III LANDSCAPE AND ENVIRONMENT

"CLIMATE- ENERGY- AND CULTURAL LANDSCAPE MODEL SAUWALD DONAUTAL" – EXPERIENCES WITH A PILOT PROJECT ON INTEGRATED REGIONAL RESOURCE MANAGEMENT BASED ON A NEW BIOGAS TECHNOLOGY

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ABSTRACT

This paper presents a model project where cultural landscape management and the production of "green" energy are combined to an integrated project on sustainable regional development. The project is based on a newly developed, small-scaled and mobile biomass-system, the 3A-biogas®-technology. 3A-biogas® uses a three-step composting-process to generate methane for the production of electric and thermal energy. The advantages compared to well known systems refer to a) low energy density required for the manipulated biogenic materials, b) a small and mobile plant, which generates low investment costs and c) possibility to combine biogenic waste, lop and hay of heterogeneous quality. These characteristics make the technology highly suitable for adoption in landscape-management of less-favoured rural regions.

The focus of the paper is set on the process of creating a regional programme interlinking landscape-, waste- and energy management based on implementation of the 3A-biogas®-technology. Therefore, two scopes are highlighted: cross-links between landscape-planning, energy- and composting-technology in the field of engineering are sketched in the first part of the paper. The 3A-biogas®-technology is briefly introduced, followed by an overview on how the technology is "translated" to fit the questions of regional landscape-, waste- and energy management. In the concluding section some important questions on calculation of costs for landscape management based on 3A-biogas® are discussed, regarding the experiences from our pilot study.

Key words: cultural landscape management, 3A-biogas®-technology, rural development, grassland vegetation

INTRODUCTION

Maintenance of traditional cultural landscapes and efforts on creating decentralised, CO_2-neutral energy systems are both outstanding issues in the current Austrian rural and regional policies. Ongoing abandonment of traditional agricultural farming systems raises increasing interest in alternative strategies in the management of – frequently touristy employed – rural landscapes. One possible alternative to livestock breeding may be the use of landscape-management hay for production of bio-energy. However, earlier experiences in trying to link production of bio-energy with landscape management issues for ecological, but also for social reasons did not end up with satisfying results: large scale projects advanced processes of intensification, concentration of land-tenure, displacement of regionally grown structures of land-use and external grasp on regional resource base (Graß, 2008; Kruska, Emmerling, 2008; Schöne, 2008; Schulze, Köppel 2007). Thus, demands for technologies better adaptable for the specific needs of landscape management and conservation issues were raised (Hasselmann, Bergmann, 2007). The crucial questions appear to be a) abilities to dispose low-energy materials in rather small capacities b) varying capacity utilization and c) low costs in investment, maintenance and management (Prochnow et al., 2007). Those framework conditions do not necessarily go hand in hand with profit maximising entrepreneurship strategies. This is why – apart from technological issues – further considerations focus on how to organise a system fitting the different needs of land-owners, communities, land managers and conservationists. As important as the technology itself seem the modes of its implementation and the embedding in regional structures within a "co-evolutionary process" (Schulz-Schaeffer, 2002).

This paper explores experiences with introduction and implementation of a small-scale technology – the 3A-biogas$^{®}$ system – for the use in landscape management and decentralised energy production in a regional pilot project. Choosing a bottom up approach – cooperation between experts, communities and stakeholders – the first part of the paper describes the pathway of integrating the technology into the regional environmental, economic and social structures. The second part of the paper outlines a few figures on financial calculation of grassland management based on 3A-biogas$^®$, as they can be educed from our case-study experiences so far.

Methodological remark

The inquiry is methodologically grounded in the principles of action research, as described by Altrichter (2007). Action research is an experience-based approach to generating knowledge by investigating praxis. In action research the researcher is part of the (cooperative, team-conducted) process he or she explores, running through a circle of acting and reflecting. The reflected experience forms the foundation for practical, professional theory (Altrichter, 2007). The action research approach was developed in teachers` research, by teachers exploring their class. Lately it has been extended and transformed to investigate several areas of social processes (Kurz, 2010). The empirical facts and data presented in the paper are an outcome of the conducted feasibility study and were gradually elaborated further in the following participatory discussions.

3A-BIOGAS$^®$ TECHNOLOGY

3A-biogas$^®$ is a technology developed for the treatment of organic material containing high dry matter percentage to produce electric and thermal energy. The technology combines biogas- and compost- production including sanitation of the compost. Using a batch-process, the biological decomposition in 3A-biogas$^®$ takes place during 3 operating phases (aerobic, anaerobic, aerobic) in a closed domain without intermediate movement of substrates (Müller et al., 2006):

- In the initial aerobic phase (up to 6 days, reaching temperatures up to 70° C) the input material is ventilated, the substrate is aerated and the aerobic microbiological activity causes an increase of temperature. Within this phase lightly degradable substances are reduced (decrease of acid formation), the substrates are sanitized (reduction of pathogen) and the material is heated for the second phase. Carbon dioxide and water is the output of the initial phase.
- The second phase of the process (25-40 days, 35-45° C) is carried out under mesophile anaerobic conditions, starting the methane production. Digestion takes place, biogas is produced and the volume of the input substrate is gradually reduced.
- The third phase starts (about 10 days, up to 60° C) with anew aeration of the substrate. Organic materials are stabilised and become quite inodorous. The output of the phase is compost, which can be further composted outside the fermentation reactors to reach a further stage of maturity.

While treating such substrates in conventional liquid biogas plants high volumes of water would be necessary (which remain in most cases as wastewater subsequently), the 3A-biogas batch-process for solid state bio-waste can reach the best available synergies of composting and fermentation technology. The 3A-biogas$^®$-process was developed by A. Steffen and patented in 1988.

Technology	Process	Substrate	Outputs
Composting	aerobic	solid state	Compost
3A-biogas	aerobic / anaerobic	solid state	Energy & Compost
Liquid fermentation	anaerobic	liquid	Energy & liquid Digestate

Source: Müller et al. ,2006

Figure 1. 3A-biogas$^®$-technology.

The technology is integrated in a container system. The minimum load of the organic material should not go below 500 t/year, optimized use of capacity can be reached up to 2000 t/year. Average gain of biogas is 120 m^3/t, containing 60% of methane. The energy output is 3 kW (electric) and 6 kW (thermal) per m^3 CH_4 (Müller et al., 2006).

CLIMATE-, ENERGY- AND CULTURAL LANDSCAPE MODEL SAUWALD DONAUTAL

Several 3A-biogas$^®$ facilities have been employed successfully in the treatment of organic waste in earlier projects (see Müller et al., 2006). The experiences indicated that well structured materials such as lop and grass contribute to an improved process. The outcomes of those test runs justified considerations on application of the technology under "field conditions" in landscape management, where high amounts of dry organic materials emerge (Prochnow et al., 2007). The 3A-biogas$^®$ technology – so the assumption – therefore could provide a tool which not only allows reintegration of those materials in regional material flows, but also contributes – to a minor degree – to regional energy autonomy. These were the considerations which ended up in the development of the pilot project “Climate-, Energy- and Cultural Landscape Model Sauwald-Donautal”. Involving a team of experts in waste management, energy management and landscape planning the project was initiated by the regional LEADER- management. The basic conception behind the project was to link issues of cultural landscape management, organic waste management and decentralised, regional energy support. The core of the project should be the 3A-biogas® technology. However, according to the philosophy of endogenous regional development (Van der Ploeg, 2009), broad integration into the existing regional (environmental, economic and social) structures was defined as a central goal of the project by the regional LEADER management. Therefore, a cooperative, participatory approach to implementation should be designed**.** As a particular – non-commercial – objective of the project the stabilisation of the open landscape and its diverse grassland types was drafted (Kurz, 2010).

The chosen model-region, the Donautal (Danube Valley) is a mountainous area, characterised by small scale agriculture. Grassland- and forestry are the predominant categories of land use. While soft tourism forms one of the major sources of income, land abandonment and reforestation create massive problems in regional development of the touristy used region (Kurz, 2011). Decline of tiny structured open landscapes not only implies losses of diversity and splendid views. It also induces negative influences on the micro-climate and quality of life of the narrow valley landscape as a whole. For these reasons several efforts on finding practical alternatives to ongoing reforestation had been undertaken in the past.

Figure 2. Model region Sauwald-Donautal.

Design of the pilot project

Fig. 3 visualises the workflow of the pilot-project: around the 3A-biogas® technology a model bottom-up process was designed, structured in a four stage setting. Starting with general information on the technical performance (Stage 1) a feasibility study regarding regional framework conditions was assigned (Stage 2). This formed the foundation for participatory development of an integrated concept in the fields of landscape management, organic waste management and regional energy production/support (Stage 3). Stage 4 should contain the elaboration of the definite plan for the implementation of the project. Each stage should be characterised by interaction between the experts` inputs (analysis), followed by discussion and further elaboration in teamwork. These processes should help identify the possible conflicts and problems, commonly elaborate solutions and – by the way – form a regional network pushing the project forward.

Assessment of feasibility in landscape conservation and landscape management

In the case of landscape- and grassland management basically two questions were considered significant:

a) how much organic material can be allocated, when does the material occur – according to time and frequency of harvesting – and which are the expectable costs for harvesting and transport?
b) how has management to be organised so that the ecological quality and diversity of the regional grasslands can be sustained or even improved?

To answer these questions comprehensive analyses of regional grassland vegetation was conducted. According to the method of Braun-Blanquet (1964), grasslands were typologically described and vegetation dynamics were analysed focussing on different management techniques. Potential yields were evaluated, regarding optimized dates and frequencies of mowing (Kurz, 2011). By mapping grassland types, structural data as plot structure, land tenure and allotment could be integrated in the examination. Founded on the analyses of the field data several maps and GIS-based analysis were generated (see Fig. 4). The technical analyses lead to the modelling of three scenarios, which functioned as a tool for communication in the following participatory process:

- minimum scenario: implementation of grassland areas currently managed by nature conservationists;

- optimum scenario: currently managed additionally including abandoned areas;
- maximum scenario: optimisation of energy output by including all areas regionally available.

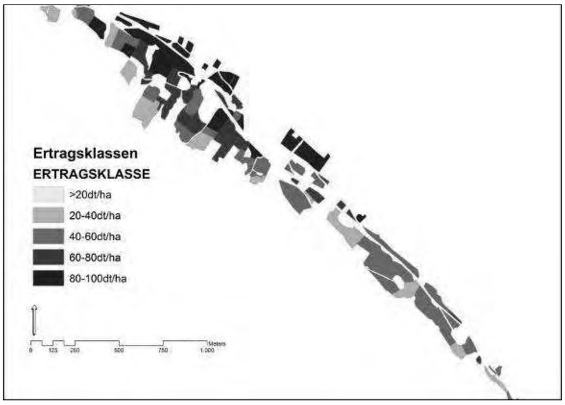

Figure 4. Potential yields of grassland types.

While scenarios 1 and 2 should estimate the economic impacts of proceeding under ecologically favoured conditions, the goal of scenario 3 was to assess environmental effects within an income-orientated setting.

Further steps in project development

Comparison of these alternatives formed the starting point for a discourse process, in which the pressure groups (landowners, community representatives, landscape managers, the team of experts etc.), elaborated the operational framework for possible implementation. Collaterally, more detailed information and data were organised. For a management concept on landscape issues for example

- hot spots of land abandonment were identified;
- measures for maintenance and management were defined;
- organisational questions of logistics were discussed and possible arrangements in the processing (legal frameworks and social organisation of cooperation, contracting between the involved actors etc.) were weighed.

These processes took place in small group settings, accompanied by the expert team, moderating the working groups and operating them by providing the data, tools and working papers. The results of these workshops were presented and discussed in another plenary session, which was eventually followed by elaboration of a definite plan for implementation. This contained the formation of a regional landscape management association, founding of a cooperation operating the 3A-plant and contractually agreements with regional waste managers on supply with organic waste (see Fig. 3).

LANDSCAPE MANAGEMENT BASED ON 3A-BIOGAS – SOME REMARKS ON THE CALCULATION OF COSTS AND RETURNS

A central issue in application of the 3A-biogas®-technology in landscape maintenance and –management actually concerned economic questions of cost effectiveness. At best, so the general assumption at the starting point of the project, landscape management and expected energy outputs should form a self supporting system. To estimate the economic feasibility of the tested technology, a cost calculation for the pilot region was elaborated. The model was based on balancing between the harvesting costs and expected yields out of the composting. Our cost modelling regarded the factors *potential yield/ha, plot size/allotment* and *mowing frequency* on the input side. For calculation of labour- and machinery costs we could access cost schedules from regional landscape management associations (using a compensation key of 30€/plot+5 Eurocent/m²). The calculation of outputs is based on the experiences from the previous test runs of 3A-biogas® -assets: Taking in account a yield of biogas of 120 m³/t (60% of methane), an output of 3 kW and an electricity tariff of 18 Eurocent/kWh, we can estimate a yield of 50 €/t organic material. Additionally, already the gained subsidies out of agro-environmental- and nature conservation schemes were taken into account for calculation. Based on these data we could calculate the expected costs and earning for each single plot. Table 1 gives calculation examples for three regionally “typical” field plots: the examples demonstrate that for large size fields (>1 ha) with intensive grassland types the yields of biomass are the central factor allowing a positive financial balance. With poor grasslands, on the other hand, a positive balancing is achieved due to the nature protection subsidies. In contrast, from an economic perspective the so called “average” grasslands generating medium yields on middle sized plots (0,5-0,8 ha) appear problematic. These types usually do neither hold high potentials of organic material, nor are they currently favoured as ecologically notably valuable by nature protection schemes. However, as highlighted by our vegetation analyses, these typical hay meadows not only cover considerable parts of the project area. They actually also suffer the highest pressure of abandonment and reforestation, so that measures for maintenance in their cases are badly needed (Kurz, 2011).

Transforming the computation to the level of the region of inquiry as a whole (about 70 ha of grassland to be managed, estimated 470t of organic material from hay, ca. 24.000 €/year earnings, 37.500 € costs, ca. 10.000 € from subsidies), our calculation saw a deficit of 3.500 €/year. This was almost exactly the amount that could be gained of charges for deposal and composting of organic waste.

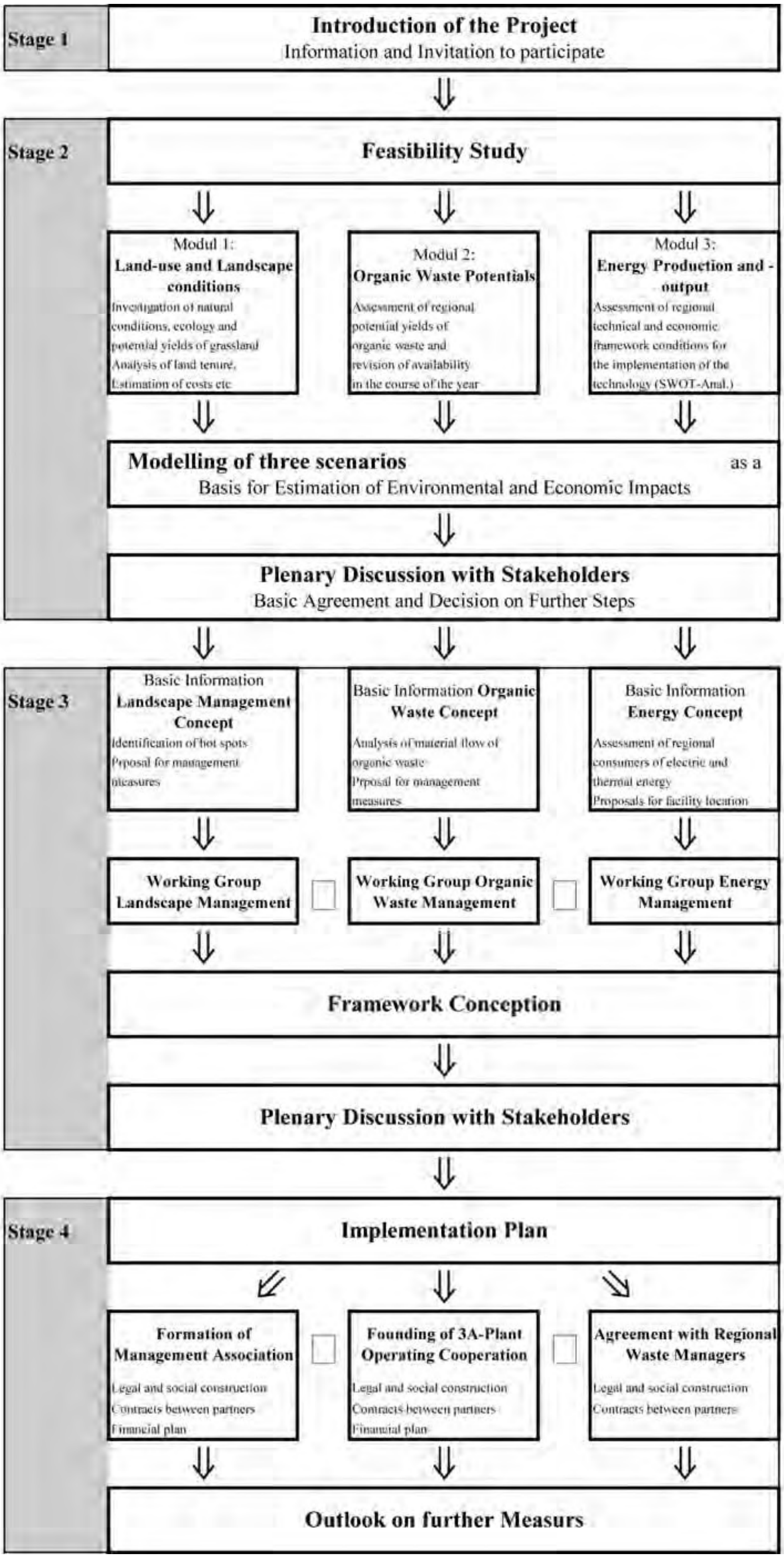

Figure 3. Project design.

Table 1

Example calculation for three plots with typical regional grassland types

Vegetation Type	Intensive grassland Alopecurus Type	Hay meadow Arrhenatherum Type	Extensive grassland Festuca rubra Type
Potential yield (t/ha)	10	7	3
Plot size (ha)	1,2	0,6	0,3
Yield (t/ha)	10,8	4,2	1
Mowing frequency/year	3	2	1
Harvest costs in €*	630	330	180
Subsidies in €**	120	60	130
Netto costs in €	510	270	50
Yield earnings from 3A biogas in €***	540	210	50
Difference in €	30	-60	0

* Calculation basis: 30 €/plot + 5ct/m² (compensation key of regional management associations)

** Calculation basis: Austrian Environmental Scheme ÖPUL, Nature protection schemes

*** Calculation basis: 50 €/t of organic material with an calculated price of 5ct/kWh

Therefore – as a result from combining the proceeding of organic waste and hay – the project could achieve an equated “raw” balance. However, neither the investment cost, nor maintenance and manpower are considered in the calculation yet. These expenses have to be funded from additional sources. In the case of our project these contain landowners’ contributions to maintenance, sponsoring and – in the long run – hopefully contributions by regional touristy as a beneficiary of cultural landscape maintenance.

CONCLUSIONS

Summarizing our experiences we can state that the 3A-biogas® technology offers a practical tool for combined, integrated management of landscape, organic waste and energy on a small scaled regional level. In our case study the system proved adaptable to local framework conditions and needs. The central importance for our project was achieved by the combination of the different sources: organic waste, lop and hay from landscape management. This results from the technical issues – achievement of well balanced relations between the energy density and composting performance – as well as from the economic point of view. While the material from landscape management is only seasonally available and expenses for harvesting and bringing of allocated materials cannot be fully covered by 3A-biogas®, organic waste material may balance and compensate those shortcomings to a certain degree.

However, a cost-effective processing of landscape management products turned out to be impossible through 3A-biogas®, so that additional financial sources (nature protection schemes, sponsoring, tourism as a beneficiary of landscape management) have to be funded. Retrospective, for these purposes the chosen bottom-up approach proved viable: it helped creating a network of regional actors who gradually identified with the project and took on responsibility for it. From this perspective we could observe not only broader regional awareness for cultural landscape issues, promoted by the project. It subsequently also increased the willingness to financially support landscape management as a regional concern, especially with some regional non-agrarian great landowners.

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