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WP 3. Report on Activity 3.1 - Joint Methodology on Data Structure and Scope related to Biomass SCORPs and Network Communication Flow

Definition of Analytical Scheme

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INTRODUCTION

Biomass represents one of the most important renewable energy sources both, in European countries and around the world. According to different regions (nations) strategies, different targets have been established for the use of biomass as energy source. Its utilisation relies on some basic principles which highlight the overall sustainability in this sector. Biomass resources for energetic use may be provided by different sectors. Forests represent one of the most extended and valuable biomass resources for energetic use.

Under different regional or national conditions, supply chains in biomass sector are different due to their local specific circumstances. In some cases improvements may be considered in order to increase the overall efficiency of the supply chains. Increased efficiency of the biomass supply chains ensures the overall sustainability of the biomass sector. Knowing the current situation in different regions represents a key factor for improveming strategies.

In order to assess the “as it is” situation in biomass supply chains, as well as to recommend improvements for the biomass supply chains, in depth knowledge regarding the Biomass Supply Chain Operational Reference Processes (BioSCORPs), Information and Communication Technologies (ICTs) as well as Network Communication Structures (NCSs) are required.

In this context, this paper provides a guideline in the attempt to approach the above mentioned problems related to the current state of regional biomass sector. It addresses the data structure and scope related to the Biomass Supply Chain Operational Reference Processes (BioSCORPs), Information and Communication Technologies (ICTs) as well as Network Communication Structures (NCSs).

FOREWORD

The enclosed methodology is based on the Supply Chain Operations Reference – model (SCOR) as a cross standard for supply chain management, developed over recent years by the Supply Chain Council (CSS – 2005). Additionally, using the stream of information determined by the SCORP, data on ICT integration and network communication structure will be collected and processed.

Present material consists in a draft regarding the methodology for data collection and primary interpretation. This material has its limitations due to early stage of data needs establishment and also because of differences between the systems in the different partner countries. Those limitations refer to:

- Not yet defined biomass supply chain operational reference processes – therefore metrics for certain processes or processes elements can only be recommended;
- Different measurements units for certain indicators, making it is necessary to implement a common measuring system or to provide conversion tools;
- Different stages of market maturity in different partner countries;
- Uncertainties regarding some data availability;
- etc.

Due to reasons described above, the methodology in this draft needs to be refined firstly at level of concepts and content and also, after definition of supply chain processes, at the level of metrics used.

1. DEFINITION OF ANALYTICAL SCHEME

1.1. The Overall Context of the WP3 – Analyses

The WP3 – Analyses – frames all the necessary steps in order to assess "as it is" situation in the regions regarding the Biomass Supply Chain Operational Reference Processes (BioSCORPs), Information and Communication Technologies (ICTs) as well as Network Communication Structures (NCSs). The above mentioned issues represent the major domains to be assessed and improved.

Based on collected and analysed data, and using a bottom up approach, recommendations will be provided for the improvement of supply chains and network communication flow. In order to provide the mentioned recommendations, the assessment of "as it is" situation has to be realized, using a SWOT analysis which will rely on the data contained in a joint transnational database.

1.2. The SCOR Model and Supply Chains

The ***Supply Chain Operations Reference Model (SCOR)*** is a management tool developed by the ***Supply Chain Council (SCC)***. The ***SCOR*** models represent reference models which can be used to map, benchmark and improve supply chain operations. ***SCOR*** model possesses standardised terminology and processes, over 200 process elements, 550 metrics and 500 best practices including risk and environment protection. It is organized around five primary management processes (standardised terminology): ***Plan***, ***Source***, ***Make***, ***Deliver*** and ***Return*** and it extends from the supplier's supplier to the customer's customer. This includes all customer interactions, all product transactions and all market interactions.

SCOR performance consists in two types of elements: ***performance attributes*** and ***performance metrics***. The ***SCOR*** model contains several levels. Accordingly, the performance metrics (standards for measuring the performance of a process) are distributed to five levels. ***Level 1*** metrics (***Key Performance Indicators***) are diagnostics for the overall health of the supply chain. Benchmarking the ***Level 1*** metrics helps to support strategic objectives. ***Level 2*** metrics serve as diagnostics for the ***Level 1*** metrics and ***Level 3*** metrics serve as diagnostics for ***Level 2*** metrics. Performance analysis of the metrics (1-3 levels) is realized through decomposition. ***Level 1*** metrics are created from lower level metrics, by considering a hierarchical structure.

SCOR model identifies five core supply chain attributes: ***Reliability***, ***Responsiveness***, ***Agility***, ***Costs*** and ***Asset Management***.

The ***Reliability*** attribute refers to the ability to perform tasks as expected and focuses on the predictability of the outcome of a process. Typical metrics include: ***on-time***, ***the right quantity*** and ***the right quality***; ***Reliability*** is a customer-focused attribute and the ***Level 1*** metric is ***Perfect Order Fulfilment***.

The ***Responsiveness*** attribute refers to the speed at which the task is performed. Typical metrics include ***cycle-time*** metrics and the ***Level 1*** metric is ***Order Fulfilment Cycle Time***. ***Responsiveness*** is a customer-focused attribute.

The ***Agility*** attribute describes the ability to respond to external influences as well as the ability to change. External influences refer to: Non-forecasted increases or decreases in demand; suppliers or partners going out of business; natural disasters; acts of (cyber)

terrorism; availability of financial tools (the economy); or labour issues. The ***Level 1*** metrics include ***Flexibility*** and ***Adaptability***. ***Agility*** is a customer-focused attribute.

The ***Cost*** attribute describes the cost of operating the processes. It includes labour costs, material costs, and transportation costs. The ***Level 1*** metrics include ***Cost of Goods Sold*** and ***Supply Chain Management Cost***. These indicators cover all supply chain spend. ***Cost*** is an internally-focused attribute.

The ***Asset Management Efficiency*** attribute describes the ability to efficiently use assets. Asset management strategies in a supply chain include inventory reduction and in-sourcing vs. outsourcing. Metrics include: inventory days of supply and capacity utilization. The ***Level 1*** metrics include: ***Cash-to-Cash Cycle Time*** and ***Return on Fixed Assets***. ***Asset Management Efficiency*** is an internally-focused attribute.

The ***SCOR*** model contains two categories of process details: ***In Scope*** which is applicable across industries and ***Not In Scope*** which is industry specific. There are four levels of detail (the first three apply across industries and the ***Level 4*** is industry specific):

Level 1 processes are used to describe the scope and high level configuration of a supply chain. ***SCOR*** has five level 1 processes: ***Plan***, ***Source***, ***Make***, ***Deliver*** and ***Return***.

Level 2 processes serve to differentiating the strategies of the ***Level 1*** processes. Both the ***Level 2*** processes themselves as well as their positioning in the supply chain determine the supply chain strategy. ***SCOR*** contains 26 level 2 processes.

Level 3 processes are used to describe the steps performed to execute the ***Level 2*** processes. Execution sequence influences the performance of the level 2 processes and the overall supply chain. ***SCOR*** model includes 185 level 3 processes.

Level 4 processes describe the industry specific activities required to perform level 3 processes. ***Level 4*** processes describe the detailed implementation of a process. ***SCOR*** does not detail ***Level 4*** processes. Organizations and industries have to develop their own ***Level 4*** processes.

As specified, the ***SCOR*** model relies on 5 ***Level 1*** processes.

The ***Plan*** processes describe the planning activities associated with operating a supply chain. This refers to: gathering customer requirements, collecting information on available resources, balancing requirements and resources in order to determine planned capabilities and resource gaps.

The ***Source*** processes describe the ordering (or scheduling) and receipt of goods and services. They include: issuing purchase orders, scheduling deliveries, receiving, shipment validation and storage and accepting supplier invoices.

The ***Make*** processes describe the activities associated with the conversion of materials or creation of the content for services. ***Make*** processes represent all types of material conversions: assembly, chemical processing, maintenance, repair, overhaul, recycling, refurbishment, remanufacturing and other material conversion processes.

The ***Deliver*** processes describe the activities associated with the creation, maintenance, and fulfilment of customer orders. They include:

- the receipt, validation, and creation of customer orders;
- scheduling order delivery;
- pick, pack, and shipment;
- invoicing the customer.

The ***Return*** processes describe the activities associated with the reverse flow of goods back from the customer. They include: the identification of the need for a return, the disposition decision making, the scheduling of the return, and the shipment and receipt of the returned goods.

Level 2 processes can be described by their type: ***Planning***, ***Execution*** and ***Enable***. A ***Planning*** process is a process that aligns expected resources to meet expected demand requirements. ***Execution*** process is a process which changes the state of material goods. An ***Enable*** process is a process that prepares, maintains, or manages information or relationships on which planning and execution processes rely.

A ***Supply Chain*** may be seen as a complex set of arcs and nodes linked (interconnected) by ***information***, ***material*** and ***cash flows***. ***Supply Chain Management*** refers to the realized measures in the attempt to bring order in such complex systems.

For complex systems analysis quantitative tools such as optimisation, simulation and decision theory are usually used. Different components of the supply chains may present different performances. There may be considered the performance optimisation of each component which, after all, is important. However, the overall performance of a network can be assessed through simulation. Simulation of complex systems (supply networks) starts from a rich description of the system. In supply chain simulation may be considered the analysis of the lead times and lead time variability, delivery accuracy and speed. This way, bottlenecks can be identified.

1.3. Definition of Representatives for the Three Expert Panels

As a starting point internal representatives of the project partners are defined. Names and affiliation data are enclosed in Table 1. As work package 3 progresses the table will be expanded with regional and national experts from the consortium countries. Within work package 4 the Table will be further extended with international experts that are collaboration with the FOROPA consortium.

Table 1 – First step: Definition of internal experts

Country/Region	Experts (name, organization, email contact)
Austria	Mr. Roland Oberwimmer, Holzcluster Steiermark GmbH, oberwimmer@holzcluster-steiermark.at Mr. Maximilian Handlos, Forest owner association Styria, maximilian.handlos@waldverband-stmk.at Dr. Peter Rauch, University of Natural Resources and Life Sciences, peter.rauch@boku.ac.at
Greece	Mr. Chrysovalantis Ketikidis, Institute for Solid Fuels and Technology Applications , ketikidis@lignite.gr Mr. Yannis Fallas, Centre for Research & Technology Hellas, yfallas@uowm.gr Mr. Panagiotis Grammelis, Institute for Solid Fuels and Technology Applications, pgra@central.ntua.gr
Italy	Mr. Christoph Mühlberg, Techno Innovation South Tyrol scpa, christoph.muehlberg@tis.bz.it
Slovenia	Ms. Nike Krajnc, Slovenian Forestry Institute, nike.krajnc@gozdis.si
Slovakia	Mr. Milan Oravec, National Forest Centre Slovakia, oravec@nlcsk.org
Romania	Dr. Stelian Alexandru Borz, Transilvania University of Braşov, stelian.borz@unitbv.ro
Bosnia and Herzegovina	Mr. Aleksandar Mrkobada, Association of Private Forest Owners "Our Forest" Čelinak, aleksandar.mrkobrada@gmail.com

Serbia	Mr. Aleksandar Vasiljevic, PE Srbijasume, aleksandar.vasiljevic@srbijasume.rs
Ukraine	Ms. Lesya Loyko, Agency for the sustainable development of the Carpathian region, lesya.loyko@forza.org.ua
Switzerland	Mr. Christian Felix, Graubünden HOLZ, christian.felix@graubuendenholz.ch Mr. Paul Baradun, Biomass Energy Graubünden, holzenergie@selva-gr.ch

1.4. Definition of Regional Areas of Intervention

In order to study the "as it is situation" regarding the biomass potential in regions as well as the structure and organization of the SCORPs, intervention areas were defined in regions. The mentioned regions are presented for each country in table no. 2.

1.5. Definition of the Biomass Supply Chain Operational Reference Processes (BioSCORPs)

BioSCORPs are defined by starting and ending points and include several sub-processes. The overall complexity of the BioSCORPs is the result of the number and complexity of each sub-component process. For each region were defined up to four SCORPs from which, the most representative ones are to be in-depth studied in the following activities of WP3, in order to identify sub-sequent processes and their efficiency in the overall context of the lignocellulosic biomass mobilization. Studies for each BioSCORP will be realized based on an interview scheme which was developed for each potential sub-sequent process of the investigated BioSCORPs.

Table 2 – *Definition of Regional Areas of Intervention and BioSCORPs Starting and Ending Points*

Country	***Starting Point***	***Ending Point***	***Defined Region***
Austria	Pellet plant	Storage of End consumer	Styria
	Small scale forests	Storage of Heating plant	Styria
	Harvesting slash at forest road	Storage of Heating plant/CHP	Styria
Greece	Storage at timber supplier	Storage at wood processing company (heating for own purposes)	Western Makedonia
	Pellet plant	End consumer	Larissa/Thessaly

	Standing tree	Storage at End consumer	Western Makedonia
Italy	Small scale forests	Storage at Heating plant	South Tyrol
	Community forests	Storage at Heating plant	South Tyrol
	Small scale forests	Private End consumers	South Tyrol
	Harvesting slash at forest road	Storage at Heating plant	South Tyrol
Slovenia	Standing tree "Forest Association"	Heating plant <10MW	Forest Association at Karst area, mostly slash and tops
	Small scale forests	Storage End consumer <0.5MW	Municipality of Ljubljana
	Pellet plant	Storage End consumer	to be decided
Slovakia	Standing tree State forests	Storage Heating plant/CHP	Slovakia
	Standing tree non-state forests/non-forest land	Storage End consumer	Slovakia
	By-products	Storage End consumer	Slovakia, Pellets, saw dust, chips
Romania	Standing tree State forests/private forests	Storage Heating plant/CHP	Central region of Romania
	Short rotation plantation	Storage Heating plant	Central region of Romania
	Wood processing by-products	Storage Heating plant	Central region of Romania
	Standing tree State forests/private forests	Storage non-industrial end users	Central region of Romania
Bosnia and Herzegovina	Small scale forests	Storage Heating plant	Municipality in North Bosnia
	Small scale forests	Pellet producers	Municipality in North Bosnia
	Small scale forests	Storage Wood industry/End consumer	Municipality in North Bosnia
Serbia	Standing trees State forests	Storage Pellet plant	Eastern part of Serbia, Timok forest area (200000ha)
	Standing trees private forests	Storage Pellet plant	Eastern part of Serbia, Timok forest area (200000ha)
	Pellet plant	B2B or B2C	to be checked: B2B vs B2C vs. export
Switzerland	Community forests	Storage District heating plant	canton Grisons
	Community forests	Storage CHP	canton Grisons
	Community forests (solid fuel wood)	Storage End consumer	canton Grisons

1.6. Definition of the Scope of ICT Applications and Network Communication Flow

The Information and Communication Technologies used in the regions are important tools for the biomass supply chains optimization. Assessment of the existent situation may provide an important overview on the existent tools, in order to identify potential directions for the improvement of current situation. Assessment of the existent ICTs will be an integrant part of the following activities of the WP 3, by using interviews as tools and methodologies in acquiring data for analysis.

Network Communication Structures describes how the things are done within biomass supply chains. Procedural aspects may differ from country to country and from region to region. Assessment of the “as it is” situation may help elucidate the organizational

structures and can provide a starting point for improvements. Assessment of the existent NCSs will be an integrant part of the following activities of the WP 3, by using interviews as tools and methodologies in acquiring data for analysis.

1.7. Definition of the Required Datasets and Methodology for the Showcase Regions

Based on the discussions during the kick-off meeting held in Ljubljana and on those which followed, as well as on the agreement of all involved partners, a stepwise structured methodology was developed as follows:

Step I – Define supply chains processes (WP3)

Description:

The first step in describing and assessing the supply chains is to define the process chain – the procedure starts with the activities of planning and selling in the forest (or other locations) and ends with the financial transactions among end consumers and biomass providers. Individual steps are to be defined within the management process of material, information and money between different actors involved in the supply chain. The work is to be structured on 4 levels (SCOR model):

- *Top level*: definition and mapping of process types;
- *Configuration level*: process categories;
- *Process element level* : decompose process;
- *Implementation level*: decompose process elements.

Mapping business processes will follow the definition of the SCORPs. Process modelling shall be performed using the Adonis business management toolkit, and it should be done in at least two modelling layers: (i) a standard process map providing an overview and (ii) a business process model giving more details of the supply chain.

Data requirements and data sources

The process types are defined using the definition and description of the processes that are available in the literature. Process categories, processes, process elements and

according data are to be collected by way of interviews as the most productive method for a system survey. In the interview, the respondents will be asked to describe the process types, to define process categories and decompose processes and process elements based on concrete business case. A better approach may consist in bringing the supply chain map at the interview place for better understanding. This modification may be operated at the interview time.

The interview should not take more than 1-1.5 hours. It is recommended that questionnaires should to be tested after development and refined (pre-test). Furthermore, sending the questionnaires to the selected respondents before the actual interview date is recommended. The interview, based on the tested questionnaire should be conducted by experts that are familiar with the industry and the processes.

In possible, the respondents should be given the opportunity to indicate strength, weaknesses, threats and opportunities of the supply chain from his own point of view.

Step II – determining and improving the performance of the specific parts of the supply chain (WP4 & WP5)

Description

As presented above, ***SCOR*** methodology defines five generic performance attributes, used in four levels of measurement of the entire supply chain process. Three performance attributes (see table 3) are ***Customer Facing Attributes*** (externally affected) and two attributes are ***Internal Facing Attributes*** (internally affected).

Table 3 – *The SCOR methodology Generic Performance Attributes*

	Attribute	Metric
Externally affected – customer	Reliability	Perfect Order Fulfillment
	Responsiveness	Order Fulfillment Cycle
	Agility	Supply Chain Flexibility
		Supply Chain Adaptability
Internal	Cost	Supply Chain Management Cost
		Costs of Goods Sold
	Assets	Cash to Cash Cycle Time
		Return on Supply Chain Fixed Assets
		Return on Working Capital

Within WP4 and WP5, all or a subset of metrics should be selected for every ***Level 2*** and ***3*** elements of part of supply chain to be improved, namely process categories and process elements. Also best practices should be identified and described if possible as a part of WP4. Every process category and process element should be described based on the templates presented in tables 4 and 5.

Table 4 - Example of process category description template

	Process Number in the supply chain map:……
Process category:……..	
Process category definition:……..	
Performance Attributes	Metric
Reliability	…..
Responsiveness	…..
Flexibility	…..
Cost	…..
Assets	….
Best practices	Features
…..	…..

Table 5 – Example of process element description template

	Process Element Number in the supply chain map:……
Process Element:……..	
Process Element Definition:……..	
Performance Attributes	Metric
Reliability	…..
Responsiveness	…..
Flexibility	…..
Cost	…..
Assets	….
Best practices	Features
…..	…..

Selection of metrics for every process category and process element is to be made after the mapping of the supply chain. Still, some guidance can be made at this moment, based on basic process categories that can be envisaged so far: ***Forest Resources Management***, ***Contracting***, ***Harvesting*** *(logging is included)*, ***Transporting***, ***Chipping and Other Processing***, ***Technical Drying***, ***Storing Including Natural Drying***, ***Pelletizing***, ***Accepting Shipment***, ***Invoicing***. Suggested SCOR metrics are guided by *Supply Chain Operations Reference (SCPR) model Overview – Version 10.0.* Metrics recommended in tables 5-14 should be revised and used to fulfil at least three conditions: ***adaptability to defined supply chains***, ***common metrics (and measurement units) to allow data assessment and transferability*** as well as ***data availability.***

Table 6 – Metrics for Forest Resources Management

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability	Delivery quantity accuracy	%	Forest administrators	Interview at forest administrators and harvesting companies	Ratio between the harvested quantities and the estimated quantities at forest road
Responsiveness	Volume estimation cycle time	Days	Forest administrators	Interview	Days between planning and volume estimation completed
	Issue harvesting authorization cycle time	Days	Forest administrators	Interview	Time between contracting and authorization issuing
Flexibility	Time and cost related to expediting the volume estimation	Days	Forest administrators	Interview	Time to verify, accept the expediting and remake the volume estimation
Cost	Cost of management planning and volume estimation	Days	Forest administrators	Interview	Days of planning and volume estimation per year
	Cost to schedule harvesting	Days	Forest administrators	Interview	Time for scheduling the harvesting operations after contracting
Assets	Fixed assets value	EUR	Forest administrators	Financial statements	
	Accounts receivable	EUR	Forest administrators	Financial statements	
	Percentage unharvested inventory	%	Forest administrators	Interview	Ratio between planned harvesting quantities and the actual volume
Additional data					
	Biomass available quantities	m^3	Forest administrators, National statistics	Literature, interview	
	Accessibility	m of forest roads /ha	Forest administrators, National Statistics	Literature, statistics, interview	
	Prices	EUR/m^3	Forest administrators, Biomass processors	Interview, statistics, literature	
	Allowable cut	m^3/year	Forest	Interview,	

			administrators	published data	
	Biomass sold for energy purposes	m^3/year	Forest administrators	Interview, published data	

Table 7 – Metrics for Contracting

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability					
Responsiveness	Negotiate or tendering (auction) cycle time	Days	Resource administrator	Interview	Days between finished plan and finished selection of customers
	Contracting cycle time	Days	Resource administrator	Interview	Days between finished selection and signed contracts
Flexibility	Time related to expediting the contracting process	Days	Resource administrators, contractors	Interview	Days between realizing the necessity of changing the contract and the new contract signed
	Cost related to expediting the contracting process	EUR/m^3	Resource administrator, contractors	Interview	Costs associated to re-contracting
Cost	Contracting management cost	EUR/m^3	Resource administrator	Managerial accounting	Costs associated to managing the contracts if separately emphasized in the managerial accounting
Assets					
Additional data					

Table 8 – Metrics for Harvesting (includes logging)

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability	Customer Commit Data Achievement Time Customer accuracy	Days	Harvesting companies	Interview	Time between agreed delivery deadline and actual time delivery
	Delivery Quantity accuracy	%	Harvesting companies & customers of harvesting companies	Interview	Ratio between planned quantities and delivered quantities

	Delivery quality accuracy	%	Harvesting companies & customers of harvesting companies	Interview	Ratio between delivered quantity from a certain quality and planned delivery of that quality
Responsiveness	Authorize supplier cycle time	Days/m^3	Harvesting companies	Interview	Time between harvesting authorization issuing and actual harvest start
	Identify sources of supply cycle time	Days/m^3	Harvesting companies	Interview	Average time from planning to contracting
	Harvest cycle time	h/m^3	Harvesting companies	Interview	Time to harvest and log from forest to road (landing)
Flexibility	Changed harvest plans cycle time	Days	Harvesting companies	Interview	Time to execute changed harvest plans (in terms of volume, location, assortments…)
Cost	Cost to plan supply	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	Cost of planning the supply
	Cost to harvest	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	Cost of harvesting
	Cost to verify	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	Cost of verifying the quantity and quality of supplied wood
	Direct labor cost	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	
	Direct material cost	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	
	Indirect cost related to production	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	
	Order management costs	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	Costs related to manage the contracts
	Costs to verify and transfer product	EUR/m^3	Harvesting companies, literature, statistics	Managerial accounting	Costs of make the products ready for delivery
Assets	Fixed assets value for production	EUR	Harvesting companies	Financial statements	
	Accounts payable	EUR	Harvesting companies	Financial statements	
	Accounts receivable	EUR	Harvesting companies	Financial statements	
	Inventory	EUR	Harvesting companies	Financial statements	
	Inventory days of supply	Days	Harvesting companies	Financial statements	
	Cash to cash cycle time	Days	Harvesting companies	Financial statements	

Additional data					
	Amount of biomass harvested for energy purposes	m^3	Harvesting companies, forest administrators, statistics, literature	Interview, literature review	
	Prices for harvesting and logging services	EUR/m^3	Harvesting companies, forest administrators, statistics, literature	Interview, literature review	
	Harvesting conditions		Harvesting companies, forest administrators, statistics, etc.	Literature review, other sources	This indicator is to be established – can be slope or other terrain or infrastructure or weather conditions influencing the harvesting process

Table 9 – Metrics for Transporting

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability	Delivery location accuracy	%	Transport companies, customers	Interview	Ratio between incorrect delivery locations and total number of deliveries
Responsiveness	Consolidate orders cycle time	Days/m^3	Transport companies	Interview	Days for consolidate a transport order
	Load products & generate transport documentation cycle time	h/m^3	Transport companies, suppliers	Interview	Hours for loading and transport documentation generation
	Transport cycle time	h/m^3	Transport companies, suppliers	Interview	Hours for transport from loading point unloading point
Flexibility	Time related to expediting the contracting process	Days	Transporters, contractors	Interview	Days between realizing the necessity of changing the contract and the new contract signed
	Cost related to expediting the contracting process	EUR/m^3	Transporters, contractors	Interview	Costs associated to re-contracting
Cost	Cost to plan transport	EUR/m^3	Transporters, literature, statistics	Managerial accounting	Cost of planning the transport process
	Cost to transport	EUR/m^3	Transporters, literature, statistics	Managerial accounting	Cost of transporting
	Order management cost	EUR/m^3	Transporters	Managerial accounting	Cost of managing the orders within the transport contracts
	Direct labor costs	EUR/m^3	Transport companies, literature, statistics	Managerial accounting	
	Direct material costs	EUR/m^3	Transport companies, literature, statistics	Managerial accounting	
	Indirect cost related to transportation	EUR/m^3	Transport companies, literature, statistics	Managerial accounting	

Assets	Fixed assets value for transportation	EUR	Transporters	Financial statements	
	Accounts payable	EUR	Transporters	Financial statements	
	Accounts receivable	EUR	Transporters	Financial statements	
Additional data					
	Average distances	Km/m^3	Transporters	Interview	
	Quantities transported	m^3	Transporters	Interview	
	Transport costs vs. Distance	EUR/m^3/Km	Transporters	Interview	

Table 10 – Metrics for Chipping and Other Processing

Performance attribute	***Metric***	***Measurement unit***	***Data owner (possible source)***	***Data collection***	***Determination***
SCOR metrics					
Reliability	Delivery item accuracy	%	Chipping company	Interview	Ratio between what was planned to be delivered and what was actually delivered in terms of items (or quality)
	Deliver quantity Accuracy	%	Chipping company	Interviews	Report the delivered quantities to the estimated quantities
	% of faultless installations (a single place where the chipper has to chip a pile of energy wood)	%	Chipping company	Interviews	Report faultless functioning time to total installation functioning
	Compliance documentation accuracy	%	Chipping company	Interviews	Report number of incorrect documentations to total number of documentations
	Payment documentation accuracy	%	Chipping company	Interviews	Report number of incorrect documentations to total number of documentations
Responsiveness	Identify sources of supply cycle time	Days/m^3	Chipping companies	Interviews	Time for identification of supply sources
	Select supplier and negotiation cycle time	Days/m^3	Chipping companies	Interviews	Time for selection of suppliers and negotiations
	Chipping cycle time	h/m^3	Chipping companies	Interviews	Time for chipping energy wood
	Package cycle time	h/m^3	Chipping companies	Interviews	Time for preparing the chips for transfer
	Generate transport documents cycle	Days/m^3	Chipping companies	Interviews	Time for generation of the transport

	time				documents
Flexibility					
Cost	Cost to plan supply	EUR/m^3	Chipping companies literature, statistics	Managerial accounting	Cost of planning the supply
	Cost to plan chipping	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	Cost of planning chipping
	Cost to receive product	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	Cost of verifying the quantity and quality of supplied wood
	Order management costs	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	Costs related to manage the contracts
	Cost to source return	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	Costs for returning material to supplier
	Direct labor costs	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	
	Direct material costs	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	
	Indirect cost related to chipping	EUR/m^3	Chipping companies, literature, statistics	Managerial accounting	
Assets	Fixed assets value for chipping	EUR	Chipping companies	Financial statements	
	Accounts payable	EUR	Chipping companies	Financial statements	
	Accounts receivable	EUR	Chipping companies	Financial statements	
	Inventory	EUR	Chipping companies	Financial statements	
	Inventory days of supply	Days	Chipping companies	Financial statements	
	Percentage excess inventory	%	Chipping companies	Interviews, financial statements	% of excess inventory out of stored quantity
	Cash to cash cycle time	days	Chipping companies	Financial statements	
Additional data					
	Quantities chipped	m^3	Chipping companies	Interviews	Total quantities chipped / year
	Market price for chipping service	EUR/m^3	Chipping companies	Interviews	

Table 11 – Metrics for Technical Drying

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability	Delivery item accuracy	%	Specialized companies	Interview	Ratio between what was planned to be delivered and what was actually delivered in terms of items (or quality)
	Deliver quantity Accuracy	%	Specialized companies	Interviews	Report the delivered quantities to the estimated quantities
	% of faultless installations	%	Specialized companies	Interviews	Report faultless functioning time to total installation functioning
	Compliance documentation accuracy	%	Specialized companies	Interviews	Report number of incorrect documentations to total number of documentations
	Payment documentation accuracy	%	Specialized companies	Interviews	Report number of incorrect documentations to total number of documentations
Responsiveness	Select supplier and negotiate cycle time	Days/m^3	Specialized companies	Interviews	Time for selection of suppliers an negotiations
	Transfer product cycle time	Days/m^3	Specialized companies	Interviews	Time for transferring the biomass into the drying plant
	Verify product cycle time	Days/m^3	Specialized companies	Interviews	Time for verification of received un-dried product
	Schedule drying activities cycle time	Days/m^3	Specialized companies	Interviews	Time for planning the drying activities
	Dry and test cycle time	Days/m^3	Specialized companies	Interviews	Time for drying and constant check of quality
Flexibility	Supply chain changes	Days	Specialized companies	Interviews	Time to adapt to changes in supply or demand
Cost	Cost to plan supply	EUR/m^3	Specialized companies literature, statistics	Managerial accounting	Cost of planning the supply
	Cost to plan technical drying	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of planning the drying process
	Cost to receive product	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of verifying the quantity and quality of supplied

					wood
	Order management costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Costs related to manage the contracts
	Cost to source return	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Costs for returning material to supplier
	Direct labor costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
	Direct material costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
	Indirect cost related to drying	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
Assets	Fixed assets value for technical drying	EUR	Specialized companies	Financial statements	
	Accounts payable	EUR	Specialized companies	Financial statements	
	Accounts receivable	EUR	Specialized companies	Financial statements	
	Inventory	EUR	Specialized companies	Financial statements	
	Inventory days of supply	Days	Specialized companies	Financial statements	
	Percentage excess inventory	%	Specialized companies	Interviews, financial statements	% of excess inventory out of stored quantity
	Cash to cash cycle time	days	Specialized companies	Financial statements	
Additional data					
	Market prices for drying	EUR/m^3	Specialized companies	Interviews	
	Dried quantities	m^3	Specialized companies	Interviews	

Table 12 – Metrics for Storing Including Natural Drying

Performance attribute	***Metric***	***Measurement unit***	***Data owner (possible source)***	***Data collection***	***Determination***
SCOR metrics					
Reliability	Delivery quantity accuracy	%	Storing facilities	Interviews	Percent of actual delivered quantities vs. documented delivered quantities
Responsiveness	Receive product cycle time	Days/m^3	Storing facilities	Interviews	Time for receiving the wood in the storage facility
	Distribute stored products cycle time	Days/m^3	Storing facilities	Interviews	Time to distribute the wood from the storage facility

Flexibility	Supply chain changes	Days	Storing facilities	Interviews	Time to adapt to changes in supply or demand
Cost	Cost to plan storing	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of planning the storage process
	Cost to receive product	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of verifying the quantity and quality of supplied wood
	Cost to distribute product	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of distributing stored wood
	Direct labor costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
	Direct material costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
	Indirect costs related to storing	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
Assets	Accounts receivable	EUR	Specialized companies	Financial statements	
	Percentage excess inventory	%	Specialized companies	Interviews, financial statements	% of excess inventory out of stored quantity
Additional data					
	Market prices for storing	EUR/m^3	Specialized companies	Interviews	
	Stored quantities	m^3	Specialized companies	Interviews	

Table 13 – Metrics for Pelletizing

Performance attribute	***Metric***	***Measurement unit***	***Data owner (possible source)***	***Data collection***	***Determination***
SCOR metrics					
Reliability	Delivery item accuracy	%	Specialized companies	Interview	Ratio between what was planned to be delivered and what was actually delivered in terms of items (quality)
	Deliver quantity Accuracy	%	Specialized companies	Interviews	Report the delivered quantities to the estimated quantities
	% of faultless installations	%	Specialized companies	Interviews	Report faultless functioning time to total installation functioning
	Compliance documentation accuracy	%	Specialized companies	Interviews	Report number of incorrect documentations to total number of documentations
	Payment documentation accuracy	%	Specialized companies	Interviews	Report number of incorrect documentations to

					total number of documentations
Responsiveness	Identify sources of supply cycle time				
	Select supplier and negotiation cycle time				
	Pelletizing cycle time				
	Generate transport documents cycle time				
Flexibility	Supply chain changes	Days			Time to adapt to changes in supply or demand
Cost	Cost to plan supply	EUR/m^3	Specialized companies literature, statistics	Managerial accounting	Cost of planning the supply
	Cost to plan pelletizing	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of planning the pelletizing process
	Cost to receive product	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Cost of verifying the quantity and quality of supplied wood
	Order management costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Costs related to manage the contracts
	Cost to source return	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	Costs for returning material to supplier
	Direct labor costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
	Direct material costs	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
	Indirect cost related to pelletizing	EUR/m^3	Specialized companies, literature, statistics	Managerial accounting	
Assets	Fixed assets value for pelletizing	EUR	Specialized companies	Financial statements	
	Accounts payable	EUR	Specialized companies	Financial statements	
	Accounts receivable	EUR	Specialized companies	Financial statements	
	Inventory	EUR	Specialized companies	Financial statements	
	Inventory days of supply	Days	Specialized companies	Financial statements	
	Percentage excess inventory	%	Specialized companies	Interviews, financial statements	% of excess inventory out of stored quantity
	Cash to cash cycle time	days	Specialized companies	Financial statements	
Additional data					
	Market prices for pelletizing	EUR/m^3	Specialized companies	Interviews	
	Pelletized quantities	m^3	Specialized companies	Interviews	

Table 14 – Metrics for Accepting Shipment

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability					
Responsiveness	Consolidate orders cycle time	Days/m^3	Final users of biomass	Interviews	Time for preparation and sending of the orders
	Receive, quantify & qualify products cycle time	h/m^3	Final users of biomass	Interviews	Time for receiving and estimating quantity and quality of products
Flexibility	Supply chain changes	Days	Final users of biomass	Interviews	Time to adapt to changes in supply
Cost	Cost to authorize supply payments	EUR/m^3	Final users of biomass	Interviews, managerial accounting	
	Cost to receive products	EUR/m^3	Final users of biomass	Interviews, managerial accounting	Cost of process of verifying the quality, the compliance of documents, etc.
Assets					
Additional data					
	Quantities accepted				

Table 15 – Metrics for Invoicing

Performance attribute	*Metric*	*Measurement unit*	*Data owner (possible source)*	*Data collection*	*Determination*
SCOR metrics					
Reliability					
Responsiveness	Invoicing cycle time	Days/m^3	Supplier companies	Interviews	Time for issuing the invoice from the moment of acceptance
Flexibility					
Cost	Cost to invoice	EUR/m^3	Supplier companies	Interviews, managerial accounting	Costs
Assets					
Additional data					

2. SHORT GLOSSARY OF BIOMASS RELATED TERMS

A

Allowable Cut — The net volume of growing stock trees removed from the inventory during a specified period (usually a cycle) by harvesting, cultural operations such as timber stand improvement, or land clearing.

Animal Logging — Procedure which involves the use of animal for timber logging. Usually associated with chain saws for felling and other mechanised means for logging.

B

Basal Area —The cross-sectional area (in square meters) of a tree trunk at breast height.

Best Management Practices — Management practices that maintain and improve the environmental values of forests associated with soils, water, and biological diversity.

Bio-based Products — A commercial or industrial product, other than food or feed, that is composed in whole or in significant part, of biological products or renewable domestic agricultural materials including plant, animal, marine materials, or forestry materials.

Biodiversity — The variety of life forms in a given area. Diversity can be assessed in terms of the number of species, the variety in the area's plant and animal communities, the genetic variability of the life forms, or a combination of these elements.

Bioenergy — Renewable energy produced from organic matter through the conversion of complex carbohydrates. This energy may either be used directly as fuel, processed into liquids or gasses, or be a residual of the processing or conversion mechanisms.

Biofuels — Liquid, solid, or gaseous fuels made from biomass resources, or their processing and conversion derivatives.

Biomass — Biomass is any organic matter including forest and mill residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residues, aquatic plants, and municipal and industrial wastes. Forest biomass comprises the total mass of roots, stems, branches, leaves, etc. of all the species found in the forest [25]. For the bioenergy industry, only a part of this is a relevant resource, i.e. by-products of existing forest practices and special wood assortments [25].

Bottom Ash — Ash that collects under the grates of a combustion furnace.

Bulk Cubic Meter (or loose cubic meter lcbm)— A measurement unit used mainly for wood chips.

Bulk Density — A measure used for piles of wood fuels that create voids among the wood pieces. Expresses in kg/stacked cubic meter or kg/bulk cubic meter.

C

Cable Yarder — A mean which incorporates and uses cable systems and associated devices for timber yarding.

Calorific Value — The maximum amount of energy that is available from burning a substance.

Cant — The remaining square section of a log when rounded edges and bark are removed.

Carbon Cycle — The distribution and transfer of carbon through the Earth's ecosystem that includes such processes as photosynthesis, decomposition, and respiration.

Carbon Dioxide (CO_2) — A colorless, odorless, incombustible gas formed during respiration, combustion of fossil fuels, organic decomposition etc.

Carbon Displacement — Offsetting of carbon dioxide emissions from fossil fuel combustion by substituting fossil fuels with bioenergy.

Carbon Sequestration — The long-term storage of carbon in the terrestrial biosphere, underground, or oceans to reduce the buildup of atmospheric carbon dioxide concentrations.

Cellulose — A carbohydrate that is the principal component of the cell secondary walls of trees and other higher-order plants.

Chipper — A mechanized device that reduces logs, whole trees, slab wood, or lumber to chips of more or less uniform size. Stationary chippers are used in sawmills, while trailer-mounted whole-tree chippers are used in the woods.

Chips — Woody material cut into short, thin wafers. Chips are used as raw material for production of paper, fiberboard, biomass fuel, and other products.

Clean Chips — Chipped wood free of bark, needles, leaves, and soil contamination.

Clearcutting — Regeneration or harvesting method that removes essentially all woody vegetation that would otherwise compete with future crop trees in a single harvesting operation.

Cofiring — Utilization of bioenergy feedstocks to supplement energy source in high efficiency boilers, usually with coal.

Cogeneration — The sequential production of electricity and useful heat energy from a common fuel source.

Combustion — Burning. The transformation of biomass fuel into heat, chemicals, and gases through chemical combination of hydrogen and carbon in the fuel with oxygen in the air.

Combustion Efficiency — A measure of the productive capture of chemical energy in the fuel to heat energy, often expressed as a percentage or ratio.

Comminuted Material — Biomass material that has been pulverized or precision reduced into smaller sized material.

Container Trailer — A trailer designed to hold bulk material. Built to be sturdy and abused, they can be left on a site and filled as desired, and then removed and replaced with an empty container.

Course Woody Debris — Piece(s) of dead woody material (includes trunks, branches, and roots) on the ground in forest stands or streams.

Crop Tree — Any tree selected to grow to final harvest or to a selected size. Crop trees are selected for quality, species, size, timber potential, or wildlife value.

Crosscutting — A harvesting component which supposes the trees fragmentation after felling using chainsaws or harvesters. Also used at landing in case of processor tower yarders (PTY).

Crown Thinning — Removal of trees from the upper level in the canopy in order to favor desired crop trees whose crowns are at a lower position in the canopy.

Cull — A tree or log of marketable size that is rejected because it does not meet certain specifications of usability or grade because of species type or defects. Defects can include crookedness, decay, injuries, or damage from disease or insects.

Cut-to-Length — A harvest system in which trees are felled, delimbed, and cut to various log lengths at the stump. Also known as Short Wood System.

D

Deadwood — Dead, standing or fallen, woody biomass from trees or shrubs. Deadwood can be the results of old age, fire, disease, logging, and natural disasters.

Deck — A pile of logs on a landing.

Delimbing — A harvesting component which supposes the limbs detachement from the trees.

Dirty Chips — Chipped wood containing bark, needles, leaves, and soil.

E

Ecology — The science or study of the relationships between organisms and their environment.

Ecosystem Services — Benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.

Effluent — The liquid or gas discharged from a process or chemical reactor, usually containing residues from that process.

Energy Crops — Crops grown specifically for their fuel value. Crops can include corn, sugarcane, switchgrass, and trees.

Energy Ratio — The ratio of the energy output versus the energy input. The energy ratio of a bioenergy process can be calculated and compared to a conventional fuel lifecycle.

Environment — The interaction of climate, soil, topography, and other plants and animals in any given area.

Even-aged Management — Management technique for a stand of trees composed of a single age class.

F

Feedstock — Raw material used for the generation of bioenergy and the creation of other bioproducts.

Felling — A harvesting component which consists in trees detaching from the stump.

Feller-buncher — A self-propelled machine that cuts trees with saw or shears near ground level and then stacks the trees in piles. Usually works in combination with skidders (see skidders).

(Primary) forest fuel (PFF): *"Forest fuel is produced directly from forest wood by a mechanical process"* (FAO, 2004, p.35) and consists of traditional fuelwood, sub-standard industrial roundwood and logging residues or according to EN 14961-1:2010 [26]: "*Forest,*

plantation and other virgin wood". Moreover, PFF are solid biofuels, also referred as energy wood.

Forest Type — Groups of tree species commonly growing in association because of similar environmental requirements.

Forest Residue — Tops, limbs, bark, foliage, and other woody materials, left after a harvest.

Forwarder — A vehicle that carries logs completely off the ground from stump to road side landing. Usually works in association with a harvester (see harvester).

Fossil Fuel — Solid, liquid, or gaseous fuels formed over million of years from plant and animal residues under high temperature and pressure. Oil, natural gas, and coal are fossil fuels.

Fuel Treatment Thinnings — The process of harvesting trees and underbrush from the forest to reduce the risk of wildfires.

Full Cost Method — Cost accounting method that allocates the total production cost across biomass and conventional wood products.

Furnace — An enclosed chamber or container used to burn biomass in a controlled manner to produce heat for space or process heating.

G

Gas Turbine — A turbine that converts the energy of hot compressed gases, produced by burning fuel in compressed air into mechanical power. Often fired by natural gas or fuel oil.

Gasification — A chemical or heat process to convert a solid fuel to a gaseous form.

Gasifier — A device for converting solid fuel into gaseous fuel.

Gigawatt — A measure of electrical power equal to one billion watts or 1,000,000 kilowatts. A large coal or nuclear power station typically has a capacity of about 1 GW.

Glucose — A six-carbon fermentable sugar ($C_6H_{12}O_6$).

Green Ton — 1000 kg of undried biomass. Moisture content must be specified if green tons are used as a measure of fuel energy.

Greenhouse Gas — A gas that absorbs radiant energy from the earth, re-emitting it as infrared radiation, contributing to the warming of the earth. Examples of greenhouse gases include carbon dioxide and water vapor.

Grid — An electric utility company's system for distributing power.

Grinder — A machine that reduce particles in size by repeatedly pounding them into smaller pieces through a combination of tensile, shear and compressive forces.

Group Selection — An uneven-aged regeneration and harvesting method used for sun loving tree species in which trees are removed and new age classes are established in groups. The width of a group is approximately twice the height of mature trees.

H

Habitat — The place or environment where a plant or animal naturally or normally lives, grows and reproduces.

Harvester — A machine used for felling, delimbing, topping and crosscutting the wood. Usually associated with a forwarder.

Harvesting — A sum of processes associated with wood path from stump to landing.

Heat Rate — The amount of fuel energy required by a power plant to produce one kilowatt-hour of electrical output. A measure of generating station thermal efficiency, generally expressed in Btu per net kWh. It is computed by dividing the total Btu content of fuel burned for electric generation by the resulting net kWh generation.

Hemicellulose — A polysaccharide (complex carbohydrate) found in plant cells that is easily extracted by dilute alkalies.

I

Improvement Cutting — An intermediate, partial, harvest that removes less desirable trees of any species to improve the form, quality, health or wildlife potential of the remaining trees. Usually occurs after the sapling stage and before final harvest.

Incinerator — Any device used to burn solid or liquid residues or wastes as a method of disposal. In some incinerators heat is recovered.

Inclined Grate — A type of furnace in which fuel is gravity fed from the top part of a grate in a continuous ribbon, passes over the upper drying section where moisture is removed, and descends into the lower burning section. Ash is removed at the lower part of the grate.

Independent Power Producer — A power production facility that is not part of a regulated utility.

J

Joule — Metric unit of energy, equivalent to the work done by a force of one Newton applied over a distance of one meter. One joule = 0.239 calories.

K

Kilowatt — A measure of electrical power equal to 1,000 watts. 1 kW = 3412 Btu/hr.

Kilowatt Hour — A measure of energy equivalent to the expenditure of one kilowatt for one hour.

L

Landing — A cleared working area in the forest, usually near a transport road where trees and logs are forwarded, skidded or yarded, to be sorted, processed, and loaded on a truck.

Lignin — Structural constituent of wood and (to a lesser extent) other plant tissues, which encrusts the cell walls and cements the cells together.

Logging residues — The unused portions of growing-stock and non-growing-stock trees cut or killed by logging and left in the woods.

Log Trailer — A trailer designed to haul trees, poles, or shortwood in racks. They are lightweight and have high payload capacities.

Loose cubic meter (lcbm)— A measurement unit used mainly for wood chips.

Low Thinning — Removal of smaller, weaker, and most deformed trees whose crowns are in the lower portion of the stand canopy.

Lump Sum Sale — A timber sale in which the buyer and seller agree on a total price for the standing timber. The standing timber is either marked or is in a delineated area. This type of sale is forbidden by forest law in some countries (e.g. in Austria).

M

Marginal Cost Method — Cost accounting method that counts only the additional costs from the conventional logging operation as the biomass production cost.

Mass Density — Ratio between the weight and volume of the wood body.

Megawatt — (MW) A measure of electric power equal to one million watts (1,000 kW).

Mill Residues — Excess material generated from wood processing mills and pulp and paper mills.

Mixed Stand — A timber stand containing two or more prominent species in the main canopy.

Moisture Content — The weight of the water contained in wood, usually expressed as a percentage of weight, either oven-dry or as received (green).

Monoculture — The cultivation of a single species crop.

N

Natural Stand — A stand of trees grown from natural seed fall or sprouting.

Negotiated Sale — A timber sale in which the buyer and seller negotiate a price for the standing timber. The standing timber is either marked or is in a delineated area.

Net Annual Growth — The average annual net increase in the volume of trees during the period between inventories.

Net calorific value: Quantity of heat released during the complete combustion at standard conditions when the formed water remains water vapour; the old term is a lower heating value [24].

O

On the Stump — Standing, uncut timber. Also: standing tree.

One-pass Method — A harvest practice where biomass and conventional roundwood (sawlogs) are harvested and recovered simultaneously.

Output — The value of production by industry for a specific time period.

Oven Dry Ton — An amount of wood that weighs 1,000 kilograms at zero percent moisture content.

Overstory — The portion of the trees forming the uppermost canopy in a forest stand.

P

Per-unit Sale — A timber sale in which the buyer and seller negotiate a price per unit of harvested wood, and the buyer pays for the timber after it is cut and the volume is determined.

Plantation — Planted tree species, typically in an ordered configuration such as equally spaced rows.

Pre-commercial Thinning — Thinning that occurs when trees are too young, too small, or of species undesirable to be used for traditional timber products.

Process Heat — Heat used in an industrial process rather than for space heating or other power generation purposes.

Processor Tower Yarder — A multipurpose machine which is used in yarding and landing processing. Works in association with harvesters or chainsaws.

Pulpwood — Wood used in the manufacture of paper, fiberboard, or other wood fiber products.

R

Reforestation — Reestablishing a forest by planting or seeding an area from which forest vegetation has been removed.

Regeneration Cut — A cutting strategy in which old trees are removed while favorable environmental conditions are created for the establishment of a new stand of seedlings.

Residual Stand — Trees left in a stand to grow until the next harvest. This term can refer to crop trees or cull trees.

Residues, Biomass — Byproducts that have significant energy potential from processing all forms of biomass.

Rotation — The number of years required to establish and grow trees to a specified size, product, or condition of maturity.

S

Salvage Cutting — Removal of trees that have dead, damaged, or are expected to die, generally as a result of natural disaster, pest infestation, or disease infestation.

Sanitation Cut — Removal of dead and weaker trees in an overstocked stand to reduce the danger of natural disasters.

Seed-tree Harvest — A silvicultural system in which all trees are harvested except for a small number of selected trees are retained for seed production for natural regeneration.

Shelterwood Harvest — A silvicultural system in which trees are removed in a series of two or more cuts, leaving those needed to produce sufficient shade to produce a new forest in a moderated microenvironment. This method produces an even-aged forest.

Short-rotation Woody Crops — Fast growing species, such as willows and poplars, which are grown specifically for the production of energy. Also: short rotation plantations.

Silviculture — Science and art of managing the establishment, growth, composition, and quality of forest stands and woodlands for the desired needs and values of landowners and society on a sustainable basis.

Site Productivity — Combination of soil and climatic factors contributing to plant growth and development; may be measured as biomass accumulation per unit of time.

Skidder — Machinery used to pull logs from their stump to a landing. Logs are pulled with a grapple, cable-winch, or clam-bunk. Also: winch skidder, grapple skidder and clam-bunk skidder.

Slash —Tree tops, branches, bark, or other residue left on the ground after logging or other forestry operations.

Softwood (conifer) — A tree belonging to the order Coniferales. Softwood trees are usually evergreen, bear cones, and have needles or scale-like leaves.

Soil Fertility — The total availability, concentration, and amount of essential plant nutrients.

Soil Function — The role that soils play in the environment and managed landscapes.

Soil Productivity — The capacity of a soil to contribute to the production of a crop, whether it is agricultural crops or forest biomass.

Solid Cubic Meter — A cubic meter which is occupied entirely by wood. Measurement unit used for timber.

Specific Gravity — An adimensional measure representing ratio between the weight and volume of water (at 4^0C) and of wood substance.

Stacked Cubic Meter — A measurement unit used for neatly-stacked log woods.

Stand — A group of trees of similar age class, composition, and structure growing on a site of uniform quality.

Stand Density — The number or mass of trees occupying a site.

Stere — A cubic meter which is occupied both, by wood and air space. Measurement unit used for fuel wood.

Stumpage — The value or volume of a tree or group of trees as they stand uncut in the woods (on the stump).

Sustainability — The capacity of forests to maintain their health, productivity, diversity, and overall integrity, in the long run, in the context of human activity and use. Sustainability can apply to single forest or ecoregions.

Sustainable Forest Management — Forest management that ensures that forest resources will be managed to supply goods and services to meet the current demands of society while conserving and renewing the availability and quality of the resource for future generations.

Sustained Yield — A forest management strategy in which the net growth and yield are balanced.

T

Thinning — A tree removal practice that reduces tree density and competition among remaining trees in a stand.

Timber Stand Improvement (TSI) — Improving the quality of a forest stand by removing or deadening undesirable species to achieve desired stocking and species composition. TSI practices include applying herbicides, burning, girdling, or cutting.

Tolerant Species — A species of tree that has the ability to grow in the shade of other trees and in competition with them.

Topping — A harvesting component which supposes detachment of the trees' tops.

Tower Yarder — A yarder which has a tower mounted on a automobile or tracked group, used for timber yarding.

Transpiration Drying — The natural drying that occurs when leafy biomass material is left on the tree.

Transport

-**Single echelon unimodal transport:** no transshipment takes place (e.g. logs from forest landing to the plant directly via log trucks).

-Multi echelon unimodal transport includes a transshipment operation, where the means of transport are changed, the mode remains unchanged (e.g. prehaulage on forest roads with all-wheel drive trucks to simple terminals and main haulage on country roads by truck-and-trailer).

-Multimodal transport: the mode (i.e. road, rail, waterway) changes (e.g. bundles, produced in the forest, are transported on trucks to a train terminal, and then transshipped on trains and delivered to a CHP plant).

-Intermodal transport: use of one loading unit on two or more means and modes of transport [21, 23].

Tree-length — A harvesting system according to which trees are felled, delimbed, and topped in the stump area and processed at the landing.

Two-pass Method — A harvest practice where roundwood and biomass are recovered in separate passes. Biomass removal can precede or follow the conventional product harvest.

U

Understory — (a) The layer formed by the crowns of smaller trees in a forest. (b) The trees beneath the forest canopy.

Uneven-aged Management — A regeneration and management technique that removes some trees in all size classes either singly, in small groups, or strips in order to maintain a multi-aged stand.

V

Value-added — Payments made by industry to workers, interest, profits, and indirect business taxes.

Water Quality — Suitability of the water coming from ground and surface water supplies for drinking water, recreational uses, and as habitat for aquatic organisms and other wildlife.

Water Quantity — Timing and total yield of water from a watershed.

Watt — The common base unit of power in the metric system. One watt = 3.413 Btu/hr.

Whole Tree Chips— Wood chips produced by chipping whole trees, usually in the forest. Thus the chips contain both bark and wood.

Whole Tree Harvesting — A harvesting system according to which the trees are felled and transported to roadside with branches and top intact. Processing occurs at the deck or landing.

Wood Ash — Ash recovered from the combustion of woody biomass; may be used as fertilizer or soil liming agent to reduce soil acidity.

Wood Processing Residue — The unused portion of materials generated during wood processing or by-products created during the pulping process.

Woody Biomass — The trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment that are the byproducts of proper forest management.

Y

Yarding — The initial movement of logs from the point of felling to a central loading area or landing, particularly by cable or helicopter.

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