1 Ecological and agricultural perspectives of NATURA 2000 grassland in Europe and related socio-economic effects

Species-rich grasslands are seriously threatened in many European countries. For the conservation of the remaining areas nature protection agencies propose an extensive grassland management with a delayed spring cut to allow many plant and animal species to naturally reproduce. The harvestable biomass resulting from such defoliation regimes is usually quite lignified and of low nutritional value to ruminants or methane producing microbes in biogas digesters. Thus, extensive grazing (e.g. with suckler cows) which is promoted in many parts of European low mountain ranges provides low economic returns. Furthermore, grazing does not allow the conservation of several endangered grassland communities more adapted to cutting (e.g. species rich Trisetum-type grasslands are destroyed by frequent grazing). Similarly because of the poor chemical and physical properties of the biomass, conventional energy conversion techniques (biogas production using whole crop silages; hay combustion) are not widespread. Recent studies report that, approximately 30% of Germany's grassland will be abandoned in the near future due to increased nutritional and feed-technology demands of modern dairy farming systems. The marginal areas will be much more badly affected than those with good soils and high crop yields. With a decline in animal husbandry, the npopulation will also withdraw from these areas, as alternatives for income from outside agriculture are rare. Progressively over time, the touristic attractiveness of formerly open areas will decline, as landscapes loose their open character and grow more monotonous towards shrub and woodland vegetations.

Conclusion: Conventional utilization methods do not provide realistic opportunities for the conservation of species-rich, semi-NATURA grasslands in Europe.

2 Legal framework for the conservation of NATURA 2000 grassland

Extensive, and increasingly abandoned, grasslands cover large areas in European countries (e.g. approx. 1.5 Mio ha in Germany, 2.2 Mio. ha in UK and 0.6 Mio. ha in Estonia). Due to the rich diversity in both flora and fauna these grasslands are listed among the targeted valued habitats within the NATURA 2000 ecological framework. Once designated, conservation measures have to be taken in order to maintain the habitats and species in a "favourable conservation status" for which they are designated (see EU Council Directives on the conservation of NATURA habitats and of wild fauna and flora (92/43) and on the conservation of wild birds (79/409)). Thus, habitats may not be reduced in area, or altered in terms of the structures and functions which are required for their long-term maintenance. Because grassland habitats are intimately associated with human use of the land, and other resources, they are extremely vulnerable to changes in the nature of this exploitation.

Conclusion: Member states will be challenged to ensure a favourable conservation status of the grassland habitats and species.

3 Utilization of NATURA grassland biomass for energy

In regions dominated by NATURA grasslands, conventional biogas concepts are economically inefficient, especially if waste heat can not be appropriately used. As livestock numbers decrease and the remaining animals are more frequently grazed, the availability of liquid or solid manure for co-fermentation will become limited. Thus, concepts are necessary which reliably allow a conversion of strongly lignified grassland biomass without the addition of manure.

In Germany the “Renewable Energy Act“ (EEG) (Anonymus, 2004) initialised a boom in the construction of biogas plants. However, this development was restricted to regions with high yielding crops and thus well adapted for the production of energy-rich whole plant maize and cereal silage. In contrast, use of biomass from NATURA and other extensive grasslands as a feedstock for fermentation is negligible.

Reasons for this are:
i) low yield potential of extensive grassland compared to silage maize
ii) multiple harvests during the growing season and
iii) variable quality of biomass.

to i): The actual contribution of grassland to biogas production as outlined in official statistics mainly comes from intensively managed species-poor swards which were established on productive cropland. Such swards are able to achieve high yields of good quality. Usually such grassland biomass is usually used as co-substrate to silage maize and slurry. Biomass from regions dominated by NATURA grassland, is much less likely to be suited to such a co-fermentation process.

to ii): To maintain a valuable grassland vegetation diversity usually two cuts per year are necessary. Hence, the specific costs of harvest are considerably higher as compared to silage maize or cereal crops with a 3 to 6-fold yield. Usually the first cut of grassland in spring is delayed and enhances biodiversity.

to iii): The spatial variability in the botanical composition of grassland, as well as temporal variation (each growth is characterised by a different composition), hampers the control of fermentation processes in conventional biogas systems. In general methane production potential is drastically reduced during the aging and lignification of biomass as results from delayed cutting. A direct thermal use of dried grassland biomass (hay) is restricted by the higher content of minerals in legumes and herbs compared to pure grasses. This implies a risk of ash slagging and sintering during the combustion process which needs to be managed by complex thermal conversion techniques. Furthermore noxious gas emissions induced by plant chemical composition must be reduced by expensive flue gas cleaning.

A further problem is to ensure an efficient utilization of heat generated in distributed heat plants. For example the low population density in marginal grassland regions would cause high costs for a district heating network. The lack of industrial purchasers also strongly limits a year-round use of waste heat. Feeding biogas into the public gas grid would solve the problem with waste heat, but is not a realistic option as methane production from NATURA grassland biomass is too low.

Conclusion: The substitution of fossil energy sources by NATURA grassland-based fuels can not be implemented with conventional conversion technologies.

4 PROGRASS: An innovative technology for a distributed bioenergy production in grassland-dominated areas

The technical concept originally designed by Professor Scheffer, University of Kassel was designed for moist biomass (i.e. ensilaged energy crops) and aims at an increase in the overall energetic efficiency in the use of energy crops. The basic principle of the technology is a separation of silage in a liquid and solid fraction. The resulting press liquid feeds the biogas plant (Fig. 1) with an adapted solid-state digester. Subsequently, the biogas is used in a combined heat and power plant (CHP) to produce electricity and heat. The press cake, which is composed primarily of cellulose and lignin, is dried with the heat from CHP and processed to a solid fuel. The result is a fuel with attributes comparable to those of wood chips, which is suitable for combustion, gasification and subsequent processing to e.g. synthetic fuels.

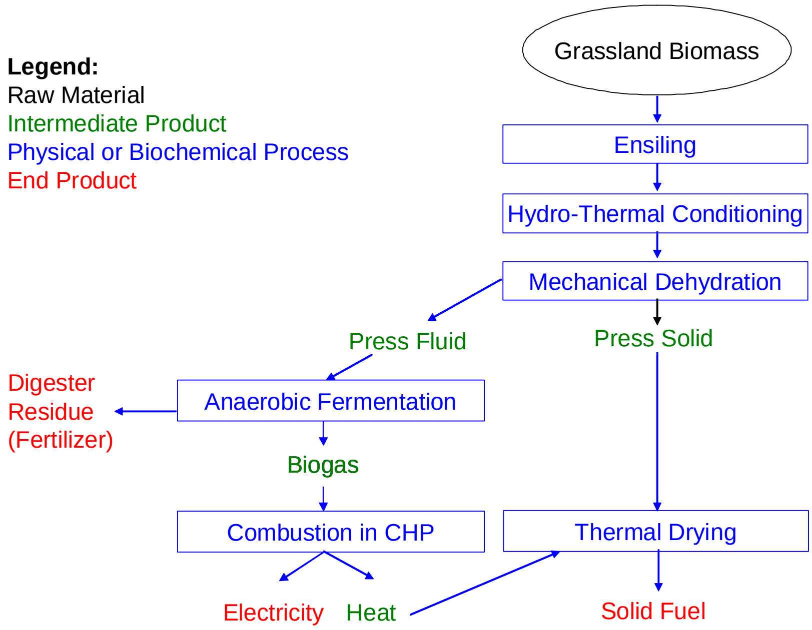

Figure 1: Layout of the integrated electricity and solid fuel production from agricultural biomass

Major technical advantages of this process for the use of NATURA grassland biomass are:

- Improved fermentation due to a flexible conditioning of the biomass, i.e. ensiling (incipient hydrolysis of structural carbohydrates), mash pre-processing (continued decomposition of structural constituents) and pressing (removal of lignin-cellulose compounds from the fermentable organic part).
- Efficient year-round utilisation of waste heat on-site for the drying of press cake.
- Advantageous fuel attributes of the press cake due to low mineral content.
- Reduced residue volumes to be transported compared to conventional biogas plants as much water is evaporated during biomass processing.
- Reduced ash formation and need for disposal in landfill.
- Efficient nutrient management through the application of digester residues on the grassland. Gaseous losses during application are expected to be low, as dry matter contents of residues and adherence to plant leaves are low.

Conclusion: The feasibility of the technology is supported by previous experience and results. Advantages of the PROGRASS technology are particularly suitable for application to NATURA grassland derived biomass.