facilitate dialogue* between scientists on the topic, to advance scientific *understanding of and clarify* divergent views on the role of forest-based bioenergy in climate change mitigation. The focus will be on empirical data and scientific and technical issues in modelling and C accounting methodology, rather than debating policy options, though some discussion on implications of research for policy formulation is anticipated.

The workshop focus is on better understanding the climate mitigation potential from developing forest bioenergy. However, as stated in the background paper, the use of forests for energy (or other purposes) has wider environmental implications (e.g. on soil, water, biodiversity, local air pollution etc.). Exploring options to address these issues will be a *sideline* of the workshop, though, and will be discussed with regard to future joint activities.

In order to *facilitate progress in the discussions* and focus on concrete questions related to climate effects of forest-based bioenergy, you are kindly asked to take position on the following statements and key questions compiled by IINAS based on discussions during and outcomes of the series of workshops mentioned above. The statements do not represent agreements from these workshops, and do not necessarily reflect the views from the workshops organizers, nor IINAS.

**Please indicate (and come prepared to discuss) the degree to which you agree or disagree with the statements listed in the following, and substantiate arguments in case of disagreement or partial agreement. Please return your response by 30th of April to Luisa Marelli ([luisa.marelli@jrc.ec.europa.eu](mailto:luisa.marelli@jrc.ec.europa.eu)) and to Uwe Fritsche ([uf@iinas.org](mailto:uf@iinas.org)), and mark each statement with:**

**3 = agree; 2 partially agree; 1 = don't know/undecided; 0 = disagree;**

**and provide short explanation where you do not agree. If an important issue of the workshop theme is not reflected in the statements provided, please include it in your response.**

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<sup>9</sup> Most recent EEA/JRC/IEA/IINAS meetings held in Arona (Italy, July 2013 - documentation forthcoming), Savannah (Georgia, October 2013, <http://www.pinshot.org/doc/468/>) and Copenhagen (December 2013 - documentation forthcoming).

IEA Bioenergy ExCo statement: <http://www.ieabioenergy.com/publications/on-the-timing-of-greenhouse-gas-mitigation-benefits-of-forest-based-bioenergy/>.

IEA Bioenergy Task 38 workshops: Vienna (November 2012), Argonne (USA April 2012), Brussels (March 2010), see <http://www.task38.org>

### Background on forest-based bioenergy and associated climate effects

1. Analysis of climate effects of forest bioenergy needs to consider changes in forest carbon stocks and the full range of forest products, in both bioenergy and counterfactual scenarios.
2. Forest product output and forest carbon stocks are determined by the forest structure (e.g., age distribution, species composition), natural abiotic/biotic forces and character of the associated forest industry (e.g., ownership, management practices, product portfolio). Since conditions vary considerably around the world, analyses must reflect the specific context (e.g. specific growth and decay rates, residues combustion at roadside, expected future forest product markets, etc.).
3. There is evidence that a *fraction* of pellets imported into the EU as well as of pellets produced within the EU comes from *non-residual* wood. Still, there is a lack of statistical data on the type (e.g. lower/higher quality roundwood, residue, wastes) of feedstocks used for bioenergy within and outside Europe, including for domestic and other small-scale uses.
4. Climate forcers other than long lived GHG (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>) such as albedo, black and organic carbon, evapotranspiration, ozone precursors etc. may also have important influences on climate effects of forest-based bioenergy. Ideally, assessments should include these factors, recognizing regional differences and counterfactuals.

### Carbon accounting and policy implementations

5. LCA-based decision support or assessments related to specific products (e.g. product carbon footprint) should follow an *attributorial* modelling approach, i.e., attributional LCA (ALCA).
6. In ALCA the decisions, actions or products analyzed are assumed to have no consequences *outside* the decision/action context, i.e. not influence available production *system*. As decisions or actions of forest managers for forest bioenergy typically concern areas capable of providing a steady flow of extracted/harvested woody material, ALCA should be done at *landscape level*.
7. To assess impacts of a given action through LCA, accounting should start at the time when the decision for action is taken, i.e. for bioenergy from existing forests this is the time of additional biomass extraction/harvest to provide bioenergy feedstock, or the time that managements was changed in other ways to respond to bioenergy demand (e.g., changed thinning frequency and extent, extra fertilization).
8. In the absence of adequate data to fully describe climate impacts of forest bioenergy use, a *risk-based* approach could be developed as a proxy applicable for

policies favoring bioenergy products and systems that give greatest contribution to the specific policy objective, e.g., near-term net GHG emission reductions. This approach would provide a *relative* assessment of different forest bioenergy products and systems based on the (qualitatively expressed) probabilities and scales of climate impacts (biogenic C included). The approach should be based on clear metrics and transparent background data, taking into account the range of settings for woody bioenergy.

#### Policy planning context

9. ALCA (e.g. product life cycle GHG emissions) or calculation of payback times *is inadequate* to support *broader long-term policy* decisions (such as setting bioenergy production targets), as it does not internalize effects of bioenergy demand on the forest sector and on other sectors of the economy.
10. Climate and energy policies aim at *change* in the energy and other sectors, e.g. agriculture and forestry. When LCA is used to support policy development (e.g. raw materials strategies, technology scenarios, policy options) a *consequential* modelling approach should be used (CLCA).
11. In elaborating policy scenarios, the *range* of possible market-mediated impacts should be analyzed (diversion of wood from other energy and materials sectors, land use changes, changes in forest management practices, etc...) and related consequences considered in the analysis.
12. Policies promoting specific energy options based on their *near-term GHG* balance may prevent investments in systems that are considered compatible with longer-term *climate stabilization* targets.
13. Development of climate change mitigation strategies in the forest sector needs to recognize the possible C sink/source function of growing forests and the full range of forest products, since other forest based industry sectors (biobased materials, biochemicals, building sector, pulp and paper, panel industry) *may* provide better GHG balance per unit wood used.
14. A better understanding of resource competition and synergies within the forest and between other sectors is needed. Cascading use of forest biomass often has favorable GHG balances: if forest products such as paper, board and construction wood are used as bioenergy feedstock at the end of their service life, the storage of carbon in these products contributes to climate benefits of the whole systems.
15. Availability of residual wood streams (forest logging residues, secondary and tertiary forest products, manufacturing residues and unmerchantable wood) is



dependent on non-energy forest products markets, which are small compared to anticipated bioenergy demand.

16. In assessing policy options, scenarios should include forest management changes which may result from policy decisions to stimulate bioenergy production (e.g., fertilization, intensified thinning). Assessment of the effects of policies should be performed at landscape, regional or global scale (as opposed to stand level) depending on the expected geographical relevance of the policy.
17. Besides Global Warming Potential (GWP), Global Temperature Potential (GTP) and/or other metrics should be considered, and should reflect the time horizon of climate targets (e.g. "limit to 2 °C increase by 2100").

**Further questions – (simple “yes”/“no” answer is also possible)**

18. At the point of combustion, burning wood emits more GHG per unit *heat released* than burning fossil fuels (except lignite). Whether burning wood emits more GHG per unit *useful energy* than burning fossil fuels depends on the efficiencies of biomass and fossil fuel conversion.

18a Is it adequate to assess climate effects of forest bioenergy considering just the point of combustion?

18b Or should the whole forest systems, including products pools, and energy system responses be considered?

19. If burning wood emits more GHG per unit useful energy than burning fossil fuels, must then the feedstock production improve the GHG balance, i.e. reduce GHG emissions or increase forest C stocks compared to the counterfactual (no bioenergy) scenario, to achieve a net climate benefit from the forest bioenergy system?
20. Converting forests into bioenergy supply systems can cause loss of carbon stock in forests that needs to be compensated by avoided fossil fuel emissions before the system delivers net GHG savings. Should “acceptable” payback times be less than 20 years?
21. In large managed forest estates, management activities in one stand are coordinated with activities elsewhere in the landscape with the purpose to provide a steady flow of harvested wood. While carbon stock decreases in stands that are harvested, carbon stock increases in other stands resulting in landscape-level carbon stock that fluctuates around a trend line that can be increasing or decreasing, or remain roughly stable. Do you agree that forest biomass can - for simplicity - be considered CO<sub>2</sub>-neutral (with regard to biogenic carbon) if stemming

from a managed forest landscape that is harvested on a sustained yield basis, i.e. if the whole forest carbon stock is not decreasing?

22. If bioenergy systems use biomass from managed forest landscapes where harvest does not exceed the annual increments, can one for simplicity exclude biogenic carbon in LCA studies?

23. Would the decision to exclude biogenic carbon in such LCA studies need documentation showing that the implementation of the bioenergy system is not expected to significantly alter the trend line for landscape-level carbon stock? What type of documentation - e.g., forest data at appropriate scale, compliance with SFM principles, information about relevant national legislation including its effectiveness in promoting sustainable use of forest resources?

## Survey results

### Summary of results:

- 33 responses (>50% of participants)
- Many supporting comments
- Topics for the parallel sessions identified based on diverging views in the survey
- Some key comments used as introductory material for the parallel sessions

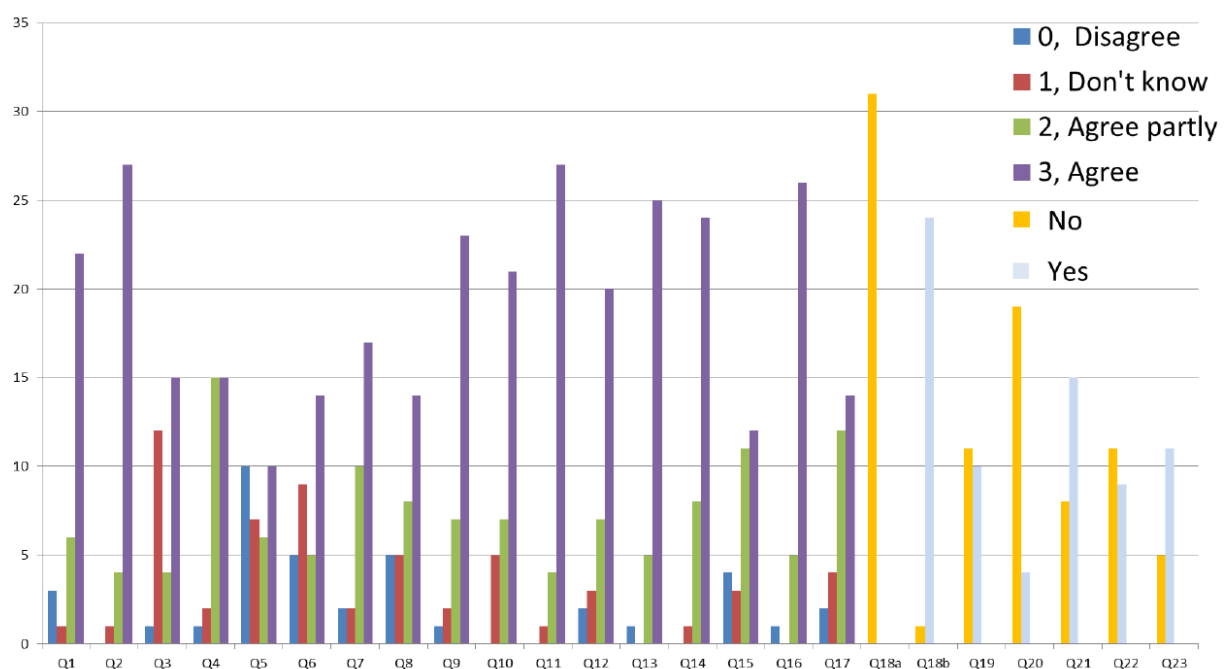


Figure 1 Responses to preliminary survey. Questions 1 to 23 detailed in text.



#### **Further Information**

IEA Bioenergy Website  
[www.ieabioenergy.com](http://www.ieabioenergy.com)

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