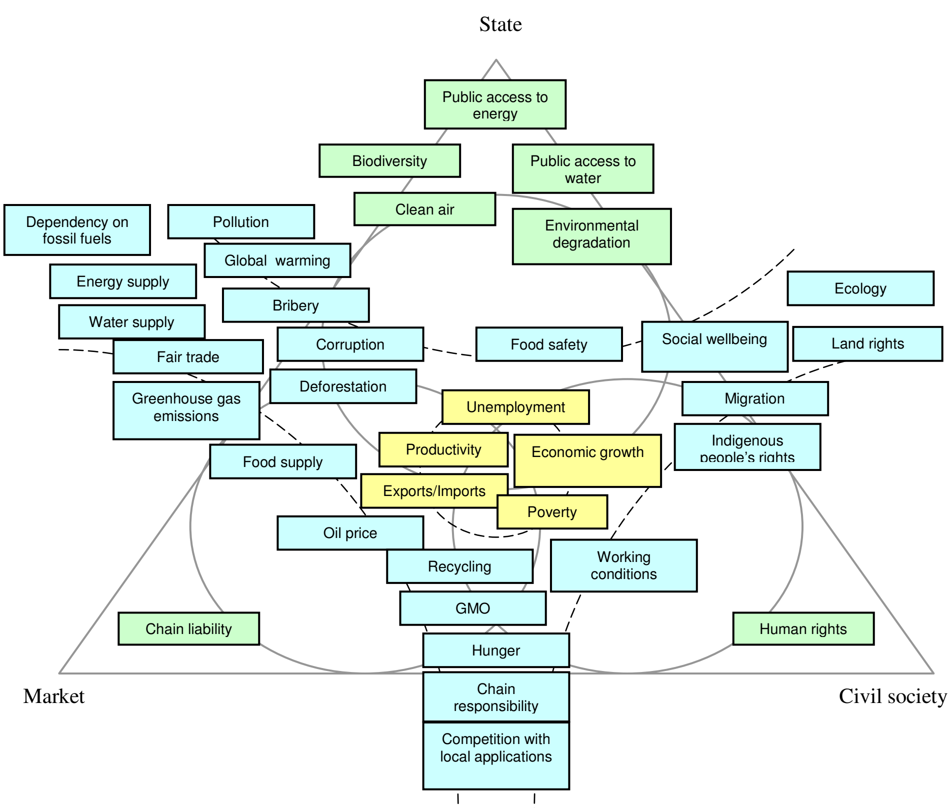
Sustainability Challenge # 15

Sustainable (bio) energy

Key Issues for biomass production and use for energy production



1. Introduction: a promising future?[1]

Biomass is seen as a promising source of sustainable energy for the future. Proponents of bio-energy state that it could contribute to climate change mitigation, diminishes dependency on fossil fuels and increases security of energy supply. In addition, it could bring energy to a part of the world's poor, stimulate local development and poverty reduction and create new markets and business opportunities. However, opponents state that bio-energy in fact worsens climate change through increased GHG emissions compared to fossil fuels and has detrimental social and environmental effects. They argue it causes global food prices to rise and threatens worldwide food security.

Several governments have set ambitious goals for the use of biomass as a source of energy for the coming years. In the EU biofuels directive, the European Parliament and the Council of the European Union set a target of a 5.75% mix-in obligation for biofuels for transport in 2010 and proposed to raise this to 10% in 2020 (EU directive 2003/30/EC: 3; Commission of the European Communities, 2007: 8). Under the Kyoto protocol the EU strives to an 8% reduction of emissions target by 2008-2012 compared to 1990 (UNFCCC, 1998: 20). The present Dutch government has the ambition to go even further and wants to become one of Europe's most sustainable and efficient energy provision economies by 2020. Therefore, the Dutch government is resolved to reduce the emission of greenhouse gases (GHG) with 30% by 2020 compared to the emissions of 1990 (preferably in European context); increase annual savings of energy from 1% to 2% annually in the coming years; and increase the part of our energy provision from renewable sources from the present 2% to 20% in 2020. Bio-energy is seen as an important contributor to the achievement of these goals (Werkprogramma Schoon en Zuinig, 2007: 2; Coalitieakkoord Balkenende IV, 2007: 20).

The EU - or the Netherlands for that matter - will not be able to meet its own targets with its domestic production, since there is simply not enough land to produce the amount of biomass needed to reach the set biomass targets, and will thus rely on imports of biomass for energy generation (Van Soest et al., 2007; Doornbosch and Steenblik, 2007; Global Bio-energy Partnership, 2007).

With an increase in the use and production of biomass expected, worries surrounding the sustainability of biomass have grown. There are several issues associated with the production of biomass that are possible to occur with significant social and environmental impacts, in particular in developing countries. The most important concerns with regard to bio-energy can be summarized in eight issue themes. These are the effects of biomass

[1] This issue dossier was written by Jasper van de Staaij. It is intended to introduce the main issues related to biomass as a source of energy (bio-energy). This introduction discusses the reasons for the increased interest in bio-energy. It identifies main issues and trade-offs. The dossier applies the Society-interface model and the Triple-E model from the book "International Business-Society Management" (Van Tulder with Van der Zwart, 2006) in analysing these issues. The dossier is intended to illustrate how this particular topic can be approached by both scientists and practitioners. Last updated: September 2008.

production and application on: food security of producing countries, land use change, greenhouse gas (GHG) balance, competition with other applications (e.g. medicines and building materials), soil, water and air quality, social wellbeing of surrounding communities and workers, local prosperity and, finally, biodiversity.

Besides these issue themes, two potential trade-offs are of concern; Food versus Fuel (a) and Economy versus Ecology (b). The Food versus Fuel trade-off is best illustrated by the question whether, with limited resources and agricultural lands, dedicated energy cultivation goes at the cost of food supplies in producing countries. The second trade-off, Economy versus Ecology, concerns the question whether countries sacrifice their own environment and natural resources in order to attain economic development and growth in order to provide a higher standard of living for its population.

2. Biomass as a source of energy

Biomass consists of any biodegradable material derived from plants or animals which can be used for the production of energy. Biomass may also include biodegradable waste and residues that can be burnt as fuel. Biomass is considered here as organic substance that was harvested from forests, agricultural plants or plantations, either from dedicated biomass production, from residues (e.g. straw) or as waste from processing forestry, plantation or farming products. It excludes organic material which has been transformed by geological processes into substances such as coal or petroleum (UN statistics division, 2008; De Vos, 2006).

Bio-energy is any kind of primary energy carrier in solid, liquid or gaseous state that stems from or is produced by processing biomass (Lewandowski and Faaij, 2006). Primary energy is energy that is contained in unprocessed raw fuels and any other forms of energy received as input in a system. Primary energies are transformed in energy conversion processes to more convenient forms of energy that can be more easily used (secondary energy). For example, when palm oil is co-fired in a power plant to generate electricity, the primary liquid energy carrier is transformed into electricity and heat (secondary energies).

Roughly, biomass for energy comes from four different sources (cf. Figure 1); it can be produced in forestry, agriculture or on plantations either as dedicated energy product or as residues and waste (Lewandowski and Faaij, 2006).

Biomass production	Forestry
	Agriculture
	Plantations
	Residues and waste

Figure 1: Origins of biomass

In general, biomass can be used in two ways as an energy source; (1) for the generation of power and heat and (2) as a transport fuel for transport vehicles (so-called biofuel). Biomass comes in different forms (e.g. solid, liquid and gaseous) and can be produced from several different types of feedstock with specific conversion techniques and characteristics. For biofuel, two types exists; *ethanol* and *biodiesel*.

Ethanol is used to substitute petrol, and can be made from, for example, maize (U.S.: "corn") or sugarcane. The US is known for its production of ethanol from maize, which is heavily supported by the government. Brazil has been specializing on ethanol from sugarcane since the OPEC oil embargo of 1973. Sugarcane from Brazil has a strong positive GHG balance, with estimated reductions of 56% (production and usage) at a cost-effective level of production (Bourne, 2007). It is regarded as one of the few independent competitors for fossil fuels, since virtually all other forms of biofuels rely on government supports or policy for their market position. The production and harvesting of sugarcane is, however, labour intense and done under tough working conditions. Mechanization is increasing rapidly and the Brazilian 'sugar belt' is expected to double in acreage in the coming decade (Bourne, 2007).

Biodiesel is used to substitute diesel. It takes less energy to process vegetable oil into biodiesel compared with ethanol, but yields are relatively low. At present, Germany is the largest biodiesel producer, using the relatively low yielding rapeseed. Palm oil, coming mainly from Malaysia and Indonesia, can also be used to transform into biodiesel. Palm oil has relatively high yields, up to 8-14 times more than rapeseed, depending on plantation management practices and responsible use of fertilizers and pesticides. American biodiesel comes mainly from soy. Biodiesel knows relatively new techniques and sources from so-called second generation biofuels (cf. box first and second generation biofuels). Examples are biodiesel from fast-growing algae, which can absorb emissions of industry or power plants, and jatropha, a crop that is used to combat desertification in Africa, grows on degraded lands and requires little attention.

Besides producing biofuels, biomass can also be used to generate *power and heat*. This is done either in dedicated installations or by co-firing in power plants together with other (fossil) fuels. A wide variety of feedstock can be used for this. Examples are palm oil and other vegetable oils, wood chips, pellets, waste from trimming, municipal waste, forest and agricultural residues.

The wide variety of origins, flows and applications contributes to the flexibility of biomass as a source of energy, but also to the complexity of the topic. Every type has its own characteristics, like performance with regard to emissions and environmental performance.

The competitiveness of biomass has improved significantly in recent years due to rising prices for fossil fuels (especially oil, but also natural gas and, to a lesser extent, coal). Governmental incentives, the development of CO2 markets (emission trading), development of more efficient conversion techniques, ongoing innovation and learning, and subsequent cost reductions have also contributed to its competitiveness. Today, 'biomass is the most important *renewable* energy option at present and is expected to maintain that position during the first half of this century and likely beyond that' [emphasis added] (IEA Bioenergy, 2007: 10).

First and second generation biofuels

A distinction is made between first and second generation biofuels. First generation biofuels include fuels that are produced using food crops, like sugarcane, grain and corn for ethanol or rapeseed and other edible vegetable oils for biodiesel. First generation biofuels only use a part of the original plant mass for their production. This is the same part which is relevant for food production, namely starch or oil of seeds (EPEA, 2007).

Second generation biofuels are distinguished from first generation by the fact that they do not use inputs that can also be used as food. Second generation biofuels include ethanol derived from cellulose and synthetic fuels obtained after gasification of whole plants (EPEA, 2007). These technologies also include fuels from residual biomass materials, like agricultural waste. Innovative, second generation biofuels are gaining interest fast and are embraced as a more sustainable solution compared to first generation biofuels. However, they are not economically viable yet (Doornbosch and Steenblik, 2007; EPEA, 2007).

Most of the issues associated with bio-energy and biofuels in specific are related to the first generation. It is argued that first generation biofuels create more problems than they solve. These problems include: increase in greenhouse gas emissions, deforestation, enhanced food insecurity, soil degradation, accelerated depletion of natural resources, decreased biodiversity and creation of more poverty (EPEA, 2007; Bindraban and Pistorius, 2008).

Second generation technologies have a smaller impact on these problems and even prevent competing claims on land relating to food production, preventing a trade-off between food and fuel. Nonetheless, second generation technologies need to be developed further before they can be used on a large scale, since costs still remain a barrier (Doornbosch and Steenblik, 2007). Some of the issues associated with first generation biofuels are due to the nature of short-rotation crops, like soil degradation and decreased biodiversity. Fuels produced from perennial crops also reduce the intensity of the problems listed above (EPEA, 2007).

Table 1: Examples of first and second generation biofuels (Source: EPEA, 2007)

Biofuels of the first generation	Biofuels of the second generation
Ethanol from grain (US and EU)	Cellulosic Biomass-to-Ethanol
Ethanol from sugar beet (EU)	Biomass to Liquid
Ethanol from sugar cane (Brazil)	Methanol
Biodiesel from rapeseed (EU)	Dimethyl ether

Besides the fact that second generation technologies are not economically viable yet, prior investments, made by companies currently involved in first generation biofuels, prevent a direct switch to total second generation dedication. However, it is argued that existing facilities that were built for first generation biofuels can be easily adapted to second generation biofuels processing facilities (Personal communication André Faaij, December 12, 2007). With current infrastructure already existing and due to the problems associated to first generation biofuels, second generation biofuels deserve to be embraced as a sustainable solution. First generation biofuels should only be used in case its negative effects can be prevented completely, or in order to gain the required knowledge and expertise to develop second generation technologies.

Biomass as a source of energy has received much attention lately, from scientific communities to popular media. In newspaper articles there is a strong debate on bio-energy and mainly on the effects of biofuels on food prices and whether they are really 'green' (The Times, September 22, 2007). Recent examples, such as the tortilla crisis in Mexico (Financial Times, March 5, 2007), beer prices rising because of increase prices of raw materials (Financial Times, February 26, 2007) and other food prices increases (The Economist, August 25th, 2007) are just a small selection of situations mentioned by media to illustrate the effects of the growing biofuels production, albeit often more complex than suggested by the media. But, rightly so, concerns are expressed on the sustainability of bio-energy and the impact of large-scale production.

3. Pros and cons for biomass as a source of energy

Motivations to use biomass as a source of energy are abundant; however, there are also worries about the sustainability of biomass. Up- and downsides vary according to the type of feedstock and its origin.

The following section describes all the pros and cons in the debate surrounding bio-energy. These arguments were extracted as follows. First, an overview of all involved stakeholders and arguments was constructed. This was done by gathering all relevant publications on bio-energy from January 2007 till January 2008. Publications included research reports, scientific papers and articles, and opinion papers and statements. These publications were gathered through experts, the research centre of the Dutch Ministry of Economic Affairs and an internet search. Besides this, publications presented or discussed during meetings and conferences were collected. Newspaper articles were also gathered, using a LexisNexis subscription from the Ministry of Economic Affairs on articles related to sustainable energy. The subscription included Dutch national newspapers (e.g. Financiëele Dagblad, De Volkskrant, Trouw), as well as local Dutch newspapers (e.g. Agrarisch Dagblad) and international newspapers (e.g. International Herald Tribune). Newspaper articles were collected from May 2007 on. This was done in order to complement suggestions from experts on main sources of information and to ensure the inclusion of relevant actors and arguments.

From this preliminary overview the main actors were identified, using the help of experts. The main actors are categorized in table 2 by organisation type. These will also be discussed in the section 'quantification of arguments'.

Table 2: Key sources of arguments

International Institutions	**Government**	**NGOs**	**International initiatives**
UN-Energy OECD FAO IEA Bioenergy GBEP	Dutch government European Commission	Oxfam Novib Friends of the Earth WWF Greenpeace	RSPO

Identification of main stakeholders was done by a selection on the basis of the type of organisation, its international reputation, its knowledge related to the topic, its presence in the debate and its relative importance in its community. This was done in order to exclude outliers and to test the arguments made with other sources of information.

Pros: arguments in favour of bio-energy

The most important reasons and arguments in favour of biomass as a source of energy:

- *Avoidance of emissions of greenhouse gasses* (GHG). Using bio-energy instead of fossil alternatives realizes a reduction of GHG emissions, thus contributing to mitigation for climate change. Biomass absorbs as much carbon during its growth as is released when burning it, thus making it a carbon neutral source of energy. This is referred to as the short carbon cycle, which is distinctive from the long carbon cycle (fossil fuels) which

store carbon for a longer period of time.
- Bio-energy provides an alternative to fossil fuels, which stems from regions with relatively unstable political regimes. Switching to bio-energy better enables importing countries to improve s*ecurity of supply* and *diversification of supply*, making importing countries less dependent on oil and gas exporting countries. Countries with large biomass potentials (e.g. Canada, Scandinavia, Eastern Europe, South America, South East Asia and Africa) in general have better relations with the West (Van Soest et al., 2007). Most countries in the world have available biomass or biomass production potential, making it a more evenly spread energy supply option compared to fossil fuels (IEA Bioenergy, 2007).
- The production of biomass can *stimulate local development and poverty reduction*, since a part of the money that is now exported for oil can be diverted 'to local agricultural and manufacturing sectors, where it would strengthen economies and generate employment' (UN-energy, 2007; 4). 'The bio-energy exporting countries benefit from the opportunities that the production and export of bio-energy can provide, especially to rural communities, in terms of market access and enhanced socio-economic development' (Lewandowski and Faaij, 2006: 84). Energy dedicated crops might also provide a diversification of rural livelihoods (Global Bio-energy Partnership, 2007).
- Bio-energy provides *opportunities, new markets and expansion* through development of biomass technologies.
- Bio-energy might *bring energy to a part of the world's poor* in a clean and sustainable way. It has the potential to significantly decrease health problems related to indoor air pollution from cooking and burning of conventional fuels in developing countries, one of the major causes of ill-health and mortality (Global Bio-energy Partnership, 2007). In developing countries '[w]omen [...] may spend more than one third of their productive life collecting and transporting wood' (Global Bio-energy Partnership, 2007: 3). A clean and more effective provision of energy might provide time and opportunity to divert time and energy to other activities, such as education.
- Growing (perennial) energy crops on degraded lands, might improve these lands, providing additional agricultural products and reducing the risk of erosion, while creating an even more favourable habitat for biodiversity compared to conventional crop production (UN-Energy, 2007; Global Bio-energy Partnership, 2007).

Cons: worries about the effects of bio-energy

The following are the main worries (potential downsides) related to large-scale production and use of biomass as a source of energy:

Environmental challenges:
- The GHG emissions, considered from well-to-wheel, might be not as positive as thought. Depending on conversion, farm and harvest practices (for example the use of agro-chemicals and fertilisers) emissions might even be higher compared to its fossil alternative. 'Where forests are cleared to make way for new energy crops, the emissions can be even higher than those from fossil fuels' (UN-Energy, 2007; 5). Draining peat lands for the development of new plantations might release such amounts of carbon and

other GHG that total emissions from biomass might be several times higher (Hooijer et al., 2006).
- The production and harvesting of crops for bio-energy might go at the cost of biodiversity or other natural high conservation value areas.
- The production and use of biomass might lead to pollution of soil, water and air and/or a decrease in soil, water and air quality.

Social challenges:
- The set-up of production, scale and degree of mechanization, determines the new employment opportunities. When switching to energy cultivation the question is whether it really provides *additional* jobs. Large scale, highly mechanized farms may provide limited possibilities for unskilled workers (Global Bio-energy Partnership, 2007).
- There is the worry that 'the bulk of the profits go to a small portion of the population' (UN-energy, 2007: 4), and that large-scale exports might lead to energy supply shortage in developing countries (Lewandowski and Faaij, 2006).
- Energy crops might compete with food supply, raising food prices and endangering food security (availability, accessibility, stability and utilization of food), mainly in developing countries (Elobeid and Hart, 2007).
- Energy crops might compete with other local or national applications (energy, provision of income from nature, building materials, medicines).
- Biomass production for energy purposes might compete with (quality farm) land, possibly increasing land prices.
- Biomass production for energy might claim and use scarce resources, that are needed elsewhere, like water. Some bio-energy crops rely heavily on irrigation. This might lead to a competition for water (and rain fed quality farm land). Countries with a growing population and changing diets as a result of increased incomes, like China or India, already have a strain on water supply. Harvesting biofuels might even further intensify this pressure, leading to both environmental challenges, due to the effects of irrigation, and to social challenges, with different cities and agricultural communities competing for water (IMWI, 2007).

Economic challenges:
- The largest part of the growth in bio-energy thus far is driven by governmental policy and incentives. In order to be a real alternative in the long term to conventional fuels and energy from fossil fuels, bio-energy needs to be economically and commercially viable (Global Bio-energy Partnership, 2007).
- The US and EU policy are to a large extent still aimed at protecting domestic production. Prices are kept artificially high hindering trade and an efficient system of biofuels production and trade (Doornbosch and Steenblik, 2007) In order to benefit fully from bio-energy opportunities, barriers to bio-energy trade and import/export must be decreased or broken down.
- Some biomass flows rely on technological breakthroughs (2nd generation) to be economically viable, making their economic outlook seems fragile, since their necessary technological breakthroughs are uncertain (Doornbosch and Steenblik, 2007)

It is clear that to embrace the benefits of bio-energy requires a truly sustainable implementation or it might prove to be highly destructive (UN-Energy, 2007). Table 3 presents an overview of the (potential) up- and downsides related to (the large scale production of) biomass.

Table 3: Tensions surrounding biomass

Biomass Tensions	**(Potential) Upsides**	**(Potential) Downsides**
Forestation	Reforest/replant degraded lands	Deforestation and erosion.
By-products	Useful application for residues and by-products.	Soil depletion (residues might be required for mineral and soil conservation)
Dependency	Decreases dependency on conventional fuels, often from relatively unstable political regions	-
Green House Gas (GHG) emissions	Less GHG emissions	Marginal decrease in GHG emissions or even increase in emissions
Energy supply	Add to the world supply of energy. Bring energy to a part of the world's poor in a clean and sustainable way	Energy supply shortage in developing countries
Local development	Stimulate local development (employment and income). Divert export of money for energy to local applications.	Deters socio-economic environment of local communities. Shift of landownership to big farms being owned by foreign investors
Employment	Generate employment	No additional jobs/at the cost of existing jobs/only jobs for skilled labourers
Biodiversity	Increases biodiversity	Decreases biodiversity
Food supply	Provides (additional) income	Endangers food supply or other local applications (e.g. building materials and medicines). Rise of food prices
Soil, water, air quality	Production potential in rehabilitated marginal and degraded land preventing top soil loss and erosion.	Deters the quality of soil surface, ground water and air
Resources	Sustainable production possibly contributes to water retention, prevents soil erosion and top soil loss and increases productivity.	Depletion of scarce resources (water, quality farm land)

4. Weighting the arguments

The arguments in favour and challenges of biomass as a source of energy are not equally balanced. For example, palm oil has a bad reputation if it comes to its GHG performance. However, illustrated with the following example, in practice this is not always correct. If an oil palm plantation is placed on deforested lands or drained peat lands, this destroys the carbon stocks above and underground. Including these effects means that gains in emission reduction compared to fossil alternatives are strongly reduced or even negative. This means that the usage of palm oil as an energy source (or for any other appliance for that matter) even contributes more to global warming than fossil fuels, instead of mitigating it. Palm oil, however, delivers quite effective returns in terms of output per acre, which is actually several times higher than comparable crops like rapeseed oil or soy oil. When attention is paid to the location of the plantation and no forests are cleared to establish plantations, nor peat lands are drained, energy from palm oil is indeed capable of displacing emissions from fossil fuels. This tentatively indicates the specificity of the circumstances and conditions required for sustainable production of palm oil. In order to quantify the challenges and the arguments in favour and against bio-energy, the following section summarizes the positions of leading actors in the societal spheres.

Civil Society

Some NGOs are actively engaged to prevent the possible wrongs and to embrace the potentials of biomass. WWF and OxfamNovib are, for example, involved in initiatives like RSPO to cooperate with governments and companies to develop a sustainable approach for the cultivation, processing and use of biomass. Others, like Greenpeace and Friends of the Earth, believe that there are more negative impacts than positives and call for a moratorium.

Scientists are not aligned either. Bio-energy is such a general concept, with so many different issues associated, that involved scientists from different backgrounds and perspectives, have totally different opinions. In the Netherlands one side argues that bio-energy is the most important option for sustainable energy in the near future, like André Faaij (UU). Others argue that other alternatives, like solar energy, are much better suited, like Rudy Rabbinge (WUR).

Market

Biomass trade is expected to increase in the coming years (Lewandowski and Faaij, 2006; MVO, 2007). The most important reasons for this are disparities in costs and potentials in countries and regions (Delzeit et al., 2007). Within the EU context companies have an mix-in obligation (5.75% biofuels by 2010). This puts extra importance on the call for sustainable biomass and will create an increase of import of biomass in the coming years. The market is aware of the business opportunities, but also wary of reputational damages that might result from the use or production of unsustainable biomass. Several multi-stakeholder initiatives are taken up in order to promote and ensure sustainable use of biomass – although some not exclusively aimed at bio-energy - such as the Roundtable on Sustainable Palm Oil (RSPO), the Better Sugarcane Initiative (BSI), the Roundtable on Responsible Soy (RTRS), the Roundtable on Sustainable Biofuels (RSB) and the BIOPEC initiative (Biomass Production, Export and Certification).

Government

In 2007, a Project group 'Sustainable Production of Biomass', chaired by Jacqueline Cramer – before she became minister of environment - developed a framework with a set of criteria to define the sustainability of large scale production of biomass (also referred to as the Cramer-criteria) (Project group 'Sustainable Production of Biomass', 2007). The Dutch government wants to ensure the sustainability of biomass by incorporating these sustainability criteria for biomass into relevant policy instruments. Critics, however, argue that due to possible conflicts with the WTO-agreements on Technical Barriers to Trade (TBT) - specifically, with the implications for non-product related Process and Production Method (npr PPM) standards - the government cannot impose legal demands with regard to sustainability, as this may be seen as trade restrictive. Within the EU the proposed mandates are heavily debated and members of Parliament call for more stringent sustainability requirements to be incorporated in the (proposed) targets.

International institutions

Also international institutions have programmes that deal with (the sustainability of) bio-energy. To name the most leading; the United Nations (UN) has its UN-Energy, the G8 has its Global Bio-energy Partnership (GBEP), the International Energy Agency (IEA) has its IEA task 40 on Bioenergy trade (IEA Bioenergy) and the Food and Agricultural Organization of the UN (FAO) has its International Bio-energy Platform (IBEP). Positions of international institutions differ. In a paper that focuses on biofuels, written for the Organisation for Economic Co-operation and Development (OECD) by Doornbosch and Steenblik (2007), it is questioned whether biofuels are better than the alternative they aim to displace or whether 'the cure [is] worse than the disease'. A publication from UN-Energy (2007) on the other hand, concludes that bio-energy should continue to be discussed as a serious option for the future, although it requires a sustainable implementation. The FAO and GBEP (2007) state that advantage should be taken of the current momentum to embrace sustainability criteria in the development of large-scale bio-energy production. The IEA sees bio-energy as the most important option for renewable energy in the future (IEA Bioenergy, 2007).

At this point in time the discussion on bio-energy includes considerable emotion and diverging perceptions. People are worried about impacts of large-scale production and use, and there is a strong need to make a distinction between facts and figures. Many 'facts' are uncertain and opinions and interests are often directly conflicting. At the end of this chapter an inventory is made of the issues on which there is (some form of) consensus and those where there is little.

5. Global Potential

At present global use of energy is around 500 EJ (ExaJoule = 10^{18} J), of which approximately 78 EJ comes from biomass - 46 EJ from 'new' biomass conversion, for example from waste incineration, co-firing and bio-fuels, and 32 EJ from 'traditional' biomass conversion, such as wood and dung burning for cooking and heating. Expectations are that the energy demand is likely to double or even triple during this century (IEA, 2006; Van Soest et al., 2007). In developing countries biomass makes up some 35% of the primary energy. In Africa it might even go up to 70%, with excesses of countries where 95% of the household fuel is biomass (e.g. the Democratic Republic of Congo) (Global Bio-energy Partnership, 2007; Van Soest et al., 2007). The usage of energy in the Netherlands is approximately 3300 PJ (PetaJoule = 10^{15} J), with around 75 PJ from biomass (Van Dril and Elzenga, 2005).

Estimates of the potential amount of energy that biomass might provide vary significantly and go up to 500-1000 EJ/yr and even more (Van Soest et al., 2007; Hoogwijk et al., 2003; Hoogwijk et al., 2005). In a recent study from the OECD, Doornbosch and Steenblik (2007) take into account the available land that might be dedicated for bio-energy crop production and come up with a more realistic potential for 2050 of 110 EJ from dedicated energy growth and another 135 EJ from residues and wastes, a total of 245 EJ. This is in line with the prognoses of the IEA Bioenergy (2007). It estimates that the total energy potential from biomass (both dedicated energy crops and residues) is between 200-400 EJ up to 2050. This estimate is under an average potential scenario where the world aims for a large-scale development of bio-energy on current agricultural land, without jeopardising global food supply. Still, the potential range is quite large, between 40 and 80% of the current global use of energy.

The availability and potential assessments vary significantly, because of several factors and assumptions, which have to be taken into account. An example of such a factor is the land available for 'energy cultivation' in the future. This is influenced by a growing world population that needs more food; a growing economy that comes with a rise in standards of living and changing nutrition patterns; effects of climate change on agricultural (quality) lands; sustainable management of scarce resources such as water and quality soils; productivity improvements in agriculture and future yields; potential for cultivation on marginal and degraded lands; potential of residues and by-products; and so on. Even though there is a large variation in the valuations of potentials, all studies infer that there is a significant potential for bio-energy, and several scholars seem convinced of a sustainable production potential.

6. Biomass: What is at stake?

There are several issues that surround biomass as a source of bio-energy. These are described and analysed using the societal triangle and issue classification of Van Tulder with Van der Zwart (2006).

According to Van Tulder with Van der Zwart (2006: 170) 'issues [do] not only define the stakes, but also the bargaining arena'. Each issue attracts different stakeholders and actors with different agendas. Mapping the issues that are related with bio-energy raises awareness of the potential up- and downsides and it provides insight in the 'bargaining arena'. In addition, it enhances comprehension of the developments surrounding biomass and ultimately enables to cope better with the challenges, prevent negative effects and embrace its benefits. To define the concept 'issue', Van Tulder with Van der Zwart (2006: 157) combine several definitions and come up with the following description of an issue: 'Issues are: Unresolved subjects of societal discontent that exist due to regulatory gaps; which involve great expectational gaps; leading to controversies; which (could) have an impact on the company and its reputation.' Figure 2 depicts this definition.

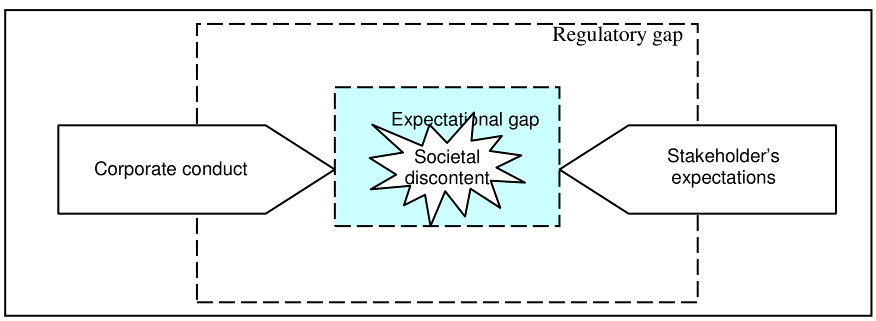


Figure 2: Issue

Issues exist because there is not a clear set of rules, laws or regulations on a societal matter. Different actors involved hold different notions on how things should be and how they actually are; there is a gap in expectations. Every issue experiences a similar 'coming into existence' and rise. Issues exhibit life cycles that are characterized by four stages. In the *birth stage* the issue comes into existence and public interest is little. In the *growth stage* the issue receives increased attention. In the *development stage* important stakeholders get together and start working towards a solution. In the *maturity stage* the issue has to be solved and public attention is high. After these four stages, the issue can either be settled and disappear, keep going on without an adequate solution or can rise up again (Van Tulder with Van der Zwart, 2006). Figure 3 presents this issue life cycle.

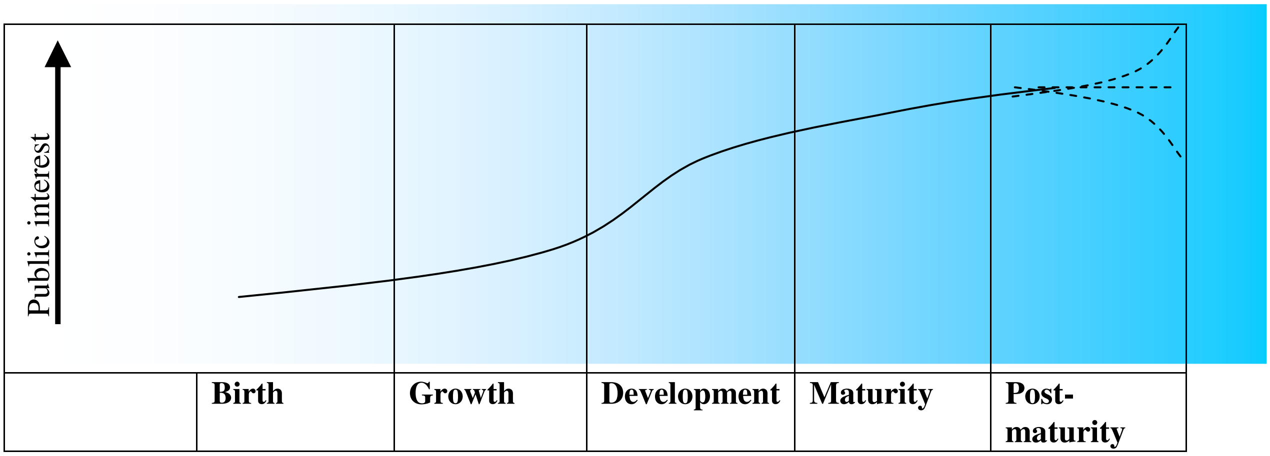


Figure 3: Issue Life Cycle

The issue of bio-energy is still in a relative early stage – the *growth* stage. Public attention is increasing and more and more stakeholders and societal actors are getting involved. Facts and definitions are, however, not yet established and structural solutions can not be expected in the short term. Issues are a part of the bargaining society and they fuel negotiations. Stakeholders still need to determine who is responsible. In order to indicate who the involved actors are that bear responsibility for an issue Van Tulder with Van der Zwart (2006) distinguish three kinds of responsibility; primary responsibility issues, interface responsibilities, and growth issues. Using this distinction, the different issues of bio-energy are identified.

6.1 Primary responsibility issues

Primary responsibility issues are issues which have a primary responsible actor or, in other words, which are in the responsibility domain of one societal sphere (either state, market or civil society) (cf. chapter 10 of van Tulder with v.d. Zwart, 2006). These issues are usually less surrounded by controversy than interface or growth issues – which involve actors from more than one societal sphere - since it is clear who is responsible. For example, access to energy can be considered a public good and could therefore be attributed as primary responsibility issue to the government.

State:
'The primary responsibility of government is to represent the common interests of citizens' and it is the state's responsibility to ensure the 'effective provision of public goods' (Van Tulder with Van der Zwart, 2006: 173). In general this entails ensuring national security, providing a solid legal framework, preventing public bads (negative externalities) (such as environmental degradation and pollution) and to provide sufficient public access to basic resources (such as energy, water and clean air). In the case of biomass this means that the government as primary responsible actor should enable the

access to (clean and sustainable) energy and at the same time ensure that the production and use of energy does not cause harm to the environment.

Public goods and external effects

According to Delzeit et al. (2007) aims like protection of climate and diversification and security of energy supply can be regarded as public goods. They state that ‘environmental policy aims to reduce external effects by using renewable energies as substitutes’ (pp. 3). They stress the importance of preventing the creation of new negative externalities, as a result of large scale production of biomass.

Civil Society:

The primary responsibility of civil society lies within the consequences of the choices made by citizens. As Van Tulder with Van der Zwart (2006: 174) put it, ‘Individuals’ primary responsibility pertains to the way they deal with global issues that can be related back to themselves’. Producers can pass responsibility back to customers, by informing them of the impacts of (the production of) their product. This only applies when individuals ‘have access to information about the consequences of their choices’ (ibid), giving them the chance to choose not to consume a product. The question remains who is responsible for providing this information. In the case of a product the producer might be held responsible for this. With issues that are less quantifiable or explicit it is often less obvious when an individual consumer might or should have known about the consequences. This implies even more for indirect consequences, since ‘reliable information on the *indirect* consequences of particular consumption patterns is not that readily available.’ (Van Tulder with Van der Zwart, 2006: 174).

Market:

‘The primary responsibilities of firms and managers are related to the efficient and effective operating of markets in order to produce and distribute goods and services that society needs.’ (Van Tulder with Van der Zwart, 2006: 174). Companies are given considerable room by societies to do this. However, when they do this in a way that is not approved by society they run the risk of losing their ‘license to operate’. Figure 4 depicts the primary responsibility issues related to biomass for each societal sphere.

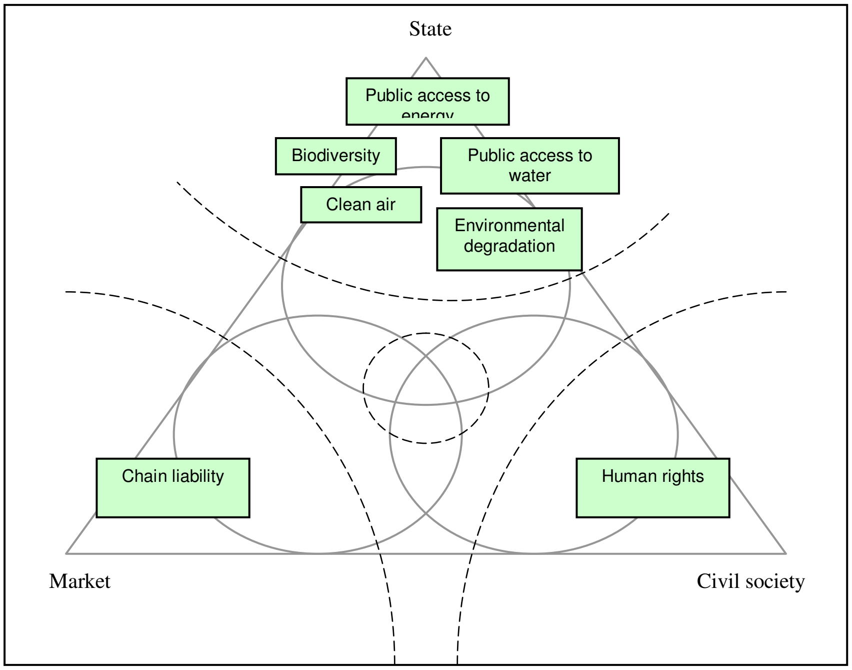


Figure 4: Primary responsibility issues related to biomass production and use for energy production

6.2 Interface responsibility issues

'The most pervasive global issues develop along the societal interfaces where the absence of adequate institutions is particularly tangible. No actor bears complete and sole responsibility for creating the problem, which makes the search for a solution an intricate process as well.' (Van Tulder with Van der Zwart, 2006: 177). They argue that the core of interface issues consists of distributional questions. Hunger, for example, is not caused because there is a lack of food in the world, but because of unequal distribution. Because it is unclear who the actor is that bears primary responsibility for addressing the issue 'the focal point of disputes between NGOs, governments and firms is often on the question of who has (or might have) the 'moral authority' in a particular issue' (Van Tulder with Van der Zwart, 2006: 177 – 178). Figure 5 depicts the interface issues related to biomass.

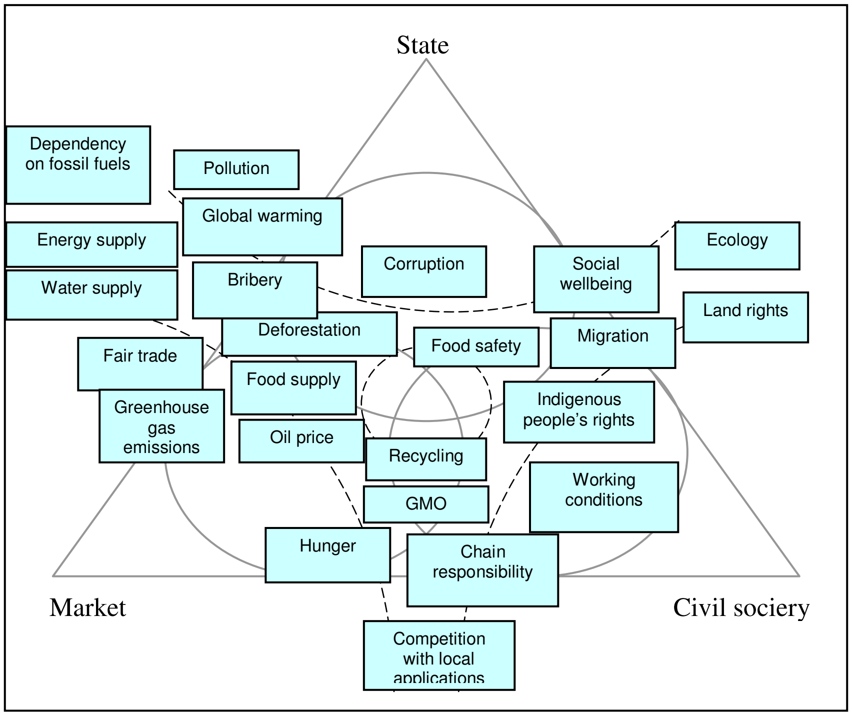


Figure 5: Interface issues related to biomass production and use for energy production

Growth issues

A growth issue 'affects all societal spheres and has significant spillover effects for all other interface issues.' (Van Tulder with Van der Zwart, 2006: 188). They can be 'positioned at the core of the societal triangle and, therefore, involve shared responsibilities for governments, firms and citizens.' Examples of growth issues are unemployment and poverty, which are mutually connected. Structural unemployment affects all spheres of society and creates poverty. Proponents of bio-energy emphasize that biomass production provides employment and development in developing countries. Opponents state that employment is limited to few - mainly the landholders with large plantations - and fear for out competing smallholders and local communities by large companies (Personal communication Diego Cardona, Friends of the Earth Colombia, December 11, 2007; Carbon Trade Watch et al., 2007). Poverty is an issue that is present in almost all interface issues. It is strongly correlated with a lack of human assets and a high degree of economic vulnerability. Eradicating extreme poverty is the first of the UN Millennium Development Goals for 2015 (www.un.org, 2007). Poverty offers room for bribery and corruption, and might force people into unsustainable behaviour, which might lead to deforestation, pollution and environmental degradation. Poor people have a relevant weak bargaining position, which affects working conditions and their rights. 'Poverty triggers unsustainable agricultural practices and a less than efficient use of other scarce resources' (Van Tulder with Van der Zwart, 2006: 189). Biomass production might lead to poverty alleviation by providing work and diverting money exported for fossil fuels to local production of energy or by generating income through exports. On the other hand if only a few benefit from the production of biomass, it might lead to more poverty, taking away means for income and survival. For example, when forests are replaced by plantations this deprives people dependent on the forests from their means of existence (mainly women and children since they are often marginally rewarded for work so they look for other means of income) (Biofuelwatch, 2007). Figure 6 depicts the relevant growth issues for biomass production and use.

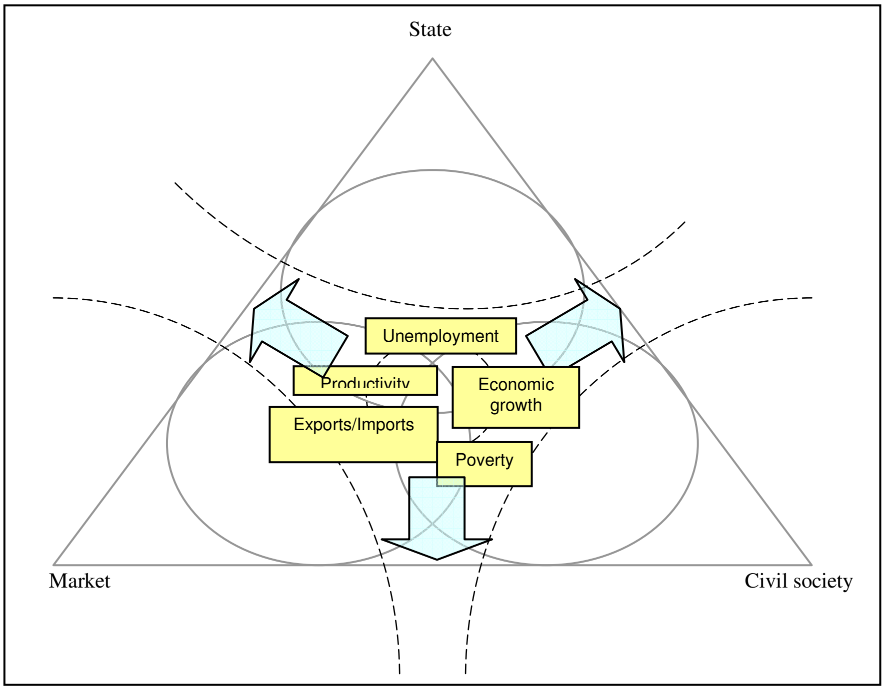


Figure 6: Growth regime issues related to biomass production and use for energy production

Issues related to bio-energy

In the previous section the issues surrounding bio-energy were identified using the societal triangle. Figure 7 shows all the issues that should be taken into account when dealing with biomass.

Remarkably, most of the primary responsibility issues fall in the domain of the government. These issues deal with the provision of public goods. The growth issues affect all spheres in society and this contributes to its complexity (4 out of 5 are dealt with by the Cramer criteria). Most interface issues are on the interfaces of the market, suggesting that companies should and can be a part of the solution. The question remains who wants to be problem owner of the integral and global issues? Figure 7 presents all issues related to bio-energy, arranged by responsibility owner. These issues are diverse. They do not have the same importance, priority or scale. The following table lists the issues and shows their scales.

Table 4: List of issues associated with biomass

Type of Issue	Issue	Scale of the issue (g) = global issue
Primary responsibility issues	Public access to energy	(g, n, l)
	Biodiversity	(g, n, l)
	Clean air	(g, n)
	Public access to clean water	(g, n, l)
	Environmental degradation	(n, l)
	Chain liability	(g, n)
	Human rights	(g, n)
Interface issues	Dependency on fossil fuels	(g, n)
	Pollution	(n, l)
	Energy supply	(n, l)
	Global warming	(g)
	Bribery	(n, l)
	Corruption	(n, l)
	Water supply	(n, l)
	Fair trade	(g)
	Deforestation	(g, n, l)
	Greenhouse gas emissions	(g, n)
	Food supply	(n, l)
	Recycling	(n, l)
	GMO	(g, n)
	Hunger	(g, n)
	Chain responsibility	(g, n)
	Competition with other applications	(n, l)
	Food safety	(n)
	Social wellbeing	(g, n, l)
	Ecology	(g, n)
	Land rights	(n, l)
	Migration	(g, n)
	Indigenous people's rights	(n, l)
	Working conditions	(n, l)
Growth Issues	Economic growth	(n, l)
	Unemployment	(n, l)
	Productivity	(n)
	Exports/imports (non-trade barriers)	(g, n)
	Poverty (reduction and local development)	(g, n, l)

7. Biomass: The trade-offs

Besides the separate issues, there are also two main trade-offs to be considered; the potential trade-off between food and fuel and between people, profit and planet.

7.1 Food vs. fuel

The available area suited for agriculture in the world is limited. With growing production of dedicated bio-energy crops, at present productivity rates in agriculture there will be a conflict between areas and croplands for the production of food and the production of energy crops. The fear is that the cultivation of energy crops displaces other applications, resulting in new farmlands, further pushing into forests or areas with high conservation value, or an increase in food and land prices or even a decrease of food supply.
The question whether it is food *or* fuel should be regarded in light of the following: (1) The issue of food supply and hunger has to do with an ineffective distribution of food. Figures from the FAO show that world food production is high enough to provide every human inhabitant with ample resources. (2) The discussion and worries about claims on scarce resources are not new. In earlier years there was a discussion on using food as an input for less vital applications, such as brewing beer. More recently, an increase in food prices and extra pressure is put on the global supply of food, due to changing food patterns and an increase in meat consumption in growing economies, such as China. Biomass is one of many competing claims on food. (3) It is remarkable that the discussion and media attention of claims on food focuses on biomass, because bio-energy flows at the moment are still relatively small.

Taking the prior into account, in coming years when possibly a larger and more structural use of bio-energy is in place, competition with food should remain under close investigation. This in order to avoid a situation that is depicted by the emotionally compelling statement: 'food *or* fuel'. Given the limited scale of bio-energy at the moment, however, it is still a matter of food *and* fuel. 'Hunger today is largely a result of social-political failures such as gross inequality, conflict, corruption, and lack of services for the poor rather than a lack of fertile land or fertilizer, and simply keeping world grain and sugar prices low is not going to solve those problems' (Widenoja, 2008: 2).

7.2 Economy vs. Ecology

In order to reduce Europe's or the northern/western world's ecological footprint, biomass is imported. However, it is unclear whether this leads to pollution, soil depletion, loss of biodiversity, or increase in emissions in the producing countries. These countries, which are often developing countries, embrace this possibility in order to improve the social circumstances of the country through economic development. According to Van Tulder with Van der Zwart (2006: 178) ecology is 'a trade-off between public and private interests'. In developed countries ecology and environmentally healthy living conditions might be seen as a public interest, while private interest might encourage people to act in a non-environmentally sound way. This might be especially true in developing countries, where there are abundant natural resources and populations live in poverty. If Western policies with regard to bio-energy are, amongst others, aimed at climate change mitigation, but *de facto* move the environmental pressure to the third world, that take this opportunity in order to improve livelihoods, it cannot be deemed sustainable.

7.3 Direct and indirect effects

There are different kinds of effects of large-scale biomass productions that should be taken into consideration. Two distinctions are of concern; *direct* and *indirect* effects and *micro* and *macro* effects.

Large-scale biomass production has effects at different levels. This study distinguishes between two effects; Micro effects, the effects at company level (on-site) and effects at a higher level (off-site), the macro effects. The effects at company level involve the immediate effects of a particular production location or plantation on the direct surroundings. These are effects on local communities or the local environment and are the direct result of a company's actions. Often micro level effects are also direct effects. The individual company or producer bears direct responsibility for these effects.

Additionally, also effects at other levels may occur. These effects are outside the immediate sphere of the production process, the macro effects. In the case of biomass production, these effects primarily concern effects on food security and competition with other applications. These effects can only be observed at a macro level, rather than on company level. An individual company does not have direct influence on these effects, since it exceeds the level of the production facility and its immediate surroundings. Often effects at a macro level are indirect effects of a company's actions. The company might have some responsibility, but is often not solely responsible for the problem. It is hard to determine the exact cause of the problem. For example, the decision to use a certain location for dedicated energy cultivation can lead to land use change. In case the location for the biomass processing unit (BPU) is converted, it is a matter of direct land use change. It is relatively easy to determine whether this is accepted or not by looking at the impacts. It becomes more difficult when dedicated energy cultivation displaces other types of land use, for example, food production. If this land use, in turn, converts another location for its own purpose there are two options; either land is used that was idle, and had no significant economic, social, cultural or environmental value; or land is converted that had value of any kind. In the latter situation it is hard to determine what the responsibility of the company that developed the BPU exactly is, and to what extent it is part of the problems. Main worries with regard to land use change are related to the indirect effects.

The two potential trade-offs are illustrative for the types of effects that biomass production might have. Economy vs. Ecology is a trade-off that stems from direct and micro effects that have a negative impact. Food vs. Fuel is a trade-off that is illustrative for indirect effects of biomass production at macro level.

8. Importance and impact of the issue themes

The importance of the issues associated with the large-scale production of biomass differs. This section distinguishes their importance.

1) The most important issue to be dealt with is connected to the primary argument to use biomass as a source of energy; the greenhouse gas balance of bio-energy. If bio-energy has a negative greenhouse gas performance in comparison to its fossil alternatives - in other words, if bio-energy, considering the whole chain from production to end-use, de facto emits more greenhouse gasses - it would be irrational, not to mention irresponsible, to continue the use of bio-energy. It needs to be absolutely clear in the public debate what the GHG performance is in order to pursue large-scale deployment of bio-energy. A carbon and GHG balance assessment is fundamental and will have to be carried out for each flow of biomass from well-to-wheel. A required reduction – as a minimum requirement for, for example, subsidies - might be adapted throughout the years as techniques evolve and improve, so as to stimulate additional reductions. Production of biomass (including preparation of the location, carbon storage under and above ground, use of fertilizers, pesticides and machinery) has the biggest impact on the emission balance.

2) The second most important issue, is the issue that is strongly related to poverty; competition with food. This issue attracts most media attention and public interest. It is also the issue where most emotions and perceptions are present in the debate. Still, it cannot be the case that in order to fulfil Western energy targets, food supplies in producing countries are endangered as a consequence.

3) Closely related to the previous issue is land use change. Land use change might occur when there is a competing claim on lands. Other land uses, like farming or breeding cattle, might be forced to go elsewhere when land is converted for dedicated energy growth, or existing lands are used for the purpose of (dedicated) energy cultivation. The risk here is that these other land uses are compelled to go elsewhere and start clearing forests or using vulnerable lands. It remains an issue that biomass production might do no harm directly to the local forests or biodiversity, but if it causes land use changes indirectly and these land use changes lead to unsustainable practices, indirectly bio-energy production also does harm.

4) Biodiversity is one of the most important factors to determine the health of an ecosystem (Rabbinge and Bindraban, n.d.). A decreasing biodiversity is a serious indicator for environmental problems, and while end of a life is not necessarily a problem, end of birth might have detrimental effects on whole ecosystems (Hawken, 2005).

5) Impacts on environment are important to establish. Deterring soil, air and/or water quality has consequences not only for energy cultivation, but also for other local applications, such as food safety and quality of drinking water.

6) Local prosperity is an important determinant of whether large-scale biomass production enables workers in producing countries to benefit or whether all gains go to

large owners of lands and plantations. The way is dealt with this issue theme determines whether biomass production indeed contributes to local poverty reduction and development or not.
7) Some people are dependent on local biomass for their income and livelihoods. If biomass production competes with other applications such as building materials, medicines and others, this might have a negative impact on lives of local communities.
8) Production of energy crops might enable local communities to benefit economically, but working conditions and worker treatment should be in line with international agreements, such as the Universal Declaration of Human Rights of the United Nations.
Table 5 lists the importance of the issue themes in decreasing importance.

Table 5: Importance of issue themes

1. GHG balance
2. Competition with food
3. Land use change
4. Impacts on biodiversity
5. Environmental impacts
6. Impacts on local prosperity
7. Competition with other applications
8. Impacts on social well-being

9. Controversy of the issue themes

What is amount of controversy issued are surrounded with? Controversy is the amount to which the facts are clear and agreed upon by different stakeholders (consensus). Sometimes, the matter of controversy also has to do with the level of the issue. Biodiversity, albeit part of a larger system, can be determined on a local level. Hunger, although it can be observed at a local level is the result of problems on a larger level, like for example global distribution of food. The definition of issues plays an important role in this as well. The definition already determines to a large extent if and how something is quantifiable. For example, income is easier defined than a lack of income. One can take the GDP per capita to determine the income, or more rudimentary, go and ask local people what they earn. A lack of income is much harder to quantify, since it requires one to know what a sufficient income is for a certain standard of life and then calculate the difference. By prioritizing the controversies, this section also quantifies the worries involved in the bio-energy dossier. If it is relatively easy to determine the effects of energy cultivation, the discussion focuses on specifics and not on general concepts, whereby it becomes one argument vs. the other. This better enables working on a solution or prevention of negative effects.

1) The impact of bio-energy on food supply and hunger remains extremely controversial. The question whether bio-energy production affects food supply is extremely complex, since many factors need to be taken into account, such as changing diets due to an increase in prosperity in countries like China and India. The production of meat requires a multiple of agricultural lands compared to a vegetarian diet with the same nutritional value. The question of indirect land use change and global potential of farming lands is also impacted by the way we as a society determine to use our farming potential.
2) The issue of competition with food is strongly connected with the second most controversial issue theme of land use change and indirect effects. It is hard to determine the exact effects of micro level activities on a national or even international scale. Some suggest that macro monitoring is a way to deal with this issue (Project group 'Production of sustainable biomass, 2007). This might be done by aggregating provided information on land use and land prices. It is also suggested to gain insights into effects of energy cultivation on food supplies to refer to information from international organizations such as the list of Low-Income Food-Deficit Countries (LIFDC) as defined by the FAO (SGS, 2007). This list indicates countries where food supply is insufficient or vulnerable. If it is the case that a country's food supply is unsatisfactory, an investigation of the local circumstances might determine whether growing energy crops is likely to worsen or to improve local peoples' conditions. Even if a country has a precarious food supply, growing and exporting biomass might allow economic development, but financial benefits to local people need to be balanced to possible increases in foods costs and shortages.
3) Competition with other applications can be determined, but is not easy to check. Little data is available on the number of people depending on local forests and fields for their local applications. Macro monitoring is required to determine changes in availability and prices of building materials, medicines and so on to determine the effects of biomass production on competition with other applications.
4) A tool to calculate the carbon and greenhouse gas balance is under development in the Netherlands, the UK and Germany. Although, at present, there is no consensus between these EU members on the exact calculations of GHG emissions, and scientists disagree about the exact performance of bio-energy (cf. Fargione et al., 2008; Tilman et al., 2006) it seems feasible that this calculation is possible and the assessment methodology will be developed in the short term.
5) The exact effects on soil, water and air quality (environmental impacts) of biomass production can be determined through sampling and measurements. Laws and regulations already exist in relation to this issue and provide a common starting ground to determine the exact effects and a framework of what is acceptable or not. It should be kept in mind, however, that in some cases national laws and regulations may not suffice to prevent environmental damage. Governments may not be able to monitor compliance or hesitate to because of a 'race-to-the-bottom', where governments might not be willing to pose strict restrictions, in fear of losing companies, investments and jobs.
6) Whether the production of biomass contributes to the social well-being of employees and the local communities can be determined by comparing local situations with agreements such as the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy compiled by the International Labour Organisation (ILO).

7) In order for biomass to be sustainable means that biomass cultivation cannot go at the cost of protected or vulnerable biodiversity. There is not a lot of controversy on how to determine the effects on biodiversity. Biodiversity is well-defined and to verify this auditors can refer to established legislation (on forest and plantation management and exploitation, protected wildlife and areas, hunting, spatial development) and international conventions such as the Convention on Biological Diversity (CBD) and Convention on International Trade in Endangered Species (CITES).
8) Whether biomass production contributes to local prosperity can be determined by investigating the direct economical value that is created, the policy, practices and budgets for local suppliers and engagement of local personnel in lower and higher positions. The Global Reporting Initiative (GRI) provides indicators to determine these effects.
Table 6 lists the extent of controversy surrounding the issue themes in decreasing order.

Table 6: Controversy of issue themes

Issue theme	Controversity
1. Competition with food supply	considerable controversy
2. Land use change	considerable controversy
3. Competition with other applications	medium controversy
4. GHG balance	medium controversy
5. Environmental impacts	medium controversy
6. Impacts on social well-being	medium controversy
7. Impact on biodiversity	little controversy
8. Impact on local prosperity	little controversy

10. Explanation for the wide variety of concerns

Looking at the issue themes related to bio-energy, the wide variety of issues is remarkable. What makes the areas of concerns so broad and the sustainability issues so diverse, when it comes to biomass as a source of energy? First of all, there is an enormous amount of different bio-energy sources. '[V]irtually any agricultural and forestry biomass may end up as bio-energy' (Verdonk et al., 2007: pp. 3910). Secondly, supply and demand potentials are extremely large (cf. Global potential) (IEA Bioenergy, 2007; Hoogwijk et al., 2003; Doornbosch and Steenblik, 2007). These potential estimates vary significantly, depending on different assumptions with regard to (future) yields and productivity of agriculture and forestry, demands for food and livestock, and availability of resources and lands. Thirdly, biomass can be produced anywhere, making (international) trading patterns extremely diversified (Verdonk et al., 2007). The wide variety in origins also brings different issues with different geographic scopes; local, national and even global, depending on the issue. Fourthly, there are several links to other markets, such as food, feed, building materials and other applications of forest and agricultural products and residues. Some applications have competing claims on the same scarce resources, such as land, quality soils and water. Finally, end-user awareness is not always evident, because complex trading patterns and long supply chains make full traceability and transparency less obvious.

Urgency of the issue themes

Taking the importance of the issues and the amount of controversy into account for the different issue themes enables us to indicate the urgency of the issues. Combining the importance of the issue themes with the associated amount of controversy leads to the following matrix (figure 8). Effects of biomass production on food security and their possible (indirect) effects on land use change have the highest urgency and require immediate attention. These are followed in urgency by the greenhouse gas balance of a biomass chain, competition with other application, environmental impacts and social wellbeing of local communities. Local prosperity and biodiversity are the least urgent of the identified issue themes, but require attention nonetheless, due to their importance.

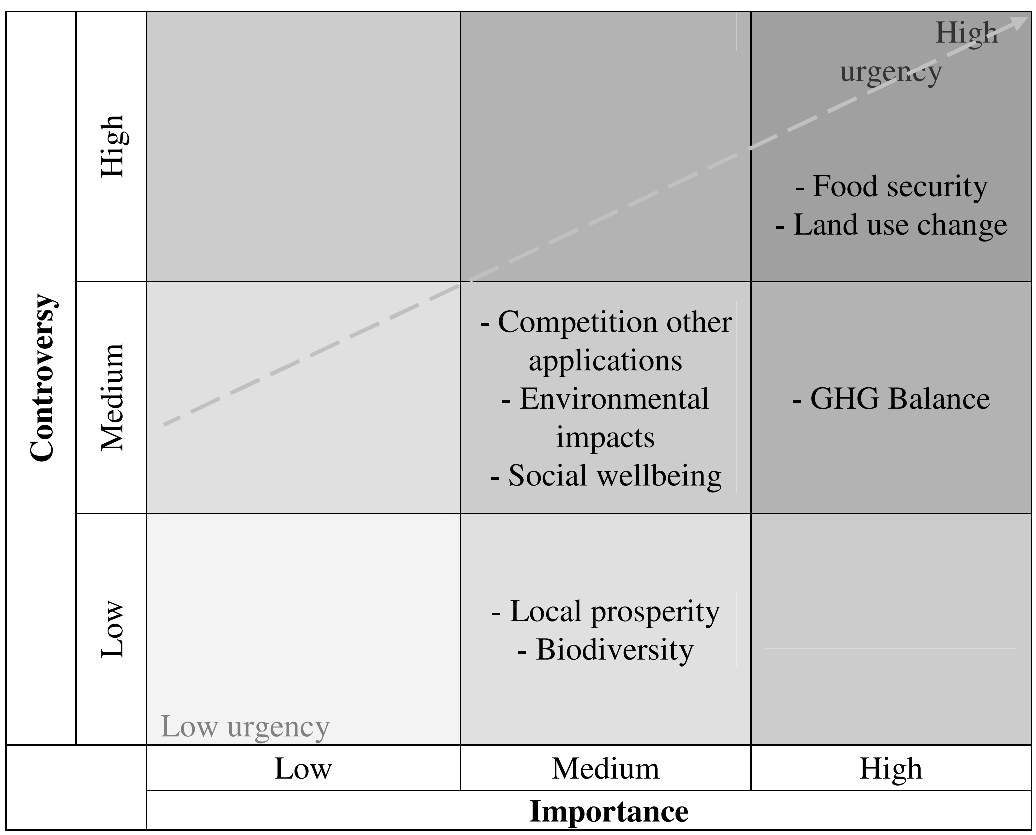


Figure 8: Urgency, importance and controversy dimensions of issue themes

Synergy
The ultimate goal is to achieve a situation where both the environment, economy and social livelihoods benefit from biomass production. Second generation bio-energy crops do not compete with food directly, and hold high expectations. Also energy cultivation on degraded or idle lands is promising, since it does not compete with (high quality) agricultural lands that are used for other needs, like food supply. A synthesis should be sought in the way that companies and organizations in general focus on doing the right things right, dealing with the challenges at hand in an effective way. Van Tulder with Van der Zwart (2006) refers to this as the Triple-E of Societal Interface Management. There is a quest for a synthesis, because there is a conflict or trade-off between efficiency and equity.

In the case of biomass this entails that companies which focus only on an *efficient* production process and have no regard for the environmental and/or social impact, run a risk of shifting a large burden of costs on society and future generations. This can be described as a focus on the Fuel or Economy side of the potential trade-offs.

Organizations only looking at *equity and ethics* might get caught up in the other side of the potential trade-offs, focussing only on direct effects of biomass production on working conditions and environment, while not embracing its potential with regard to decreasing dependency on fossil fuels or poverty reduction. This can be described as a focus on the Food or Ecology side of the potential trade-offs. The *effective* way of dealing with bio-energy is to produce economic viable bio-energy in a sustainable manner. This includes a focus on both the direct effects of biomass production and on the indirect effects of biomass production to deal with the social, economic and environmental challenges effectively. Figure 9 shows the triple-E model and the related challenges with regard to biomass.

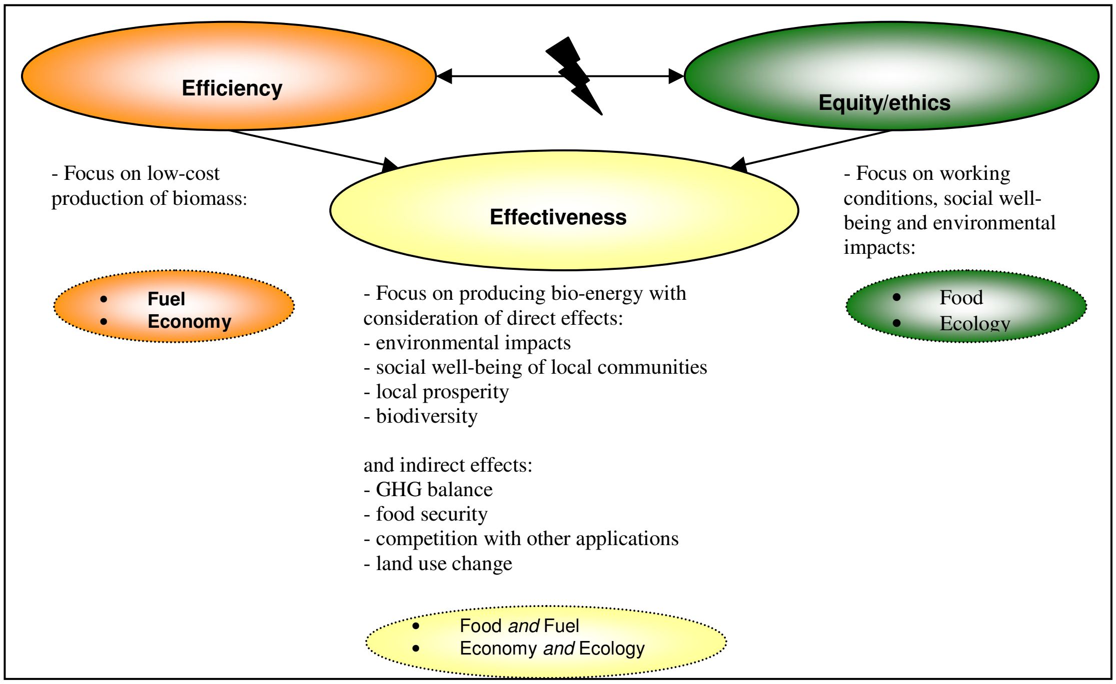


Figure 9: applying the Triple-E model to bioenergy

In order to ensure sustainable bio-energy…

In order to deal effectively with ensuring sustainable biomass production and use for energy purposes, one or multiple instruments are needed that deal with all issue themes and take into account both direct and indirect effects of biomass production. Currently, certification of sustainable biomass is often mentioned as a tool to ensure sustainable biomass production (cf. Project group 'Sustainable production of biomass', 2007; Van Dam et al., 2007; Schlegel and Kaphengst, 2007; Lewandowski and Faaij, 2006). Others, however, are more sceptical about the effectiveness of certification (cf. Bindraban and Pistorius, 2008; Doornbosch and Steenblik, 2007; Carbon Trade Watch et al., 2007; Biofuelwatch, 2007). This issue dossier is complemented by issue dossier # 16 on certification as sustainable self-regulation, which describes the effectiveness of certification as a tool to ensure sustainable behaviour.

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