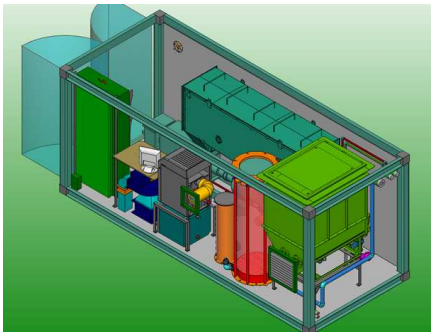
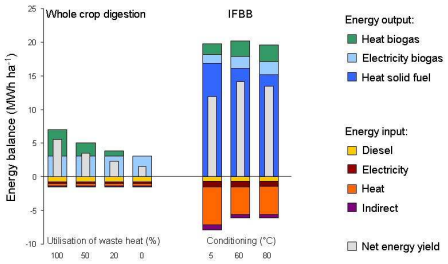
PRO GRASS




Securing the conservation of protected grassland habitats with a decentralised bio energy production

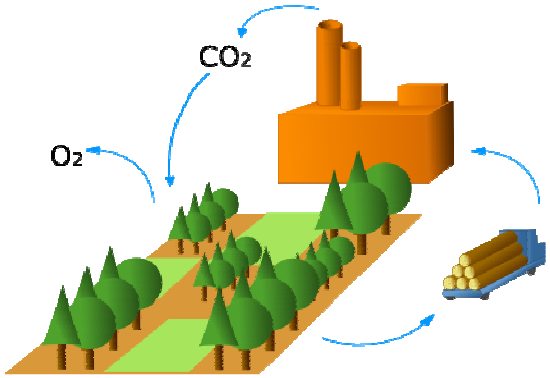
Interim Results of the Project (08/2011)





Background

The rising global consumption of energy and the growing shortage of fossil fuels require an urgent development of sustainable and eco-friendly energy supplies.



Using biomass is one of the possible ways to contribute to sustainable development and to reduce green-house-gas (GHG) emissions

Its strength is the neutral balance between the amount of CO_2, taken from the atmosphere during the period of plant growth, and the amount of carbon released to the atmosphere through biomass combustion

However, the cultivation of dedicated crops and subsequent conversion and use may entail significant GHG-emissions and other negative environmental impact (soil erosion, nutrient leaching and reduced soil fertility).

Furthermore, the cultivation for energy production (maize, rapeseed and cereals) competes with food production.

PROGRASS' view turns around the idea that biomass from grasslands can play a role in maintaining biodiversity.

Indeed, Grassland swards have been identified as having extraordinary value in terms of preserving biodiversity, also in the European Habitats Directive.

But then, their species-richness is seriously threatened since livestock numbers have decreased and thus grazing.

To prevent those habitats from scrub encroachment those areas have to be extensively harvested according to strict regulations.

However, though the late harvesting fosters biodiversity the biomass retrieved is of insufficient quality for conventional biogas plants and most other bio energy production plants.

For these reasons, the PROGRASS approach focuses on protected semi-natural grasslands and interconnects production of bio energy from formerly unused plots with the protection and management of the natural habitats to conserve and increase the biodiversity of those most valuable sites..

Protection of Grassland Habitats

European grasslands represent 90 million of hectares, at least a third of the total agricultural land area (FAO).
They range from humid grasslands/meadows through steppic and mesic types (in North and North-West Europe), to almost desertic types in south-east Spain.
They play both ecological and social roles.

Ecological functions	„Social“ functions
Carbon storage Soil Protection Biodiversity Hot-spots	Food Energy Forage and livestock Tourism and recreation

In the past years the decrease of agricultural activities (grazing) led to a continuing reduction of those ecologically valuable, extensively used grasslands since the succeeding Progressively over time, the attractiveness of formerly open areas will decline, as landscapes loose their open character and grow more monotonous towards shrub and woodland vegetations, thus leading to a reduction of biodiversity.

Threats to conservation
Changes in land use and land abandonment / abandonment of traditional activities Afforestation Changes in livestock density Intensification of grassland management and mowing Lowering of water tables

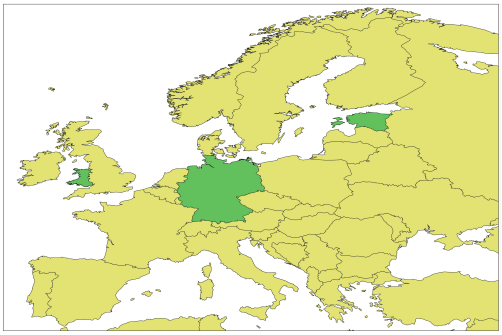
Nowadays ecological and sociopolitical interest in Europe want to stop their ongoing decline (by 12.8% from 1990 to 2003 - FAO 2006).

EU Policy is committed by financing agri-environmental measures and projects (LIFE Programme), directly or indirectly targeted grasslands habitats

The aim of PROGRASS is to provide an integrated concept for the conservation of semi-natural grassland. This can be achieved through the regular, extensive use of these areas and the energy recovery of biomass by means of the innovative concept of “**Integrated Generation of Solid Fuel and Biogas from Biomass**” (**IFBB**).

.

European Grassland Sites



In the framework of the PROGRASS project a number of interdisciplinary investigations have been carried out at six experimental sites in each of the partner regions of Germany, Wales and Estonia.

The sites were chosen with the aim to meet the most representative plant vegetations of the respective region hence giving a full picture of most vegetation types to be found in NATURA habitats.

Thus the approach secures the European wide transferability of PROGRASS' ecological, energetic and technical results.

The German sites are situated in the low mountain range of the Vogelsberg region in central Germany on, the Welsh areas are located in the Western part Ceredigion and Estonian grasslands have been selected in the lowlands of central Estonia.

The scientific works have been dealing with the productivity and quality of the grassland biomass.

Also the dynamics of the biodiversity under different cutting regimes have been investigated.

The conversion performance of the biomass has been assessed by analysing the mass and energy flows into the products such as solid fuel and biogas substrate to investigate the technical and economical potential of the biomass harvested from the protected sites.

PROGRASS Grassland Sites

NATURA 2000
Germany, Area II, 6510 - Lowland hay meadows

NATURA 2000
Germany, Area VI, 6431- Humid tall herb fringes of watercourses and wood-lands

NATURA 2000
Germany, Area IV, 6230 - *Species-rich *Nardus* grasslands

NATURA 2000
United Kingdom, Wales Area I, 7120- Degraded raised bogs still capable of natural regeneration

NATURA 2000
United Kingdom, Wales Area I, 7130-Blanket bogs

NATURA 2000
United Kingdom, Wales Area III, 7120- Degraded raised bogs still capable of natural regeneration

NATURA 2000
Estonia, Area I, 6450- Northern boreal alluvial meadows

NATURA 2000
Estonia, Area VI, 6530 Fennoscandian wooded meadows

NATURA 2000
Estonia Area IV, 6450- Northern boreal alluvial meadows

Technical Approach

Utilisation of NATURA grassland biomass for energy – A Challenge

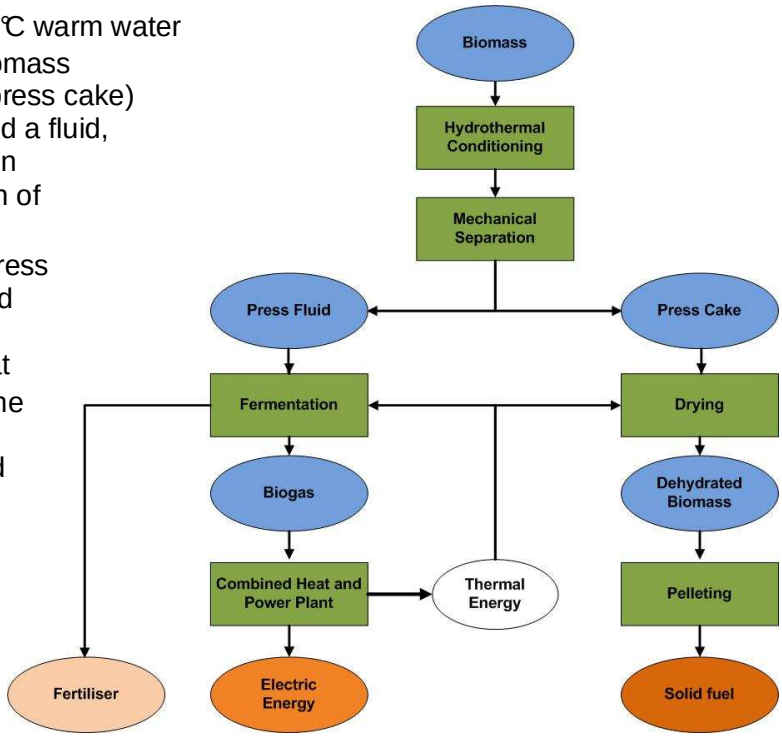
Biomass from semi-natural grasslands is characterised by a high proportion of ligno-cellulose and minerals. That makes it difficult to use in conventional systems like biogas production or combustion of hay.

IFBB- Integrated Generation of Solid Fuel and Biogas from Biomass

For this reason, the IFBB technique aims at the separation of the grassland silage into a solid part for combustion and a liquid fraction for biogas production. The extraction of minerals and easily digestible compounds into the liquid significantly improves the combustion performance of the fuel and makes the press fluid to valuable substrate for biogas production.

Procedural Design:

- Silage is first mashed with 40℃ warm water
- Separation of the mashed biomass into a solid, fibrous fraction (press cake) to be used as a solid fuel, and a fluid, biologically convertible fraction (press fluid) for the production of biogas and electricity
- Biogas production from the press fluid and its use in a combined heat and power plant (CHP) to produce electricity and heat
- Drying of the press cake by the waste heat of the CHP and supply of a fuel with improved combustion characteristics compared to the untreated biomass
- Prevention of unused waste heat from CHP through year-round drying of the press cake
- Digestates can be used as valuable fertiliser containing a lot of mineral nutrients



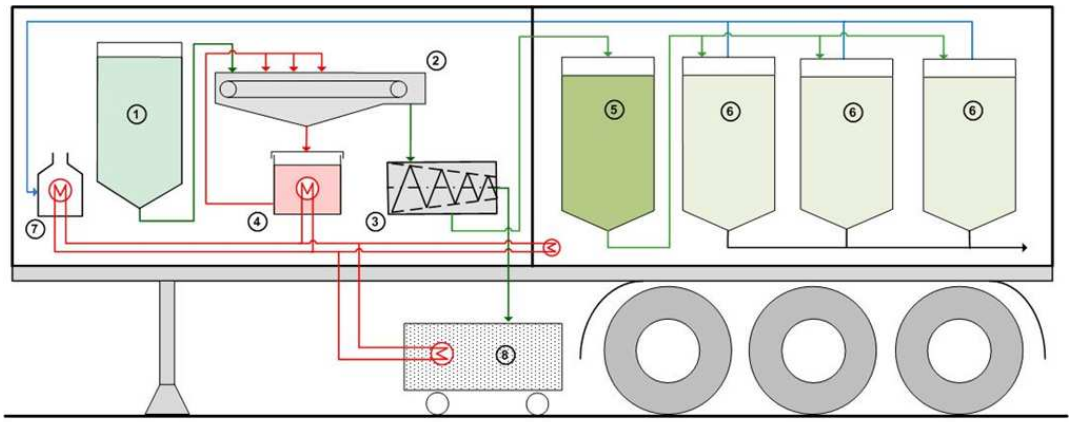
The Prototype as Demonstration Plant

By means of a mobile PROGRASS prototype the IFBB technique is being assessed on a pilot scale, and demonstrated in 2010 and 2011 in Vogelsberg, Hesse, Germany, and in the European partner regions of Wales and Estonia. The accompanying scientific research analyses the quality of silage and fuel, the digester dynamics and the biogas yield as well as the feasibility of the technical concept in a continuously operating mode.

Apart from research work and continuous press cake and pellet production, the distribution of the new technical approach is one of the main tasks of the project. Numerous demonstration events are hold to inform farmers, representatives of local and regional authorities, scientists, politicians and a wide public

Technical data of the demonstration plant:

- Processing capacity: 400 kg silage per day
- Fuel production: 90 kg dry matter per day
- Biogas yield: 7 kW



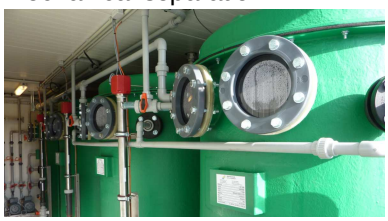
① Biomass storage tank
② Hydrothermal conditioning
③ Screw press for mechanical separation
④ Mash water tank
⑤ Press fluid storage tank
⑥ Digester
⑦ Biogas burner
⑧ Press cake dryer
Heat exchanger

Prototype and Process Steps

Feeding of the silage

Hydro-thermal conditioning

Mechanical separation



Fixed bed digesters (press fluid)

Biogas burner and system control

Drying boxes for the press cake

The demonstration plant was designed to fit in two standard containers in order to facilitate European wide transportation.

The prototype includes all of the core elements of the IFBB process. The pre-treatment of the silage is conducted by a mash water percolation system at a temperature of 40 ℃.

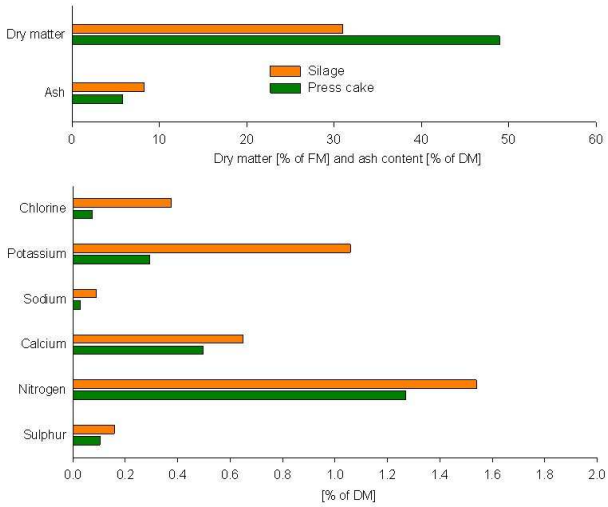
Mechanical dewatering of the mashed silage is carried out by a screw press. The resulting press fluid is transferred into the second container of the prototype where it is converted to biogas in three digesters with a volume of 1.3 m^3 each at 37 ℃ and anaerobic conditions. The biogas is used by a biogas burner to produce heat for heating of the mash water, the digesters and drying of the press cake which still contains 50 % water after pressing. Compacting and combustion of the pellets is done externally.

Process Steps

- Filling of the plant with a band conveyor
- Hydrothermal Conditioning (Mashing)
- Mechanical Separation by a screw press (Press liquid – Press cake)
- Fixed bed digester for press fluid digestion
- Drying with a biogas driven burner in drying boxes for the press cake

PROGRASS - Results: Combustion Properties

First results of processing by the IFBB prototype reveal that pre-treatment and mechanical dehydration lead to significantly improved combustion characteristics of the fuel.



Dry matter content of the silage can be increased by 20 percentage points resulting in reduced heat demand for the drying process.

Through the pressing procedure all of the nutrients detrimental to combustion can be reduced. In particular, ash softening and corrosion affecting elements like potassium and chlorine are decreased in the press cake. In contrast, reduction of nitrogen and sulphur is only low.

Ash softening temperature can be increased at about 1200℃ and also the heating value steps up to more than 18.5 MJ/kg dry matter.

Technical Advantages of the IFBB Process:

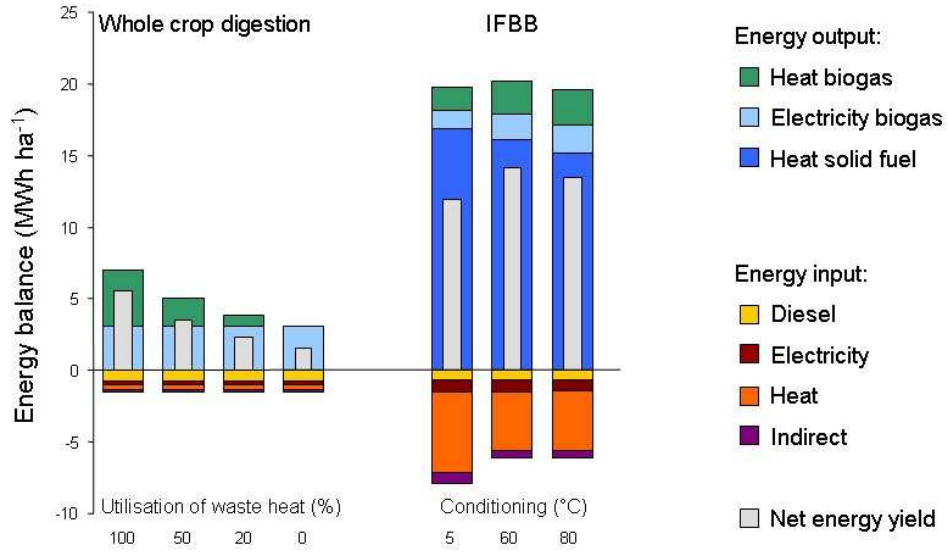
- Improved digestion caused by conditioning of the biomass (Silage, mashing, separation of solid and fluid phases)
- Efficient, year-round utilisation of the process heat to dry the press cake
- Improved combustion properties of the press cake through decreased amount of minerals and decreased requirements regarding flue gas cleaning
- Reduced transport volume for residues through drying and compacting of the press cake
- Efficient nutrient management via re-distribution of digestates.

PROGRASS - Results: Energy Balances

In the framework of the PROGRASS project extensive analyses of the biomass taken from the different European grassland sites have been carried out in order to highlight the energy balances.

As stated above the combustion quality of all the samples was equivalent to mid-quality wood chips and above.

Looking at the overall efficiency, IFBB system (right columns) obtains higher net energy yields compared to whole-crop digestion (in conventional biogas plants, left columns) , due to mainly thermal use of the fibrous biomass.



The energy inputs are higher as those of a conventional biogas plant due to mesh-ing and drying (visualised in the lower part of the graphic), but the output of energy is three times higher (lower part of the graphic). Main product is the solid fuel which has the additional benefit of being storable and transportable.

Conclusion:

The results of the scientific analyses clearly show that the IFBB approach applied in PROGRASS is very well suitable to convey the cellulose and lignin rich biomasses harvested from extensive grasslands into bio energy.

Hence with the help of PROGRASS a new source for renewable energy can be exploited coupled with the simultaneous protection of species rich protected NATURA 2000 grassland sites.

PROGRASS Results: Socio-Economic Aspects

In areas less favorable for agricultural production, a decentralized energy generation using grass from semi-natural grasslands can provide alternative income for the population of rural areas.

In addition, the preservation of typical cultural landscapes – besides maintaining valuable habitats – may lead to a higher tourist attractiveness of the natural scenery.

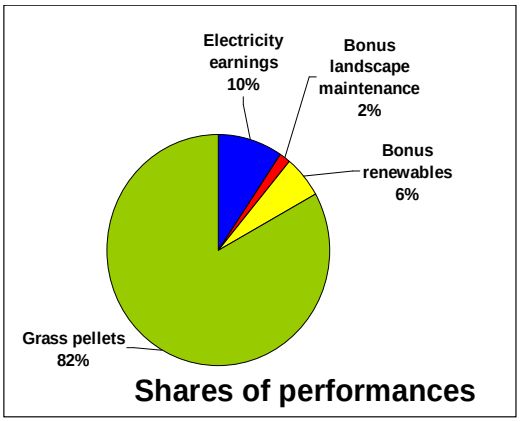
Within PROGRASS, the complex socio-economic effects of costs and benefits of the PROGRASS approach are evaluated at microeconomic and regional level.

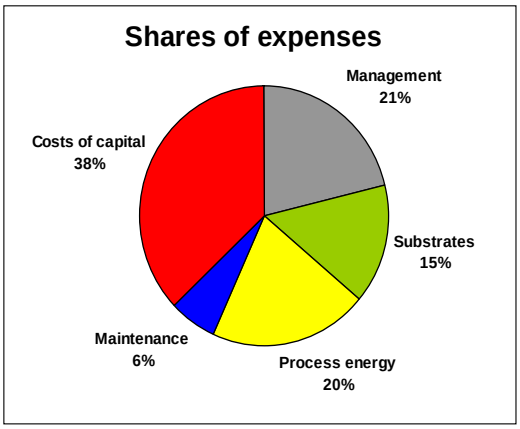
The cost calculation of grassland in regard to different cultivation systems and the economic comparison of different extensive land use systems and profound investment calculations contribute to the identification of suitable managing options for extensive grasslands.

Based on **expert interviews** in the Vogelsberg region and Wales several parameters were identified that may influence the implementation process of the PROGRASS approach in a certain region:

- Availability, harvest yields of NATURA 2000 grassland sites
- Harvesting feasibility of grassland sites (technical and meteorological requirements, accessibility of sites)
- Site location in relation to the bio-energy plant, affecting transportation costs
- Involvement of stakeholders (farmers, local administration, etc.) in the PROGRASS implementation process
- Path dependencies in local agricultural farming practices
- Competition for NATURA 2000 grassland material within other land use systems
- Availability of nearby pellet burning furnaces, demand for grass pellets as solid fuel
- Subsidy situation

PROGRASS Results: Economic Viability of the Approach





Investment calculations verify a profitable use of semi-natural grassland within an IFBB plant, especially dependent on the prices and future rate of price increases of solid fuels.

The rentability of the approach is dependent on the following factors:

- Prices for solid fuels
- Increase of prices of solid fuels
- Grassland harvest yields
- Costs of substrates
- Composition of substrates
- Investment costs
- Labour costs
- Transport cost
- Amount and interest for external capital
- National/regional funding and subsidies

Considering characteristic regional premises, calculations of land use options and plant investment show that the PROGRASS approach can exhibit a valuable economic alternative preserving semi-natural grassland habitats.

Properties Full Scale IFBB-Plant (Basic Standalone-Version, Germany)

Calculated life span	20 Years
Thermal performance:	1,05 MW_{therm}
Electrical performance:	50 kW_{el}
Grassland requirements	approximately 600 ha (assuming 4 t DM/ha)
Pellet-production:	1.730 t/year
Investment costs:	approximately 1,7 Mio. €
Return on Total Assets:	7,59 %
Positive cash flow from:	Year 1
Start of dividend payout:	Year 1

PROGRASS –Project - Partners - Contact

PROGRASS, as a demonstration project, has been funded in its initial phase through the European LIFE+ Programme of the European Commission for 3,5 years up to June 2012.
In the framework of the model project experts from nine partner organisations from science, practice, regional and state administrations and ministries, education and public relations collaborate to practice, test and demonstrate the PROGRASS approach on a European level.
In this first interdisciplinary approach all basic technical, ecological, social and economic questions have been tackled. At the end of the project standardised procedures of best practice will be established to introduce the PROGRASS approach in other European NATURA 2000 sites and grassland habitats.

Partner Organisations

- Universität Kassel, Department of Grassland Science and Renewable Plant Resources, Witzenhausen (as coordinating partner)
- Department for the rural area (ALR) of the Vogelsberg County, Lauterbach
- Institute of Biological, Environmental and Rural Sciences (IBERS) Aberystwyth, Wales
- Estonian University of Life Sciences, Tartu, Estland
- Rheinische Friedrich-Wilhelms-Universität, Institute of Animal Science, Bonn
- Blended learning institutions' cooperative; blinc eG, Göttingen
- Education and Project Network lt, BUPNET GmbH, Göttingen
- MAWERA/Viessmann GmbH & Co. KG, Allendorf
- Hessian State Ministry for Environment, Energy, Agriculture and Consumer Protection, Wiesbaden

Contact

In the framework of the model project, the PROGRASS association was founded as legal body of a growing European network. It is open for regions and stakeholders who use the PROGRASS approach to protect their protected NATURA sites and produce bioenergy from the abandoned grassland sites using the PROGRASS procedures and IFBB technique.
If you are interested to join us please contact:

PROGRASS e.V
C/O Universität Kassel Fachbereich ökologische Landwirtschaft
Fachgebiet Grünlandwissenschaft und Nachwachsende Rohstoffe
Steinstrasse 19 - 37213 Witzenhausen
email: info@prograss.eu
Website: www.prograss.eu

PRO GRASS

Sefydliad y Gwyddorau Biolegol, Amgylcheddol a Gwledig
IBERS ABERYSTWYTH
Institute of Biological, Environmental and Rural Sciences

UNIKASSEL VERSITÄT

www.emu.ee
Eesti Maaülikool
Estonian University of Life Sciences

HESSEN

VOGELSBERG
HESSENS URGESTEIN

MAWERA
VIESMANN Group

blinc
blended learning institutions' cooperative

BUPNET
Bildung und Projekt Netzwerk

universitätbonn

Life

www.prograss.eu