SHOULD WE TRADE BIOMASS, ELECTRICITY, RENEWABLE CERTIFICATES, OR CO2 CREDITS?

B. Schlamadinger[a], A. Faaij[b] and E. Daugherty[a], on behalf of
IEA Bioenergy Task 38 "Greenhouse Gas Balances of Biomass and Bioenergy Systems"[1], with contributions from IEA Bioenergy Task 35 (Techno-economic Assessments for Bioenergy Applications) and Task 40 (Sustainable International Bioenergy Trade: Securing Supply and Demand)

[a]Joanneum Research Institute for Energy Research, Elisabethstrasse 11, A-8010 Graz, Austria
[b]Department of Science, Technology and Society, Copernicus Institute, Utrecht University

ABSTRACT: This paper describes different trading options that exist to reconcile the geographical disparities between supply and demand for bioenergy and bioenergy services, depending upon the specific situation of the "exporting" and "importing" country. Trade in biomass fuels, electricity, renewable certificates, and CO_2 credits are introduced and presented as options for business and policy makers as they try to meet increasing energy demands while at the same time addressing national and international commitments to reducing CO_2 (GHG) emissions and increasing renewable energy sources.

Keywords: biomass trade, carbon credits, emissions trading, green electricity market

1 INTRODUCTION

Biomass energy is a "renewable" energy source that is increasingly utilized to reduce emissions of greenhouse gases, which are believed to alter the radiation balance of the Earth and lead to global climate change. Biomass has the advantage that it is CO_2 neutral, if sustainably produced; and biomass fuels can be stored until when the energy is demanded by the user, therefore meeting both peak and baseline energy demands. Biomass can take various forms, such as residues from forestry, wood industry, agriculture; dedicated woody or herbaceous crops; gaseous and liquid biofuels [1].

Biomass energy systems provide the following (and other) services that, for the purposes of this paper, should be distinguished from each other:

- Energy in the form of useful electricity, heat, or liquid/gaseous fuel
- Reductions of net greenhouse-gas emissions, thus adressing global climate concerns
- Other benefits of 'renewables': such as job creation, reduction of local air pollution, reduced reliance on a limited resource, etc.

Demand for bioenergy is increasing as concerns about climate change lead to implementation of policy measures that favour renewable energy sources over their fossil fuel based competitors. Examples of such policy measures and mechanisms are renewable energy mandates, feed-in tariffs for electricity from renewables, trading of green certificates, cap-and-trade systems for greenhouse gases. Demand is also driven by price mechanisms such as subsidies and taxes. All of these mechanisms seek to internalise the externalities of fossil fuel use in terms of climate change and other impacts and provide a more balanced energy choice.

As mentioned above, there is not only a demand for 1) useful energy, but also for 2) "climate friendly" energy systems and 3) energy systems that bring with them all the other advantages of renewable energy. Biomass energy can help meet all three demands. It is noteworthy that the first benefit, useful energy, must usually be provided at the location of demand, whereas the other two types of services are, at least partly, more independent of location. For reduction of greenhouse gases it does not matter where it occurs, because the atmosphere is well mixed globally and an emission (or reduction therein) will have an equal effect wherever it occurs. Similarly, many of the benefits of renewable energy (such as job creation, decreased use of fossil fuels which is a limited resource) will not depend so much on where the biomass is used although these benefits do occur locally.

This suggests that biomass may not have to be transported in all circumstances, especially where the demand is largely on 2) and 3). Instead, it may be possible to convert biomass into useful energy at the place where it occurs, and "transport" the produced electricity, or possibly trade only the immaterial services such as "CO_2 neutrality" or "renewable features" to the location where these services are in demand, for example due to policy measures as those mentioned above.

2 OPTIONS FOR MATCHING DEMAND AND SUPPLY OF "SERVICES" FROM BIOMASS ENERGY

2.1 Trading of Physical Biomass Energy Carriers such as Biomass Fuels

Some world regions (like for example Latin America and Eastern Europe) have a larger bioenergy production potential than others, a combination of large land areas with good crop production potential, low population density and often extensive agricultural practices. Consequently, various countries may become net suppliers of renewable bioenergy to countries that are net importers of energy. For example, there is growing interest in importing bio-ethanol from Brazil to e.g. Japan and the US. In order for bioenergy to be available to importing regions, transport of biofuels over relatively long distances is necessary. This, however, implies extra costs, complex logistics and energy losses.

[1] www.joanneum.at/iea-bioenergy-task38

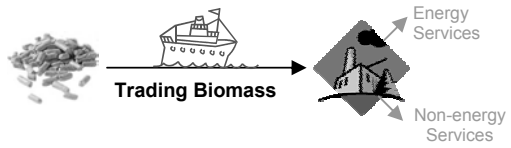

Figure 1: Trading Biomass

International bioenergy trade can include direct transport of biomass materials (chips, logs, bales), intermediate energy carriers (such as bio-oil or charcoal) or high quality energy carriers such as ethanol, methanol, Fischer-Tropsch liquids and hydrogen. Besides, factors like the production method of biomass, the transport type and the order and choice of pre-treatment operations are of importance. The design of the transport chain will influence the costs and energy efficiency, via a large number of variables, such as transport distance, dry matter losses, fuel prices, total volumes transported, and equipment performance.

One of the main drivers for increasing the use of biomass is the aim to reduce CO_2 emissions. Biomass is a CO_2 neutral energy source to the extent that CO_2 uptake by growth of plants equals the release of CO_2 from the energy conversion. In national GHG inventories the use of biomass will result in less emission reported from using fossil fuels, while CO_2 emissions from biomass are reported, but not counted in national totals [2]. Thus the relative benefit of biomass leads to an improvement in the national GHG inventory. When biomass is traded between countries, the exporter will experience a CO_2 flux from the atmosphere to its land, whereas the importer will experience a CO_2 flux from its energy system to the atmosphere, both roughly cancelling each other out. In order to preserve the GHG incentives to use bioenergy, it is essential that not the gross CO_2 fluxes are recorded in the GHG inventories of the two countries, but the net changes in carbon stocks on these countries' lands [3, 4]. Thus, if biomass is produced sustainably, both countries will report a zero carbon stock change, and the importing country will experience a reduction in CO_2 emissions from fossil fuels in its national inventory.

Various drivers for international bio-energy trade can be distinguished:

1. Cost-effective GHG emission reduction. At present, the demand for biomass is especially growing due to climate policies of various countries. In situations where indigenous resources are insufficient at required quality and cost, import may be an attractive alternative to local biomass supplies.

Use of proper reference systems is crucial: the GHG mitigation potential of biomass use is strongly affected by e.g. the carbon intensity of power generation in both the importing and exporting country. This is for example true for bio-oil export from Karelia (Russia) to the Netherlands. The possibilities to use biomass for CHP in Karelia (as well as the relatively low distribution density of forest residues) and the relatively efficient power generation in the Netherlands indicate that local use of biomass resources may be preferred over export [5]

2. Socio-economic development; many institutions and much research have indicated the potential strong positive link between developing bio-energy use and local development. Furthermore, for various countries that may export bio-energy in the future, doing so may provide substantial benefits for their trade balances.

3. Sustainable management and use of natural resources. Large-scale production and use of biomass for energy will involve use of (additional) land. When biomass production can be combined with better agricultural methods, restoration of degraded and marginal lands can provide a sustainable source of income for rural communities.

4. Fuel supply security. Biomass may diversify the total portfolio of fuels used and imported by countries and thereby adding to reducing risks of supply disruptions both in terms of quantity and in price, especially in the case of biofuels for transport, since they replace oil imports.

2.2 Trading of Physical Biomass Energy Carriers such as electricity

International trade of electricity is established. Electricity produced from biomass will usually be CO_2 neutral, and can be an effective means of meeting energy demands of the electricity importer while at the same time not adding to the CO_2 emissions of the exporting country. That is, neither the importing nor the exporting country experiences any GHG emissions from the transaction.

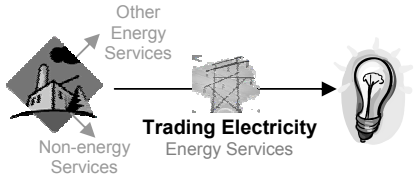

Figure 2: Trading Electricity

Countries may be importers or exporters of electricity for only parts of the year, parts of the day etc., depending on peak load demands, electricity price variations and other factors. When electricity is traded, CO_2 emissions will be accounted for in the national greenhouse gas inventory of the country where the emission from electricity production occurs. Thus, it is conceivable to meet an emission reduction target by reducing domestic electricity generation and making up the shortfall through imports. This is certainly an unintended outcome of GHG limits and may occur especially where not all countries in a region are subject to such limits.

A key advantage of this trading option is that production of renewable energy can be optimized in power plants with better technologies and economies of scale that could not be realized without the increased flexibility and increased demand of trade.

Both biomass and electricity trade will lead to GHG emission reductions in the importing country. The magnitude of reductions, and thus the viability of these two options, will depend on the GHG intensity of the energy system in the importing country, i.e., what type of

energy carrier and conversion system is displaced (baseline scenario). Usually this will be the marginal power plant that would have gone into operation (or would have increased its level of output) in absence of the electricity import. If this marginal production system is a rather inefficient coal-fired power plant, then the GHG reductions will be greater by a factor as high as three than if the marginal plant is natural gas using state-of-the-art technology.

2.3 Trading non-energy services

'Non-energy services' includes benefits from biomass energy that are unrelated to the energy as such. Examples are environmental, social, and emission reduction benefits compared to other energy sources. The emission reduction benefits are packaged in various forms and, for example, change their owner in emissions trading schemes. Industry tends to be supportive of emissions trading since it enables a given emissions target to be met at lower cost than with conventional regulations. The cost savings are possible because emission sources have more flexibility in the choice of where emissions are reduced. Sources with low cost reduction opportunities can implement larger reductions and sell their surplus reductions at a potential profit. Sources with high cost reduction options can save money by purchasing surplus reductions from other participants instead.

2.3.1 Trading Renewable Certificates.

The 'renewable certificates' supply the demand for the renewable quality of energy to meet national or regional renewable energy targets.

This option allows the "seller" country with biomass supply to produce renewable energy above and beyond its own national targets, use the excess electricitiy locally without the renewable quality, and sell the renewable quality of the electricity as a renewable certificates to the "buyer" country which needs renewable certificates to meet renewable energy commitments.

Figure 3: Trading Renewable Certificates

Much flexibility exists, as the "seller" country could also sell the electricity (without the renewable quality) separately The renewable quality of the energy can either be attached to the energy purchase, or removed and sold separately to those buyers that only need the renewable quality of the energy for their own portfolio.

2.3.2 Trading CO_2 Credits

Concerns about global climate change have led to limits on emissions of greenhouse gases. One outcome of this concern is the Kyoto protocol to the United Nationls Framework Convention on Climate Chnage (UNFCCC) which provides limits to the emissions of industrialized nations in the period of 2008 – 2012 (the "first commitment period").

The Kyoto Protocol foresees flexibility in meeting the targets, using the concept of emissions trading. For example, countries that over-comply with their targets can sell emission allowances to countries that would otherwise not meet their targets.

The Protocol also foresees that emission-reducing projects carried out in other industrialized nations ("Joint Implementation", JI) or in developing countries ("Clean Development Mechanism", CDM) can generate GHG credits that are tradable. Governments of industrialized countries with Kyoto commitments have begun to invest in JI and CDM projects, for example the Netherlands (www.carboncredits.nl) or Austria (www.ji-cdm-austria.at). Current Joint Implementation (JI) projects in the Dutch programme include mainly wind energy, biomass energy, hydroelectricity and landfill gas utilisation, and the market price is around 5 Euros per ton of CO_2.

There are several arrangements in which corporations, governments, or groups of the former either purchase carbon credits directly, or indirectly through 'carbon funds'. Examples of the fund approach are the WorldBank's Prototype Carbon Fund(PCF), www.prototypecarbonfund.org. The PCF invests contributions made by companies and governments in projects designed to produce Emission Reductions fully consistent with the Kyoto Protocol and the emerging framework for JI and the CDM. Other WorldBank carbon funds are: Community Development Carbon Fund (focussing on small-scale projects in the poorer rural areas of the developing world) and Biocarbon Fund (concentrating on projects that sequester or conserve carbon in forest and agro-ecosystems). For further details see www.carbonfinance.org.

In the case of bioenergy, trading CO_2 credits would mean that a biomass conversion plant is put in place in the "seller" country and CO_2 credits are sold to the "buyer" country. The amount of credits will depend on the baseline scenario of the "buyer" country (whereas in the cases of physical biomass or electricity trade the baseline scenario of the "seller" country was of interest).

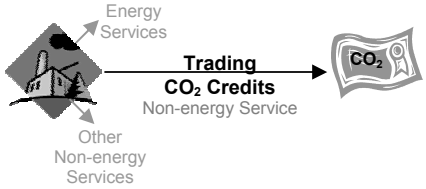

Figure 4: Trading CO_2 Credits

CO_2 trading provides the flexibility of investing in those places where energy investments (either replacement of existing facilities, or investments to meet new energy demand) are due anyway, thus reducing the costs of CO_2 mitigation.

3 CRITERIA INFLUENCING THE EFFECTIVENESS OF THESE OPTIONS

Policy and business decision makers will consider a host of criteria when determining the way to most efficiently reconcile supply and demand of renewable energy service. The following is an example of some criteria that decision makers may consider:

- [Supply Potential] What is the (longer term) potential for a sustainable supply of "services" (quantity and economic) of the exporting region (consider competition with food production, other biomass uses, pressure on existing forests (deforestation, local energy demand, …).
- [Secure Demand] How will demand for "services" develop in the importing region (e.g. competing (renewable) options, development of conversion capacity and indigenous biomass resources, future markets for certificates and credits, …).
- [Logistical Capacity] What logistic and conversion capacity is available in importing and exporting country? Examples are transport infrastructure (harbors, roads), possibilities for co-fired systems, power lines etc). Other example is existing energy infrastructure in importing country, that may be more costly to change than would be the import of certificates / credits.
- [Reference Systems] What is the reference system for importing and exporting countries? E.g., low carbon intensity for importer and high carbon intensity for exporter indicate it may be better to use biomass locally and trade bio-electricity, credits, or certificates, or a combination. Similarly, the ability to use CHP in either location can enhance then amount of fossil fuel displaced.
- [Sustainable Development] What are opportunities for matching "services" production and export with rural and sustainable development? Includes issues of job creation, local air pollution, etc.
- [Diversification] The need for diversification of the energy supply mix in exporting and importing countries.
- [Policies and Regulations] Policies (such as renewable energy or CO_2 targets and long term commitments in this respect) and regulations (e.g. trade barriers, carbon accounting rules that apply to quantify carbon credits of trading schemes).
- [Flexibility and Risks] Some options may allow more flexibility over time than others. For example, CO_2 credits and green certificates are traded at spot markets and will only be needed at the end of a longer period to close accounts, whereas physical energy carriers have to be imported at the time the demand occurs, i.e., on a continuous basis

4 CONCLUSIONS AND KEY FINDINGS

Only recently international trade of biomass or energy carriers from biomass has become part of the portfolio of energy companies and countries to increase the share of biomass in their fuel mix and to meet environmental objectives. This trade is growing rapidly and in the longer term a global market of renewable energy carriers derived from biomass may emerge. Advantages of such a market are potentially plentiful. For example, CO_2-neutral biomass resources are utilised efficiently on a large scale; new markets may generate substantial income sources for relatively poor world regions; and energy markets world-wide may become more stable due to a larger number of energy suppliers compared to the current situation. Most important may be the effect that such a market may indeed lead to development and sustainable use of the vast bio-energy production potential in many world regions.

However, physical trade of biomass (or energy carriers derived from biomass such as liquid fuels) is not always the optimal solution from both a cost and a GHG mitigation perspective. International logistics lead to higher costs and energy use compared to local or regional utilisation of resources. Although with optimised chain design (e.g. involving large scale transport, transport of high energy density commodities) such additional costs and energy uses remain modest, local use as such and subsequently trading electricity, CO_2 credits or Renewable Certificates provide important alternatives. It will depend on various essential criteria what option suits best for each combination of (potential) exporting and importing country.

However, all those options can contribute to building sustainable biomass markets and increasing the share of biomass in the global energy use. The variety of tools (physical biomass trade, electricity trade, credits and certificates) allows for selecting the most efficient mechanism for each of those unique situations.

5 REFERENCES

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