EU-Project – Regional Supply Chains for Woody Bioenergy

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Foreword

BioRES project aims at introducing the innovative concept of “Biomass Logistic and Trade Centres” (BLTCs) in Serbia, Croatia and Bulgaria, based on international cooperation with European technology leaders. The overall objective of BioRES is to increase market uptake of domestic supply chains for quality-controlled woody bioenergy products from sustainable forestry and wood residues by means of developing BLTCs as regional hubs.

“Biomass Logistic and Trade Centres (BLTCs) are local or regional centres with optimised logistics and trading organisation, where different woody bioenergy products (and/or heat) are marketed at standardised quality focusing on the domestic market uptake. It’s an innovative business model competitively operating as an intermediary to organise local woody bioenergy value chains between local biomass suppliers and customers of different scales from private households up to large heat and power plants. In Slovenia, Austria, Germany and Finland BLTCs of different shapes with own production, storage and logistic facilities are competitively operating.”

List of Key Words:

Biomass, Sustainability, Supply, Demand, Operation, Traceability, Quality Standards, Forest Certification, Wood fuels, Firewood / split logs, Wood chips, Wood pellets
List of Abbreviations:

BLTC – Biomass Logistics and Trade Centre
ISO – International Organization for Standardization
EN – European Standard
SEE - South Eastern Europe
EBR - The European Business Register
PESTLE - Political, Economic, Social, Technological, Legal and Environmental
PEST - Political, Economic, Social, Technological
SWOT - Strength weaknesses opportunities threats
Lcbm - Loose cubic meter
Cbm - Cubic meter
ENplus - Wood Pellet Quality Certification
GHG - Green House Gas
GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit
Ha - Hectare
Km - Kilometre
kWh - Kilo Watt hour
LNG - Liquid Natural Gas
MW - Megawatt
RES - Renewable Energy Sources
T - Ton
1. Assessment of Local Market Potentials (Supply and Demand) & Didactic Approaches and Motivation

1.1 Introduction
The establishment of woody Biomass Logistic and Trade Centers is an investment project and as such needs careful planning.

Basic questions that should be asked and answered before starting the investment are:
- **What** are the existing framework conditions?
- **What** amount of which quality of biomass is really available in the area?
- **Who** are the main existing players?
- **Who** could be potential suppliers and customers?

Answers to these questions will help us understand the supply and demand side of the future BLTCs. The purpose is not to present a standardised procedure for collecting data and information about the local woody biomass market.

A new biomass logistic and trade centre is a new market player on otherwise very traditional and partly informal local market with wood fuels. To be a successful project all positive and possible negative influences should be considered and the project should be developed together with local stakeholders.

<table>
<thead>
<tr>
<th>+ Influence of new biomass logistic and trade centre on wood fuel market</th>
<th>- Influence of existing market on new initiative</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ New trader</td>
<td>☐ Lowering the prices of products</td>
</tr>
<tr>
<td>☑ Quality assurance</td>
<td>☑ Availability of wood biomass</td>
</tr>
<tr>
<td>☑ Transparent marketing &amp; more promotion of woody biomass for energy</td>
<td>☑ Negative promotion (by existing market players) among local population</td>
</tr>
<tr>
<td>☑ Demand for wood fuels and wood residues</td>
<td>☑ Higher prices of raw material</td>
</tr>
<tr>
<td>☑ New jobs and value chains</td>
<td></td>
</tr>
<tr>
<td>☑ More actors on the market can bring better quality of services (competition between actors)</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1: possible Market interactions*
1.2 Market Analysis

The goal of a market analysis is to determine the attractiveness of a market and to understand its evolving opportunities and threats as they relate to the strengths and weaknesses of the project idea. The key elements are presented below (Picture 1).

![Diagram: Key elements of wood biomass market](image)

*Picture 1: Key elements of wood biomass market*

The key success factors are those elements that are necessary in order to achieve foreseen objectives. A few examples of such factors include:

- access to needed resources;
- ability to achieve economies of scale;
- access to distribution channels;
- technological progress.

It is important to consider that key success factors may change over time, especially as the product progresses through its life cycle (www.netmba.com).
1.3 Criteria for BLTC Site Selection

1.3.1 Supply of Wood Fuels
1.3.1.1 Natural Resources
Collecting Data about the natural resources is important to understand the overall setting. Data about natural resources should include the following information:
   1. Forests in the region:
      a. area of forests
      b. % of land covered with forests
      c. growing stock
      d. increment
      e. ownership structure
      f. annual planed cut
      g. forest road networks condition
      h. tree species composition
   2. Wood residues quantity and qualities in the region (e.g. from sawmills, wood processing companies)
   3. Other land uses:
      i. short rotation plantation area
      j. abandoned agricultural land
      k. other wooded areas

This Data is already gathered by Public forestry service or by municipalities and e.g. available in forest management plans.
THE MAIN SOURCES OF WOOD FUEL THAT SHOULD BE CONSIDERED

Forests
- low quality round wood, residues from forest production

Plantations
- defined as short rotation energy plantations.

Other virgin wood:
- wood from gardens, parks, roadside maintenance, vineyards, fruit orchards and driftwood from freshwater

By-products and residues from the wood processing industry
- chemically untreated wood residues (wood either with or without bark, or the bark itself) from primary wood processing (mainly sawmills)

Used wood
- post-consumer / post society wood waste; and natural or merely mechanically processed wood

Forests are the most important source of wood fuels. Only low quality round wood should be considered as potential for energy production. Beside part of round wood, forest residues (branches and tops) are also important source for energy production. However, the harvesting operations need to be based on verifiable legal and sustainable forest management.

Picture 2: Forest woodpile

Short rotation energy plantations are generally planted on agricultural land, with fast growing species like poplar, willow, alder, black locust and eucalyptus are commonly used with the aim to produce high biomass yields in a short period that can be used for energy purposes (mainly wood chips). (Find more information: http://www.srcplus.eu/images/Handbook_SRCplus.pdf)

Picture 3: Plantation

Other virgin wood: under this category segregated wood from gardens, parks, roadside maintenance, vineyards, fruit orchards and driftwood from freshwater can also be considered. If local communities don’t have a program for using wood biomass from parks and roadside, they should consider use of this “wastes” as a benefit, so an analysis of present use of wood from parks and green areas of local communities could be considered based on the requested volume and quality level of planned woody bioenergy products.
By-products and residues from wood processing industry

This wood fuel can be chemically untreated wood residues (wood either with or without bark, or the bark itself) from primary wood processing (mainly sawmills) or chemically treated wood residues, fibres and wood constituents, but without heavy metals or halogenated organic compounds that result from treatment with wood preservatives or coating. This resources are very important for production of quality wood chips. An analysis of available residues is an important part of the market analysis.

![Picture 4: wood residues](image1)

**Used wood**

This group includes post-consumer / post society wood waste; natural or merely mechanically processed wood. It is important to understand that this kind of wood should not contain any heavy metals or halogenated organic compounds as a result of treatment with wood preservatives or coating.

![Picture 5: Used wood](image2)

1.3.2 Assessing Woody Biomass Potential from FORESTS and Other Resources in Vicinity of Selected Region

How much woody biomass is annually available in a radius of about 50 km from selected BLTC location? THAT IS THE IMPORTANT QUESTION. In general, we can talk about:

**Real potentials:** that is the amount of wood that could come to the market according to forest infrastructure, available technologies, costs of forest production and according to natural conditions. Important limits are the transportation costs.

For market actors the actual amount of woody biomass and wood assortments and qualities that appear on the market is relevant. The amount of wood consumed for own use of forest owners needs to be excluded.
1.4 Forest Biomass Production Chains

The most common system of wood production in South East Europe (SEE) is a combination of traditional felling with a chainsaw and skidding with an adapted forest tractor. After felling, the tree is trimmed and cut in assortments according to assortment criteria, economic factors and market demands.

Costs of transport vary from distance, forest road network conditions, transport modalities, labour costs and amount (see BioRES country specific market information tables: http://bioresproject.eu/index.php/market-information/)

Costs of wood chips production again vary according to size of wood chipper and according to the raw material. They can be calculated using WoodChainManager (free web based tool developed by Slovenian forestry institute – on http://wcm.gozdis.si (available in Slovenian, English and German language). Wood
chips could be produced at the forest road side and in this case wood chips would be transported to the biomass logistic and trade centre.

There is rather large variety of different combinations of different machinery and combinations of places where and how wood fuels (fire wood and wood chips) can be produced. It is important that before starting the BLTC different options are analysed and assessed.

1.4.1 **Wood Energy Production**

When planning the BLTC you have more options:
- buying round wood (low quality) and producing wood energy products at the site with your own machinery;
- buying round wood (low quality) and renting the machinery for producing wood energy products;
- buying wood energy products (e.g. wood chips, firewood) and selling them to end users.
Picture 11: Strengthens and weaknesses of different options in wood energy production

Before selection, an analysis of existing wood fuel producers should be done – to see what kind of machinery is already available.

The analysis of wood fuel producers in the area is an essential part of the market analysis. Data about registered wood fuel producers could be collected from National Business register and also from The European Business Register (hereinafter referred to as: EBR). Additional sources of data are regional Chambers of commerce (if they exist), Forest service, and local wood sector associations.

A catalogue of wood fuel producers in 9 countries/regions (Slovenia, Croatia, Romania, Italy – Northern part, Austria - Styria, Germany - Bavaria, Spain, Ireland and Greece) was published in the framework of BIOMASTRADECENTRE II project and is available on http://www.bomasstradecentre2.eu/wood-biomass-production/service-providers/

Picture 12: View on “Service provider” web based search tool
We advise a twostep data collection. In the first stage general data from different existing databases are collected. In second stage identified producers are interviewed to collect more detailed information about their production.

First step of data collection can be done by collecting data using the form presented in next table.

<table>
<thead>
<tr>
<th>Name of the company</th>
<th>Address</th>
<th>Type wood fuel produced</th>
<th>Size of the company</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xy 1</td>
<td></td>
<td>Wood logs, Wood chips, Wood pellets</td>
<td>Micro, SME, Large</td>
<td></td>
</tr>
<tr>
<td>Xy 2</td>
<td></td>
<td>Wood logs, Wood chips, Wood pellets</td>
<td>Micro, SME, Large</td>
<td></td>
</tr>
<tr>
<td>......</td>
<td></td>
<td>Wood logs, Wood chips, Wood pellets</td>
<td>Micro, SME, Large</td>
<td></td>
</tr>
</tbody>
</table>

*Table 2: Table for collecting data about wood fuel producers – first stage*

First stage of data collection can be done by desk research. Data collected in second stage is more detailed (see next table).

Table for collecting data about wood fuel producers – second stage

<table>
<thead>
<tr>
<th>Name of the company</th>
<th>Average yearly production (tons)*1</th>
<th>Main source of wood biomass</th>
<th>Main existing buyers</th>
<th>Available wood biomass for new buyers (t)</th>
<th>Quality classes of wood energy products produced*2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xy 1</td>
<td>Forests, Wood industry, Non forest land, Other</td>
<td>Households, Existing biomass systems / Industry Export Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xy 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>......</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 3: Table for collecting data about wood fuel producers – second stage*

Remark: *1: specifying moisture content.  
*2: according to relevant ISO standards (ISO/DIS 17225 series (7 parts))
1.4.1.1 *Main Characteristics of Different Wood Fuel Producers:*

Each type of wood fuels producers has specifics that are important and should be considered as activities in biomass logistic and trade center.

**Firewood producers:**
- Smaller and locally orientated (forest owners selling firewood on local scale, often informal market activities)
- Including small scale producers in the logistic network as supplier could be challenging (quality issues, reliability, low volumes etc.)
- Bigger firewood processors or splitters, having their own machinery could be an important partner for biomass logistic and trade center operations.

**Wood chips producers are usually:**
- More market orientated (trying to sell wood chips but also to work with machines as service);
- Easier to find and to include in business initiatives
- Quality of wood chips and delivery conditions should be discussed.

**Wood pellet producers are usually:**
- Market orientated (they are looking for new markets);
- Easier to find and to include in business initiatives (similar as wood chip producers)
- Quality of wood pellets and delivery conditions should be discussed.

1.4.2 *Buying or Selling Wood Fuels*

When buying and selling wood fuels, two main questions arise:
1. Units of measurements & respective prices
2. Quality of wood fuels – what are the quality classes

1.4.2.1 *Units of Measurements*

A simple Biomass calculator is developed by BioRES project, which enables to calculate different units of measurements; it is available on: [www.bioreproject.eu](http://www.bioreproject.eu)


Before starting a new biomass logistic and trade centre, potential customers and their needs for different wood energy products and qualities should be analyzed taking, into consideration the following facts:

- The quality of wood energy products has to match the requirements of the boiler. Smaller boilers (with the capacity under 200 kW) have higher requirements about the quality. Moister content
should be under 25 %, size of particles is strictly defined, and the percentage of fine dust particles should be lower. The requirements for the highest quality classes are presented in the next table.

- The wood energy products properties should be specified in the product declaration. It is important to emphasise that the whole responsibility for correct and accurate information is on the producers/suppliers side.

<table>
<thead>
<tr>
<th>Basic requirements (according to ISO standards)*</th>
<th>Relevant standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wood logs</strong></td>
<td>M 20 or M25 (moisture below 25 %), No visible decay, more than 90 % of pieces should be split</td>
</tr>
<tr>
<td><strong>Wood chips</strong></td>
<td>Particle size P16S or P31S, up to M35 (moisture below 35 %), Ash content less than 1,5 %, fines fraction less than 15 %</td>
</tr>
<tr>
<td><strong>Wood pellets</strong></td>
<td>M10 (moisture less than 10 %), Ash content less than 0,7 %, Mechanical durability more than 97,5 %, Bulk density more than 600 kg/m³</td>
</tr>
</tbody>
</table>

**Table 4: Basic wood fuel quality requirements**

**Recommendations**

- Quality of wood fuels marketed should be an important issue from the beginning.
- Quality should be regularly tested.
- Price should depend on quality.
1.5 Demand for Wood Fuels

Wood fuel users in the area of planned biomass logistic and trade centre can be divided in several groups:

1. Smaller private users – households and micro businesses, that need less than 50 m$^3$ of wood per year (boiler capacity is less than 80 kWh).
2. Medium size private users – smaller businesses that need up to 150 m$^3$ per year (boiler capacity is less than 250 kWh).
3. Medium size public users – public users that need up to 150 m$^3$ per year (boiler capacity is less than 250 kWh).
4. Large size users (private /public) – users that need more than 150 m$^3$ per year (boiler capacity is more than 250 kWh). They are the most important customers.

For collecting data regarding the public buildings, the table below can be used to get more uniformed and to be able to arrange data better. More information on local market demand for each priority area is presented in the BioRES Report about priority locations for new BLTCs in Bulgaria, Croatia and Serbia.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the public building</th>
<th>Town / village</th>
<th>Year of construction / renovation</th>
<th>Total surface</th>
<th>Insulation</th>
<th>Energy use (type of fuel)</th>
<th>Energy use</th>
<th>Boiler (type and year of construction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SFI</td>
<td>LJ</td>
<td>1958 / 2010</td>
<td>2560</td>
<td>No</td>
<td>Wood chips</td>
<td>460-550</td>
<td>Froling, 220 kWh</td>
</tr>
<tr>
<td>2</td>
<td>....</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 5: Table for collecting data about public building in the region*
1.6 Didactic Approaches

1.6.1 PESTLE Analyse

PESTLE analysis gives you an overview on Political, Economic, Social, Technological, Legal and Environmental factors which usually need to be considered for any market orientated project or product. After collecting different data about supply and demand side and talking to different stakeholders in the region, a PEST or PESTLE analysis can be easily prepared. It can be done by investor itself or by group of co-workers or even together with the most important stakeholders.

PEST analysis was introduced nearly 50 years ago by Harvard Business School professor Francis Aguilar (with the acronym ESTP). The four components of PEST analysis are political, economic, social (including cultural and demographic), and technological component. Each of the PEST factors may represent constraints or opportunities, depending on circumstances. This makes it important to analyse the PEST factors periodically in order to be aware of changes in the business climate and ready to respond to any that could impact current product or service offerings (Shapiro A, www.trainingindustry.com).

- **Political factors** include a government’s ability and willingness to provide services. Influence on business through tax policy, tariffs and regulation are also political factors.
- **Economic factors** include the business cycle as well as trends in growth rate, interest rates and inflation. Status of the labor market including unemployment rates.
- **Social factors** include demographic influences such as population growth and median workforce age, as well as education levels and cultural norms of work by different strata of the population, more specific also forest owners structure can be included here.
- **Technological factors** include available technologies, new communication methods or automation.

These four factors provide a big-picture view of the framework conditions in which any organization is operating. Understanding how they affect the business environment on a macro level can help a company be more responsive in relation to the market (www.trainingindustry.com).

The PEST taxonomy has served well for a long time, but more recently a couple of factors have been added and an acronym has been developed: PESTLE. The “L” stands for legal and the final “E” for ecological. Legal may be fairly redundant with political, but it could include variations in regional laws and reliability of law enforcement and the court system. However, ecological is an entirely different matter. Ecological factors include all forms of natural resource conservation and management, including forest management. It includes energy availability and consumption, as well as waste disposal. Further, we live and do business in a world of climate change and increasing frequency of adverse weather events.
A PEST analysis most commonly assesses a **market**; a SWOT analysis assesses a business unit, a **proposition** or idea.

**Table 6: Topics that could be consider for PEST analysis**

<table>
<thead>
<tr>
<th><strong>POLITICAL</strong></th>
<th><strong>ECONOMIC</strong></th>
<th><strong>TECHNOLOGICAL</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ecological/environmental issues</td>
<td>home economy situation</td>
<td>competing technology development</td>
</tr>
<tr>
<td>current legislation home market</td>
<td>home economy trends</td>
<td>research funding</td>
</tr>
<tr>
<td>future legislation</td>
<td>general taxation issues</td>
<td>associated/dependent technologies</td>
</tr>
<tr>
<td>international legislation</td>
<td>taxation specific to product/services</td>
<td>replacement technology/solutions</td>
</tr>
<tr>
<td>regulatory bodies and processes</td>
<td>seasonality/weather issues</td>
<td>maturity of technology</td>
</tr>
<tr>
<td>government policies</td>
<td>market and trade cycles</td>
<td>manufacturing maturity and capacity</td>
</tr>
<tr>
<td>government term and change</td>
<td>specific industry factors</td>
<td>information and communications</td>
</tr>
<tr>
<td>trading policies</td>
<td>market routes and distribution trends</td>
<td>consumer buying mechanisms/technology</td>
</tr>
<tr>
<td>funding, grants and initiatives</td>
<td>customer/end-user drivers</td>
<td>technology legislation</td>
</tr>
<tr>
<td>home market lobbying/pressure groups</td>
<td>interest and exchange rates</td>
<td>innovation potential</td>
</tr>
<tr>
<td>international pressure groups</td>
<td>international trade</td>
<td>technology access, licencing, patents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>intellectual property issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>global communications</td>
</tr>
</tbody>
</table>

Local biomass production chains

- POLITICAL
  - ecological/environmental issues
  - current legislation home market
  - future legislation
  - international legislation
  - regulatory bodies and processes
  - government policies
  - government term and change
  - trading policies
  - funding, grants and initiatives
  - home market lobbying/pressure groups
  - international pressure groups

- ECONOMIC
  - home economy situation
  - home economy trends
  - general taxation issues
  - taxation specific to product/services
  - seasonality/weather issues
  - market and trade cycles
  - specific industry factors
  - market routes and distribution trends
  - customer/end-user drivers
  - interest and exchange rates
  - international trade

- SOCIAL
  - lifestyle trends
  - demographics
  - consumer attitudes and opinions
  - media views
  - technology image
  - consumer buying patterns
  - fashion and role models
  - major events and influences
  - buying access and trends
  - advertising and publicity
  - ethical issues

- TECHNOLOGICAL
  - competing technology development
  - research funding
  - associated/dependent technologies
  - replacement technology/solutions
  - maturity of technology
  - manufacturing maturity and capacity
  - information and communications
  - consumer buying mechanisms/technology
  - technology legislation
  - innovation potential
  - technology access, licencing, patents
  - intellectual property issues
  - global communications
1.6.2 SWOT Analysis
SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is a commonly used instrument of strategic planning which surveys internal strengths and weaknesses on the one side and opportunities and threats on the other side. Moreover, it provides a framework for deriving strategies based on promising combinations of found strengths, weaknesses, opportunities or threats (Rauch 2007).

For the first time a portfolio analysis on forest biomass supply chains was carried out on a European scale within the FOROPA project (www.foropa.eu). The objectives of this EU-project are the creation of a common research and innovation network to increase the competitiveness of diverse types of forest fuel for bioenergy. You can find more information on SWOT analysis being implemented and analysis of best practice examples in the report “Potentials and limitations for the transfer of good practice examples” on the BioRES website.

1.6.3 ‘H-form’ - a Method for Monitoring and Evaluation
Introduction
Andy Inglis developed a method to assist local people to monitor and evaluate local environmental management. He called this the ‘H-Form’ or ‘Rugby Post form’. Since then it has been modified in other monitoring and evaluation exercises in Scotland, Wales, Austria, Northern Ireland, Egypt, England, India and Romania.

Examples of applications:
- To assist local people to evaluate the performance of partnerships, programmes, agencies, initiatives, and a range of social and environmental topics.
- To identify local indicators for ongoing monitoring and evaluation
- To assist agency staff to evaluate and monitor their activities related to smallholder farming, forestry, fisheries, public consultation process, etc.
- To assist participatory appraisal (PA) workshop participants to evaluate their training and scenarios of good and bad practice for engaging with people.
- To facilitate and record semi-structured interviews with individuals and or groups of people, young and old.

Materials
A large piece of paper (e.g. flipchart paper if working with a group, or smaller if working with an individual), enough markers so that everyone in the group has one.

Steps
1. As it is important to get the dimensions right at the beginning, fold the paper as follows: fold it in half length-wise, then fold it in half width-wise and half again width-wise. Now unfold the paper and with a marker, draw a large H using the folds as your guide lines (don’t bother drawing in the centre vertical line).

2. Write the question being discussed in the top centre area of the H-form. This question must be simple and focused, such as ‘How well does the local economy benefit from forestry in this area?’ or ‘How well do organisations work together in this area?’ At the left end of the horizontal centre line of the H write 0 or ‘not
at all well' or a sad face symbol, and at the right end of this line write 10 or ‘extremely well’ or a smiling face symbol.

3. If you are working with a group of people, give each person a marker and ask them to place their individual score along the line between 0 and 10 (or ‘not at all well’/‘extremely well’, or sad face/ happy face symbols). See Figure 1.

4. Give each person 3 ‘post-its’ and ask them to write (or draw) the negative reasons for their individual score, i.e. why did they not give it the maximum possible score. Write or draw one reason on one post-it.

5. While participants are recording their own reasons, the facilitator can make a heading at the top left hand side of the H-form: ‘Negative Reasons for Your Score’. Once everyone has written down their reasons, ask them to stick these up on the left-hand side of the H-form (See Figure 2.).

6. Then give each person another 3 ‘post-its’ and ask them to record the positive reasons for their individual score, i.e. why they did not give a zero score. Once these are written on the ‘post-its’, participants stick these on the right-hand side of the form (see Figure 3).

7. Then each person reads out her/his negative and positive reasons for their score. Encourage people to simply read what they have written (or drawn) on their own ‘post-it’-notes without going into lengthy discussion, with any clarification if necessary. The group does not have to agree or disagree with any of the reasons people have recorded. This is simply an opportunity for each person’s views to be heard and understood.

8. The next steps depends on the objective of the exercise. In most of the uses of the Hform to date, one of the objectives has been to encourage the individuals in a group to record, share and understand each others’ points of view. Asking them to agree to a group score provides the focus and impetus for the discussion of all the views expressed.

9. Once everyone has read out their negative and positive reasons for their individual score, the group can develop a group score. The facilitator asks the group to decide upon a score between 0 and 10 or whatever
the scale is you are using. This group score is based on the negative and positive reasons people recorded on the ‘post-its’. This is often a quick process because the group will have heard a wide range of reasons behind the individual scores and can therefore usually agree on the group score. Once the group has decided upon a score between 0 and 10 then that score can be marked as a large number (or number of beans) at the top centre section of the H-form.

10. Again, depending on the objectives, the next step could be to ask the group to list ways in which the current situation as represented by all the positive and negative reasons could be improved. This is carried out by asking someone from the group to record everyone’s ideas in the bottom centre half of the H-form. Alternatively, this step can also be done individually by giving each person 3 ‘postits’ (see Figure 5).

11. The outputs of this tool can be easily transferred into a report without losing any detail or changing any words or symbols people have used to record their own views and ideas (see Figure 6). This can be done by creating one H-form and marking on it all the individual marks from all the H-forms on the horizontal line and listing all the negative and positive reasons as well as all the ideas for improvement. Another way is by scanning or photocopying (and reducing to A4 if necessary) all the original H-forms and incorporating them in a report.

We have found that this tool helps individuals and/or groups to record their own views and ideas in a non-threatening and open, yet structured, way which fosters individual expression as well as common understanding and consensus. It can be used in team meetings, workshops, conferences as well as on the streets, etc. The sequence and clear framework that the H-form provides keeps discussion focused, specific, progressive and can easily lead to action points. This structured format helps to facilitate and record semi structured interviews without introducing facilitator biases. H-forms can be used to enable people of all ages to participate in monitoring, evaluation and planning for improvement in many contexts.
H-forms have been used to evaluate e.g.:
- how well objectives are being met;
- how effectively money is being spent;
- how well agencies/organisations work together; and,

1.6.4 Motivation of the Investors
The main motivator for BLTC investors is the positive cash flow from the operation of a BLTC

The main argument for use of locally available woody biomass for energy production is replacing fossil fuels with renewable bioenergy. The mitigation of climate change is a global driver. By using forest biomass for energy production, the local communities and private households are able to replace fossil fuels with renewable counterpart, increase energy security and in most of the cases, save also money.

On the local scale, the social benefits of using local resources are one of the main benefits for people. The use of forest resources creates job opportunities in forestry, transport and energy production especially in rural areas. Moreover, the benefits from operations are distributed on the whole supply chain from forest owners to the energy producers, and the money stays within the region.

Market analysis, especially the estimation of real biomass potential (from the supply side) and demand for wood fuels, should be one of the main decision factors for planning the Biomass logistic and trade centre capacity.

\[ \text{Picture 17: Market analysis} \]
1.7 Implementing Countries Specifics

1.7.1 Bulgaria
Information about Bulgarian forests are available on below links:

- National Strategy for the Forest Sector for 2015-2020:
  [http://www.strategy.bg/FileHandler.ashx?fileId=4209](http://www.strategy.bg/FileHandler.ashx?fileId=4209)
- The national action plan for the Forest Sector:
- Presentation from the Executive Forestry Agency, explaining the structure of the private forest in Bulgaria:

1.7.2 Serbia
Data on Serbian forests you can gather from several sources:

- National forest inventory results – **Available on request**
- National statistics ([http://webrzs.stat.gov.rs/WebSite/](http://webrzs.stat.gov.rs/WebSite/)) – please note that data in National forest inventory and National statistics are not the same, since statistic is not based on National forest inventory but forest management plans – methodological issue foresters with experience in national inventory do understand. Note that National statistics does not have accurate record about harvesting in private forests.
- Forest management plans you can find several months before or after their acceptance by the Ministry of agriculture - [http://www.mpzs.gov.rs/obavestenje-javnosti-o-donosenju-osnova-gazdovanja-sumama/](http://www.mpzs.gov.rs/obavestenje-javnosti-o-donosenju-osnova-gazdovanja-sumama/)
- Other Studies - **Available on request**

1.7.3 Croatia
Information about Croatia forests are available:

- Forest Management Strategy for Croatia. This is a long term strategy covering 10 years. This one is up to 2015 and still valid. – **available on request**
- Official website of Hrvatske Sume d.o.o.  [http://javnipodaci.hrsume.hr/](http://javnipodaci.hrsume.hr/)

When you scroll down you will see a link to „Kartografski prikaz javnih podataka“ and when you click on it an interactive map will appear. You need to zoom in and click on the area of interest. At first contact details for local forest management offices will appear, but when you zoom in more - to the point of the very site specific forest office - in addition to contact details there will be also documents attached with all available data and descriptions for this location.

2.1 Basic Economic Calculations and Projections

2.1.1 Basics

In forestry management different units are used. In addition to the units which are currently used in the forestry sector, there are more units in the biomass sector. It is therefore very important that there is a precise definition of the individual units. The abbreviations and accurate units may vary slightly from country to country. They are based on experience and testing conversion factors between units. These conversion factors are approximate and depend on a variety of factors.

The conversions listed are guidelines which may vary depending upon layering, grain size, compaction, transport etc. (according to ÖNORM M-7132, M-7133).

<table>
<thead>
<tr>
<th>Timber wood</th>
<th>split logs 100 cm</th>
<th>split logs 33cm</th>
<th>wood chips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>settled</td>
<td>poured</td>
<td>fine</td>
</tr>
<tr>
<td>[m³]</td>
<td>[Rm]</td>
<td>[Rm]</td>
<td>[lcbm]</td>
</tr>
<tr>
<td>1 m³ timber wood round wood equivalent</td>
<td>1</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>1 rm split logs 1 m length, settled</td>
<td>0.7</td>
<td>1</td>
<td>0.85</td>
</tr>
<tr>
<td>1 rm ovenready split logs 33 cm length, settled</td>
<td>0.85</td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>1 lcbm ovenready split logs 33 cm length, poured</td>
<td>0.5</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>1 lcbm wood chips fine</td>
<td>0.4</td>
<td>0.55</td>
<td>0.5</td>
</tr>
<tr>
<td>1 lcbm wood chips rough</td>
<td>0.33</td>
<td>0.47</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 7: Wood conversion factors
**Moisture content:**
For biomass, the most important unit is the moisture content. The moisture content describes mass of water, which is available free in the whole wood mass (excluding cellular water). The water content is the factor which determines the energy content of woody biomass. The higher the water content, the lower the calorific heat value.

The moisture content is determined by a standardized procedure. This process is described and defined in the standard EN 14774-2.

**Dry ton:**
For the settlement of biomass, absolutely dry mass is the fairest and most correct variant for both parties. To get absolutely dry mass, you have to multiply the fresh weight with the dry matter content (100% - moisture content).

Another step would be the settlement by actual delivered calorific value. This is a mathematical conversion, in which the absolute dry mass, the moisture content and conversion factors are used.

### 2.1.2 Operating Costs
Operating costs are the actual costs, which are incurred in a full year. They include the ongoing administrative costs, but also the depreciation of investments, taking into account any subsidies. The administrative costs include all costs which are needed for the running business. Investment costs are usually calculated over a defined period (for example: storage hall, 33 years; wheelloader, 10 years). Standards for the periods are regulated by the state tax authority. It is important that these costs offset on each product, distributed in percentage terms. This means that the percentage distribution of products for sale, must be taken into the calculation for each product price.

This operation cost can vary from one year to another, because these costs greatly depend on the total selling quantity per year.
2.2 Technical Equipment and Processes

In Austria a Biomass logistic and trade centre is entitled to wear this brand name when certain conditions are met. These conditions serve to comply with three principles:

- Fair and accurate price
- From the region for the region
- Guaranteed security of supply

Technical equipment for measurement the quantity

To determine the exact amount of input and output quantities, it is important to make measurements over a weighbridge. This weighbridge must be a calibrated weighbridge and can weigh up to 60 tons. It is very important that the weighbridge can always swing freely. If a foreign body is blocking the weighbridge, the weighings and results are not correct.

Technical equipment for quality assurance and quality control:

For taking samples at the energy timber wood delivery, a chain saw with a collecting device is used. It is recommend to use an electric chainsaw, because the maintenance is rather low and the chain saw works immediately, at any weather. The chain should be regularly sharpened. A blurred chainsaw is producing removal heat, which is transferred to the sample material and thereby a proper moisture content test is no longer feasible.

The collecting device should be designed so that all sample chips enter into the device. Furthermore, the catcher should be dimensioned so that the whole sample material can be captured.

To avoid losing the guarantee and the declaration of conformity, it is not allowed to attach the catcher directly to the chainsaw.

For taking samples at the wood chips delivery, a shovel (hand shovel), a bucket and, optionally a tub is needed for sampling. It is important that the blade walls are not too small, otherwise you will lose (mainly in sampling) the finer fraction of the sample material.

The best blade for sampling is a animal feed bucket.

The bucket for sampling should be able to hold the amount of sample. In addition, the size of the bucket has to be chosen so that the sample material can be mixed properly in the bucket. If the bucket for sampling is too small, it is recommended to use a big tub for the mixing.

Technical equipment for quality assurance and quality control

A verifiable precision scale is needed, with a scale at least 0.1 g. This precision scale has to stand on a flat surface and away from draft.

As further technical equipment required is a drying oven. Drying oven must be designed, so that it can maintain the desired temperature (in this case 105°C). The samples are placed in sample cups for the drying periode in the oven. For this purpose, conventional bakeware or grill cups can be used. However, sample
cups can’t have outlets at the bottom or on the side, as otherwise the fine fraction of the sample material can escape.

![Picture 20: quality control](image1)

![Picture 21: quality control](image2)

**Technical equipment for loading the products:**
A main aspect which has to be considered before selecting machines is the main product. It is very difficult to load small amounts of firewood by a large wheel loaders. In any case, technical equipment should be designed so that the daily use is on the forefront. To avoid unnecessary repair and maintenance costs, do not exploit equipment to its daily limit.

2.2.1 **Processes on a Biomass Logistic and Trade Centre:**
To guarantee the quality of products and work, it is necessary to have a Quality Assurance/Quality Control (QA/QC) handbook, in which all work processes are accurately described and documented, hence it serves as guidance also for the employee(s) how work is performed. This QA/QC manual must be adapted to the current standards and guidelines. It is necessary to keep this manual up to date.

2.2.1.1 **The Process: Acceptance of Deliveries:**
The acceptance of supplies must be very accurate and correct classification of the supplied product and the samples has to be taken according to the guidelines. The acceptance by weight and moisture content is recommended, because this is the most accurate and most correct method.

**Description of steps:**
The delivery vehicle drives on the weighbridge. The weight must only be taken when the vehicle engine is turned off and no person is in the vehicle.
The employee has to evaluate and classify the product of the delivery.
During the sampling process it is important to consider that the sample is a representative sample for the whole delivery.
Subsequently, the measurement of the moisture content must be determined immediately, if this is not possible, than the sample must be protected from drying out or humidify.
2.2.1.2 The Process: Storage

If the supply is accepted, in most cases the raw material is stored until processing. The storage management requires accurate storage logistics. This storage management should be described in the handbook. For the natural drying the best way to dry is to store the raw material in an open storage, which means no shading, and if possible, windy position. The marking of the delivery period on the storage piles is useful for further processing.

Picture 22: storage plan

2.2.1.3 The Process: Wood Chipping

In the production of wood chips, it is important to pay attention to the right particle size. Which particle size is suitable to which boiler, depends primarily on the woodchips delivery system to the boiler. The woodchips delivery system is the technical equipment which brings the wood chips from the wood chips storage to the boiler. If a screw is used, a small particle size is needed. If the boiler is filled via a hydraulic push rod system, the woodchips can be more rough.

When chipping roundwood itself, it is important to have the right settings on the chipper:
- leap ahead: is the depth of which the chips are cut down from roundwood;
- screen mesh: is significant for the particle size;
- sharpness of knifes: is important for the correct cut, cutting not tearing;

If the wood chips are transported by the chipper directly in the storage hall, this can be done with a fan or with a conveyor belt. For the pieciness of the wood chips and to avoid an excessive fine particles, it is advisable to work with the conveyor belt. The water content of the processed raw material is also a criteria for the quality of wood chips. Basically, higher water content means less fine particles.

A part of the sales quantity is stored in the storage hall until the sale. The larger part of the sales quantity is chipped directly on the delivery vehicle and transported to the customers, according the principle "delivery just in time".

For the chipping of round timber the use of a large chipper (truckchipper) is recommended. For chipping directly in the forest, it is recommended, to use a small manoeuvrable chipper, mostly a Tracktor-chiptrailer combination.
2.2.1.4 The Process: Produce Split Logs/Firewood:
In the production of split log/firewood, a distinction is made between two types of production. One possibility is the manual production of firewood, the second possibility is the production of firewood by a fully automated cutting-splitting system.

With the manual production of firewood, the length of the finished product is cut with a burlap chainsaw from energy wood and then pieces are splited with a hydraulic splitter. This method is very time consuming, but has the advantage, that the quality of the logs is very high. For typical firewood this method is used.

In the fully automated production of the firewood, the whole energy wood is applied to a cutting-splitting system. This system first cuts a piece in the required and finished measurements (25 cm, 33 cm, 50 cm ...), then the cutting piece is passed directly into the splitter, where split by a massive split-cross and runs on a conveyor belt of the cutting-splitting system. This method of manufacturing splitlogs saves many work steps and thereby time, but requires a high degree of logistics. The best solution for this system is that the firewood is filled directly into sellable and storable units and can be manipulated. For this purpose, different systems are used, such as: wire-baskets, Big Pags or net-systems with pallets. The disadvantage of this very fast method is, that the employee has little opportunity to influence the quality of the individual logs in the process.

2.2.1.5 The Process: Delivery Systems:
The delivery of the products is based on the same system as the acceptance. During loading several samples are taken at regular intervals for quality control. After loading, the weight of the load is determined on a weighbridge. In most cases, delivery is organized by the employees of the biomass logistic and trade centres. For the employees it is important to know the customer requirements in order to select the right delivery system. The difference between delivery systems are the volume, the system of discharge (tilt, blow, walking floor ...) and possibility of access.

The split logs weighing functions in the same manner. However, the splitlogs are sold after being air dry. In order to guarantee the quality, every 1500 kg 3-4 splitlogs are taken for measuring the moisture content.

The relationship between delivery depends on the customers and their wishes. Some customers will select their split logs and than they have to load them on their own.
2.3 Organizing the Owners of a BLTC/Ownership and Business models

Regional BLTCs are decentralized hubs for organizing supply and demand.

**Important questions are:**
- Where does the raw material come from?
- Who organizes, manages and markets?
- Who and where are the customers?
- Who and where are the competitors?

**Where comes the raw material from?**
It is important to know who the suppliers are. They could be local farmers, forest owner associations, wood processing companies or forest enterprises. The structure of the suppliers has a major impact on the average delivery amount, the payment terms and conditions and the delivery quantity per year.

If the biomass comes from near a river it has higher moisture content, if the biomass comes from near a road, it could be contaminated with heavy metals.

One important criteria for choosing the location for the BLTC is how the raw material is delivered. It could be delivered by trucks or tractor-trailer combinations or by train. This affects the average delivery quantity and the storage plot. The road is very important, because if road leads over bridges, it is important to be aware of the maximum weight level of the bridges and of the ownership of the streets (public or private).

Another important fact is a good connection to motorways or land roads, so that routes can be optimized and transport costs can be reduced. In order to optimize routes, it is important to know where the suppliers are located.

**Who organizes, manages and markets?**
The estimation of the work load defines the workforce and thus the number of employees. The employee costs are a major factor in the business plan and in the operating costs. That’s why it is very important to do an exact calculation (for office and field work). Office work includes all tasks for organizing supply and deliveries, marketing, purchase and sale, calculation of the prices, organisation of work processes, accounting and human resource management. Field work includes all tasks on e.g. processing and storage plot (delivery, management of the storage, preperation and support, cleaning the plot, loading the products and many other manual tasks).

Marketing is essential to win costumers. Advertising in regional newspapers is very useful because customers from the region are addressed and the delivery distances are not too big. For advertising it is important to also use various social media platforms. An opening ceremony is a great opportunity to advise potential customers in a personal conversation and thus additional events should be repeated every year in order to bring new customers to BLTCs.
Folders, brochures and giveaways could be distributed in trade fairs and events. These promotion materials are ideal reminders for the customers and are very important to make the company known.

**Who and where are the customers?**
The products of a BLTC can be firewood, wood chips, split logs, wood pellets, wood briquettes, charcoal, heat or other biomass fuels. The choice of the products and offered services has an impact on the logistics, and required infrastructure. Besides specialization it’s important to know, who are the main customers (e.g.: a
The main buyers influence the product range, the logistics and services and the quantity and quality control.

**Who are the main competitors?**
Another factor for a successful development and implementation of a BLTC is the knowledge about the competitors. Therefore it is very important to gather information about competitors, their prices, customer relations and products thoroughly. The wood energy products compete with respective fossil fuel counterparts (see country specific price tables on BioRES market information system.

**Operational models:**
In Austria, three different types of operational models are used for BLTCs:

1) **Cooperative**
2) **Limited liability company**
3) **Networking company**

1) **Cooperative:**
A cooperative is a legal entity which is owned and controlled by its members. Members often have a close association with the enterprise as producers or consumers of its products or services, or as its employees. The United Nations define a cooperative as »an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise.« The co-operative model is flexible and may be applied to different purposes from social services to business ventures.
A cooperative as an operator model for a BLTC is useful when main deliverers of BLTC are farmers or forest owners, typically rather small forest area. Members of a cooperative hold a share which is connected with a certain forest area and a fixed delivery amount of wood per year. The cooperative has to take every year the defined delivery amount of wood from each member. The members are liable up to certain percentage of the share value which were bought at the beginning.
The idea of a cooperative is not always to make the highest business profit, but to pay a good and fair market price for the energy wood from the members.
Cooperative has usually a general meeting which selects the board of a cooperative. The board makes the decisions related to the cooperative operation and development. The cooperative may also have hired employees such as operative managers and operators.

2) **Limited liability company (Ltd./Ld./GmbH/ d.o.o.):**
A limited liability company is a type of legal entity very common in Germany and Austria for instance. The main task of a limited liability company is to be profitable in its operation and thus generate profit for its owners.
The owners have to invest their own capital for the company. The minimum share capital required to establish varies between countries, but for instance in Germany it is EUR 25,000 and in Austria EUR 35,000 (can also be made up of contributions in kind). At the time of registration, 50% of this liability amount in cash.
A limited liability company is managed and legally represented by its managing directors (at least one managing director is usually required). By issuing binding instructions or directions to the managing
directors, the owners may exercise direct influence on the management of the company. In order to be valid, a limited liability company must be entered into the commercial register. A limited liability company is an operating model for a BLTC especially, if there's no forest ownership involved in the business. The limited liability company may have full supply chain services from harvesting and transportation of raw material, production of wood energy products and/or heat services and finally sales and delivery, or it can be only a sales platform of products.

3.) Networking company:
A networking company is a business model, where a group of companies establish together a new company which is administrating the operations through its member companies. The member companies are also members of the board of a networking company and thus they are actively involved in the decision making of a networking company. As in limited liability company, also a networking company has a managing director who is selected by the board of a networking company. The benefit of a business model is that network combines the expertise and resources of individual companies and thus even out the seasonal challenges of operational environment by more wide spectrum of services. The member companies are responsible to give their own resources for the benefit of other companies in the network.
3. Quality Assurance & Verification of Sustainability Requirements Including EU Timber Regulation

Good quality solid biofuels are at the core of the BLTC concept and hence how constant good quality is managed, assured and measured needs to be described. The legality and sustainability of the raw material is also essential to ensure the security of supply and continuation of operation in the long run.

3.1 European and International Quality Standards on Solid Biofuels

The international quality standards on solid biofuels have been recently developed and were published in 2014. Hence they are now in place and used by the industry with varying uptake depending on the fuel and country. These international standards on quality have been adopted into national standards at least in all EU countries and Serbia. The most common usage of quality standards is in supply contracts where a reference is made to the applicable standard, clearly defining the quality of the solid biofuel. Also the measurement of solid biofuels is standardised, to ensure that all measurements are comparable. At the moment a majority of measurement standards are European standards adapted by the countries to national standards, but for the most important measurements international standards have been developed.

3.1.1 Standards on Product Definitions

The ISO 17225-1 “Solid biofuels — Fuel specifications and classes — Part 1: General requirements” sets the general specifications for all the solid biofuels from firewood to straw bales. It classifies different raw material, which can be used. An example of the highest level of detail is coniferous stem wood with bark originating from forest, another example is chemically untreated broad-leaved wood by-products and residues. Hence it does not go into high detail specifying the species of the tree, or the geographic origin. The standard also includes tables specifying what needs to be measured, according to what standard and how to present the values in what types of classes. The following table gives an indication of the requirements set by the standard on various fuel types:

<table>
<thead>
<tr>
<th>Summary table of required parameters of the ISO 17225 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Wood chips</td>
</tr>
<tr>
<td>Wood pellets</td>
</tr>
</tbody>
</table>
The additional parts to ISO 17225 are describing the requirements for different types of solid biofuels in more detail than the ISO 17225-1, which states the general requirements. They also classify the fuels to different classes for easier specification as the quality class can be referenced to. These are recommended for smaller scale appliances, and hence the main customer segments of BLTCs. The requirements are also available for solid biofuels used in industry, but their uptake varies.

### Standards on Quality Assurance

The EN standard 15234-1 “Solid biofuels – Fuel quality assurance – Part 1: General requirements” sets the basic principles in fuel quality assurance for professionals in the business. It sets requirements for the biofuels producer on:

- **Traceability** – ensuring that the origin of the feedstock is known throughout the supply chain for both the type and the geographic origin
- **Production requirements** – the specification of the biofuel according to ISO 17225 and how to ensure this is met
- **Transportation, handling and storage** – to maintain the quality of the biofuel during the supply chain
- **Fuel analysis and specification** – measuring and specifying the biofuel properties
- **Product declaration of fuel quality and labelling** – the producer ensures in writing the quality and origin of the biofuel in the product declaration given to the customer.

In general the standard gives a rather complete checklist on what needs to be thought of when managing quality. However it is not very detailed and uses phrases such as “appropriate methods” hence leaving room to discussion regarding for instance handling methods. The standard also clarifies on practices regarding when to measure and what, as well as how product declarations should look like. It also helps at identifying critical control points where quality is measured. The standards ISO 15234-2 to 15234-6 provide fuel specific (non-industrial) fuel quality assurance requirements for wood pellets, wood chips, wood briquettes and firewood and non-woody pellets.

### Standards on Measurement

There are measurement standards available for each measurement needed to comply with the quality standards. However this does not mean that everything needs to be measured for every production batch, as this would set a too high cost on testing the quality. The customer and supplier should have an agreement
of what needs to be measured and what can be measured in-house and what needs and how often measurements need to be made in laboratories and do the laboratories need to be accredited. The role of accredited laboratories is to provide independent verification of a property. The standard for fuel quality assurance (EN 15234-1) also states that the quality analysis (for instance on the element composition or the size distribution) may not be needed if there is sufficient information on the origin and the methods used in the supply chain. This does not remove the responsibility of providing accurate information to the customer.

The operators of the BLTCs should keep a track of the wood used (species and type) and measure the moisture content and size specifications (e.g. chip size) to verify quality. The wood used will affect the amount of elements (Chlorine etc.) and to some extent ash content and calorific value. The supply chain practices have also an effect on ash content, as if sand or dirt is mixed with the biofuel, the ash content is higher. Also the chip size distribution should be monitored as the degrading of the condition of the chipper blades often leads to lower quality wood chips. The moisture content is such an important parameter in fuel quality and it should be measured, as it affects significantly the heating value of the fuel. The size distribution and the moisture content measurement can be done according to standards with low investment on measurement devices at the BLTC. For moisture content standards ISO 18134-2 should be used and for particle size ISO 17827 could be used. Hand held moisture measurement devices can be used for internal control, but they do not comply with the measurement standard, as only the oven method is standardized. Hence if hand held devices are used, the results should be verified with the oven drying method relatively frequently, as there are differences in the accuracy of the devices and should be mainly used to provide an indication of moisture content. The sampling should also be properly done and the standard ISO 18135 states the requirements. In general the sample should be of suitable size with a good representation of the material being sampled.

For measurement of other parameters (i.e. ash content, element contents, calorific value etc) laboratories are needed. When the feedstock is being sourced consistently from the same supply, and there is no reason to believe that any important parameter is likely to have changed or be outside the normal range, it may be sufficient simply to rely on typical values for many of the parameters, or test only occasionally to ensure compliance.
3.2 Woody Bioenergy Fuel Qualities and Heating Value in Comparison to Respective Fossil Fuels

The properties for different solid biofuels vary, and the majority of this variation comes from the moisture content as can be seen in the image below. For 0% moisture content the lower heating value is 5,2 kWh/kg but at 50% moisture content (wet basis) it is about half of this. Hence good practices can be used to make drier fuel to increase the heat output of the same amount of wood. This leads to more resource efficient use of solid woody biomass for energy. It depends on the technology of the heating device which specific fuel is providing the best price – performance ratio. Actually for a large scale heating plant wood chips of 35% moisture content can be the best choice depending on technology whereas stoves using firewood should only use wood with a maximum of 20% moisture content.

![Dependence of heating value of biomass from water- and moisture content](image)

Picture 23: moister and heating value

The energy content of one ton of wood depends primarily upon the moisture content and not on the tree species. This is not true on volume basis as the densities of species vary. Hence the energy content of 1 m³ wood depends upon the species (1), the moisture content (2), bark content (3) and the form of the wood (4): logs, fire wood pieces, chips etc.
The main fuel properties for selected wood fuels are presented in the table below.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Net calorific value, dry content kWh/kg (moisture content 0%) ($q_{p,net,d}$)</th>
<th>Moisture content w-% (Mar)</th>
<th>Net calorific value, as received=actual value kWh/kg ($q_{p,net,ar}$)</th>
<th>Bulk density kg/loose m³</th>
<th>Energy density (MWh/loose m³)</th>
<th>Ash content, dry, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawdust</td>
<td>5,28-5,33</td>
<td>45-60</td>
<td>0,60-2,77</td>
<td>250-350</td>
<td>0,45-0,70</td>
<td>0,4-0,5</td>
</tr>
<tr>
<td>Wood pellets</td>
<td>5,26-5,42</td>
<td>7-8</td>
<td>4,60-4,90</td>
<td>550-650</td>
<td>2,6-3,3</td>
<td>0,2-0,5</td>
</tr>
<tr>
<td>Log wood (oven-ready)</td>
<td>5,14-5,28</td>
<td>20-25</td>
<td>3,72-4,03</td>
<td>240-320</td>
<td>1,35-1,95</td>
<td></td>
</tr>
<tr>
<td>Logging residue chips</td>
<td>5,14-5,56</td>
<td>50-60</td>
<td>1,67-2,50</td>
<td>250-400</td>
<td>0,7-0,9</td>
<td>1,0-3,0</td>
</tr>
<tr>
<td>Whole tree chips</td>
<td>5,14-5,56</td>
<td>45-55</td>
<td>1,94-2,78</td>
<td>250-350</td>
<td>0,7-0,9</td>
<td>1,0-2,0</td>
</tr>
</tbody>
</table>

Table 9: main fuel properties for selected wood fuels

1kWh/kg = 1 MWh/ton = 3.6 GJ/ton
Source: EUBIONET “Biomass fuel supply chains for solid biofuels”

The density and energy density for selected renewable and fossil fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Density</th>
<th>Oil Equivalent kg/L OE</th>
<th>Oil Equivalent L Fuel/L OE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil</td>
<td>0,84 kg/L</td>
<td>0,84</td>
<td>1,00</td>
</tr>
<tr>
<td>Rapeseed oil</td>
<td>0,92 kg/L</td>
<td>0,97</td>
<td>1,05</td>
</tr>
<tr>
<td>Stone coal (w = 5,1 %)</td>
<td>860 kg/m³</td>
<td>1,28</td>
<td>1,49</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0,79 kg/L</td>
<td>1,34</td>
<td>1,70</td>
</tr>
<tr>
<td>Wood pellets (EN 14961-2, w = 10 %)</td>
<td>664 kg/m³</td>
<td>2,15</td>
<td>3,24</td>
</tr>
<tr>
<td>Straw pellets (w = 10 %)</td>
<td>603 kg/m³</td>
<td>2,36</td>
<td>3,91</td>
</tr>
<tr>
<td>Hydrogen (liquid at –252.8 °C)</td>
<td>0,07 kg/L</td>
<td>0,30</td>
<td>4,23</td>
</tr>
<tr>
<td>Beech log wood (air-dry, split, 33 cm long, w = 15 %)</td>
<td>445 kg/Rm</td>
<td>2,35</td>
<td>5,28</td>
</tr>
<tr>
<td>Spruce log wood (air-dry, split, 33 cm long, w = 15 %)</td>
<td>304 kg/Rm</td>
<td>2,30</td>
<td>7,54</td>
</tr>
<tr>
<td>Wood chips (pine air-dry, w = 15 %)</td>
<td>217 kg/m³</td>
<td>2,25</td>
<td>10,35</td>
</tr>
</tbody>
</table>
### Table 10: density and energy density for selected renewable and fossil fuels

<table>
<thead>
<tr>
<th>Material</th>
<th>Density (kg/m³)</th>
<th>Energy Density (tkWh/m³)</th>
<th>Water Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saw dust (spruce air-dry, w = 15 %)</td>
<td>160</td>
<td>2.3</td>
<td>14.35</td>
</tr>
<tr>
<td>Crop straw – large cubic bales (air-dry 15 %)</td>
<td>140</td>
<td>2.52</td>
<td>18.00</td>
</tr>
</tbody>
</table>

Source: TFZ, Klaus Reisinger, Herbert Sporrer, Dr. Hans Hartmann
3.3 EU Timber Regulation Requirements for Market Actors

The aim of the EU Timber regulation (adopted in 3/2013) is to ensure that illegally harvested timber products do not enter EU Markets.

The regulation counters the trade in illegally harvested timber and timber products through three key obligations:

1) It prohibits the placing on the EU market of illegally harvested timber and products derived from such timber;
2) It requires EU traders who place timber products on the EU market for the first time to exercise ‘due diligence’. Once on the EU market, the timber and timber products may be sold on and/or transformed before they reach the final consumer. To allow for the traceability of timber products economic operators in this part of the supply chain (referred to as traders in the regulation) have an obligation to
3) keep records of their suppliers and customers.

The EU Timber regulation, sets out procedures to which those trading timber within or to the EU must put in place to minimise the risk of illegal timber (or products) being sold. This is done by using a “due diligence system”, which can be supported by chain of custody certification. The core of the “due diligence system” is a risk management exercise. The due diligence system consists of three main components:

Due diligence system for EU timber regulation.

<table>
<thead>
<tr>
<th>INFORMATION</th>
<th>RISK ASSESSMENT PROCEDURE</th>
<th>RISK MITIGATION PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>There must be access to the following information:</td>
<td>Assurance of compliance with applicable legislation (e.g. certification, verification, FLEG etc)</td>
<td>Measures and procedures which are adequate and proportionate to minimise risk effectively. May include requiring:</td>
</tr>
<tr>
<td>• product description</td>
<td>• Prevalence of illegal logging of species</td>
<td>• Additional information</td>
</tr>
<tr>
<td>• species</td>
<td>• Prevalence of illegal logging in country or region</td>
<td>• Additional documents</td>
</tr>
<tr>
<td>• country of harvest</td>
<td>• Sanctions and armed conflict</td>
<td>• Third party verification</td>
</tr>
<tr>
<td>• quantity</td>
<td>• Complexity of supply chain</td>
<td></td>
</tr>
<tr>
<td>• supplier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• customer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• compliance with applicable forestry legislation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Picture 24: Due diligence system for EU timber regulation


A majority of the requirements are for the company first placing the timber (called operator) on the EU Markets. There are also requirements in the further supply chain mainly aiming at ensuring traceability of the products. **A clear requirement for the traders buying or selling timber products already placed in the markets is the requirement to keep records for a minimum of 5 years, which identify the operator or trader who supplied the timber and timber products, and where applicable, the trader to whom the timber and timber products were sold.**

For the operator who brings the timber product to the EU market for the first time, the requirements are more complex. To help the operators private monitoring organizations have entered the business which need to be recognized by the EU, providing ready-made systems. In order to recognize good practice in the forestry sectors, certification or other third party verified schemes that include verification of compliance with applicable legislation may be used in the risk assessment procedure (Art. 19 EU-Timber Regulation). Chain of custody certification shall provide assurance that a product only contains timber, or a specified percentage of timber, from certified forests and timber from controversial sources is excluded. If relying on certification as assurance and purchasing from a supplier holding chain of custody certification, the buyer needs to ensure that the certification is valid, the product is covered by the certification scope and the documentation match the product. For this usually the buyer needs to specify certified products in the purchase order and check the online database of certified companies (or see the certificate) and verify that the CoC numbers and claims about certified materials (e.g. FSC 100%) are valid in the invoice or delivery note.

It is possible to be compliant with the EU timber regulation with non-certified wood as well and without CoC. For this adequate evidence proving legality and/or sustainability is needed. This means in practice credible evidence showing that the forest source is legally and sustainably managed and the chain of custody is robust. This needs to be done on a case by case basis and in EU member states competent authorities and monitoring organisations should be able to help what evidence is acceptable. Regarding legality, legal usage rights can be proven by a timber sales agreement, harvesting licence, logging permit, woodlot license or a land tenure agreement. In addition the company needs to comply with national and local laws and ensure that all royalties and taxes are paid.

For assessing if the procured biomass is derived from sustainably managed forests the following questions could be asked:

*Is sustainable forest management defined by a multi-stakeholder process and based on international forest management criteria (e.g. Forest Europe Process⁴)? How is it documented and verified?*

The traceability needs to be ensured throughout the supply chain if there is no Chain of Custody certification. It should be possible to trace back up to the origin of the wood. This can be difficult with wood residues and thus storage at facilities needs to be well organised with proper documentation.

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3.4 Certification and Auditing Procedure

There are multiple actors in the certification procedure: the certifying organization (or licenser), the accreditation organisation and the accredited certification body. The certifying organization owns the rights to the certification scheme. The accreditation organisation does the accreditation of certification bodies and checks the auditing procedures. The certification body grants the certificate to the company if it follows the rules of the certification scheme. Below is a simplified certification procedure, which most certification schemes follow:

- Application
- Conformity assessment by independent bodies
- Inspection report evaluated by certification body
- Pay licence fees
- Company certified
- Surveillance (Audits to ensure company follows certification rules, how often varies on the certification)
- Company re-certified after successful surveillance

3.4.1 Forest Certification

The need for wood as a natural resource for raw material use and for energy continues to increase. This trend is accelerated, especially in Europe, by the growing importance of wood in the renewable energy mix. Safeguarding wood resources for the future and maintaining their availability is therefore becoming increasingly important. This is boosting the demand for credible sustainability standards in the forestry sector. The Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) are the most widely used forestry standards systems worldwide. In Bulgaria, Croatia and Serbia FSC is dominant with 25%, 80% and 40% of forests FSC certified and no presence of PEFC forest certification.

Forestry standards initiatives aim to ensure that management of commercial forests is verifiable and sustainable. They do this by seeking to improve the transparency and management of timber production and timber trade. FSC is a standard system of national and regional standards consistent with ten principles of SFM that cover the following issues:

1. The compliance with laws and FSC principles.
2. Long-term tenure and use rights and responsibilities that are clearly defined and documented.
3. Legal rights for indigenous people to manage their own lands.
4. Through forest management operations the long-term social and economic well-being of forest workers and local communities shall be enhanced.
5. The forest’s multiple products need to be used in an efficient manner.
6. The biological diversity and its associated values of the forest needs to be preserved.
7. The objectives of the management, and the means of achieving them, shall be clearly stated.
8. Monitoring of the forest and of the management activities shall be conducted.
9. The high conservation forests shall be maintained.
10. The forest plantations should complement the management of forests, reduce pressures on, and promote the restoration and conservation of natural forests.

Both FSC and PEFC schemes are striving to achieve sustainable forest management by independent third party assessment of on-ground forestry practices. These inspections and certification conforms to a set of
international standards, evolved by ISO, for standards-setting and independent third party verification by certification bodies. The actual procedure is not described here, as the BLTCs are not forest owners in most cases.

There is also an ISO standard 13065:2015 “Sustainability criteria for bioenergy” which is more focused on the origin and sustainability in terms of environmental, social and economic basis. This was published in October 2015 and hence its adaptation is has not yet properly begun. It set requirements of proof for similar issues as forest certification but has a broader focus, on all biomass, including agricultural residues etc.

3.4.2 Chain of Custody Certification (CoC)
Most manufacturing processes are complex and go through a series of stages starting with the initial raw materials and ending with the final product. This is often referred to as the product supply chain. “Chain of custody” is the process of tracing material through this supply chain in order to know where the material in a particular product came from.

The FSC and PEFC System have central Chain of Custody standards (FSC-STD-40-004, PEFC ST 2002:2013) which contain the requirements for sourcing, processing, selling and tracing certified products. These standards have to be applied by all companies processing and/or trading FSC or PEFC certified products.

There are two possibilities to become FSC or PEFC Chain of Custody certified for BLTCs:
- Individual Chain of Custody certification for one company.
- Chain of custody certification for multiple sites for groups of small companies (which requires the application of further standards and requirements in addition to the central Chain of Custody Standard and allows an improved access to certification for small companies).

Please find more information on the certification process on your usb-stick and in the training presentation.

3.4.3 Product Certification
At the moment the only widely used certified solid biofuel are wood pellets. Two certification schemes, ENplus and DINplus are existing in parallel, both having very similar product requirements. The main difference between these certification systems is in ENplus all the companies in the supply chain from the mill to the end user need to be certified when delivering bulk pellets. ENplus bagged pellets can be sold by anyone, but their marketing has certain rules. DINplus certifies the production plant only and there is a voluntary possibility to become a “DIN-tested Qualified Enterprise of Pellet Logistics” for companies involved in the logistics of pellets. Hence for companies trading DINplus pellets, it is voluntary to get the DIN acceptance. Furthermore, a few product parameters are addressed more strict in the ENPlus System. ENplus and DINplus also exist for wood briquettes, but their market uptake is very limited.

In the certification procedure the first task is to contact the organisation issuing the certificates for the exact requirements and full procedure

In the pellet certification schemes (ENplus and DINplus) the certification of the feedstock (Forest management certificate) is asked, but it is not compulsory for certification. What the material is (i.e. harvesting residues, saw dust, whole tree chips,) needs to be stated in the certification requirements as this is also a part of the standard they use as a basis for their requirements (ISO 17225-2).
3.5 Benefits of Certification

The main benefits of performance (such as FSC) and product certification (such as ENplus) are

1) To safeguard the sustainable management of forests and along the supply chain and communicate sustainability claims (e.g. labels) defined by the used standard/certification system.

2) Ensure a standardised quality of the products

This could lead to make management processes of the company more efficient and sustainable, ensure a better positioning on the market, and improves the image of the certified company. Forestry standards systems are an important criterion for risk-based investment decisions in forestry. Holding a certificate also proves the product claims and increases market transparency.
4. Other Training Material

The complete literature with presentations, animation videos and EU timber regulation documents in different languages is available on BioRES website: http://bioresproject.eu/index.php/training-of-stakeholders-along-the-supply-chain-of-woody-bioenergy-products/
5. Sources and Literature

- PLA Notes (1999), Issue 34, pp.84–87, IIED London
- PEST to PESTLE [www.trainingindustry.com](http://www.trainingindustry.com) (13.11.2015)
- Joint SWOT analysis for wood supply chains in SEE countries, [www.foropa.eu](http://www.foropa.eu)
- Different literature about Biomass trade centers and wood fuel quality assurance systems on: [http://www.biomasstradecentre2.eu](http://www.biomasstradecentre2.eu)
- OBERBERGER I., 1995–Logistik der Aschenaufbereitung und Aschenverwertung, Bundesministerium für Ernährung, Landwirtschaft und Forsten, Bonn (DE).
- AEBIOM statistical report 2015.
- BioRES 2015. Status Report on sustainability in forestry and along woody bioenergy supply chains in Bulgaria, Croatia and Serbia
- EN 15234-1:2011 Solid biofuels - Fuel quality assurance - Part 1: General requirements
- EUBIONET – Biomass fuel supply chains for solid biofuels
  http://www.biomasstradecentre2.eu/data/upload/D5_5_Biomass_supply_chains_eubionet_1_%281_%29.pdf
- European commission, Environment, International forest issues EU timber regulation:
  http://ec.europa.eu/environment/forests/timber_regulation.htm
- Forest Stewardship Council – www.fsc.org
- SolidStandards – Quality and sustainability standards for solid biofuels http://www.solidstandards.eu
  (EN standards)
- Wikipedia (www.wikipedia.org )