BIOENERGY PROMOTION
Final report for Task 4.2
- Regional Bioenergy Potential -

The following document is the final report on Task 4.2 – Regional bioenergy potential, submitted by Taskleader Alexander Rosenberg, Lower Saxony Chamber of Agriculture
(BIOENERGY PROMOTION project partner 4)

Table of Contents

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I. Executive Summary

The coordination of Task 4.2 - Assessment of potential for biomass utilisation in regions – was taken over by the Chamber of Agriculture Lower Saxony, Germany (BIOENERGY PROMOTION PP 04) from the initially responsible Partner County of Nordwestmecklenburg (PP 06). At the WP 4-meeting in Hadeland/Norway May 2009, a 3-steps´ approach was decided, covering a qualitative description, a quantitative estimate and a sustainability assessement, the latter being based on criteria to be developed by Task 3.1 (WP 3 – Policy). Partners were asked to provide reports on those bioenergy resources which they regard as relevant for their (sub-)region within their specific expertise. In cases of more than one organisation active in a region, regional partners could decide on who would be responsible for reporting.

Bioenergy resource were pre-classified into types of land-use they are originating from and the level of processing to an energy carrier as main product, or as by-product or waste from processing for other purposes. For the 16 model regions, 22 project partners co-operated in providing more than 100 individual reports on specific bioenergy resources.

Particular attention was given to the feasibility of the regional approach (BE resources being imported into/exported out of a region), the defintion of waste as resource (when becoming a marketable product) and the role of peat, which was excluded from the definition a s bioenergy resource in the frame of the BIOENERGY PROMOTION project., Main actual and potential sources for bioenergy are agriculture and forestry, where energy carriers can be produced as a main or complementary product in a primary or secondary stage of processing. A considerable share of these resources as well as those from other types of land-use would be available without major impacts on food, fodder or material wood production, often even supporting other, e.g. environmental, goals. Therefore, ecological and social sustainability criteria are mostly fulfilled. However, economic sustainability will, on local and company level, in some cases of BE resources only be ensured, if financially stimulated by political decisions, taking into account the climate change mitigation and other positive environmental effects, otherwise, microeconomic and macroeconomic sustainability aspects would not always coincide under present economic conditions.

Task Leader 4.2 wants to express his gratitude to the reporting partners´commitment to this project work package and task.

II. Methodology

A. Definition of Task 4.2 in the Project Data Form/Application

In the BIOENERGY PROMOTION project application, Task 4.2 was described as follows:

> *(Task 4.2) Assessment of potential for biomass utilisation in regions: The potential for increased utilisation of biomass resources in the sub-regions will be assessed taking sustainability criteria into account. The preparation of a common methodology for data-mapping and assessment of the regional potentials will ensure that main resources from forest, agriculture and biological waste and by-products from agriculture and the food-industry will be included. Relevant results from other European projects could be used (e.g. REFUEL- they have done a European analysis on biomass availability.*

B. Links to other Tasks and WPs

Basically, Task 4.2 and the entire WP4 is dependent on the identification of (sub-)regions, as the basic goal for WP4 was described as:

> *For the rural regions biomass and bioenergy could be centres for regional development. Effective use of biomass shows new agricultural perspectives and creates regional employment. This work package aim is to develop regional value added chains and process chains in the area of biomass production (strategic management plan - biomass production concept). - compare developing conditions between different regions in the BSR area. - pinpoint regional trends, tendencies and differences regarding the main goal of a balanced Europe. - The results of the project will be compared and discussed at regional, national and European level (cf. WP4).*

The main cross-task links therefore were those in Task 4.1 – the identification of regions in general – and Task 4.4. - Business and Industry analysis. The WP 4 working group very soon realised that the (natural) potential and the processing capacity in the regions are intrinsically tied to each other, as a certain type of land use or crop would become a BE resource only through a specific type of management or processing. In contrast to the REFUEL-Project (www.refuel.eu) under the “Intelligent Energy – Europe” programme, which focussed on the transportation-related bioenergy potential under different scenario conditions, BIOENERGY PROMOTION and WP4 deal with the actual situation in partner regions and options, which are realistic under the given ecological, social, economic and political framework conditions. Those options and possible changes will, however, themselves give inputs to

Task	Definition	Effects from Task 4.2 and 4.4
Task 4.3	Regional network points	Information and training for increased use of bioenergy
Task 4.5	Feasibility studies and projects	Regions as testing grounds for changes and innovation
Task 4.6	Strategic management plans	Regional plans under the focus of promotion of bioenergy

Moreover, links between WPs can be found as follows:

The task description clearly refers to sustainability criteria, which in the framework of the project are to be identified under Task 3.1 and further Task 3.2, which leads to the policy related issues covered by WP3. Since regional BE potential and related business is subject to the current political framework, options and constraints for increased/improved use of BE, as identified in Task 4.2 (and 4.4), can provide valuable input to the policy recommendations as developed in WP3. However, the situation in the participating regions will probably not always reflect the situation in the whole particular country, and large parts of some partner countries are involved in neighbouring INTERREG regions (e.g. Poland, Germany, Sweden, Denmark), where theoretically, similar projects to BIOENERGY PROMOTION might lead to conclusions different from those elaborated in BIOENERGY PROMOTION.

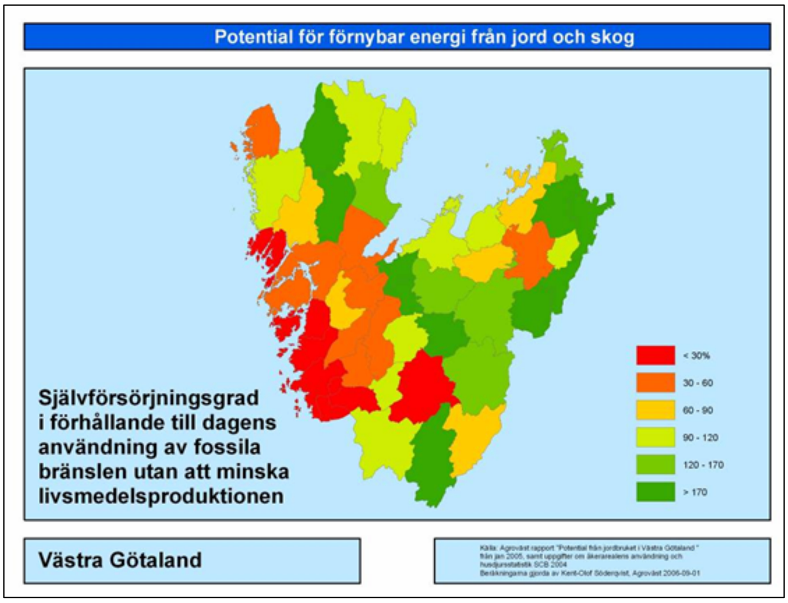
Both tasks 4.2 and 4.4 are also strongly linked to WP 5, as the use of the regional and natural BE potential might create transnational business contacts and investments.

C. The (sub-)regional approach

Not just specific transnational aspects, as represented in WP5, but also trans-regional viewpoints raise questions on the extent to which the regional approach and the concept of regional added-value chains are realistic and goal-oriented:

The (administrative) delineation of (sub-)regions has mainly arisen in accordance with historical, political, natural, economic, ethnic or/and various other parameters and has probably little to do with a natural regional linkage of natural potential/land management – processing industry – consumers of bioenergy. Trans-regional effects, however, are inevitable, if “biological waste and by-products from agriculture and food-industry” (Task 4.2 description) are to be considered.

As an example, in the City of Wismar, situated in the centre of the project region of Nordwestmecklenburg, a huge forest industry cluster is located, consisting of 6 sector-related companies, one of them being a large-scale wood pellet producer. This factory makes use of the immense sawdust resources from other local factories, which in their turn process roundwood mainly from outside the region and as much as 50% from Scandinavia, Poland, the Baltic States and Russia. The most of the pellets as a complementary product leave the region and are exported to other parts of Germany and western Europe. It does not seem useful to consider those activities as "regional biomass potential", and it seems questionable whether a business analysis should cover these aspects, since they are not part of a regional added-value chain. However, those companies are important under the transnational business development topics in WP5.



Another example is the project region of Västra Götaland in Sweden. The county was established as recently as 1998, when Gothenburg, Älvsborg County, Bohus County and Skaraborg County were merged. In terms of BE potential, the eastern part of the new region would be significantly over 100% self-sustaining from BE, compared with Gothenburg as an industrial centre and second biggest city in Sweden with <<30%, the regional BE potential balance thus being based mainly on a political decision.

For Task 4.2, it was therefore decided that the focus should mainly be on BE resources from the land-base of the specific region, though trans-regional effects cannot be completely avoided when dealing with residues and waste.

D. Participating BIOENERGY PROMOTION partners

The following partners have resources allocated for Task 4.2:

PP	Organisation	Country
02	JiLu tema Skog, Jämtlands läns Landsting	SE
03	Nordic Energy Research	all
04	Chamber of Agriculture Lower Saxony	DE
06	Landkreis Nordwestmecklenburg	DE
07	Potsdam Chamber of Commerce and Industry	DE
08	University of Rostock	DE
09	Research Institute of Food and Resource Economics	DK
12	Forest Development Centre Tapio	SF
13	Foundation Private Forest Centre Erametsakeskus	EE
16	Latvian State Forestry Research Institute "Silava"	LV
17	Vides projekti (State project management company)	LV
18	Latvia University of Agriculture (Latvijas Lauksaimniecības Universitāte, LLU)	LV
20	Lithuanian Energy Institute (LEI)	LT
21	Lithuanian Institute of Agriculture (Department of Plant Nutrition and Agroecology?)	LT
22	Institute of Fluid Flow Machinery (IMP PAN) and Baltic Eco Energy Cluster (BKEE)	PL

PP	Organisation	Country
23	Technical University of Koszalin	PL
28	Norwegian Forest and Landscape Institute	NO
30	The Energy Farm	NO
32	Naturbrukskansliet, Region of Västra Götaland	SE
35	Region Zealand	DK
36	Roskilde University (Roskilde Universitet, RUC)	DK
27	Grodno Regional Forestry Board	BY

Additionally, PP 11, University of Joensuu, contributed with valuable information for the North and South Karelian region.

In most cases, several national partners co-operated and shared the work of assessing and reporting on BE resources for the specific regions. The following report therefore will refer rather to the regions than to individual partners. For specific regional information, the following abbreviations will be used:

Country	Region	Abbreviation
Sweden	Västra Gätaland	SEV
Sweden	Jämtland&Västernorrland	SEJ
Norway	Hedmark & Oppland County	NOH
Denmark	Zealand	DKZ
Germany	Brandenburg	DEB
Germany	Nordwestmecklenburg	DEN
Germany	Rotenburg	DER
Poland	Pomorskie	PLP
Poland	West-Pomerania	PLW
Lithuania	Kaunas	LTK
Latvia	Tukums	LVT
Latvia	Jelgava	LVJ
Estonia	Saaremaa	EES
Finland	North-Karelia	SFN
Finland	South-Karelia	SFS
Belorus	Grodno	BYG

E. Classification of BE resources

In order to make reports and findings comparable, BE resources were classified according to the type of land use (and other sources) that they originate from, and their status in the production process.

1. Classification according to land use

As mentioned before, emphasis was laid on the regionality of BE origin, so the type of land use was chosen as a main criterion. The following classification was used:

Land-use	Specification
Agriculture	Covers also short rotation coppice
Forestry	Without short rotation coppice
Other professional land use	Any land use, not being agriculture or forestry, where primary production of crop or livestock is the main purpose (e.g. horticulture)
Land use other than production	Land use where primary production is not the main purpose, but may occur as a side-effect (e.g. coppice along roads)
Unused land	Land not dedicated to one of the former categories
Other sources (e.g. water-based)	Sources not clearly linked to the land basis of the region, e.g. floating organic material along shores;
Animals	Residues from food processing from imported animal sources

2. Classification according to processing level

Here, a 3 level basic classification was used and further divided into sub-categories:

1st Level Category	2nd Level Category	Specification
BE main primary product from corresponding type of land use	BE only possible product	No other options on the site, e.g. low quality coppice on bogs
	BE alternative use of land	BE is competing with other primary production (e.g. short rotation coppice vs. nature conservation)
	BE alternative product	BE is competing with other products within same land use category (e.g. short rotation coppice vs. cereals)
	BE alternative use of existing product	A specific product is used for BE instead of other purposes (e.g. wheat for bioethanol vs. food)
BE being primary, but not main product	BE complementary product	BE raw material which is generated together with the main crop but processed in at least one separate step.
	BE by-product	BE raw material which is generated together with the main crop in the same process
	BE waste from land use	BE raw material which is generated together with the main crop but would need removal and/or waste treatment if not used for BE (see H)
BE as a side-effect of further processing of main product	BE by-product or complementary product from further processing	BE generated in the course of production of other main product (e.g. sawdust)
	BE waste from further processing	BE raw material which is generated together with the main (industrial) product, but would need removal and/or waste treatment – see H

3. Matrix table and main foci of reports

The above-mentioned classifications were integrated into a matrix and the fields were used as the index for the classification of each reported BE resource. The qualitative reports (see 3-step approach F), as received from regions, distributed as shown in the following table:

Origin	Agriculture	Forestry	Other professional landuse	Land-use Other than production	Non-used land	Other sources (e.g. Water-based)	Animals	Total
BE only possible product	6	9	1	3				19
(alternative) use of land for BE	5							5
BE alternative product	8	4						12
BE alternative use of existing product	6	5						11
BE complementary product	2	14						16
BE by-product	4	7						11
BE waste from land-use	2			7		4	1	14
BE By-product from further processing	1	4						5
BE waste from further processing	2	3				5		10
TOTAL	36	46	1	10		9	1	103

Agriculture and forestry were regarded as main suppliers of BE, but also other non-professional land use, specifically nature reserves, infrastructural elements and difficult-access areas are a base for BE, mainly as a result of regular maintenance. In terms of processing, BE as the main product from land and as a product generated together with other crops are represented in similar frequency. Some of the reports described more than one or overlapping resources, so that the total of reports evaluated in each section does not correspond with this overview.

F. Considerations about peat as BE resource

Peat as energy carrier has a high relevance in Finland and in the Baltic countries. As it

- can be regarded as a resource between BE produced from actual vegetation and fossil energy, though having a biogenic origin from long ago in the Earth's past,
- is renewable in very low rates
- but has left the carbon cycle a long time ago

the issue has been discussed within WP 4 and communicated with WP 3 and on project leadership level. It was decided to exclude peat from being considered as BE resource in the framework of the BIOENERGY PROMOTION project. Exclusion of peat is in compliance with IPCC (http://www.ipcc.ch/pdf/glossary/ar4-wg3.pdf), the EU RES Direc.tive (DIRECTIVE 2009/28/EC) and the Global Environmental Facility (GEF).

G. 3-step approach

Task 4.2 partners/regions were asked to report those BE resources which are in the main the focus of the regions' and partners´competence. The reason was that some regions and partners have entered the BIOENERGY PROMOTION project because of a focus on one BE category where they have competence, experience and access to data. The idea of the Task 4.2 design was therefore to make similar features comparable across regions and facilitate region-to-region experience exchange rather than giving a mere description of the complete BE sector of each region, but with many BE resources having low relevance for the trans-regional and trans-national cooperation.

From May to December 2009, partners therefore were asked to report on templates to the following questions for each BE resources of importance:

Information on partner, region and category matrix ID

Step I: Qualitative description

- General description of bioenergy material
- General description of main production process

- Options, preconditions and consequences for increased use of this type of bioenergy resource
- Time frame for significantly increased bioenergy availability, if all preconditions fulfilled (1-3/4-10/> 10 years)
- Legal framework for production and legal aspects for increased production of bioenergy
- Main energy carrier, gained from this bioenergy resource, and basic processes for this
- Main end-consumer of energy for this resource and the described production process

In the case that BE material is regarded as waste under national law, an indication of the European Waste Code was required.

Step II: Quantitative description

- volume of this resource in typical units (tons, m³ etc.), as far as it is presently used for energy
- maximum additional volume of this resource in typical units (tons, m³ etc.), as far as it can realistically be used for energy
- volume of this resource in energy units (MWh), as far as it is presently used for energy
- maximum additional volume of this resource in energy units (MWh), as far as it can realistically be used for energy
- additional energy consumption in energy units (MWh), needed to increase the use of this bioenergy resource

The quantitative description could not be delivered for all BE categories and are, where available, in many cases rough estimates. The reason is that the BE sector largely forms part of the private economy, where figures, if not relevant for business, are not collected or not available for the public, regional authorities or the BIOENERGY PROMOTION partner organisations.

Step III: Sustainability Assessment

For this step, a set of (tentative) sustainability criteria was applied which was developed in Task 3.1 (WP3 – Policy). By mid December 2009, which was the editorial deadline for this sustainability assessment, only preliminary principles, criteria and 39 indicators were availableBelow the sustainability principles which were used for this assessment have been summarized[1]:

1. Biodiversity

• Biomass production and extraction shall not endanger biodiversity at the landscape6 level. However, special considerations to threatened species shall be taken at the local level. Biomass production shall whenever possible, strengthen biodiversity and contribute to an increased variation in the landscape.

2. Resource efficiency

• Natural resources, such as soil, water and land, shall be used efficiently and biomass production or extraction shall not endanger soil or cause further deterioration to water quality and quantity.

3. Energy efficiency

• For a sustainable production and use of bioenergy the energy balance shall be considered, with a special emphasis on the use of fossil sources during production of bioenergy. Input energy shall be minimized throughout the whole production chain and be distributed and accounted for on all products (main and by-products) based on an average product value proportion basis.

4. Climate mitigation efficiency

• Greenhouse gas emissions (i.e. emissions of CO_2, CH_4 and N_2O in CO_2 equivalents) from bioenergy production and use shall be minimized.
• Biomass production shall not endanger important carbon stocks and greenhouse gas emissions caused by land-use change shall be low in relation to the amount of greenhouse gas emissions that can be avoided over the long term.

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[1] For more information cf. the Task 3.1, Report: „Sustainable bioenergy production – defining principles and criteria (to be published in June 2010 on the BIOENERGY PROMOTION website)

5. Social aspects

• The production and use of biomass for energy shall not endanger food security or local production of biomass for other applications.

• Bioenergy production should not endanger the conservation of cultural remains and heritages or prosperity of local communities and cultures.

6. Economic issues

• Bioenergy production, extraction and use should contribute to an increase in rural activity and contribute to the development of viable business and security in energy supply.

Task 4.2 partners were asked to estimate their reported BE resources, whether the indicators would lead to a total, partial or failing compliance with the criteria. Considering economic aspects, basically a microeceonomic approach was used by reporting partners, which might not always comply with a macro-economic approach to sustainability of a bioenergy resource. However, a thorough analysis of all economic aspects, inlcuding social costs, would have overcharged the assessment, since the database would be rather weak and because of increasing effors to convert external social costs to internal costs on company level, e.g. through carbon emission trading.

H. Role of “waste” definition

An intensive discussion was conducted about the definition of “waste” in the context of certain types of BE. A valid perception could be that material cannot be waste if it is used for a special purpose. The taskleader therefore recommended the following definition for a consistent use of the term for demarcation of BE as “by-product” and “complementary product” from “waste”:

A BE by-product or complementary product

- is neither an unwanted nor undesired material or substance, not needing any kind of waste management such as control of collection, treatment or disposal (e.g. logging residues, which can also remain in the forest)
or
- there is a market for it, meaning that there are customers existing, not being authorities responsible for waste disposal and prepared to pay a positive price (> 0), e.g. used paper (alternatively to be recycled)
or
- at least one additional production process in order to convert the material to an energy raw material is applied - e.g. sawdust further processed to pellets.

In the case that national legislation still regards products under this definition as “waste”, partners were asked to comment on this and indicate the respective code of the European Waste Index http://www.euwas.org/content/e266/e1091/e6692/e6698/index_eng.html. The above mentioned definition was generated for practical reasons specifically for Task 4.2 and reflects specific problems, some partner countries may face if using related definitions, as given in the EU RES Directive, in the context of national legislation for waste removal, waste treatment etc. The Task 3.1 Report 6 on sustainability criteria will in detail deal with this issue. Basically, national rules should not hamper the use of substances of biological origin for energetic purposes, if there is a market for this type of biomass. However, key actors in this field will have to tackle the problem of changing market conditions for those materials, similar to the material use (e.g. “waste” paper – secondary fibre).

III.Main findings

A. BE from agricultural areas

1. Bioenergy from agricultural areas as only possible product

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☒	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**3**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

Reasons for BE being the only option for agricultural production can be:

Site conditions:

- Topography as steep slopes, which do not allow cultivation of any commercial crop; in former times, those areas might have been used as grazing land or for other crops, generally managed under extremely unfavourable conditions. Therefore the energy carrier today would mostly be woody biomass, which can be harvested in an extensive manner from time to time. In many cases a link might occur to parallel goals as nature conservation (code D1).
- Soil pollution and contamination, not making food or fodder production feasible for human or animal health reasons.

Legal aspects:

- Here, EU support for the set-aside of land was an incentive to make use of those areas by producing bioenergy.

For polluted areas, specific agricultural crops are possible, as Virginia Mallow or Miscanthus, but also woody resources as poplar, willow or Black Locust. On this type of area as well as on set-aside land, bioenergy production could be increased in short or medium range. However, this is completely depending from the EU agricultural policy and related financial support. Bioenergy from unfavourable sites will increase in a medium range because traditional agriculture will more and more be abandoned.

These types of bioenergy resource should be encouraged, since they are not competing with any kind of food or fodder production.

c) Figures for reporting regions

For #NOH, an increase of biomass from 3000 to 20,000 tons, 13,200 to 88,000 MWh accordingly, is estimated. Contaminated areas in #PLP are estimated as part of former non-used land as reported under Type A2.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Woody biomass from slopes	1000 t	660	660	Additional energy need not deducted, as hard to estimate

d) Sustainability Aspects

From a purely microeconomic point of view, sustainability will be mostly given only if this type of bioenergy is financially supported. In this case, however, it will also help to create jobs and income in rural areas. In general, it will improve biodiversity, though it will have selective impacts on species. The structure of habitats concerned should therefore be considered. Depending on the impacts, alternative set-aside of those areas would have impacts on soil structure and the water regime, and the carbon balance must be assessed.

2. Alternative use of land for bioenergy

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☐	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☒	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☒	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**3**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

For #PLP, considerable areas of former farm land are no longer used. Production of bioenergy could be an option to get those areas again under active management. Specific agricultural energy crops (Virginia Mallow, Miscanthus) as well as fast growing tree species (willow, poplar, Black Locust) can be considered. For #SFN and #SFS, fast growing trees are an option for follow-up land use on peat soils, where peat has been exploited for energy purposes. Depending on the availability of financial support, this resource could be significantly increased in a 4 - 10 year time frame. There is a broad range of possible energy carriers to be produced from this resource, such as wood pellets, briquettes or chips for consumption in CHP plants, private heating, farms and district heating systems.

c) Figures for reporting regions

For #PLP, an area of 150,000 ha of idle land is estimated, from which roughly 65,000 ha would be feasible for planting with fast growing willow. This includes a certain share of contaminated areas, as described for Code A1. Depending on the rotation period, 965,000 to 1400,000 t dry matter acc. 4.0 -

6.1 x 10^6MWh could be produced on this area. The additional energy consumption is estimated with 243 - 730 x 10^3MWh, so that an enormous net yield can be concluded.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Willow 1-3 year cropping	1 kg	5.2	5.4	Gross value; additional energy cons. not deducted.
Additional energy for establishment and maintenance of willow plantations	1 ha	3.4	8.4	Depending on rotation period
Additional energy for harvesting and chipping, drying of willow plantations	1 t	222.3x 10^3 MWh	182.8 x 10^3 MWh	Depending on rotation period

d) Sustainability Aspects

The re-establishment of management of unused agricultural land for bioenergy production can be considered economically sustainable, provided financial support is granted. Impacts on natural resources as soil and water as well as the carbon balance must be assessed for certain types of former idle land. Transport distances to consumers will influence energy efficiency.

3. Bioenergy as a product alternative to food or fodder production.

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☒	Lithuania	LTK	Kaunas
☒	Sweden	SEJ	Jämtland/Västernorrland	☒	Latvia	LVT	Tukums
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☒	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**8**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

For this category, two main types of crop were reported:

- Woody biomass from short rotation coppice (SRC)
  - Willow
  - Poplar
  - Hybrid aspen
  - Black Locust (Robinia pseudacacia)
- Specific agricultural energy crops
  - Reed Canary grass (Phalaris arundinacea)
  - Cannabis sativa
  - Sakhalin Knotweed (Reynoutria japonica)
  - Miscanthus ssp.
  - Sida (Sida hermaphrodita)

For **fast growing tree species**, in the case of willow and poplar plantations, cuttings, otherwise plants are used. High yield hybrids of willow, poplar and aspen have been bred in the last 10 years. Efficient equipment for the establishment of willow and poplar plantations using cuttings has been developed and is largely in use. For preparation of the site and maintenance of the crop, adapted agricultural technology is widely used. For initial improvement of the nutrient situation, in #LVT/#LVJ sludge can be applied. Efficient harvesting can be done by modified agricultural machines, as forage harvesters. Alternatively, traditional motor-manual tools can be used where high performance equipment is not available or not feasible due to the small size of areas or limited accessibility, and chipping can be carried out with multi-purpose wood chippers.

In #DEB, short rotation coppice is an option on marginal sandy sites and also prevents erosion. For #LTK, the impact on an existing drainage scheme is mentioned as a limiting factor. Willow, poplar and Black Locust is usually grown and harvested in a 2 - 5 year rotation cycle, which allows appr. 3 - 5 times natural regeneration from the stump without any need for artificial regeneration. Moreover, the annual natural nutrient circulation of deciduous species makes fertilizer application after the initial preparation unnecessary. Hybrid Aspen is usually grown in medium rotation periods of 10 - 25 years (#SEJ, #LVT, #LVJ) and might need expensive fencing against game damages (#SEJ).

All reporting regions emphasize the impact of related legislation both on national and EU (CAP) level, as farmers and other land owners would avoid the effect of farmland becoming legally converted to forestry through the establishment of tree vegetation. Meanwhile, in the framework of EU CAP the establishment of SRC does not endanger the option of receiving agricultural support when returning to food or fodder production, though support to the SRC bioenergy production as such will probably not be continued. In intensively managed agricultural regions as #DER, farmland is in any case indispensable for fodder production and SRC will play a marginal roll. The national legislation in respect of the legal character of SRC is in some cases unclear (#SFN, #SFS) or in transition (#DEB, #DEN, #DER), but with a trend to define SRC as agricultural land use, which might have the effect, that it is not allowed on forest land.

The main energy carrier, generated from SRC, is woodchip for district or individual heating boilers as well as farms or a heat source for industry. The use for CHP is increasing. For #LTK, also the production of pellets and wood briquettes from SRC material is relevant.

Specific agricultural energy crops are mostly grown with similar techniques as food or fodder, except for those crops which have to be planted similarly to trees, such as Miscanthus. For #SEJ and #PLW it is assumed that those crops will on average have a higher demand on soil quality than SRC.

c) Figures for reporting regions

There is a broad range of reports from regions about how far SRC can increase: Whilst #SFN and #SFS condider it to remain in a marginal position, mainly due to competition with natural gas from Russia, #DEB, #LTK and #LVT / #LVJ expect a considerable increase, depending on supporting decisions at EU level. In #LTK, at present 10 ha have been planted with 100 to/ha dry matter and an energy content of 53 MWh, but the potential up to year 2020 is estimated to be as much as 1000 ha, corresponding with 5.3 GWh. For #SEJ, the future area of abandoned farmland is estimated at 20,000 ha, from which 10,000 ha could be planted with hybrid aspen which would generate 16,000 m^3 of energy timber corresponding to 400 GWh.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Hybrid Aspen (cbm wood)	1 m³	2.5	2.5	Rotation period 20-25 y
Willow SRC Chips	1 m³	0.78	0.78	20% moisture
Willow SRC Chips	1 to	3.4	5.3	20% moisture
Willow SRC Chips	1 to	1.2	1.2	Green (50% moisture)
Agricultural energy crops	1 to	5	5	Dry matter

d) Sustainability Aspects

For both categories of alternative energy crops (SRC and specific agricultural crops), the criteria for economic sustainability are largely estimated to be fulfilled. For the latter, similar to food and fodder production, environmentally sound management methods must be considered to avoid problems such as nutrient leakage (#SEJ), and the climate mitigation effect should be assessed against the background of alternative agricultural production (#PLW). For SRC, improved biodiversity can be assumed (specifically for willow), compared with intensive food production, and there is little human interference in the ecosystem throughout the whole period of an SRC plantation. Positive impacts on the water balance and mitigation of erosion on sandy sites can be expected. However, the effects of rapidly changing land use on SRC at the landscape scale must be considered, according to #LTK opinion. Although bioenergy can create income and jobs in rural areas, profound changes in land use may have considerable effects on social aspects, which at present are difficult to estimate. For #PLW, a good public information and participation policy seems necessary. In terms of energy efficiency, energy consumption for transport, depending on the development of local bioenergy consumers, must also be considered (#LTK).

4. Bioenergy as an alternative use of crops which could be used for either food or fodder

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☒	Sweden	SEV	Västra Götaland	☒	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☒	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☒	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**21**
☒	Poland	PLW	Westpomerania				

This category of bioenergy resource is in competition with the alternative use for foods for humans or animals, mostly livestock, or even for material use. However, some types of crop in this category have less importance in competition with other uses than others, e.g. oil-yielding crops (rape, sunflower, flax). Extended cultivation of these crops brings it close to the category according to code A 3.

b) General qualitative description

There are four sub-categories reported by partners:

- Fermentation of green biomass or biomass silage to biogas (often in combination with manure), with methane as the main component, reported for #SEV, #DEN, #DEB, #LTK, #PLW
- Starch extraction and generation of bioethanol after breaking down to glucose and its fermentation, reported for #PLP, #LTK, #LVJ, #LVT, #DEB
- Vegetable oil extraction from oil-yielding plants, with the option of further processing to biodiesel after catalyst dissociation and addition of methyl alcohol to rape methylester, reported for #NOH, #DEN, #DEB, #PLP, #LTK, #LVJ, #LVT,
- Direct combustion of cereals, reported for SEV

For the **biogas** line, heat production, possibly in cogeneration with electricity, and, after (expensive) cleaning also use for transportation (according to #SEV also for public transport) is of interest. #DEN reports, that there is a German quality standard for biogas. For most regions, maize is the main crop to be used, but #LTK also mentions perennial grasses such as *Dactylis glomerata* and *Festuca arundinacea*. In all cases, silage is commonly in use in the conservation process, to make the raw material available also after the harvesting period. For Germany, #DEB reports restrictions affecting availability of manure in co-fermentation, whereas legal limitations of the conversion of grassland to arable land in combination with reduced milk production might improve the availability of grass as a resource for biogas.

For the **bioethanol** production line, maize, sugar beet, (winter) wheat, (winter) rye, barley (only #DEB) and triticale are reported as raw material. The production is based on the usual agricultural methods. For maize, the harvester must be able to separate the corn grains (#PLP). In #LTK, triticale has been found to be the most efficient for bioethanol. It requires only moderate soil conditions, compared with resources like wheat or sugar beet, which can be grown in crop rotation (#PLP, #DEB, #LTK). Specific cultivation of crops for bioethanol, however, is dependent on the presence of a treatment plant at a reasonable distance which is prepared to sign an agreement with regional farmers. In contrast to the situation with biogas or vegetable oil for engines, bioethanol cannot be produced on a small or even farm scale. Whereas there is a bioethanol plant available in #LVJ, there are none in the #LVT region. Also for #DEB, the absence of a bioethanol plant is an obstacle to increasing this bioenergy resource, though a number of fuel stations are available in this and neighbouring regions. For big investments, market conditions and the political framework (e.g. compulsory admixture to conventional fuel) are uncertain, as some regions, as #PLP, #LTK, #LVT, #LVJ, emphasize.

For the cultivation of oil yielding plants for the production of **vegetable oil/biodiesel**, suitable crops are rape seed (winter rape, spring rape), sunflowers and flax, the latter mentioned by #PLP as an option for less fertile soils. Not neglecting ecological concerns, #LTK would expect a high potential for yield increases in genetically modified varieties of rape. However, cultivation of crops like rape require a high level of professional knowledge. Besides the hot pressing technology and the esterification to biodiesel, which require processing on an industrial scale, cold pressing technology can be applied at the farm level, generating fodder as a by-product (#LVT). The fuel can be widely used for heat/electricity co-generation and any kind of engine, and the use of adapted motors for vehicles as well as availability of fuel stations with standardized fuel (#DEN: EU, but also national standards) is well established. For bigger amounts of this bioenergy resource in transportation, however, political decisions such as compulsory admixture to conventional diesel (#PLP) will again be crucial. Not only the market competition with fossil fuels, but in regions with intensive livestock farming, the demand for animal foodstuff will have a significant influence on both supply and demand for oil-based bioenergy.

Direct burning of cereals was reported only for #SEV. It takes place generally in exceptional cases, e.g. very low grain prices, and can be done on a small scale or in district heating facilities. This option is subject to the serious ethical concerns of the public[2].

c) Figures for reporting regions

#DEN expects a dramatic increase in maize silage yields from 58,000 tonnes up to 116,000 tonnes within a 3-year time frame. For #LTK, the amount of green mass from perennial grasses could increase to 40,000 t, though it is starting from a low level due to a lack of biogas plants. In the sub-regions of #DEB, the increase of grass silage for bioenergy purposes is expected to have a factor of 2.5. For bioethanol from maize, #PLP calculates that 67% of the energy gained is consumed in the production process.

In #DEN, starting from a level of 32,190 tonnes of energetically used rape seed, an increase of 2% can be expected within 4 - 10 years. #PLP calculates the additional energy consumption for an increased production of biodiesel of 66%, of which 14% is used for the cultivation of the crop and 52% for the biodiesel production. In #LTK, an increase from 29,000 ha to 55,000 ha of oilseed is a rough estimate, of which appr. 50% could be processed to biodiesel, which would give 19,500 tonnes (210,000 MWh). For #LVT and #LVJ, an increase in oil seed cultivation is expected to be slow with an average of 10%/year.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Maize silage	1 to	1.1		
Perennial grass	1 to	0.85		
Cereals for bioethanol	1 to	2.11	4.84	
Wheat for bioethanol	1 to	1.3		Net output; production/consumption 2:1
Rape seed/biodiesel	1 to	3.2	10.7	

d) Sustainability Aspects

For **biogas** from maize, social (including recreation and landscape design) and ecological (monocropping; water pollution through fertilizer and slurry) consequences are considered neutral or even critical in #SEV and #DEN, though economic sustainability criteria seem to be fulfilled. In contrast, biogas from grass would help to accord some grasslands with a lot of positive aspects for the landscape, habitats, groundwater protection and lower risk of erosion. Against the background of alternative food production, most sustainability criteria of **bioethanol** production are seen as neutral and for #LTK and #PLP, positive for energy and resource efficiency. However, increases of this kind of bioenergy production should not happen in areas with high carbon stock. For **oil yielding plants**, there are certain concerns about ecological sustainability, since these crops require intensive management and fertilizer applications (#DEN). #LTK and #PLP see most of the ecological and social sustainability criteria balanced, with resource and energy efficiency even positively rated. Economic sustainability criteria will probably be fulfilled, as oil-based fuel is already well established. The **direct burning of grain** will probably remain a problem under social sustainability aspects due to ethical concerns.

[2] Though traditionally huge agricultural areas must have been used for bioenergy - foodstuff for horses, the most important means of production and transportation in agriculture, forestry, transportation, mining etc. For agricultural work alone, a general estimate was 20% of the farmland to be dedicated to foodstuff for horses. (Author´s comment).

5. Bioenergy from complementary products in agriculture

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☒	Sweden	SEV	Västra Götaland	☒	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☒	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**7**
☒	Poland	PLW	Westpomerania				

b) General qualitative description

The definition chosen for this category was that it should not be the main product, but, in order to become a resource, be subject to at least some kind of special treatment. For #DEZ, #DEB, #NOH and #SEV, for example, a certain proportion of straw usually is ploughed into the ground to ensure carbon balance and in some cases may be burned on the field. Collection, packaging, separate transportation and storing thus is a special treatment, required for the use for bioenergy (and other uses). Established agricultural technology is available and applied. Most regions expect an increase in the energetic use of straw in a 1 - 3 year time frame. The burning of straw is usually carried out in farm-based special straw boilers or in rural district heating systems. For #PLW and #PLP, pellet production from straw is relevant, easier to store, and can increase sales also beyond the range of rural consumers. For #DEB, one option is to use straw even for BtL processes (bioethanol, biodiesel) similar to woody biomass.

c) Figures for reporting regions

For #DKZ, about 2/3 of the total straw volume is used in regional CHPs and also in those located in the neighbouring capital of Copenhagen. In #LTK, starting from a present annual consumption of about 2000 tonnes, an increase up to 75,800 tonnes (15% of the total volume) would be possible, provided that the number and capacity of boiler houses rises substantially. About 54% of the produced straw was used on the farms themselves in #PLP in 2002. Out of the remaining volume of 46% the bioenergy use could make up to 30%, assuming a maximum total of 347,000 t/year of straw. In #DKZ, a recently established bioethanol plant is intended to convert 30,000 tons of biomass, mainly straw, into bioethanol, solid fuel and animal feed. Other consumers in the region are:

Plant	Annual straw consumption (1000 tonnes)
Masnedø CHP	40
Maribo-Sakskøbing CHP	40
Slagelse CHP	28
Haslev CHP	26

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value GJ		
Straw	1 to	3.3	4.2	
Straw	1 m³	2.8		

d) Sustainability Aspects

Since straw is a complementary product to cereals, no concerns are expressed regarding ecological sustainability criteria. Depending on soil characteristics, however, intensified use of straw for energy purposes could lead to a depletion in nutrient supply and deterioration of physical properties. As an additional resource, energy and resource efficiency are regarded positively. From the economic point of view, some additional income and job opportunities may be created in rural areas through additional manufacturers of specific equipment and logistic services. However, the increased use of straw should not result in the cultivation of crops on account of land use with higher carbon stock.

6. Bioenergy from by-products from agriculture

a) Reported Regions:

Rep	Country	Abbr	Region	Rep	Country	Abbr	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**1**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

The definition given referred to those resources, which do not need any major processing to become a bioenergy resource but are co-produced with the main product. For #NOH as the only reporting region, cereal clearings in grain mill could be a resource. As the material is available in grain mills which often are centrally located, the material could be burned in district heating boilers, directly linked to the mill. Those boilers, however, have to be designed to deal with slagging.

c) Figures for reporting regions

For #NOH, a considerable increase from currently 100 tonnes (400 MWh) to 2,400 tonnes (9600 MWh) with almost no additional energy consumption is estimated.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Cereal clearings	1 to	4.0		

d) Sustainability Aspects

As a by-product, no major influence on ecological or social sustainability is expected, whereas the economic value would increase, as the material often is regarded as waste.

7. Waste from agricultural land-use

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**2**
☒	Poland	PLW	Westpomerania				

b) General qualitative description

#NOH here reports a non-homogenous raw material, which can occur in different types of agricultural or horticultural land use, such as unused fruits and vegetables, and also in mixtures with grass from weeding, woody material from fruit tree cuttings etc. The resource could be used in biogas plants or as firewood. #PLW refers here to orchard waste.

c) Figures for reporting regions

Taking these materials into account, considerable additional volumes of bioenergy could be gained. A rough estimate for #NOH estimates an increase from 20 t 3000 t, corresponding with an energy content increase from 88 MWh to 13,200 MWh. Only about 2% of this additional energy would be used for the specific exploitation beyond the energy, that is used during removal etc. For orchard waste, 32,828 m³ are estimated at present in #PLW, corresponding to 7000 MWh of bioenergy.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Mixed agricultural waste	1 to	4.4		Very rough estimate
Orchard waste	1 m³	0.2		

d) Sustainability Aspects

Not many criteria will be affected; there is probably good energy and resource efficiency and reduction of the need for waste disposal will improve ecological sustainability.

8. Bioenergy from further processing of agricultural products

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☒	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☒	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**7**
☒	Poland	PLW	Westpomerania				

b) General qualitative description

This section deals with manure, often mixed with other organic matter from agriculture – manure being a kind of by-product from the further processing of primary production through animal digestion. The process of energy production is anaerobic fermentation with biogas as the energy carrier. If the dry matter content exceeds 15%, dry anaerobic digestion can be used, which has advantages in terms of waste water generation, transport of fertilizer and the scale of the plant (#PLP). Manure is mixed with other secondary material from livestock farming (e.g. spoiled straw up to 50% for #DEN). In many cases, manure is fermented together with organic material from primary production (silage). The main energy carrier is biogas or biomethane (depending on consumer´s technical requirements) for combined heat and power production, for heating private households or as a vehicles fuel. Electric power can be supplied to the individual power grid (e.g. farm) or the public grid, where remuneration may contain an RES incentive. This, and thus profitability, is dependent on political decisions. Residues are used as fertilizer. This type of energy can be produced at the farm scale and such farms can operate as a network supply for district heating boilers. At the industrial level, such biogas plants are also run using waste water sludge.

Due to increased meat production, manure is available in large amounts but for #SFN, there is still a risk that livestock composition might change and affect availability of slurry.

c) Figures for reporting regions

Considerable volumes of increased biogas generation are possible in #PLP, 11.6 to 217 million m³/year corresponding to 55,600 MWh (50% power) to 1.39 MWh/year. #LTK has a potential to produce 5.9 million cbm biogas (35,400 MWh), but no biogas production at all currently. For #DEN, the present volume of 38,500 to could almost be doubled in size to 70,000 tonnes (4620 MWh to 3788 MWh). However, there are considerable energy losses in CHP (efficiency 39%), power generation (efficiency 90%) and power transmission (loss is about 10%).

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Pig manure	1 to	0.2	0.5	
Pig manure	1000 cbm	4.8	6.0	

d) Sustainability Aspects

The conversion of manure to biogas is in all reporting regions regarded as positive or balanced regarding sustainability aspects. Ecological aspects include the reduction of surplus of organic fertilizer which otherwise could lead to nutrient (N, P) leakage and odour problems. Biogas supply networks can provide local energy for villages, public buildings and SMEs in rural areas and create and support small trades and services. It could help to meet needs for increased RES utilisation through local producer-consumer cycles.

9. Waste from further processing of agricultural products

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**1**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

For #NOH, slaughterhouse waste is mentioned as an add-on in biogas plants

c) Figures for reporting regions

No detailed figures are available about this resource. A rough estimate could be 60,000 tonnes, although the material is currently not used at all.

d) Sustainability Aspects

Due to reduced space for waste disposal, ecological aspects may be improved, provided that the procedure is able to avoid risk of spreading diseases.

B. BE resources from forestry

Common aspects for almost all forestry-related resources are:

- Demands from certification (CEPF, FSC, National standards): A certain amount of dead wood should stay in the forest (#NOH)
- The use of woody material for bioenergy will reduce nutrient supply more than commercial harvests, since quantities of the material are low and have a relatively high proportion of bark and often also needles/leaves, the main nutrient carrier. Therefore, wood ash recycling is highly recommended. The EU LIFE project RECASH has in depth explored the problem and compiled recommendations for ensuring sustainability of the natural nutrient resources. A handbook is available on http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=brochure&fil=Recash_International_Handbook_Final2006_EN.pdf.
- Many bioenergy resources from forestry are bound to certain stages or periods of a forest stand´s life cycle. Resource sustainability in those cases must therefore be understood as a cyclical (even > 150 years) rather than a continuous process (e.g. bioenergy from pre-commercial thinnings in oak stands).

1. Bioenergy as the only possible product from forestry

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☒	Sweden	SEJ	Jämtland/Västernorrland	☒	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☒	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☒	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☒	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☒	Finland	SFS	South Karelia
☒	Germany	DER	Rotenburg	☒	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**14**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

Unlike agriculture, forestry can produce different grades of wood products at the same time or/and during different phases of a stand´s life cycle. Bioenergy as "only possible" in this section therefore covers also resources which appear under special circumstances, such as low age, natural disasters etc. Those resources are available independent of regular harvest operations and would not compete with the material use of wood. A sub-classification shows reasons for appearance of this resource:

- Age
  - Pre-commercial thinnings (#NOH, #EES, #LVT, #LVJ, #SFN, #SFS, #SEJ, #DER)
- Second storey trees
  - Deliberately established for bioenergy purposes (#SEJ – upper storey birch!)
  - Natural regeneration, especially when having negative impact on management and/or biodiversity
    - of domestic species (e.g. Grey Alder – *Alnus incana*) (#BYG, #LVT, #LVJ)
    - of invasive species (e.g. Black Cherry – *Prunus serotina*) (#DER)
- Low quality wood
  - Stands without commercial use, possibly to be re-designed (#BYG)
  - Trees which are left after commercial harvest (#BYG, #SFN, #SFS, #NOH)

    - Trees damaged through natural disasters (#BYG)
- Maintenance of forest side areas with removal of trees and shrubs
    - Forest roads and timber landing places (#NOH, #LVT, #LVJ, #DER)
    - Ditches (#LVT, #LVJ)
    - Power lines (#EES, #DER)
    - Open habitats in forests (#NOH, #EES)

- Pre-commercial thinnings:

For #NOH and #SFN/#SFS, use of this material is feasible because of financial support granted on condition that the material is used for bioenergy. Such support is provided also for #ROW, but *on condition that no commercial use* is made from the material. Here, a difference must be made between conifers and broadleaves, as bioenergy from the latter often is generated as firewood, as opposed to from woodchips in most of the other cases. #SFN/#SFS also refer to the parallel harvest of bioenergy wood with pulpwood in one operation. #LVT/#LVJ report a maximum upper stand height of 8 m for receiving national and EU funding for pre-commercial thinning operations.

Swedish investigations even consider two pre-commercial thinnings as there will be a small additional increment of growth which can be used for bioenergy in the second operation. #LVT/#LVJ report experience with Scandinavian feller-bunchers and pre-drying of the material at the roadside. This measure is usually still carried out with brush cutters, and e.g. in #SEJ there is a lack of skilled staff for this type of operation.

- Second storey trees

For #SEJ, there is a good option of growing birch and spruce simultaneously with birch going ahead in growth. This requires removal of most of the birch after some years and is a good opportunity for bioenergy use. Bioenergy from the understorey can be obtained from natural regeneration of shadow tolerant species and from those that hamper management, as regeneration of commercial trees or marking and harvesting in commercial thinnings. In #BYG, #LVT and #LVJ, White Alder is such a species, whilst #DER would like to remove Black Cherry, which was widely introduced from NE USA in the middle of the 20th century and now is regarded as a “forestry weed”. Investigations in #DER show, however, that the woody mass volume is so low, that bioenergy would not cover costs; utilisation of this resource thus must be co-financed through less expensive regeneration or thinning of the main stand.

- Low quality wood

In #BYG and #LVT/#LVJ, Grey Alder is very common, densely regenerating from sprouting. There is almost no commercial use to be made from this species, except bioenergy. In #BYG, Grey Alder is often growing along water courses, which might worsen accessibility, and even more in the future because of climate change effects. Low quality wood may also occur due to natural disasters (#BYG, #SFN, #SFS, #NOH). Those trees may be harvested for bioenergy individually or in connection with tops and branches (code A5) from normal thinnings or clearcuts

- Maintenance of forest side areas with removal of trees and shrubs

For bioenergy in connection with forest road maintenance, a study was conducted at the Swedish University for Agricultural Sciences (SLU)
http://ex-epsilon.slu.se:8080/archive/00003225/01/Arbetsrapport_243.pdf
with the result, that natural regrowth along roads with less than 3cm would lead to a negative economic result and the effect of improved road quality has to count as a complementary financial effect. Generally this will more or less be the background for most of similar situations, where otherwise only maintenance has to be financed, e.g. under power lines (#EES) or for nature conservation purposes (#NOH). However, increased awareness should be developed for this resource, which is often easy to access (roads, power lines).

c) Figures for reporting regions

In #SEJ, more than 100,000 ha of young stands are in acute need of pre-commercial thinning, whereas under regular management conditions 40,000 ha would be normal. For #BYG, the bioenergy use of Gray Alder of currently 94,700 m³ could be increased by about 12%. For #LVT a potential of 8000 tonnes (≈35,000 MWh), for #LVJ of 15,000 tonnes (≈12,000 MWh) annually is estimated with an additional power consumption of only 3.4% of the energy obtained. The potential of wood from pre-commercial thinning for #SFN is roughly 95,000 m³ annually, from which about 45% is used for bioenergy under subsidised conditions. This share will increase to 65% within the next 5 years. In #SEJ, these resources are not used at all at present, but have a potential of 800,000 m³ ≈ 2000,000 MWh.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Woody biomass	1 to dry matter	2.2		Mainly small-dimensioned
Woody biomass	1 m³	4.000	4.375	Mainly small-dimensioned

d) Sustainability Aspects

Most regions estimate that social sustainability aspects will by positively affected through those resources as more jobs are created and recreational use in forests (e.g. through road and habitat maintenance) is improved. The broad range of resources of this type, however, induce a need for detailed assessment of ecological issues: For #DER e.g. removal of Black Cherry undergrowth, an introduced species, would be desirable, whereas that of e.g. beech would cause deterioration in the microclimate, nutrient circulation and habitat functions. Almost as a rule, economic sustainability is not guaranteed without either financial support or positive financial side effects, e.g. from infrastructure maintenance.

2. Forestry bioenergy after land-use change

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☐	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☒	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**1**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

Only for #BYG, conversion from agricultural land to forestry with the main goal of bioenergy production is discussed. Domestic species such as pine, spruce and birch would be used. Management is based on usual forestry technology.

c) Figures for reporting regions

Over a long time scale (> 10 years) an outcome of 10,000 m³ might be realistic for #BYG

d) Sustainability Aspects

This resource must be seen in comparison with the opposite approach – SRC on former forest land as well as afforestation of farmland for traditional sustainable forestry.

3. Forestry-based bioenergy as alternative product to wood material

No reports were received for this option. Theoretically, this could mean growing SRC on forest land. This, however, would according to legislation in most countries be regarded as agriculture and mean a land use change. It is already covered under A3. For #DER, the question was discussed about growing SRC on forest areas where no high trees are allowed to grow, e.g. along highways or under power lines, classified as “non-productive forest land”. But even here, a permit for land-use conversion would be needed and stakeholders do not see a need for driving such an option.

4. Bioenergy from forests as alternative use of existing products

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☒	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☒	Finland	SFS	South Karelia
☒	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			7
☐	Poland	PLW	Westpomerania				

b) General qualitative description

There is a smooth transition between B4 and B5/B6, as the decision between bioenergy or industrial use of small-dimension wood for some (coniferous) grades is dependent on market demands and prices. In this section, only reports from partners who have explicitly mentioned bioenergy as an alternative to industrial use were reflected.

#SFS highlights the dependence of the use of bioenergy on the actual market situation. For #DEB, the competition between bioenergy and industrial use will significantly increase with decreasing resources. Whereas woody bioenergy is harvested by highly efficient equipment and chipped (in the stand, at roadsides or in a yard), there is a growing demand for traditional fuel wood from private operators equipped with chainsaw, axe and, for transport, car and trailer. This caused a number of severe accidents, as those persons are not always experienced and take necessary precautions. There is an unclear situation concerning responsibility and insurance. In #SEJ, a clear dependence on the price for fossil fuels creating competition for pulpwood is observed. In this region, promising approaches have been made to generate fuel from black liquor from the pulp industry. This means that a low price for pulpwood would affect two different types of bioenergy in opposite directions. For bioenergy assessment, the mutual dependence on pulpwood – pulp – black liquor is a potential source for errors through double counting of parts of the same resource. For #NOH, at present problems in the paper industry is reducing the competitive situation.

The industry/bioenergy competition is a highly relevant topic in Poland: #PLP reports, that clear preference is given to the industrial use of wood, as added-value generation is much higher than for bioenergy. This concept can be largely implemented in the region, as 78.1 % of the forest area is State owned. Moreover, energy consumers who have to prove a certain share of renewables have to exclude woody biomass from forestry or forest industry in the calculation, which certainly discourages the increased use of that resource. In Poland, wood fuel is classified, and category S4 would be applicable for the grade in question.

c) Figures for reporting regions

Depending completely on the market situation, #SEJ as an example calculates that if 50% of the present pulpwood volume was used for bioenergy, roughly 2,400,000 m^3, corresponding with 6 TWh, could change use. The energy consumption involved would be less than for industrial use. In #PLP, in 2007 227,779 to (350,429 m^3 ≈ 506,178 MWh) of wood fuel was used, of which 114,129 to (175,584 m^3 ≈ 228,259 MWh) was S4 type. For #NOH, an increase by 900,000 to ≈ 3,800,000 MWh at an additional energy input of 200,000 MWh can be estimated, but is significantly dependent on the market situation.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Pulpwood	1 m^3	1.3	2.5	
Pulpwood	1 to	4.2		

d) Sustainability Aspects

In #SFS, increased use of pulpwood for bioenergy will considerably change the situation for the local population and have impacts in biodiversity. The use of bioenergy instead of industrial activity will rather reduce income options, but according to #SEJ, create other job opportunities. For #PLP, ecological sustainability criteria are fulfilled, whereas the preference for industrial use, favoured politically, implies the assumption of a loss for economic and social aspects.

5. Bioenergy from forestry as complementary product

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☒	Lithuania	LTK	Kaunas
☒	Sweden	SEJ	Jämtland/Västernorrland	☒	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☒	Latvia	LVJ	Jelgava
☒	Denmark	DKZ	Zealand	☒	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☒	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☒	Finland	SFS	South Karelia
☒	Germany	DER	Rotenburg	☒	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**25**
☒	Poland	PLW	Westpomerania				

b) General qualitative description

This resource is the most important in the forest sector. In covers mainly logging residues and, to a limited extent, stumps. For logging residues, there is a transition to grades which could also be used for industrial purposes, as described under B4.

According to national rules, in #PLP this material is classified as M1 and M2-type. It is mainly collected by private consumers, mechanical harvest is rare and limited to bigger areas. The exclusion of this woody bioenergy from RES accounting is not applicable for energy (heat and power) plants < 5 MW, so that personal use of small-dimensioned residues is attractive.

For #DER, 4 ways of technical harvesting are more or less established:

1. chipped at skidding road, chips transported to drying place or heating plant (able to burn moist chips)
2. bunched and dried in forest/transported to plant and dried, chipped subsequently
3. stored on stacks, chipped after pre-drying (needles dropped), transported to after-drying place or heating plant
4. cross-cut with chain saw for conventional wood fuel. Further processing and drying in forest or at farm/private house, using chainsaw, axe or circular saw, hydraulic splitter or combined equipment, possibly with feeding and collecting equipment, packaging etc. Drying on stacks in forests or at farm, or under roof, or with additional hot air ventilation (e.g. from biogas)

The latter described use of this material is very similar in #LTK, #DEB, #DER and #SFN and due to a good forest road network, the resources here are easily accessible. However, safety rules and certification requirements (leaving deadwood and single trees) can be a critical issue. For #BYG, the allowable cut in total is $1m^3$/ha per year of which about 10% can estimated as branches and tops, suitable for bioenergy. With the annual volume increment rising, the total amount of bioenergy will increase in future. FSC-certification rules for retaining single trees or tree groups on certain sites must be considered.

For #LVT and #LVJ, too, a share of 10% of the roundwood harvested for bioenergy wood is estimated. Chipping at roadside is common, but bundling technology is increasing. Firewood is often sold with a high moisture (40%-50%) as most private consumers have drying possibilities down to 30%. Parts of the slash is chipped, but due to low quality, the chips must often be exported to Sweden, where CHP plants can tolerate higher ash and moisture contents. A certain amount can also be used as admixture for wood pellets. Stumps can be additionally harvested with caterpillars. A big resource are stumps on road constructions sites, where no risk for soil deterioration will occur.

#NOH expects a considerable increase of this type of bioenergy where a good network of forest roads is available. Forest owners' associations already now provide a full service for harvesting, processing and logistics for bioenergy from slash. Market price will be the main driver of this development. In #SFS, about 70% of the mass of branches and tops are piled to bunches and so will dry along forest roads for 1-2 years.

In #SEJ, 31% of the annual clearcut area is cleaned for slash, using high performance technology, usually run by the same contractor who has carried out the roundwood harvest. This must be done immediately with subsequent drying under cover, otherwise energy content will decrease significantly. Here stumps are regarded as an attractive bioenergy resource: forming about 20%-25% of the biomass of a tree, the potential is approximately 48 tonnes/ha on average. Regarding technology, #SFN has great experience with equipment able to split stumps prior to extraction. Stumps must be dried for at least 1 year.

In the #LTK region, both high efficient harvesting technology and small-scale techniques are in use, the latter being the only way to gain bioenergy from remote and inaccessible places. The closure of the Ignalina nuclear power plant was a driver for higher energy costs and increased interest in wood-based bioenergy.

For slash, most regions explicitly emphasize the need of observing the nutrient situation (ash recycling) and certification requirements.

c) Figures for reporting regions

In #PLP, in 2007 227,779 to (350,429 m³ ≈ 506,178 MWh) of fuel wood was used, from which 113,649 to (174,847 m³ ≈ 227,301 MWh) was S4 type.

For #LVT 13.000 m³ ≈ 26,000 MWh, for #LVJ 5000 m³ ≈ 10,000 MWh per year is estimated, an increase would be possible only in line with the annual harvest volume.

In #NOH, the theoretical potential would be >8,000,000 MWh, whilst only 13,000 MWh are generated today.

For #LTK, a total of 116,000 to is estimated as the potential. Stumps would provide an additional potential of 87,818 tonnes.

#SFN could increase the present quantity of 181,000 m³ ≈ 367,000 MWh to 250,000 m³ ≈ 507,000 MWh, #SFS from about 140,000 m³ ≈ 268,000 MWh to 175,000 m³ ≈ 340,000 MWh.

In #SEJ, slash collection could increase by at least 50%, Together with stumps, bioenergy from residues could go up to 3.6 TWh from currently 1.5 TWh. Stumps alone would give a potential of 1,123,000 m³.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Slash	1 m³	1.30	2.0	
Slash	1 to	2.0	2.2	

d) Sustainability Aspects

There is a common opinion that use of slash will contribute to economic sustainability by generating jobs and income.

Ecological aspects, however, are judged in a different way: On certain sites, removal of slash may lead to severe deterioration of future nutrient supply, and wood ash recycling is highly recommended but almost impossible to be applied exactly on those sites were bioenergy was taken. Moreover, due to the special (aggressive) chemistry of wood ash, the substance must be prepared. Sub-standard technological management can also lead to severe mechanical soil damages, as showed by a broad range of ash contents between 3% and >20% from forest woodchip – the higher value significantly influenced by soil particles in the fuel.

Bioenergy from logging residues might cause changes in flora and fauna, and as a minimum, certification requirements for retaining some deadwood and single trees and tree groups must be observed.

Stump extraction may on sites high in clay or loam lead to a deterioration in water penetrability and cause soil compression.

Many factors will affect the issue of ensuring carbon sequestration more with deadwood or by replacing fossil fuels with increased use of woody biomass from slash and stumps. Here, further investigation in different stand-soil-climate compositions are needed.

6. Bioenergy as a by-product

No reports received or similar reports classified under B5, as one or separate processing steps are needed in order to transfer this materials to bioenergy

7. Bioenergy from forestry waste

No resource was classified under this category because even in the case of low demand for bioenergy, residues in forests can remain on the site and do not require any removal or treatment.

8. Forestry-based bioenergy as a by-product (or complementary product) in the forest industry

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☒	Sweden	SEJ	Jämtland/Västernorrland	☒	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☒	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☒	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☒	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☒	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**12**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

This type of resource is generated in sawmills (bark, slabs, sawdust etc.) and in pulp mills (black liquor). Since these resources are generated on an industrial scale, in many cases a strict congruence with the regional forest land base will no longer be given. This is typical for #EES, where pellets are produced from sawdust from wood manufacturing, which mostly uses timber imported into the region.

Main production lines are

- slabs/bark to woodchip (often directly used for drying main products),
- milling slabs etc. to small particles, processed with sawdust to pellets,
- pressing small woody pieces to wood briquettes
- processing black liquor to biodiesel.

According to #LVT/#LVJ, woodchip from sawmills which has a low ash content is in competition with pellet production, but is also used as a raw material for pulp and chipboard production. The latter is 35% and 10% respectively in #NOH, whereas at 15% is used for direct heating (drying). In #PLP, 10% of the wood processed in sawmills is sawdust and there is strong competition for chips from slabs etc. from the panel industry. Bark is wet and heavy, which gives problems in burning directly in the plant. In #BYG, sawmilling residues amount to 20% of the total volume. According to #LVT/#LVJ reports, there is a significant difference, whether logs in bark or debarked are delivered, as biofuel from logs in bark can have a proportion of 50% to 56%, whereas about 30% from debarked logs can be used for pulpwood. #SEJ estimates the share of sawmilling residues at 17% of the total harvest volume. #PLP mentions wood briquettes as a bioenergy product, which is cheap to produce, requires low investment and can make use of a broad range of residues. In contrast to #LVT/#LVJ, the demand is increasing in #PLP.

c) Figures for reporting regions

For #NOH, an increase from 108,000 to ≈ 473,000 MWh by 320.000 to ≈ 1,400,000 MWh with an additional input of 5% of the obtained energy would be possible. Without increased harvest, in #BYG the additional amount of sawmill residues could be 11% from now 43.000 m^3 per year. For #LVT, the annual amount is estimated by 209,000 m^3 ≈ 167,000 MWh, for #ILVJ 74,000 m^3 ≈ 59,000 MWh. The technical potential of by-products from the forest industry is 512,740 MWh/y in #PLP.

Black liquor at present is used in the pulp industry itself, companies thus being energy self-sufficient in #SEJ, but processing to biodiesel could create added value. Increased use of pulpwood for bioenergy would reduce availability of black liquor.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Slabs, bark, sawdust	1 to	0.3	4.4	
Slabs, bark, sawdust	1 m^3	0.2	0.8	
Black liquor	1 to	2.51		Corresponds to 1000 m^3 pulpwood.

d) Sustainability Aspects

Generally, all sustainability criteria for increased use of wood processing residues as bioenergy are fulfilled. Exceptions for economic and social sustainability could emerge if this material reduces the supply of pulp or panel production with the option of later bioenergy use in a "cascade" utilisation.

9. Bioenergy from woody industrial waste

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**2**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

#NOH here reports wooden waste from, for example, furniture production or the demolition of old houses. This material might often be polluted and needs special treatment. It should be run in close cooperation with a waste plant. A loss for waste of 15% is a rough figure for furniture production.

c) Figures for reporting regions

#NOH estimates the present use of wood from house demolition, as used for energy, of 2000 tonnes ≈ 8800 MWh, the additional potential up to 100,000 tonnes ≈ 440,000 MWh, from which about 12% would be needed as energy input for collecting, processing etc. A rough estimate for furniture waste results in an increase of 190,000 MWh from 43,000 tonnes.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Wooden waste from house demolition	1 to	4.4		

d) Sustainability Aspects

Waste deposit plants could be reduced and integrated into a woodchip supply chain. The additional input needed for logistics and investments is unknown, therefore carbon balance, resource efficiency and economic sustainability need further investigation.

C. Other bioenergy resources

By far the majority of reports covered bioenergy from agriculture and forestry. The following section will summarize other, less significant resources in the participating regions.

- ***C9: Biomass from trade and industry, based on other types of professional land use.***

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☐	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☐	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**2**
☐	Poland	PLW	Westpomerania				

b) General qualitative description

Besides agriculture and forestry, other land-uses for organic production here were to be covered. Horticulture is an example. #PLP has some estimates about the potential from gardening and orchards. #DEB reports related material as waste from the distribution of gardening products in market gardens. As an alternative to conversion to compost, processing to biogas as a limited add-in due to non-homogenity could be an option.

c) Figures for reporting regions

#PLP estimates the potential from garden waste in the city to 2,513 tonnes ≈ 2,909 MWh, that from orchards and commercial gardening to 1,279 tonnes ≈ 1,478 MWh annually.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Gardening waste	1 to	1.15		Incl. orchards

❖ *D1: Biomass from land use other than organic production as only possible product*

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☒	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**11**
☒	Poland	PLW	Westpomerania				

d) General qualitative description

This category covers bioenergy resources in areas which are dedicated to purposes other than biological production. Consequently, this material is the only *organic* product on those sites. Examples are maintenance of streets, power lines, parks, gardens, hedgerows in the landscape and from nature reserves. There is a high potential for bioenergy from hedgerow maintenance in #DER. The hedges are very different in age, species composition, density and accessibility. The Nature Conservation Act allows maintenance only in wintertime. Felling or pruning and chipping on site becomes more and more common. However, for rows growing along roads, the cuttings are often chipped to the ground and there are therefore legal uncertainties as to whether this material is regarded as polluted, which would result in the requirement of special treatment. Equipment is often available but suitable for maintenance, not for the harvesting of bioenergy from hedgerows. Trials in #ROW showed that maintenance alone is currently cheaper than utilisation of the material. Development of a harvesting system is necessary and the volume on one plot and transport distances to the consumer (depending on boiler houses in the region) have a critical impact on costs. For #DER, the removal of woods and shrubs on bogs and heather for nature conservation purposes is also relevant. On bogs, this should be done before water re-loading the site for restoration of a bog habitat, as the place is hardly accessible afterwards.

Maintenance of power lines is mentioned by #DER and #NOH. Since the shrub vegetation there must be cut frequently anyway, additional costs occur only for removal and transport to the energy conumer and thus will depend from accessibility of the site and transport distances. #DEB reports mixed green mass – branches, grass, hay, from infrastructure areas, military training sites, and parks. This is a heterogeneous resource, where grass/herbs must be separated from woody material for bioenergy use in biogas plants or boiler houses. Even then, heterogeneity of e.g. grass requires high substrate tolerance within the installation.

e) Figures for reporting regions

Cutting from trees for road maintenance are estimated at 75,290 m³ (44,000 MWh) at present in #PLW. For #NOH, an increase of 2,700,000 MWh with 15% additional energy requirement is roughly estimated.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Tree trimming from road maintenance	1 m³	0.58 MWh		

f) Sustainability Aspects

Due to heterogeneity, sustainability aspects are hard to assess. Economic sustainability will need the development of utilisation-oriented rather than maintenance technologies. Ecological and social sustainability criteria can only be fulfilled if the main purpose of the area (park, road, nature reserve) has priority. In special cases, such as re-establishment of bogs after shrub removal, sustainability of the resource is may not be desired. This can also be assumed for nutrient supply on sites were vital growth is not wanted (e.g. heath vegetation).

❖ *D7: Biomass from land use other than organic production, regarded as waste*

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☐	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☒	Germany	DER	Rotenburg	☒	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**4**
☐	Poland	PLW	Westpomerania				

g) General qualitative description

In this case, a need for the removal of the material must be given. It can refer to biodegradable kitchen waste from garden products or waste from private gardens, which are usually collected as “rubbish” by waste removal agencies and carried to a tip. There might be a certain competition with the requirement that waste deposits have easily degradable material as a component together with woody elements. The problem is heterogeneity and the need for separate collection, often on inaccessible sites. Most of the material would be suitable for biogas, as a plant in #DEB demonstrates.

#BYG mentions also the exceptional cases where forest land is converted to building areas. In those cases, stumps (often too small for profitable bioenergy generation) have been removed and are often carried to a tip.

h) Figures for reporting regions

For #DEB, between 20,000 and 27,000 tonnes of biodegradable waste was recorded.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Fresh biodegradable waste	1 to	0.25		

❖ *F6: Other resources, not clearly linked to the regional land basis: Primary production*

- **Reported Regions:**

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☐	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**1**
☐	Poland	PLW	Westpomerania				

- **General qualitative description**

#DEN mentions biodegradable waste from beach cleaning which can be used for biogas and the residues as fertilizer. Woody components can be burned in CHP plants. [3]

- **Sustainability Aspects**

For ecological sustainability, the risk of contamination with heavy metals must be taken into account.

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[3] Authors comment: This is very common along the North Sea coast (German Term: “Teek” or “Treibsel”): Under http://www.dbu.de/PDF-Files/A-11950.pdf, a related project is described (in German)

❖ *F9: Other resources, not clearly linked to the regional land basis and regarded as "waste" in the sense of "rubbish"*

a) Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☒	Lithuania	LTK	Kaunas
☒	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☒	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☒	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☒	Poland	PLP	Pomorskie	**Number of Reports:**			**10**
☒	Poland	PLW	Westpomerania				

b) General qualitative description

Under this category, 2 sub-types were reported

- Municipal and household waste (#NWN, #NOH, #LTK,#PLW,#SEJ, #DEN, #PLP)
- Sewage sludge (#PLP, #DEB, #LTK)

Municipal and household waste has a broad variety of components. The common view is that there is a need to separate non-combustible and hazardous components and introduce hygiene measures before introduction to any kind of bioenergy generation process. This can be combustion (CHP) or biogas generation. #NWN separately mentions edible oil and fat waste from canteens and commercial kitchens which must be documented and can, if separately collected, be processed to biodiesel.

Sewage sludge is subject to a number of EU rules and in #PLP, national regulation, since, as an alternative to deposition or energy production, the use as fertilizer is possible under certain conditions. Biogas production from this resource, however, is possible only in large plants. Much of the heat and power can be used in the plant itself.

c) Figures for reporting regions

#NOH expects a possible increase in the use of Municipal and household waste from 2000 tonnes ≈ 5000 MWh to 80,000 tonnes ≈ 200,000 MWh, of which 5000 MWh would be consumed as additional energy input.

For #LTK, 204,015 tonnes/year are recorded but the Kaunas waste incineration plant burns in total about 300,000 tonnes/year, including that of neighbouring regions. This is an example of the limited importance that the regional bioenergy assessment approach has, as mentioned in the introduction.

#PLW mentions landfills equipped with degasification for energy production.

In #DEN, an increase of 920 tonnes ≈ 476 MWh (47% el. power) to 4573 tonnes ≈ 2363 MWh could be possible. However, the currently available waste is still composted.

In #PLP, 215 municipal sewage treatment plants produce sludge corresponding to 33,600,000 dry matter. It is assumed that 60% of the decentralised plants could be used in central plants for biogas generation, the energy output could increase from currently 3056 MW h/y to 75,202 MW h/y.

Parameters for conversion

Resource	Unit	Lowest	Highest	Comment
		Energy Value MWh		
Municipal combustible waste	1 to	0.5	3.0	
Waste water sludge	1 to	1.1		

d) Sustainability Aspects

Ecological sustainability will be improved due to a reduced need for waste removal operations and landfill sites when considering necessary treatment to avoid pollution and hygiene problems. Generally, the energetic use of waste will create more jobs and income than just disposal in landfills. Energy efficiency is very much dependent on population density as this will affect the energy needed for waste collection. Careful selection of the location of plants to avoid inconvenience for people in the neighbourhood will ensure social acceptance.

❖ *G: Resources with animal origin, not clearly linked to the regional land basis*

Reported Regions:

Rep	Country	Abbr.	Region	Rep	Country	Abbr.	Region
☐	Sweden	SEV	Västra Götaland	☐	Lithuania	LTK	Kaunas
☐	Sweden	SEJ	Jämtland/Västernorrland	☐	Latvia	LVT	Tukums
☐	Norway	NOH	Hedmark & Oppland County	☐	Latvia	LVJ	Jelgava
☐	Denmark	DKZ	Zealand	☐	Estonia	EES	Saaremaa
☐	Germany	DEB	Brandenburg	☐	Finland	SFN	North Karelia
☒	Germany	DEN	NW-Mecklenburg	☐	Finland	SFS	South Karelia
☐	Germany	DER	Rotenburg	☐	Belorus	BYG	Grodno
☐	Poland	PLP	Pomorskie	**Number of Reports:**			**1**
☐	Poland	PLW	Westpomerania				

General qualitative description

Although this type of resource may be similar to A 8 or A 9, here no direct link to the regional primary production is given. Only #DEN reports on residues from preparation of meat and fish etc. Unlike food waste as described in F 9, this material is cleaner and in some cases can be used as animal food. Otherwise, it has to be disposed of or can be used for biogas generation after hygiene measures. No figures are available from the region.

Conclusions

The consolidated reports show a **broad variety of bioenergy potential** and many examples where the energetic use of biomass can be considerably increased or is currently even not at all used as a resource. Huge resources are available from **agriculture** and **forestry**, but in many cases, short-term **profitability** is not assured and **financial support** is needed, justified by the reduction of fossil fuel consumption and, accordingly, the carbon sequestration and climate change mitigation effect. In accordance with WP 3, **peat** was **not** regarded as a renewable bioenergy resource and therefore excluded from the survey.

In both categories of land use and further processing of the primary production, considerable resources are available with low or no impact on solid material, food or feed production. It seems that **energy efficiency** for wood-based bioenergy is better than that for agricultural (by-)products.

Moreover, organic material from land, where primary production is not the main purpose, can be used through regular **maintenance** operations, which would generate expenditures and energy input anyway. Similar conditions are given for all kinds of **waste**, and energetic use here would also reduce costs and space for waste disposal. Communication with partners and with WP 3 showed a need for distinguishing and specifying **terms** like “waste”, “rubbish”, “residues”, “by-products”, etc. for materials, suitable for bioenergy, but obtained from a non-energetic production process, since they might be subject to particular national legislation.

The reports received gave a profound and comprehensive **overview** of the bioenergy potential in the BIOENERGY PROMOTION project regions, additional information on relevant issues on national level and are largely representative of the respective countries. However, for some categories of bioenergy resources, mainly residues and waste from further processing of primary products imported from other regions or even countries, the regional approach for the potential assessment may be limited.

***Task Leader 4.2 wants to express his gratitude to the reporting partners´commitment to this project work package and task*.**

Annex

Questionnaire

BIOENERGY POTENTIAL ASSESSMENT FORM

Partner No. :		Partner Name:	
Country:		Region acc. Task 4.1:	

Please copy the following table as often as you need for description of different categories of bioenergy resources and paste it to a new page! You can also generate separate files for each BE resource. You might also copy completed tables or files and re-use them for the differentiation of aspects, overwriting specific boxes.

<table>
<tr><td>Matrix Field:</td><td></td><td>Short Definition:</td><td colspan="3"></td></tr>
<tr><td colspan="4">In case of waste (= rubbish), EU waste code http://www.euwas.org/content/e266/e1091/e6692/e6698/index_eng.html</td><td colspan="2"></td></tr>
<tr><td colspan="6">FOR DEADLINE 31 JULY 2009</td></tr>
<tr><td colspan="6">General Description of bioenergy material</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">General Description of main production process</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">Options, preconditions and consequences for increased use of this type of bioenergy resource</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">Time frame for significantly increased bioenergy availability, if all preconditions fulfilled</td></tr>
<tr><td>1-3 years</td><td></td><td>4-10 years</td><td></td><td>> 10 years</td><td></td></tr>
<tr><td colspan="6">Legal framework for production and legal aspects for increased production of bioenergy</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">Describe the main energy carrier, gained from this bioenergy resource, and basic processes for this</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">Describe the main end-consumer of energy, gained from this resource and the described production process</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">Additional Comments to this category of bioenergy</td></tr>
<tr><td colspan="6">☞</td></tr>
<tr><td colspan="6">FOR DEADLINE 30 September 2009</td></tr>
<tr><td colspan="6">WAIT FOR FURTHER INSTRUCTIONS TL 4.2; QUESTIONNAIRE MIGHT BECOME MODIFIED AFTER CO-ORDINATION WITH TASK 4.4

Quantify the volume of this resource in typical units (tons, m³ etc.), as far as it is presently used for energy</td></tr>
<tr><td colspan="6">☞</td></tr>
</table>

Quantify the maximum additional volume of this resource in typical units (tons, m³ etc), as far as it can realistically be used for energy
☞
Quantify the volume of this resource in energy units (MWh), as far as it is presently used for energy
☞
Quantify the maximum additional volume of this resource in energy units (MWh), as far as it can realistically be used for energy
☞
Quantify the additional energy consumption in energy units (MWh), needed to increase the use of this bioenergy resource
☞
Additional comments to quantification of this type of bioenergy
☞
FOR DEADLINE 30 September 2009
WAIT FOR FURTHER INSTRUCTIONS FROM WP 3 THROUGH TL 4.2; QUESTIONNAIRE MIGHT BECOME MODIFIED Give your estimate and comments, how sustainable the present and the potential availability of this type of bioenergy will be, from aspects of … **… economic sustainability**
☞
… social sustainability
☞
… ecological sustainability
☞
Additional comments to sustainability aspects
☞

Classification Matrix

BIOENERGY RESOURCE MATRIX

Partner Nr. :		**Partner Name:**	
Country:		**Region acc Task 4.1:**	

		A	B	C	D	E	F	G
	Origin	**Agriculture**	**Forestry**	**Other professional land use**	**Land use other than production**	**Non-used land**	**Other sources (e.g. water-based)**	**Animals**
1	BE only possible product		7 D	1 D		1 D		
2	(alternative) use of land for BE							Example Code G 2
3	BE alternative product							
4	BE alternative use of existing product		4 D					
5	BE complementary product		4 D					Example: 2 DQ 1 DQS
6	BE by-product							
7	BE waste from land-use				1 D			
		Only "rubbish" – classify acc. to EU waste code http://www.euwas.org/content/e266/e1091/e6692/e6698/index_eng.html						
8	BE By-product from further processing							
9	BE waste from further processing							
		Only "rubbish" – classify acc. to EU waste code http://www.euwas.org/content/e266/e1091/e6692/e6698/index_eng.html						

Reporting instruction

From: Chamber of Agriculture Lower Saxony Alexander Rosenberg				*To:* Task 4.2 partners and associates
	PP 04	**X**	Task Leader 4.2	
My reference: @ 23 May 2009				Your reference: your comments

Message

Subject: **Task 4.2 procedure; instruction and questionnaire**

Dear Partners,

Please find attached

- the revised bioenergy resource matrix
- the assessment form
- a completed assessment form as Example

for assessment and description of regional bioenergy potential.

According to our schedule, the qualitative description shall be delivered latest 31 July 2009. The attached Assessment Form, however, contains also questions for the remaining steps (quantitative description, sustainability assessment), but I do not recommend spending too much time in these parts now, as

- I see a need to avoid overlapping and doubled effort in the quantitative analysis with Task 4.4 (see Mikael´s EXCEL questionnaire); we will discuss this with Mikael as TL 4.4 and Gunnhild as WPL 4
- We have to wait for a WP 3 input (Criteria), regarding the sustainability part.

And the Assessment Form might become re-designed in these sectors.

For the first part – bioenergy resource description - please indicate your partner name, number, country and project region on the header of the Matrix and on the Assessment Form and then fill in separate Assessment Forms for each type of bioenergy which is in the focus in your project region. Duplicating the form, please copy the table as often as you need for description of different categories of bioenergy resources and paste it to a new page! You can also generate separate files for each BE resource.

The **bioenergy category** is identified by a column/row code combination from the attached matrix. You need a separate assessment table for each category. You might even generate more than one form for the same code, in case there are differences in some aspects (e.g. woody bioenergy from branches and tops may be used for fuel wood or woodchips, with different processes and consumers). You might also copy already completed tables (or files) and re-use them for differentiation of aspects, overwriting specific boxes, if you want to define similar resources, but with significant differences in specific aspects.

As the assessment form and procedure still will contain some uncertainties (e.g. mutual dependency of different types of bioenergy, as increased use of small-dimensioned saw logs now for bioenergy (Code B4) will reduce availability of saw milling residues (Code b8)) –

please feel free to give any comments, either (if possible) in the specific box or in the "Comment"-Box – final box in each section. Furthermore, when indicating **options for increased bioenergy use,** you should **be realistic**; in many cases, these options will refer to already existing techniques and procedures or those based on firm research, even if they are not yet used specifically for bioenergy. E.g. switching to barley with higher yield and increased BE from respective straw is an established strategy, but might not realistically be applied only for bioenergy.

Some advice for the Categories (rows in the matrix)

Row 1: This might be the case, where no other options are realistically available, e.g. shrub and coppice on steep dry slopes.
Row 5 and 6: By-products should be those which are generated together with the main crop, whereas **complementary products** are processed in a separate step
Row 7 and 9: As there were no negative comments to the tricky question of "**waste**", compared with "**by-products**", we will use the negative definition for "waste" as suggested: All material, which fulfils one of the following criteria:

> - it is neither an unwanted nor undesired material or substance, not needing any kind of waste management (control of collection, treatment or disposal) - *e.g. logging residues, which can also remain in the forest*
> or
> - there is a market for it, meaning that there are customers existing, not being authorities responsible for waste disposal and prepared to pay a positive price (> 0) - *e.g. used paper (alternatively to be recycled)*
> or
> - at least one additional production process in order to convert the material to an energy raw material is applied - *e.g. sawdust further processed to pellets.*

Is not waste, but a main product, a by-product or a complementary product.

For the remaining waste, more or less what will be determined as "rubbish", the **EU waste code** (http://www.euwas.org/content/e266/e1091/e6692/e6698/index_eng.html) should be identified and indicated. Since the above mentioned narrow definition will not comply with the official and legal waste definition in many countries, your clear comment is desired on this issue (preferably in the "Legal"-Box). This could give valuable inputs to WP3.

After having processed the Assessment Form(s), please also **complete the Matrix**, indicating in the respective cells how many Assessment Forms you have generated and in which stage they are. Both Assessment Forms and Matrix should be updated in the next steps.

Please use abbreviations:

D	General description avail.	Q	Quantities assessed	S	Sustainability check exec.

Example:
2 DQ, 1 DQS means in B4 means: 3 Types of forest-based bioenergy, competing with alternative use of the material, are described and quantified, for one of them, a sustainability estimate is carried out.

I would be grateful if you could keep to the

Deadline 31 July 2009

for sending me your assessment forms and completed matrix (MS WORD format, but not .docx). Please rename the

- Matrix with "matrix_PPXY.doc"
- the Assessment Form with
  - "Assessment_PPXY.doc"

  or
  - "Assessment_PPXY_xy.doc", in case you prefer separate files per BE category.

Here
- XY stands for partner number and
- xy for the bioenergy category matrix code, if separate files.

I look forward to a fruitful cooperation!

Best regards

Alexander Rosenberg
Chamber of Agriculture Lower Saxony, Germany
Task leader 4.2

Questionnaire "Sustainability assessment"

Partner Nr. :		**Partner Name:**	
Country:		**Region acc. Task 4.1:**	

Matrix Field:		**Short Definition:**	

Assessment of sustainability

1. Biodiversity

Principle:
Biomass production and extraction shall not endanger biodiversity at the landscape6 level. However, special considerations to threatened species shall be taken at the local level. Biomass production shall whenever possible, strengthen biodiversity and contribute to an increased variation in the landscape.

Indicators:
- Number and abundance of species at the landscape level
- Spreading of alien species
- Land use within the landscape Width of buffer zones

Criteria:……………………………………….*fulfilled*	Y	Partly	N
i. Biomass production or extraction shall have neutral or positive effects on biodiversity at the landscape level			
ii. Biomass production or extraction can only be performed in protected areas or areas with high conservation values if it is part of a management plan to protect biological values			
iii. The integrity of relevant ecosystems and habitats for rare and endangered species shall be maintained			

iv. Alien species shall be cultivated under conditions of careful control and monitoring to avoid unintended dispersal			
v. Biomass plantations shall, preferably, be located and designed to contribute to a varied landscape			
vi. Biomass extraction shall, if possible, be conducted in relation to other management practices in the landscape so as to sustain or enhance biodiversity, including the regional recovery and persistence of endangered species			
vii. Buffer zones or vegetation filters between biomass production areas and waters and wetlands shall, if needed, be used to reduce the risk for damage on			

Comments:

2. Resource efficiency

Principle:

Natural resources, such as soil, water and land, shall be used efficiently and biomass production or extraction shall not endanger soil or cause further deterioration of water quality and quantity.

Indicators:

- Water quality and quantity
- Methods and compensatory measures
- Soil damages
- Soil nutrient status
- Local management plans to optimise land use

Criteria:...fulfilled	***Y***	***Partly***	***N***
i. Methods shall be chosen to minimize the risk for permanent physical damage to the soil			
ii. Methods that cause a net depletion (after compensatory measures) of humus, nutrients and minerals in the soil below levels necessary for the maintenance of the long-term soil production capacity shall be avoided			
iii. Nutrient rich waste products and by-products should preferably be recycled			
iv. Residues from forestry and agriculture should be used for energy production or other purposes			
v. Biomass production and extraction shall be conducted in a way that prevents further deterioration, for example by erosion or nutrient leakage, and protects (or enhances) the status of aquatic ecosystems7			
vi. Water shall be used efficiently without endangering water supply			
vii. Land shall be used efficiently, and practices that optimise productivity shall be used			
viii. The use of the land should be optimised through locating, managing and designing the production in the best suitable way and where synergistic effects are at the best			

Comments:

3. Energy efficiency

Principle:

For a sustainable production and use of bioenergy the energy balance shall be considered, with a special emphasis on the use of fossil sources during production of bioenergy. Input energy shall be minimized throughout the whole production chain and be distributed and accounted for on all products (main and by-products) based on an average product value proportion basis.

Indicators:

- Part of waste products recycled
- Use of residues, by-products and waste
- Energy yield ratio: quantity of useful bioenergy produced per unit of fossil fuel consumed
- Conversion efficiency: the amount of energy produced as a percentage of the amount of energy consumed according to Directive 2009/28/EC the Member States should promote biomass conversion technologies that achieve a conversion efficiency of at least 85 % for residential and commercial applications and at least 70 % for industrial applications
- For the production of heat and electricity, the cumulative energy demand for biomass production, extraction and conversion to bioenergy should preferably be less than 20 % of the energy output
- For the production of biofuels the energy input in biomass production, extraction and conversion should preferably be less than 50 % of the energy output
- Supply chains of raw materials should be easily followed from production to end-use

Criteria:..fulfilled	*Y*	*Partly*	*N*
i. Residues and by-products should be used for energy or other applications in order to increase efficiency			
ii. If reuse or recycling of waste is not possible, use for energy shall be preferred over dumping8			
iii. The energy input in production, extraction and conversion of biomass to bioenergy should be minimized			
iv. Efficient conversion technologies shall be used			
v. Long distance transports of non-processed raw materials shall be avoided			
vi. Use of waste heat shall be encouraged			
vii. Combined production of heat, electricity and other products (chill, steam) should be promoted whenever possible			

Comments:

4. Climate mitigation efficiency

Principle I:

Greenhouse gas emissions (i.e. emissions of CO2, CH4 and N2O in CO2 equivalents) from bioenergy production and use shall be minimized.

Indicators:

- The methodology for calculating greenhouse gas emission reductions is described in Directive 2009/28/EC
- Methods for calculating of greenhouse gas emissions in the land use sector is described in IPCC 2000 Good Practice Guidance for Land Use, Land-Use Change and Forestry
- The greenhouse gas emission savings from the production and use of biomass for heat, chill and electricity production should preferably be at least 80 % compared to if fossil fuels had been used
- The greenhouse gas emission savings from the production and use of biofuels should preferably be at least 50 % compared to if fossil fuels had been used

Criteria:..fulfilled	*Y*	*Partly*	*N*
i. The greenhouse gas emission savings of the production chain - including production, extraction, conversion and transport - shall be maximized and compared to a reference scenario with fossil fuels. Both long and short term gain and losses shall be evaluated			
ii. The use of waste, residues and by-products shall be encouraged and accounted for when calculating greenhouse gas emission savings			

iii. Special consideration shall be taken to organogenic soils. For example, frequent tillage should be avoided on carbon rich soils			
iv. Bioenergy production that leads to a reduction of greenhouse gas emissions, for example usage of manure for biogas production, shall be promoted			

Comments:

Principle II:

Biomass production shall not endanger important carbon stocks and greenhouse gas emissions caused by land-use change shall be low in relation to the amount of greenhouse gas emissions that can be avoided in a long-term perspective.

Indicators:

- Before a new land area is exploited, the producer shall determine the extent of carbon loss the activities will result in and establish whether the losses will be compensated for by means of the biomass production within the stipulated time period or relevant management cycle
- All land-use change shall be reported
- Methods for calculating of greenhouse gas emissions associated with land-use change is described in IPCC 2000 Good Practice Guidance for Land Use, Land-Use Change and Forestry

Criteria:………………………………………fulfilled	*Y*	*Partly*	*N*
i. Biomass (used for heating, cooling or electricity) shall only be produced on land where the loss of carbon stock caused by the land-use change can be compensated for by the accumulated greenhouse gas emission savings from substituting fossil fuels with produced biomass within a period of 50 years. Emission savings from usage of by-products can also be accounted for.			
ii. Land with high carbon stock such as wetlands and continuously forested areas should not be used for the production of biofuels if it implies a permanent change in land status			

Comments:

5. Social aspects

Principle I:

The production and use of biomass for energy shall not endanger food security or local production of biomass for other applications.

Indicators:

- Use of waste, residues and by-products for energy
- No land can be used without the informed consent of the rightful owner

Criteria:………………………………………fulfilled	*Y*	*Partly*	*N*
i. The production of biomass for energy shall only occur at sites where it does not threaten local/regional food supply			
ii. Negative effects of competition between energy, food, fodder and material use should be minimized			
iii. The possibilities of a secured long-term supply of biomass shall be considered and demonstrated when establishing a heat or power plant			

Comments:

Principle II:

Bioenergy production should not endanger the conservation of cultural remains and heritages or prosperity of local communities and cultures.

Indicators:

- Documented information opportunities (all neighbours affected by a bioenergy installation should be given the opportunity to be a part of/comment on the project already at the planning stage)
- Regional planning for land use, including set aside land for recreation

Criteria:..fulfilled	*Y*	*Partly*	*N*
i. The bioenergy producer should take responsibility for the assessment of the values of the production area and also for the assessment of how the production may affect the local community			
ii. Production of biomass for energy should not influence the possibility for recreational activity in a negative way			
iii. Local acceptance and avoidance of conflicts should be reached through regional and local planning instruments, and preferably comprise multi-stakeholder dialogues			
iv. Bioenergy production should be carried out with consideration to local communities and cultures			
v. Biomass production should not violate the basis of existence for the indigenous population			

Comments:

6. Economic issues

Principle:

Bioenergy production, extraction and use should contribute to an increase in rural activity and contribute to the development of viable business and security in energy supply.

Indicators:

- Rural income
- Migration to and from rural areas
- Building of new roads in areas were roads are lacking
- Creation of employment

Criteria:..fulfilled	*Y*	*Partly*	*N*
i. Activities shall have generally positive effects on social welfare and accessibility to rural areas			
ii. Development of local energy systems that enable combinations of different renewable energy sources shall be encouraged			
iii. Bioenergy systems should preferably have positive effects on local economy			
Comments:			