Views on sustainability of solid and gaseous biofuels:
UNIFORM CRITERIA FOR ALL BIOENERGY

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Bioenergy plays a significant role in climate change mitigation, in improving the security of supply of energy, and in creating jobs and well-being. Especially in Northern Europe, it is an important part of the sustainable energy system and increases the use of domestic energy resources. Bioenergy is the only renewable energy source that can replace fossil fuels in the production of electricity, heat and traffic fuels. There are significant growth and technology export opportunities associated with bioenergy.

Sustainable bioenergy production and use is gaining increasing attention globally. All bioenergy use must be environmentally, economically and socially sustainable. Only bioenergy that is sustainably produced and used should be classified as renewable energy and taken into account in the fulfilment of renewable energy obligations as well as counted as zero-emissions in EU emissions trading.

All bioenergy, whether in liquid, solid or gaseous form, needs one set of criteria in order to promote a predictable and stable regulatory environment, develop bioenergy market operations, and create a level playing field for competition. The sustainability criteria should target the origin of the bioenergy, regardless of its end use or form.

Overlapping regulation should be avoided in creating the sustainability criteria for solid biomass. Sustainable forestry and sustainable agricultural practices should be the foundation when defining sustainability criteria. The existing legislation on forestry and agriculture, which takes into account national special characteristics, as well as voluntary international standards/systems should be utilised in the verification of sustainability. In terms of competition and a well-functioning internal market, it is important to ensure mutual recognition of the different systems.

The EU criteria should align with key international regulations (e.g. standardisation of bioenergy), and the goal should be global definitions for the sustainability of bioenergy. Before establishing global criteria, the EU criteria should be applied to also the bio-raw material imported into the EU.

In terms of governance and cost efficiency, it is expedient to apply the criteria to plants within the sphere of EU emissions trading (>20 MW plants).

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APPENDIX 1

SUSTAINABILITY OF BIOENERGY FROM A PERSPECTIVE OF INNOVATION ACTIVITIES

Bioenergy production from solid biomass is in a phase of strong development. A lot of academic research and industrial development work is under way in the sector. A number of new bioenergy innovations are being developed in Finland, including pyrolysis oil production in Joensuu, biogasification in Vaasa, and a pellet-fired heat plant in Tampere. All of these innovations have significant export potential.

Analysing the sustainability of biomass in different ways based on the form or the technology used can, at worst, hinder development of the technology and eliminate the economic and environmental benefits that the technology can bring. In fact, the goal should be a cost-efficient and uniform way to analyse the sustainability of biomass, regardless of its end use or form.

Biomass is fractionated naturally into different forms: gas, liquid and solid matter[1]. Technologically, it is irrational that different sustainably criteria would be applied to the products created. The fact that biomass gasification, liquefaction and biochar production are even discussed as different methods is actually only due to the technological limitations and the incompleteness of development. Technological development enables efficient use of the raw material and the production of all forms of bioenergy in the same process[2]. A good example of the process producing good-quality grades of all forms – biogas, biochar and biodiesel – is the German-developed Thermo-Catalytic Reforming (TCR)[3]. In the process, the biosludge feedstock is converged into fractions, 90% of which can be utilised. Also in the production of bio-oil, including at the Joensuu plant, the produced gaseous and solid fractions can be used as independent energy sources in addition to the pyrolysis oil.[4]. Applying different sustainability criteria to these fractions produced from the same raw material and the same process is not expedient. Essential is only that the biomass used at the plant is produced in a sustainable manner.

Resource efficiency should be maximised in bioenergy use so that it can be utilised to the fullest in climate change mitigation and in increasing bioenergy. A good way to increase the efficiency is to integrate the bioenergy production plant with other production, such as the integration of the Joensuu pyrolysis plant with the existing combined heat and power (CHP) plant. From the perspective of overall efficiency, climate impacts and technology, it doesn’t matter whether the biomass is producing electricity, heat or pyrolysis oil.

Practical examples of biorefineries show that a plant’s end products and the processes used vary over time. A good example of this is the Borregaard biorefinery in Sarpsborg, Norway[5]. The fractionation of the spruce raw material used and the products have varied considerably over the course of its history (see figure 1). Thus the sustainability criteria should be constant over time; it shouldn’t be different for different end products.

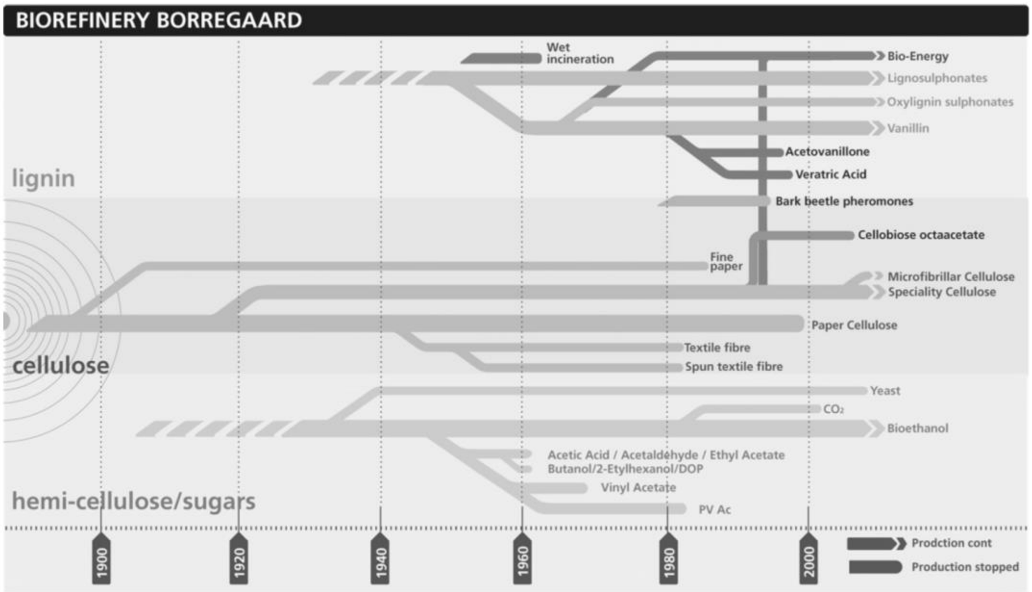

Figure 1. Timeline of the Borregaard Sarpsborg plant's products[5]

Resource efficiency can be significantly improved in transportation and storage. If stringent, batch-specific and physical separation and traceability of the raw material are required in the verification of sustainability, it results in significant additional costs. A study commissioned by Finnish Energy Industries indicates that the physical separation of solid biomass significantly increases transportation and storage costs at every phase of bioenergy production[6].

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APPENDIX 2

SUSTAINABILITY OF BIOENERGY – PRACTICAL CHALLENGES
CASE: JOENSUU POWER PLANT-PYROLYSIS PLANT

Verifying the sustainability of bioenergy leads to many practical challenges. The following describes some of the experiences with Fortum's power plant-pyrolysis plant in Joensuu. A process integrated with the combined heat and power (CHP) plant produces liquid biofuel, bio-oil, from forest residues. The RES Directive's sustainability criteria for biofuels and bioliquids is applied to the biomass used in the bio-oil production, whereas the biofuel used at the CHP plant is not currently within the sphere of the sustainability criteria.

Solid biomass use at the Joensuu CHP plant

Without the pyrolysis plant, the Joensuu power plant's total fuel use is about 1,000 GWh annually. The breakdown of the energy sources is: peat 300 GWh, forest residues 500 GWh, and wood fuels 200 GWh. On average, a truckload contains about 100 MWh of energy, so some 10,000 loads of fuel are delivered to the Joensuu power plant annually. Fuel use is weighted to the winter months.

Solid biomass use for pyrolysis oil production

The pyrolysis oil production plant has been integrated with the Joensuu CHP power plant. The pyrolysis process uses the heat produced by the power plant. The by-products of pyrolysis oil production are returned to the power plant boiler, so the verified sustainable biomass is used also in electricity and heat production. The production of pyrolysis oil reduces the amount of fuel used directly in the boiler. The pyrolysis plant uses an estimated 400 GWh of raw materials per year. The raw materials include forest residues, forest industry by-products, and plant-based raw materials.

Biomass supply chain

The biomass supply chain is complex and varies based on the biomass source. Forest residues are produced from two main sources: logging residues and stems from energy wood thinnings. These production methods differ significantly from each other. Logging residues consist of the branches and tree-tops remaining after mechanical felling. Stems from energy wood thinnings are produced as a result of removing small diameter trees from overly dense forest areas. Thinning enhances forest growth. After processing (chipping or crushing), forest residues are delivered directly to a power plant or to an intermediate storage for storage and/or processing, and from there they are delivered for end use.

Forest industry by-products are delivered to a power plant either directly from the production plant or via an intermediate storage.

Measurement uncertainties

There is a lot of uncertainty associated with the biomass moving through the supply chain: measuring its volume, estimating its energy content, and verification of the information about it. For the delivery of forest residues, different units of measurements are commonly used in the harvesting, collecting, transporting and processing phases. Logging residues and stems from energy wood thinnings are usually measured by load weight (tonnes), which is then converted into volume (solid m3) using a weighting coefficient. In some cases, it is possible to measure the amount directly by volume (solid m3). Wood-based biofuel is usually in used in the form of chips. The amount of chips is usually reported in loose cubic meters (loose-m3). The fuel amount arriving to a power plant, in turn, is measured by load weight (tonnes). Billing is usually based on the amount of energy (MWh), which is calculated by multiplying the fuel's thermal value (MWh/tonne) by the fuel amount.

The energy content of the residues can vary (even significantly) during the different phases of delivery. The residues can dry out or become wet, measuring errors can become cumulate into big errors, and there can be many types of losses at different phases in the supply chain.

Verification challenges

Batch-specific verification of the sustainability of biomass is laborious. About 10,000 truckloads of fuel per year are delivered to the Joensuu power plant. The fuel consists of thousands of batches of raw material collected from different geographical areas. As a matter of logistics, the different batches and categories have to be combined into a single load, and thus estimating the average transport distance, for example, requires a lot of recordkeeping.

The processing of forest energy takes place at many different phases. The raw material residues might consist of the easier-to-process stem chips or the more difficult-to-process logging residues. The amount of the residue changes as a result of, e.g., drying, loss, or unit conversions (tn => m^3=> loose-m^3 => tn, tn => MWh) in the many different phases. The season in which the residues are harvested (summer/winter) and the drying period after the logging (days/years) also have a significant impact on the final energy content.

Because energy demand is highest in winter, the use of intermediate storages is necessary and causes an extra intermediate phase before end use.

Some of the raw materials used in pyrolysis oil production are also used for energy production at the power plant. In exceptional situations, fuel that is going to the power plant can be redirected to the pyrolysis plant as raw material – and vice versa.

Exporting bio-oil – mutual recognition

Exporting the bio-oil produced in Finland to other EU countries is currently problematic. The bio-oil sustainability system created in accordance with the RES Directive and the Finnish Act on the Sustainability of Biofuels and Bioliquids is not mutually recognised in other EU countries. In practical terms, this means that when exporting oil the exporter must get approval for its own sustainability system by the authority of each EU country.

Conclusions

Forest biomass for use in energy production is typically sourced from a relatively small procurement area because transporting biomass long distances is not profitable. There are many fuel suppliers, and the fuel may consist of several thousands of batches that have been collected from different geographical areas. Forest biomass processing occurs in multiple different phases. For these reasons, batch-specific tracking is technically challenging, causes significant expenses, and limits competition by excluding small players in practice. Small fuel suppliers can't afford to build and maintain expensive "stump-to-gate" data systems, so the strict sustainability verification practice puts raw material suppliers in an unequal position.

As a whole, the sustainability system for pyrolysis oil is considerably extensive and laborious. If this type of biofuel and bioliquid verification system were expanded to encompass the solid biomass used in electricity and heat production, the economic ramifications would be staggering. The use of domestic bioenergy would be threatened, while dependence on energy imports would increase and well-being in the bioenergy production areas would weaken. The price of forest fuels would rise with the decrease in the number of fuel suppliers, competition would decrease, and fuel costs would climb, and that, in turn, would put pressure on the price of district heat. Consequently, that could change the competitive position of different fuels and thereby compromise the target of increased bioenergy. The currently low price of fossil fuels on global markets and the low price of emission allowances are already challenges in the effort to increase bioenergy use. When creating a sustainability system for solid biomass, the complexity of verification must rightly be lessened.

In the Joensuu-type of solution that integrates a CHP plant and a pyrolysis oil production plant, the various requirements for verification of raw material origin and sustainability hamper the cross-use of the electricity and heat production fuel and the pyrolysis raw materials.