D4.1

Report on the state of the art of the occurrence and use of LCMW material for energy consumption in Europe and examples of best practice

15.1.2016

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 646443.
About the greenGain project

The greenGain project aims at increasing the use of biomass originating from landscape conservation and maintenance works (LCMW) for bioenergy. The main target groups are regional and local players, who are responsible for maintenance and conservation work and for the biomass residue management in their regions. Moreover, the focus will be on service providers - including farmers and forest owners, their associations, NGOs and energy providers and consumers.

The three-year project, which started in January 2015 is supported by the Horizon 2020, European program to foster research and innovative solutions in the EU. The project is gathering partners and researchers from Germany, Italy, Spain and Czech Republic. Researchers will map biomass potential coming from landscape conservation and maintenance work, various technological options to utilise it, identify possible obstacles and provide recommendations to a wide range of stakeholders in the EU28.

Project coordinator

Project partners

[Logos of project partners]
About this document

This report corresponds to **D4.1** of greenGain: *Report on the state of the art of the occurrence and use of LCMW material for energy consumption in Europe and examples of best practice.*

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Summary

The project greenGain aims to promote the energetic use of biomass from landscape conservation and maintenance work (LCMW) and to mobilize its potential. LCMW biomass is mostly not utilised in Europe, although it originates as a residue by the necessary maintenance measures and its utilisation is in accordance with the principles of sustainability.

To support an efficient treatment of LCMW biomass, the data on its potential, types and possible utilisation technologies need to be reviewed. Therefore, one of the tasks of the greenGain project is to create a knowledge base on the status quo of the use of LCMW feedstock in Europe. With this motivation, available information on the topic was analysed in this report.

In a number of regions as for example in Rotenburg (Wümme) and Elmshorn in Germany, Asturias and León in Spain and Vitembro in Italy LCMW biomass has already been recognised and studies on the occurrence and potential of LCMW biomass are available. In the example regions Vest-og-Sydsjaelland in Denmark and Paris in France the assessed feedstock potentials of green urban areas are very promising (Pudelko, et al., 2013).

The conversion of the LCMW feedstock to energy or an energy carrier is still exceptional. A frequent treatment of the LCMW material is for composting. Compost is used as source of organic matter and nutrient for agriculture, gardens and as a component of flower soils. Although the energetic utilization of biomass from LCMW is not yet common practice, it includes an added value, which should be exploited.

The currently existing data on LCMW biomass are rather scattered. Several interesting activities conducted in Europe were recognised during the research and are mentioned in this report. Besides biomass potential estimations made on the European level, the potential of green residues has been evaluated in a number of smaller regions aiming at the incorporation of this biomass into the local energy cycles. When focusing on the implementation of a more effective use of LCMW biomass it became clear, that the possibility of an economic gain is the strongest motivation of the responsible bodies to introduce such actions.

However, increased recovery of LCMW feedstock for bioenergy requires in depth analysis of the benefits and challenges of such practice. The benefits of LCMW feedstock utilization are numerous. A crucial factor from an economic perspective is income originating from selling LCMW or from bioenergy sales, which can decrease the cost of processes generating the road maintenance LCMW and enable investment in more efficient machinery. Savings in LCMW costs can also be achieved by using the feedstock for own energy needs. The local economy and material flows are strengthened by setting up a feedstock supply chain in the region, resulting in direct tax savings of the citizens. Environmental savings can be accounted as regional achievement and lead to a positive consumer perception. The set up of the
adequate concept and finding of the most appropriate technology for a certain type of biomass, establishing new networks and gaining acceptance for the project from various actors (e.g. land owners, maintenance bodies, administration bodies, service operators) is however a challenging undertaking, which will be supported by the greenGain project.

The project activities should trigger further exchange of knowledge on the topic and a transfer of LCMW biomass utilisation strategies elaborated in the model regions into further European regions. This report on the status quo of occurrence and use of LCMW biomass contributes to this mission.
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List of abbreviations

CHP     Combined Heat and Power
DBH     Diameter at breast height (trees)
DM      Dry Mass
EROEI   Energy Return on Energy Invested
FM      Fresh Mass
HPP     Heating and Power Plant
HTC     Hydrothermal Carbonisation
LCA     Life Cycle Analysis
LCMW    Landscape Conservation and Maintenance Work
NEG     Net Energy Gain
NUTS3   Nomenclature of Territorial Units for Statistics (Level 3)
SRC     Short Rotation Coppice
USD     U.S. Dollar
WP      Work Package

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1. Introduction

The greenGain project focus lies on the use of biomass originating from landscape conservation and maintenance work (LCMW) for bioenergy production. The LCMW biomass includes a wide variety of materials, both woody and herbaceous. It originates during the maintenance of urban green areas, roadsides, waterways, hedgerows, etc. Utilisation of this resource is only rational since the maintenance measures are indispensable or given by law, and the biomass arising during the process is their inevitable side product. Furthermore, biomass from such areas of origin represents no competition to the agriculture areas and to the food production. However, the LCMW biomass remains mostly not utilised – it is either left on site or disposed as waste. There are several barriers hindering its utilisation, which will be further discussed. Next to the economic and technical issues, the legal character of the biomass makes it difficult as the material is mostly considered as waste.

One of the objectives of the greenGain project is to map the current situation, activities and knowledge on the occurrence and use of the LCMW biomass in the EU28. The following report addresses this objective and defines the context in which greenGain activities take place.

The report is divided into two main sections, where the first section is a literature review of available information about the LCMW biomass potential, occurrence, technologies used for extraction & processing, and conversion technologies. Moreover, general observations to the problematic perceived during the research and challenges of the data collection are addressed. The review is accompanied with a collection of best practice examples and interviews with European actors, regarding their knowledge from all along the utilisation pathways, offering valuable descriptions of concrete practices and experience.

The second part of the report is constituted by an information database, which completes the literature review with references to further ongoing activities regarding LCMW. Therefore, a complex insight on the topic is provided, targeting a wide audience. The database presented in the report will be extended continuously within the project duration and its actual version will be presented at the greenGain Information Platform\footnote{The Information Platform will be launched in January/February 2016 and will be presented on the main project website www.greengain.eu}.
2. Potential and occurrence of LCMW biomass in the EU28

2.1. Available estimates of the potential

Before reviewing the available estimations, the classification of biomass potentials should be mentioned. The theoretical potential represents the upper limit of biomass potential. It is the maximum amount of biomass which can be utilised taking no practical barriers into account. However, the theoretical potential is in reality limited. The technical potential is a part of the theoretical potential, which is available when considering current technical possibilities, ecological restrictions and structural/legal limitations. Therefore, it is the time and location dependent amount of biomass, which can contribute to the energy supply. Economic potential is a part of the technical potential, which can be exploited economically given the current economic frameworks. For the LCMW feedstock, in particular the realizable potential is important, which represents the actual contribution of the feedstock to the energy supply and depends on further conditions, such as socio-political. For example, economic potential becomes realizable when the involved parties approve the project (Thrän, et al., 2015).

Generally, the parameters determining the biomass potential are (DBFZ, 2013):

- biomass yield (determining the theoretical and therefore also all other potentials)
- feedstock quality (determining the use of the feedstock)
- loss of the feedstock, concurrent use (reducing the theoretical potential)
- spatial occurrence (determining the harvest and logistic concept and extraction costs)

To illustrate the influence of these parameters, for instance at waterside biomass, the concurrence is not very relevant. However, the technical barriers of the harvest and insufficient equipment play a significant role in such terrain (DBFZ, 2013).

Methods for estimating a biomass potential can be divided into two main groups. The data can be extracted from statistical reports, which is the most common method (Long, et al., 2013). However, the availability of statistical data for LCMW feedstock is low. The other approach is using the indirect methods like remote sensing and GIS techniques for evaluation of the biomass resources and available land. The indirect methods allow estimating the biomass potential without direct measurements by felling and destructive sampling, which is time-consuming and forbidden in some environments (e.g. nature conservation areas). For example, calculation of biomass amounts originating by the pruning operation can be based on allometric equations with the use of dendrometric variables, like crown diameter. (Sajdak, 2012).

Several studies address the problematic of LCMW feedstock potential on different scale. The estimations of the biomass potential on the EU level are summarized in Table 1.
The geoportal created in the *BioBoost* project\(^2\) provides potentials of roadside vegetation, green urban areas and pruning residues on NUTS3 level. Besides the theoretical and technical potential (kt/PJ), the biomass density (t/km\(^2\)) on NUTS3 level was assessed (Pudelko, et al., 2013). The *Biomass Futures* project gives information about the technical potential of verge grass and landscape care wood on the national level for the time horizons 2010, 2020 and 2030 (Elbersen, et al., 2012). In 2030, the highest potential of landscape care wood occurs, according to these estimations, in France, Germany and Poland. These results are based on data from the *EUwood* project (Mantau, et al., 2010), but this data included also wood from agriculture land prunings. That is why the estimated potential was higher in case of *EUwood*. *Biomass Futures* assessed the potential of biomass from roadside verges – in this case the biggest potential in 2030 is located in France, Germany and UK.

### Table 1: Potential of LCMW feedstock in EU according to different resources

<table>
<thead>
<tr>
<th>Feedstock type</th>
<th>Specification</th>
<th>Area</th>
<th>Biomass Potential</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green urban area</td>
<td>Leaves, shrubs, grass from the conservation of green urban areas, port and leisure facilities</td>
<td>EU27+ CHE</td>
<td>1.18 Mt 17 PJ</td>
<td>(Pudelko, et al., 2013)</td>
</tr>
<tr>
<td>Roadside vegetation</td>
<td>Cut grass, shrubs and trees grown by the roadside</td>
<td>EU27+ CHE</td>
<td>3.17 Mt 47 PJ</td>
<td>(Pudelko, et al., 2013)</td>
</tr>
<tr>
<td>Verge grass</td>
<td>Roadside verges assuming grassland cover of 10 meters on either side</td>
<td>EU27</td>
<td>46 PJ (1097 ktoe)</td>
<td>(Elbersen, et al., 2012)</td>
</tr>
<tr>
<td>Woody biomass outside the forest</td>
<td>No specification</td>
<td>EU/ EFTA 29</td>
<td>113 PJ (13 Mm(^3))</td>
<td>UNECE(^4)</td>
</tr>
<tr>
<td>Landscape care wood</td>
<td>Landscape care potentials outside agricultural permanent crop land</td>
<td>EU27</td>
<td>380 PJ (9073 ktoe)</td>
<td>(Elbersen, et al., 2012)</td>
</tr>
<tr>
<td>Landscape care wood</td>
<td>Maintenance operations, tree cutting and pruning activities in agriculture and horticulture industry; Other landscape care or arboricultural activity in parks, cemeteries, etc.; Maintenance along roadsides and boundary ridges, rail- and waterways, orchards; Gardens</td>
<td>EU27</td>
<td>756 PJ (86.7 Mm(^3))</td>
<td>(Mantau, et al., 2010)</td>
</tr>
</tbody>
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\(^2\) [http://bioboost.iung.pl/](http://bioboost.iung.pl/)

\(^3\) Unit conversion according to [EUwood](http://www.unece.org/forests/mis/energy/wad.html)

\(^4\) [http://www.unece.org/forests/mis/energy/wad.html](http://www.unece.org/forests/mis/energy/wad.html)
Following tables list the potential estimations on the level of countries (Table 2) and regions (Table 3). The exact values of the potential are not displayed, because there are specific variables in each study, which make the data hardly comparable. It is necessary to consider more closely the type of potential estimated, the investigated area and the methodology. Different units are used for the results (ton, fresh mass ton, dry mass ton). The source area is given in various units as well (e.g. square area, km of roads, number of trees, exact area taken into account, area of the entire region).

Table 2: Studies on LCMW biomass occurrence and potential available for EU countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Feedstock type</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>CHE</td>
<td>Roadsides</td>
<td>(BAFU &amp; BFE, 2009)</td>
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<tr>
<td></td>
<td>Urban area</td>
<td></td>
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<tr>
<td></td>
<td>Hedges</td>
<td></td>
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<tr>
<td></td>
<td>Watersides</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>Roadside grass</td>
<td>(Kaltschmitt, 2013; Umweltbundesamt, 2007)</td>
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<tr>
<td></td>
<td>Grass from parks and playgrounds</td>
<td></td>
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<td></td>
<td>Grass from cemeteries</td>
<td></td>
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<tr>
<td></td>
<td>Residual biomass from landscape conservation, roadsides, waterways, “Treibsel”(^5)</td>
<td>(FNR, 2015)</td>
</tr>
<tr>
<td></td>
<td>Landscape conservation wood</td>
<td>(DBFZ &amp; KIT, 2013)</td>
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<tr>
<td></td>
<td>Landscape conservation material</td>
<td>(BMU &amp; UBA, 2012)</td>
</tr>
<tr>
<td>DK</td>
<td>Roadside grass</td>
<td>(Meyer, et al., 2014)</td>
</tr>
<tr>
<td>NL</td>
<td>Verge grass</td>
<td>(Siemons, 1991; Faaij, et al., 1998)</td>
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<td>SK</td>
<td>Urban green biomass, windbreaks, watersides</td>
<td>(Chudiková, et al., 2010)</td>
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<td>UK</td>
<td>Roadside biomass</td>
<td>(ADAS, 2008)</td>
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<tr>
<td></td>
<td>Arboricultural arisings</td>
<td>(AEA, 2011)</td>
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\(^5\) German expression for “Biomass (particularly vegetation) that is washed up on dikes along coastlines or estuaries” (Pehiken, et al., 2015)
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<th>Country</th>
<th>Region</th>
<th>Feedstock type</th>
<th>Reference</th>
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<tr>
<td>BE</td>
<td>Flandern</td>
<td>Roadside herbaceous biomass</td>
<td>(Van Meerbeek, et al., 2015)</td>
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<td>DE</td>
<td>Ludwigsfelde</td>
<td>Urban green biomass</td>
<td>(Bioenergie-Region Ludwigsfelde, 2013)</td>
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<td></td>
<td>Rotenburg (Wümme)</td>
<td>Hedgerows</td>
<td>(Bioenergy Promotion, 2014)</td>
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<td></td>
<td>Altmark</td>
<td>Waterways maintenance, roadside maintenance and public urban green spaces</td>
<td>(RUBIRES, 2010)</td>
</tr>
<tr>
<td></td>
<td>Dornum; Ihausen</td>
<td>Roadside vegetation, waterside biomass, green spaces, dike areas</td>
<td>(Pehlken, et al., 2015)</td>
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<tr>
<td></td>
<td>Wurzen; Elmshorn; Duisburg</td>
<td>Roadside timber</td>
<td>(Rommeiß, et al., 2006)</td>
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<td>Havelland</td>
<td>Waterside biomass</td>
<td>(DBFZ, 2013)</td>
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<tr>
<td></td>
<td>Mainland coast; Estuaries</td>
<td>“Treibsel”</td>
<td>(Niedersächsische Wattenmeerstiftung, 2011)</td>
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<td>ES</td>
<td>Asturias</td>
<td>Urban wood residues</td>
<td>(Paredes-Sánchez, et al., 2015)</td>
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<td>León</td>
<td>Urban tree prunings</td>
<td>Local Biomass Plan&lt;sup&gt;7&lt;/sup&gt;</td>
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<td>IT</td>
<td>Vitebro</td>
<td>Biomass arising from urban green pruning</td>
<td>(Carlini, et al., 2013)</td>
</tr>
<tr>
<td>LV</td>
<td>Salacgrīva Region</td>
<td>Roadside biomass</td>
<td>(Bioregions, 2012)</td>
</tr>
<tr>
<td>NL</td>
<td>East Netherlands</td>
<td>Roadside verge grass</td>
<td>(Voinov, et al., 2015)</td>
</tr>
<tr>
<td></td>
<td>Achterhoek</td>
<td>Harvestable wood from small landscape elements, wood landscape maintenance</td>
<td>(U2020 Going Local, 2012)</td>
</tr>
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<td></td>
<td>Overijssel province</td>
<td>Recreational areas, seasonal leaf-fall</td>
<td>(Arodudu, et al., 2014)</td>
</tr>
<tr>
<td>UK</td>
<td>Powys</td>
<td>Roadside verges</td>
<td>(Delafield, 2006)</td>
</tr>
</tbody>
</table>

<sup>6</sup> German expression for “Biomass (particularly vegetation) that is washed up on dikes along coastlines or estuaries” (Pehlken, et al., 2015)

Situation in the USA

Even though this report is focused on the situation in the EU, it is necessary to note, that the problematic of LCMW feedstock utilization is just as relevant in the USA. There are a number of literature sources and studies describing the situation, predominantly with reference to wood residues from urban woods (Donnelly, et al., 2014; Lane, 2008; McKeever, et al., 2003).

In the USA, an amount of 25.1 million tons of yard trimmings was estimated in 2000, including grass, leaves, tree brush and brush trimmings from residential, institutional and commercial sources. It represented ca. 12 % share of the municipal solid waste in the USA (McKeever, et al., 2003). The potential estimations range from 16 to 38 million green tons annually (Bratkovich, et al., 2014). However, significant amounts of urban wood and urban green residues are underutilized and mostly end up on a landfill or are left on site (Donnelly, et al., 2014; Springer, 2012; Stephenson, et al., 2013).

Among the reasons, why the urban wood does not raise big interest are e.g. small amounts of the wood obtained during single operation, lower quality of the wood compared to trees from natural forests or lack of planning in the field of urban wood utilization accompanied with poor understanding of the local markets.

2.2. Seasonal and spatial occurrence

The timing and frequency of cutting operations is given by the seasonal fluctuations during the year. The frequency is further determined by the requirements on work to be done in order to ensure the safety regulations (e.g. on roadsides and visibility), where the amount of the work have to be balanced with the available budget (Delafield, 2006).

Timing of the harvest differs by herbaceous and woody biomass. The grass is moved during the vegetation season while the tree maintenance proceeds outside of it. The length of a vegetation season is determined by latitude and altitude, and therefore varies within the European continent. Generally, the summer and the autumn peak of the LCMW feedstock occurrence are considered (Meisel, et al., 2014; Meyer, et al., 2014; DBFZ, 2013). In Central Europe, grass is mown between March and September with a peak in July. Maintenance of trees proceeds during October and February, with its peak in October (Meisel, et al., 2014). The seasonality of the LCMW feedstock occurrence is important because it determines its logistic concepts (Meisel, et al., 2014).

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8 Alliance for Community Trees; Available at http://actrees.org/news/trees-in-the-news/research/urban_tree_utilization_and_why_it_matters/
The frequency of the landscape maintenance work is determined by legal regulation and safety requirements and, at the same time, is if possible low in order to prevent unnecessary costs. The responsibility of the water maintenance authority to dispose of the vegetation in Northern Germany once a year is stated (Pehlken, et al., 2015). In Havelland region in Germany, the watersides are maintained once or twice a year and from economic reasons only about two-thirds of the watercourse is under maintenance (DBFZ, 2013). The roadside cuts proceed twice or three times a year, the road verges in towns can be cut up to five times a year (Voinov, et al., 2015; Delafield, 2006; Rommeiß, et al., 2006). There can be special management regimes, for example to avoid extensive maintenance work during peak holiday period (Delafield, 2006) or mowing in the evening to reduce negative effects of the transportation (Voinov, et al., 2015).

Fresh biomass harvested in summer and in autumn has different characteristics because of its different composition. The biomass collected in July has a higher content of hemicellulose and cellulose, while the October harvest has a higher content of lignin and consequently lower biogas yield in anaerobic fermentation (Purwin, et al., 2014). Examples can be found for the cascade use of both the summer and the autumn cuts of permanent grasslands (Pehlken, et al., 2015). Grass from the first two cuts is used as animal feed. The third to the fifth cuts, which are done in order to enhance the grassland quality, are then used in a biogas plant. Despite the lower biogas yield and more intensive processing requirements, the landscape material still represents an interesting feedstock for the biogas plant and it utilises biomass, which would be otherwise expensively disposed. However, to compensate the disadvantages, the feedstock has to be available for a low price.

Different techniques are applied for tree pruning, such as cleaning, formation, maintenance or renewal technique (Sajdak, 2012). The quantity of biomass obtained from pruning operation of trees is influenced both by tree dimensions and by the pruning practice. The choice of the pruning practice depends on the location, e.g. trees on streets versus trees in parks, which results in different amount of the residues obtained from same species in different location (Velázquez-Martí, et al., 2013).

2.3. Challenges of the data collection

Generally, the availability of information on LCMW feedstock amounts and potentials are limited, scattered and often of an uncertain quality (FNR, 2015; Meyer, et al., 2014; DBFZ, 2013; Long, et al., 2013; Sajdak, et al., 2012).
Following factors hinder the data collection and its comparison:

- LCMW feedstock includes a broad spectrum of biomass types and species.
- Terminology used for describing the feedstock and its classification is inconsistent. Precise wording is firstly important for the search of information itself and secondly is crucial for the comparison of data from various regions. Moreover, in a number of studies, the biomass type is only described by its title and is not specified any further. This is important from the reason mentioned in the first bullet point. Table 4 shows a few examples of terminology used for LCMW feedstock in the literature.
- The data is scattered, which is, among other factors, related to the variety of owner structures (Sajdak, 2012). Even the respective institutions responsible for the maintenance might not be able to provide information on the biomass potential and the feedstock quality (DBFZ, 2013).
- The quantity of the biomass removed by pruning operations varies on local, national and international level due to differences in biomass treatment, management policies, economical background or environmental awareness. Estimation of the amounts of the mass removed by a pruning operation of trees is hard to make when only dangerous or damaged parts are removed (Sajdak, et al., 2014).
- Various methods are used for potential estimations and evaluation of the results. Moreover, there is a variability in reference areas and yields (FNR, 2015; Sajdak, 2012). For instance, when considering the biomass from roadside maintenance, the width of the roadside taken into account and methodology are individual by different authors (Pehlken, et al., 2015; Meyer, et al., 2014; Pudelko, et al., 2013).
LCMW feedstock is generally not in the centre of interest in the renewable energy sector (Sajdak, et al., 2012). This confirms the need to raise awareness about the topic, which is one of the aims of the greenGain project.

The data on LCMW feedstock in statistics are mostly not present, especially on the European level (e.g. Eurostat statistics). In the European Compost Network (ECN) statistics, data about biodegradable municipal solid waste amounts including kitchen and garden waste from households, park and garden waste from public estates, and waste from the food industry are available. However, the share of LCMW biomass is not distinguished and remains unclear. In some of the ECN national statistics, the municipal green waste is addressed separately, but without further specification. In studies regarding the potential estimations the LCMW feedstock is commonly neglected (IPCC, 2012; Esteban, et al., 2011; EEA, 2006).

3. Technologies for LCMW biomass treatment: from harvest to storage

The residual biomass originating from maintenance operation is commonly either disposed or left on site and mulched, bringing organic material back to the soil and therefore improving its fertility. Utilisation of the LCMW biomass for bioenergy is therefore, inherently connected with extracting the nutrients from the area. The extraction operations should therefore consider the soil fertility and the function of the area. Removal of the nutrients is sometimes desired, because it results in lower biomass growth and lower need for maintenance, which means lower costs (Voinov, et al., 2015). However, clearing of the residues from roadsides brings positive effect in form of higher biodiversity (Meyer, et al., 2014; Delafield, 2006; Wide, 2015). On soils with lower fertility, the slow growing species develop better in contrast to rich soils where they are easily outcompeted by fast growing...
species. Biomass residues left on site also create light, temperature and moisture conditions unfavourable to germination and growth of new plants (Delafield, 2006).

First steps in the utilization chain of the LCMW biomass are the harvest and collection, which are the most costly steps (Wide, 2015; Boeve, 2015; Enegiequelle Wallhecke, 2008). The lack of convenient and efficient machinery seems to be a common problem (Paredes-Sánchez, et al., 2015; Pick, et al., 2012). Renting the machinery or delegate the complete maintenance service to a private company is an option, but it raises the overall costs. The availability of equipment influences the frequency of the maintenance and other variables, like the width of the mowed strips along the roadside (Pick, et al., 2012).

There is often the need for specific measures for the harvest and the extraction of the cutted biomass in order to extract sufficient amounts (e.g. in bad accessible areas like steep slopes). Collecting biomass from roadsides might be impossible with common farming equipment (Pick, et al., 2012). For the maintenance of watercourses, small, hand-driven special equipment (e.g. hand pushed mower with cutter bar and motor driven rake) which allow accessing the banks properly (Pick, et al., 2012). Special treatment require the nature conservation areas or areas with protected species, where selective strategies should be considered (Voinov, et al., 2015).

**3.1. Drawing the processing pathways**

1. **Example of a pathway for herbaceous biomass**

The utilisation pathways of roadside cleaning biomass including detailed analysis of the costs are concerned in a German study (Rommeiß, et al., 2006). As the common treatment for grassy residues, the cutting and mulching was mentioned. Woody material was preferably left in place (chipped and blown on the marginal areas). When this was not possible, it was collected and transported, stored in intermediate storage, chopped, composted or combusted or used as mulch. Partially was the material divided among the employees or private persons. Table 5 presents the suggested utilisation pathway for both types of biomass.
Table 5: Typical harvest and preparation costs for roadside biomass  
(Rommeiß, et al., 2006)

<table>
<thead>
<tr>
<th>Roadside grass</th>
<th>Cutting Mulching</th>
<th>Collecting</th>
<th>Transport</th>
<th>Silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>95 €/t</td>
<td>24 €/t</td>
<td>8.10 €/t</td>
<td>1.46 €/t</td>
</tr>
<tr>
<td>Machinery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woody roadside biomass</td>
<td>Cutting, processing (chopping)</td>
<td>Transport</td>
<td>Storage (loading)</td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>50 €/t FM⁹</td>
<td>11.5 - 18.5 €/t FM</td>
<td>2.6 €/t FM</td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>Truck</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As for the machinery for grass cuttings, following requirements were stated: simultaneous cutting and collection, large collecting capacity and the possibility of cutting while driving the machine on the highway without compromising the road safety (Delafield, 2006). Supporting this, combined mowing and suction of verge grass was mentioned as the mainly used technique (Voinov, et al., 2015). On the other hand, the use of mowing and suction machine caused disapproval of local nature conservation groups because of sucking up the invertebrates and has been therefore abandoned (Delafield, 2006). Using the suction device also brings the feedstock to a form of small clippings, which causes problems for the potential use in a biogas plant (Pick, et al., 2012).

The benefit of having a bulking site along the roadways for collecting of the mowed grass during the maintenance was stressed out (Delafield, 2006). The collected grass is than picked up by large capacity vehicles and brought to the final use facility, which reduced the number of journeys while the harvester has not to interrupt its work.

For roadside mowing the use of flail mowers is more beneficial compared to rotary mowers or cutter bars, because they are more robust (Van Meerbeek, et al., 2015). On the other hand, more soil particles and litter are sucked up with the grass, therefore the grass has to be washed and sieved before being used as substrate for wet anaerobic digestion (Van Meerbeek, et al., 2015; Meyer, et al., 2014). The high contents of soil particles causes higher ash contents which brings problems by meeting the standards and legal limits for biomass fuels, e.g. for pellets for non-industrial use (Piepenschneider, et al., 2015; Delafield, 2006).

2. Example of a pathway for woody biomass
Description of an utilization pathway of woody biomass from hedges resulted from a German-Dutch project Heating with Hedges (Enegiequelle Wallhecke, 2008). The pathway includes harvest of the biomass, chipping, transport, drying and combustion or marketing of the woodchips (or combination), where every step is discussed in detail in including its costs. The calculated costs are shown in Table 6.

⁹ Average value for trees with 10 – 20 cm DBH (diameter at breast height)
There are two possibilities for the harvest (Enegiequelle Wallhecke, 2008): fully mechanized harvest and manual harvest. The fully mechanized harvest proceeds e.g. by hydraulic hedge trimmer and can be used for shrubs and woody growths with maximum about 12 cm diameter. The manual harvest proceeds with chainsaw and is used for hardly accessible growths or trees over 20 cm diameter. Processing of the biomass, like chipping mostly precedes the transport and is in general cheaper when it directly follows the harvest (Rentizelas, et al., 2009). The main types of chippers are disc-, drum-, and worm-chippers. Wood chips can be produced on site with help of mobile chippers or with large stationary chipper. The large chippers have a higher capacity for the feedstock and works with higher rates, but the transportation time and costs are remarkably higher. The purchase or rental costs are also significant, for the secondly mentioned around 150 - 260 €/h. The price range is not only given by the machine’s performance but also by its different requirements on personal supervision (Enegiequelle Wallhecke, 2008).

Table 6: Costs within the utilization of woody biomass from hedges (Enegiequelle Wallhecke, 2008)

<table>
<thead>
<tr>
<th>Hedges</th>
<th>Fully mechanised harvest</th>
<th>Chipping</th>
<th>Transport</th>
<th>Drying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>6 - 10 €/m³ loose volume</td>
<td>3,90 €/m³ loose volume</td>
<td>2,30 €/m³ loose volume</td>
<td>--</td>
</tr>
<tr>
<td>Machinery</td>
<td>Hydraulic hedge trimmer</td>
<td>Large stationary Chipper with container (rented)</td>
<td>80 m³ loose volume container (80 % capacity use)</td>
<td>Active or passive</td>
</tr>
<tr>
<td>Manual harvest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>3 - 5 €/m³ loose volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>Chainsaw</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The logistic planning of urban green maintenance was in detail addressed in the case study from Halle, one of the greenest cities in Germany (Meisel, et al., 2014). The current management of the feedstock involves transport to the disposal site, where there are material uptake costs of 28 €/t for grass or wood. Interestingly, the disposal costs are annually more than twice as high as the costs of the transport. Transport can be secured with heavy goods vehicles or rather agricultural/forestry machinery. In the decision process, average transport distance, biomass density, carrying capacity, speed and availability of the machinery is considered (Rentizelas, et al., 2009). The problematic of logistics with focus on storage, as an important issue for biomass with seasonal occurrence, was also addressed (Rentizelas, et al., 2009). Generally, the feedstock can be stored on-field, in an intermediate storage or directly next to the final conversion plant.

Drying the wood chips aims to raise their heating value, reduce their weight or reduce the risk of fungal and mold growth during the material storage. There are generally two
possibilities – passive drying (in dry storage) and active drying (with artificially introduced heat). One of the options here is using the waste heat from biogas plants (Enegiequelle Wallhecke, 2008).

The costs and possible incomes for the processing of woody urban green residues for combustion are available for a German county (Bioenergie-Region Ludwigsfelde, 2013). The processing (shredding, sieving) represents the cost of 12 – 15 €/t. These costs arise either through an extern service provider or through the own costs on appropriate machinery and additional work. Moreover, the processing and storage areas have to be available with certain characteristics (asphalt pavement, drainage, partial roofing). The costs for building such a facility for a capacity of approx. 4 000 t of green residues would require costs of 1,2 Mio. €. The transport distance from decentralised collection points to the central treatment is typically around 23 – 70 km, where the average transport costs are 17 – 18 €/t. The material could be marketed very well in the region, where an exemplary price of woodchips is 24 €/t.

4. Feedstock use: conversion technologies

Conversion of the LCMW feedstock to energy or energy carriers is still exceptional (Van Meerbeek, et al., 2015). A frequent treatment of the LCMW material is composting (Bioenergie-Region Ludwigsfelde, 2013). In this process, the organic material is decomposed in the presence of oxygen by bacteria and fungi, producing CO₂, water, compost and heat. Compost is used as source of organic matter and nutrient for agriculture, gardens, as a component of flower soils (replacing peat) or for recultivation (Delafield, 2006; Interview, 2015). The olive tree pruning residues are mentioned as an excellent raw material for composting (Charisiou, et al., 2014). However, composting has the disadvantage of low efficiency since the process heat is lost (Boeve, 2015; Van Meerbeek, et al., 2015; Rabou, et al., 2006). In Spain, shredded olive pruning residues are also commonly ploughed directly into the soil as a fertiliser.

By composting and also by the usage in a biogas plant, the occurrence of high levels of contamination by heavy metals and other pollutants is of concern (Pick, et al., 2012). By application of the compost on agriculture land, limit values of contaminants have to be respected. At the biogas plant, extensive levels of inorganic pollutants can disturb the digestion process and complicate the further use of the digestate on agricultural land (Piepenschneider, et al., 2015). However, results of number of authors did not show any concentrations crossing the limits (Piepenschneider, et al., 2015; Meyer, et al., 2014; Delafield, 2006).
A big potential is hidden in the field of utilisation of the seasonal-leaf fall. Significant amounts of this material occur every year, but the energy utilisation is not a common practice. However, composting of this material is rather problematic since it requires high amounts of time and space. The technology for utilising this feedstock would therefore be welcomed by many municipalities (Interview, 2015; Bioenergie-Region Ludwigsfelde, 2013).

An overall scheme of conversion routes to bioenergy including their stage of development offers the report Renewable Energy Sources and Climate Change Mitigation (IPCC, 2012) or the report Biomass for heat and power (IEA-ETSAP & IRENA, 2015).

Processes relevant for LCMW biomass conversion to bioenergy are following:

**A. Conversion to energy** (Castellucci, et al., 2014; Carlini, et al., 2013):
- Biochemical conversion (anaerobic digestion)
- Thermochemical conversion (combustion, gasification)

*Flags in the text indicate the language of the source material being other than English.*

<table>
<thead>
<tr>
<th>Biochemical conversion</th>
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<tbody>
<tr>
<td><strong>A. Anaerobic digestion</strong></td>
</tr>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Anaerobic digestion is a biological decomposition process, where breakdown of organic matter occurs in absence of oxygen. It proceeds in four stages involving four different groups of microorganisms. The final product of the decomposition is biogas – mixture of methane (50 to 70%) and CO₂. According to the water content in the digester, dry or wet fermentation is distinguished. The residues from the digestion can be after a stabilisation be used as a fertiliser, depending on the composition of the input material (IPCC, 2012; Delafield, 2006).</td>
</tr>
</tbody>
</table>

**Literature on use of LCMW**

*A practical trial to investigate the feasibility of wide-scale collection of cuttings from roadside verges in Powys, for use in biogas and compost production* (Delafield, 2006)

Processing of grass in an anaerobic single-stage, semi-continuously fed reactor, previously fed with chicken litter. Grass was chopped immediately after the delivery by an agricultural ‘diet feeder’, then compacted and ensiled. Before being fed into the digester, the feedstock was soaked in water in order to dilute it. Roadside grass was considered as good material regarding the biogas yields and no problems with the digestion occurred.

*Model of energy use of biomass from roadside maintenance for two roadside maintenance depots in Germany* (Rommeiß, et al., 2006)

Study on possible use of the biomass for biogas production or combustion including economic analysis with defining the starting point of the energy use for two road maintenance depots. An analysis of fuel composition and characteristics is contained, as well as recommendations for the depots regarding the biomass use.
Technically, the potential would be sufficient for a smaller and, therefore, more cost-intensive biogas plant. Economically it would be more advantageous to use biomass from more depots in one bigger facility. However, from the communication with the managers of biogas plants became clear, that they did not have any interest in using this feedstock. Among the reasons were concerns about the feedstock quality and biogas yield, lack of experience with such substrate and especially the insecurity in legal issues connected with this kind of biomass.

**Biogas Production Potential from Economically Usable Green Waste**  
(Pick, et al., 2012)  
A county-wide study in Germany on biogas production potential from residual grass. The biogas yield from residual grassland and conservation grassland was estimated.

**Forming stakeholder alliances to unlock alternative and unused biomass potentials in bioenergy regions**  
(Pehlken, et al., 2015)  
Use of alternative biomass as resource of bioenergy was addressed. The option of partially replacing maize in biogas plants by grassy material from cultural landscape conservation was investigated in two model regions in Germany. Landscape conservation biomass was confirmed to be interesting for use in digestion as it creates more than 50% of the feedstock for the biogas fermenter in one of the model regions.

**Methanogenic potential of biomass from roadside verges preserved with various additives**  
(Purwin, et al., 2014)  
The roadside verges grass was analysed after 180 days of storage in microsilos with and without formic acid, bacterial inoculant, bacterial-enzymatic preparation and enzymatic preparation. Samples from summer and autumn period were compared in loss of organic matter, chemical composition, biogas and methane yield in order to determine the influence of the storage with previously mentioned additives.

**The bioenergy potential of conservation areas and roadsides for biogas in an urbanized region**  
(Van Meerbeek, et al., 2015)  
Determination of the bioenergy potential of non-woody biomass from conservation areas and roadsides in Flanders based on anaerobic digestion. Biomass-to-bioenergy supply chain was optimized in four scenarios. The analysis showed that the energetic valorization of the feedstock through anaerobic digestion had a positive net energy balance.

**Element concentrations in urban grass cuttings from roadside verges in the face of energy recovery**  
(Piepenschneider, et al., 2015)  
Elemental concentration in the grass can influence anaerobic digestion process, especially the inorganic contaminants. Composition of urban grass and dependence on number of cuts and soil element concentration were
Development of transferable concepts for energy use of grass and reed, example from Havelland region in Germany (DBFZ, 2013)

The whole utilization chain of grass used for biogas production was outlined. Grass from landscape conservation and intensive grassland could be used as feedstock for biogas plant, where the use of robust technique and appropriate pre-treatment is decisive. However, successful establishment of biogas production from landscape conservation material requires targeted legal support measures.

Bioenergy production from roadside grass: A case study of the feasibility of using roadside grass for biogas production in Denmark (Meyer, et al., 2014)

Using roadside grass for biogas production can result in positive net energy gain. However, practical challenges connected with the technology process would require further energy investments (e.g. management of inorganic waste in the harvested grass, removal of sediments from the digester, operational failures due to long grass particles getting stuck in the digester stirring equipment, and pre-treatment of grasses with high lignin content). The heavy metal content in the feedstock did not exceed the mandatory limits for further use on agricultural land and neither the concentrations inhibitory for the process of anaerobic digestion.

Biogas from landscape maintenance grass - possibilities and limitations (Leible, et al., 2015)

The favorable funding conditions under the German renewable energy act (EEG) have led to the operation of approx. 8,000 biogas plants in Germany by the end of 2014. The additional construction of biogas plants, however, pushes its limits, which is why alternative substrates are sought. Landscape maintenance grass could be such an alternative. In this study, the question was investigated how far landscape maintenance grass is technically suitable for this purpose and what costs are associated with it. In addition to the techno-economic analysis of the entire process chain - from harvesting to the utilization in the biogas plant - especially technological tests for mechanical substrate preparation and the attainable biogas yields were necessary for this purpose.

Therefore analysed. Ash content in the material was higher than the German non-industrial standards DIN for pellets from non-woody material. Influence of the IFBB technique (“integrated generation of solid fuel and biogas from biomass”) was estimated, where the biomass is divided into a fibre-rich press cake and a highly digestible press fluid.
As a result, mainly the lower specific biogas yields lead to higher overall costs of the biogas.

Rich flowering wild plant mixtures for a natural and environmentally friendly biogas production (FNR, 2015)

Exploiting the added value of the cultivation of wild plants on roadsides. The article represents the advantageous properties and potential of wild plants for biogas production.

"Green energy" from landscape maintenance - Pilot project: climate, energy and cultural landscape Sauwald-Danube Valley (Kurz, 2014)

The 3A-biogas technology (production of biogas and compost in a closed cycle) can provide a flexible and adaptable tool for the combined and integrated processing of landscape maintenance material and organic waste. However, the feasibility study has made clear that, even with the involvement of the agricultural and nature protection premiums, cost-recovery of the landscape maintenance based on the 3A-biogas technology is not realistic. Under the current pricing structures, only a partial refund of the cost of maintenance work and plant operations through the generated energy is possible.

<table>
<thead>
<tr>
<th>Thermochemical conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Combustion</td>
</tr>
<tr>
<td>Description</td>
</tr>
</tbody>
</table>

Combustion is a process of oxidation, where carbon and hydrogen contained in cellulose, hemicellulose, lignin or other molecules like methane react with excess oxygen, releasing CO₂, water and heat. Biomass combustion processes are well explored with a number of tailored technologies for different kind of biomass (IPCC, 2012). When combusting biomass or biogas for electricity production, the recovery of excess heat is desirable. The integrated systems of combined heat and power generation (CHP) utilize the excess heat for heating, cooling, dehumidification, or process applications. Biomass power plants are described according to their boiler technology, where either fixed bed combustion or fluidised bed combustion are the possibilities (IEA-ETSAP & IRENA, 2015). The optimal size for a biomass CHP plant is supposed to be around 20 MWe, with ideal biomass sourcing distance of maximum 50 km (IEA-ETSAP & IRENA, 2015).

<table>
<thead>
<tr>
<th>Literature on use of LCMW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimating the potential of roadside vegetation for bioenergy production (Voinov, et al., 2015)</td>
</tr>
</tbody>
</table>

Study evaluating the energy efficiency of cultivating different energy crops in order to determine a potential vegetation mix for producing bioenergy on the road verge (grasses, willow, SRC). Inventory of different conversion processes - direct combustion of the biomass for electricity and/or combined heat and electricity generation at the biomass power plant, or gasification of grass biomass for electricity and/or combined heat and electricity production.
Model of the energy use of biomass from roadside maintenance for two roadside maintenance depots in Germany (Rommeiß, et al., 2006)

Study on possible use of the biomass for biogas production or combustion including economic analysis with defining the starting point of the energy use for two road maintenance depots. An analysis of fuel composition and characteristics is contained, as well as recommendations for the depots regarding the biomass use. Technically, the potential of pruning residues would be sufficient for operation of a wood combustion plant.

Sustainability Analyses for the Exploitation of Olive Tree Cultivation Residues (Charisiou, et al., 2014)

Treatment of olive tree prunings in Greece is addressed. The most common practice is burning it by the farmers in open lumps, which represents serious environmental threat. A techno-economical study for the design and implementation of a central pilot plant with final product of compost and pellets for energy application was performed.

Development of transferable concepts for energy use of grass and reed, example from Havelland region in Germany (DBFZ, 2013)

The whole utilization chain of production of hay pellets and its combustion. The quality of the pellets was evaluated and the use of additives to improve the fuel properties.


Two scenarios were investigated: Combustion in a woodchip boiler for heat production and gasification for heat and electricity, where in both cases wood chips were used as feedstock. Using the residual biomass it would allow to install a 50 kWe and 115 kWt gasification plant. The scenario with wood-chip boiler would here be more favourable, where 5 plants (200 kW each) have been chosen and for heating of 5 big public buildings.

B. Gasification

Description
Gasification of biomass takes place when the material is treated by high temperature (800 – 900 °C) under limited presence of oxidising agent. The product of this process is called synthetic gas or syngas – mixture of CO, CO2, CH4, H2 and water. The energy content of the gas is given by the biomass type and the gasification agent (air, oxygen, steam or hydrogen, where hydrogen is used rather rarely) (Castellucci, et al., 2014; Carlini, et al., 2013; IPCC, 2012). Commonly used air or oxygen produce syngas with low to medium energy content, which is used in combustion for generating heat and electricity (Castellucci, et al., 2014).

Literature on use of LCMW

Waste Wood Biomass Arising from Pruning of Urban Green in Viterbo

Two scenarios were investigated: Combustion in a woodchip boiler for heat production and gasification for heat and
electricity, where in both cases wood chips were used as feedstock. Using the residual biomass it would allow to install a 50 kWe and 115 kWt gasification plant. The scenario with wood-chip boiler would here be more favourable, where 5 plants (200 kW each) have been chosen and for heating of 5 big public buildings.

The aim of this study is to analyse several biomass types available in Mediterranean Area, including their energy characteristics to determine the potential use of a single type of biomass or a mixtures of them in gasification plants.

B. Production of energy carriers and intermediate products (IEA-ETSAP & IRENA, 2015):

- Pyrolysis, Torrefaction, HTC
- Pelletizing, Briquetting

<table>
<thead>
<tr>
<th>Pyrolysis, Torrefaction, Hydrothermal Carbonisation (HTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>These processes produce energy carriers with increased heating value compared to the original biomass. Pyrolysis is a process of thermal degradation of biomass under absence of an oxidising agents. The products are in solid (charcoal), liquid (pyrolysis oil) and gaseous form. The proportion of the fractions depends on process temperature, heating rate and residence time. At lower temperatures around 400 °C, the main product is charcoal, while at temperatures about 800 °C, mainly gas is yielded. Pyrolysis performed at high heating rates is known as fast or flash pyrolysis with residence time of seconds. In case of slow pyrolysis or carbonisation residence time of days is applied.</td>
</tr>
</tbody>
</table>

Torrefaction is a mild pyrolysis carried out by 200 – 300 °C, where the solid fraction represents the main product. It also offers the possibility of making torrefied pellets representing an even more densified form of an energy carrier (Chen, et al., 2015).

Hydrothermal carbonisation (HTC) is conducted in the presence of subcritical liquid water under temperatures between 180 – 250 °C. It converts the moist input material into carbonaceous solids without the need of previous drying. The water is kept liquid during the process by letting the pressure to come up with the steam pressure in a pressure reactor (Libra, et al., 2011). Charcoal creates the main fraction among the products.
Use of LCMW

- HTC facility in Halle¹⁰, Germany; processing green communal residues and seasonal leaf-fall
- SunCoal® Pilot plant¹¹; HTC coal from green communal residues and seasonal leaf-fall
- Research on Max-Plank Institut¹² in Germany; HTC from biomass residues

Pelletizing and Briquetting

Description

Pelletizing and briquetting aims mechanical compaction of bulky biomass, usually with screw or piston presses. Pellets and briquettes offer the advantage of consistent quality and size, better thermal efficiency and higher density than loose biomass, which allows higher transport distance (IEA-ETSAP & IRENA, 2015; IPCC, 2012). Different LCMW feedstock can be used for the production of pellets and briquettes like grass, woody residues or leaf-fall. Because fresh grass from the first cuts has a high protein content and therefore high ash content, it is more beneficial to use the matured grass from last cuts which, above that, cannot be used as animal feed.

Use of LCMW

- Pellets from olive pruning residues (Charisiou, et al., 2014)
- Pellets from hay and their application in monovalent heating boilers (150 kWt) and bivalent heating system combined with heating oil boilers (150 kWt + 300 kWt) (DBFZ, 2013)
- Florafuel¹³ pellets and briquettes produced from grass, leaves, roadside biomass, silage and fermenting waste See the Database of Projects for more!
- Pellets from urban forest maintenance residues (Paredes-Sánchez, et al., 2015)
- Briquettes from grass produced with the PROGRASS® approach, IFBB procedure¹⁴
- Briquettes from seasonal leaf-fall¹⁵ See the Best Practice Database for more!
- BtE® Biomass to Energy¹⁶: Briquettes and pellets from grassy residues

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¹⁰ Brochure in German available at https://www.energetische-biomassenutzung.de/fileadmin/user_upload/Steckbriefe/dokumente/Brosch%C3%BCre_HTC_13.pdf
¹¹ Information in German available at http://www.suncoal.de/de/unsere-loesung/kommunale-entsorgung
¹² Information in German available at https://www.mpg.de/521319/Zauberkohle_Dampfkochtopf
¹³ http://www.florafuel.de/en/
¹⁵ Information in German available at http://www.flaechenmanager.com/Archiv/Suche-im-PDF-Archiv/Herbstlaub-Blattgold,QUIEPTQ3NzMzNDgmtUJEPTE2Nzc4Mw.html
¹⁶ Information in German available at http://www.getproject.de/media/pdf/FlyerBtE-Verfahren.pdf

*Insight on the biomass conversion technologies by the International Renewable Energy Agency (IEA-ETSAP & IRENA, 2015)*

Key aspect for bioenergy is the availability of the feedstock over the plant’s lifetime as well as the market stability, which is critical even when policy support is established (e.g. feed-in-tarif). For bioenergy, the feedstock price has 40 – 50 % impact on the total electricity production costs. The costs vary around 0 – 4 USD/GJ for biomass processing residues and 4 – 8 USD/GJ for locally originating feedstock (excluding transport costs)\(^{17}\).

See the report for:
- Description of technologies used for bioenergy production and for biomass pre-treatment
- Conversion technologies and their development status
- Electric efficiency of biomass CHP
- Typical feedstock costs and plant capacities

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**Environmental performance of LCMW biomass utilisation pathways**

Several authors address energy efficiency of LCMW biomass utilisation pathways, while two main indices are named. Energy Return On Energy Invested (EROEI) is the ratio of the energy delivered by a process to the energy, which was both directly and indirectly used during that process. Net Energy Gain (NEG) is the energy output from the production minus the required input energy. As the input energy, the energy needed along the whole utilisation pathway (harvest, collection, loading, transport, offload, storage, conversion) is considered. The output energy is the energy gained e.g. through the conversion, where its part is contained in the side products like digestate from anaerobic digestion, which can be used as fertiliser (Meyer, et al., 2014; Ibrahim, 2012).

A summary of EROEI values for fossil fuels and other renewables in various regions are available (Voinov, et al., 2015; Hall, et al., 2014). Because of the high input energy demands of the systems, the efficiency of bioenergy is usually low, compared to fossil fuels (Ibrahim, 2012). In case of bioenergy production, EROEI is given by the biomass species, production practice, nutrient requirements and the location of the production (Ibrahim, 2012).

- (Ibrahim, 2012): Estimation of EROEI of biomass from build-up areas in the Netherlands province of Overijssel, including abandoned construction sites, organic domestic waste, urban wood waste, bulky garden waste, areas under trees in recreational parks, and green roofs. Here, the bioenergy production from recreational parks was comparable with production of bio-methane from palm oil both having similar net-energy gain and EROEI. Overall, the calculated EROEI for the biomass from the urban area are comparable to some

\(^{17}\) 1 USD = 0,92 EUR (01/2016)
energy crops. Using these biomass resources could meet the renewable energy demand up to 2.3 - 13.5 % in the province.

- (Meyer, et al., 2014): Estimation of the energy efficiency of grass for use in Danish biogas plants. Scenarios of using grass in a farm-scale biogas plant, centralised biogas plant and their combination are addressed, while in all cases the NEG had positive values meaning the energy outputs being higher than the inputs.

- (Smyth, et al., 2009): An analysis of bio-methane produced from grass used as fuel for vehicle in Ireland. As grass is the most important agricultural crop in Ireland, only agricultural areas are mentioned. Interesting for the biomass from maintenance work can be grass from rough grazing, as it covers uncultivated grassland on hills, uplands or moorlands.

- (Voinov, et al., 2015): Scenarios of gasification of verge grass and cultivating willow on roadsides for direct combustion, considering cultivation with and without fertilisers and herbicides were compared. The lastly mentioned case is presented as the most efficient. The reference system for the energy input is represented by the current treatment - dumping of the grass at composting sites twice a year – which shows as clear waste of energy.

The CO₂ emission savings from producing biomass from landscape maintenance work are not addressed in the previously mentioned studies. However, the reduction of CO₂ emission can be estimated either by subtracting the emission reduced through substituting of fossil fuels, or as the CO₂ amounts, which are absorbed by the plants during photosynthesis (e.g. when growing more biomass in urban areas) (Ibrahim, 2012).
5. Observations to the problematic of LCMW feedstock utilisation

Because LCMW feedstock is mostly not utilized (Bioenergie-Region Ludwigsfelde, 2013; Delafield, 2006) and the costs for maintenance work, which represent a considerable financial burden, stress the public budget of municipalities without compensation (Piepenschneider, et al., 2015). In the Czech Republic, for instance, the costs for maintenance of public green spaces in county seats represent percent units of their annual budget. Utilization of LCMW feedstock with potential prospects of economic revenue is likely to be appealing for public bodies responsible for the maintenance as it at least mitigates the inherent costs (Meisel, et al., 2014).

In public spaces, the aesthetic purposes and the financial issues have the priority above the interests of the energy use. The interest of the energy use is possibly high yield of the feedstock, which means faster growth of the biomass and more frequent maintenance. However, in urban green spaces rather the opposite is preferred. In parks, slow growing species of grasses are being used in order to reduce the mowing frequency and therefore costs for the maintenance (Arodudu, et al., 2014; Ibrahim, 2012). As an example, the Bridgend County Borough in Wales with an area of 24 600 ha can be mentioned. The administrative bodies announced lower frequency of roadside verges cutting and moving of grass in open spaces because of financial reasons, which will lead to total savings of ca. 180 000 € annually.18

During interviews, the respective administration and management bodies expressed strong desire to minimize the growth of vegetation along roadsides. Therefore, they could achieve the goals of the roadside management at possibly low costs. The main management goals were, apart from aesthetics, good visibility and safety (Pick, et al., 2012). On the market, products can be found which aim slowing down the growth of perennial grass by roadsides. Such products even claim to ensure CO₂ emissions savings because of reducing the mowing operations.

The use of the LCMW feedstock for bioenergy requires the opposite attitude – increasing the biomass yield (Voinov, et al., 2015). Nevertheless, increasing the frequency of maintenance work when using quick growing species can cause public disapproval since e.g. the roadside maintenance work is a duty of public authorities, therefore paid from taxes (Van Meerbeek, et al., 2015). In that case, reasons for new public green treatment have to be communicated with the public properly to avoid its disfavour. As feasible seems e.g. growing of perennial grasses or short rotation wood (Voinov, et al., 2015).

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Also other conflicts occur regarding the use of the land for bioenergy. In case of the nature conservation areas is the intensive use in direct conflict with its character and respective legal frameworks. There are strict restriction on use of fertilizer and mowing frequency (Pick, et al., 2012). At roadsides, the areas might be used already for other purposes, like advertising, electricity poles, sidewalks, nature conservation etc. Problems with the neighbours might occur at the border area, e.g. in a residential district (Voinov, et al., 2015).

The intensified use and the harvest frequency are also limited by the available equipment. Harvesting beyond the usual width of the roadside in order to increase the yield might not be possible with the same machinery or results in unfeasible labour demand (Pick, et al., 2012). On the other side, the higher demand on personal labour when intensifying the use of the area could support local economy by creating new jobs and networking within the regions, e.g. by establishing common solution for the maintenance work and sharing the machinery. Cooperation among the stakeholder in the region can offer a financial benefit for wide spectrum of institutions within the biomass supply chain (Pehlken, et al., 2015).
6. Experience from the greenGain model regions: Pre-identification of the utilization pathways

In the greenGain model regions, a research was performed by the project partners in order to find out what LCMW biomass types are available for utilisation. Moreover, the plants and facilities present in the region were listed to provide an idea of where the LCMW feedstock could be utilised.

Based on this information, three possible utilisation pathways were pre-identified for the model regions. Out of many possible pathways including different processing steps and final products, those three were chosen based on the experience from praxis, desk research and the interviews with local stakeholders. The three pre-identified utilisation pathways will be investigated more closely within the further project work in the Work package 4 (WP4) and will serve as starting point for the Work package 5 (WP5) when deciding about the possible pathways to be assessed in the model regions. The pre-identified pathways are depicted in Figure 1.

Figure 1: Pre-identification of three typical utilisation pathways relevant in greenGain model regions

<table>
<thead>
<tr>
<th></th>
<th>Woody</th>
<th>Mixed</th>
<th>Herbaceous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hedgerows on banks</strong></td>
<td>falling/chipping</td>
<td>dry medium quality wood chips</td>
<td>medium size firing</td>
</tr>
<tr>
<td><strong>River side cleaning</strong></td>
<td>felling/cutting collection</td>
<td>mixed material</td>
<td>composting sieving</td>
</tr>
<tr>
<td><strong>Roadside maintenance</strong></td>
<td>cutting/chopping collection with hopper</td>
<td>chopped grass</td>
<td>wet fermentation</td>
</tr>
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<tr>
<th></th>
<th>HEAT AND ELECTRICITY</th>
<th>ES</th>
<th>DE</th>
<th>CZ</th>
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<tr>
<td>Woody</td>
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<tr>
<td>Mixed</td>
<td>COMPOST</td>
<td></td>
<td>CZ</td>
<td></td>
</tr>
<tr>
<td>Herbaceous</td>
<td>BIOMASS</td>
<td></td>
<td>CZ</td>
<td>IT</td>
</tr>
</tbody>
</table>
7. Conclusions

During the research work on the problematic of LCMW biomass utilisation in Europe, several interesting issues have been observed.

In a number of regions, the potential of LCMW biomass has been recognised already, as a possible complement of the local renewable resources. Following the common sense, activities have been performed to explore what possibilities this resource offers and where are the chances and challenges of involving this kind of biomass in the local energy cycles. The existing examples of the potential estimations can serve as inspiration for other regions, taking advantage of the methodologies used, biomass types involved and the resulting values. Although the data from different authors and regions are difficult to compare, it provides an essential knowledge base and support for the next activities.

The knowledge exchange, awareness raising, networking and the local dialog proved their importance during the research. Since the change of behaviour is generally not welcome by the responsive bodies, the benefits of optimising the current treatment of the biomass has to be elucidated properly. Here, the know-how, best practice examples and practical experience from other regions can be used as instruments for explaining the advantages of the new actions. Involving wide audience of stakeholders in such kind of discussions allows to present the benefits for different branches and avoids later disapproval, e.g. within a municipality or community.

The strongest factors influencing the treatment of LCMW biomass are financial costs and safety requirements. The maintenance measures aim at fulfilling the binding regulations regarding the maintenance of public greenery, while keeping the costs of the operations as low as possible. For this reason, slow growth of the biomass and possibly low frequency of the maintenance work is desired. However, this attitude stands directly against the interests of the bioenergy use, where possibly high amounts of the feedstock and more frequent harvest would be needed. The issue of costs closely relates to the question of available machinery and technology. In order to extract efficient amounts of the residues or to process it for the energetic use mostly special machinery is needed and, therefore, additional costs to be considered. Nevertheless, possible solution can be seen in cooperation within a region and sharing both the machinery and the burden of initial investment.

As the typical utilisation technologies, composting, anaerobic digestion and combustion were identified from the literature and the interviews. The examples of LCMW feedstock usage in different technologies prove it to be a viable resource of bioenergy and energy carriers.
The data collection brought together various literature resources and aimed to cover resources from different countries. However, the barriers for involving more countries are probably caused by the limited amount of literature available in English language. For further data on the topic of LCMW biomass utilisation in Europe, the information database is presented in the Annex of this report, offering concrete experience and ongoing activities in the field.
8. References


Bioenergy Promotion. 2014. Bioenergy Promotion Demo Region: Rotenburg (Wümme), Germany - Sustainable woody bioenergy resources from private forests and hedgerow maintenance -. 2014.


Wide, Maria Ivarsson. 2015. Interview. 8 November 2015.
## 9. Best practice examples of LCMW biomass utilization in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
</tr>
</thead>
</table>
| **CH**  | Regional woody residues in a large-scale CHP  
           *CHP, Combustion, Best practice* |
| **DE**  | Energy solution for an organic farm: Gasification of woodchips from landscape maintenance  
           *Conversion, Gasification, Agroforestry, CHP, Energy cycle, Best practice* |
| **DE**  | Heating with hedges (Energiequelle Wallhecke)  
           *Combustion, Networking, GIS, Sustainable pathways, Public acceptance, Best practice* |
| **DE**  | Heating with woodchips at a cow farm  
           *Combustion, Wood chips, Best practice* |
| **DE**  | Dry fermentation: Chiemgauer model  
           *Dry fermentation, Decentral systems, Best practice* |
| **DE**  | Heating with woodchips from river side maintenance  
           *Combustion, Wood chips, Best practice* |
| **DE**  | Autumn leaves into briquettes  
           *Combustion, Briquettes, Leaf-fall, Best practice, Public acceptance, Best practice* |
| **DE**  | LCMW biomass in a German bioenergy region  
           *CHP, Public acceptance, Networking, Energy cycle, Best Practice* |
| **DE**  | LCMW woodchips as a part of the communal climate protection plan  
           *Combustion, CHP, Wood chips, Sustainable pathways, Best practice* |
| **DE**  | Heating plant Rieste  
           *CHP, Best practice* |
| **DE**  | Residual wood-fired heating plant  
           *CHP, Best practice* |
| **DE**  | RWE Biomass-fired CHP and pelleting plant  
           *CHP, Pellets, Best practice* |
| **ES**  | Planning of biomass management and conversion to a solid fuel for the use in a public buildings property of Serra City Council  
           *Residual biomass, Pellets, Best practice* |
| **ES**  | Energetic use of biomass from urban parks maintenance and industrial residual biomass  
           *Residual biomass, Conversion, Best practice* |
| **PL**  | LCMW wood chips-fired boiler: a pilot installation  
           *Combustion, Wood chips, Networking, Best practice* |
| **PL**  | Heating with LCMW woody residues: a pilot installation  
           *Combustion, Wood chips, Best practice* |
## Regional woody residues in a large-scale CHP Switzerland; Basel

### Keywords
- CHP, Combustion, Best practice

### Feedstock
- Fuel mix composition in 2014: Forest wood (43.1%), wood waste (34.7%), landscape conservation material (21.0%)
- Total fuel consumption in 2014: 187,680 m³ loose volume (energy input of the wood was 171,000 MWh)
- 73% of the wood originates from maximum transport distance of 40 km
- 13% of the fuel is transported by railroad

### Summary
Wood-fired CHP plant in the city of Basel represents a large-scale bioenergy project in an urban area, which can serve as a pioneering example for other parts of Switzerland and other non-Scandinavian countries.

### Technical aspects
Energy production in 2014: 125,400 MWh of heat and 15,824 MWh of nett electricity (after deducting own consumption)

### Economic and environmental aspects
- Emission savings compared to a gas or heating oil-fired plant with the same performance: 28,864 t CO₂
- First wood-fired power plant in Switzerland with the certification “naturemade star” for renewable energy.
- The Canton of Basel-City and Basel-Land are very progressive in sustainable energy support and environmental protection, regarding the pursuits on the legal level as well.

### Transferability
Western and Central Europe

### Contact
www.iwb.ch

### Additional information
- 2014 yearly report
- Socio-economic analysis of the project
Energy solution for an organic farm: Gasification of woodchips from landscape maintenance
Germany, Hude

Keywords  Conversion, Gasification, Agroforestry, CHP, Energy cycle

Summary of the actions and results
Five students from University of Oldenburg in Germany have developed a small-scale power plant (30kW_e and 60kW_th) which is able to convert solid biomass fuels - like woodchips and other agricultural or landscape maintenance residues, which cannot be used in biogas plants - by the thermo-chemical gasification into high quality syngas to generate CHP electricity via usual combustion engine and generator.
Since the plant worked very well and they received interest from number of farmers, they decided to proceed in a commercial scale and founded the company “LiPRO-Energy GmbH & Co. KG” in August 2015.

Motivation
In the beginning of 2012 while thinking about a meaningful topic for their Master theses, they quickly came to the conclusion that they will try to solve one big insufficiency of their parents’ organic farm.

The farm has been in operation for thirty years already and its regional production of organic food aims to complete the local nutrition and resource cycles and to densify local value chains. The farm is well prospering with own cattle, cheese factory, bakery, vegetable cultivation, greenhouses and seven markets a week with about 20 permanently employed people. The only thing, which was missing to complete the local resource cycle was the energy provision. The idea was that the capacity should fit to the demand of the farm and the fuel should originate from local sources, which do not work contraire to the ecosystems demand and to the neighbours’ expectance.

First idea which came to their mind was to use digestion technology, but there were quite a lot of disadvantages like size of a common plant (>500kW_e), extra crop farming like maize (ecological disadvantages), the fact that they already use the manure for own nutrition cycle and society’s attitude to the technology. After an intensive market research, they focused on wood gasification. Disadvantages of this technology like the requirements on high quality fuel or instability of the process brought them to the decision of developing their own technology. The goal was to use landscape maintenance material from maintaining the hedges around their fields and field roads, furthermore they established more hedges into the open landscape as an agroforestry concept to improve ecological synergies between farming and natural vegetation.
They started in early 2013 to build and develop the power plant with about 50,000 € budget from the farm. After three months, the plant was more or less working but it was not stable and not fully automatized. At the end of 2013 they first connected the plant to the grid and started feeding electricity to the grid. At the beginning of 2015, after permanent improvements and further development, the power plant was fully automatized and ready for 24/7 operation. In 2015, during 7000 CHP operating hours, 210.000 kWhel were generated. About 90.000 kWhel were used at the farm and the rest was sold to the grid. The 420.000 kWhth were used at the farm for heating, hay drying and greenhouse operation. Due to the low development expenses the payoff of the prototype is about three years.

Half of the annual feedstock amount comes from farm’s own hedges and the other half from nearby forest residues (5 km radius).

If the plant is operated for 8000 hours per year, it needs about 240 tDM wood or other ligno-cell based fuel. If calculation would be made with 10 tDM/ha*a, 24 ha of forest or 60 km of hedges with a width of four meters would be required. Means if a farm operates 400 ha with average block size of two ha surrounded by a hedge it will have enough fuel to supply the farm and several neighbours depending on their demand. In other cases, villages can supply their energy demand with their road site maintenance biomass.

Fuel from roadside pruning, bush mulching, tree falling, wood processing residues, etc. can be used. Fuel needs to be dried to 15% moisture content, which is done with help of the waste heat.

Simplest and most cost-efficient way to use roadside biomass or hedges is to manage this landscape elements with a tractor equipped with a crane and felling grapple. Trees are harvested from thick end e.g. every three years, best size is at about 20 cm bhd. The whole trees are piled up at a place accessible to a truck. They are chipped with self-propelled chipper. The costs from harvest to storing place is about 9 € per loose cubic meter.

The plant operates fully automatic and is remote controlled. The woodchips are stored next to the power plant and they are dried with the heat coming from the gasification process.

The fuel is heated up to ca. 700 °C by the process heat under a shortage of oxygen. The products are pyrolysis steam and charcoal, pyrolysis steam gets oxidized by ca. 1100 °C in the next step to crack long and ring shaped carbon-hydrogen molecules to avoid tar compounds in syngas. Third step is to reduce

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19 Brest height diameter (130 cm above the ground)
CO2 from the oxi-process by reacting with the hot charcoal to CO, due to several further reactions like water steam shift, syngas has following components: 3 % methane, 20 % hydrogen, 21 % carbon monoxide, 12 % carbon dioxide and 44 % nitrogen and a calorific value of 5,7 MJ/Nm³. After filtering the gas by a simple dry fabric filter the high quality gas is ready for the combustion engine.

Transition to this technology is worth in case that the existing heating technology has at least 60 kWth installed heating capacity, demand of heat should be > 4 000 boiler operating hours per year. The opportunity costs (costs for existing energy supply) for heat should be about 6 ct/kWhth and 17 ct/kWhel for electricity (net). Fuel price should not be higher than 100 €/tDM. But in general it depends on specific circumstances – e.g. with right management can the fuel costs decrease and therefore all the other costs decrease as well.

During the procedure, charcoal-ash mixture originates and it is used in compost for biological activation, which means that microorganisms can explore and settle in the carbon matrix. The compost-charcoal-mixture is brought out to fields between hedges to bring back mineral components to trees. Charcoal also known as “terra-preta” has the ability to improve ecological soil functions. Thanks to a large relative specific surface of the carbon matrix soil it is able to buffer way more nutrition needs, enables moisture storage. Stable structure lets lots of air in the soil, and in the end, the soil has with the right treatment a big capacity of carbon sequestration. Two goals can be reached with this system, fixing the eroded humus contend and decarbonize the atmosphere.

The organic farm is now provided by heat and electricity produced from local renewable resources. The plant fulfils the needs of the farm and also sells the surplus electricity to the grid. Heat is used for house heating, drying, greenhouse operation, refrigerator operation etc.

Reaching a stable process and an automatic operation was difficult at the beginning, but they managed it with proceeding exercise.

There were no difficulties regarding legal issues with a plant of this scale. Regarding the feedstock supply, the situation when the operator was not the owner of the hedges was a barrier and it required a lot of negotiations with local stakeholders. It was rather problematic to persuade them to change their actions or to find out more details about the process of their work. Among the public the plant is very positively perceived. It succeeded in
combining several societies’ demands. The plant is not that visible as wind
turbines, it does not compete to the food production, it uses local resources,
which have to be handled anyway and now they can be valorized. The
farmers have a chance to reach ecological benefits when managing their
hedges correctly. They managed to bring two opposite attitudes of “intensive
farmers” and “protect everything from human beings use” to a compromise
like “protect nature by responsive usage”.

*Transferability*

Technology can be used in all rural regions.

*Contact*

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Christian Engelke (automatization engineer)
Georg Zimmermann (programming engineer)
Julian Fintelmann (economy engineer)
Frederik Köster (engineer for renewable energy)

*Additional information*

[LiPRO Energy](#)
[Organic farm Grummersort](#)

*Photo Gallery (Author©LiPRO Energy)*
Heating with hedges (Energiequelle Wallhecke)

**Germany:** Kreis Steinfurt, Borken, Coesfel and Warendorf, Landkreis Grafschaft Bentheim

**Netherlands:** Regio Achterhoek, Particulier Agrarisch Natuurbeheer, Vereiniging Agrarisch Natuurbeheer, t’Onderholt

**Keywords**
- Combustion
- Networking
- GIS
- Sustainable pathways
- Public acceptance
- Best practice

**Feedstock**
- wood from hedge rows on banks (protected landscape element)

**Summary**
A concept of management and utilization of biomass from maintenance of hedgerows on banks in the project regions; creation of the position of a hedge manager who advises owners and companies (this position exists until present as a 50% position); online registration of private hedgerows on banks; GIS database.

**Time period**
2009-2013

**Administrative and legal requirements**
The German Federal Act for the Protection of Nature defines hedgerows on banks as a landscape component protected by law. Hedgerows on banks cannot be removed. All actions impeding the growth of trees and bushes are prohibited. It is allowed to perform conservations and maintenance work (from October to February) as well as building new or widening of passages through the hedgerows on banks. These should not be wider than 12 m and maximum two hedgerows on banks per management intervention can be worked at. The work on passages has to be reported to the local Nature Conservation Agency at least a month beforehand.

**Results/Innovation**
Securing of sustainable management of the hedgerows on banks. Creation of a new position in the county administration: the hedge manager.

**Difficulties**
Online registration is not used very often because private hedge owners are often older people and they prefer using a telephone.

**Transferability**
Possibly transferable to a number of regions. The LCMW is rather specific and according to the regional partners of the only pilot region, which also has this biomass type (Friesland, Germany), the creation of the position of a hedgerow manager is too costly. However, the concept of registering hedge rows (on banks or not) and then planning an efficient harvest process could be a good example for carrying out other linear LCMW types (e.g. along streets or streams).

**Contact**
Benedikt Brink (DE), Wilfried Berendsen (NL), Jan Stronks (NL), Wilfried Klein Gunnewiek (NL)
Heating with woodchips a cow farm

**Germany, Baden-Württemberg**

**Keywords**  Combustion, Wood chips, Best practice

**Feedstock**  Landscape conservation material (70 % of biomass from hedges)

**Summary**  The company has about 8,5 ha of nature protected area and 22 ha of forest. A big part of it are protected hedges, which have to be maintained from November to April according to the nature protection legislation. Wood from the maintenance is chipped at the facility and stored in a covered silo. It is combusted in a 55 kW woodchip boiler. Heat is used in own households at the moment. The costs of maintenance are more than compensated by the savings for heating oil.

**Time period**  Since 2003

**Contact**  www.alb-rind.de

**Additional information**  MULLE websites

**Interlink**  MULLE project
**Dry fermentation: Chiemgauer model**

**Germany, Bayern**

<table>
<thead>
<tr>
<th><strong>Keywords</strong></th>
<th>Dry fermentation, Decentral systems, Best practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feedstock</strong></td>
<td>Possible feedstock includes a wide variety of biomass residues like grass, roadside biomass, wild plants, manure, corn, landscaping material, green rye, straw etc. Use of corn stalks and leaf-fall is tested.</td>
</tr>
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</table>

**Summary**

Decentral dry fermentation technology for small amounts of feedstock, especially residual materials was developed.

**Time period**

Since 2001

**Technical aspects**

The family’s own plant has four fermenters, each 55 kW producing heat and electricity and the annual feedstock requirement is about 900 t. The capacity of until now installed plants lies between 30 and 90 kW. Its specialty is that the fermentation takes place under a gastight membrane and, therefore, the investment in a garage fermenter is not necessary.

**Economic and environmental aspects**

Investment costs are around 5 000 EUR/kW, which is well below the investments in other dry fermentation technologies.

**Contact**

[www.chiemgauer-biogasanlagen.de/startseite/](http://www.chiemgauer-biogasanlagen.de/startseite/)

**Additional information**

[MULLE websites](http://www.chiemgauer-biogasanlagen.de/startseite/)

**Interlink**

MULLE project
<table>
<thead>
<tr>
<th><strong>Heating with woodchips from river side maintenance</strong></th>
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<tr>
<td><strong>Germany; Bremen</strong></td>
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<th>Combustion, Wood chips, Best practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feedstock</strong></td>
<td>Woody material from riverside and dike maintenance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Summary</strong></th>
<th>The dike maintenance association uses the woody residues from the maintenance for heating of their administrative buildings and workshop halls and in winter to produce hot water.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time period</strong></td>
<td>Since 2008</td>
</tr>
<tr>
<td><strong>Technical aspects</strong></td>
<td>The plant has a heating capacity of 165 kW and works in continuous operation mode. Annually 300 000 kWh of heat is produced.</td>
</tr>
<tr>
<td><strong>Economic and environmental aspects</strong></td>
<td>The investment costs for the plant including the roofing for the wood chips storage were around 160 000 EUR and are foreseen to be amortized in 9-11 years. Since the material used as fuel originates from the maintenance work, there are no additional costs for the fuel and there are saving for heating oil, which would have to be otherwise purchased.</td>
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<tr>
<th><strong>Contact</strong></th>
<th><a href="http://www.dvr-bremen.de/">www.dvr-bremen.de/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Additional information</strong></td>
<td>MULLE websites</td>
</tr>
</tbody>
</table>
## Autumn leaves into briquettes

**Germany; Ibbenbüren**

### Keywords
- Combustion, Briquettes, Leaf-fall, Best practice, Public acceptance

### Feedstock
- Seasonal leaf-fall, LCMW biomass

### Summary
Successful experience with utilization of small-diameter wood and biomass from hedges maintenance lead to the next step – producing briquettes from seasonal leaf-fall.

### Processing steps
In the first phase only the LCMW biomass was treated - it was chipped, dried and fractionated, while the coarse fraction was combusted directly and the fine fraction was used for briquettes production. Later on, the press technology for the leaf-fall was introduced. Briquette press can be used both for the fine fraction of woodchips coming from landscape maintenance work and the briquettes.

### Technical aspects
From one kilogram of the briquettes around 5 kWh of heat can be gained, which means 2 500 MWh of heat if the whole leaf-fall from the city would be used.

### Economic and environmental aspects
Annually there are 500 t of the leaf-fall from 28 000 urban trees and maintenance costs of 40 000 EUR arise. Ashes coming from the briquettes can be used as fertilizer as they have high pH and represent a source of Potassium, Calcium and Magnesium. The contaminants are present in contents similar to ash from woodchips.

### Public acceptance
In order to gain public acceptance of their actions, they invited local citizens and local press to the facility in order to show the technology and its performance. There was also the chance to leave the leaf-fall at the facility for free at that day. In the future, it is aimed to keep this service cost-free for the local citizens.

### Contact
Ibbenbürener Bau- u. Servicebetrieb (Bibb); [www.ibbenbueren.de](http://www.ibbenbueren.de), Netz ingenieurbüro; [www.netz-gmbh.eu](http://www.netz-gmbh.eu)

### Additional Information
[Article at Flächenmanager](http://www.ibbenbueren.de)

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**greenGain: D4.1 | 49**
LCMW biomass in a German bioenergy region

Germany; Jena-Saale-Holzland

Keywords

CHP, Public acceptance, Networking, Energy cycle, Best Practice

Feedstock

Private garden green residues, Landscape conservation material

Summary

Because the resources of forest residues were almost exhausted since there are three wood heating plant in the region, a need to unlock new local biomass resources occurred. In contrast to that, resources like private garden residues or landscape conservation biomass were combusted during the permitted periods with no energy use or shredded and blown at the roadsides. From this reason, four LCMW biomass collection points were installed in the region in order to use it for energy production. Within six weekends, about 90 tons of LCMW material were collected. After the success of the project became clear, it was extended to twelve collection points and cooperation with the municipal service and waste collection company was established. In 2014, around 250 tons were collected, where about 50 % was wood suitable for production of electricity and heat. The rest was utilized by composting. The local cogeneration plant recognized an opportunity and kept this service for local citizens. A positive response from the public persuaded also at first sceptical administrative bodies to take part in the process.

Time period

2013

Contact

www.bioenergie-region.de/

Additional information

Bioenergy Regions: Project of the month

Interlink

Bioenergy Regions project
## LCMW woodchips as a part of the communal climate protection plan

**Germany; Murrhardt**

<table>
<thead>
<tr>
<th><strong>Keywords</strong></th>
<th><strong>Combustion, CHP, Wood chips, Sustainable pathways, Best practice</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feedstock</strong></td>
<td>Forest residues, landscape conservation wood, residues from the wood industry; feedstock originates predominantly in the Murrhardt forest.</td>
</tr>
</tbody>
</table>

### Summary

The municipal utilities operate four heating plants where heating oil and gas can be combined with wood chip boilers. The fifth also included cogeneration and, therefore, electricity and heat are produced. The total installed heat capacity in now 6 MW. In the season 2014/2015, 3.9 Mio kWh heat was produced. The annual consumption of wood chips was 6 000 SRm.

### Motivation

The city of Murrhardt with around 14 000 inhabitants was looking for ways to lower its environmental footprint and prepared a climate protection plan in 2012, part of which was also focused on potential or renewable energy in the region.

### Contact

Rainer Braulik, Stadtwerk Murrhardt

### Additional information

[Energetic community Murrhardt](#)
### Heating plant Rieste

**Germany; Rieste**

**Keywords**  
CHP, Best practice

**Feedstock**  
Exclusively landscape conservation wood, strict quality control (important for reaching the German subsidy for energy use of landscape conservation material (LPfi-Bonus))  
Forest wood only used if it originates from non-productive forest (e.g. nature protection areas; Nature park Harz)

**Summary**  
A wood-fired CHP plant processing residual wood. Sourcing area of the wood about 100 km. Produced heat is used in Adidas factory and for drying of firewood. Electricity is produced via a steam turbine.

**Technical aspects**  
Electric production performance max. 4 994 MW  
Heat production performance 10 MW  
Annual fuel requirements: 60 000 t air-dried wood; in winter 200 – 220 t/day, in summer 180 t/day  
Limited storage capacity of 1300 t (one-week consumption)

**Economic and environmental aspects**  
Ash production of about 2180 tons of bottom ash; disposal costs 60 EUR/t  
262 tons of fly ash; disposal costs 98 EUR/t  
Potassium content is 2 – 2.8 %, therefore it cannot be considered as K fertilizer (3 % content required)

**Contact**  
[www.bestenergy1.de](http://www.bestenergy1.de)

**Photo gallery**  
(Author©Heating plant Rieste)

*Picture 1 and 2: Wood chips and residual woody material used as fuel in Rieste*
### Residual wood-fired heating plant

**Germany**: Heidelberg

**Keywords**  
CHP, Best practice

**Feedstock**  
Landscape conservation material

**Summary**  
A decentralized cogeneration plant fired with approximately 60,000 t of wood from the region around Heidelberg, which consists of 90% landscaping material and green residues.

**Motivation**  
The city of Heidelberg set the goal of reducing the CO₂ emissions by 95% compared to 1990 until 2050.

**Time period**  
Since 2013 in a test operation

**Technical aspects**  
The plant has an output of 3 MW electrical power and 10.5 MW thermal power and it produces an average of 24,000 MWh of electricity and 80,000 MWh of heat.

**Contact**  
Stadtwerke Heidelberg GmbH

**Additional information**  
[Article at Stadtwerke Heidelberg](#)
RWE Biomass-fired CHP and pelleting plant
Germany; Wittgenstein

Keywords
CHP, Pellets, Best practice

Feedstock
Landscape conservation wood

Summary
The biomass-fired CHP plant at Wittgenstein produces heat and electricity on the basis of green wood, landscape conservation wood and residual forest wood from the region. The heat is delivered to a neighbouring pellet plant.

The plant is capable of producing up to 120,000 tons of wooden pellets annually. Therefore, sawdust and industrial wood are being used from the nearby region. The plant is being run by 100 000 MW heat from the Biomass-fired power plant next to it. The region of Siegen-Wittgenstein is known as the largest forest circle in Germany and therefore a sustainable use of wood is granted.

Time period
Since 2009

Technical aspects
CHP plant:
Thermal output: 30 MWth
Electrical output: 5 MWel
Biomass input: 90000 t/a
Electricity production: 38 000 MWh/a
Process heat production: 100,000 MWh/a

Economic and environmental aspects
The combination of carbon-neutral energy generation and wood pellet production results in a "dual green effect": the annual CO2 savings in the CHP plant amount to approx. 48 000 tons. An additional 100 000 tons of CO2 are saved annually by using the wood pellets in residential households.

Contact
www.rwe.com

Additional information
Materials
# Planning of biomass management and conversion to a solid fuel for the use in a public buildings property of Serra City Council

**Keywords**  
Residual biomass, Pellets, Best practice

**Feedstock**  
Urban residual biomass

**Summary**  
The biomass residues management carried out by the Serra Council administration, reaching 1 286 t of biomass residues from urban public and private parks, was used to heat an elementary school and to fuel a boiler of a pelleting plant.

**Time period**  
2011

**Technical aspects**  
Boiler: 35 kW  
Surface to be heated: 320 m²  
Tons per year of biomass: 322 t

**Economic and environmental aspects**  
Savings in the residues management: 15 113.4 €  
The former management of the material from park maintenance was landfilling, which involved certain costs. Utilization of the residues brought savings compared to such treatment.  
Annual savings in electricity: 6 400 €

**Additional information**  
[PDF presentation](#)

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# Energetic use of biomass from urban parks maintenance and industrial residual biomass

**Keywords**  
Residual biomass, Conversion, Best practice

**Feedstock**  
Urban residual biomass

**Summary**  
The use of biomass from management of public and private parks carried out by the Merida Council administration and industrial residual biomass for organic fertilizer production and energy purposes.

The 20 MW plant plans to generate around 160 million kWh/year and with a biomass consumption of 150 000 tons/year from the city surroundings which will help to clean the Woodland surroundings and, therefore, contribute to decrease the fire risk. In comparison with a fossil fuels, the biomass plant will save 160 000 tons of CO₂ emissions per year.

**Time period**  
2011

**Additional information**  
[Article at Europapress](#)
<table>
<thead>
<tr>
<th><strong>LCMW wood chips-fired boiler: a pilot installation</strong></th>
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<tbody>
<tr>
<td><strong>Poland; Otwock</strong></td>
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<tr>
<td><strong>Keywords</strong></td>
</tr>
<tr>
<td>Combustion, Wood chips, Networking, Best practice</td>
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<tr>
<td><strong>Feedstock</strong></td>
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<tr>
<td>Residual wood from urban green areas</td>
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<tr>
<td><strong>Summary</strong></td>
</tr>
<tr>
<td>150 kW wood chip fluidal boiler was installed in a greenhouse replacing an old coal-fired boiler.</td>
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<tr>
<td><strong>Time period</strong></td>
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<tr>
<td>1997 - 1998</td>
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<tr>
<td><strong>Economic and environmental aspects</strong></td>
</tr>
<tr>
<td>Reduction of sulfur dioxide emissions by ca. 530 kg/year; of carbon dioxide by 120 t/year</td>
</tr>
<tr>
<td><strong>Results/Innovation</strong></td>
</tr>
<tr>
<td>Benefits and savings of the pilot installation over one heating season:</td>
</tr>
<tr>
<td>• Savings of 50 tons of coal (20 000 PLN = 6349 USD)</td>
</tr>
<tr>
<td>• Savings for the removal and storage of 126 tons of wet waste at a compost site (30 PLN/t) or at a landfill (100 PLN/t); at least 3780 PLN (1200 USD)</td>
</tr>
</tbody>
</table>

The project workers visited 6 towns of the Lower Silesia (Jelenia Gora, Bielawa, Wakbrzych, Wroclaw, Opole, Legnica), where preliminary estimates concerning wood waste resources were made - as a result Joint Implementation Project was planned together with Dutch in Jelenia Gora. A preparatory feasibility study done for Lodz, Warsaw, Otwock, Pruszkow, Skierniewice and Siedlce proved existing unused resources in those towns.

Interesting cooperation between municipal Waste Management Company, Town of Otwock and an NGO was established. The pilot installation became known and Otwock became a place of frequent visits from various places of Poland (local governments, individuals, experts).

**Transferability**
Project was replicated later by the Polish Ecological Club in Gliwice.

**Contact**
Social Ecological Institute (Spoleczny Instytut Ekologiczny)

**Additional information**
Small Grants Programme
### Heating with LCMW woody residues: a pilot installation

**Poland:** Jelenia Góra

<table>
<thead>
<tr>
<th><strong>Keywords</strong></th>
<th>Combustion, Wood chips, Best practice</th>
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<tbody>
<tr>
<td><strong>Feedstock</strong></td>
<td>Residual wood from urban green areas</td>
</tr>
<tr>
<td></td>
<td>There was a total surplus of 2540 m³ waste wood in the city; At least 700 m³ of residual wood was landfilled.</td>
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</table>

**Summary**

The first pilot Joint Implementation Project in Poland, at the City Greenery Unit in Jelenia Góra, replaced two low-efficient coal-fired boilers (with efficiency below 50 %) with a high efficient boiler for wood chips obtained as waste from the management of the city green areas.

**Time period**

2000

**Processing steps**

Residual wood is shredded, transported to a long-term storage, stored for a few months and dried with a floor channel drier. Wood chips are transported by a screw feeder to a short-term storage and afterward combusted in the boiler.

**Technical aspects**

The amount of waste wood from green areas maintenance available immediately for the energy production is 700 m³ and the entire technical potential is equal to 2.540 m³. It represents a potential of 2.100 GJ and 7.500 GJ respectively.

**Economic and environmental aspects**

220 tons of coal saved thanks to its replacement with biomass

**Results/Innovation**

After the modernization, the annual quantity of wood used for heating purposes was 388 t (1100 m³, moisture content 55 %), one automatic wood chips fired boiler was installed (350 kW) and no coal was consumed.

**Contact**

[www.ibmer.waw.pl/ecbrec](http://www.ibmer.waw.pl/ecbrec)

**Additional information**

Material
10. Interviews with European actors along the LCMW biomass utilisation pathways

Interviews were conducted with European actors and experts along the LCMW biomass utilisation pathways, from processing to conversion. They provide an interesting insight on the problematic from different European countries and from people with different experience. The interviews complete the overview on the situation provided by the literature review and the examples of Best practice with further knowledge from research and practice.

List of the Interviewees:

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<tr>
<th>Country</th>
<th>Name</th>
<th>Affiliation</th>
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<tr>
<td>BE</td>
<td>Willem Boeve</td>
<td>Inagro (Research Center on Agriculture and Landscape)</td>
</tr>
<tr>
<td>CH</td>
<td>Christoph Aeschbacher</td>
<td>Association Holzenergie Schweiz</td>
</tr>
<tr>
<td>CH</td>
<td>Rolf Jenni</td>
<td>Heating and power plant Aubrugg</td>
</tr>
<tr>
<td>CZ</td>
<td>Petr Liška</td>
<td>EKOPORTA Bohemica spol. s r .o. (Composting plant)</td>
</tr>
<tr>
<td>DE</td>
<td>Nicole Menzel</td>
<td>DVL e.V. (Landcare Germany)</td>
</tr>
<tr>
<td>DE</td>
<td>Dr. Christian Struve</td>
<td>BERNHARD JÖCKEL – Innovation consulting</td>
</tr>
<tr>
<td>ES</td>
<td>Alberto Centelles Martín</td>
<td>Monroyo Industrial S.L</td>
</tr>
<tr>
<td>ES</td>
<td>Agustín Oliver</td>
<td>Oliver Energy consultancy</td>
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<tr>
<td>ES</td>
<td>Andrea Lacueva Laborda</td>
<td>Independent engineering and energy consulting</td>
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<tr>
<td>ES</td>
<td>Pedro Miguel de Matos Serra Ramos</td>
<td>Forestfin, Florestas e Afins, Lda./ ANEFA</td>
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<tr>
<td>ES</td>
<td>Anonymous</td>
<td>Government of Aragon</td>
</tr>
<tr>
<td>ES</td>
<td>Anonymous</td>
<td>Agricultural engineer</td>
</tr>
<tr>
<td>GR</td>
<td>Manolis Karampinis</td>
<td>Chemical process and Energy institute (CERTH)</td>
</tr>
<tr>
<td>HU</td>
<td>Csaba Vaszkó</td>
<td>World Wide Fund Hungary (WWF)</td>
</tr>
<tr>
<td>IT</td>
<td>Prof. Bianca Maria Torquati</td>
<td>University of Perugia</td>
</tr>
<tr>
<td>IT</td>
<td>Anonymous</td>
<td>CPR (Biomass Producers’ Consortium)</td>
</tr>
<tr>
<td>NL</td>
<td>Dirk de Boer</td>
<td>Ministry of Agriculture, Dienst Landelijk Gebied</td>
</tr>
<tr>
<td>PL</td>
<td>Magdalena Borzęcka-Walker</td>
<td>IUNG (Institute of Soil Science and Plant Cultivation)</td>
</tr>
<tr>
<td>RO</td>
<td>Mihai Adamescu</td>
<td>University of Bucharest</td>
</tr>
<tr>
<td>SE</td>
<td>Maria Iwarsson Wide</td>
<td>Skogforsk (Forestry Research Institute of Sweden)</td>
</tr>
</tbody>
</table>
Belgium, Rumbeke-Beitem

<table>
<thead>
<tr>
<th>Field of work</th>
<th>Harvesting and valorisation of grass</th>
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<tr>
<td>Technique for mowing and collection of grass used in anaerobic digestion</td>
<td></td>
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<tr>
<td>Grass from nature conservation areas and roadsides (minor roads)</td>
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</table>

<table>
<thead>
<tr>
<th>Experience</th>
<th>About the feedstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within the COMBINE project, the treatment of grass from nature conservation area (4 ha) and from roadside mowing (1 ha, minor road) was investigated for two years. The total yield of grass from 5 ha was 50 t. The yielded grass was used as a substrate for anaerobic digestion.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Processing chain</th>
<th>Mowing: Disc mower</th>
</tr>
</thead>
<tbody>
<tr>
<td>The flail mower was not used because it takes soil together with the grass, which is unfavourable for the digestion.</td>
<td></td>
</tr>
<tr>
<td>Collection: Forage harvester</td>
<td></td>
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<tr>
<td>Forage harvester offers an advantage of shredding the grass simultaneously with the collection, which is favourable for the use in a digester. Moreover, no metal objects are collected with the grass, because the harvester stops once it encounters a metal object.</td>
<td></td>
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<tr>
<td>Transport: Wagon</td>
<td></td>
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<tr>
<td>Size of the wagon was limited in order to avoid soil compaction on the conservation area. During the first year of the experiment, the grass was transported in a wagon with capacity of 10 t directly to a small anaerobic digestion plant (5 km distant; 30 kW). In the second year the grass was first brought to an intermediate storage and picked up after ca. 24 hours by a larger truck with a capacity of 25 – 30 tons. It was transported with the truck to a more distant plant with a larger capacity (20 km; 2 MW).</td>
<td></td>
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<tr>
<td>Digestion:</td>
<td></td>
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<tr>
<td>In the first year, the grass was ensiled for ca. 3 months and processed in small bits in the 30 kW digestion plant. In the second year, it was immediately digested in the 2 MW plant and, therefore, there was no need for storage. No complications occurred during the processing of the grass.</td>
<td></td>
</tr>
<tr>
<td>Besides the pilot case studies, the PROGRASS® procedure was developed within the project, where grass is washed and separated in two fractions – fibrous and liquid. The liquid fraction can be easily digested in a biogas plant and the fibrous fraction is processed in briquettes. Briquettes are dried to 85 % DM content by waste heat from the biogas plant. They can be easily combusted and stored.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Economy</th>
<th>Costs along the processing chain:</th>
</tr>
</thead>
</table>
Mowing: 10 €/t
Forage harvester: 30 – 35 €/t (slow)
Transport with the small wagon: 15 €/t; with the larger truck: 10 €/t
Processing at the digestion plant: there were no costs since it was their own plant;
Usual price in Flanders for uptake of such biomass at a digestion plant: 20 €/t
Usual price for accepting grass at a composting plant: 30 – 40 €/t

In Flanders, there are big amounts of residual grass to be managed, since there is an obligation of removing grass from roadsides and nature conservation areas after a maintenance work. The amounts are estimated for 200 – 350 000 t/year. The grass from maintenance work is considered as waste, and its treatment brings considerable costs. Other motivation of the project, besides utilizing the amounts of waste grass was to substitute the most usual feedstock of digestion plants – maize.

The grass is mostly composted, although there is minimal economic revenue for selling the compost. The prices for accepting the grass at the composting plants are high, which means an extensive economic burden for the municipalities and other management authorities. However, composting is still the prioritized solution for residual grass treatment. Although the costs for disposing of the biomass in a biogas plant are much lower, requirements on the feedstock quality are higher. Using grass in a biogas plant would mostly require new machinery and quality control, which seems too complicated to the administrative bodies. Moreover, this treatment is also discouraged by the government, who supports composting and promotes it as a better way of residual biomass usage, since it valorises the nutrients. The only motivation for the administrative bodies to change their behaviour is economic. The environmental point of view or the fact, that this biomass could be used as a sustainable source of energy has little resonance.

When organizing a series of workshops with government bodies, grassland managers and digester managers in several regions in Flanders, the aim was to communicate the benefits of grass digestion. The workshop showed that these actors prefer the easiest way of the biomass treatment, which does not require additional investments or care. Municipalities have mostly one mower, which can be used for all areas and are not interested in purchasing a special equipment. In only two cases, the meetings triggered change. In one case, for example, it was thanks to the high interest of the digester and because the municipality purchased smaller machinery which was not so costly. Nevertheless, the system setting is not ideal and complication still
occurs when optimising it.

**Related formalities** Grass from nature protection areas and roadsides is categorized as waste in Flanders and regarding its treatment, recovery of organic material by composting is preferred before its energy use. The use of grass for compost production is supported by legal frameworks while they are not foreseen to change.

Combustion of grass briquettes from the PROGRASS® procedure is illegal in Flanders, as from a legal point of view it is waste combustion. Nevertheless, the briquettes are produced and combusted in Germany proving to be good and easily storable fuel.

**Messages**

There are large amounts of grass from landscape conservation and maintenance work in Flanders to be treated. However, the legal setting and the attitude of the decision makers remains unfavourable for its use for bioenergy production. Grass could potentially substitute maize - the usual feedstock for biogas plants and could provide easily storable biomass fuel for combustion.

**Contact information**

willej.oeve@inagro.be

**Interlink**

Project COMBINE and GR3 – Grass to green gas

**Photo Gallery (Author©Inagro)**

*Picture 1: Flail mower used conventionally for mowing*
Picture 2: Mowing with disk mower

Picture 3: Forage harvester, picking up and blowing grass into the wagon

Picture 4: Ensiling the grass
Energetic use of wood from landscape and maintenance work (LCMW) is rather a side issue for Holzenergie Schweiz. However, because the association works with actors in whole Switzerland they have a good overview in which heat and power plants (HPPs) is this type of feedstock processed.

Big plants have a significant influence on the use of wood in their regions and often the feedstock is also transported to them from other parts of the country. For example, the HPP “Lignocalor” in the canton Bern works with municipalities, forestry companies and civil communities, which are joined in a bundled organization. According to its quality, the feedstock from all these partners is then optimally dispersed on different processing plants.

The experience made by Holzenergie Schweiz is that operators of smaller plants do not use wood from LCMW. In order for their boilers to process this feedstock without problems, pre-treatments like sieving and drying are necessary. However, these additional processing steps lead to more work and result in higher costs.

For example, a big HPP in the canton of Jura manages bigger and smaller boilers, which lend them, especially in summer season more flexibility. Like for the operator of a small firing plant, the feedstock for the small boilers needs pre-treatment to secure proper and continuous work. However here the drying can happen with waste heat from the big boilers and the purchase of a sieving machine is for a big HPP operator more likely to be economical.

In Switzerland mostly a direct supply chain is followed to use the wood from landscape and maintenance work with no intermediate storage (see below).

In Switzerland, funding programs are developed by the single cantons and thus can vary from region to region. Basically, financial aid should depend on the actual prices of fossil energy carriers. Should they rise above a certain level, the funding should be automatically frozen. With that, enough incentive would be created to build new plants. Additionally, with plants run by wood energy it is still possible to generate CO2-emission certificates which can be sold on the market.

At the moment Switzerland has a feedstock surplus.
A big plant in the eastern part of Switzerland (Domat-Ems, 85 MW) is not working on full capacity (problems with investors) and throughout the whole country, there is a lack of consumers.

The total surplus lies between 2 – 2.5 million m³ per year, of which about 0.3 million m³ come from wood from maintenance and landscape work.

The Swiss price-index for the energy wood was adapted in the beginning of October according to the market situation by – 7 %.

Problems

The strong Swiss Franc and the low oil prices made the year 2015 especially difficult for the producers of wood-firing systems.

With the actual market situation it is to expect, that in bivalent HPPs the oil and gas boilers will be used more than usual.

It remains to be seen how the harvest volume of the coming season 2015/2016 will develop due to the low oil prices.

Outlook

Today, when a feasibility study is made for a new power system fired with wood it can lead to the decision not to do it. However, this is not a final valuation and it should be kept in mind that in the future the same study can lead to a positive outcome. Basically, the will to use renewable energies is here but at this moment the economic factors are not favourable.

It can be expected that plants built 10 – 15 years ago and those which have to be renewed in the next years are not going to be replaced by oil or gas heating systems.

Society

In the last decade a rethinking took place. The consumers are no longer indifferent in regards to the energy origin and the amount of their energy consumption. This is a chance for the energetic use of wood because persuasive efforts are not needed anymore.

Operators and contractors of big HPP are aware of the potential represented by wood from LCMW. However, to utilize this feedstock, a sensible utilization has to be elaborated.

For example: a plant in Gstaad/Saanen mixes different wood types (landscape, forest, waste) according to the feedstock quality and the actual energy need. Combined with a small oil or gas boiler the use of cheap feedstock and the security of optimized heat production can be realized.

Messages

– In most regions in Switzerland big HPPs influence the use of the local wood production.
– With a strong Swiss Franc and low prices of fossil fuels, the market is not favourable for renewable energies.
– Switzerland has currently a feedstock surplus in regard of woody biomass.
The society is aware of the benefits represented by the energetic use of wood. However, the market situation complicates the building of new sites.

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Neugasse 6, 8005 Zürich
Switzerland: Rolf Jenni

**Institution**

Heating and power plant (HPP) Aubrugg (operative since 2010)

Partners:
- EKZ (Power Plants Canton Zürich)
- ERZ (Disposal and Recycling Zürich)
- ZürichHolz AG

In near proximity (a few 100 m), the EKZ operates a waste incinerator plant Hagenholz with a long-distance heating grid, which connects also the HPP Aubrugg.

**Position**

Manager

**Feedstock**

Wood chips from forests and landscape maintenance work (< 10%) in mixed deliveries.

Only HPP in Switzerland which uses solely fresh wood.

Average transport distance: 25 km, delivered by the company “ZürichHolz AG” (co-owner of the HPP Aubrugg).

For the coming season, a new project is planned. The management wants to use wood from main roads and motorways for the first time, from December to February to produce power and heat in an adjacent waste incinerator plant. With the additional heat production, linked gas firings (which are only used in winter) will have lower gas consumption. The costs saved for the gas can then be used for covering the costs of the woody feedstock. With that, a heat production can be achieved with bigger share of renewable energy and less use of fossil fuel.

In season 2015/2016 the process will be tested step by step to determine the important factors (especially energy content of the feedstock) to assess how much additional long-distance heating can be produced and accordingly how much natural gas be saved.

It is estimated to achieve around 3000-4000 MWh.

Problem: The wood from main roads and motorways contains high amounts of chlorides (10-1000 times more than fresh wood) which leads to a higher risk of corrosion damages in the boiler. Accordingly, corrosion cycles have to be estimated, respectively costs for more frequent boiler replacements assessed.

If the prices for natural gas keep declining, the use of wood from main roads and motorways will not be economical anymore.

**Price**

In the contract with the supplier “ZürichHolz AG” a price of 43 Swiss Francs/MWh (now approx. 40 EUR/MWh) for fresh wood was set.

Wood from main roads and motorways has similar prices as forest wood.

**Ash Management**

Produced ash is delivered to the company „Kies und Beton AG“ in Bad-Ragaz in the canton of Grison. With a new technique, the ash (poisonous chrome 6 is
reduced) is mixed with other substances resulting in an environment-friendly alternative for wall gravel used for the backfilling of excavation pits.

<table>
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<td><strong>Supply area</strong></td>
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<td><strong>Financial aid</strong></td>
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<td><strong>Motivation to build the HPP Aubrugg</strong></td>
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<th>Steps until the building</th>
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<td><strong>Permissions</strong></td>
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<td><strong>Logistics</strong></td>
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<td><strong>Investors</strong></td>
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<th>Ongoing Operation</th>
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<tr>
<td><strong>What could have been done better?</strong></td>
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and power first into the grid, complemented through the production of the HPP. With that, the input of the HPP depends on the daily and seasonal fluctuations of the energy use of the consumers. That is also why the HPP is shut down from the beginning of June until the middle of September.

Also there is a yearly loss of performance of 10 MW through renovations of buildings, which, at the moment, is just balanced through new connections asking for a performance of nearly 10 MW per year.

**What is most difficult to keep the plant going?**

The main problems are the storage site and the transport of the wood chips. From the storage site to the boiler room, the wood chips have to cross underneath a bridge supporting the national motorway. This is a long way and the conveyor system performs an additional incline. With a considerable share of fine material in combination with high water contents, the probability of disturbances while transporting fresh wood chips over such a long way is rather high.

**Operation alternatives**

Waste wood could also have been processed with a lower steam parameters. The feedstock is cheaper (0 – 10 Swiss Francs) and several bigger HPP in Switzerland use it (Bern 50 % and Basel 30 %).

**Messages**

- The used technologies are very good (see also technical report20) and the plant has high efficiency (90 % in winter and 80 % over the whole year).
- The HPP Aubrugg saves yearly 25 000 tons of CO₂, which corresponds approximately 9.5 million litres of oil.
- The accumulated ash is used in an environmentally friendly process, which means that the HPP Aubrugg produces no residual materials.
- If the prices for fossil fuels and electricity decrease further and the costs for fresh wood will rise the financing of the HPP will become more difficult.

**Contact information**

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20 [http://www.hhkw-aubrugg.ch/beschreibung](http://www.hhkw-aubrugg.ch/beschreibung)
<table>
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<tr>
<th><strong>Czech Republic, Malé Žernoseky</strong></th>
<th>Petr Liška</th>
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<tr>
<td><strong>Institution</strong></td>
<td>EKOPORTA Bohemica spol. s r.o. - composting plant</td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td>Executive director</td>
</tr>
<tr>
<td><strong>Field of work</strong></td>
<td>Company focused on processing of greenery from public spaces.</td>
</tr>
<tr>
<td><strong>Experience</strong></td>
<td></td>
</tr>
<tr>
<td><strong>About the feedstock</strong></td>
<td>There is a very low possibility to use the biomass for energy purposes, but composting is possible. Wood and branches from private gardens and public green spaces are processed into wood chips. The amount of 150 t/year throughout the year is produced (seasonally variable composition). Content of water, nitrogen and carbon seasonally is variable by the raw materials (wood in autumn and winter, grass and crop residues in spring - autumn); 100 t herbaceous residues + 50 t of woody residues. The feedstock comes from the region and they get it for free. All compost is made from the LCMW feedstock and is used as a substrate on agricultural land.</td>
</tr>
<tr>
<td><strong>Processing chain</strong></td>
<td>Maintenance of green public areas including collection and processing of the residues is provided by the local community. Collection of organic waste from households provides the community. Composting takes place at a local composting plant together with a local farmer. Usage of the substrate on fields is a responsibility of the farmers and usage of the substrate on public gardens and parks is a responsibility of the municipality.</td>
</tr>
<tr>
<td><strong>Economy</strong></td>
<td>Costs of the collection are ca. 50 000 CZK (1 850 EUR) and of the processing ca. 30 000 CZK (1 100 EUR) annually.</td>
</tr>
<tr>
<td><strong>Context</strong></td>
<td>Cooperation of more actors in the locality takes place (citizen and community assuring the maintenance - composting plant and the farmer processing the feedstock - citizen and farmer using the product). The compost market situation is good. Premises for keeping the activity economic are subsidies from the municipalities.</td>
</tr>
<tr>
<td><strong>Related formalities</strong></td>
<td>There are subsidies for a purchase of equipment and</td>
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technology for the handling and processing of waste.

**Difficulties**

Legal and administrative matters. Unnecessarily complicated bureaucracy and administration for waste management facilities as this one.

**Wider insight**

Personal estimations are that the demand can grow from newly coming people. Present demand is stable.

**Contact information**

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**Photo Gallery (Author©Petr Liška)**

*Picture 1: Compost soil - the final product of the processing of LCMW biomass*

*Picture 2: Sifted substrate*
Picture 3: Loading of raw materials, using heavy machinery

Picture 4: Chipping of the woody residues
Picture 5: Compost turner and aerator
Germany, Ansbach  
Nicole Menzel

**Institution**  
Deutscher Verband für Landschaftspflege e.V. (DVL, Landcare Germany)

**Position**  
Project leader of MULLE

**Field of work**  
Biogas from landscape management material  
Project MULLE: "More landscaping material in existing biogas plants - multiplication of field-proven solutions for energy recovery of untapped potential from landscape management"

**Experience**

**About the feedstock**  
Landcare Germany (DVL) is an umbrella organization of 155 Landcare Associations (LCA) in Germany. These regional non-governmental associations link nature conservation groups with local farmers and local communities. Therefore, the experiences about the material from landscape conservation and maintenance work are wide-ranging.

**Processing chain**  
In the MULLE project herbaceous material for biogas production was analysed and all steps of the processing chain have been assessed.

- harvesting and transport: e.g. with forage harvester (shredding from 1 to 3 cm) or short-cut loading wagon (shredding from 3 to 20 cm), silage bales (to store the biomass on-site)
- conservation: to store the biomass (e. g. to feed the plant continually) it has to be conserved by silaging
- material processing – shredding and pulping: to enlarge the surface

Rule of thumb: The later the landscaping material is conditioned, the higher is usually the use of resources.  
The step of shredding and pulping is the most important step. The enlargement of the surface by size reduction allows the use of a wider range of feedstock materials, increases the biogas yield and improves the mixing and pumping capacity and utilization of digester space.

**Context**  
Following variables affecting the economy of the energetic use of landscape material:

- the distance between the area and the biogas plant
- area size: small areas are difficult to manage
- harvesting machinery
- processing technology / shredding (10 – 20 cm length) / chippers (2 - 3 cm length): the smaller the better for the biogas plant and the greater the biogas yield
• material quality: e.g. material with shrubs like blackberry or sloe have a high wood content or material from floodplains has a high mineral content
• energy crops: the higher the price of cultivated energy crops, the more likely the use of landscaping material is economical. Corn and grain are available actually always on this day and age, that’s just a question of price, transport route etc.

Related formalities

The Renewable Energies Act (EEG) of 2014 eliminates the additional remuneration for renewable resources. Whether maize, clover grass or landscaping material - you will receive per kilowatt hour, only the basic salary to a maximum of 13.66 cents, with a rated power of 150 kW.

The Biowaste Ordinance unsettles the biogas plant operators so that partly they do not dare to use regionally accumulated landscaping material, in particular, green cuttings, in the biogas plant. Loppings (green cuttings) from public and private areas are declared as waste (EEG/5.1), landscaping material from nature conservation and landscaping work not (BiomasseV Annex 3/5). There are uncertainties on the part of operators and authorities and many operators currently do not use these feedstocks.

Wider insight

The utilization of herbaceous material from typical landscape elements, like pastureland, marsh areas or grassland for biogas production competes with the use of this material as feed or litter for stables. Landcare Germany (DVL) makes sure that the use of this kind of biomass for livestock farming has priority over the use of biogas.

Messages

The main obstacle in the utilization of landscape material is the German Waste Management Law because it declares green cuttings as waste. Biogas plants for landscaping material, e.g. from sports grounds etc., require different permission and must meet many requirements. If this problem would disappear, more biogas plant operators would declare their willingness to ferment green cuttings. In an amendment to the EEG, the focus should lie on a remuneration for the energetic use of landscaping material.

Furthermore, to promote the use of landscape material in biogas plants test for harmful substances should be done in the digestate and not in the feedstock. At present, the substrate is not tested for hazardous substances. The feedstock is divided into groups e.g. corn as a renewable resource is not hazardous. Green waste is an organic waste and the waste legislation must be complied. Whether the substance is actually contaminated, e.g. corn along a highway, is not examined.

Also the provision of cheaper shredding technologies, like mobile shredding solutions, could make the material more attractive for biogas plants and increase its utilization.

Contact information | Interlink
MULLE project & Advisory folder “From landscaping material to biogas”

Photo Gallery

Picture 1: Landscaping material - with a special equipment the farmer mows steep mixed orchards in Lower Franconia; Source: Peter Roggenthin

Picture 2: Colmberg and the hamlet Meuchlein receive heat from this biogas plant, which is gaining around 30 % of its energy from material of wet meadows of the adjacent bird sanctuary; Source: DVL
Picture 3: Mulched green area in the district of Biberach - no use of the material; 
Source: Hans-Peter Seitz
**Germany, Darmstadt**

**Institution**  
BERNHARD JÖCKEL - Innovation zum Erfolg

**Position**  
Innovation Consultant

**Field of work**  
Innovation and network management with technical focus on biomass, energy technologies and energy efficiency, environmental engineering, electrical engineering and electronics, pharmaceuticals, microsystem technology, sensor technology, transportation.  
Network manager of W-BAST (technology and competence network for material from LCMW in Germany, i. a. value chain, biomass (pre)treatment, material & thermal recycling)

**Experience**

**About the feedstock**  
The technical vision of the innovation network W-BAST is to develop individually pre-treatment techniques for (woody) loppings from roadside and landscape management activities to make the material materially and thermally "usable".  
In the focus are grass cuttings and loppings from roadside maintenance, landscape management activities on public areas and private gardens which are transported to commercial/public collecting points. In the network W-BAST several 10,000 t/a are treated with a primary water content of approx. 60 %.  
Within W-BAST herbaceous material from these collecting points is transported to a composting plant and is subsequently sold as compost and the woody biomass is sold as fuel to energy plants without noteworthy profits.  
A technical process to produce wood chips, pellets, briquettes and WPC, within single plants is developed by the W-BAST network.

**Processing chain**  
The biomass is transported to the collection points by public, private or commercial units.  
Within W-BAST the biomass is biologically dried to a water content of 40 % on-site and technically dried down to a water content of 10 %, e.g. using waste heat of biogas plants. The dried biomass is fed into a pre-treatment plant at the collection point, which produces different feedstock fractions (see the pictures at the end).

**Economy**  
The costs of all steps depend from the ownership of machines, transport vehicles and stores. The price is also dependent on capacity and location of these. Communities often have their own collection point and vehicle pool.
**Context**

Operators of commercial collection points (with public-service mission) and public collection points for loppings want to increase their financial output from selling herbaceous and woody biomass. The quality of their woody biomass is comparable with forest wood and they want to exploit the potential. The W-BAST network was established to develop a technical process to shred and to treat loppings for the production of briquettes and wood chips. The network consists mainly of medium-sized companies from the area of collection, processing and recycling of loppings, scientific institutions and strategic partners.

**Related formalities**

The German Waste Management Law also applies for the material from landscape management. Loppings are declared as waste and waste is not saleable and transportable without permission. Because of the status of waste they have difficulties in selling their products. For example, to sell briquettes authorities in each federal state of Germany have to agree.

**Wider insight**

People want sustainability and resource efficiency and they contribute e.g. by bringing their garden waste to the collecting points and they prefer to buy briquettes made by “their” own material. This could be a big Unique Selling Proposition (sales advantage).

**Messages**

The energetic use of material from landscape management could be supported by the German government, e.g. by establishing standards, to get rid of the waste status. That would also strongly minimize the need for imports of wood for the energetic use, because biomass cogeneration plants in Germany are increasing and the demand for biomass is growing.

**Contact information**

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<tr>
<th><a href="mailto:c.struve@bernhardjoeckel.com">c.struve@bernhardjoeckel.com</a></th>
<th>Interlink</th>
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<td>W-BAST</td>
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**Visual materials (Author©W-bast project)**
Spain, Aragón  |  Alberto Centelles Martín
---|---
**Institution** | Monroyo Industrial S.L
**Position** | Manager and owner of the company

**Field of work**
In recent years, Monroyo Industrial S.L has focused on services for forest conservation, protection and improvement of the natural environment. Currently they are engaged in production of biomass as fuel.

**Activities:**
- Processing of pine wood for woodchips, biomass from forest maintenance
- All forestry works; firewalls, ecosystems and natural habitats maintenance, reforestation
- Installing park banks and garden furniture, building playgrounds, trails and signs

**Nature protection activities:**
- Cleaning beaches and other natural environments
- Riverbanks protection work

Monroyo Industrial S.L has equipment and experienced staff focused on the quality of their work.

**Experience**

**About the feedstock**
Pine wood residues such as bark or splinter of different sizes are used as garden mulch. Pine splinters are used for combustion and heat production in farms and public buildings. The pine wood is used for building of viewpoints, trails or recreational areas in natural parks

**Processing chain**
Steps in the processing chain of biomass:
1. Locating the spots with a good access to perform the work
2. Cutting the trees with chainsaws, piling the logs, loading at a truck
3. Transport to a harbor, export

**Economy**
Purchase of the raw material in the forest 3 - 6 €/t
Costs of the felling: 25-30 €/t (pine and cypress trees)
Production of pine splinters with a wood chipper: 12-14 €/t
Processed pine chips price: 45 – 90 €/t

In Matarraña region, there are two companies selling wood chips, Gil Forestal and Monroyo Industrial S.L. They produce about 4000 tons per month.

**Context**
80 % of the raw material is exported outside Spain (mainly to Italy, also to France)
20% of the material is sold in 150 km radius (Huesca, Zaragoza, Barcelona, Tarragona, Lleida, Girona, etc.)
Monroyo Industrial S.L has their own biomass logistics center in Alcaniz.

Related formalities
Industrial Monroyo S.L received subsidies covering 28% of the costs for the machinery.
There is a support scheme for small projects creating new jobs.
There are no subsidies for biomass production in Aragón, but such subsides can be received in the Valencia community.

Wider insight
The biggest motivation for using the LCMW biomass is the possibility of economic compensation for the maintenance work. Due to the difficult access to riverbanks and roadsides and low density of the material is the extraction unprofitable. However, cleaning is necessary in these areas to prevent fires and harms connected with rivers floods.

Contact information
alberto@monroyoindustrial.com

Photo Gallery (Author©Alberto Centelles Martín)

Picture 1: Creating trails and viewpoints
Picture 2: Forest brigades

Picture 3: Forestry work
Picture 4: Wood chips

Picture 5: Resting spots
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<tr>
<th>Spain, Aragón</th>
<th>Agustín Oliver</th>
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<tbody>
<tr>
<td><strong>Institution</strong></td>
<td>Oliver Energy consultancy</td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td>Owner of the company</td>
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**Field of work**
Oliver Energy consultancy is specialized in bioenergy, mainly on its production from local resources.
They are engaged in biomass energy audits, processing of grants and seeking of funding for equipment.
Distribution of feedstock such as as almond shells, olive pits and pruning briquettes.

**Experience**

**About the feedstock**
Pine wood, agricultural residues, almond shells, olive pits, peach pit and straw; Production of briquettes and pellets

Properties of the pellets/briquettes:
- High calorific value
- Low moisture content, which favors the ignition
- Low ash content
- Easy to store
- Low production costs

**Processing chain**
Manufactured pellets are dried in the sun.

**Economy**
The final price of briquettes is 105-110 € per ton.

**Context**
Oliver Energy S.L have biomass logistics center built in Fabara (Zaragoza, Spain).

**Related formalities**
Every year there are subsidies for energy savings, rational use of energy and utilization of local energy sources.

**Difficulties**
The main barriers for further development are:
- Performance of the biomass engines and boilers is lower than of those using fossil fuels
- The processing of biomass requires special handling or technology, which results in higher processing costs and, therefore, final price
- Bioenergy production requires higher amounts of feedstock to achieve the same energy gains. More feedstock means additional costs for storage.
- In case of biofuels production the costs increase almost by 50 - 80 % compared to conventional fuels production
- It is difficult to quantify the feedstock potential, accurate data are missing and further studies are necessary

**Wider insight**
The prunings and residual wood have a high potential to generate sustainable energy and to enter the market in form of e.g. pellets or woodchips.

**Contact information**
pelletsaragon@gmail.com
Picture 1: Final products - pellets and briquettes

Picture 2: Processing of the pruning residues
<table>
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<tr>
<th>Spain, Aragón</th>
<th>Andrea Lacueva Laborda</th>
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<tbody>
<tr>
<td><strong>Position</strong></td>
<td>Independent engineering and energy consulting</td>
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**Field of work**
She studied electrical and thermal energy consumption of 38 buildings in municipalities in the Bajo Aragon and Matarraña regions from 2013 to 2015. In all municipalities of Matarraña and in some municipalities of Bajo Aragón she introduced projects to replace 39 oil boilers by biomass boilers (900 kW, installed in administrative buildings, schools, medical clinics, offices, etc.). During the same time period she studied electrical and thermal energy consumption of agricultural cooperatives and farms where steps were taken to install biomass boilers and, therefore, to assure their own energy production. In the focus was the state and durability of existing oil boilers, their annual consumption and performance. Arising replacement costs, savings and payback periods as well as the possibility of receiving subsidies to repay the investment faster was studied.

**Experience**

| Feedstock | Pinewood (woodchips, pellets), olive pits, almond shells |
| Economy | Consumption (100 m² building): |
| | Pellets 240 €/season |
| | Diesel 400 €/season |
| | With the biomass boilers between 40 and 60 % of the costs are saved compared to diesel. 39 new biomass boilers bring savings between 70,000 € and 100,000 € per year. |

**Context**
Biomass boilers projected require creating cooperatives within the municipality.

**Related formalities**
There are no subsidies for biomass production in Aragón.
There are subsidies for investments in machinery ([Link here](#)).

**Difficulties**
Biomass boilers require more maintenance than oil boilers (diesel) and people prefer the comfort of diesel. However, with introducing the biomass boilers, new jobs are created.

**Wider insight**
Usage of biomass instead of heating oil for energy production lowers the GHG emissions and supports job creation. In Aragon, and, especially in Teruel there are problems of depopulation, therefore the job creation can help to maintain a permanent population.

**Contact information**
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Spain, Zaragoza

Pedro Miguel de Matos Serra Ramos

Institution: Forestfin, Florestas e Afins, Lda./ ANEFA. Portugal, North, Vila Nova de Gaia

Position: Agricultural engineer

Field of work: Project Director/Chairman of ANEFA

Experience: 20 years of experience with biomass from landscape conservation and maintenance work, coordinating different teams that produce this feedstock.

About the feedstock: Types of LCMW feedstock in their scope of activity were different, from fresh grass cut, pruning residues, wood chips from harvesting residues, wood chips from forest bushes, etc. The amounts of feedstock depend on the season, but at least 80 - 120 t per month in average arise.

Feedstock characteristics also depend on the material and the season; we can find material with 60 % water content and others with 20 - 30 %.

The feedstocks they work with are mainly produced by their teams and they work normally within 60 km distance.

Processing chain: Usually the material to produce energy is delivered at the energy plants or pulp mills with own energy plants. There is another type of material that is used for production of compost in their own facilities and therefore that biomass remains at their centre. They manage two different processes regarding the destination of the material.

If the material is to be delivered to energy plants, which is usually the case of the residues of pruning or harvesting, they collect and chip them and transport to the energy plants. The machinery for harvesting and collection are harvesters and chainsaws. For collection a tractor with a trailer and a crane are used. The chipper is powered by a tractor and the chips are piled up on the ground. When there is enough material to be transported the truck is loaded with the front loader of the tractor. The total costs of the operation are 23-27 €/t where harvesting costs are not included since we concern harvesting residues, which means that the harvesting costs were already considered in the log production. If the material is used for compost then it is collected and spread in piles at the composting plant. They have a pile for each kind of material and then they mix in the composting rows with the proportion desired of each kind.

Economy: The selling price of the wood chips is around 25-30 €/t if the customer is an energy plant.

The maximum distance taking into account the price mentioned above is 25 km. Currently there is a large demand for biomass due to new energy plants and pellet factories but the prognosis is that this trend will decrease in the future.

The biomass must be processed with better quality, producing different types.
of feedstock for different kinds of markets but to do so the price must increase.

**Context**

They are part of ANEFA which is the National Association of Forest, Agriculture and Environmental Entrepreneurs. Cooperation that exists between the companies is exchange of services, especially when a bigger machine to produce chips is needed.

The environmental issues/threats connected to the treatment, processing or conversion are related to any problems of the machinery, which is the same like by harvesting other types of biomass.

There is a supply instability, which means that since the energy plants and pellet industry are consuming logs instead of residual biomass, it is difficult to create a true production chain for it with quality patterns, because the business is not yet stabilized. To stabilize it, it would be necessary to invest and in order to invest we have to have customers on regular basis.

**Related formalities**

Certification of the wood chips or the shredded material is currently not demanded by the relevant legislation.

There are subsidies for the machinery but that applies to all harvesting machinery, not specifically for this biomass.

**Wider insight**

Their personal estimation of the potential of the feedstock from landscape conservation and maintenance amounts 1 400 000 t of biomass per year. The future aim is to produce different kinds of biomass for different purposes – industrial consumption, domestic consumption, pellet industry, etc. To do so, the prices of the biomass should be established according to the use and the quality required.

**Contact information**

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<tr>
<th><strong>Spain, Zaragoza</strong></th>
<th><strong>Anonymous</strong></th>
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<tbody>
<tr>
<td><strong>Institution</strong></td>
<td>Government of Aragon. Department of Rural Development and Sustainability.</td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td>Forest fires section</td>
</tr>
<tr>
<td><strong>Field of work</strong></td>
<td>Fire prevention work and prevention taskforce management and coordination.</td>
</tr>
<tr>
<td><strong>Experience</strong></td>
<td><strong>About the feedstock</strong> The Department of Rural Development and Sustainability does only work in public utility woodlands (in Spain 49 % is public owned woodland and 51% is private owned woodland). The biomass is obtained from firewall (currently known as special prevention areas) and auxiliary belt opening and maintenance and forest recreational areas. Regarding the maintenance work and cleaning of forest recreational areas, due to the reduced amount and type of material obtained, especially the amount, the biomass produced should not be taken into account for energy purposes. During the work carried out for fire prevention purposes, the vegetation is not removed completely (firewall areas used to be completely cleared of vegetation) to avoid the shrub invasion. The tendency for the last years is to carry out a pruning and clearing of scrub, still there is some firewall in which all vegetation is removed. Teruel province in Aragón (Spain), where the pilot regions of Bajo Aragón and Matarraña are located, accounts around 900 ha of firewalls and auxiliary belts (including opening and maintenance). Around half of this area corresponds to opening and the other half to maintenance work. Huesca Province, sited in Aragón Region, accounts currently around 700 ha in total of firewalls and auxiliary belts (opening and maintenance). The maintenance is always carried out from March to October (sometimes even November). The work is carried out by the prevention brigades and their working radius is less than 30 km from the operating base during the summer and less than 40 km from the operating base during the rest of their contract. Aragon accounts with 70 prevention brigades.</td>
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<tr>
<td><strong>Processing chain</strong></td>
<td>Felling and limbing is carried out manually by the prevention brigades (subcontracting SARGA, public enterprise in charge of environmental works in Aragón) which is one of the limitations due to the lack of mechanic means like forwarders or skidders. The brigades are composed of 5 persons, 9 in the case of heliborne brigades. Hauling is carried out by the prevention brigades in the case of a firewood. The timber wood and crosscut wood is object of a public bidding and is collected by whom the contract is awarded to.</td>
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Economy

Firewood is left on site for the neighbours. If the neighbours do not come to pick-up the firewood it would involve an important limitation, because it would require some treatment most likely expensive. Whenever this risk is evaluated to be high, they might decide not to work in the area.

The feedstock cost could range in average:

- Timber harvesting for shredding: 10-12 €/t standing
- Forest residues (branches, etc.) 0 €/t, if the amount is significant is it crushed and if the amount is low simply left on site.

Cost and yields (performance in terms of tons per hour) are not representative since the prevention brigades only combine this work with their main occupation, fire extinction. Therefore, their work yield is 2-3 times lower than the performance yield achieved by a forest harvesting industry. Additionally the brigades only carry out the felling and hauling work, the other activities included in the supply chain are carried out by other stakeholders. Transport costs can rise in average up to 12 €/t (100 km distance considered)

Context

The administrative process to carry out a work related to opening of firewall or auxiliary belts (maintenance work due to the low amount of material obtain is not considered) in public forests which owner are the local councils, are as follows:

- Directorate General of Aragon sends a letter to the Council informing about the work they intend to carry out.
- Directorate General of Aragon prepares the technical specifications statement that he sends to the Council.
- The Council prepares the administrative-economic specifications statement
- Adjudication by public auction procedure
- Directorate General of Aragon issues a license

The whole process takes in average 3-4 months.

But if the forest area belongs to the Aragon Government they do not follow this process, it is an internal process in which only the Directorate General of Aragon and SARGA to execute the work are involved in general.

The agents usually involved in the process are SARGA,

Department of Rural Development and Sustainability from the Government of Aragon, Councils, forestry company and or final user.
Regarding the biomass market situation, there seems to be an increasing demand over the last years. The limitations from their point of view would be the lack of balance between the local consumption and the biomass production. The problem is more related to the quantity and the costs more than to the feedstock quality.

Regarding the environmental constraints, the fire prevention brigade carries out their work during summer so there is an important risk of plague. Some technicians have some concerns when the whole tree is harvested regarding the environmental impact (nutrient cycle) of this kind of exploitation system. Additionally, in some cases, the area has a certain degree of protection due to the presence of species under protection, in this case the operation will be carried out with limitations to not disturb or damage those species.

**Related formalities**

In order to carry out the work the requirements included in the technical, administrative-economic specifications statement should be fulfilled. Additionally the laws related to this kind of exploitation that might need to be considered are: Law 15/2006 Forestry Act modified in 2014, Public Sector Contracts Act 3/2001, Aragon heritage law 4/2013, Regulation regarding the local entities goods, services and activities 347/2002, Action Plan FLEGT (CE 2173/2003).

There are no subsidies or grants connected with the utilisation of given feedstock.

**Wider insight**

There is an awareness of the problematic from the administration point of view but not from the forest companies and society.

**Messages**

Need of regulatory development since the current tools are neither practical nor convenient and funding in accordance to the goals established. Due to the limitations in the funding, the areas in which the works are carried out are very reduced and therefore the amount of biomass obtained small, which contributes to a negative economic balance and increase the difficulty to use it.

The clearing is carried out during summer time therefore involving a fire risk associated with the machinery operation even though if the prevention means are always monitoring the work to act in case of ignition. Occasionally the residues are left in site without shredding due to a lack of funding.

Sometimes, after the brigades have carried out the job, stakeholders interested in use of the biomass come along; but for this purpose they require some conditions regarding the form in which the biomass is left on site, so that they can operate more efficiently. This happens to be impossible once the works have started, and there is not a possibility to change the “modus operandi” of felling and limbing, since it has been programmed and done many times already. The operational system of felling and handling the residues could be changed and adapted if the fire brigades knew before the specifications required by an interested stakeholder. This situation evidences the lack of planning and contact between the public and the private sector.
In his opinion, it will become a raw material with its own market for a certain application, but it would take longer than he had though in first instance; it would happen rather on a long term.

Contact information

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Spain

Anonymous

Position
Agricultural engineer

Field of work
Energy crops management Aragón
Energy crops fields production and logistic of the feedstock
Poplar and eucalyptus
Occasional work regarding the road and field borders cleaning, etc.
The company current activity involves the production chain of biomass energy crops, forest harvesting, biomass trade and other minor products.
They carry out the felling, assembling, chipping and transport operations.

Experience

About the feedstock
For the energy crops they have obtained an average yield of 60 t/ha, harvesting every 3 years. Sometimes, cleaning work in the surrounding fields are carried out, associated with the energy crops harvesting. These cleaning works are usually carried out in up to 10 km distance from the energy crop field not further. The further operation point from the logistic centre is 80 km away.
The moisture content at the felling stage is 45 % by the poplar and 50 % by the eucalyptus. The moisture content decreases considerably if the biomass is left on site for a couple of weeks/months before the chipping.
On the market, G-30 and G-50 chips are demanded.

Processing chain
They are involved in the whole logistic chain from the felling to the transport to final use.
Different options can be implemented during the chain. Frist alternative involves a forest combine harvester, chipping and discharge in truck or trailer.
The operation cost highly depends on the field size and the biomass yield. In average should be around 15 €/t.
A second alternative will involve the manual felling (with chainsaw), stockpiling (machinery), chipping and transport. Just as by the previous operation chain, the cost will be highly influenced by the biomass yield.
Approximately the felling will cost around 4 €/t, 4-8 €/t stockpile and 11 €/t chipping on site.
Regarding the transport, the owner of the biomass will take care when transported to the logistic centre. Most likely, when the biomass is sold, the transport cost to the final use location will be negotiated (paid by the seller) or the price considers the biomass placed at the logistic centre (paid and transported by the buyer).

Economy
The feedstock price highly depends on the biomass type origin (poplar, almond, etc.), chip format (chipped, shredded, log, stem) and the moisture
content.
Of course, there are other characteristics that should be taken into account.
For example, the presence of undesired elements (stones, soil, leaves, bark, plastics, etc.) or the original form (thin branch, stem, etc.).
Due to the low value of the feedstock in the market, many times the owner hand it over to the company that wants to take it with no charge.
Merely indicative we could consider 0.12 €/t and km with mobile floor truck and chips.

**Context**
As for the harvesting and extraction of the biomass, they work most of the time with forest and agriculture service companies (Mycsa, Monrollo and others).
The main parameters that need to be taken into account are the price (€/t), considering the operations involved from harvesting until the feedstock arrives to the logistic centre, biomass type (poplar, almond, etc.), chip format (chipped, shredded, log, stem) and moisture content.

**Related formalities**
For the work on agriculture and forestland it is required to obtain a permit from OCA.

**Wider insight**
Difficulties with keeping the profitability: the price of the feedstock needs to cover the harvesting, extraction and transport (and pre-treatment when required) costs. The experience gained has an important role in order to solve the problems that can arise during the logistic chain.
Athens, Greece  Manolis Karampinis

Institution  Chemical process and Energy institute (CERTH)

Position  Research associate

Field of work  Solid biofuels logistics and energy conversion technologies
Technical/research advisor to municipalities and waste management companies in Greece
Prunings from parks and public spaces

Experience

About the feedstock  There are no official data about LCMW feedstock amount. Its quantity depends on the size of municipality and number of trees. For example, it is estimated that the Athens Municipality produces about 5,000 tons of green prunings from parks and public spaces.
Moisture content of the green residues is estimated to be 40 - 50 % wt.
LCMW feedstock originates from pruning of certain tree types (olive trees, bitter oranges, mulberries) harvested once per year as a part of typical gardening activities. Other trees in a municipality are pruned or cut down if there is a specific reason (e.g. danger of a damage on the electricity cables in case of a downfall). The material is mostly landfilled, some municipalities use it as feedstock for composting. In rural areas, larger branches can be used as firewood.

Processing chain  Pruning of trees by municipality workers
Piling of prunings on roadsides
Collection into municipal trucks
Transport to a landfill (mostly) or to a composting plant

Environmental issues  The feedstock has high moisture content and is expected to have high ash content. Presence of leaves and bark is to be expected, resulting in high nitrogen content. It is not an ideal feedstock for domestic heating, since the emissions can be high. Combustion in larger plants would be possible.

Context  As a research organization, CERTH has been approached by several municipalities with interest in utilizing local biomass sources, including LCMW. CERTH has also worked with waste management companies which may handle LCMW as a resource.
Currently, there is no established market for the feedstock. Pruning of trees in the public spaces and collection of prunings is an ongoing activity, performed regularly throughout the whole year. What is missing in the majority of cases is conversion to bioenergy or other utilization step. For this to occur, political will and a change in the waste treatment scheme is required.

Difficulties  The feedstock characteristics make the use in some conversion technologies
difficult, especially in small-scale applications; drying might be required. Due to the high moisture content, transport of the feedstock may be limited. The amount of feedstock in some municipalities may not be sufficient to justify such investments, therefore LCMW biomass should be a part of a larger logistics / waste handling scheme.

**Wider insight**

LCMW biomass has a potential within a waste handling system which would include separate collection and treatment steps for the organic fraction of municipal waste. Since in the near future is expected that municipal waste handling in Greece will have to adopt better practices, including separate collection and treatment of the organic fraction of municipal waste, it is expected that the potential of this feedstock will be used for bioenergy production.

**Contact information**

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**Photo Gallery (Author © Manolis Karampinis)**

*Picture 1: Residues from maintenance of public green spaces*
Hungary, Budapest

Csaba Vaszkó

Institution
World Wide Fund Hungary (WWF)

Position
Programme Manager

Field of work
Leader of an expert team on climate change and energy
Coordinating multinational and national projects on climate
change mitigation, adaptation including renewable energy
development with the engagement of private sector companies
and municipalities

Mr. Vaszkó is managing a project on floodplain restoration and
bioenergy generation. He built up a partnership including a power
plant, a district heating plant and a municipality. The municipality
owns floodplains and provides biomass to the district heating
plant and also uses biomass for its own bioenergy.
The company experience cover supply contracting, landscape
management, biomass potential assessments, local bioenergy
generation, energy plantation establishment and management.

Experience: Summary

About the feedstock
Type of feedstock, which they use - woodchips from short rotation
coppice (willow plantations,) woodchips from invasive plant
species.

Annual consumption: 100 ATO\(^21\)/year, Yield: 8-12 ATO/hectare.
Willow plantations: 45 % moisture content; size G30
Invasive plant species: 15 - 23 % moisture content, size G30
Moisture content is lower in winter periods.
Feedstock origin - Supplier is the municipality; it provides
feedstock both for the municipality itself and the near district
heating plant.
Distances: Municipality - 3 km; District heating plant: 12 km
Previously the municipality supplied feedstock to a 60 km distant
power plant.
Feedstock price: 65 EUR/ton.
End products: woodchips – used for local heating in solid biofuel
boilers and district heating distributed to residential homes.

Processing chain
Maintenance of municipal floodplain habitats and cutting invasive
bushes > transport to the municipality > chopping by municipality

\(^21\) Absolute dry ton
owned chopping machines > storage at the municipality > using for heating in public buildings

Maintenance of short rotation coppices > cutting with motor-scythe > transport to the municipality > storing > chopping > use as feedstock in public buildings or transport to the district heating plant

**Economy**

Costs: Establishing short rotation coppices (SRC): 2,000 €/ha

Maintenance of SRC: 200 €/ha

The market is less developed; the demand is rather local than distant. They calculate with 20-30 km distance. Premises for keeping the activity economic: Minimal feedstock yield in case of SRC is 8 ATO/ha/year. Minimal size of willow or invasive plants is 6 cm in diameter.

**Environmental issues**

No fertilizer or pesticide use, no irrigation.

**Context**

Feedstock supplier: municipality

Administrative bodies: water management authority; national park

Final consumer: either the local municipality or the district heating plant

**Related formalities**

WWF controls the feedstock supply, no specific certification applied

Subsidy for electricity is the Feed in Tariff: 10 cent/kWh.

**Difficulties**

The biomass supply chain is not ideal in terms of transport, storage and conversion. There is a need of a sufficient technology for transport and conversion. The area of the established and maintained SRC is not sufficient.

**Wider insight**

Biomass potential of the region: 500 000 tons/year.

Risks for the nature are environment: over-exploitation of forests, planting invasive plant species used for energetic utilization

There is little space for SRC and for the future development in this field a financial support is needed. For floodplain management is required new zonation of the space to improve the function of the system.

**Detailed description of the actions**

Before: heating system based on natural gas, spending 35 000 €/year.

After: heating system converted into biomass, using invasive plant species and energy plantations as a feedstock

Results: 35 000 €/year cost savings annually; new biomass feedstock introduced in the market; 500 kW
local bioenergy capacity; 500 kW new bioenergy capacity for district heating.
Start in 2008 with biomass supply contract, establishment of energy plantations and cutting invasive plant species.

Steps of implementing the activity

WWF Hungary has initiated an innovative pilot project in Tiszatarján village, next to the Tisza River in North-Eastern Hungary. Its goal is to restore the area’s natural floodplains and produce local renewable energy while increasing and diversifying local energy streams.

A new company, set up within the frame of the project by the Tiszatarján municipality and a local farmer paid local people to cut wild bushes of the highly invasive Amorpha species, which have been shipped and combusted at a large nearby energy plant to produce bioenergy. Amorpha fruticosa is an invasive plant which disrupts biodiversity and reduces flood capacity, and it has colonized large areas of floodplains alongside the river Tisza in Hungary. Large areas of land formerly covered by Amorpha, together with less productive arable lands, are now being given back to nature, to restore the floodplain’s former glory. Some of the area is being replanted with willow trees, which will serve as a long-term, sustainable supply of biomass. Participating farmers are obliged to set some land aside for wetland and grassland conservation, the management of which will be paid for by revenues from biomass sales. Additional project mechanisms include the introduction of grazing animals such as grey cattle and water buffalo to prevent the return of invasive species, and to assist with grassland management. Finally, these changes provide an attractive landscape for eco-tourism, which will bring in additional revenues to economically diversify and better sustain this rural community.

The municipality and some landowners began clearing, transporting, and selling the biomass. Key for WWF was what clearing of the land would take place. A contract was jointly developed which included stipulations concerning natural areas and which specified that a certain proportion of cleared land had to be set aside for nature, whilst a certain proportion could be planted with indigenous tree species for future combustion, to ensure the mechanism was not just a “one-off”.

In this way cutting and combustion Amorpha from the floodplain leads to restoration of grasslands or wetlands, and planting of fast-growing willow trees which will be combusted in 3 years. Tisza Tarjan municipality together with WWF is working on a new small-
scale heating system for the public buildings in the village. Biomass from within a 10 km radius around the village is economically competitive with natural gas, and the Tisza floodplains around Tiszatarján have hundreds of hectares of Amorpha which could be cleared.

Yet this mechanism has led to the restoration of 50 hectares of nature wetlands and grasslands. Beavers have been re-introduced to act as wetland managers, and water buffalos have been re-introduced to play the same role for the species rich grasslands. The landscape – and the economy – of this area have been completely transformed.

**Technical specifics**

- Installed capacity in the municipality: 6x50 kW and 2x75 kW; solid fuel boilers
- Installed capacity in the district heating plant: 500 kW; fluid bed combustion

**Costs and funding**

- Municipality: 70 000 € funded by WWF and 50 000 € funded by the state;
- District heating: 240 000 € funded by the company; 240 000 € funded by EU

**Results, benefits for the region, improvements**

The area was a beautiful mosaic of sparsely forested floodplain grassland wetlands and floodplain softwood forests. A large part of the area was nationally protected, and internationally protected as a Ramsar wetland site. Due to climate change (serious floods and droughts) and wrong floodplain management, the communities have witnessed a rapid expansion of invasive species and the original vegetation has been forced back. WWF and the village of Tiszatarján built up a partnership and started to restore nature on 90 ha of the non-protected floodplain habitats. First, wild bushes had been cut on 30 ha and used in 8 local, small-scale boilers to produce bioenergy for the public buildings. So far we managed to replace 55 000 m³ of natural gas and reduce 90 tons of CO₂ emission annually.

We reintroduced beavers, water buffaloes and 40 Hungarian long-horned grey cattle. Semi-managed grazing has been successful in attracting new biodiversity, especially water birds. Key species include globally significant species e.g. black stork, European ground squirrel, white-tailed eagle, saker falcon, and countless water birds that migrate to the area. Due to the severe and long drought periods habitats are losing their water resources and
freshwater species are looking for habitats. Our project site provides those appropriate conditions and the refugee species in the floodplain occupy our project sites and use them as feeding, breeding and hiding places. Water buffaloes have created new, small-scale ponds where common spadefoot toads found new home attracting many water birds including grey herons, great-white herons, little egrets and night herons.

**Required extern consultations**
Consultation with experts has been made on estimation of cost-benefit analysis

**Weak spots, improvement possibilities**
Efficiency of chopping and solid fuel boilers, transport and briquette production; More efficient public buildings that could contribute to biomass feedstock consumption reduction and indirectly to higher biomass export

**Examples from the region**
Bad example: the biggest biomass power plant is only 80 km far from the location but it has had several blackouts due to non-proper biomass supply.

**Contact information**
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**Photo Gallery (Author©Csaba Vaszko)**

*Picture 1: Harvest of the biomass for heating. Workforce provided by currently unemployed persons*
Picture 2: Biomass loading

Picture 3: Loading of raw material with heavy machinery
Picture 4: Wood chips prepared for combustion

Picture 5: Final use of wood chips
### Italy

<table>
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<tr>
<th>Prof. Bianca Maria Torquati</th>
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<td><strong>Institution</strong></td>
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### Experience

<table>
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<tr>
<th>About the feedstock</th>
<th>In particular:</th>
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<tbody>
<tr>
<td>Olive, vineyard and other tree prunings</td>
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<tr>
<td>Residues of olive oil extraction</td>
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| Processing chain | Branches either come directly from pruning (potential at the regional level is 12,000 tons per year) or from the 50 oil mills active in the Umbria region. Usually they are burnt on farms. Some experiments are being done for chipping at the local level. Another product coming from oil mills is the pomace (potential at the regional level 6,000 tons per year). |

| Economy | The production costs for olive oil are 4 to 8 €/litre. The share of the costs for pruning is 0,5 €/litre and the production of pomace has no costs because it originates as a waste product (but it generates profit for 0,4-0,5 €/ton). For the construction of a plant for treatment and transformation of the prunings, an investment of 800,000 € - 1,000,000 € is needed. The annual revenue for a medium-sized farm could be of around 275,000 €, the expenses for the procurement of the feedstock would be around 50,000 €, so the profit could be around 225,000 € per year. The production costs for the kWh is around 0,40 - 0,50 €. Regarding the projects of Parco 3A, the costs at the moment are paid by research funds. |

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<tr>
<th>Context</th>
<th>The further development of production and use of woody biomass in Italy is affected by:</th>
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<tr>
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<td>- undeclared employment and market for woody biomass, in particular logs;</td>
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<td>- incentive policies too much oriented toward electricity production and not enough toward renewable heat;</td>
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<td>- Too low prices of biomass directed at supplying large power plants or large district heating plants;</td>
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</table>
- Infrastructural barriers for biomass mobilization: lack of forest roads and access to forest stands;
- High fragmentation of both forests and arable lands;

**Related formalities**
There are no particular authorization needed besides the respect of the minimum environmental standards.

**Wider insight**
Information exchanges between university, public administration, rural structures, extension services are widely recommended.

**Messages**
The researchers must transfer the results of research through the Mountain Communities and other communal development bodies, and through the Agricultural Assistance Centres (CAA).

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[www.crnet.it](http://www.crnet.it): Rural Development Plan (EAFRD), CNR (National Research Council) - Research about biomass

**Photo Gallery (Author©University of Perugia and CNR websites)**
Italy

<table>
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<th>Institution</th>
<th>Anonymous</th>
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<tr>
<td><strong>Position</strong></td>
<td>Member</td>
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<tr>
<td><strong>Field of work</strong></td>
<td>All the way from biomass harvesting to heating plant management</td>
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</table>

**Experience**

**About the feedstock**

CPR is a consortium of 30 farms around the Euganean district. It comprises members from all the 3 main national farmers’ associations (CIA; Coldiretti, Confagricoltura). All the farms have vineyards and some of them have olive groves or forests (usually not maintained). Others have buffer zones with hedges around their fields. The Consortium takes care of all the steps of the chain, from biomass harvesting to heating plant management. They deal with all kind of feedstock, either coming from vineyards – which is the main one, olive groves, forests, waterways or roadsides maintenance.

**Processing chain**

Most of the information is available about the vineyards’ pruning. Vineyards are pruned and bundled directly by farmers, then picked by the consortium which packs them in round bales and stores them in a nearby farm (in a space provided by a farmer member of the consortium) and covers them with transpiring cloth in order to let them dry. In 3 months the trenches still have 30% of humidity and in 6 months it goes down to 12%, so they are ready for processing. Balls are then cut in half, chipped, transported and burned in a boiler. The cutting is done by hand; the machines used are: (roto)baler, chipper, truck or tractor with trailer for transport.

**Economy**

Farmers are available to provide the prunings for free. The collection costs would be 30-50 €/t, the consortium collects it for free and uses it for energy production with a clear economic advantage for both parties. For the farmers it is beneficial, because the disposal is a problem due to the fact, that the traditional technique – the ploughing of prunings in the ground – creates plant-health problems related to the spreading of esca disease and corky bark. The consortium has to cover costs for chipping (30-40 €/ha) and transport.

**Context**

Farmers are always very much available for working together towards a sustainable use of residual biomasses, which could lower the costs for them. The consortium is the demonstration of their pro-activeness in this sense. The awareness of the public administration seem a bit lower and we are still missing clear policies for the energy use of biomasses.

About LCMW coming from forests, formal difficulties related to nature protection (see the **Formalities** paragraph) hinder the harvesting.

A difficulty related to waterways biomass is the storage on site. As it is not possible to store the biomass inside the floodplains – for safety reasons: it could be carried away by a flood in anytime – the field operations are much more complicated.

Another problem with biomass use is the opposition of local citizens living
nearby the boilers. It would be necessary to elucidate properly, that the emissions from biomass combustion are no environmental threat and that filters currently used and available in the market are very much efficient.

**Related formalities**

In Italy, we always must be careful about the formal classification of the LCMW: if the content of pollutants is higher than the threshold, they are surely to be considered as waste and be treated as such. Biomass harvesting – either when coming from agricultural activities or from landscape maintenance – is allowed only in certain periods of the year. Usually in autumn and winter when the vegetation production is lower. Forest biomass: in the Euganean park it is very difficult to fetch the feedstock as the area is protected and an Environmental Incidence Assessment evaluation is needed in order to get permission for conducting forest maintenance.

**Wider insight**

The widespread use of LCMW biomass is still only an idea, but the consortium is convinced that it is a good way to be independent in energy provision. The biomass is there, the amounts are significant and currently it is a problem to dispose it properly.

Political action is needed for increasing the demand for biomass. For example, mid-long term contracts (5-6 years) are needed in public buildings management for the provision of energy and the maintenance of boilers. In this case it would be easy even to use good filters. Big plants are not sustainable, you must collect the biomass further than 20 km away from the plant and there is a considerable environmental impact. Ideal size of a plant is 200-300 kw, which is the size for a residential block or a public building/complex.

**Messages**

The main challenge is to increase the demand for biomass for energy production. Political action is requested for increasing the use of biomass boilers in public buildings and other small plants in residential buildings. The economic sustainability is ensured given an adequate demand, and the technical feasibility of the biomass collection is consolidated: the use of small centralized district heating systems for small cluster of 3-4 houses - i.e. in new blocks would be especially effective. Give us something to heat up.

**Contact information**

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*Photo gallery (Author®AIEL and CNR IVALSA - Recupero delle potature di vigneti e frutteti finalizzato alla VALORIZZAZIONE ENERGETICA)*
Picture 1: Harvesting/baling field operations.
**Netherlands**  
*Dirk de Boer*

**Institution**  
Ministry of Agriculture, Dienst Landelijk Gebied

**Position**  
Project Manager; Project North Sea Bio Energy; Project DELaND

**Field of work**  
Roadside maintenance work (wood and grass);  
Energetic use of biomass from maintenance work;  
Feasibility studies of heat networks and new power plants;  
Regularly presentation and dissemination of knowledge about energetic use of biomass from landscape maintenance work

**Experience**

**Project North Sea Bio Energy (Interreg IIIB)**  
Project coordination in cooperation with Germany (competence centre 3N), the province of Friesland (NL), Belgium and Scotland. Dirk de Boer concentrated on woody biomass from landscape maintenance work.

The project started 11 years ago (2004 - 2008). At that time, wood from landscape maintenance work was not used for energy production in the Netherlands but was rather burned on the field or chipped and left on site. Dirk de Boer approached several municipalities in the Netherlands and explained that a consumer was needed to use the woody biomass from landscape maintenance work. He started to contact different stakeholders and organised an excursion to Germany and Denmark. He could motivate 45 people (one mayor, directors of municipalities, officials, landscape maintenance associations, farmers of agriculture- and nature-protection societies, people from the provinces, students and a professor) to participate at a three-day trip. After this excursion the participating mayor showed great interest in building a biomass plant in his town.

However, the project could not give any financial aid for the plans of the mayor. The municipality decided to design a plant anyway and then see how far the realisation goes. In the end, the investments and the risks were too high and the first draft of the designed failed. However, the biomass plant was realised on a later occasion and today it stands in the middle of a town between a public swimming pool and a retirement home. The gas heating system of the swimming pool functions as a backup to secure the heating of 10 objects (town hall, library, retirement home, swimming pool, two sport halls, fitness centre, etc.).

Other possible sites were looked at during the course of the project and a house for disabled people in Beetsterzwaag (Revalidatiecentrum-Friesland; south-east of province Friesland) was chosen. The facility has a swimming pool and a school and used to have a consumption of about 500 000 m³ of natural gas per year. After securing the support of the responsible actors, it was determined that the local farmers create an Ltd (GmbH) to organise all issues concerning the energy delivery. The plant started in 2008 with a consumption of 5 000 m³ wood chips per year. The suppliers provide the plant mostly with wood from landscape maintenance work from the region.

*greenGain: D4.1 | 109*
Project DELaND

Project initiation in cooperation with the former Agricultural Chamber in Oldenburg (Germany) and later work on the project directly realised by the provincial government of Drenthe.

The grass from roadside maintenance work of the municipality Borger – Odoom was processed in a dry fermenter used by a landfill in Germany. The grass was first ensiled by a contractor in the Netherlands and during winter season every week one to two truckloads were transported to the fermenter. In total 1000 tons of grass could be processed.

The advantage of dry fermenters: no malfunctions, even with waste or pollution in the grass (no moving parts in the fermenter). However, the roadside grass, in this case, did not show much waste or pollution because it was cut in rural areas.

In Belgium the cut grass along roads has to be removed by law. The dry fermenting was studied over the same time period as in the project DELaND, however in the Belgian case the responsible persons planned to continue this way of using grassy biomass.

Current Project

Feasibility study to equip a big prison complex in Veenhuizen in the province Drenthe with a woodchip heating system.

Power production with woody biomass

In the Netherlands the power production with woody biomass happens mostly in coal-fired power plants.

Formalities

Waste, emissions and permissions

During the project North Sea Bio Energy, wood from landscape maintenance work counted as waste (a product was defined as waste if it was produced unconsciously). The team of the project challenged that wood from landscape maintenance work was a product produced consciously, arguing the use of maintenance plans and defined methods as well as complying standards for wood chips. As a result, today this biomass is not defined as waste anymore.

Emission limitations were already 11 years ago quite harsh and today electrostatic filters are in any case necessary above 500 kW installations. This leads to higher costs and lowers the attractiveness of installing a woodchip heating system.

Building permission and environmental permits are rather hard to receive as well and lead to further effort when installing a new woodchip heating.

Subsidies

In the Netherlands most subsidies (SDE) on renewable energies are for power producers which feed sustainable power into the grid (like EEG in Germany). Unfortunately, the subsidies are mostly too low regarding what the operators need and with using a gradually rising approach the risk is high that at a certain level no more money can be provided.

In 2016, the Minister of Economic Affairs is increasing the subsidies for both
electricity and heat production (SDE+).

Problems

*Market situation and trade*

In the Netherlands only very few heating sites work with wood chips. The wood is often traded between the regions of the Netherlands but is also delivered to Germany or even Luxembourg.

As an example: Purmerend, a city in close proximity to Amsterdam, has a heating network without natural gas and several wood heating sites. The yearly consumption reaches 300 000 m$^3$ so that the state forestry administration of the Netherlands made contracts to secure wood delivery even from northern Provinces.

Nearly everyone in the Netherlands is connected to the natural gas network, because it is convenient. Accordingly, people rarely change to other heating systems if compared for example to when an oil heating has to be renewed. This also affects the initiation of projects on renewable energies: when searching for fitting objects to work with, the first interest is rarely shown by the energy consumer and without a reasonable consumer the planning of a new wood chip heating makes no sense.

At the moment, the energy prices are way too low and the interest of the consumers on alternative energy production with biomass is not noteworthy.

Messages

It is crucial that local political stakeholders like mayors are included when initiating new wood heating projects. Unfortunately, in the Netherlands this is often not the case. Nearly everyone in the Netherlands is connected to the natural gas network.

At the moment, the enthusiasm for renewable energies is not high due to the low prices of fossil energy carriers. The society is not as critic towards the energy problem as it once was.

*About the interviewee*

Dirk de Boer hat many contacts to stakeholders in the sector of wood energy and energetic use of biomass from landscape maintenance work in the Netherlands and Germany.

The initiation of a new project and first feasibility studies are always in close cooperation with Mr. Michael Kralemann from the German competence center 3N.

*Contact information*

dirkdeboer@planet.nl

*Interlink*

Project North Sea Bio Energy (Interreg IIIB) and DELaND

*Photo gallery (Author©Dirk de Boer)*
1: LCMW regarded in the project Beetsterzwaag

2: Municipality Marum

3: LCMW woodchips, project Beetsterzwaag

4: Firing of the biomass, project Beetsterzwaag

5: Grass from roadsides in Borger Odoorn is ensilaged by a contractor

6: Storage of the grass from roadsides in Borger Odoorn
7: Grass from roadsides in Borger Odoorn is transported to the fermenter

8: Grass from roadsides in Borger Odoorn is unloaded for fermenting
<table>
<thead>
<tr>
<th>Poland, Puławy</th>
<th>Magdalena Borzęcka-Walker</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institution</strong></td>
<td>IUNG (Institute of Soil Science and Plant Cultivation)</td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td>Assistant professor; Department of Bioeconomy and System Analysis</td>
</tr>
<tr>
<td><strong>Field of work</strong></td>
<td>Biomass potential assessment in Europe; Environmental impact of conversion of biofuels, LCA; GHG emissions of food crops cultivation, biofuels production</td>
</tr>
<tr>
<td><strong>Experience</strong></td>
<td>Within the BioBoost project, theoretical potential (NUTS2 level) and technical potential (NUTS3 level) of biomass from Roadside vegetation, Green urban areas and Residuals of pruning was estimated.</td>
</tr>
<tr>
<td><strong>About the feedstock</strong></td>
<td>Estimation of roadside vegetation (herbaceous and woody): Surface area was assessed according to the open street map – a vector map of the EU road network, while 10 m wide stripes of roadsides (5 m on both sides) were considered, at local roads only 5 m stripes. Biomass amounts were estimated with help of the net primary productivity map. This map provides data on the potential growth of vegetation on different habitats, also with geographic location taken into account.</td>
</tr>
<tr>
<td><strong>Potential estimations</strong></td>
<td>Estimation of green urban areas (leaves, shrubs and grass): Many different types of biomass occur in these areas. The area of urban green spaces was estimated based on CORINE land cover map and included all kinds of green areas in towns. Again, the net primary productivity map was used for determining the biomass amounts extracted from the area. The annual biomass potential (technical potential) is the 50 % of the increase in the biomass growth per year.</td>
</tr>
<tr>
<td><strong>Further context</strong></td>
<td>If the LCA analysis should be made for this feedstock, the suggestion would be to set a start at the moment, when the biomass is loaded on the track (cradle) since the previous steps would have to be made anyway within the waste treatment. However, the collection of the feedstock is one of the steps with higher economic costs, since it is very time-consuming. The next expensive step is conversion, like combustion, digestion or turning into biofuel.</td>
</tr>
<tr>
<td><strong>Problems</strong></td>
<td>By the estimation of the potential using the CORINE land cover map, it is sometimes not completely sure if there is vegetation or a building. Also, the</td>
</tr>
</tbody>
</table>
presence of a park on the map does not say anything about how many trees or how much grass there is. The maintenance technique and organization varies among countries and regions.

**Wider insight**

In Poland, the management of green spaces and available equipment differs a lot among the municipalities. In Puławy, there is a municipal greening office, which hire a number of companies to perform the maintenance. The work includes spring and autumn cut of shrubs and autumn collection of leaf-fall. Private garden waste can be left at the facility for compost, or self-delivered to the landfill (free of charge). The cost of collection, disposal and transport amounts at about 10 EUR per m³. Gate fee is high and most of the people compost it in their garden. Once a year there is the possibility to give the garden waste away for free.

The municipal waste is collected once a week from citizens, where there are two categories: “dry waste” (paper, glass, plastic) and “wet waste” (organic waste, dirty plastics etc.). Some citizens also add the garden waste to the wet waste. The unsorted waste or badly segregated goes to the segregation process in the sorting line and then biodegradable waste processed or disposed. The landfill company produces compost from the collected green waste.

**Messages**

One of the few potential estimation of feedstock from landscape conservation and maintenance work in Europe was made within the BioBoost project.

**Contact information**

mwalker@iung.pulawy.pl

**Interlink**

Projects **S2Biom** and **BioBoost**
Visual Materials (Source)

BioBoost Geoportal: [www.bioboost.iung.pl](http://www.bioboost.iung.pl)

密度 [Density: (t/ha)]

- 0.1-10
- 10-20
- 20-50
- 50-100
- >100

To view the technical potential statistics, enable calculating, then click any units on the map and "Show values in columns" button.

<table>
<thead>
<tr>
<th>NUTS name</th>
<th>Straw</th>
<th>Residues pruning</th>
<th>Livestock residues</th>
<th>Waste from permanent grassland</th>
<th>Forestry residues</th>
<th>Green urban areas</th>
<th>Perennial crops</th>
<th>Roadside vegetation</th>
<th>Biodegradable municipal waste</th>
<th>Bio-waste of food industry</th>
<th>Total</th>
</tr>
</thead>
</table>
Romania

Mihai Adamescu

Institution
University of Bucharest

Position
Researcher

Field of work
Ecology, Biology; Research station director (Braila Research station)

Experience

About the feedstock
Roadside biomass maintenance is the activity for which there are most information in Romania; woody biomass

Processing chain
The term used in Romanian for LCMW is “Asigurarea esteticii rutiere” or “Ensuring road aesthetics”. The roadside maintenance depends upon the road category (e.g. the highway and European and National roads are under the national road authority; county and local roads are under local authority supervision; this system includes also the LCMW). In most of the case the maintenance is done after the work is auctioned to different private companies; Usually the material is transported to a composting plant.

In some cases the biomass was used for heating (of local school and administrative buildings).

Economy
The price of road aesthetic maintenance works for a county for 1 year is about 100,000 euro. In some areas like Semlac, Şeitin and Nădlac from Arad County investments were made by planting different tree species (willow) on the roadsides (the total investment cost was about 120.000 euro). The investments will continue, in other areas: Zăbrani-Fântânele, Ususău-Bata-Lipova and Arad-Şiria (Link).

Context
In general, the LCMW is not seen as an important biomass supply. For the roadside biomass there are no special laws; the way the biomass is used depends upon the requirements from the auction documents (there are situations in which the biomass is burned to produce heat for local schools and hospitals or used in other different ways)

No subsidies.

Related formalities
No special requirements are needed for LCMW roadside maintenance. The company should respect the requirements specified in the auction documents (like for e.g. the proof of existing equipment, the experience, etc.).

No business plan is required. As the roads are managed by the National road administration they are either doing the maintenance work themselves or there are organizing auctions and different companies are wining and they are doing the work.

In some cases LCMW cuttings are approved by the forest administrators in many cases (especially at local level) even this is not classified as forest.

Wider insight
Potential: Biomass from forestry: 0,5 mil. m³ in the whole country (= primary energy production 0,12 ktoe), estimated to be equal to the residues from felling (tops, branches, bark, stumps) from forest activities (Link).

Perception of the problematic in their sector/in general public: at the national level debates about cutting the road trees took place. Two contradictory opinions were discussed: a negative one - that the trees should not be cut as this is against the
nature and the second opinion that cutting tree is good as the number of accidents will decrease due to reduced number of collisions.

Problems with public acceptance encountered for LCMW feedstock provision at local level: In many cases, there was an opposition in the community against cutting trees. This is highly dependent on the type of road (from highway to national or local roads). The sense of ownership is increasing towards the local roads. Cutting creates inconvenience in the local community.

We are aware of one case in which the local community received the cut trees and they have used them for heating the school and the administrative buildings.

**Contact information**

mihaicristian.adamescu@g.unibuc.ro;
Tel/fax: +40 21 318 15 71; mobile +40 722 277 479;
University of Bucharest; Department of Systems Ecology; Spl. Independentei 91 – 95; 050095 Bucharest; Romania
<table>
<thead>
<tr>
<th><strong>Sweden, Uppsala</strong></th>
<th><strong>Maria Iwarsson Wide</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Institution</strong></td>
<td>Skogforsk (Forestry Research Institute of Sweden)</td>
</tr>
<tr>
<td><strong>Position</strong></td>
<td>Program manager; Forest Energy, Wood and Fuel properties</td>
</tr>
<tr>
<td><strong>Field of work</strong></td>
<td>Research on harvesting of small trees</td>
</tr>
<tr>
<td></td>
<td>Small trees in abandoned pasture and agricultural land, at forest roadsides</td>
</tr>
<tr>
<td></td>
<td>Potential of such areas, optimal use of technique, costs of the harvest</td>
</tr>
<tr>
<td></td>
<td>Maintenance actions for the forest roadsides</td>
</tr>
<tr>
<td></td>
<td>Young dense tree stands</td>
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<td></td>
<td>Small bushes</td>
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</tbody>
</table>

**Experience**

**About the feedstock**

After clearcutting of trees are the forest roads often not maintained for several years. Especially the forest roads in North Sweden can be left abandoned up to 30 years. When there is the need to clear the roads in order to access the land again, there is a chance to use the harvested biomass for energy production. The growth stands are after the years very dense, formed by small diameter trees and bushes. Moreover, there are many abandoned pasture and agriculture land areas with small trees stands in Sweden. The motivation for harvesting trees from those areas is reaching the subsidies for maintenance of permanent pastureland, because an area can be categorized as permanent pastureland only when there are less than 50 trees on it.

The biomass along main roads and asphalt roads is mostly composed of small bushes. From safety reasons, the maintenance has to be done more often (every 2 or 3 years), which means lower yield of the residues. Moreover, the growth speed is lower because of the climate. Therefore, the amounts of biomass residues are too low to represent a profitable resource. Bigger wood stems are collected, but the rest is commonly left on site unless the utilization plant is very near to the source.

The freshly harvested wood has moisture content around 50%. The stem wood can be easily stored along roadsides and the wood is of a good quality. The residues are more contaminated by clay etc., but they have high energy content.

**Processing chain**

Harvesting and forwarding of the biomass

Whole trees are stored along roadsides, where they also dry
Chipping, Transport to the utilization site (mostly CHP plants, but also industrial plants)

**Economy**

Costs of harvesting both sides of the forest roadside, a five meter wide
strains:

Forest roadsides - trees
Harvesting and forwarding: 13 000 – 20 000 SEK/km (1400 – 2200 €/km)
Chipping and transport: 10 000 – 15 000 SEK/km (1100 – 1600 €/km)

Shrubs
Harvest with harvester: 5 000 – 10 000 SEK/ km (500 – 1100 €/km)
Harvest with forestry mower: 2 500 SEK/km (300 €/km) (when there is less biomass the mower moves faster and, therefore, it is cheaper)

Gains for the material:
35 000 – 45 000 SEK/km (3800 – 4800 €/km) by larger trees
10 000 – 13 000 SEK/km (1100 – 1400 €/km) by trees 5 – 10 cm diameter,
5 – 12 kg DM, 4 000 – 7 000 trees/ha

Feedstock amounts which allow keeping the activity profitable:
Trees: depends also on the size, of bigger trees there can be less
At least 40 – 50 t DM/km
At abandoned pasture land is has to be more – around 50 t DM/ha

Shrubs along main roads: offer no gain, amounts are not sufficient

Context
The feedstock price is around 180 – 190 SEK/MWh (cc. 20 €/MWh).
However, the prices are sinking since 2011. It is caused by several mild winter in last years and a lot of residual and waste wood available (from sawmills and demolitions). Demolition wood is also shipped from Norway and used as cheap fuel since the combustion of this material in power plants is not allowed in Norway.

Related formalities
Subsidies for maintenance of permanent pasture land

Wider insight
The estimated overall theoretical potential of biomass from railroads, roadsides, powerlines, abandoned pasture and agricultural land is 189 TWh. However, only the annual yield of 8 TWh is realistic and sustainable – mainly from pasture land. In the surrounding of cities, there is an annual potential of 1 TWh. Harvesting of the realistic potential would bring 1300 new jobs annually, it would improve the biodiversity of those areas and it would support the technical development of the respective machinery.
**Messages**
Technical development of machinery used for harvesting of dense small forest stands aims to lower the costs of the maintenance. The machinery can be used for other areas dealing with this kind of vegetation as well, like main roadsides. The cost for harvesting and forwarding represent the biggest share of the costs in a processing chain. Therefore, the aim is to develop better techniques and make the harvest more profitable.

**Contact information**
Maria.IwarssonWide@skogforsk.se

**Interlink**
Infres project

**Photo gallery (Author©Skogforsk)**

*Picture 1: Forest road before the harvest*

*Picture 2: Forest road after the harvest*
Picture 3 – 5: Harvesting machinery
11. Annex: Information database

The database of further literature resources, related projects and actors completes the picture of the ongoing activities in the field. This database presented in the report will be extended continuously within the project duration and its actual version will be presented at the second project website – the greenGain Information Platform.\(^\text{22}\)

11.1. Literature database

Further Literature to the topic, not addressed in the literature review.

11.1.1. Scholarly Articles

List of all:

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Also in meadows grows energy wood</td>
<td>Hansjakob Baumgartner</td>
</tr>
<tr>
<td>The potential for CO2 reduction of energetically used landscape</td>
<td>Renée Bradford Britton</td>
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<tr>
<td>conservation materials and green waste in the county Marburg -</td>
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<tr>
<td>Biedenkopf, Germany</td>
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<tr>
<td>Recovery of prunings in vineyards and orchards for the production</td>
<td>Chamber of Commerce of Padova</td>
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<td>of energy</td>
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<tr>
<td>Mobilisation and economical utilization of raw wood from forests</td>
<td>Tobias Cremer</td>
</tr>
<tr>
<td>and landscape for energy production</td>
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<tr>
<td>Diffusion of bioenergy in urban areas: socio-economic analysis of</td>
<td>Madlener, R., Vögtl, S.</td>
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<tr>
<td>the planned Swiss wood-fired cogeneration plant in Basel</td>
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<td>The energy transition at the cemetery - the production and use of</td>
<td>Andreas Morgenroth</td>
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<td>renewable energies in the cemetery open spaces</td>
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<tr>
<td>Framework for energetic utilization of biomass from landscape</td>
<td>Dr. Jan Stegner</td>
</tr>
<tr>
<td>management in Saxony - Final Report</td>
<td></td>
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<tr>
<td>Preparation of a biomass potential map</td>
<td>Müller, S., Steensen, T., Büscher, O., Jandewerth, M.</td>
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<tr>
<td>Establishing an example of a regional energy cycle with biomass</td>
<td>Prof. Dr. habil S. Tischew, Prof. Dr. P. Heck</td>
</tr>
<tr>
<td>from LCMW in the natural park Unteres Saaletal with special</td>
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<tr>
<td>consideration of a GIS- assessment on the long-term availability of</td>
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<td>the biomass potential</td>
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<td>pruning Morus alba L., Platanus hispanica Münchh. and Sophora</td>
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<td>japonica L. in urban areas</td>
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<tr>
<td>Energy wood potentials outside of the forest in Switzerland</td>
<td>Bundesamt für Umwelt &amp; Bundesamt für Energie</td>
</tr>
<tr>
<td>The effect of the surrounding conditions in the assessment of</td>
<td>D. García, J. Pascual, A. García, J. Asín</td>
</tr>
<tr>
<td>biomass: case study of agricultural residual biomass in Teruel</td>
<td></td>
</tr>
</tbody>
</table>

\(^{22}\)The Information Platform will be launched in January/February 2016 and will be presented on the main project website [www.greengain.eu](http://www.greengain.eu)
province (Spain)

| Using remote sensing to estimate a renewable resource: forest residual biomass | A. García-Martín, J. de la Riva, F. Pérez-Cabello, R. Montorio |
### Also in meadows grows energy wood

Auch in der Flur wächst Energieholz

Hansjakob Baumgartner

4/2010, Federal Office for Environment (CH), Magazine "Umwelt"

**Summary**

Meadows enrich the landscape among other also by providing important habitats for animals and plants. To fulfil this function on a long term regular maintenance work is necessary. The resulting woody biomass has a high potential to contribute to a climate neutral energy potential.

**Key messages and data for greenGain**

In the city of Bern, biomass coming from LCMW is nearly completely used for energetic purposes. Description of the use of LCMW biomass in Switzerland.

### The potential for CO2 reduction of energetically used landscape conservation materials and green waste in the county Marburg - Biedenkopf, Germany

Renée Bradford Britton

2013

Master Thesis; Kassel University, Kassel, Germany and Faculty of Engineering, Cairo University, Giza, Egypt

**Summary**

The goal of this paper is to ascertain the annual average amount of green waste available from LCMW and to determine the potential of its energetic use and its positive contribution to the climate targets.

**Key messages and data for greenGain**

**Approaches:**
- Bio-waste management analysis in Marburg-Biedenkopf
- Literature review on relevant energy-conversion technology
- Overview on green waste in Germany, key stakeholders of the energetic use
- Importance of logistic for the use of green residues
- Determining the potential of the green residues for the energy utilisation (yield of methane)
- Tool for modelling CO2 emissions
- Case scenario for Marburg-Biedenkopf: coal vs. grass plant
- Transferability of the concept to Jamaican context

**Related**

- [Thesis](#)
- [Presentation](#)
Recovery of prunings in vineyards and orchards for the production of energy
Recupero delle potature di vigneti e frutteti finalizzato alla valorizzazione energetica
Chamber of Commerce of Padova, in cooperation with CNR-Ivalsa, Confagricoltura, Coldiretti, CIA 2012, own publication

Summary
The publication presents the results of a project, which aimed to test new rational solutions that would allow market actors to have economic benefit from the use of LCMW biomass from pruning in vineyards and orchards in the Padua area. The test was conducted through the creation of collection / treatment sites in the hills and plains, aimed at studying and testing functional technologies able to overrun the challenges related to collection and logistics.

Objectives:
• Define the productivity of the machines and the cost of recovery of the residual biomass, according to various length of the rows, extraction distance, yield of the pitch and type of collection;
• Identify the elements of optimization to reduce the cost of pruning collection;
• Identify the quality of wood chips obtained (size, water content and energy content).

Key messages and data for greenGain
Given that the biomass boilers are three time as expensive as a natural gas boiler, the cost of primary energy provided by chipped trenches in an optimized system is the cheapest possible: 27 €/MWh against 70 €/MWh for natural gas and 108 €/MWh for heating oil/diesel.

Related
www.aiel.cia.it/pubblicazioni.html
### Mobilisation and economical utilization of raw wood from forests and landscape for energy production

**Mobilisierung und wirtschaftliche Nutzung von Rohholz aus Wald und Landschaft zur Energieerzeugung**

**Tobias Cremer**

04/2007, **DBU** (Deutsche Bundesstiftung Umwelt)

**Summary**

The aim of this project was to develop and implement optimised mobilisation, supply and logistic concepts for energy wood from forests and LCMW biomass for a concrete region. Existing and innovative technologies and organisational approaches for the supply of energy wood were further developed and combined. During this process, all affected regional actors were involved.

**Key messages and data for greenGain**

- It is advisable to follow the norm QM (Qualitätsmanagement-Holzheizwerk) more often to secure a binding and objective base for the supply of wood chips.
- Chipping and transport of wood chips is mainly done by independent companies.
- The analysis of the wood chips quality for forest wood (42 %) and LCMW wood (45 %) showed similar results as other studies.
- LCMW wood chips have an average heating value of 19,1 MJ/kg and with that do not significantly differ from wood chips from forest biomass.
- A new approach for the assessment of the potential of LCMW biomass for energetic use was developed based on areal photos and terrestrial measures.
- The supply chain of energy wood from forest was optimized.
- Innovative harvest techniques and optimized chipping procedures were tested.
- Publicity work and presentations were held.

**Related Information**

[See the Database of Projects for other DBU projects!](#)

### Diffusion of bioenergy in urban areas: socio-economic analysis of the planned Swiss wood-fired cogeneration plant in Basel

**Madlener, R., Vögtl, S.**

2006; **CEPE Working Paper**

**Summary**

The municipal utilities of Basel (IWB) are in the process of building a 30 MW wood-fired CHP plant in the city of Basel, a project idea that was initially propelled by visionaries from the forest sector. The plant is attractive both politically and from a business perspective, as several goals related to the increased use of renewable energy can be achieved simultaneously. Moreover, significant woody biomass resources are awaiting further exploitation in the Basel region, which could help to improve markedly the cost effectiveness of forest maintenance. In this paper we study the history and some of the characteristics of the planned project from a socio-economic perspective.

**Related**

[See the Best Practice database!](#)

### The energy transition at the cemetery - production and use of renewable energies in cemetery open spaces

**Die Energiewende auf dem Friedhof - Erzeugung und Nutzung regenerativer Energien auf Friedhofsfreiflächen**

greenGain: D4.1 | 127
Andreas Morgenroth
07/2006

Summary
Landscape architect Andreas Morgenroth describes the benefits and shows how to use renewable energy in cemeteries. He constitutes the framework of the energy transition and explains sustainability aspects of cemetery management, taking into account the special cemetery cultural concerns. On German cemeteries approximately 15,000 hectares are no longer needed for burials. The trend is towards small urn graves. Morgenroth explains several options of production and use of renewable energies and describes cemetery open spaces as predestined.

Due to increasing maintenance costs, there is a considerable need to develop options for this unused land. In this respect, regenerative energy production on unused cemetery land serves the open space protection and thus protects against construction land designation.

If renewable energy resources of a cemetery are used optimally, in many cases a feeding into a district heating network could be possible in addition to the extensive internal supply. The savings of fossil fuels are described as significant.

Key messages and data for greenGain
Potential of landscape material from cemeteries for incineration and digestion
Related
Report
Article

Framework for energetic utilization of biomass from landscape management in Saxony - Final Report
Rahmenkonzept zur energetischen Verwertung von Biomasse aus der Landschaftspflege im Freistaat Sachsen – Abschlussbericht
Dr. Jan Stegner
11/2010
Sächsischen Staatsministeriums für Umwelt und Landwirtschaft

Summary
Following topics are assessed:
- Political and legal framework for energy recovery from biomass from landscape management
- Volume of landscaping material in Saxony
- Determination of energetic utilization demand for biomass from landscape management
- Technical solutions for utilizing biomass from landscape management
- Analysis and presentation of technological deficiencies and uncertainties
- exploitation potential
- Regionalized analysis of acceptance for plant operators and farms with regard to their willingness to energetic utilization of biomass from landscape management
- Suitable recycling methods and technologies for the energy use of landscaping material

Under the current technical and technological and politico-economic conditions, the energetic use of landscape material via biogas and combustion in small and medium combustion plants or large combustion plants are appropriate ways. Both pathways require further procedural and logistical improvement.

The energetic use of landscape material is currently in Saxony barely realized. Especially in biogas plants, energy use with small technical changes would be possible. However, the political and economic conditions contradict such use.
Key messages and data for greenGain
Pathways require further procedural and logistical improvement
The political and economic conditions contradict the utilization of this biomass type
Related
Report

Preparation of a biomass potential map

Müller, S., Steensen, T., Büscher, O., Jandewerth, M.
2014; Proceedings of the 28th EnvirolInfo Conference, Oldenburg, Germany

Summary
Normally, there are no reliable data sources that give information about the objects of interest like hedges and vegetation along streets, railways, rivers and field margins. There is a great demand for an inventory of these biomass sources which could be answered by applying remote sensing technology. To generate that kind of spatial information, satellite imagery is used in combination with area-wide available GIS and elevation data.

Establishing an example of a regional energy cycle with biomass from LCMW in the natural park Unteres Saaletal with special consideration of a GIS- assessment on the long-term availability of the biomass potential

Etablierung eines beispielhaften regionalen Energiekreislaufs mit Biomasse aus der Landschaftspflege im Naturpark Unteres Saaletal unter besonderer Berücksichtigung einer GIS-gestützten Abschätzung des langfristig zur Verfügung stehenden Biomassepotenzials
Prof. Dr. habil S. Tischew, Prof. Dr. P. Heck
2013; DBU (Deutsche Bundesstiftung Umwelt)

Summary
1) Analyse status quo - classification of the research area with areal photos and existing data to select LCMW areas
2) Determination and definition of use- and maintenance- categories based on aims of nature protection
3) Establish 18 test areas to verify height classes, perform a biomass collection (harvest) and record data on vegetation and habitat.
4) Develop a procedure based on GIS to assess the biomass potential
5) Selection of several representative forest stands and record of random samples to derive forest stand types
6) Calculation of the biomass stock of the selected stands and calculation of the wood stock of the single stand types
7) Derive the actual useable biomass potential of all LCMW areas
8) Develop a regional concept for the use of wood from LCMW for a heating site in the primary school Wettin and make a cost calculation for the heating system

Key messages and data for greenGain
Method for a comprehensive determination of the available standing woody biomass potential from LCMW
Related
Information
See the Database of Projects for other DBU projects!
# Wood characterization for energy application proceeding from pruning Morus alba L., Platanus hispanica Münchh. and Sophora japonica L. in urban areas

2014; Renewable Energy

## Summary
Pruning urban forests generates significant amounts of lignocellulosic biomass every year. The energy potential of this biomass is unclear. The aim of this research was direct analysis of the gross calorific value (GCV), elemental composition and moisture content of Morus alba L., Platanus hispanica Münchh. and Sophora japonica L. by means of laboratory equipment.

### Key messages and data for greenGain
The gross calorific value and other analysis proved these residues to be an interesting source of bioenergy.
### Energy wood potentials outside of the forest in Switzerland

**Energieholzpotenziale außerhalb des Waldes**

Bundesamt für Umwelt (BAFU) & Bundesamt für Energie (BFE)

2009, Ernst Basler + Partner AG

**Summary**

This study assesses the potential amount of meadow wood (= wood growing on areas outside of forests) in Switzerland, how it is currently used and what gains and costs occur. The authors defined five sources for meadow wood (along roads, along rivers and lakes, urban green, hedgerows and agricultural areas). They used a GIS-model and conducted expert interviews for the data collection. The study showed that on 10% of Switzerland’s area meadow wood is growing (400,000 ha) and that 420,000 t TS per year can be sustainably used. Over 80% of the meadow wood is on urban or agricultural are and mostly in the region of the Swiss midland. Of today’s use only 54% are used for energetic purposes, 39% are left on the site and 7% is used for material production. The profits and costs differ strongly between the regions. In some regions, the same material is sold and in others, disposal charges have to be paid.

**Key messages and data for greenGain**

Broad overview of the situation of LCMW biomass in Switzerland

---

### The effect of the surrounding conditions in the assessment of biomass: case study of agricultural residual biomass in Teruel province (Spain)

D. García, J. Pascual, A. García, J. Asín

Paper presented to the 15th European Biomass Conference & Exhibition, 7-11 May 2007, Berlin, Germany

CIRCE Foundation - Centre of Research for Energy Resources and Consumption

**Summary**

The best location for the sitting of a biomass plant inside a territory requires as input data the energy potentials of the territory. Up to date the area outside the territory under assessment has not been considered, and the territory was studied as an island. The paper summarizes the results of using different spatial resolution degrees for the area surrounding the Spanish Teruel province (NUTS 3). Residual biomass from woody crops pruning has been estimated inside the province of Teruel using the geographical resolution of the Corine Land Cover. The resources evaluation for the area surrounding Teruel province (50 km in straight line) has been carried out at four levels of spatial resolution: no biomass in the surroundings, biomass per province (NUTS3), biomass per municipalities (NUTS5), and biomass assigned to the Corine Land Cover land use characterisation. The sum of the potential biomass in a 50 km-radius circle has been calculated for every point inside the province of Teruel per resolution scale. A comparison among the cases has been carried out by qualitative and quantitative observations. The results have shown the essentiality of the surrounding areas when searching for the maximum potentials in a territory. The use of spatially vast information (NUTS 3) generates a distortion in the geographical potentials and may lead to excessively large errors. For the analysed zone, it has been proved that municipality resolution (NUTS5) is accurate enough as surrounding area.

**Related**

The Author is one of the greenGain project partners (Daniel García, CIRCE).
Determination of the real potential of greenhouse emissions reduction in Spain by means of the cofiring implementation (Ene2005-00304/Alt Project): methodology for the biomass potential of cofiring

D. García, M. Gómez, A. García, F.J. Royo
Paper presented to the 16th European biomass conference. 2 – 6 June 2008, Valencia, Spain
CIRCE Foundation - Centre of Research for Energy Resources and Consumption. Natural Resources Division

Summary
The reduction of greenhouse gas (GHG) emissions is a relevant part in many of the current energy and environment policies in most of the European countries. Diverse alternatives are being used by the governments and the private companies to palliate the emissions and the costs derived from the emissions trade system; one of these possibilities for the CO2 emission remediation is the replacement of solid fossil fuels by biomass (co-firing) in different sectors. In Spain the consumption of fossil fuels account for more than 124 Mtep, from which solid fossil fuels represent 20 % of the share in the primary energy. The main solid fuel consuming sectors are the power generation sector (more than 82 %) and cement industry (more than 7 %). The equivalent CO2emissions of those solid fuel intensive consuming sectors account for more than 20 % of the gross CO2 equivalent emissions, similar to other important sectors like the transport. Therefore the co-firing technology arises as a promising mean to reduce the emissions from solid fossil fuels. The current paper presents the project ENE2005-00304/ALT (founded by the Spanish Ministry of Science and Education). The main objective is the assessment of the potential of co-firing in Spain and the development of a methodology based on the Life Cycle Analysis (LCA), allowing a precise knowledge about the multiplier effect, in terms of GHG emissions reduction, associated with this technology and the related economic benefits.

Related
The Authors are one of the greenGain project partners (Daniel García, Maider Gómez; CIRCE).

Using remote sensing to estimate a renewable resource: forest residual biomass

A. García-Martín, J. de la Riva, F. Pérez-Cabello and R. Montorio

Summary
The objective of this chapter is to explain a methodology developed to estimate the amount of FRB potentially suitable for renewable energy production in the pine forests of Mediterranean areas at regional scale, using satellite images and forest inventory data. It is intended, therefore, to eliminate a major barrier to the use of this renewable source of energy. In turn, by using a plain methodology, it is intended that the method developed can be adopted by decision makers and land managers for both forest management and regional planning, considering that energy planning is a major component of land management.

Related
Available here

11.1.2. Media Articles

greenGain: D4.1 | 132
Babcock & Wilcox Vølund lands order on second generation multi-fuel plant. New multi-fuel fired CHP plant in Landskrona

WMW (Waste Management World)

Multi-fuel fired plant.

The new facility in Landskrona, Sweden is part of a new generation of plants capable of burning a wide range of biomass and sorted waste fuels. Multi-fuel fired combined heat and power plants will cover the future need for advanced technology to exploiting all resources. New fuels, ranging from sorted industrial waste to wood chips, will contribute towards meeting the EU requirements for a reduction in the emission of greenhouse gases.

Available here

Barcelona website

Green spaces are in Barcelona of a big importance. In their website, a lot of information about it can be found. Regarding the use of natural resources, maintenance of the parks and gardens generates a biomass that is recycled by turning it into compost, an organic fertilizer for the green spaces in Barcelona.

Link

Brochure Street tree management in Barcelona
## Biomass logistic centers in Ourense, Galicia

The network of biomass treatment centres (CTB) distributed along Ourense (Spain) allows the use of biomass from roadside cleaning and forest for energy purposes. The Provincial Council of Ourense has converted the existing problem regarding the residues accumulation and fire risk related to roadside biomass and forest areas in an opportunity to increase the life quality of the local habitants through the biomass potential use for energy which is strategically distributed among the 3 biomass logistic centres.

Available here

## Enel Energia begins work on first mini-biomass plant

**Biomass magazine** (2015)

Enel Energia has begun construction of an innovative combined-cooling,-heat-and-power (CCHP) mini-biomass plant (capacity of 199 kWe) at the historic Luxottica factory in Agordo, in the Veneto region’s Belluno province of Italy. The plant will be fuelled with solid biomass from the local area, such as woodchips, clippings and pruning by-products.

Available here

See the Database of Projects for more! (Bioenergy-Regions)

## Energy Transition - Do it yourself

**/Energiewende selber Machen**

The German regions Teltow, Kleinmachnow and Stahnsdorf lack sufficient biomass for a biomass facility. But now there is the idea of using leaf-fall for energy production. The local citizens should take part on this project.

Available here

## Recycling and biomass plant to use biomass from roadside cleaning

**/Sugieren una planta de reciclaje y aprovechamiento de biomasa para residuos de cunetas**

La Voz de Galicia.es (2007)

Pontevedra could carry out a project to use biomass from roadsides for energy purposes if the initiative proposed by the Workers' Commissions succeed. The trade Union asked the Council, to which are attributable 2,200 km of roads, to launch the initiative.

The plant would produce energy and fertilizers or both at the same time. It would also treat the biomass residues from different centres and farms of the provincial agency. Additionally it would process the residues from the forest cleaning, agriculture and vineyards.

The residues from the roadside cleaning are many times abandoned in site and therefore become a dangerous fuel in case a fire starts.

Available here

## The majority of the forest fires could be avoided through a plan to clean the forests

**/La mayor parte de los incendios serían evitables mediante un plan para la limpieza de las masas**
The withdrawal of forest biomass surplus allows to decrease the forest fires occurrence 70%, and in case of fire, and in case of occurrence, allows a faster and most efficient extinction and also a better forest recovery.

The forests cleaning are an important source of employment and renewable energy. [Available here](#)

**Urban Tree Utilization and Why It Matters**

**Alliance for Community Trees (2008)**

Comprehensive article about the problematic of treatment of urban wood in the USA. [Available here](#)

### 11.2. Relevant European Actors, Institutions, Events

#### 11.2.1. Actors and Institutions

For more see the Interview section.

<table>
<thead>
<tr>
<th><strong>EUBIA (European Biomass Industry Association)</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Position/Field of activity</strong></td>
<td>EUBIA’s main objective is to support the European biomass industries at all levels, promoting the use of biomass as an energy source, developing innovative bioenergy concepts and fostering international co-operation within the bioenergy field. EUBIA also promotes bioenergy activities at small, medium and large scale in collaboration with local and national authorities, biomass providers, industries, research centres and local partners. In particular, EUBIA contributes in identifying and promoting modern concepts, commercial technologies and biomass resources able to penetrate energy industrial markets.</td>
</tr>
<tr>
<td><strong>Contact information</strong></td>
<td>Websites</td>
</tr>
<tr>
<td><strong>Related</strong></td>
<td>EUBIA is frequently a partner in international projects on bioenergy co-financed by the European Commission. EUBIA is currently participating as a partner organisation in ten internationally funded projects, and we are the coordinator of the NEWAPP project. <a href="#">Link</a></td>
</tr>
</tbody>
</table>
| Dr.-Ing. Marc Schneider | Fraunhofer-Institute for Material Flow and Logistics  
Germany; Dortmund |
|------------------------|--------------------------------------------------|
| **Position/Field of activity** | Head of Department Environment and resource logistics  
Sectors of the department: Environment and resources, Waste and recycling management, Construction site logistics, Cross cutting themes (e.g. process optimization) |
| **Contact information** | marc.schneider@iml.fraunhofer.de |
| **Related** | BioLogio project  
Green Logistic project |

| Dipl.-Ing. Carsten Keichel | Fraunhofer Institute for Material Flow and Logistics  
Germany; Dortmund |
|---------------------------|--------------------------------------------------|
| **Position/Field of activity** | Branch office **ER-WIN®** (Energy and resource-efficient value chains)  
Contact person for project Energy Efficient City Magdeburg |
| **Contact information** | carsten.keichel@iff.fraunhofer.de |
| **Related** | Website of the project  
**Presentation**: Regional biomass for heat and electricity supply in urban areas  
Dr.-Ing. Matthias Gohla:  
Business manager of Process and Installation engineering  
matthias.gohla@iff.fraunhofer.de |

| Dr. Wolfgang Peters | Bosch & partner  
Germany; Berlin |
<table>
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<tbody>
<tr>
<td><strong>Position/Field of activity</strong></td>
<td>Diplom Ingenieur in Landscape Planning, Managing Partner and Office manager Berlin, Contact person of the renewable energy section</td>
</tr>
<tr>
<td><strong>Contact information</strong></td>
<td><a href="mailto:w.peters@boschpartner.de">w.peters@boschpartner.de</a></td>
</tr>
</tbody>
</table>
| **Related** | **Presentation** from symposium “Biogas from landscape maintenance material, residues and biodiversity material”; Supporting the energy use of residual and landscaping materials through regional energy concepts - example of regional energy and climate protection concept of Oberlausitz – Niederschlesien (estimation of LCMW feedstock potential, performing interviews, concepts for mobilization of the resources)  
**Article in the Brochure**: “Bioenergy and Nature conservation”: Energy utilization of landscape conservation feedstock  
Projects concerning LCMW feedstock energy use (in German only):  
**LCMW material in Brandenburg** – estimation of the potential and possibilities of energy recovery  
**Bioenergy from landscape conservation** - documenting best practice examples; within the MULLE project |
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Position/Field of activity</th>
<th>Contact Information</th>
<th>Related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diana Pfeiffer</td>
<td>DBFZ Deutsches Biomasseforschungszentrum (German Biomass Research Centre)</td>
<td>Project coordinator of the Biomass energy use programme</td>
<td><a href="mailto:Diana.Pfeiffer@dbfz.de">Diana.Pfeiffer@dbfz.de</a></td>
<td>Biomass energy use programme</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>Presentation from conference “Energy use of biomass from landscape conservation and maintenance work” 2011, Berlin (German)</td>
</tr>
<tr>
<td>Sven Schicketanz</td>
<td>Bosch &amp; partner</td>
<td>Diplom Ingenieur in Landscape Planning, Renewable energy section</td>
<td><a href="mailto:s.schicketanz@boschpartner.de">s.schicketanz@boschpartner.de</a></td>
<td>Involved in project Havelland – concepts for LCMW feedstock utilization (within “Biomass energy use”)</td>
</tr>
<tr>
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<td>Videospot on the Biogas channel about LCMW</td>
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<td>Presentation on LCMW feedstock utilisation from Conference of the European Biogas Association in 2014</td>
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<td>Projects concerning LCMW feedstock energy use (in German only): LCMW material in Brandenburg – estimation of the potential and possibilities of energy recovery</td>
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<td></td>
<td></td>
<td>Bioenergy from landscape conservation - documenting best practice examples; within the MULLE project</td>
</tr>
<tr>
<td>Dr. Frank Hensgen</td>
<td>Universität Kassel, Department of Grassland Science and Renewable Plant Resources</td>
<td>Research Assistant at Department of Grassland Science and Renewable Resources</td>
<td><a href="mailto:hensgen@uni-kassel.de">hensgen@uni-kassel.de</a></td>
<td>Ph.D. Thesis: &quot;Examining European semi-natural grassland silages and urban green cut as input sources for the integrated generation of solid fuel and biogas from biomass.&quot;</td>
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<td>Education and Publications</td>
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<td></td>
<td></td>
<td>Universität Kassel: IFBB technology (integrated generation of solid fuel and biogas from biomass)</td>
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<td>Poster about IFBB</td>
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<td>Project COMBINE and Prograss® approach, Best life environment projects 2013</td>
</tr>
<tr>
<td>Iris Feldmann</td>
<td>Bioenergie-Region Ludwigsfelde Plus+</td>
<td>Germany; Ludwigsfelde</td>
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<tr>
<td><strong>Position/Field of activity</strong></td>
<td>Project manager of the Bioenergie-Region Ludwigsfelde Plus+</td>
<td></td>
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</tr>
<tr>
<td><strong>Contact information</strong></td>
<td><a href="mailto:i.feldmann@bioenergie-region-ludwigsfelde.de">i.feldmann@bioenergie-region-ludwigsfelde.de</a></td>
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<tr>
<td><strong>Related</strong></td>
<td><a href="#">Project websites</a></td>
<td><a href="#">Article</a> in Potsdamer Tagesspiegel</td>
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</table>

| GALK - Deutschen Gartenamtsleiterkonferenz - GALK e.V. (German Garden Department Conference) | Germany |
| **Position/Field of activity** | GALK eV. is an association for the promotion of the public green of cities, mainly pursues social, ecological and economic concerns in the spirit of sustainable urban development and the Agenda 21 of Rio de Janeiro. Ground topics: City trees, Playgrounds, Green Areas Construction & Maintenance, Computerized systems |                         |
| **Contact information** | redaktion@galk.de | [www.gakl.de](#) |
| **Related** | List of German road side trees & further publications |                         |

| C.A.R.M.E.N. (Centrales Agrar-Rohstoff Marketing- und Energie-Netzwerk e.v) | Germany, Bavaria |
| **Position/Field of activity** | Public relations, consulting, project assessment, communication between science and practice, collect and evaluate market data. Material- and energetic-use of biomass, other renewable energies, efficiency and energy saving. It is an association with 70 members of all parts of the production chain of renewable resources. |                         |
| **Contact information** | Websites |                         |
| **Related** | One of three pillars of the competence centre for renewable resources ([Kopetenzzentrum für Nachwachsende Rohstoffe](#)) |                         |

| 3N competence centre Lower Saxony network renewable resources (Kompetenzzentrum Niedersachsen, Netzwerk Nachwachsende Rohstoffe) | Germany; Lower Saxony |
| **Position/Field of activity** | Support development and use of marketable products, production methods and services; support cooperation between economy and scientific institutions, represent interest of Lower Saxony on national and international level; engage in regional, national and european projects and initiatives; inform along the production chain of renewable ressources and bionenergy |                         |
| **Contact information** | Websites |                         |
| **Related** | Part of the INTERREG project |                         |
| **Position/Field of activity** | The KWF is the competence centre for forestry work, forestry technology and wood logistics in Germany and Europe and provides advice to all key players in the forestry, wood and bio-energy sectors. It is available as an interlocutor to everybody.  

The KWF is the only organization that examines and certifies forestry technology, tools, supplies and protection equipment at the national and transnational level.  

The KWF conference is the second-largest forestry fair worldwide and includes a congress, specialist excursions and a forestry machinery and novelty show. In addition, the KWF organizes special shows on the subject of forest and wood, e.g. also at INTERFORST.  

At its headquarters in Groß-Umstadt, the KWF organizes specialist forums, seminars, workshops and expert talks on current topics related to forest practice. |
<p>| <strong>Contact information</strong> | <strong>Websites</strong> |
| <strong>Related</strong> | Part of the project Bioenergy Promotion (as well as one of the greenGain model regions county Rotenburg (Wümme)) |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Position/Field of activity</th>
<th>Contact information</th>
<th>Related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magdalena Sajdak</td>
<td>Wood Technology Institute, Poland; Poznan</td>
<td>Assistant Professor, Renewable Energies – Biomass Environmental Protection and Wood Chemistry Department</td>
<td><a href="mailto:m_sajdak@itd.poznan.pl">m_sajdak@itd.poznan.pl</a></td>
<td>Graduated at Universidad Politécnica de Valencia with the Ph.D. thesis on Indirect methods for residual biomass measurement coming from pruning operations of urban forests; Number of scholarly articles regarding biomass pruning under Universidad Politécnica de Valencia. LiDAR technology, aboveground biomass determination by means of allometric equations, bioenergy, solid biofuels, environmental protection.</td>
</tr>
<tr>
<td>Borja Velazquez-Marti</td>
<td>Universidad Politécnica de Valencia, Spain; Valencia</td>
<td>Department of Rural and Agrifood Engineering; Number of publications on urban biomass pruning, methods for estimation of pruned biomass</td>
<td><a href="mailto:borvemar@dmta.upv.es">borvemar@dmta.upv.es</a></td>
<td>Projects: PellCert – ENPlus; BIOMASUD</td>
</tr>
<tr>
<td></td>
<td>BIOPLAT (Spanish Biomass technology Platform)</td>
<td>Spain</td>
<td>Websites</td>
<td>Framework for all actors involved in the development of biomass technologies. The Spanish Biomass Technology Platform –BIOPLAT– is supervised by a Steering Group. The activities are carried out by the members of Eight Working Groups. Currently, 314 entities are joining BIOPLAT currently: BIOPLAT also participates in the European bioenergy technology platforms that mirror the Spanish one, namely the European Biofuels Technology Platform (EBTP) and the European Technology Platform on Renewable Heating and Cooling (RHC-Platform).</td>
</tr>
<tr>
<td></td>
<td>AVEBIOM (Spanish Biomass Association)</td>
<td>Spain</td>
<td>Websites</td>
<td>Promoting the development of the bioenergy sector in Spain.</td>
</tr>
</tbody>
</table>

Related Projects:
- BIOmasud, PellCert, Biomass Trade Centre II, Bioenergy & Fire Prevention;
- Publications

Contact information
- Websites
| **Position/Field of activity** | CTAER’s main objective is to contribute to a greater use of renewable energy through research, technology development, transfer, innovation, dissemination and training, in proper and others projects, promoting the improvement of the competitiveness of the enterprises and the social and environmental benefits associated with the use of these energy sources. 

Regarding biomass, CTAER has set up in Mengibar (Jaen) a laboratory and a test bench for biomass boilers, which are already a national reference for companies specialising in the exploitation of energy from the different forms of biomass. 

CTAER carries out both its own and collaborative research and technological development projects, either subcontracted or directly ordered by the developers. |
| **Contact information** | info@ctaer.com |
| **Related** | Projects under execution: LIFE SOSTRICE, LIFE BIOSEVILLE, Hibridación solar-biomasa, Desarrollo multifuncional de la máquina de recogida sat-4, Cenit Biosos "Biorrefinería sostenible" II, Bio-AndaluS |

[Scientific articles]
<table>
<thead>
<tr>
<th>CIEMAT (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas)</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position/Field of activity</strong></td>
<td>Public research body assigned to the Ministry of Economy and Competitiveness under the Secretariat of State for Research, Development and Innovation, focusing on energy and environment and the technologies related to them. It has offices in several different regions of Spain, and its activity is structured around projects, which form a bridge between R&amp;I and social interest goals.</td>
</tr>
<tr>
<td><strong>Contact information</strong></td>
<td><a href="mailto:contacto@ciemat.es">contacto@ciemat.es</a></td>
</tr>
<tr>
<td><strong>Related</strong></td>
<td>Projects, Publications</td>
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<table>
<thead>
<tr>
<th>Centre for the Development of Renewable Energy Sources (CEDER)</th>
<th>Spain</th>
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<tbody>
<tr>
<td><strong>Position/Field of activity</strong></td>
<td>Belonging to the CIEMAT (Research Centre for Energy, Environment and Technology) and attached to the Department of Energy of this Public Research Organisation. CEDER is considered a pioneer centre in Spain for the energetic use of biomass, as well as being a national and European reference in small wind energy. The Biomass Unit of the CIEMAT carries out applied research activities in energy/energetic crops, evaluation of resources, supply logistics and storage, as well as in biomass preparation and conditioning in the CEDER.</td>
</tr>
<tr>
<td><strong>Contact information</strong></td>
<td>Websites</td>
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<tr>
<td><strong>Related</strong></td>
<td>Projects, Publications</td>
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<table>
<thead>
<tr>
<th>Spanish Forestry Association (PROFOR)</th>
<th>Spain</th>
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<tr>
<td><strong>Position/Field of activity</strong></td>
<td>Association which gathers citizens interested in the forest role and functions and demanding a regional management to promote its restauration and valorization.</td>
</tr>
<tr>
<td><strong>Contact information</strong></td>
<td><a href="mailto:comunicacion@profor.org">comunicacion@profor.org</a></td>
</tr>
<tr>
<td><strong>Related</strong></td>
<td>Projects, Publications</td>
</tr>
</tbody>
</table>
| **Position/Field of activity** | **Agresta Cooperative Society**  
Spain | Environmental consultants specialized in the forestry sector, environmental engineering and environmental impact assessment.  
**Contact information** | Websites |
| --- | --- | --- | --- |
| **Position/Field of activity** | **TRAGSA**  
Spain | Performs rural development works and services, environmental conservation and emergency relief operations. Its 37 years of experience working for the public authorities to the service. It operates, from the provision of agricultural, forestry, livestock, and rural development services, to the conservation and protection of the environment.  
**Contact information** | Websites |
| **Related** | The Tragsa Group forms part of the group of companies of the State-owned holding company Sociedad Estatal de Participaciones Industriales (SEPI).  
**Projects**  
**Publications** |
| **Position/Field of activity** | **ASEMFO (National Association of Private Forest Companies)**  
Spain | ASEMFO is a national non-profit association of private forestry companies. It represents and defends the interests of the private forestry sector and coordinates relations between our members and public service organizations. The association represents 85% of the forest private companies and contractors in Spain. These companies aim to protect, preserve and improve the natural environment.  
**Contact information** | asemfo@asemfo.org |
**Aranzada Gestion Forestal, S.L.P.**
Spain

**Position/Field of activity**
SME is specialized in forest planning, including technical plans, management plans and territorial planning of forests managed by the local and central administration. Its activity has been focused in three main issues:

- forest management planning in public and private forests
- development of forest biomass exploitation projects
- development of computer tools for assessment

Social involvement of ARANZADA GF is expressed through research and spreading activities in agricultural issues, with a special emphasis in forestry.

**Contact information**
info@aranzadagf.com

**Related**
Since 2007 ARANZADA has been involved in 26 projects concerning forest planning, 5 projects to assess the potentiality of forest biomass, 3 projects related to the development of computing tools for forest management and 5 training courses for forest managers from local administrations.

---

**Forest Sciences Centre of Catalonia (CTFC)**
Spain

**Position/Field of activity**
Contribute to the modernisation and competitiveness of the forest sector, to rural development and to the sustainable management of natural habitats.

**Contact information**
Websites

**Related**
Publications
Projects: INFORMED, NEWFORESTS, MedPINES
<table>
<thead>
<tr>
<th>Position/Field of activity</th>
<th>Description</th>
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<tbody>
<tr>
<td>• Representation of industry interests among institutions European, national and local to promote laws aiming at the growth of the market.</td>
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<tr>
<td>• Participation on the annual assembly and the possibility to become a member of one of the 6 interest groups: domestic appliances, boilers, biomass producers, installers, ENplus pellet, engineers</td>
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<tr>
<td>• Advisory council on feasibility studies, drafting contracts, trade, biomass production, new technologies, emissions, etc.</td>
<td></td>
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<tr>
<td>• Weekly newsletter reporting on legislation, events, fairs and training courses</td>
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<tr>
<td>• Four issues per year of «Agriforenergy», the official magazine published by AIEL</td>
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<tr>
<td>• Free tickets to visit the most important biomass fairs, which AIEL is technical partner of</td>
<td></td>
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<tr>
<td>• Discount to have lab qualitative analysis of your biomass</td>
<td></td>
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</tbody>
</table>

**Contact information**  
secreteria.aiel@cia.it

**Related**  
Information and technical material available at:  
www.aiel.cia.it
CRB – Centro di Ricerca sulle Biomasse
Italy, Legnaro (Padova)

**Position/Field of activity**
CRB - Biomass Research Centre is a research centre sponsored by the Italian Ministry of Environment and Territory at the University of Perugia. CRB is the Italian reference centre for research on biofuels and biomass for energy.

- Promoting certification of biofuel and bioenergy as well as energy and environmental labelling of products and processes related to biomass energy production
- Acting as a support for energy/environment regulatory bodies in order to determine facilitations, permit procedures, law constraints, grants
- Promoting training in the field of biomass energetic use
- Promoting dissemination of information on the environmental benefits of bioenergy

Legislation gives the CRB a key role in the certification of biomass energy chains. It defines the Biomass Research Centre near the University of Perugia as the subject which the Network administrator (ex-GRTN today GSE) can avail\(^{23}\) in order to make the verifications needed for the green certificates and guarantee of origin acquisition for the production of electricity from biomass plants, including hybrid plants\(^{24}\).

The Centre aims at developing and organising national and local initiatives on the use of biomass for energy purposes. The Centre promotes research to optimise biomass production, processing and energy conversion in terms of efficiency, profitability and environment. Their activities are focused on the main production chains to energy from agriculture, forestry and industry and developing best practice guidelines.

CRB is the official reference centre on the national level for bioenergy research with the goal of highlighting and promoting Italian activities in this industry. CRB has at its disposal the professors, researcher and PhD students from Department of Industrial Engineering of the University of Perugia.

**Contact information**
segreteria@crbnet.it

\(^{23}\) Article 11, paragraph 6 of DM 24.10.2005 - OJ No 265 of 14.11.2005

\(^{24}\) Article 6 paragraph 3 DM 24.10.2005 - OJ No 265 of 14.11.2005
<table>
<thead>
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<th>Position/Field of activity</th>
<th>Body of the regional system in Lombardy which:</th>
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<tbody>
<tr>
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<td>• Supports the Regional Council in realizing the government objectives which can be found in the Regional Development Programme according to a cross-cutting, multifunctional and integrated approach</td>
</tr>
<tr>
<td></td>
<td>• Provides technical and certified services to the agriculture and forestry sector, either public or private, and supports the Regional General Direction of Agriculture in the operational activities</td>
</tr>
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<thead>
<tr>
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<th><a href="mailto:info@ersaf.lombardia.it">info@ersaf.lombardia.it</a></th>
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<td><a href="http://www.aiel.cia.it">www.aiel.cia.it</a></td>
</tr>
<tr>
<td>Position/Field of activity</td>
<td>ENAMA is recognised in accordance with the provisions of Italian Presidential Decree 361/2000 as a body established to offer the agromechanical industry in Italy effective support in order to improve competitiveness, enhance technology and raise awareness of the performance and safety features of the machinery amongst those operating in the industry. To guarantee impartiality and to implement a policy of agreement through consultation in the farming industry, the following bodies all form part of ENAMA: the Italian Ministry of Agriculture and Forestry, the Italian Regional Authorities, Assocap, Cia, Coldiretti, Confagricoltura, Unacma, Unacoma and Unima. The operational structure is constituted by CRA-ING, the Council for Research and Development in Agriculture and the Institute for Experimental Research into Agricultural Mechanisation. ENAMA’s personnel has the necessary expertise to tackle all of the various problems faced by the industry day in, day out, such as the complex regulations on performance, safety, environmental protection (UNI, EN, ISO, OCSE, etc.) and road traffic regulations for agricultural machinery, certification, new technologies and alternative fuels. Specialized centres within the operational facilities offer the opportunity to conduct internationally recognized tests and checks of all types on everything from tractors to farm implements and components, and can even provide details of other important facilities overseas that are associated with ENAMA.</td>
</tr>
<tr>
<td>Contact information</td>
<td>ENAMA office in Legnaro c/o Tesaf Department: Viale dell'Università 16 - 35020 Agripolis Legnaro (Padova) <a href="mailto:info@enama.it">info@enama.it</a></td>
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### 11.2.2. Events, others

**Conference**

**Energy use of biomass from landscape conservation and maintenance work**

/ Energetische Nutzung von Landschaftspflegematerial

Germany, Berlin (2011)

German Federal Ministry of Economic affairs and Energy and Deutsche Biomasseforschungszentrum

**Description**

Conference addressing political background, offered expert lectures on applied research and practice in six blocks with different thematic focus:

- Area of conflict in municipal waste problematic: LCMW biomass and bio waste
- Energy use of roadside green
- Grass in Biogas plants
- Grassy residues and combustion: Status quo and development
- Potential of the LCMW
- Concepts for special habitats

**Related**

Materials including the presentations: [About the funding program](#)
[Program of the conference; Presentations; Flyer](#)

**Symposium**

"Biogas - but of course!" Symposium on Biogas from landscape management, waste and biodiversity material

/ "Biogas - aber natürlich!" Fachtagung zu Biogas aus Landschaftspflegematerial, Reststoffen und Biodiversitätsmaterial

Germany, Schwäbisch Hall (2014)

DVL - Deutschen Verband für Landschaftspflege (German Association for Landscape Conservation)

**Description**

Symposium for introducing the results of [MULLE project](#) (supported by FNR), where around 80 participants learned about successful examples of mobilization of the energy potential of LCMW biomass, new process concepts, the legal framework and current development.

**Related**

[Article about the symposium](#)
[Flyer with programm](#)
Value chain development

**Activation of the forest-wood-energy supply chain in the environmental center of Prim’Alpe Canzo**

ERSAF

/Attivazione della filiera bosco-legno-energia nel centro ambientale di Prim’Alpe di Canzo di ERSAF

Italy, Lombardy

ERSAF - Ente Regionale per i Servizi all’Agricoltura e alle Foreste

(Lombardy Regional body for Services to Agriculture and Forests)

**Description**

Development of a small supply chain forest-wood-energy in the environmental centre of ERSAF in Prim’Alpe di Canzo due to the availability of large quantities of wooden material obtained from the forest management. The installation of a 110 kW boiler using wood chips was approved, together with a storage system which enables the centre to be autonomous for one to two months.

The fuel comes from silviculture mainly of coniferous forests (fir red, white pine, black pine) and secondly deciduous (broad-leaved tree) in 450 ha. The availability of fuel is much bigger than the potential of the plant, which is demonstrative.

**Related**

[PDF presentation here](#)
11.3. Relevant projects

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Nature Outlook 2010-2040: Regional case study .................................................................... 185
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The overall objective of BioBoost is to pave the way for decentral conversion of residual biomass to high energy density carriers, which can be utilised in large scale applications for the synthesis of transportation fuel and chemicals or directly in small-scale combined heat and power (CHP) plants.

The project concentrates on dry and wet residual biomass and wastes as feedstock for de-central conversion by fast pyrolysis, catalytic pyrolysis and hydrothermal carbonization to the intermediate energy carriers oil, coal or slurry.

Major activities include the analysis of economic efficiency of the complete production pathways, the optimization of logistic chains and the investigation of environmental compatibility.

Feedstock, potential, supply and demand

- Determination of the feedstock potential of agricultural residues, organic wastes and forestry residues in EU27 and Switzerland and calculation of the costs of feedstocks at
field site. Development of a transport and logistic concept for year round feedstock supply to conversion sites.

**Decentralized conversion technologies to an energy carrier**

**Extraction of high-value by-products**

**Transport and logistics**
- Logistic model to optimize biomass and energy carrier transportation regarding distances, costs and CO2 emissions and to identify optimum locations for de-central and central plants.

**Application of energy carrier**
- Testing and classification of the technical and economic utilization paths of energy carriers – biosyncrude, catalytic pyrolysis oil, HTC coal.

**Techno-economic, social and environmental assessment of complete chains**

**Additional**
- Participation of a greenGain project partner (SYNCOM)

*See the Interview with Magdalena Borzęcka-Walker!*
**S2Biom**


**Keywords**: residual biomass, non-agriculture biomass, logistic chain, conversion, modelling tools, regulatory frameworks, sustainable pathways, case study, biomass potential

**Period**: 2013 - 2016

**Area**: EU28 + Western Balkans, Moldova, Turkey, Ukraine

**Partner countries**: DE, UK, NL, AT, FI, IT, BE, PL, HR, TR, FR, ES, SI, GR, UA, RS

**Languages**: EN

**Feedstock**: Lignocellulose biomass from forestry and agriculture

Biomass from road side verges, landscape maintenance

Secondary residues from wood industry (see Appendix 2 of D2.2)

**Useful Materials**

S2Biom Toolset will be made accessible in 2015 (data on biomass cost-supply, conversion technology, full chain assessment)

D 2.2: Selection methods to match biomass types with conversion technologies

D5.1: Methodology for life-cycle based environmental sustainability assessment of non-food biomass value chains

D3.1: Review of the main logistical components

D8.1: Overview report on the current status of biomass for bioenergy, biofuels and biomaterials in Europe

**Approaches**

- Modelling of cost-supply potential on NUTS3 level in EU28 and Albania, Bosnia-Herzegovina, Former Yugoslav Republic of Macedonia, Moldavia, Montenegro, Serbia, Kosovo, Turkey, Ukraine
- Identify conversion pathways
- Creating a computerized tool
- Database for policy instruments and measures and information on relevant regulations in target countries
- Analysis of the extent EU biomass potential and sufficiency to meet the renewable energy targets for 2020 and beyond
- Case studies on three levels – Pre-studies, Advanced case studies (both on EU28 level) and Strategic case studies (in areas with lower biomass supply and logistics development, and relatively poor availability of data)

**Description**

The main aim of this project is to support the sustainable delivery of non-food biomass feedstock at the local, regional and pan European level. It should proceed through developing strategies and roadmaps, that will be informed by a “computerized and easy to use” toolset (and respective databases) with updated harmonized datasets.

A key issue of the S2Biom analysis is to build up a concise knowledge base both for the efficient resource mobilization (sustainability criteria, costs, logistics, availability) and for the assessment of resource efficient biomass value chains (with a set of consistent technical indicators).

**Sustainable biomass cost-supply**: Creating a database on cost-
supply potential; Two levels of sustainability constraints -> two datasets of supply potential; Determination of cost-supply potential per spatial unit at any assumption of price levels (in order to identify the potential current and future sustainable supply of domestic solid biomass)

**Biomass conversion technologies:** Identify and extensively characterise existing and future non-food biomass conversion technologies for energy and bio-based products (thermal conversion, anaerobic digestion, biochemical conversion)

**Sustainable feedstock logistic:** assess new and existing logistic concepts, design the most promising logistic supply-chains for cases at local, regional and pan-European level

**Computerized toolset:** provides overview of data on biomass cost-supply, characteristics of conversion and pre-treatment technologies, biomass hubs and yards and matching biomass to technologies, market demand and policies for biomass for bioenergy and bio-based products

Participation of greenGain project partner (CIRCE, FNR, SYNCOM)
### GR3 – Grass to Green Gas

<table>
<thead>
<tr>
<th>Link</th>
<th><a href="http://grassgreenresource.eu/">http://grassgreenresource.eu/</a></th>
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<tr>
<td>Keywords</td>
<td>residual biomass, non-agricultural biomass, biogas, anaerobic digestion, conversion, economic assessment, best practice, logistic chain, biomass potential, regulatory frameworks</td>
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<td>Period</td>
<td>2013 - 2016</td>
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<td>Partner countries</td>
<td>BE, DE, IT, DK, BE, PT</td>
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<td>Languages</td>
<td>EN</td>
</tr>
<tr>
<td>Feedstock</td>
<td>Grass and herbaceous residues from landscape management</td>
</tr>
</tbody>
</table>
| Approaches | • Determination of biogas potential from grass residues  
• BATs and best practices for grass residue collection and valorisation into biogas  
• Environmental and socio-economic analysis of grass residues-to-biogas chains (LCA, Cost benefits analysis)  
• Legal framework, policy support and development of mechanisms for overcoming nontechnical barriers  
• Business development |
| Useful Results | **State of the art report**: Chapter 4: Mowing and storage of residues from roadsides, watercourses, natural reserves and agricultural grass residues, Chapter 5: Logistic model for grass transport  
**SWOT Analysis for each country**: Determination of non-technical barriers hindering the promotion of grass cuttings in biogas plants  
**Incentives evaluation in each country**: based on grass origin  
**National estimates on grass residue availability**  
**Report on BAT’s and Best practices for grass residue collection and valorisation**  
**Legal assessment for each country** |
| Description | Today maize is the major feedstock for anaerobic digestion but because of the competition between food and energy it is interesting to look for other feedstock. In Europe, a large quantity of grass is produced annually in nature and roadside management. The cutting and removal of these grasses increases the biodiversity but they are considered as waste. Because of certain barriers, the energy potential of grass and other herbaceous residues is highly underutilized across Europe. Barriers are insufficient awareness and acceptance of suitable technologies for the mowing, storage and anaerobic digestion of grass residues, absence or lack of cooperation between stakeholders along the value chain, as well as legal barriers. That is why GR3 promotes the use of these residues from landscape management as a resource for biogas.  

Since the project aims to increase the use of grass and other herbaceous residues from landscape management as a resource for biogas production, the project is divided in three big tasks. First of all, knowledge is gathered for example regarding the biogas yield and grass production. Secondly, the stakeholders producing...
the grass and the digesters will be brought together and will be aided to find economic feasible solutions. Lastly, during the project we will organize workshops and meetings to inform the stakeholders.
EuroPruning project aims to be the take-off for an extensive utilisation of the agricultural prunings for energy in Europe. The project aims to the development of new improved logistics for pruning residues. This includes harvesting, transport and storage for agricultural prunings.

EuroPruning project will:

- Develop new machinery for harvesting and on-site pre-treatment of the prunings which will fill a technology gap
- Provide practical solutions about how to carry out the storage in order to obtain a product of sufficient quality for the bioenergy market
- Develop an integrated concept where location and quality allow a wise decision tool to support decisions for logistic operators and transport companies. A smart-box will be developed to be installed in trucks, connected to the central information system, and will be able to predict quality depending on resource and weather conditions
- Monitor soils in the demo sites for three years. Results will allow to advice farmers on the best option for sustainable management of soils, what they can do with the prunings etc.
- Estimate the best logistic chains in terms of environmental and economic impacts, social impact will be also assessed.
- The demonstrations will take place in three regions (areas of demonstration) corresponding to three prevailing Bio-Geographic Regions in Europe (European Environment Agency classification): Aragón (Spain) representing dry Mediterranean climate, Aquitaine (France) which climate is humid oceanic, and Brandenburg (Germany) having continental climate.

**Additional** Participation of a greenGain project partner (CIRCE)
<table>
<thead>
<tr>
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<th>Link</th>
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<td><strong>Period</strong></td>
<td></td>
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<td><strong>Area</strong></td>
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<td>The Baltic Sea Region</td>
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<td><strong>Feedstock</strong></td>
<td></td>
<td>Germany, Rotenburg (Wümme): woody biomass (logging residues, LCMW biomass from roadside vegetation)</td>
</tr>
</tbody>
</table>
| **Approaches**      |      | • Developing pilot projects for 17 demo regions in Europe  
|                     |      | • Biomass potential assessment  
|                     |      | • Preparation of strategic plans  
|                     |      | • Triggering business cooperation and networking in Baltic Sea Region |
| **Useful Materials** |      | LCMW biomass assessment in Rotenburg (Wümme) |
| **Description**     |      | During the period 2009 – 2011, the consortium behind the Bioenergy Promotion project implemented many activities to promote sustainable bioenergy production and use in the Baltic Sea Region (BSR). The partners developed shared principles and criteria for sustainable bioenergy production in the BSR.  
|                     |      | In addition, they supported policy development at different levels of government, analysed sustainable biomass potentials, developed pilot projects and strategic concepts for the 17 demo regions. These activities comprised the establishment of regional network points, assessments of regional biomass potentials taking into account sustainability criteria, regional business and industry analyses, technology assessments and the preparation of pilot projects. In ten of the regions, these activities resulted in the preparation of strategic plans and concepts to further promote sustainable bioenergy production and use in the demo regions.  
|                     |      | Furthermore were prepared good practice projects, policies and business models relevant for the Baltic Sea Region and beyond.  
|                     |      | The principles and criteria developed in the Main stage project cover all use of biomass for energy purposes (not only biofuels and bioliquids) and include biodiversity, resource efficiency (including land use), energy efficiency, climate change mitigation efficiency, social well-being and economic prosperity.  
<p>|                     |      | In cooperation with the Rotenburg (Wümme) County as demoregion, the potential of woody biomass resources were the main focus. Besides logging residues from private forests also the feedstock from one out of many LCMW elements – roadside |</p>
<table>
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<tr>
<th>Additional</th>
<th>Participation of greenGain project partners (COALS, FNR)</th>
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vegetation was assessed, a methodology was developed and technologies for harvesting have been tested.
### 4biomass

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<td>Feedstock</td>
<td>Diverse</td>
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</table>
| Approaches   | • Identifying and describing the practical “best of” for exploiting biomass  
  • Direct support to regional stakeholders (workshops, field trips, project development)  
  • Carry out three pre-feasibility studies of investments into biomass projects in close co-operation with three stakeholders strongly interested into setting up such projects  
  • Discussion with stakeholders on their expectations on National Biomass Action Plans  
  • Creating a national and transnational network of stakeholders |

#### Useful Materials

- **Country studies** on biomass potential
- **Stakeholders dialogue** (survey on national bioenergy frameworks)
- **Studies on biomass trade**

#### Description

The Project 4Biomass fosters usage of bioenergy throughout Central Europe (CE) via turning know-how to show-how.

The project contributes to sustainable exploitation of biomass in two ways:

- The exchange of best practice concerning technology, demonstration projects and management approaches throughout CE will contribute to territorial cohesion. It will provide an equal level of knowledge regarding available technologies, investment possibilities and operation of bioenergy systems.

- Direct support to regional stakeholders by turning know-how to show-how (workshops, project development, field trips). A Joint Management Tool consisting of a databank will pool information on CE demonstration projects and best practise. It will help stakeholders to find tailor-made solutions for investments in bioenergy plants, and for their operation.

For biomass as a limited resource, a political framework is needed to regulate its usage. In this context, the project 4Biomass analyses the exploitable biomass potential in CE and its respective trade. A core activity is an internationally aligned stakeholder dialogue. ("What do you expect from your national Biomass Action Plan/Renewable Energy Action Plan (nBAP/REAP)?").
Furthermore, a coordinated regulatory framework – a Transnational Action Plan directed at policy makers and implementing authorities – will be developed giving advice on how an integrated and transnational coordinated bioenergy policy can be designed. Implementation of policies will be facilitated by the preparation of a Transnational Forum for stakeholders to exchange experiences on and to further coordinate, national policy implementations.

Moreover, criteria for giving a mandate to “Central European Biomass Centres” will be elaborated. They will address transnational biomass & sustainability issues and in addition play vital roles in the Transnational Network 4Biomass. National networks of stakeholders will be optimized and enlarged in order to operate as part of this network.

Additional Participation of a greenGain project partner (CZ Biom)
BioEUParks

Link
http://www.bioeuparks.eu/

Keywords
agricultural biomass, sustainable pathways, regulation frameworks, demo project, logistic chain, networking

Period
2013 - 2016

Area
EU

Partner countries
DE, HU, GR, IT, AT, SI, NL

Languages
EN

Feedstock
Biomass from sustainably managed forests and agricultural residues

Approaches
- Awareness raising and development of methodologies for facing local conflicts
- Development of solid biomass supply pathways
- Facilitating the implementation and managing of further similar initiatives

Useful Materials
Planning one solid biomass supply chain for each nature park involved

Description
The Project is going to contribute to increase the local supply of biomass from sustainably managed forests and agricultural residues, aiming to develop an efficient and sustainable biomass supply chain in 5 European Nature Parks, and promoting short chains (< 50 km) and small-scale installations (< 1 MW)

This can be realised due to an approach promoting sharing of objectives and co-planning with local key actors. For this reason, the project aims also to develop a methodology of encounter, discussion, sharing and co-planning for overcome the social conflicts that can born in occasion of significant structural interventions.

Furthermore, the project is going to mainstream the experience done and improve the skills of Nature Park managers, engineers and technicians on the matters dealt with the project.

Additional
Participation of a greenGain project partner (FNR)
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<tr>
<td><strong>Feedstock</strong></td>
<td>Biomass from landscape elements (mainly hedgerows)</td>
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</tbody>
</table>
| **Approaches** | - Reveal an overview of available knowledge, experiences, information about all aspects of valorising biomass on a local scale  
- Develop a basic planning tool to make valorisation of biomass from landscape elements possible, taking into account ecological and social constraints  
- Work out a specific application of the planning tool for each region and test it in pilots of local short chain systems for valorisation of biomass from landscape elements in different parts of the Northwest Europe region  
- Integrate the knowledge and developed tool in local, national and European policy |
| **Useful Results** | **Report**: Management Impacts on Ecosystem Service Provision of Landscape Elements |
| **Description** | The TWECOM project wants to sustainably valorise the, until now unused, biomass from landscape elements for heat and energy production on a local scale. Landscape elements like hedgerows had an economic function in the past and are typical for a large part of NW-Europe.  

The TWECOM-project wants to revalorize the biomass from landscape elements in an economically feasible way, with respect for ecological and social functions. Therefore, Natura 2000 will be taken into account as well as more regional ecological directives.  

TWECOM wants to demonstrate that local short chain valorisation of biomass from landscape elements is economical feasible, with a surplus value for the current ecological, cultural and social functions that these landscape elements have.
<table>
<thead>
<tr>
<th><strong>Biodiversity and Energy wood (Biodiversität und Energieholz)</strong></th>
<th><strong>Link</strong></th>
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**Keywords**
- non-agricultural biomass
- residual biomass
- economic assessment
- ecological assessment
- sustainable pathways
- regulatory frameworks
- biomass potential

**Period**
- 2009 - 2013

**Area**
- DE

**Partner countries**
- DE

**Languages**
- DE

**Feedstock**
- Wood from landscape conservation areas maintenance

**Approaches**
- Model regions
- Modelling of the harvesting measures
- Analysis of GHG emission of current use and potential energy use with LCA
- Developing of effective utilization pathways with respect to the special character of the area and their economic assessment

**Useful Results**
- Approval procedures for research on protected habitats
- GHG emissions analysis (LCA)
- Biomass potential estimation
- Quality of the wood chips
- Optimisation of the utilisation pathways

**Report:** Summary

**Description**
The project activities focus on optimizing of the energy use of wood from maintenance work performed in landscape conservation areas, like orchards, meadows and hedges. Technically and financially feasible solutions will be investigated, which would also respect the local conditions, taking ecology into account.

For that purpose, 41 representative areas in Thüringen and Brandenburg was chosen where the harvest will take place.

The production of wood chips from biomass from landscape conservation brings profit only in exceptional cases, but it can allow reducing of the maintenance cost. The project aims to develop concrete and environmental friendly measures for the energy use of wood for each given habitat.
<table>
<thead>
<tr>
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</tr>
<tr>
<td>Feedstock</td>
<td>Semi-natural grasslands, set-aside meadows, road- and railroad-side grass verges, but also other types of green cut</td>
<td></td>
</tr>
</tbody>
</table>

### Approaches

- Decentral energy production
- PROGRASS® approach: pre-treatment of the fibrous material by a mash water percolation system, mechanical dewatering of the mashed silage is carried out by a screw press. The resulting press fluid can be converted to biogas by anaerobic digestion in any biogas plant
- Location the procedure near a biogas plant – using the waste heat

### Description

COMBINE aims at opening up of abandoned urban, natural and agricultural areas for the energy production.

In the four partner regions the COMBINE project strives for this by:
- Producing storable solid fuel with a highly energy-efficient process
- Utilising biomass from extensively used grassland areas and landscape management, which can neither be used in animal feeding nor in conventional energetic conversion technologies
- Increasing the efficiency of biomass supply chains, through the addition of a year-round heat sink in distributed biogas or AD plants and by new harvesting and conditioning techniques.
- Creating new energy supply chains from biomasses in the project regions and beyond
- Securing livelihood for small farmers and disadvantaged persons in retreated areas through the creation of new income sources and regional added values with renewable energy production
- Contributing to reducing the conflict between bio-energy and food production by exploring and utilisation of new raw materials

Usually, the biomass obtained by harvesting extensively used grasslands late in the year contains a large fraction of fibrous and ligneous materials. Such kind of biomass is less suitable for animal feeding. Utilization in biogas plants is inefficient since the material is only poorly digestible and the gas yield would be low. It is also less suited for combustion due to the high ash and nitrogen contents.
These problems can be solved by the innovative IFBB technology (integrated generation of solid fuel and biogas from biomass) which is the heart of the PROGRASS® approach to utilise biomass from grasslands for distributed energy production. During the COMBINE project, the processing of roadside green-cut will be analysed to ensure the absence of contamination by hydrocarbons and heavy metals. In addition, the project provides efficient and standardised methods for harvesting roadside verges and for separating sand from the green cut.

*See the Interview with Willem Boeve!*
<table>
<thead>
<tr>
<th>LogistEC</th>
<th>Link</th>
</tr>
</thead>
</table>

### Keywords
- agricultural biomass, energy crops, modelling tools, logistic chain, economic assessment, economical assessment, sustainable pathways, demo project

### Period
- 2012 - 2016

### Area
- EU

### Partner countries
- BE, ES, FR, DK, UK, FI, NO, IT, PL

### Languages
- EN

### Feedstock
- energy crops: annual and multi-annual crops, perennial grasses, short-rotation coppice

### Approaches
- Innovative crop management practices such as intercropping or multifunctional land use and recycling of process residues and other waste streams will be developed
- Development of improved agricultural machinery would ensure cost efficient biomass harvesting and handling and lower environmental impacts
- Develop pre-treatment technologies to improve biomass properties prior to densification and transport
- Multi-criteria assessment to optimize all steps of the supply-chain (feedstock types, cultivation sites, crop management, harvesting and pre-treatment technologies, transport and storage)
- Development and application of a set of quantitative models and application of qualitative methods for the optimization of biomass supply chains in a spatially explicit manner taking into account environmental, economic and social sustainability criteria and regulatory framework
- The developed system will be tested in bio-energy and biomaterials projects all across Europe

### Useful Results

- Biomass supply chain: environmental assessment (not available online)

### Description

The LogistEC project aims to develop new or improved technologies of the biomass logistics chains. Cost-efficient, environmentally-friendly and socially sustainable biomass supply chains are needed to achieve the 2020 EU RES targets that might be impeded by the potential scarcity of lignocellulosic biomass from agriculture. The project covers all types of lignocellulosic crops: annual and multi-annual crops, perennial grasses, and short-rotation coppice.

The project focuses on improvement of all biomass value chain’s components and assesses the sustainability in terms of environmental, economic and social impacts. Innovative techniques for crop management, biomass harvesting, storage and transport provide a possibility to increase biomass supply whilst keeping costs down and minimizing adverse environmental impacts.

The barriers for optimal use of supply chains include scattered and
bulky nature of biomass, high moisture content, unsuitable for lignocellulosic crops harvesting equipment, biomass deterioration during storage and transport, etc. Therefore, by employing specific meta-analysis, laboratory tests, filed trials, ecosystem modelling and mechanical engineering, the project will deliver recommendations for optimal technologies as well as new equipment and systems.
<table>
<thead>
<tr>
<th>MULLE</th>
<th>Link</th>
<th><a href="http://mulle.lpv.de/">http://mulle.lpv.de/</a></th>
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<tbody>
<tr>
<td>Keywords</td>
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<td>Partner countries</td>
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<td>Languages</td>
<td>DE</td>
<td></td>
</tr>
<tr>
<td>Feedstock Approaches</td>
<td>Landscape conservation material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Internet portal – data bank with examples of use of landscape conservation material for bioenergy from research and practice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Providing information on legislative frameworks</td>
<td></td>
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<tr>
<td></td>
<td>• Pilot projects</td>
<td></td>
</tr>
<tr>
<td>Useful Results</td>
<td><strong>See the Best practice database!</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heating with woodchips from riverside maintenance in Bremen</td>
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<tr>
<td></td>
<td>Biogas plant Chiemgauer Modell, Bayern,</td>
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<tr>
<td></td>
<td>Wood chips heating Fröhlich (also with an interactive map)</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Database on related projects and practical examples</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Platform promoting energy use of landscape conservation material – first internet portal for electricity and heat from biomass</td>
<td></td>
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<tr>
<td></td>
<td>Bringing together projects with the aim of mobilization of the unutilized potential of biomass from landscape management in existing and newly built biomass plants and in heating plants.</td>
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<tr>
<td>Additional</td>
<td>Participation of greenGain project partners (COALS, FNR)</td>
<td></td>
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<tr>
<td></td>
<td><strong>See the Interview with Nicole Menzel!</strong></td>
<td></td>
</tr>
</tbody>
</table>
Keywords: residual biomass, non-agriculture biomass, agricultural biomass, case study, biomass potential, logistic chain, demo project

Period: 2009 - 2012
Area: Germany and Spain
Partner countries: DE, ES
Languages: EN

Feedstock: woody wastes and residues from landscape conservation, agriculture and forestry

Approaches:
- Inter-regional cooperation focus, further promoting the cooperation between the European regions of Saxony-Anhalt in Germany and Valencia in Spain
- 14 Field tests which analysed different aspects of the biomass mobilization chain: the harvesting, skidding, storage, chipping and transport process supported by specific methodological and technological developments; tests were structured as to compare different mobilization variants – conventional
- Development of prototype biomass assessment concepts, used to assess the regional availability of biomass resources, depending on site factors; different prototype processes developed also in field of harvesting, processing, transport
- Analysis of regional logistic factors influencing the biomass supply chain, site catalogue, recommendations for actions, based on the results as elaborated above, to develop context-sensitive, economic and ecologic best practice solutions and technologies.

Useful Results:
- Final report
- D7.2 Site catalogue
- D7.4 Logistics concept
- D7.5 Selection and documentation of best practices
- List of available documents

Description:
Green wastes and residues as raw materials for variants of utilization
The main object of the project is the testing, demonstration and transfer of the applicability of conventional and innovative technologies and methods to process woody wastes and residues from landscape conservation as well as agriculture and forestry. It aims to produce raw materials, previously classified as waste, for energy and material utilization chains, determine and evaluate best practices and technologies in the field to develop economically and ecologically efficient material flows.

Among others, objectives of the project include:
- Demonstrating innovative overall concepts,
- Preventively minimizing environmental impacts of the mobilization processes,
- Demonstrating economic-ecological potentials to eliminate
barriers to development and utilization,
• Increasing the proportion of biomass residues utilized as energy and material,
• Mobilizing unutilized and/or underutilized potentials and motivating forest owners,
• Developing new service sectors promoting employment and
• Generating sustainable impulses for regional development

One of the main objectives of the project was the development of alternative material flows for the material and energy use industries to contribute to the alleviation of the competition in use of biomass resources.

The project built on an interregional network of researchers, administrative level stakeholders and practitioners in the field of biomass. The Best4VarioUse consortium included actors from all steps in the biomass value chain to work on comprehensive concepts that provide a perspective on the complete biomass mobilization chain.
### Green Partnership: Expert Working Group Biomass

<table>
<thead>
<tr>
<th>Link</th>
<th><a href="http://www.greenpartnerships.eu/">http://www.greenpartnerships.eu/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Keywords</strong></td>
<td>biomass potential, demo project, best practice, networking</td>
</tr>
<tr>
<td><strong>Period</strong></td>
<td>? – 2015</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>Mediterranean countries (MED)</td>
</tr>
<tr>
<td><strong>Partner countries</strong></td>
<td>AL, SI, BA, GR, HR, IT, ME, CY, PT, FR, ES</td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>EN</td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>Diverse; in case of studies from Cyprus also products from municipal gardening</td>
</tr>
<tr>
<td><strong>Approaches</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Creating Expert Working Group (EWG); relevant for greenGain – Biomass group</td>
</tr>
<tr>
<td></td>
<td>• Pilot projects on increasing energy efficiency; four of them on biomass (in Slovenia, Cyprus, Croatia, Portugal)</td>
</tr>
<tr>
<td><strong>Useful Results</strong></td>
<td>Report with biomass potential estimation, best practice examples etc.</td>
</tr>
<tr>
<td></td>
<td>Cyprus: Report on biomass</td>
</tr>
<tr>
<td></td>
<td>Portugal: Internet platform showing the biomass production and potential in a given region</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Local Partnerships for Greener Cities and Regions</td>
</tr>
<tr>
<td></td>
<td>Project’s aim is to support local administrations to overcome existing obstacles and effectively implement the set measures on the way to energy efficient cities and regions. Sustainable solutions will be implemented by creating local partnerships between owners, suppliers and final users of these initiatives.</td>
</tr>
<tr>
<td></td>
<td>Green Partnerships will connect cities and regions from 11 MED countries that will overcome obstacles by establishing a common transnational approach with focus on creating local partnerships, which will contribute to more efficient implementation of innovative EE and RES solutions leading to sustainable local and regional development.</td>
</tr>
<tr>
<td></td>
<td>Local partnerships will connect stakeholders affected by a certain EE measure, from the owner to suppliers, potential investors, employees and final users. They will share their proposals and actively take part in their implementation.</td>
</tr>
<tr>
<td><strong>Additional</strong></td>
<td>Expert Working Group Biomass: possible source of actors for greenGain</td>
</tr>
</tbody>
</table>

### Biomass energy use (Energetische Biomassenutzung)

<table>
<thead>
<tr>
<th>Link</th>
<th><a href="https://www.energetische-biomassenutzung.de">https://www.energetische-biomassenutzung.de</a></th>
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<tbody>
<tr>
<td><strong>Keywords</strong></td>
<td>Residual biomass, biomass potential, best practice, environmental assessment, energy carriers, demo project</td>
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<tr>
<td><strong>Period</strong></td>
<td>Phase 1: 2009 - 2011</td>
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<tr>
<td></td>
<td>Phase 2: 2011 - 2014</td>
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<tr>
<td></td>
<td>Update 1: 2012 - 2015</td>
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<tr>
<td></td>
<td>Update 2: 2015-2016</td>
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</tbody>
</table>

**greenGain: D4.1 | 175**
<table>
<thead>
<tr>
<th>Area</th>
<th>Partner countries</th>
<th>Languages</th>
<th>Feedstock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EN, DE</td>
<td>LCMW included in topic areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Utilisation of residues, Bio- methane, Regional Bioenergy</td>
</tr>
</tbody>
</table>

| Approaches           |                   |           | Funding provided by German Federal Ministry of Economic affairs and Energy as a long term support for wide range of projects |

| Useful Results       |                   |           | [List of projects](description available in German only) |
|                      |                   |           | [List of Publications](Link) |
|                      |                   |           | [Method Handbook](Link): Methods for determination of technology indicators, costs of energy and greenhouse gas effects |
|                      |                   |           | [Results of four working groups](Link) (in German only): Sustainable substrate provision, Provision of gaseous bioenergy carriers, low emission small firing systems, Systemic aspects of bioenergy; Test heat facilities |

| Description          |                   |           | The funding programme aims at the research and development of energy efficient technologies as well as the optimisation of processes and procedures for supply with electricity and heat from biomass, in particular organic waste and residues. Feasibility studies, measure programmes as well as pilot and demonstration projects contribute crucially to an improved energetic biomass use. |

**Subject area 1**: Optimisation of the framework and the technologies for the efficient development and use of biogenic residues.  
**Subject area 2**: System studies and international cooperation projects for the development of best practice projects for an improved supply of sustainable bioenergy  
**Subject area 3**: Development and demonstration of innovative bioenergy technologies for efficient supply of combined heat and power, in particular biomass gasification technologies  
**Subject area 4**: Development and demonstration of a European bio-methane strategy  
**Subject area 5**: Further development of a sustainable bioenergy strategy  
**Subject area 6**: Development of concepts and projects for flexible supply of electricity from biomass  
**Subject area 7**: Validation of the market potential of research results  
**Subject area 8**: Contribution to the development and support of a consistent, cross-sectoral biomass strategy

| Additional           |                   |           | Examples of interesting projects (in German only): |

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• CO2 sequestration and biomass utilisation in cities – material and energy use of biomass from LCMW and CO2 sequestration in buildings (Leibnitz-Institut project)
• Use of biogenic residues/wastes in thermo-chemical plants for the power/fuel provision (Final report)
• Regional concepts for extension of bioenergy production from wood (Final report: p.27: Amounts of LCMW feedstock)
• Optimized energy and material use of biogenic waste in Germany; Sustainable integration of bioenergy systems in the context of local decision-making (Fraunhofer UMSICHT project)
• Feasibility Study for a decentralized wood chip gasification plant with cogeneration in the bioenergy region Achental (Final report)
• Development of transferable concepts for the use of grass from landscape conservation on the example of the Havelland region (Final report; included grass from riverside maintenance)
• Optimization of regional flows of biogenic fuels for power generation in Achental region (Final report; LCMW biomass from roadside maintenance, municipal areas or cultural landscapes)
• “BioKommunal”: Development of nationwide bioenergy networks and measures for enforcement of bioenergy use in municipalities (Final report; unlocked potential of LCMW biomass in municipalities)
• Increasing energy efficiency in the utilization of biogenic residues (Final report)
• Qualification of torrefied biogenic residues for use in power plant furnaces (Final report; characteristics of torrefied LCMW feedstock)
• Integrated strategy for municipal biomass: HTC Halle Water and Urban Economics (Report; DBFZ; urban grass)
• Heat from biomass (overview of all projects)
Bioenergy-Regions (Bioenergie-Regionen)

<table>
<thead>
<tr>
<th>Link</th>
<th><a href="http://www.bioenergie-regionen.de/">http://www.bioenergie-regionen.de/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Keywords</td>
<td>residual biomass, biomass potential, networking, regulatory frameworks, best practice</td>
</tr>
</tbody>
</table>
| Period | Phase 1: 2009 - 2012  
Phase 2: 2012 - 2015 |
| Area | DE |
| Partner countries | DE |
| Languages | DE |
| Feedstock | Diverse, LCMW biomass among others |
| Approaches | • Creating concepts of regional development based on analysis of concrete local data and networks – technical, economic, social and political aspects, assessment of the local biomass potential  
• Handbook oriented on practical implementation |
| Useful Results | Library of materials (German only):  
Literature, brochures  
Presentations: LCMW biomass  
Database on Projects of the month – very nice examples of best practice, also in field of LCMW  
Ludwigsfelde Plus+ Initiative (Feasibility study (in German) which also includes overview on German legal standards regarding urban green, technical and environmental assessment, examples of best practice, amounts of feedstock and its costs etc.)  
Unused biomass resources |
| Description | The project funded by the German Federal Ministry of Food and Agriculture promoted structures for the generation and use of bioenergy in the so-called Bioenergy-Regions. In the first phase (2009 - 2012) the focus was especially on building networks and laying the foundations for bioenergy production and use. In the second period from (2012 - 2015) concentrated the actors on the targeted increase in regional economic prosperity through bioenergy, on increasing efficiency and optimization of material flows and on the dissemination of the experiences of partner regions. The Bioenergy-Regions work now with so-called twin regions and thus convey a targeted knowledge transfer.  

The aim of funding was creating functional networks. The networks received in the regional strategy a crucial role and contributed to the valorisation of existing biomass potential. The priority was a sustainable development, which also led to new jobs in the region.  

Already between June 2009 and July 2012 the Ministry supported innovative concepts which helped to promote the valorization of bioenergy potential. In a two-stage selection, an expert panel has decided about the funding |
the up to 400,000 € to 25 out of 210 candidate regions. Within three years, the winning regions have implemented various measures with the help of this funding.

The aims of the program were particularly concrete measures to implement Energiewende focus on local actions, exploitation of the bioenergy economic potential in rural areas, creating jobs, optimization of material and economic flows, efficient use of bioenergy resources, establishing model regions for communication and implementation of these goals.

Additional Participation of a greenGain project partner (FNR)
In cooperation with players from the model region "Emscher-Lippe" in Nordrhein-Westfalen (NRW) and the parallel BMU research projects BioRegio possible logistics systems were developed and analysed for specific weak spots. For this purpose, initially the basic logistics chains for wood fuels were systematized, and the respective processes have been specifically described and modelled mathematically. Therefore, a foundation was created to incorporate similar processes within logistic systems in the future and to identify key figures such as process costs.

As a practical example, the untapped wood fuel source roadside timber was examined. As part of a survey in cooperation with the national enterprise Straßenbau NRW and Wald und Holz NRW, a concept to the detailed assessment of the annual amounts of roadside timber was developed, derived from the practice data indicators for potential. The potential for the model region for NRW and for Germany as a whole was estimated. Furthermore, the logistical chains of internal and external maintenance measures of roadside timber were modelled including its costs. The costs intensive-processes were identified, the weaknesses were discussed and the solutions for economical deployment chain were demonstrated.

Furthermore, the concept of "energy wood yard" has been studied as an integral part of a regional supply chain "wood fuel". To this end, existing wood yard concepts were researched and validated by means of a telephone survey of energy wood yards. The figures for the respective logistic processes were collected and based on them plans for energy wood yard were designed.

Parallel project BioRegio: Strategies for a sustainable energetic utilisation of biomass in chosen model regions
<table>
<thead>
<tr>
<th>Biomass Futures</th>
<th>Link Keywords</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>residual biomass, agricultural biomass, non-agricultural biomass, networking, logistic chain, modelling tool, regulatory frameworks</td>
</tr>
</tbody>
</table>

| Period | 2009 - ? |
| Area | EU |
| Partner | NL, UK, GR, AT, DE |
| countries | EN |
| Languages | Diverse; including road side verges and landscape wood |
| Feedstock | - Detail market analysis in partner countries (also potential of landscape wood): demand, availability, supply |
| Approaches | - Defining sustainability standards for the biomass supply |
| | - Modelling the role of bioenergy in EU energy systems |
| | - Helping policy makers deal with key challenges associated with the development of bioenergy solutions |

<table>
<thead>
<tr>
<th>Usefull Results</th>
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</thead>
<tbody>
<tr>
<td>List of all deliverables, e.g.:</td>
</tr>
<tr>
<td>Atlas of EU biomass potential (including verge grass, landscape care wood)</td>
</tr>
<tr>
<td>Resolve model; estimation on how the different biomass resources can be allocated in a cost-effective way to the different energy uses; The ECN RESolve model consists of a set of three independent sub-models, known as RESolve-biomass (developed during Biomass Futures project to enable biomass allocation), RESolve-E (dedicated renewable electricity model) and RESolve - H (dedicated renewable heat model). The RESolve-biomass model calculates the most cost effective way to fulfill the specified bioenergy demand (for electricity, heating and cooling and the transport sector), given and constrained by a number of assumptions on economic and technological parameters in a specific target year, in terms of bioenergy production, cost and trade (trade of primary feedstock and/or biofuels). One of the most important features of the RESolve-biomass model is the ability to link the national production chains allowing for international trade. RESolve-biomass allows for trade of feedstocks and final products.</td>
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<tr>
<td>Results from the survey on bioenergy in EU among experts (Interviews oriented at policies)</td>
</tr>
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<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>The Biomass Futures Project will assess the role that biomass can play in meeting EU energy policy targets. It will develop tailored information packages for stakeholders, as well as inform and support policy makers at both the European and national levels.</td>
</tr>
<tr>
<td>The project will define the key factors likely to influence biomass supply, demand and uptake over the next twenty years (meeting the RED targets). Among other factors, partners will examine the EU heat, electricity-CHP and transport markets; supply and demand dynamics; the effects of indirect land use change, water use and social aspects on future biomass supply, etc.</td>
</tr>
<tr>
<td>Throughout the project collaboration with stakeholders will be vital.</td>
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</tbody>
</table>
Working with key stakeholders from the industry & policy sides, we will be able to gain from the interactions and have their feedback to validate the findings from the modelling work. Stakeholder perspectives and feedback will be integrated into the project outputs and deliverables at every stage.
<table>
<thead>
<tr>
<th><strong>RUBIRES: Rural Biological Resources</strong></th>
<th><strong>Link</strong></th>
<th><a href="http://www.rubires.de/aindex.php">http://www.rubires.de/aindex.php</a></th>
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<td><strong>Period</strong></td>
<td><strong>2009 - 2011</strong></td>
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<tr>
<td><strong>Area</strong></td>
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<tr>
<td><strong>Partner countries</strong></td>
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<tr>
<td><strong>Languages</strong></td>
<td><strong>EN</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td><strong>Diverse</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Approaches</strong></td>
<td><strong>- Material flow analysis</strong>&lt;br&gt;<strong>- Regional land-use analysis</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Useful Results</strong></td>
<td><strong>Regional analysis including LCMW feedstock (in German only):</strong>&lt;br&gt;<strong>Burgenlandkreis</strong> <em>(the final report not available, LCMW data missing)</em>&lt;br&gt;<strong>Altmark</strong>&lt;br&gt;<strong>Havelland, Wood as renewable energy source;</strong> including English summary describing experience and results of interviews performed with wood processing companies</td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td><strong>The specific objective is to increase the use of renewable resources and create regional added value. Therefore new tools and methods have to be developed and implemented.</strong>&lt;br&gt;<strong>The project is based on three major items: development and improvement of material flow management, the management of land-use demands, the implementation of the method to manage regional added value partnerships and chains.</strong></td>
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<tr>
<td><strong>Florafuel</strong></td>
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<td><strong>Keywords</strong></td>
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<tr>
<td><strong>Period</strong></td>
<td>Patent application in 2003</td>
<td></td>
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<tr>
<td><strong>Area</strong></td>
<td>DE</td>
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<tr>
<td><strong>Partner countries</strong></td>
<td>DE</td>
<td></td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>EN</td>
<td></td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>grass, foliage, reeds, marshland cuttings, roadside cuttings and silage</td>
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<tr>
<td><strong>Approaches</strong></td>
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</tbody>
</table>
  - With the florafuel Procedure, almost all kinds of humid biomass can be treated to generate CO2-neutral energy sources and fuels.  
  - The treatment or conversion of biomass types to generate energy sources is carried out in several working steps in florafuel plants. Firstly, the biomass lots are classified according to entry humidity content, cutting length, structure, washability and percentage of foreign bodies. Following this, the material is washed, shredded and then mechanically dried with very low energy consumption. The washing process flushes out mineral particles such as stones, sand and earth as well as metals. It also significantly reduces those substances generally found in stalk material, which are harmful when set free during combustion, such as chlorine and potassium.  
  - Following thermal drying, during which the waste heat from industrial and biogas plants may be used, the material is condensed to form briquettes and pellets. The fuels generated in this way are CO2-neutral and might be used as single lots (grass, foliage, etc.) or as mixed fuels (wood/grass pellets or wood/foliage pellets, etc.) for heat and electricity generation. |
| **Description** | florafuel AG has developed an innovative procedure which enables local authorities, farmers, composting plant operators and trade companies to process biomass and biogenic waste (such as grass, foliage, reeds, marshland cuttings, roadside cuttings and silage) into high-grade, regenerative CO2-neutral energy sources in the form of pellets and briquettes. The plants and dryers needed for this are developed and sold on the market by florafuel AG.  
  [Presentation](presentation) about the procedure  
  Article on [Forum](forum)  
  Article on [Ingenieur.de](ingenieur.de)  
  Article on [Flächenmanager](flaechenmanager)  
  Press release |
<table>
<thead>
<tr>
<th>Nature Outlook 2010-2040: Regional case study</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Keywords</strong></td>
<td>[<a href="http://themasites.pbl.nl/natureoutlook/2012/residual_biomass">http://themasites.pbl.nl/natureoutlook/2012/residual_biomass</a>, non-agricultural_biomass, networking](<a href="http://themasites.pbl.nl/natureoutlook/2012/residual_biomass">http://themasites.pbl.nl/natureoutlook/2012/residual_biomass</a>, non-agricultural_biomass, networking)</td>
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<tr>
<td><strong>Period</strong></td>
<td>2010 - ?</td>
</tr>
<tr>
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<td>NL</td>
</tr>
<tr>
<td><strong>Partner countries</strong></td>
<td>NL</td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>EN, NL</td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>woodchips from LCMW</td>
</tr>
<tr>
<td><strong>Approaches</strong></td>
<td>The case study focused on the regional use of wood chips. This fuel comes mainly from coppice wood and trimmings from landscape features and public green spaces. As an example serves the Achterhoek region, or here. In the Achterhoek region, the Agricultural Nature Association ‘Onderholt’ has linked its name with the economic use of wood chips and strengthening the cultural-historical landscape. <strong>Local Action Plan</strong> of Achterhoek region</td>
</tr>
<tr>
<td><strong>Useful Results Description</strong></td>
<td>With the Nature Outlook 2010 – 2040 the PBL Netherlands Environmental Assessment Agency aims to provide a source of inspiration to support government authorities and societal organisations in formulating the long-term policy for nature and the landscape. The case study focused on the regional use of wood chips. This fuel comes mainly from coppice wood and trimmings from landscape features and public green spaces.</td>
</tr>
<tr>
<td><strong>Newapp</strong></td>
<td><strong>Link</strong></td>
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<tr>
<td>------------</td>
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</tr>
<tr>
<td><strong>Keywords</strong></td>
<td><a href="http://www.newapp-project.eu/en/">http://www.newapp-project.eu/en/</a></td>
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<tr>
<td><strong>Period</strong></td>
<td>residual biomass, agricultural biomass, non-agricultural biomass, conversion, HTC, energy carrier, demo project</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>2013 -2015</td>
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<td><strong>Partner countries</strong></td>
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<td><strong>Languages</strong></td>
<td>GE, ES</td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>EN</td>
</tr>
<tr>
<td><strong>Approaches</strong></td>
<td>green waste, agricultural waste, municipal solid waste (grass, foliage etc.), waste from food processing industry, waste from food markets</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>• Characterization of wet biomass waste streams and definition of end-user requirements • Obtention of HTC carbon at pilot scale from selected waste streams and post-treatment development for improved solid fuel • Post-processing of HTC carbon for high-technological applications: biodiesel and electrodes • Technology assessment and business plan development • Demonstration of project results</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>NEWAPP is a research project focusing on hydrothermal carbonization (HTC) of wet biomass residues. <a href="http://www.newapp-project.eu/en/">Project Handout</a></td>
</tr>
<tr>
<td>BioenNW</td>
<td>Link</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>Keywords</td>
<td>residual biomass, agricultural biomass, non-agricultural biomass, case study, conversion, demo project, networking, sustainable pathways</td>
</tr>
<tr>
<td>Period</td>
<td>2010 - 2015</td>
</tr>
<tr>
<td>Area</td>
<td>North West Europe</td>
</tr>
<tr>
<td>Partner countries</td>
<td>UK, BE, NL, FR, DE</td>
</tr>
<tr>
<td>Languages</td>
<td>EN</td>
</tr>
</tbody>
</table>
| Feedstock Approaches | Diverse; including LCMW, food waste, forestry residues etc. The project will create innovative bioenergy power plants across the North West Europe, fuelled by waste on a small scale (from 5-10 MW output) and will test cutting edge bioenergy technologies (e.g. combined pyrolysis and anaerobic digestion) in the following regions: 
- The West Midlands, UK 
- Ile-de-France, France 
- Wallonia, Belgium 
- Eindhoven, The Netherlands 
- Saarland, Germany |
| Bioenergy Support Centres (BSC) have been created as part of the BioenNW project to support companies, organisations and local authorities to deliver local bioenergy more efficiently and cost-effectively. Five BSCs have been created located in these regions. 25 potential sites for the development of new innovative bioenergy schemes have been identified; case study database |
| The progress in North West Europe towards meeting 2020 targets has been slow. To date, central government bioenergy support schemes tend to favour large scale developments that result in long distance transport of low density fuels with limited use of heat. Carbon balances may be positive, but there is no stimulation to the local bioenergy economy and many local biomass resources remain unused. With this in mind, the BioenNW project has been put in place to support companies, organisations and local authorities to deliver local bioenergy in parts of the UK, France, Germany, Belgium, and the Netherlands. BioenNW is focused on promoting the adoption of local bioenergy and stimulating the potential for biomass to make a substantial contribution to increasing energy security, reducing carbon emissions and creating employment. |

<table>
<thead>
<tr>
<th>W-bast</th>
<th>Link</th>
<th><a href="http://www.w-bast.de/">http://www.w-bast.de/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Keywords</td>
<td>conversion, logistic chain, networking, sustainable pathways, best practice, biomass potential</td>
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<td>Period</td>
<td>2013 - 2016</td>
<td></td>
</tr>
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<td>Area</td>
<td>DE</td>
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<td>Partner countries</td>
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</tr>
<tr>
<td>Languages</td>
<td>DE</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>----</td>
<td></td>
</tr>
<tr>
<td>Feedstock</td>
<td>residual biomass from LCMW</td>
<td></td>
</tr>
</tbody>
</table>
| Approaches | - Creating an interdisciplinary cooperation network covering the whole utilisation chain  
               - Creating local value chains |

**Useful Results**
- [Media Article](in German), [Article](#)  
- [Press release](#)  

**Description**
The technical vision of the network is that the network partners will develop a number of innovative solutions to make the mowing residues a recyclable material green waste, the (energy) can be exploited both materially and thermally. Declared part of the vision is the process of developing as many different recovery options (p. Value chain). In material area this could be WPC compounds, bioplastic products or structural body. In the field of thermal utilization of recycled green waste can be processed into briquettes or used in dust burners as dust to generate heat. In addition, the green waste could be used in biogas plants. The focus will initially be on woody green waste, creating a value for leafy greens, grasses, needles etc. is also tackled.

**Additional**
- See the Interview with Dr. Christian Struve!
The aim of the research project AgroForNet is to build regional-value networks for a sustainable and efficient production and provision of woody biomass from the forest, short-rotation coppices and landscape in the three model regions. After the project period the results should serve as best practice for other regions in Germany.
<table>
<thead>
<tr>
<th>PROFORBIOMED</th>
<th>Link</th>
<th><strong><a href="http://proforbiomed.eu/">http://proforbiomed.eu/</a></strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Keywords</td>
<td></td>
<td>biomass potential, sustainable pathways, networking</td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td>2011 - 2013</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td>Mediterranean countries</td>
</tr>
<tr>
<td>Partner countries</td>
<td></td>
<td>ES, FR, IT, SI, PT, GR</td>
</tr>
<tr>
<td>Languages</td>
<td></td>
<td>ES, FR, IT, SI, PT, GR</td>
</tr>
<tr>
<td>Feedstock</td>
<td></td>
<td>Forest biomass</td>
</tr>
<tr>
<td>Useful Results</td>
<td></td>
<td>- Assessment of the forest biomass available for energy production in a social, economic and environmental sustainable way in MED regions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Transfer and adoption of know-how on sustainable forest management including forest biomass production chains and its use as an energy source</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Improvement of the rural areas governance, development of clusters and agreements between public and private actors in 10 MED regions and the implementation of polices for the development of renewable energies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Development of a model of public support to sustainable forest management and biomass production</td>
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<tr>
<td></td>
<td></td>
<td>- Identification of financing mechanisms for public and private investments</td>
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<tr>
<td></td>
<td></td>
<td>- Increase of incomes for forest owners through the biomass production chain reducing risks and improving the conservation status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Creation of new economic opportunities</td>
</tr>
<tr>
<td>Description</td>
<td></td>
<td>PROFORBIOMED promotes renewable energies (RE) in MED areas by developing an integrated strategy for the use of the forest biomass as a RE source, recovering the forest biomass potential, developing technical and legal aspects and promoting the use of forestry biomass for energy. The strategy relies on the involvement of key stakeholders in a forestry biomass production chain that takes into account sustainability and compatibility with other uses and provides new economic opportunities.</td>
</tr>
</tbody>
</table>
The main results of the implementation of the proposed actions will be the followings:

- Using 2,000 t of locally sourced biomass saving more than 3,400 t of CO2 compared to a fossil fuel and contributing to a stable renewable energy generation.

- Demonstration of technical and economic viability of the supply chain of shrub biomass based on mechanized harvesting methods in four different situations, reducing the risk of forest fires.

- Determination of the quality parameters of shrub biomass: energetic chemical characterization of 120 samples and production of eight types with standardized quality pellets.

- Establishment of patterns for shrub biomass combustion to ensure lower emissions than those established in the more restrictive regulations.

- Job creation in the demonstration areas by investing more than 50 % of the project resources in these areas.

- Establishment of guidelines and policy documents for discussion by the main stakeholders involved.

- Production of consolidated documents on management guidelines and policies and recommend them to the decision-making centers.

- Embodiment of the project dissemination and its results with conventional means: print, radio, web, publications, doors open days, specific seminars, Layman's report, etc.

- Establishment of guidelines for making contacts for the creation of a network using projects with similar objectives but different areas of activity, methodologies and results.

- Maintenance of the various tools to hold the knowledge and dissemination of results and new actions, after the completion of the project, to
different locations inside and outside of Spain for 10 years after the end of the implementation period.

The overall aim of ENERBIOSCRUB project ("Sustainable management of shrubs formations for energy purposes") is to contribute, as part of the overall objectives of LIFE+ Environmental Policy and Governance, to reduce greenhouse gas emissions (GHG) to mitigate the effects related to climate change, through the demonstration and deployment of technologies that contribute to substantially reduce GHG emissions.
<table>
<thead>
<tr>
<th>Heating with hedges (Energiequelle Wallhecke)</th>
<th>Link</th>
<th>Websites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keywords</td>
<td></td>
<td>residual biomass, non-agricultural biomass, GIS</td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td>2009 – 2013</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td>Germany: Kreis Steinfurt, Borken, Coesfel and Warendorf, Landkreis Grafschaft Bentheim</td>
</tr>
<tr>
<td>Partner countries</td>
<td></td>
<td>Netherlands: Regio Achterhoek, PAN (Particulier Agrarisch Natuurbheer), VAN (Vereiniging Agrarisch Natuurbheer), t’Onderholt</td>
</tr>
<tr>
<td>Languages</td>
<td></td>
<td>DE, NL</td>
</tr>
<tr>
<td>Feedstock</td>
<td></td>
<td>EN, DE, NL</td>
</tr>
<tr>
<td>Feedstock</td>
<td></td>
<td>wood from hedgerows on bank (protected landscape element)</td>
</tr>
<tr>
<td>Useful Results</td>
<td></td>
<td>Concept for the LCMW of hedge rows on banks in the project regions, creation of the position of an hedge manager which advises owners and companies, online registration of hedge rows on banks of private owners, GIS database</td>
</tr>
<tr>
<td>Additional</td>
<td></td>
<td>Part of INTERREG IV A Deutschland-Nederland Project database Article Presentation Flyer, brochure and material of public relation work of the project are available from COALS</td>
</tr>
<tr>
<td><strong>Project DBU 24692-33</strong></td>
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<tr>
<td><strong>Link</strong></td>
<td><a href="https://www.dbu.de/projekt_24692/_db_799.html">https://www.dbu.de/projekt_24692/_db_799.html</a></td>
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</tr>
<tr>
<td><strong>Keywords</strong></td>
<td>residual biomass, non-agricultural biomass, status quo, biomass potential</td>
<td></td>
</tr>
<tr>
<td><strong>Period</strong></td>
<td>2007 - 2009</td>
<td></td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>Germany; Nature Park Unteres Saaletal, County Sachsen-Anhalt</td>
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</tr>
<tr>
<td><strong>Partner countries</strong></td>
<td>DE</td>
<td></td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>DE</td>
<td></td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>LCMW biomass</td>
<td></td>
</tr>
<tr>
<td><strong>Approaches</strong></td>
<td>Establishing an example of a regional energy cycle with biomass from LCMW in the natural park Unteres Saaetal with special consideration of a GIS-assessment on the long-term availability of the biomass potential.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) Analyse status quo - classification of the research area with areal photos and existing data to select LCMW areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) Determination and definition of use- and maintenance-categories based on aims of nature protection</td>
<td></td>
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<tr>
<td></td>
<td>3) Establish 18 test areas to verify height classes, perform a biomass collection (harvest) and record data on vegetation and habitat.</td>
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<tr>
<td></td>
<td>4) Develop a procedure based on GIS to assess the biomass potential</td>
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<tr>
<td></td>
<td>5) Selection of several representative forest stands and record of random samples to derive forest stand types</td>
<td></td>
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<tr>
<td></td>
<td>6) Calculation of the biomass stock of the selected stands and calculation of the wood stock of the single stand types</td>
<td></td>
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<tr>
<td></td>
<td>7) Derive the actual useable biomass potential of all LCMW areas</td>
<td></td>
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<tr>
<td></td>
<td>8) Develop a regional concept for the use of wood from LCMW for a heating site in the primary school Wettin and make a cost calculation for the heating system</td>
<td></td>
</tr>
<tr>
<td><strong>Useful Results</strong></td>
<td>Method for a comprehensive determination of the available standing woody biomass potential from LCMW</td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>For the use of LCMW biomass as an energy carrier often reliable data on the potentials, technical possibilities and economic frameworks is missing. The aim of the project was thus to develop a method (based on GIS) to assess biomass potentials and to develop a concept for the supply and use of LCMW biomass as energy carrier with special regard to the aims of nature protection in the studied area.</td>
<td></td>
</tr>
</tbody>
</table>
| | Therefore, the superior aim of the project was the restoration and maintenance of valuable habitat, the valorisation of LCMW biomass as energy resource and the
initiation of an exemplary project for climate-friendly and
decentral heat supply.
Project DBU 22128-33/0

- DBU Websites [here](#) and [here](#)
- **Keywords**: biomass potential, logistic chain, networking
- **Period**: 2004 - 2008
- **Area**: Germany, Baden-Württemberg
- **Partner countries**: DE
- **Languages**: DE
- **Feedstock**: energy wood from forests and LCMW

### Approaches

1) Questionnaire about use of energy wood for power plant operators
2) Assessment of sustainable energy wood potential from forest and LCMW
3) Assessment of already existing harvest- and supply-concepts
4) Develop new concepts based on step 3) and test them in the field with regard to public acceptance
5) Use results to develop best fitting processes for studied region
6) Implement results in practice in cooperation with local actors
7) Evaluate new methods

### Useful Results

- It is advisable to follow the norm QM: [Qualitätsmanagement-Holzheizwerk](#); more often to secure a binding and objective base for the supply of wood chips.
- Chipping and transport of wood chips is mainly done by independent companies.
- The analysis of the wood chips quality showed for forest wood (42 %) and LCMW wood (45 %) similar results as other studies.
- LCMW wood chips have an average heating value of 19.1 MJ/kg and with that do not significantly differ from wood chips from forests.
- A new approach for the assessment of the potential of LCMW biomass for energetic use was developed, based on areal photos and terrestrial measures.
- The supply chain of energy wood from forest was optimized
- Innovative harvest techniques and optimized chipping procedures were tested
- Publicity work and presentations were held

### Description

The aim of this project was to develop and implement optimised mobilisation-, supply- and logistic- concepts for energy wood from forests and LCMW for a concrete region. For that, existing and innovative technologies and organisational approaches for the supply of energy wood were further developed and combined. During this process, all affected regional actors were involved.
<table>
<thead>
<tr>
<th>PRONARO</th>
<th>Link</th>
<th>Presentation</th>
</tr>
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<tbody>
<tr>
<td>Keywords</td>
<td>residual biomass, sustainable pathways</td>
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<tr>
<td>Period</td>
<td>2010 - 2011</td>
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<tr>
<td>Area</td>
<td>German; Nordrhein Westfalen</td>
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<td>Languages</td>
<td>DE</td>
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</tr>
<tr>
<td>Feedstock</td>
<td>Roadside vegetation</td>
<td></td>
</tr>
<tr>
<td>Approaches</td>
<td>Exploitation of previously unused biomass potential and avoid competitive uses</td>
<td></td>
</tr>
<tr>
<td>Useful Results</td>
<td>Good quality information for road construction departments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avoiding costly individual measures</td>
<td></td>
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<tr>
<td></td>
<td>Combination of individual measures rationalization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction of fixed costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimize the interference with the traffic</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>PRONARO – Comprehensive analysis of economically and ecologically sensible use of renewable resources on roadside areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remote sensing based analysis for the collection of Roadside vegetation and derivation of care concepts</td>
<td></td>
</tr>
<tr>
<td>Additional</td>
<td>Results available at University (TU) of Dresden</td>
<td></td>
</tr>
</tbody>
</table>
### Project for energy recovery of urban green in the municipality of Rome

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td><strong>Link</strong></td>
<td>Presentation here</td>
</tr>
<tr>
<td><strong>Keywords</strong></td>
<td>Municipality of Rome</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>IT</td>
</tr>
<tr>
<td><strong>Partner countries</strong></td>
<td>IT</td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>Straw, wood</td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>Project for valorization of public LCMW in the municipal area of the city of Rome. Maintenance works of roads and public parks integrated with railway and waterways biomass produce more than 50,000 tons of biomass /year. Biomass is burnt in 2 boilers for heating of public buildings (total thermal power is 1.5 MW).</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td></td>
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</tbody>
</table>

### Biomass Trade Centre 1 & 2

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Link</strong></td>
<td><a href="http://www.biomasstradecentre2.eu/Biomass-Trade-CentreII/">http://www.biomasstradecentre2.eu/Biomass-Trade-CentreII/</a></td>
</tr>
<tr>
<td><strong>Period</strong></td>
<td>2007-2014</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>EU</td>
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<tr>
<td><strong>Partner countries</strong></td>
<td>AT, HR, DE, GR, IE, IT, RO, SI, ES</td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>AT, HR, DE, GR, IE, IT, RO, SI, ES</td>
</tr>
<tr>
<td><strong>Feedstock</strong></td>
<td>Woody biomass</td>
</tr>
<tr>
<td><strong>Approaches</strong></td>
<td>The Biomass Trade Centre II project aimed at increasing the production and the use of energy from wood biomass by organizing motivation events. They engaged target groups to invest in biomass business and biomass logistic &amp; trade centres (BLTC) in 9 EU countries by presenting clear, integrated and market orientated information to potential investors: farmers and forest owners, forest entrepreneurs, wood energy contractors and other stakeholders regarding business opportunities to produce and sell energy products and services to the market. It also fostered wood energy contracting between biomass providers and potential users. 14 new biomass trade and logistic centres were build, 40 new BLTC are in progress – with technical support of this project. Energy contracting model in English available here. Energy contracting booklet in 10 languages here. Wood fuel prices (biannual collection) from 2011 to 2014 here.</td>
</tr>
<tr>
<td><strong>Useful Results</strong></td>
<td></td>
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</table>

### Biomass Policies

<table>
<thead>
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<th>Feature</th>
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<tbody>
<tr>
<td><strong>Link</strong></td>
<td><a href="http://www.biomasspolicies.eu/">http://www.biomasspolicies.eu/</a></td>
</tr>
<tr>
<td><strong>Integrated policies</strong></td>
<td>for the mobilisation of resource efficient indigenous bioenergy value chains</td>
</tr>
<tr>
<td>Project</td>
<td>Website</td>
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<td>------------------------</td>
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<tr>
<td>Infres</td>
<td><a href="http://www.infres.eu">http://www.infres.eu</a></td>
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<tr>
<td>bioenarea</td>
<td><a href="http://www.bioenarea.eu/">http://www.bioenarea.eu/</a></td>
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<tr>
<td>EUwood</td>
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<tr>
<td>Groen Gas - Grünes Gas</td>
<td><a href="http://www.groengasproject.eu">http://www.groengasproject.eu</a></td>
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<tr>
<td>BioRegions</td>
<td><a href="http://www.bioregions.eu/">http://www.bioregions.eu/</a></td>
</tr>
</tbody>
</table>
D4.1 Media Kit

According to the greenGain Communication and dissemination plan (D2.1), a special section should be added at the end of each deliverable in order to simplify its dissemination (Media Kit). The Media Kit shortly introduces the respective Work package and sums up the content and the results of the deliverable so it can be easily communicated with the public (e.g. on project websites).

<table>
<thead>
<tr>
<th>WP4 LCMW feedstock potential and best usage in conversion routes to bioenergy</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP4 comes with a top-down approach for mapping the LCMW feedstock potential as</td>
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<tr>
<td>a source of bioenergy. After gathering available data on the problematic,</td>
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<tr>
<td>performing interviews with experts and important actors and summarising the</td>
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<tr>
<td>status quo in EU28, the most important utilization pathways will be defined.</td>
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<tr>
<td>In the further activities, the economic and environmental aspects of those</td>
</tr>
<tr>
<td>pathways will be precisely described and the key success criteria will be</td>
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<tr>
<td>extracted in order to adapt them for other regions in EU28. With help of</td>
</tr>
<tr>
<td>newly gained information, scenarios for utilisation pathways under different</td>
</tr>
<tr>
<td>conditions will be analysed. Final stage of those activities will be drafting</td>
</tr>
<tr>
<td>business models for bioenergy value chains, which should foster the energy</td>
</tr>
<tr>
<td>utilization of LCMW biomass in EU28.</td>
</tr>
</tbody>
</table>

| D4.1. Report on the state of the art of the occurrence and use of LCMW material | |
| for energy consumption in Europe and examples of best practice | |
| The activities of greenGain should trigger exchange of knowledge on the LCMW | |
| biomass and the transfer of its utilisation strategies into further European | |
| regions. To support a more optimal treatment of LCMW biomass, the data on its | |
| potential, types and possible utilisation technologies need to be reviewed. The | |
| report on the status quo of occurrence and use of LCMW biomass contributes to | |
| this mission. |

The report is divided into two main sections, where the first section is a literature review of available information about the LCMW biomass potential, occurrence, technologies used for extraction & processing, and conversion technologies. Moreover, general observations to the problematic perceived during the research and challenges of the data collection are addressed. The review is accompanied with a collection of best practice examples and interviews with European actors, regarding their knowledge from all along the utilisation pathways, offering valuable descriptions of concrete practices and experience.

The second part of the report is constituted by an information database, which completes the literature review with references to further ongoing activities regarding LCMW. Therefore, a complex insight on the topic is provided, targeting a wide audience. The database presented in the report will
be extended continuously within the project duration and its actual version will be presented at the second project website – the greenGain Information Platform.  

**Results, outcomes and further use of the document**

The report provides a knowledge base on the topic of LCMW utilisation, which will be accessible to wide public on the greenGain website and the Information Platform. Moreover, it will be utilised in the next project actions, as a source of examples and experience from both research and practice.

**Visual materials**

- Review of available information
- Best practice examples and Interviews
- Database of Literature, Projects and Actors

Biomass from landscape conservation and maintenance work: Report on the Status quo of the occurrence and use in the EU28

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25The Information Platform will be launched in January/February 2016 and will be presented on the main project website [www.greengain.eu](http://www.greengain.eu)