Analysis of bioenergy in Denmark

Summary

As part of the energy agreement of 22 March 2012 it was agreed that an analysis concerning the use of bioenergy in Denmark be undertaken: “The analysis will focus on whether the right framework conditions for an efficient and environmentally sustainable use of biomass resources are in place in the Danish energy supply system. The analysis will also examine carbon footprint”.

The share of renewable energy in Denmark is expected to account for about 35% of overall energy production by 2020 and more than half of this will be produced from biomass. The use of all types of biomass will increase in total from 132PJ in 2012 to 166PJ in 2020.

In the long term, an even larger share of the Danish energy system will be based on renewable energy, and a number of scenarios for the consumption of biomass in 2050 have been analysed, with the results showing that the consumption of biomass varies between roughly 200 and 700 PJ.

Potentials, demand and prices

Biomass is an internationally traded resource. In 2050 the global realisable biomass volume available for use in bioenergy is expected to be in the range of 100-300EJ per annum, of which the Danish potential in 2050 is estimated to be in the region of 205-245PJ. Furthermore, there is energy production from organic waste.

Global demand for biomass to meet energy and transport needs is expected to increase from 53EJ in 2010 to 78EJ in 2035. However, estimations of the developments in biomass consumption up to 2050 are shrouded in uncertainty. Consumption will depend on population growth and the global political and economic situation with the associated effects on technological development, demand for food and feed, and the development of agriculture and forestry.

A projection of prices commissioned by the Danish Energy Agency indicates moderate price increases for biomass up to 2050 in a number of different scenarios for global development, taking into account, among other things, the degree of global regulation of climate policy.

Technologies

Biomass may be used directly or converted into other types of fuel. For example, liquid fuels and gas can be produced and subsequently used for various purposes; as fuel in the transport sector or for the production of electricity and heating. Traditional upgrading of gas and the adding of hydrogen are also possible. The different types of conversion can thus contribute to increasing the volume of fuels and make various types of residual products more accessible to the energy and transport sector.

Environmental sustainability

Biomass is a considerable factor in the global carbon cycle and is thus a crucial factor for determining the concentration of greenhouse gases in the atmosphere.

According to the most recent assessment report from the Intergovernmental Panel on Climate Change (IPCC), there are many different profiles for land use emissions in various scenarios for stabilising the level of greenhouse gases in the atmosphere. In some scenarios, land use is assumed to contribute

with significant reductions due to increased carbon sequestration compared with the baseline scenario. Other scenarios predict that there will be net emissions from land use over the period covered.

The widely varying contributions from land use are primarily the result of scenarios with little or negative contribution to greenhouse gas reductions from land use assuming a considerable use of bioenergy and this, in turn, assumes a massive expansion of bioenergy plantations as well as increased deforestation compared with the baseline scenario. Biomass is a significant part of the energy mix in the majority of the scenarios for stabilising greenhouse gases.

A Lifecycle Assessment (LCA) commissioned by the Danish Energy Agency shows that the use of wood from thinning, logging off-cuts, straw, manure and other residual and waste products is associated with low greenhouse gas emissions as seen over a 20-year or 100-year period. This is not the case if existing forests, productive soils or high carbon savannahs are converted to bioenergy plantations or planted with other crops for energy and transport. However, if the time perspective is extended beyond a 100-year period, there will be benefits in relation to greenhouse gas emissions.

The results of the LCA can be used to compare the use of different types of biomass for heat, power and transportation, however, the results are also associated with uncertainties.

The results can by no means be compared with the emission figures used by countries in connection with their national greenhouse gas emissions accounts. In this context, the principle applies that only emissions which take place in the relevant country should be included. Furthermore, emissions as recorded in the national greenhouse gas emissions account are analysed by sector. This means that the emissions attributed to the energy sector are attributed only to the specific burning of coal, for example, but not to the emissions associated with transporting the coal to the power plant or with the construction of the power plant itself.

Optimisation in relation to the carbon accounts in connection with the use of biomass from forests can favour forestry systems with relatively short rotation times and a high exploitation of the overall biomass produced. Optimisation in relation to biodiversity can exhibit bias in the opposite direction with longer rotation times, more deadwood and more old trees in forests.

Challenges up to 2020

The development up to 2020 entails a number of challenges relating to environmental sustainability. From the expected main exporting countries, Denmark will be able to purchase wood pellets and wood chips based on various types of residual wood products and timber from thinning as well as from environmentally optimised forests. It is more than likely that there will be biomass available on the market which has been harvested from forests that have been managed with the sole purpose of supplying the energy sector.

Major Danish energy companies have a strong focus on purchasing wood which has the potential to be advantageous to the climate and to minimise the impact on the environment and biodiversity.
The above risks are primarily related to the use of biomass by existing plants. With regard to the construction of new, large biomass CHP plants and heating plants in the period, long lifespans make it necessary also to address the challenges linked to the sustainability of biomass in the long term.
It is likely that up to 2020 the transport sector will use imported bioethanol produced from sugar cane and maize. There are a number of climate-related risks linked to the use of these types of biofuels, including, in particular, possible indirect land use changes (ILUC).

Bioenergy production can threaten food security when production takes place on the basis of food production.. However, if bioenergy is produced from agricultural residues such as straw and manure, as well as organic household waste, it has been shown that preserving the food supply and supplying bioenergy at the same time is indeed possible.

Challenges may arise with regard to the taxation of energy if there is extensive conversion to biomass for CHP and if boilers are established to meet an increased demand for heating in connection with the phase out of the basic amount paid to small-scale CHP plants. This will, ceteris paribus, lead to a loss of tax revenues.

Challenges in the period after 2020

The global situation will play an important role in terms of the environmental sustainability of biomass use for energy and transport in Denmark after 2020, including realisation of the government's climate and energy targets for 2035 and 2050.

There is an increasing risk of indirect effects linked to the Danish demand for biomass when global and regional demands for wood rise. Given the limited, short-term supply of wood from thinning, residual wood products, etc., customers may be "pushed" in the direction of buying wood products that are not sustainably produced.

On the basis of the modelling commissioned by the Danish Energy Agency, it is likely that a situation in which there is no strong global regulation will entail a risk that productive soils are used for bioenergy crops and that existing forests and carbon-rich savannahs are converted to bioenergy plantations in order to address Danish demand for biomass.

On the other hand, the modelling also indicates that a situation with stronger regulation will lead to a greater exploitation of marginal lands, grasslands and low carbon savannahs. However, even with strong regulation, there will be a risk that high-carbon savannahs are converted to wood production and grass-like crops.

In a situation with the strongest possible global regulation, in which all countries are subject to binding targets for greenhouse gas emissions, including changes in carbon stocks, as part of efforts to meet a two-degree goal, Denmark's biomass consumption will not have a negative impact the realisation of any such goal.

If a global framework is not established, the risk of a negative climate impact will increase concurrent to the volume of biomass used in the long term in connection with Danish climate and energy policy. Furthermore, other negative environmental impacts may occur, including, in particular, effects on biodiversity.

Biomass consumption in a future energy system that is based on renewable energy will be most efficiently minimised through the use of biomass in sectors where no alternatives to fossil fuels, for example heavy-duty transport and certain types of process energy.

The scope of biomass use is assessed to be of no significant importance to the total costs linked to the various future scenarios for the overall energy and transport system in 2035 and 2050. However, there are significant uncertainties attached to this estimate.With regard to the security of fuel supply, a consumption level above 200 PJ of biomass will increase the dependency upon imported biomass. As there are many potential biomass suppliers, this may not be a problem for the security of supply, but it

will increase sensitivity to higher biomass prices. On the other hand, scenarios with less consumption of biomass will be challenged in terms of ensuring a reliable electricity supply, due to the expected increase in the use of wind power.

With regard to energy efficiency, a key point is that a limited use of biomass will ensure a high security of supply and low climate-related risks which highlights the importance of a high level of efficiency in the exploitation of biomass in the future energy and transport system.