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THE SUBMISSION OF FINLAND TO NOTIFICATION NO. 2008 -100 – REQUEST FOR SUBMISSIONS OF INFORMATION ON EXPERIENCES ON THE DEVELOPMENT AND APPLICATION OF TOOLS RELEVANT TO THE SUSTAINABLE PRODUCTION AND USE OF BIOFUELS

Outline of the national and regional experiences on the sustainable production and use of biofuels

Background

In Finland bioenergy and renewable energy sources represent about a quarter of the total primary energy consumption. In Finland biomass is used to manufacture fuels, biofuels, which can be produced from field biomass and waste, as well as forest biomass. The biofuels produced and used in Finland are:

- Wood-based fuels (industrial waste liquids and wood residues such as black liquor, bark, chips and process waste; forest chips, crushed and chopped wood, wood pellets and briquettes, stumps, energy willow, pyrolysis oil)
- Field biomass (e.g. reed canary grass, oilseed plants, straw)
- Liquid biofuels (ethanol, biodiesel)
- Biogas (biowaste gases from landfill sites, water purification plants and farms)
- Biodegradable components in recycled and wastefuel material
- A further fuel to be mentioned is peat, which is widely used for fuel in Finland, even if it is not considered as renewable biomass.

Almost half of the biomass harvested from Finnish forests ends up in energy use, either directly as forest chips and fuelwood or as by-products from the forest industry. The internationally high bioenergy production volume in Finland is founded on the high utilisation rate of forest biomass for energy production in industrial plants. Instead, the energy use of field biomass and biowaste is still very low in Finland.

In Finland biofuels are primarily used in the combined production of electricity and heat, where Finland is one of the leading countries in the world. Instead, up until 2008 the use of biofuels for transport was very low. However, Directive 2003/30/EC of the European Parliament and of the Council on the promotion of the use of biofuels or other renewable fuels for transport and Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (5421/08)(2008/0016 (COD)) have made it necessary for Finland to reconsider the perspectives on transport biofuels. These directives set clear and specific objectives for the minimum proportions of renewable fuels in transport fuels in the EU Member States: in 2010 5.75% of transport fuels must be biofuel or other renewable fuel and by 2020 renewable energy should in each Member State represent at least 10% of the total amount of motor gasoline and diesel oil sold. In Finland an Act was passed in 2007 on increasing the use of biofuels in transport (446/2007), which obligates the liquid fuel distribution companies to mix a certain percentage of biomass fuel to the amount of fuel for transport they sell in a year. The percentage is calculated from the total energy content of all transport biofuels the distributor has sold in one year, and it increases gradually from 2% in 2008 to 5.75% in 2010.

In Finland the use and production of transport biofuels has started off through fuels derived from agricultural biomass. Considering the current motor vehicle fleet and fuel distribution network in Finland, both ethanol and vegetable and animal fat based biodiesels are the most feasible transport biofuels in the near future. In Finland the possible arable crops for this purpose include barley, turnip rape and, perhaps, sugar beet. The use of the so-called first generation biofuels derived from these is restricted by the fact that the current motor vehicles can use them only when mixed with petrol or diesel. In most cases the maximum proportion of biofuel is about 10%. To improve this as well as the energy and cost efficiency, work has been started to develop so-called second generation transport fuels, which do not involve any significant use restrictions. The range of raw materials that can be used for these is also wider than in the case of the first generation, including e.g. wood and waste based raw materials. Biorefineries using various kinds of biomass to produce feedingstuffs, chemicals and other materials and electricity and heat promote energy efficiency particularly well. In addition to raw materials available in Finland, imported raw material can be used for both first and second generation fuels (e.g. sugarcane, palm oil). In 2008 most of the transport biofuel used in Finland was ether imported (bioethanol) or manufactured in Finland from imported raw material (biodiesel).

In Finland the production and use of bioenergy from agricultural sources has started to increase significantly only in the 2000s. The agriculture sector offers numerous potential raw materials for the production of renewable energy: Plant mass can be burned directly for energy production, plant and animal products can be processed into liquid fuels and animal and plant based biomass can be processed into biogas. These can be used to substitute for unrenewable energy raw materials both on farms and in other energy production. When estimating the bioenergy potential of agriculture, besides the available agricultural area we should take account of the bioenergy potential of manure, plant residue and other waste material, different efficiency ratios obtained from using different raw materials as well as development prospects of production technologies.

Of the agricultural raw materials the large Finnish energy establishments covered by the emissions trading of the EU now use mainly reed canary grass as the solid fuel. In 2008 the production area of reed canary grass for energy purposes totalled about 17,500 hectares. Because of the rise in fodder and bread cereal prices, the growth in the cultivation area of reed canary grass has slowed down, at least temporarily. The prospects for the energy use of straw are good. The most common raw materials for biogas used on Finnish farms and in rural enterprises are manure, various animal by-products and other organic waste material, but there is growing interest in also using various types of plant mass for biogas production. Biogas production can be increased by using, among others, plant mass, food industry by-products or organic waste materials as additional raw materials in the process.

In promoting transport biofuels the priority is on second generation biofuels, whose raw material supply is founded on products other than those used as food. Of these the most significant raw materials used in Finland are wood, waste and field biomass. In Finland the objective is to develop second generation transport biofuels through systematic research, product development and demonstration activities, with the aim to start production on a relatively large scale in Finland.

The use of forest-based biomass is mainly restricted to electricity and heat production, while its use as raw material of liquid biofuels for transport is a thing of the future. However, as even now a significant share of the biomass harvested from forests ends up in electricity and heat production, there has also been wide interest in Finland in how this will impact on, for example, biological diversity and waters.

The lifecycle of using wood-based energy comprises forest management and timber harvesting operations. In 2004 about 27% of the renewable energy produced in Finland

was produced from wood fuels of industry and energy production (wood residue, recycled wood, forest chips and other by-products and waste from the wood processing industry). The solid forest industry by-products are the most advantageous alternative among the wood-based fuels.

Long-term climate and energy strategy of Finland

Increasing the use of bioenergy and biofuel production are essential elements of the Finnish energy and climate policy. On 6 November 2008 a new, quite ambitious climate and energy strategy was adopted for Finland, with a very detailed account of the climate and energy policy measures until 2020 as well as indicative outlines up until 2050. The aim of this long-term climate and energy strategy is to increase the share of renewable energy to 38% by 2020, in accordance with the obligation for Finland set by the European Commission. Besides other actions, in order to fulfil the obligation regarding renewable energy the use of wood-based energy, waste fuels and biogas must be increased. The use of, for example, forest chips will be increased two to three fold from the present.

Sustainable production and use of biofuels in Finland

The basic premise in producing bioenergy and biofuel in Finland is that the assessment of sustainability takes account of the economic, social and ecological dimensions of the different bioenergy production systems. Secondly, bioenergy should not be dealt with alone but as part of the energy system as a whole. In other words, bioenergy production can promote sustainability only as part of a more sustainable energy system.

The study of the bioenergy production methods is founded on lifecycle thinking. Lifecycle assessment also allows the comparison among different production methods. For lifecycle assessment the production of bioenergy and biofuels comprises the growing, harvesting, handling, storage and transportation of the biomass as well as the manufacture, transportation, storage and use of the fuel. Each stage in the production chain, i.e. stage in the life cycle, calls for energy and various raw materials. Emissions into the waters, air and soil as well as waste are created in all stages of the life cycle: in arable farming or when growing forest, harvesting a crop or timber, processing the raw material, and use. In addition, through land use the actions in the different stages of the life cycle have impacts on biological diversity and occupy land areas so that they are not available for other uses. Lifecycle thinking also takes account of import flows and their impacts.

The manufacture and use of transport biofuels is growing rapidly, both in Finland and internationally. Only part of the transport biofuel to be used in Finland in the future can be produced in Finland. Rapid growth in the production causes ecological and social problems in countries which produce the raw material. Finding the right balance between domestic production and imported raw material requires thorough knowledge and understanding of the environmental impacts of the whole lifecycle chain and the economic and social impacts of the different alternatives. One question to be taken into account is whether biomass should be used for energy production or as material for food or feed, paper, building or medicinal substances.

The environmental impacts of field energy and biofuels derived from this are mainly due to land tillage, fertilisation (incl. manufacture of fertilisers) and use of pesticides as well as harvesting and handling of the crop (e.g. drying of cereals). Fertilisation of arable lands causes nutrient discharges, leading to eutrophication of waters. Studies made in Finland have shown that cereal processed into bioenergy as such does not burden the waters any more or less than cereal used for food, but in both cases the burden depends on the cultivation practices. Nutrient leaching and erosion can be considerably reduced by means of e.g. direct sowing. In Finland the cultivation of energy crops on arable lands which at its best could be quite extensive (400,000 ha) could lead to a significant

reduction in erosion and nutrient loading, by as much as 25-25% from the current loading. Intensive cultivation of energy crops may also have negative impacts on soil productivity (soil compaction, decrease in the amount of soil organic matter and erosion). Energy plants (e.g. reed canary grass) may also reduce the diversity of field ecosystems.

Forestry measures have impacts on the loading of waters due to biofuel production based on forest biomass and on the nutrient balance of forests. The harvesting of crown mass from final felling sites reduces the leaching of nutrients into waters but, on the other hand, nutrients are removed from forests along with the logging residue. The long-term impacts of the removal of nutrients along with the logging waste from the final felling sites on the tree growth and productivity of forests and functioning of the ecosystem are not yet known. Logging residue and especially stumps have been removed on a larger scale only during the 2000s, which is why long-term experiences or research information on its impacts on forest biodiversity, soil nutrient loss and deterioration of the humus layer as well as soil productivity are not available as yet. Research on the impacts of the harvesting of energy wood on forest ecosystems has been started under the Bioenergy from forest research programme of the Finnish Forest Research Institute. Harvesting of energy wood may increase the need for forest fertilisation, which may in turn increase the risk of nutrient loading.

The profitability of biofuel production and energy and greenhouse gas balances of the whole life cycle depend a great deal on the yield level of materials used for transport biofuels.

In the bioenergy sector research and development activities have been supported very strongly for decades, for example, through research programmes concerning wood-based energy. Research and development work in the public sector and its financing has had and will continue to have significant impacts on the future production practices.

Practical evaluation of whether bioenergy and biofuel production promote more sustainable development requires criteria that are suitable for assessing the different dimensions of sustainability. In Finland, however, such national criteria have not been defined. The need for these has been recognised, for example, in the National Strategy for Sustainable Development (2006). Finland has also been active in the preparation of the sustainability criteria for biofuels of the EU, which will also provide suitable criteria to be applied in Finland. As regards biomass production, the sustainability criteria must be the same regardless of whether the biomass ends up in industry or as food or energy. The criteria to be established for energy wood must be the same as those for wood used to make paper, pulp or sawn goods.

In Finland various kinds of indicators have been developed to concretise the social dimension of sustainable development. These concern, among other things, the possibilities of local population to influence the policies and decisions and their employment and working conditions, developing the skills and competence of the labour force, economic dimensions of multiple use, recreational opportunities, functioning of the local social systems and continuity of local culture. Basically the different forms of bioenergy and biofuel production rest on a sustainable basis when they reinforce the above-mentioned factors compared with the other forms of energy production.

Studies conducted in Finland relating to bioenergy and biofuel production and its sustainability

1 The aim of the so-called BIOAGRE project completed in 2008 was to produce research information to be used as the basis for the assessment of the profitability of bioenergy production and use from both private and socioeconomic perspective. The project focused on agricultural bioenergy sources, where the technical applications for their use are available. Of the bioenergy raw materials the project covered reed

canary grass, straw, turnip rape, energy cereals, animal manure and energy grass. The production methods were heat production, combined electricity ad heat production and production of transport biofuel. The environmental impacts of agricultural bioenergy sources (emissions into the air from small production plants, water loading from cultivation and animal husbandry, environmental impacts of transport) compared to unrenewable energy sources were also examined, as well as what kind of reductions in greenhouse gas emissions can be achieved by means of agricultural bioenergy production.

2 Study on bioenergy crop production and climate policies; case of reed canary grass in Finland. The study was conducted at the University of Helsinki in 2006.

3 In 2004 the agroenergy programme study on the potential of both production and use of agroenergy in eastern Finland was carried out by the Business Management Group of Electrowatt-Ekono Oy in co-operation with the Faculty of Forestry, University of Joensuu. The programme deals with the most important agrobiomasses and their upgrading possibilities into different fuels (pellets, briquettes and liquid fuels) and, using these fuels, in direct combustion of as transport fuel. The programme also comprises a target for the utilization of agroenergy by 2010, the species with the greatest potential and development actions, as well as a proposal for practical organization.

4 In 2005 the Ministry of Labour drew up an estimate for the long-term target for the introduction of alternative transport fuels as well as for the extent to which the use of alternative fuels in accordance with the target can be based on Finnish raw materials that can be processed into transport biofuels.

5 In 2006 the Department of Biological and Environmental Sciences of the University of Jyväskylä carried out a study on the energy potential of farms from the ecological perspective. The study examined the national and regional potential for bioenergy production on farms and the environmental impacts of the production with the aim to assess an ecologically acceptable potential for the use of resources in the short and long term.

6 The research programme Bioenergy from forests (2007-2011) of the Finnish Forest Research Institute produces information on the grounds for the production and utilisation of forest and peatland biomass and the impacts of this on forest resources. The programme studies the impacts of the harvesting of logging residue and stumps on e.g. biodiversity of forest species and groundwater quality. A report on the environmental impacts of the harvesting of energy wood was published in 2008. (http://www.metla.fi/ohjelma/bio/esite-en.pdf)

Ongoing biofuel projects in Finland

- In 2007 Neste Oil started a biodiesel production plant with an annual capacity of 170,000 tonnes. The construction of another plant has been started and it should be ready in 2009.
- In 2007 St1 Biofuels Oy started the building of a production plant network that utilises waste from food and bakery industry to manufacture bioethanol to be used as transport fuel. The network will consist of 5 to 10 production plants connected to food industry plants. The 85% bioethanol produced in these will be refined for fuel use in a specialised enrichment plants. In the beginning of 2009 there were four production plants and one enrichment plant in operation.
- In 2009 St1 Biofuels Oy constructs a bioethanol plant whose production is based on the processing of biowaste from households collected specifically for this purpose.
- Neste Oil and Stora Enso are building a test plant for refining biodiesel from wood residues. Wood raw material will be used to produce biofuel in the near future. Neste Oil, which is aiming to be the world's leading producer of biodiesel, and the forest industry company Stora Enso are cooperating in developing new-generation production technology. Stora Enso will produce wood-based biomass for raw

material and utilize the heat generated from this. Neste Oil will carry out the final refining and marketing.

- UPM has announced that it will strongly increase its stake in second generation biodiesel and prepares to become a significant producer of renewable biofuels. Business concepts and technical solutions are currently being developed. Locating biofuel production plants adjacent to existing UPM pulp or paper mills would further enhance the company's ability to utilise the wood raw material efficiently. Even now UPM uses wood extensively and efficiently both for the manufacture of various products and for energy production.

Biodiversity and production and use of biofuels in Finland

In Finland some studies have been conducted on the impacts of bioenergy and biofuel production on biological diversity. Essential indicators identified in these contexts include: 1) total biodiversity, 2) number of species, number of declined and threatened species, 3) vascular plants, butterflies, beetles, birds (agriculture) and, in addition to these, polypores, fungi, lichens, mosses and liverworts (forests) and amount of decayed wood (forests), 4) amount of soil organic matter, 5) soil fertility and productivity, and 6) landscape structure.

The most significant biodiversity impacts of the lifecycle of bioenergy relate to the first stages in the chain: agriculture and forestry operations. In the following stages, for example, the refining and energy production plants occupy lands and thus weaken the possibilities of species to live in these areas. The use of the fuels may also have indirect biodiversity impacts on the species composition through acidifying and eutrophic emissions. Below a brief account is given on the biodiversity impacts of the raw material production.

Production of field biomass

In general we can say that arable farming has very little significance as regards the declined and threatened plants (with the exception of certain "traditional" weeds spread along with the sowing seed) or insects. Instead, cultivation measures and crop rotations have impacts on declined and threatened bird species living in agricultural environments. Decrease in perennial grassland areas is one of the most significant changes in Finnish agriculture which has impoverished the biological diversity of agricultural environments. In most cases perennial (permanent) grasslands are used for grazing or set aside and thus they have a positive impact on the biodiversity of agricultural environments. This means that all energy plants have negative environmental impacts when permanent grassland areas are converted to energy production.

Taking annual fodder grass areas into energy production has no clear negative impacts on biodiversity, because these are usually poor in terms of species diversity, in most cases much poorer than cereal areas. Compared to perennial grasslands the impact of reed canary grass is the most negative of the energy plants because few other plants are able to grow under the high and thick mass of reed canary grass. There is also the risk that reed canary grass may spread to the field margins and impoverish their species diversity. In addition, reed canary grass has negative impacts also when converting cereal areas into reed canary grass production because there are few other species under the high and thick mass of reed canary grass, while cereal areas host a quite rich variety of weed species. On the other hand, reed canary grass may provide shelter for overwintering pheasants and, in the spring, for willow grouse before the plants start to grow on the neighbouring parcels used for feeding. Reed canary grass does not offer any feed for the birds. Reed canary grass plantations are in most cases quite poor as regards avifauna, and the harvesting time of reed canary grass causes further problems. In southern Finland dominated by cereal cultivation the areas under reed canary grass enhance the landscape diversity, but this benefit is lost in cases where the alternative to reed canary grass would be set aside land. So far there is so little land under reed canary

grass in Finland that no information on the species diversity has been accumulated as part of other studies on the biodiversity of agricultural environments.

Production of forest biomass
All forestry measures undertaken in forests, including thinnings, final felling, land tillage, etc. influence the species and their diversity one way or the other. This also applies to the harvesting of energy wood. The impacts on the species can be studied as regards e.g. flora, organisms depending on decayed wood and soil organisms. Decrease in the amount of decayed wood is the most significant single factor that reduces the biological diversity of commercial forests. A major share of Finnish forest species (about 20–25%) depend on decayed wood, and the amount of these has been decreasing due to forestry operations. The plans to significantly increase the harvesting of logging residue cause further pressures on the state and trends in forest biodiversity.

In recent years a large number of research results and literature reviews on the impacts of harvesting energy wood on the biological diversity of forest species have been published both in Finland and in the other Nordic countries. In spite of the abundance of research information on the biodiversity impacts of the harvesting of logging residue, we obviously do not as yet have a sufficiently clear picture of the rapidly growing scale in the harvesting and its long-term impacts on the species. So far few research results are available on the impacts of lifting stumps. The objective is to prevent the potential negative impacts in advance and urge those harvesting energy wood to comply with the recommendation for this. In forest management recommendations special attention has been given to increasing the amount of decayed wood from large diameter trees by leaving, where possible, living shelter trees in forests and by taking measures to protect the existing decayed wood from large trees during harvesting operations. According to the recommendations, 30% of the logging residue should not be harvested and e.g. valuable forest habitats are excluded from harvesting. The recommendations will be reviewed during 2009.

It is estimated that the biodiversity impacts of the increased harvesting of forest chips are greater in southern Finland than in the north, because the species diversity is greater in the south. The pressures relating to endangerment are more serious, in particular, as there is less decayed wood and natural-state forest and the surface area of the forest protection network is also smaller in southern Finland.

Finnish development cooperation policy and biofuels
Finnish development policy (2007) is based on a consensus - which emerged at the Conference on Environment and Development in Rio as long ago as 1992 - that all development must be ecologically sustainable. The ways in which we meet our own needs must not reduce the possibilities available to future generations to meet their needs.

In energy production Finland supports programmes and projects aiming at saving energy, increasing energy efficiency and producing renewable energy. These will target specifically poor countries and regions. Production of renewable energy, especially bio-energy, provides work and income for the local population.

Bio-energy projects can be linked with the promotion of sustainable forestry and wood from thinnings and logging residues utilized in power generation. Local production of renewable energy and linking it with forestry generates sustainable economic growth.

Reference:
Suomen ympäristökeskus (2007): Bioenergian uudet haasteet Suomessa ja niiden ympäristönäkökohdat – Nykytilakatsaus / Finnish Environment Institute (2007): New challenges for bioenergy in Finland and environmental considerations – Review of the current situation