Perspective

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Long-term strategies for sustainable biomass imports in European bioenergy markets

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Abstract: Projections show that biomass will remain important for reaching future EU renewable energy targets. In addition to using domestic biomass, European bioenergy markets will also partly rely on imports of biomass, in particular in trade-oriented EU member states like the United Kingdom, the Netherlands, Belgium, and Denmark. There has been a lot of debate on the sustainability of (imported) biomass and how policy should deal with this. In this research, therefore, we defined long-term strategies for sustainable biomass imports in European bioenergy markets. We used the input of different stakeholders in our approach through focus-group discussions and a global survey, focusing on the following aspects: key principles of sustainable biomass trade, risks and opportunities of biomass trade, both for import regions (EU countries) and for sourcing regions, and practical barriers for trade. Overall we conclude that policies should be stable and consistent within a long-term vision. An overall sustainability assurance framework of biomass production and use is key, but should ultimately apply to all end uses of biomass. Furthermore, the mobilization of biomass should be supported, as well as commoditization, considering the large diversity of biomass. Side impacts of biomass use should be monitored. Reducing investors' risk perception is crucial for future developments in the biobased economy, and a clear policy to phase out fossil fuels, e.g. through a carbon tax, needs to be implemented. The results of this research are of interest for policy makers when deciding on long-term strategies concerning sustainable bioenergy markets. © 2018 Society of Chemical Industry and John Wiley & Sons, Ltd

Keywords: biomass; trade; energy policy; sustainability; lignocellulosic biomass; wood pellets

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Introduction

At the Paris climate conference (COP21) in December 2015, 195 countries adopted a global climate deal.[1] Governments agreed on a long-term goal to limit global warming to well below 2 °C above pre-industrial levels. This will require a substantial increase in renewable energy at the global level. The European Commission had already set a renewable energy target of 20% by 2020 in the Renewable Energy Directive of 2009.[2] In the 2030 Climate and Energy Framework, presented in 2014, a renewable energy target of at least 27% was announced for 2030.[3] In November 2016, the European Commission published a proposal for a revised Renewable Energy Directive in its 'Energy Winter Package 2016'.[4] The proposal includes a strengthening of biomass sustainability criteria.

Different renewable energy options will be needed in parallel to achieve the increased renewable energy targets. It is generally acknowledged that biomass will play an important role, representing at least half of total renewable energy production in the EU up to 2030.[5] Projections imply that, in addition to using domestic biomass, European markets will also rely on moderate amounts of imports of biomass. At the EU level, the total contribution of imported biomass is not expected to exceed 10% of total biomass supply,[6] but in particular in trade-oriented EU Member States with limited biomass resources like the United Kingdom, the Netherlands, Belgium, and Denmark, the share could be higher. Some well-positioned regions of the world – in particular the United States, Canada and Russia – are already playing a role in supplying biomass to the European markets[7,8] and could become increasingly relevant in the near future.

As a result of several support measures, the market for biobased heat and electricity and transport biofuels has seen major increases in the past decade. According to Eurostat, gross inland consumption of bioenergy in the EU-28 amounted to 5437 PJ in 2014, representing a 64% share of all renewable energy consumption.[9] Most biomass is being used in the heating sector, followed by transport and electricity. In the longer term, an increase in biomass demand will be reinforced by other (non-energy) sectors moving from fossil resources to biomass as renewable feedstock. Reference can be made to the launch of initiatives such as the Biobased Industries Joint Undertaking, which aims for the development of biobased and renewable industries for development and growth in Europe.[10] Among the prerequisites for achieving a more competitive biobased industry, it is necessary to ensure access to renewable raw material at competitive prices, to support market creation, and stimulate market demand for biobased products. Lignocellulosic feedstocks are likely to become very important, as they are the basis for advanced biofuels, and as support for food-based biofuels is being phased out in the EU.[4] Overall, bioenergy strategies should take into account that trade in lignocellulosic biomass will be part of the international bioenergy markets. There has been a lot of debate on assuring the sustainability of biomass and how policy should deal with this. It is generally agreed that all biomass should be produced sustainably and used in a resource-efficient way, but special attention is paid to imported biomass, as this is outside the direct realm of influence of EU member states or the European Commission. The main objective in this research was to define policy strategies and guidelines that could provide a frame to include biomass imports in European bioenergy markets, while safeguarding sustainability of biomass production and achieving sufficiently high greenhouse gas reduction compared to fossil pathways, and at the same time meeting international trade agreements like those of the World Trade Organization (WTO), safeguarding domestic biomass demand in exporting regions, and being practical in implementation. The basic approach in the research was to assemble the viewpoints of different stakeholder groups and strive towards a consensus regarding how sustainable biomass imports can be part of European bioenergy markets. This work builds further on the previous work of EUBIONET III[11,12] and IEA Bioenergy,[13,14] which focused on sustainability governance and trade barriers for biomass. This paper will present the approach followed and will discuss the results of the stakeholder consultations on key principles for sustainable trade, opportunities and risks, barriers for trade, and potential policy options. It will conclude with the recommendations and guidelines for long-term strategies for European bioenergy markets in relation to trade.

Method

Scope

The work presented in this paper has been carried out within the BioTrade2020plus project, supported by the Intelligent Energy for Europe program of the European Commission. The main aim was to provide guidelines for the development of a European bioenergy trade strategy for 2020 and beyond. The project focused on lignocellulosic biomass, i.e. woody resources, agricultural residues, and cellulosic crops, with case studies in a number of potential sourcing regions situated in North America, South

America, East Europe, Southeast Asia and Africa (Mai Moulin et al., accepted for publication). A central task was focused on defining solid long-term strategies to include sustainable biomass imports in European bioenergy markets. The time horizon for the strategies is 2020–2030 but it is acknowledged that policy strategies should have a longer time horizon in mind of at least 10 to 20 years as these are the timeframes for industry investments. While the project focus was on lignocellulosic biomass, the guidelines developed can also be valid for other types of biomass.

Approach

Preceding steps

The policy work in the BioTrade2020plus project started with an analysis of the existing policy framework in the EU and in the sourcing regions considered, which may have an impact on biomass trade to the EU. Factsheets about relevant policies are available at an online policy database,[15] which is shared with the European S2Biom project.[16]

Next, a regulatory SWOT (strengths, weaknesses, opportunities and threats) analysis was made for the different sourcing regions as trade partners to the EU (United States, Canada, Brazil, Colombia, Indonesia, Kenya, and Ukraine). The availability of global biomass for export to the EU will depend on international policies and strategies on biomass and bioenergy. While biomass exports can initiate local supply chains, countries may shift to increased domestic valorization over time. It is also important to consider the quality and stability of regulations and governance, to indicate how firm sustainability provisions are in terms of biomass production in sourcing regions. Strengths, weaknesses, opportunities, and threats of the considered sourcing regions were defined in relation to regulatory stability, investment climate, renewable energy and climate strategies, and feedstock governance (both forestry biomass and agricultural biomass). Initial SWOT statements were discussed with several stakeholders through webinars and a survey. This included representatives from industry, biomass producers, certificators/auditors, regulators/administrators, NGOs, consultants, and researchers. Most originated from (or were very familiar with) the specific sourcing region in focus. The final SWOT overview of the different sourcing regions is available in the online toolset of the BioTrade2020plus website.[17]

Towards long-term strategies

The information from both analyses above was used to structure meetings with various stakeholder groups as preparation for a survey on long-term strategies. The knowledge of what sectors and stakeholders perceive as opportunities, risks, and barriers, as well as a shared view on key principles for sustainable trade was the basis to come to long-term strategies and suggested policy frameworks around biomass trade. *Opportunities* are defined as circumstances that allow or facilitate progress in a certain field (economic, environmental, or social), while *risks* may lead to undesirable situations or circumstances that have both a likelihood of occurring and a potentially negative consequence, or the effect of uncertainty on objectives.[18] Opportunities and risks are different between import regions and sourcing regions (net exporters), so in our analysis we made a clear distinction between these. Bioenergy *trade barriers* are defined as 'any issue that either directly or indirectly hinders the growth of international trade of biomass commodities for energy end-use.'[13] *Key principles* are fundamental norms, rules, or values that represent what is desirable and positive for a person, group, organization, or community, and help in determining the rightfulness or wrongfulness of its actions. Principles are more basic than policy and objectives, and are meant to govern both (http://www.businessdictionary.com/definition/principles.html).

Several meetings and focus-group discussions were organized to receive input and feedback from stakeholders and experts. A first international workshop was organized in Brussels in October 2014, which included breakout discussion sessions, discussing opportunities and risks among other matters, as well as key principles for sustainable biomass trade. In this workshop 66 people participated, from diverse backgrounds and different continents, including Europe (from 11 Member States), Africa, Asia, Australia, North America and South America. Figure 1 shows the background of the participants.

Second, a telephone conference was held in November 2014 to discuss key principles for sustainable trade with

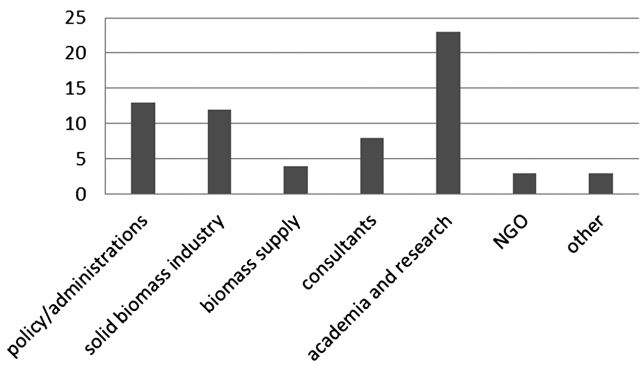

Figure 1. Background of the participants of the workshop of October 2014.

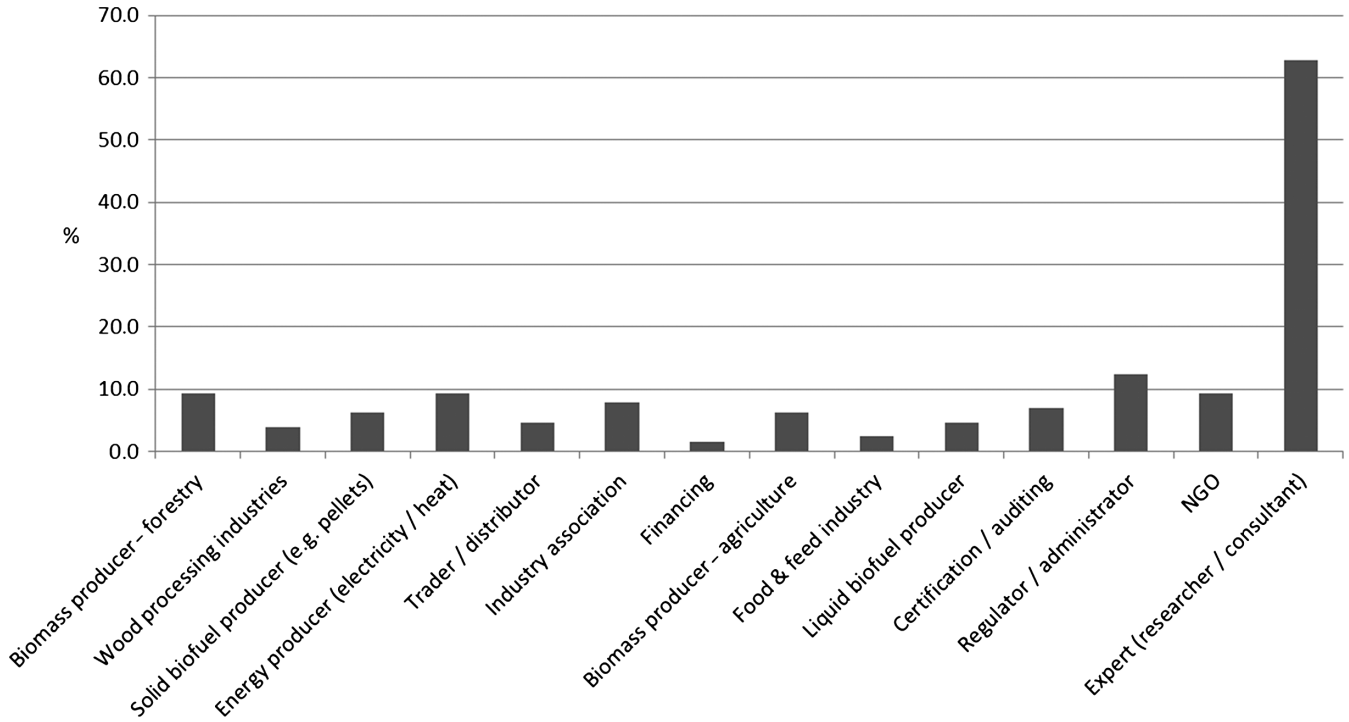

Figure 2. Background of the participants to the global survey.

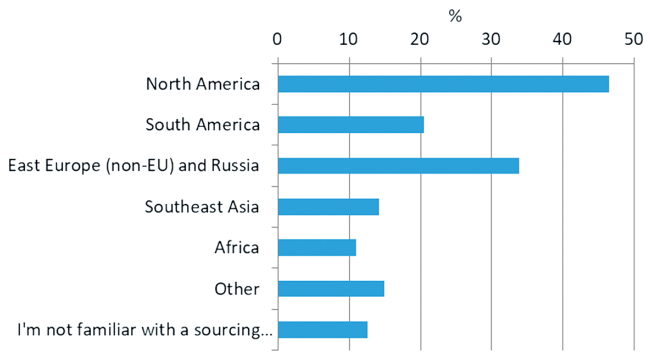

Figure 3. Global survey – familiarity of respondents with different sourcing regions.

members of the project working group on strategies. This had 15 participants. In February 2015, a third dedicated discussion took place with the project advisory board on key principles, opportunities, and risks. The advisory board is a group of around 10 external observers of the project, with representatives from industry, research organizations, and non-governmental organizations (NGOs), originating from the EU, North America, South America, and Africa.

We used the input from these stakeholder focus-group discussions to develop a global survey that was open from April to June 2015. The survey focused on (1) risks and opportunities of biomass trade, both for import regions (EU countries) and for sourcing regions, (2) practical barriers for trade, (3) key principles of sustainable biomass trade, and (4) policy options for biomass imports. The survey received 127 responses from stakeholders and experts in the field from 35 different countries;[19] 72% of respondents were from Europe, 16% from North America, 4% from South America, 6% from Asia/Australia, and 2% from Africa. Figure 2 shows the sectors represented. Note that the total percentage is over 100% as respondents could select multiple organizational types. The majority of respondents (62%) qualified themselves as expert (researcher/consultant), but most other sectors were also represented.

Respondents were also asked to indicate which sourcing regions they were familiar with. This is shown in Figure 3. Respondents were most familiar with North America and East Europe. Nevertheless a significant number of respondents were also familiar with the other sourcing regions.

Next to the four focus points mentioned above, the survey also contained a number of policy options that would reduce some of the risks and barriers. A workshop on 'Policy options for sustainable biomass trade' was organized as a side event to the European Biomass Conference and Exhibition in Vienna in June 2015. The

workshop had 50 participants – mostly researchers, but also policy makers and industry representatives – and was focused on the options to ensure sustainable biomass sourcing and how to avoid displacement of local use. Based on the survey results, feedback from the workshop discussions and expert judgement, draft long-term strategies were defined. These were further discussed in the final project workshop in Brussels in June 2016 (with 41 participants from 14 countries) and with the project advisory group in the period June–August 2016. Strategies were also aligned with other projects, i.e. Biomass Policies and S2Biom. Comments and suggestions were processed and implemented in a final advisory document for the project, which was published and handed over to the European Commission in August 2016.

In the following sections, we present the main conclusions from these stakeholder consultations and the resulting proposed long-term strategies.

Results of the global survey

Key principles for sustainable trade

In this work key principles provide guidance regarding what is desirable to ensure sustainable biomass production and imports, in this case from a societal point of view; these principles are more basic than policy and objectives, and are meant to govern both. Common principles of sustainable production and use of biomass for energy purposes can be found in several initiatives aiming at the certification of biomass, biofuels and bioenergy, such as the Cramer Commission in the Netherlands,[20] or the Global Bioenergy Partnership (GBEP), work towards sustainability indicators for bioenergy.[21] Recently, efficient use of resources came up as an additional principle, which implies that energy efficiency should be optimized as biomass is a limited resource, and – where possible – priority should be given to higher value applications or a biorefinery approach and the 'cascading' principle' should be acknowledged.[22]

In this work, the discussion on key principles was focused on the international biomass trade. The project members drafted a number of key principles for sustainable biomass trade, which were discussed with various stakeholders and experts and adapted accordingly. A final list of seven key principles – along with some background explanation per principle – were included in the global survey. Respondents could indicate to what extent they agreed with a certain principle and provide comments.

The following overview indicates the key principles, starting from strongest agreement among the respondents to the global survey. The level of agreement (indicated 'agree' or 'totally agree') by respondents is also indicated.

1. *Trade should be based on sustainable and legally acquired biomass sourcing (traceable and verifiable)* (97% agreed).

   Practically all respondents agreed with this principle. There should be biomass sourcing requirements for 'good management practices' in forestry, agriculture, landscape management, waste management – e.g. in terms of biodiversity, carbon stock, soil, water, social conditions and land tenure – and the requirement that it is legally acquired. It was indicated in the focus group discussions that region specificity of sustainable practices should be considered, e.g. sustainable forest management practices can differ depending on climate, soil, and forest type, as is also acknowledged in Forest Stewardship Council (FSC) and Programme for Endorsement of Forest Certification Schemes (PEFC) sustainable forest management certification systems.
2. *Markets should be transparent, with clear reporting and monitoring systems* (90% agreed).

   Better trade monitoring may stimulate the general transparency and legality of biomass trade practices, particularly from developing countries.
3. *Assessment (and incentives) of biomass value chains should be based on an evaluation of energy use and greenhouse gas emissions over the whole value chain, including biomass production, pre-treatment, transport, and final conversion to electricity, heat, and/or biofuels* (88% agreed).

   For traded material, it is important to consider pre-processing to tradable commodities and long-distance transport. Although most respondents agreed that the full value chain has to be taken into account, it was also questioned whether biomass processors can have an influence on the previous steps within the value chain.
4. *Trade should follow the principles of 'fair trade', i.e. all actors in the value chain receive a fair price/a fair share of the benefits* (86% agreed)

   The majority of the respondents also agreed with this principle. Various voluntary fair trade schemes exist, mainly for food purposes. Principles and definitions of fair trade are described in a 'Charter of fair-trade principles,', published in 2009 (http://fairtrade-advocacy.org/images/Charter_of_Fair_Trade_principles_EN_v1.2.pdf). Some respondents indicated that 'fair' should be better defined.

5. *Markets should be open, i.e. there should be no discrimination in market access* (80% agreed).

   This principle implies WTO compliance and avoidance of protectionist market mechanisms. Sustainability requirements can be perceived as trade barriers.[11] It is important to find a balance between sufficiently strong quality and sustainability requirements and market access. In the discussion with stakeholders it was indicated that administration and practical procedures to demonstrate sustainability criteria can be a barrier for smallholders, so solutions are needed to also open up opportunities for smallholders. Examples can be group certification, or risk based approaches.
6. *Local use of biomass should have priority over trade. Displacement as a result of trade demand should be avoided* (76% agreed).

   In principle, trade is about balancing excess availabilities in some regions with shortages in other regions. The main question about the potential for trade is if there actually is an excess of biomass supply in the sourcing regions, or if in fact local use may be displaced through subsidized demand from the European side. This could reduce opportunities for these regions to achieve their own renewable energy potential or to produce higher value products, or it may drive existing applications away to other less sustainable resources (fossil fuels, or non-certified forest land). Most respondents agreed with the basic principle, although the extent to which policies can steer this was questioned. Some indicated that in terms of open markets and WTO compliance, it is not allowed to give preferential treatment to local applications of biomass.
7. *Displacement and indirect effects in sourcing regions should be taken into account in support mechanisms* (75% agreed).

   Most respondents agreed that it is important that potential displacement effects are identified and understood. Nevertheless, various stakeholders stressed in the focus group discussions that quantifying indirect effects (like indirect land use change) and including these in value-chain assessments is difficult and very dependent on assumptions. Another way to deal with this is to identify practices/value chains that inherently have low risks of indirect effects.[23]

Opportunities and risks

This section summarizes the main conclusions from the stakeholder discussions and the survey in terms of opportunities and risks related to biomass trade. Describing opportunities and risks is politically sensitive. Opportunities and risks are different between import regions and sourcing regions (net exporters), so in our analysis we made a clear distinction between these. Opportunities and risks can also differ between sourcing regions. Respondents in the global survey could indicate how important they rated a certain opportunity/risk. When considering sourcing regions, they also needed to indicate for which region their input was valid.

A first list of potential opportunities and risks was drafted by the project partners. These were discussed with various stakeholders and experts and adapted accordingly for the global survey. The survey contained a list of eight potential opportunities for importing regions in the EU, seven potential opportunities for sourcing regions, six potential risks for importing regions in the EU and seven potential risks for sourcing regions. Participants of the survey could rate the importance of these options. For the sourcing regions they could fill different sheets for different regions.

Opportunities for biomass imports for the EU regions

Based on the input received from the global survey, the following were ranked as the most important opportunities for biomass imports for EU regions. The opportunities mentioned were rated as important or very important by more than 60% of the people who provided an answer in this section.

1. *Imported biomass from regions with abundant and easily accessible biomass can be a cost-efficient way to reach renewable energy targets* (79% rated it as important or very important).

   Imported biomass from regions with abundant and easily accessible biomass can be cheaper than domestic biomass, especially when long in-land supply chains are required to transport this domestic biomass, or when infrastructure is lacking. Some respondents noted that, while it may be more cost-efficient, there may be questions about the sustainability of the imported biomass.
2. *Imported biomass is of interest in regions where domestic resources are limited* (77% rated as important or very important).

   In particular, this is the case in regions with high population density, and relatively high energy demand related to industrialization. If these countries have energy conversion facilities for biomass already in place and easy access to international markets (through seaports), this creates an extra motivation to include imports.

3. *Imported biomass can be complementary to domestic intermittent energy sources like solar or wind* (71% rated this as important or very important).

   Biomass is one of the renewable energy options, and can play a complementary role to wind, solar, hydro, and geothermal energy. It can serve as a backup for intermittent renewable electricity sources, and can have a major role in heat and transport fuels. Some respondents commented that imported biomass is mainly used in larger facilities, which are less flexible and, therefore, the complementarity is of less importance.
4. *International trade opens up the feedstock portfolio of bioenergy installations in the EU. This creates flexibility in feedstock sourcing and stabilizes prices* (68% rated as important or very important).

   The business case for biorefineries and bioenergy installations in the EU depends very much on their feedstock sourcing. For larger installations, in particular, international trade opens up the feedstock portfolio, creating some flexibility for feedstock sourcing. Increasing and diversifying the supply also offers the opportunity of more stable prices.
5. *EU countries can invest in technological solutions such as advanced biofuels or biorefineries that need substantial biomass volumes to reach economy of scale. Imports can fill the gap if these volumes are not (yet) available domestically* (61% rated as important or very important).

   Some respondents indicated that the larger amounts of biomass, available through imports, are used in large burning installations and are not available for new technologies that focus more on domestic types of biomass.

   For the other three options concerning opportunities for EU regions, opinions were more divided. More or less 50% of the respondents rated the opportunity 'Biomass imports can be an intermediate tool to facilitate the development of local bioenergy infrastructure in the EU' as important or very important. Only 46% and 45% rated 'EU countries can build trading links with strategic trade partners' and 'Opening markets for imported biomass can reduce competition for domestic biomass resources, e.g. related to the demand of existing biomass processing industries (for materials)' as important or very important, respectively.

Opportunities for biomass exports for exporting regions

Statements were provided to the respondents concerning the following topics: economic development, job creation, synergies with local sectors, improved productivity, sustainable practices, building up supply chains, and capacity building. Table 1 shows an overview of how many respondents indicated an opportunity as important or very important, in relation to a certain sourcing region. The number of answers per sourcing region is also indicated between brackets. Below we provide more detailed information on the answers of the respondents concerning the opportunities for exporting regions.

Based on the input received from the global survey, the following were ranked as the most important opportunities for biomass exports for exporting regions (see also Table 1). Some opportunities are more pronounced for developing countries, e.g. when considering capacity building or improved productivity.

1. *Export markets may provide economic opportunities for regions to market excess feedstocks that are not used at the moment.* One respondent mentioned that, particularly in the United States, biomass production for energy is helping to revitalize rural communities and provides a small boost to the forest products market that has been lagging in recent years due to the economic downturn. Another respondent noticed that biomass may be abundant only due to a lack of local incentives to use it for energy.

Table 1. Global survey – opportunities for different sourcing regions; percentage rated important or very important.

Region (#respondents)	North America (41)	South America (15)	East Europe (non-EU) and Russia (30)	Southeast Asia (6)	Africa (11)	No specific region (24)
Economic development (%)	73	80	77	100	64	78
Job creation (%)	56	80	77	83	91	74
Synergies with local sectors (%)	63	80	70	83	73	48
Improved productivity (%)	60	67	53	100	64	39
Sustainable practices (%)	68	80	63	83	91	61
Building up supply chains (%)	58	73	79	100	64	68
Capacity building (%)	53	67	57	100	82	57

2. In relation to the previous argument, biomass export creates economic activity, thereby *creating or sustaining jobs* in local forestry, agriculture and industry.
3. Providing an outlet for biomass residues from agriculture, forestry or the wood processing industry creates *synergies with these local sectors* and may improve the business case for these sectors.
4. Demand from outside the region – with specific sustainability requirements, or request for sustainability certification – may contribute to *improved sustainable practices* in forestry, agriculture, and industry. Such practices also depend on voluntary best management practices (and to what level they are adhered to) and/or local regulations and the capacity of the government to enforce them.
5. Setting up biomass supply chains and building infrastructure based on demand from outside the region may *trigger local use of biomass for energy* in these regions.
6. Cooperation with sourcing regions may add to *capacity building* (skilled jobs) and improved know-how and awareness of sustainable and efficient biomass use. This may particularly be the case in some developing regions (it was, for example, rated less important for North America).
7. Additional demand may create an incentive to *improve productivity* of forestry and agriculture. This was least supported by respondents who did not have a specific region in mind.

Risks of biomass imports for EU regions

Based on the input received from the global survey, the following were ranked as the most important risks of biomass imports for EU regions. The risks mentioned below were rated important or very important by more than 60% of the people who provided an answer.

1. Bioenergy investors may experience a *lack of long-term stability in terms of policies and prices* (68% rated this important or very important).

   Policy support has changed frequently in the past years and post-2020 prospects remain quite unclear in the EU. Moreover, fluctuating fossil fuel prices reduce the economic viability for EU bioenergy players. The current investment climate is sketched as quite difficult.
2. For some feedstock types, subsidies in the EU renewable energy sector *may drive up world market prices for other sectors* (61% rated this important or very important).

Opinions were more divided regarding the other risks for biomass imports for EU regions:

- 'Relying on imported biomass moves the problem of energy import dependency from one region to another. This presents no real solution in terms of energy security.' Only 44% of respondents rated this risk as important or very important. Some respondents indicated that diversification can provide additional value for energy systems, and imports are usually shifted towards politically more stable regions.
- 'Pre-treatment and long-distance transport consume substantial amounts of energy and reduce the greenhouse gas advantage of bioenergy.' This risk is rated important or very important by 42% of respondents. Some respondents argued that this is not a risk if it is taken into account in the sustainability criteria for biomass.
- 'Domestic potential in the EU may be outcompeted by imports (potentially favored by subsidies or lower environmental constraints), leaving some of it underutilized.' 39% rated this important or very important.
- 'Support for pellet co-firing may extend the life of older coal-power facilities, or encourage investments in new coal facilities and therefore lead to a longer reliance on coal for power production.' 39% rated this important or very important.

Risks of biomass exports for exporting regions

Statements were provided to the respondents concerning the following potential risks: overexploitation, displacement, access to land, lower local renewable energy opportunities, less opportunity for smallholders, low added-value exports, and unstable EU policy. Table 2 provides an overview of the percentage of respondents that indicated a risk as important or very important in relation to a certain sourcing region. The amount of answers per sourcing region is also indicated between brackets.

The following risks were ranked as the most important risks of biomass exports for exporting regions. Anticipated risks can be very region dependent:

1. *Changing support frameworks and requirements (quality and sustainability) in the EU* may harm the business model in sourcing regions. Long-term contracts are often required before investments are made in new biomass production lines. This risk was generally rated important for all sourcing regions.
2. Additional demand for tradable biomass generates a *risk of overexploitation in forestry and agriculture*. Without precautions, this may result in biodiversity loss and a loss of carbon in forests and agricultural soils. It was stated by respondents that overexploitation can be

Table 2. Global survey – risks for different sourcing regions, percentage rated important or very important.

Region (#respondents)	North America (37)	South America (15)	East Europe (non-EU) and Russia (26)	Southeast Asia (5)	Africa (14)	No specific region (21)
Overexploitation (biodiversity loss and carbon loss in forests and soils) (%)	38	67	69	80	85	67
Displacement of local biomass/land use (%)	23	40	62	80	62	57
Reduced access to land (%)	11	60	38	100	69	48
Lower local renewable energy opportunities (%)	23	20	42	60	69	43
Mainly opportunity for large players, less for smallholders (%)	26	73	65	100	85	43
Low value-added exports (%)	21	53	54	80	62	50
Unstable EU policy (%)	67	79	58	60	85	71

managed if sustainability guidelines receive strict attention. Note that, for North America, most respondents indicated that this risk was of low importance.

3. International trade is generally linked to *large-scale players*. There may be *limited opportunities for smallholders* to access these new export markets. This risk was rated relatively low for North-America but important in other regions.
4. Subsidized demand from the EU may *increase local prices of biomass feedstocks and land*. Demand from outside the region may compete with local use, drawing away feedstocks and land from local applications (energy, materials, food). This risk was rated low in North and South America, but relatively important in other regions.
5. Export is generally restricted to low value-added products (e.g. raw biomass feedstocks or intermediates), limiting the economic benefits in sourcing regions. This risk was rated medium in most regions, and low for North America.
6. There is a risk of 'land grabbing' of large players, limiting the *access of local people or smallholders to land*. This risk was indicated important by a number of respondents for Southeast Asia, Africa, and to a smaller extent South America.
7. Claiming certain feedstocks for export may lower future opportunities in sourcing regions, e.g. to use their own resources for (modern) energy production. This risk was rated low for most regions, with exception of Africa and Southeast Asia.

Barriers for trade

Bioenergy trade barriers are defined as 'any issue that either directly or indirectly hinders the growth of international trade of biomass commodities for energy end-use.'[13]

It is difficult to define clearly what (indirect) trade barriers are and what general barriers hamper the use of biomass (irrespective of being traded or used domestically). Based on previous research work[7,8,11,12,13,14,24,25,26,27] and discussion panels with stakeholders and experts, we defined 23 potential biomass trade barriers, categorized in (1) national/regional protectionist policies and trade tariffs, (2) technical standards, (3) logistics, (4) safety and sanitary/phytosanitary requirements, (5) sustainability criteria and certification systems, (6) global classification and trade statistics and (7) public knowledge and public opinion. These were included in the global survey. People could indicate how important they rated a certain barrier. Table 3 provides an overview of the percentage of respondents that rated the different potential barriers as being important or very important.

The following overview discusses the barriers that were rated as 'important' or 'very important' by over 60% of respondents who answered this section.

- There has been growing public debate on biofuels in the past ten years, with claims of unsustainable practices and side effects (like indirect land use change), which created a *bad public image* in society (public, media and policy makers) for biofuels and – by extrapolation – for bioenergy in general.[28,29] This has reduced the willingness to support bioenergy considerably. In general, *the public is not very well informed* about possibilities and opportunities of biomass and bioenergy, or about sustainable practices, and therefore public opinion is susceptible to simplifying headlines/one-liners on a topic which has different sides to it. Around 80% of respondents rated public knowledge and public opinion as an important barrier. Many respondents agree that actions should be taken to improve the

Table 3. Global survey – barriers, percentage rated important or very important.

Statement/barrier	Percentage important and very important
National/regional protectionist policies and trade tariffs	
Domestic bioenergy is favored over imports in EU Member States' policies.	47
Import tariffs for biomass commodities to the EU	47
Subsidies for exported biomass and export tariffs in certain souring regions	38
Technical standards	
Technical standards are too strict for certain feedstock.	32
Diverging technical quality standards between countries/regions or even companies	51
Uncertainty about standards that are still in negotiation phase	55
Logistics	
Lack of roads and port infrastructure in sourcing regions	65
Lack of port infrastructure in Europe	32
Safety and sanitary/phytosanitary requirements	
Varying or inconsistent safety requirements for traded biomass.	44
Varying or inconsistent sanitary/phytosanitary requirements.	55
Sustainability criteria and certification systems	
Different sustainability requirements in EU Member States for solid biomass (not EU-wide)	78
Proliferation of certification systems.	64
Differences in sustainability governance of agriculture and forestry policies (legislation and enforcement) by country/region.	74
Different rules for domestic feedstock vs imports.	47
Sustainability criteria only required for energy and not for other applications of biomass.	66
Lack of sustainability criteria for fossil fuels creates an unlevel playing field.	69
Certification systems don't include sufficient aspects of sustainability.	39
WTO doesn't allow specific sustainability requirements (like social criteria).	41
Changing sustainability requirements creates uncertainty for stakeholders.	67
Global classification and trade statistics	
No clear view on biomass trade statistics, in particular which part is used for energy.	55
Problems with reporting of trade flows and unreliable statistics.	55
Public knowledge and public opinion	
Bad public image (towards public, media and policy makers) due to claims of unsustainable practices for biofuels.	80
Insufficient knowledge of public/media/policy makers.	81

image of biofuels/bioenergy. Respondents also argue that more and better education and training is needed.

- At present numerous biomass and biofuel sustainability certification schemes are being developed or implemented by a variety of private and public organizations.[26,27] Several issues in terms of sustainability criteria and certification systems have been identified that may impact trade opportunities:
  - In contrast to liquid biofuels, at the moment there are *no binding criteria for solid biomass at the European level.* (Note that the stakeholder consultations within the BioTrade2020+ project were performed in the course of 2015 and 2016. Meanwhile, in its Winter Package of November 30, 2016, the European Commission proposed to introduce binding sustainability criteria for solid and gaseous biomass for energy, after 2020. In fact the results have been used as input for the Commission's proposal.) Over 75% of respondents rated this as an important or very important barrier. In the absence of mandatory EU-wide sustainability criteria for solid biomass, a number of individual European Member States unilaterally developed (further) sustainability criteria, while others maintain the status quo.[24] Such

a development could have two consequences: (1) diverging sustainability criteria could undermine the environmental effectiveness of national schemes. This situation is likely to promote leakage effects with less sustainable raw materials, subject to mandatory requirements, being moved to parts of the EU where they will not receive the same level of environmental scrutiny; (2) a heterogeneous regulatory approach to biomass sustainability raises a number of concerns from an internal market perspective in the EU, including potential distortions to biomass trade, market segmentation, and overall market inefficiency.

- Some regions already have a wide range of policies (legislation, regulations, and guidelines) and sufficient enforcement in place to safeguard sustainable biomass production and regulate related markets. The problem of unsustainable biomass production most likely occurs in *countries with weak or failing governance structures* (i.e. lack of enforcement and control mechanisms).[14] Almost 75% of respondents rated differences in sustainability governance of agriculture and forestry policies (legislation and enforcement) by country/region as an important barrier.
- Changing sustainability criteria over time have a profound impact on the industry. Ongoing debates, like the indirect land use change (iLUC) debate between 2010 and 2015 [30] or the ongoing forest carbon accounting debate[31] have increased uncertainty amongst industrial stakeholders and have raised questions about long-term perspectives of policies. It may discourage broad new investments in solid biomass conversion capacity, and ultimately may act as indirect barrier for solid biomass trade. This barrier is rated as an important one by 67% of respondents.
- Sustainability criteria are only required for biofuels/bioenergy, but remain voluntary or absent for other applications of biomass. This means that the market drive to certify the production of biomass only comes from the part that is destined for bioenergy. Consequently the incentive of biomass producers to certify their feedstock may be limited. 66% of respondents rated this an important barrier.
- Sustainability requirements placed on biomass for energy create an extra administrative burden and cost to these value chains.[14] This gives them an extra disadvantage compared to fossil fuels, which do not have to track their chain of custody or demonstrate their performance in terms of sustainability criteria. Circa 70% of respondents rated this uneven playing field as an important barrier.
- The main driver for companies to seek sustainability certification is to comply with the requirements of legislation and to maintain or gain market access.[14] The proliferation of schemes has led to competition among schemes in the market. This may bring further improvements in efficiency and effectiveness, but different approaches and requirements may also lead to confusion in the market place, or a tendency to use the least demanding system. Scheme proliferation is rated as an important barrier by 64% of respondents.

- When setting up biomass fuel supply chains for large-scale biomass systems, logistics are a pivotal part in the system. Limited logistical infrastructure (e.g. railways, roads) can seriously hamper transport of inland biomass to the ports for international trade.[13] 65% of respondents rated the lack of roads and port infrastructure in sourcing regions as an important barrier.

Feedback regarding suggested policy options

In relation to the list of potential risks and barriers, a number of policy options were drafted by the project partners, based on experience and previous projects. The policy options were discussed with stakeholders and experts and adapted accordingly. Ten policy options were included in the global survey, separated in the categories (1) sustainability criteria for bioenergy, (2) displacement and indirect effects, (3) standards and labeling, and (4) monitoring. Table 4 shows how many of the respondents who filled this part agreed (or totally agreed) with certain statements/policy options. More than 85% of respondents agreed with the suggested policy option concerning *sustainability criteria*. Only the option that requirements should go further than current criteria in the Renewable Energy Directive received less support (69%). There was a suggestion that the FLEGT Action Plan and the European Timber Regulation (EUTR) can play a role in achieving cooperation or good practice exchange with sourcing regions. FLEGT stands for Forest Law Enforcement, Governance and Trade. The EU's FLEGT action plan was established in 2003. It aims to reduce illegal logging by strengthening sustainable and legal forest management, improving governance and promoting trade in legally produced timber (http://www.euflegt.efi.int/what-is-flegt). Under the European Timber Regulation (EUTR), placing illegally harvested timber and products derived from such timber on the EU market is prohibited. The Regulation came into effect in 2013 and requires EU traders who place

Table 4. Global survey – agreement to certain policy options.

Statement/policy option	Percentage agree and fully agree
Sustainability criteria for bioenergy	
Harmonized/common binding sustainability criteria are needed on EU level, including for solid and gaseous biomass for energy.	85
Requirements should go further than the current criteria for biofuels in the renewable energy directive (greenhouse gas emissions, biodiverse land, high carbon stock land).	69
When forestry biomass is used, a proof of sustainable forestry management (e.g. FSC, PEFC) should be required.	90
The EU should put more dedicated efforts in cooperation/good practice exchange with sourcing regions towards sustainable practices in biomass production and harvesting, and capacity building.	86
Displacement/indirect effects	
Certain types of feedstock that have higher risks of indirect effects/displacement should be excluded from support, or support can be capped to a certain amount of feedstock.	80
There should be incentives for practices that avoid/reduce negative indirect effects. The EC should clearly define such practices.	80
Indirect effects should be quantified and included in value-chain calculations (e.g. in terms of GHG balance).	72
Standards and labeling	
Technical standards for traded biomass should be agreed at international level, e.g. ISO.	85
All wood-derived products (i.e. materials and energy carriers) should be labeled to indicate whether they come from legal and sustainable forests.	84
Monitoring	
Better monitoring systems with distinct classifications are needed for international trade flows of wood and other lignocellulosic products.	83

timber products on the EU market for the first time to exercise 'due diligence'. They also need to keep records of their suppliers and customers.

The majority of the respondents also agreed with the policy options concerning *displacement and indirect effects*. Nevertheless, in terms of risk profiles of feedstock types, there were some who argued that one should look at practical situations instead of feedstock type. Some respondents also indicated that the risk exists that a large part of the potential will be excluded. Most respondents agree that the quantification of indirect effects is an important issue but they questioned whether it can be put into practice as there are many uncertainties around this quantification.

Statements concerning *standards and labeling*, as well as *monitoring* received rather high support (83% to 85%).

Recommendations for long-term strategies and guidelines on European bioenergy markets and trade

Starting from the results of the stakeholder discussions and the global survey in terms of risks and barriers, but also the feedback on the proposed policy options, we developed a number of long-term strategies and guidelines in relation to bioenergy trade. These guidelines are also aligned with other projects: Biomass Policies and S2Biom. In fact, we do not propose a specific 'European trade strategy' in terms of biomass for energy but suggest considering overall bioenergy strategies and the fact that trade will be part of these bioenergy markets.

Our recommendations and guidelines can be summarized as follows:

- Policy needs to be consistent but also dynamic to be effective, e.g. in case of price fluctuations (to avoid overcompensation). As new insights emerge (e.g. in terms of indirect effects) some adjustments can be applied to avoid negative impacts but it is important to have a grandfathering approach. This means that provisions are applied in which an old rule continues to apply to some existing situations while a new rule will apply to all future cases. It is very important to have a long-term policy vision. A policy framework needs to be clear for the next 10 to 20 years, as this is also the timeframe for investments. There should be consistency between different policy fields.[32]

- Risk perception is high in the biobased economy and access to finance is an issue.[33] Governments should provide tools to reduce financing risks, e.g. through providing guarantees, low-interest loans, purchase mandates and/or tax credits, and long-term targets. Developing and spreading knowledge about technologies and value chains to reduce risk perception is also crucial. This can be done through supporting innovation and R&D, but also through supporting education on circular economy and biobased economy, as well as developing a transparent knowledge base on the status and prospects of bioenergy and biobased products.
- Variability of biomass quality is an issue, particularly for residues or herbaceous material. Low-quality material would need to be converted to an intermediate product, e.g. pyrolysis oil or pellets (potentially torrefied or steam explosion treated material).[34] Biomass commodities need to be fully tradable and compatible with storage facilities, shipping, and conversion processes. This facilitates contracting, opens markets, and provides easier access to finance. Governments can stimulate this process by providing funding for research, development, and demonstration of commoditization, as well as supporting standardization initiatives.
- Trade is a natural phenomenon of all supply-demand markets; some regions are short of material, while others are abundant. Some regions may have lower production costs and/or better growing conditions than others, which may compensate for the additional costs of pre-treating and transporting the material. Open markets also provide more flexibility in feedstock sourcing and can stabilize prices. Market access needs to fulfil WTO rules; there should be no discrimination between imported and domestic biomass. Nevertheless, sustainability requirements (including assessment of value chains) can be justified in terms of WTO compliance, if they are not intended as a trade barrier to protect or prioritize domestic resources.[35] Governments need to aim for a balance between, on the one side, sufficiently strong sustainability requirements that ensure certain conditions, while, on the other side, market access should not be overly restricted with such rules. For example, risk-based approaches may be applied for regions that have low implementation of sustainable forest management certification schemes.
- As long as different sustainability criteria applied for a certain type of biomass depends on its end use, undesirable leakage effects are hard to avoid. Consistency in sustainability requirements along European Member States and different markets is needed to avoid market distortions and prevent leakage effects. On the longer term, an overall sustainability frame needs to be applied to the management of forests and agricultural land, independent of the end use of its products in the biobased economy, be it for food, feed, material applications or bioenergy. Transparency and controllability of the chain of custody are key for such a system. It is important to build on existing systems like the European Timber Regulation [36] or voluntary schemes like FSC or PEFC for forestry, or Roundtable for Sustainable Biomaterials (RSB) for agricultural products. Voluntary schemes can be an important tool to demonstrate compliance to mandatory requirements.
- Fossil-fuel use must be considerably reduced in the frame of climate change mitigation. Fossil fuels are by definition unsustainable and currently they do not have to demonstrate their sustainability performance, e.g. in terms of greenhouse gas (GHG) emissions, land use, or indirect effects. This creates an uneven playing field with the alternatives to biomass, which have to carry out chain-of-custody reporting and certification. Tools for phasing out fossil fuels (for example a carbon tax) need to be implemented.
- Mobilization of biomass is the key for further deployment of the biobased economy and major bottlenecks can be found related to mobilization, both within Europe and in other regions.[33] Cooperation/good-practice exchange would help in developing regions to facilitate progress in agricultural productivity, forest management, and waste management, and develop infrastructure and logistics to mobilize biomass. Possibly, bilateral agreements with sourcing regions to support the sustainable mobilization could help mitigate both sustainability concerns and investment risks.
- It is important to monitor the impacts related to EU policies on markets, both in the EU and on global markets. These can be co-benefits or trade-offs. In terms of indirect land use change (iLUC) it is important to demonstrate innovative approaches to avoid or mitigate iLUC and identify cases where iLUC impact is low or even positive.[22]
- When assessing the performance of bioenergy value chains, the full chain (from production of biomass, over logistics, conversion, up to the end use) needs to be taken into account, with a focus on greenhouse-gas emissions and energy use.[21] In terms of greenhouse-gas emissions, requirements are included in the sustainability criteria for biofuels (in the Renewable Energy

Directive of 2009),[2] and this could be extended to other applications of solid and gaseous biomass for electricity and heat, as is also proposed in the Winter Package of the European Commission.[4] Improved energy efficiency means that more can be done with the same amount of biomass.

- As the project focused on trade issues, the end use of the biomass was less in focus. Nevertheless, the efficient use and so-called 'resource efficiency' is a key principle as sustainable supply of biomass is not unlimited. (Resource efficiency means using the Earth's limited resources in a sustainable manner while minimizing impacts on the environment. It allows more to be created with less and enables greater value to be delivered with less input. http://ec.europa.eu/environment/resource_efficiency/index_en.htm.) In the discussion about resource efficiency, cascading use of biomass is often mentioned. Cascading defines a certain priority of use (materials, energy) of biomass, depending on its quality. In a biorefinery approach synergies between energy and (new) material markets can be explored. The question is how and if policy should interfere and impose a priority list in terms of cascading use, or whether this should be left to markets. A more thorough analysis of resource efficiency was done in the Biomass Policies project.[32]
- To improve the image of biofuels and bioenergy, unbiased and independent information needs to be provided to the public, media and policy makers. Answers should be given in response to the concerns about sustainability of biofuels and bioenergy, and the focus should be on the demonstration of opportunities.[37]

Summary and conclusions

Overall bioenergy strategies should take into account that trade will be part of international bioenergy markets. As a basis for a long-term trade strategy, a number of key principles were agreed as a prerequisite to have sustainable biomass trade. There was most consensus on the principle that trade should be based on sustainable and legally acquired biomass sourcing. One of the other key principles is that local use of biomass should have priority over trade. Nevertheless, there are also opportunities in some regions where trade can facilitate local use of biomass (as a means to build infrastructure and knowledge) and also trigger sustainable production of biomass. A number of long-term strategies and guidelines were proposed in relation to biomass trade: policies should be stable and consistent within a long-term vision; the overall sustainability assurance framework of biomass production and use is key, but not only limited to energy use, and should ultimately apply to all end uses of biomass.

Furthermore, side impacts are to be monitored; investors' risk perceptions should be reduced and access to finance facilitated; commoditization should be in focus considering the large diversity of biomass; mobilization of biomass feedstocks should be supported; and a clear policy to phase out fossil fuels, e.g. through a carbon tax, needs to be implemented. These recommendations have been supplied to the European Commission and can form a basis for the long-term policy framework for the sustainable use of biomass within the biobased economy.

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