THE ADDED VALUE OF A TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN

KEY RESULTS OF A STUDY MADE IN THE CLEANTECH FINLAND BIOENERGY (CFB) DEVELOPMENT PROJECT

15.12.2014

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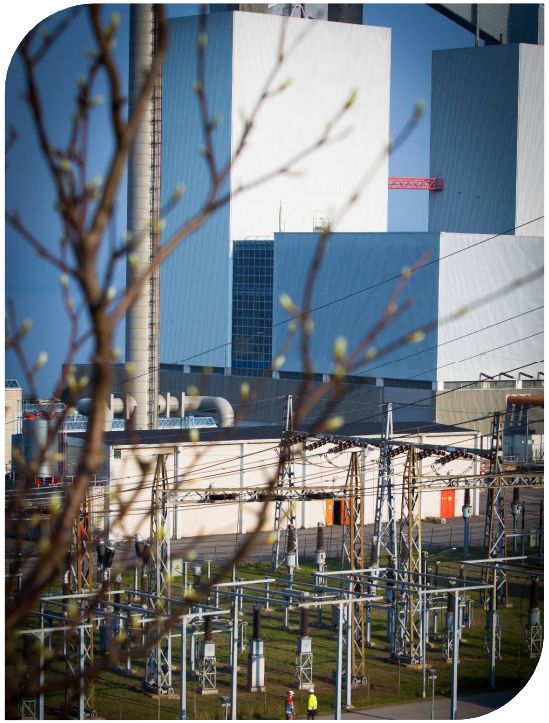
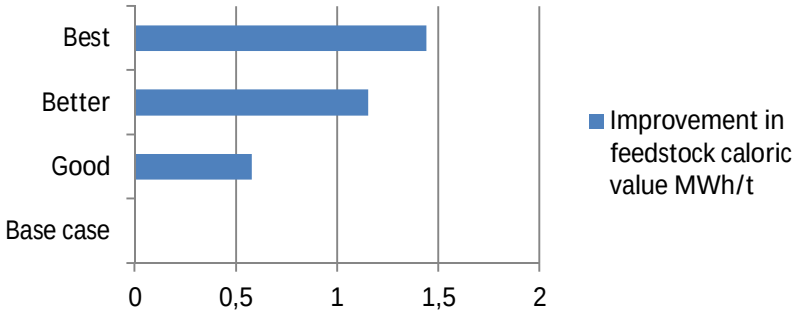
CONTENT

- Why a total quality-driven optimal biomass supply chain is needed ?
- What is a total quality-driven optimal biomass supply chain ?
- How much is the benefit / the value added ?
- Wrap up - Who to contact ?

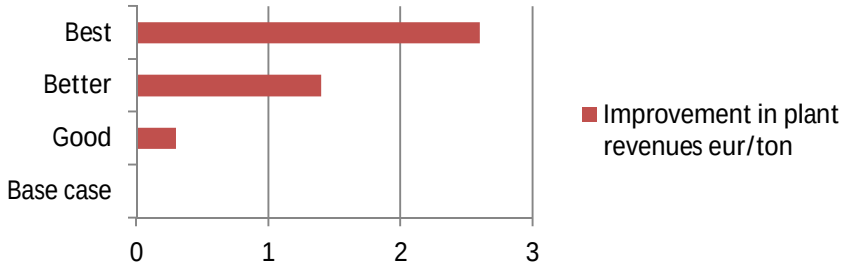


A TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN SAVES MONEY

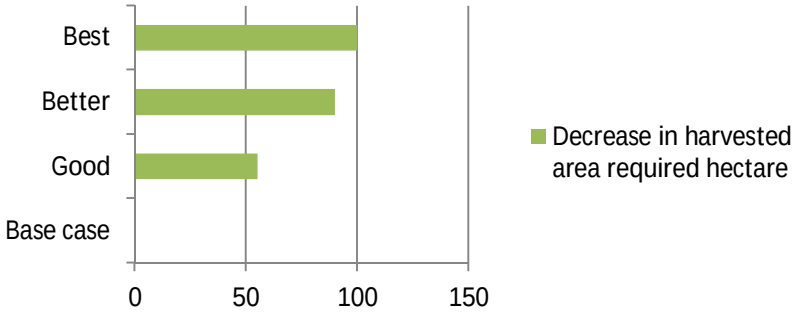
Improvement in feedstock caloric value, MWh/ton



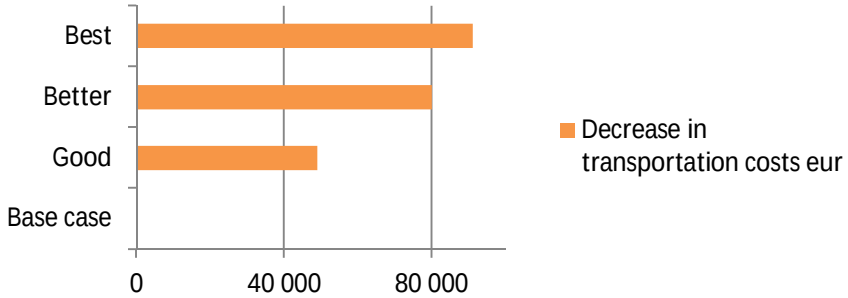
Improvement in plant revenues, eur/ton



Decrease in harvested area required, hectares



Decrease in transportation costs, eur (average 50 km legs)



LOW FUEL QUALITY MEANS EXTRA COSTS FOR THE PLANT

Quality problem of biofuel (wood chips)	Impact on the handling and storage of fuel	Impact on the operation of the boiler
Too high moisture content	Causes freezing on the equipment. Freezing and sticking form big lumps, which block the equipment. Risk of mould (occupational health). Complicates handling and storage	Lower output (energy). Fuel consumption and emissions increase. Uneven burning. The control of combustion becomes more difficult. In the worst case a break in the boiler operation may occur.
Too dry fuel (<35%, excl. gasification plant)	The ignition risk increases, especially when the amount of fines is high (logging residues).	Control of the combustion becomes more difficult. The temperatures may rise too high causing boiler damages.
Too large particle size (branches, sticks etc.)	Sticks cause blocking, bridging and/or wedging in feeding screws etc. Handling problems	Control of the combustion becomes more difficult, chips don't burn fast enough (grate) or burn too low in the bed and raise the temperature too much (fluidized bed)
Too small particle size, plenty of fines	Fines prevents air moving in the storage pile and slow down drying. Fines blocks air scoops and causes explosion risk. Dry content losses increase.	Fines can end up with fly ash (grate), chips burn too high in the bed and raise the super heater temperatures too much. Emissions increase.
Impurities: rocks, sand, metal, soil, dirt, plastics, ice, snow	Impurities wear out conveyance equipment. Impurities cause increase in transportation weights. Risk of melting and refreezing. Overall cause extra requirements in handling.	Impurities cause wearing in boiler surfaces, mechanical damages, fouling of fluidized beds, more frequent change of bed sand and air scoop blocking. Impurities decrease efficiency and effect the amount of and quality of ash.
Green mass (needles), chemical composition		The alkali metals and chlorine cause deposition and hot corrosion. The amount of ash increases.
Quality variation of fuel (sudden)	Design and use of receiving, handling and storage structure and equipment becomes more difficult. Extra requirements are needed in storage and handling.	Boiler structure design becomes more difficult. Variations cause sudden temperature changes in combustion and make the control more difficult. Feeding, its adjustment and predictability gets harder, efficiency decreases.

The quality problems of biofuel (wood chips) create extra costs in fuel supply, storage, handling, process, operating and maintenance.

FUEL QUALITY IS AFFECTED IN VARIOUS STAGES OF THE SUPPLY CHAIN

Forestry transport can also be considered as a part of the harvesting stage. In this study these stages are analysed separately.

ORIGIN OF BIOMASS: FOREST AND WOOD

- The characteristics of the forest and wood material

→ Inapplicable or poor material, tricky field conditions

SALES AND PURCHASE TRANSACTION

- Different opinions
- Lacking co-operation and processes
- Variable terminology

→ Misunderstandings, impacts on supply reliability

CRITICAL STAGE

HARVESTING AND FOREST STORAGE

- Conditions (weather, field)
- Working proficiency and techniques used
- Timing and deadlines (drying)

→ Extra costs, production losses, low quality and damages, increased moisture and impurities

CRITICAL STAGE

FORESTRY TRANSPORT

- Conditions (weather, field)
- Working proficiency and techniques used
- Timing and deadlines

→ Extra costs, damages, increased moisture and impurities

CRITICAL STAGE

ROADSIDE STORAGE

- Conditions (weather, field)
- Working proficiency and techniques used
- Timing and deadlines (drying)

→ Extra costs, damages, increased moisture and impurities, solid matter content losses

CHIPPING AND LONG-DISTANCE TRANSPORT

- Conditions
- Working proficiency and techniques used
- Timing
- Lack of necessary rejections
- Shaking during chipping
- The chosen chipping method cf. features of raw materials

→ Impacts on particle size, moisture content, impurities, green mass

DELIVERY AND RECEIVING

- Management and control
- Transport and site equipment
- Capabilities of receiving stations and feed-in processes
- Timing of deliveries, varying hours of day

→ Quality control process, tolerances, unloading problems, delays, rejections

CHIPPING AND STORAGE

- General conditions (weather, storages)
- Working proficiency and techniques used
- Timing and deadlines (esp. as for drying)
- Lack of necessary rejections
- Shaking during chipping
- The chosen chipping method cf. features of raw materials

→ Impacts on particle size, moisture content, impurities, green mass

Problems will materialize latest in

ENERGY PRODUCTION: PLANT PROCESS AND COMBUSTION

- High moisture content
- Heterogeneity of fuels
- Unwanted particle sizes
- Impurities and contaminations
- Low calorific value

→ Impacts on economy, work problems, combustion process and side-products (emission, ash etc.)

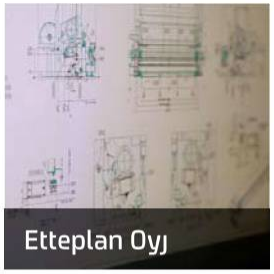
- Uncertainties
- Shortage of fuels (in relation to demand
- Unwanted delivery times

→ Impacts on value chain reliability

CONTENT

- Why a total quality-driven optimal biomass supply chain is needed ?
- What is a total quality-driven optimal biomass supply chain ?
- How much is the benefit / the value added ?
- Wrap up - Who to contact ?

TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN - FROM THE FOREST TO THE BOILER



VALUE ADDING SOLUTIONS - FROM THE FOREST TO THE BOILER

Solution provider	Company Solution	Value added / customer benefits (according to studies, interviews and company information)
FIXTERI Professional in harvesting technologies and logistics chain solutions	Fixteri Oy is a company specialized in the harvesting technologies and the development of a comprehensive logistics chain of small-dimensioned wood. Fixteri is developed for harvesting stem wood at renovation sites of young forests and first thinning sites. The Fixteri baler bundles stem wood into bales.	• As the first company in the world, Fixteri has developed a logistics chain solution for harvesting small-dimensioned wood, as well as the necessary technologies, which simultaneously benefit the forest and energy industries, harvesting entrepreneurs, forest owners, and nature alike. Cost efficient and flexible harvesting and logistics chain are enabled by the Fixteri baler, which is the result of years of product development and testing work, guided by long practical experience • The Fixteri harvesting technology, is intended for first thinning and refining of young forests. The technology is most cost-competetive in and improves profitability most when harvesting small-dimensioned wood, • The baling saves harvesting time , makes transportation more cost-efficient and reduces storage space requirements • The Fixteri bales dry well (down to 30 % moisture in good circumstances) • The yield per forest hectare can – as a result – be up to 40 % better • The bales are measured and registered automatically in the process • With bales , the savings in long-distance transport are in average 40 %. The entire transportation chain can benefit even from 200-300 % efficiency gains and 50 % smaller storage requirements

MHG systems
 	
The provider of MHG Biomass Manager - the most complete ERP solution for bioenergy production
	MHG Systems provide scompanies with an opportunity to renew their business and operation model by means of accurate cost monitoring and real-time enterprise resource planning
	MHG Biomass Manager is focused on inventory monitoring, managing biomass delivery chains in realtime, feedstock assessment, origin tracking and terminal management
		• MHG's services bring about significant cost savings and environmental benefits to all operators of biofuel supply chains, thus allowing improvement in value chain profitability.
		• Customers can use MHG's services to monitor and verify the social and environmental impacts of their operations, to match performance reports or voluntary standards
		• MHG's solutions facilitate increasing revenues and more complex business models
		• The materialized benefits from using MHG's solutions include
		  • Optimization of working hours, leading to significant manpower cost savings – starting from 10 % savings in the field work up to 50 % savings in the office work
		  • Savings in transportation costs, from improved efficiency of driver work up to improved utilization of transportation capacity (up to 10 % savings)
		  • Savings related to reduced storage requirements due to the faster supply cycle (savings up to 30 %)
		  • Improved quality of acquired biomaterials due to a significantly better monitoring and control of the value chain
		  • Environmental benefits arising e.g. from reduction in transportation volumes

KÄRKIMURSKAUS OY The ecofriendly method in production of wood chips from tree stumps	Kärkimurskaus Oy produces and supplies solid biomass fuel from wood chips	• The wood chips produced from stumps by Kärkimurskaus technology do not warm up during clamp storing, thus the risk of self ignition is very low. The fuel is very suitable for buffering and back-up storages • The efficiency and speed in the transportation will improve. The residues from chipping and sieving, as well as impurities, will remain in the forest, which means savings in transportation costs and improved efficiency in subsequent handling processes • The quality of the fuel will improve, e.g. the ash content varies typically between 0.4 – 2.3 %. This contributes to a more efficient hand-over at the gate and more efficient production processes at the plant, as well as less equipment breaks.

VALUE ADDING SOLUTIONS - FROM THE FOREST TO THE BOILER

Solution provider	Company Solution	Value added / customer benefits (according to studies, interviews and company information)

INRAY
 	
The X-ray quality measurement system for biofuels
	Inray is a high tech company that develops and offers novel x-ray scanning solutions for saw mills, power plants, pulp mills and biorefineries.	• In bioenergy production the indicators of the fuel quality, especially moisture content and share of impurities , are the key parameters for the control of the plant process.
		• The water content of the fuel is a parameter used to adjust the settings of a biomass boiler. But it is also essential for verifying the lower calorific value (LCV) of the fuel which is typically used for purchase pricing of the fuel. Solid biofuels often contain impurities such as stones, sand, soil and also metals that lower LCV and increase operation and maintenance costs in the power plant.
		• InrayFuel is a reliable and transparent solid fuel online quality control system that enables remarkable savings for power plants in:
		  • fuel procurement
		  • operation and maintenance costs
		  • sampling and analysing costs
		• The Inray Fuel systems measures online from the fuel flow the moisture content, density, volume and impurity content . It reports on-line the load-specifi quality data and related energy content (caloric value).
		• Inray Fuel system recognizes foreign objects, classifies them according to size and materials and transmits the information to main system in less than one second, whereby foreign substances can be removed before further processing. and thus avoid problems e.g. in chipping and crushing
		• The key benefits of the Inray Fuel system are
		  • Improved energy efficiency
		  • Less manual work in sampling and analyzing
		  • Better identificatuion of moisture variations inside one load
		  • Less ash
		  • Less problems in the production process, better overall quality of the process.

SAIMATEC ENGINEERING
 	
We are proud to introduce our advanced biomass drying system
	The biomass drying system is based on Saimatec's long-term knowledge and technology for bulk material handling in pulp & paper industry. The vertical type dryer is suitable for different types of biomass, like wood bark, all varieties of wood chips, sawdust mixed in other materials and sludges mixed with biomass.	• The system is a self-contained unit including infeed silo and outfeed equipment as well as automation. Drying process is controlled in an energy efficient way
		• Construction will be easily scaled and dimensioned for different capacity ranges. Biomass flow from few to many hundreds of cubic-meters per hour can be handled.
		• The following beneficial features can be linked to Saimatec' s solution
		  • no need to fine-grind material
		  • drying time is sufficiently long for also coarse particles to dry
		  • low temperature (typically under 150 Celsius) eliminates risk of volatile emissions and fire
		  • low speed of the drying air eliminates the tendency of dust spreading and therefore reduces need for
		  • housekeeping
		  • compact, sealed construction also prevents dust emissions to surroundings
		  • energy efficient 1 to 3- stage drying
		  • vertical construction makes installation easier also when space is limited
		• From the viewpoint of the power plant , the key benefits of Saimatec's system are
		  • Improved energy efficiency due to better fuel quality with lower water content
		  • Less space needed for storing the fuel
		  • Cost savings in the process

VALUE ADDING SOLUTIONS – RELATED PLANT TECHNOLOGY

Solution provider	Company Solution
Etteplan Etteplan has diverse expertise in engineering design	Etteplan has comprehensive competence in electronics and embedded systems development, automation and electrical design, mechanical design as well as in technical product information solutions and services.
Clean Flame Better Burning Experience	Clean Flame specializes in burner systems for utility companies Clean Flame is developing a new multifuel burner for liquid and gaseous fuels, which can burn LFO, HFO, pyrolysis oil, waste and bio oils, natural gas, LNG and bio gases clean and efficiently
Caverion Life Cycle Solutions for Buildings and Industries	Caverion designs, builds, operates and maintains user-friendly and energy efficient technical solutions for buildings and industries. Services from high-pressure pipelines to boiler house ventilation solutions and from valve maintenance to comprehensive maintenance solutions.
kpa unicon Responsible energy solutions	KPA Unicon is specialized in customized and modularized boiler plant turnkey projects. KPA Unicon's products utilize biomass fuels as well as fossil fuels in a sustainable way. KPA Unicon delivers projects as turnkey basis or process delivery , depending on customer's need. KPA Unicon can take responsibility of operation and maintenance at the plant KPA Unicon's solutions: • Unicon Biograte, capacity range 3 - 150 MWth • Unicon Pellet, capacity range 3-150 MWth • Unicon BFB, capacity range 5-20 MWth • Unicon O& G capacity range 3-600 MWth
Nordic Power Service Our most important business objective is a satisfied customer	Nordic Power Service Ltd specializes in the maintenance and repair of power plant boilers
ANDRITZ Biomass power for sustainable production and profits	ANDRITZ delivers complete solutions – from biomass receiving to fuel feeding to combustion (boilers or gasifiers) to ash handling to on-going service. BFB and CFB boilers from ANDRITZ are proven in installations around the world. Rebuild services enable conversion of existing boilers to biomass firing and co-firing.

SUMMARY: ADDED VALUE FROM A TOTAL QUALITY-DRIVEN OPTIMAL BIOMASS SUPPLY CHAIN

ORIGIN OF BIOMASS: FOREST & WOODS

- Relevant data available : raw material, resources and field conditions
- Data available for financial estimates / budgeting
- Availability of raw materials known in real time
- Increased predictability towards next stages

SUPPLY AND PURCHASE

- Improved knowledge of feedstock and storage values
- Less errors and misunderstandings, improved co-operation
- Real time information about feedstock (availability, features)
- Enhanced selling-purchasing process

HARVESTING AND FOREST STORAGE

- Improved planning and preparation - right technology, right staff , right timing
- Real time measurement and relevant data for the harvesting contractor
- Fixteri bales speed up harvesting process and make transports more efficient

FORESTRY TRANSPORT

- Real time tracking of transports (from field to plant)
- Improved predictability, used to plan and prepare next stages
- Efficiency of forestry transports up to 200–300 % (Fixteri bales)

ROADSIDE STORAGE

- Improved planning and preparation due to real-time accurate data
- Real time data about storage values
- Improved drying process and reduction in storage volumes with Fixteri bales and related storing models

CHIPPING/ LONG-DISTANCE TRANSPORT

- Optimized chipping and transportation based on contracts and quality requirements
- Costs of long-distance transports decreased even 40 % comparing to chips produced on roadside
- Improved chipping and crushing with Fixteri bales
- Feedstock with less impurities - less damages

DELIVERY AND RECEIVING

- Less errors and misunderstandings, improved co-operation
- Better preparations for varying unloading conditions
- X-ray based measurements provide real time information, improving quality control of delivered fuel (load specific info)
- Cost savings in sampling and analysing processes

CHIPPING/ STORAGE

- Feedstock with less impurities - less equipment damages
- Dry chips improve quality and enable longer storage times (Saimatec drying systems)

PROFITS REALIZED

ENERGY PRODUCTION: PLANT PROCESS AND COMBUSTION

- Improved process economy, a satisfied end-customer
- Efficient process adjustments based on measurements before combustion
- Predictability of fuel quality
- Right plant technology selections → chance for remarkable savings
- Expertise to maximize the opportunities and benefits of high-quality chips

QUALITY BENEFITS

COST SAVINGS

CONTENT

- Why a total quality-driven optimal biomass supply chain is needed ?
- What is a total quality-driven optimal biomass supply chain ?
- How much is the benefit / the value added ?
- Wrap up - Who to contact ?

SEVERAL ECONOMICAL BENEFITS ARISE FROM THE TOTAL QUALITY-DRIVEN OPTIMAL SUPPLY CHAIN

I. Economical benefits for the companies in the value chain

- Benefits for business and marketing, e.g. online visualization of available storages and their location
- Economical benefits related to improved data , e.g. optimization of fuel storage sizes, storages used as a collateral, ...
- Reduced labor and handling costs throughout the supply chain
- Logistics savings – delivery batch characteristics (moisture), optimized transport chain and vehicle selections

II. Competitive fuel price and availability at the gate; benefits in the procurement process

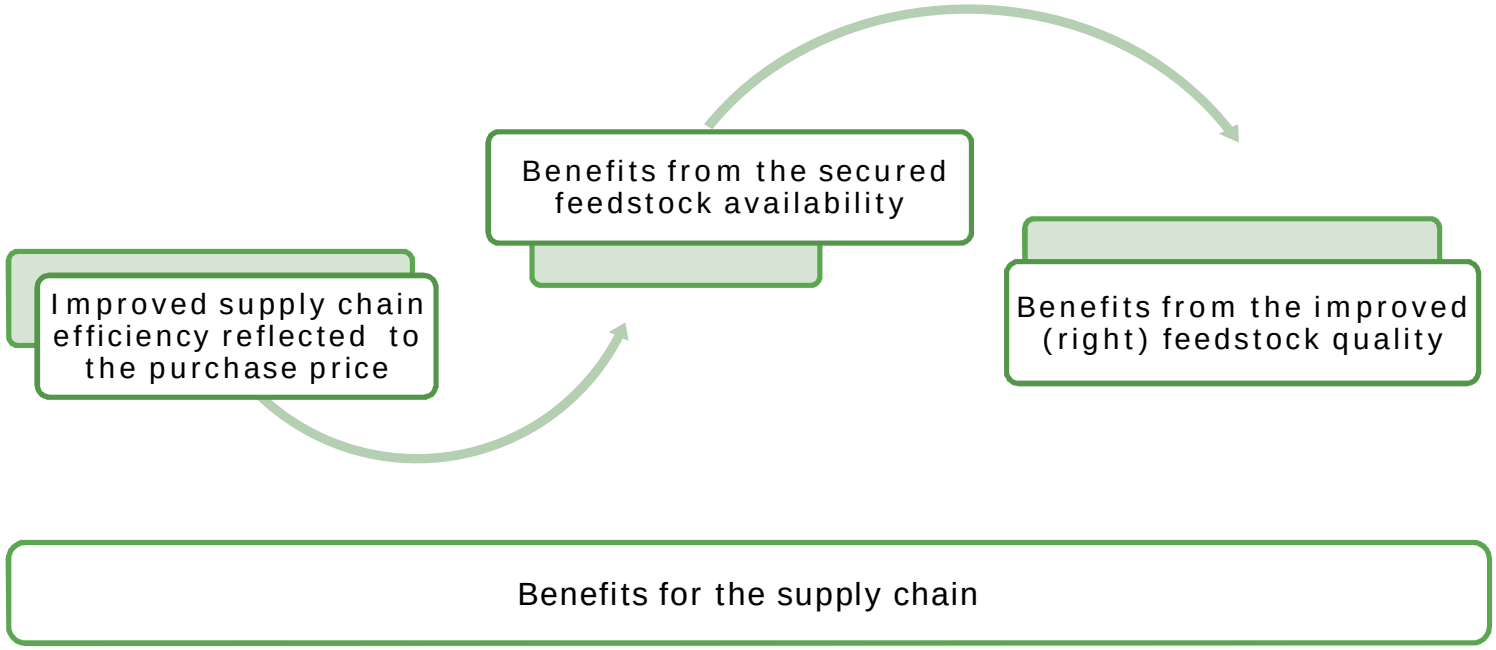
- Right price : from the plant viewpoint lower cost, from the supply chain viewpoint higher margin
- A predictable and effective procurement process
- Supply reliability: from the plant viewpoint secured availability, from the supply chain viewpoint predictable income
- Reduced investments to backup storages due to secured availability

III. Economical benefits from the good quality for the plant

- Improved/known quality: moisture, particle size, impurities, "green mass" content, homogeneity
- Higher efficiency and energy yield
- Process controllability and forecasting
- Reduction in operation and maintenance costs
- Smaller investments in fuel storage and pre-processing due to even / predictable quality
- Reduced production downtime
- Reduced need of biomass feedstock
- Reduction in harmful emissions
- Ash reduction, easier replacement and boiler sand resistance

FROM THE END CUSTOMER (PLANT) VIEWPOINT THE BENEFITS CAN BE GROUPED IN THREE GROUPS

1. Improved supply chain efficiency reflected to the purchase price
2. Benefits from the secured feedstock availability
3. Benefits from the improved (right) feedstock quality



1 THE PLANT BENEFITS FROM THE BETTER TECHNICAL AND ECONOMICAL YIELD

Source	Benefit	Examples
Type of procured feedstock (branches, stumps,...)	Better caloric value depending on the feedstock	Variations can be around 40 %: 2,1 kWh/kg harvesting residues 2,4 kWh/kg stem wood 2,9 kWh/kg stumps
Harvesting method (affecting the yield)	Harvesting small-dimensioned whole-trees instead of stem wood leads 10-40 % better yield per hectare	Compared with 100 m3 of yield from stem wood, the method for the whole-tree gives 110-140 m3
Moisture content of the harvested feedstock	Less procurement costs per MWh - smaller forest area (hectares) to be procured	Base case - moisture 30 % If moisture 55%, additional 0,002 ha per MWh is required
Stem wood bales, affecting the yield of the chipping process	The speed (yield, MWh/h) of chipping baled stem wood can be double as compared with chipping other types of raw material	Cost savings in the chipping process
Storage location / drying circumstances	Lower moisture content with better drying circumstances	The resulting moisture content can vary from 55 % to 30 %. 10 % less moisture leads to 2 % increase in yield
Amount of rotten wood	Less rotten wood - better caloric value of the feedstock	Rotten wood can lower the caloric value 0 -50 %

2 THE PLANT BENEFITS FROM THE BETTER FEEDSTOCK AVAILABILITY

Source	Benefit	Examples
Substitute fuels	Reducing use of more costly substitute fuels (typically oil), avoiding extra costs	Non-availability of 2-3 days can cause extra costs from several thousand euros up to tens of thousand euros, depending on the plant size
Back-up storages	Avoiding excess back-up storages, reducing related capital and process costs	A back-up storage for e.g. one weekend corresponds in average to 1 % of annual feedstock consumption

3 THE PLANT BENEFITS FROM REDUCTION IN PROCESS FAILURES AND MAINTENANCE

Source	Benefit	Examples
Feedstock particle size, amount of sticks etc.	Avoidance of failures from blocking, bridging and/or wedging in feeding screws etc	Problems in particle size cause 0% – 30% of process failures. Example from a 180 MW plant operating 7000 hours/a: low quality can cause extra costs up to 380 000 eur/a (*)
Feedstock impurities (rock, sand, ice ..)	Avoidance of wearing and tearing caused by impurities	Impurities cause 0% - 35% of process failures. Example from a 180 MW plant operating 7000 hours/a: low quality can cause extra costs up to 440 000 eur/a (*)
Caloric value of the feedstock	Low or varying caloric value has a negative effect on the boiler performance, increasing need for additional fuel (oil)	Problems in caloric value cause up to 8 % of process failures. Example from a 180 MW plant: low quality can cause extra costs up to 100 000 eur/a (*)
Green mass (needles etc)	Green mass has a negative effect on the boiler performance	Green mass causes 0% - 7% of process failures. Example from an 180 MW plant: low quality can cause extra costs up to 90 000 eur/a (*)
Low quality of the fuel	Avoidance of wearing and tearing of the plant equipment, i.e. avoidance of extra maintenance work	The costs due to extra maintenance work are highly plant-specific.
Extra investments	Avoidance of investments in the pre-processing equipment (like extra sieves etc)	The avoided investment costs can vary from thousands up to tens of thousands euro

** The basis of calculations derived from the study: extra costs from process failures can be estimated in average as 1 eur/MWh*

SIMULATION : ADDED VALUE FROM BETTER QUALITY AND AVAILABILITY

Example 1:

- Annual wood chip combustion 50 000 MWh
- Using whole-tree chips
- Average storing conditions, moisture 45 %
- Problematic particle size, impurities
- Availability problems

Example 2:

- Annual wood chip combustion 50 000 MWh
- Using whole-tree chips
- Very good storing conditions, moisture 30 %
- Minor problems with particle size and impurities
- No availability problems

	Example 1	Example 2	Unit	
Harvesting methodology (stem wood)				
Forest area needed	219	219	hectares needed	Benefit - Supply chain *
Harvesting costs	346 136	346 136	eur less	Benefit - Supply chain *
Impact of harvesting				
Calorific value	0.58	1.44	MWh/t	Benefit – Plant **
Efficiency (combustion)	1	3	%	Benefit – Plant **
Plant revenues	0.3	2.6	eur/t	Benefit – Plant **
Price paid	11.5	28.8	eur/t	Benefit - Supply chain **
Forest area needed	55	100	hectares less	Benefit – Plant + Supply chain **
Annual transportation (50 km)	2 292	4 167	km less	Benefit – Plant + Supply chain **
Emissions (combustion)	90	165	CO2 ton less	Benefit – Plant + Surroundings **
Transportation cost	49 000	91 000	eur less	Benefit – Plant + Supply chain **
Disorders, damages etc.				
Plant costs	0.80	0.37	eur/MWh	Extra cost - Plant
Plant costs	40 000	18 500	eur/a	Extra cost - Plant
Fuel availability and purchasing				
Plant costs	294 000	183 750	eur/a	Extra cost - Plant

* = compared with harwesting stem wood ** = compared with 55 % moisture content

SIMULATION : ADDED VALUE FROM BETTER QUALITY AND AVAILABILITY

Example 3:

- Annual wood chip combustion 500 000 MWh
- Using whole-tree chips
- Average storing conditions, moisture 45 %
- Problematic particle size, impurities
- Availability problems

Example 4:

- Annual wood chip combustion 500 000 MWh
- Using whole-tree chips
- Very good storing conditions, moisture 30 %
- Minor problems with particle size and impurities
- No availability problems

	Example 3	Example 4	Unit	
Harvesting methodology (stem wood)				
Forest area needed	2 190	2 190	hectares needed	Benefit - Supply chain *
Harvesting costs	3 461 360	3 461 360	eur less	Benefit - Supply chain *
Impact of harvesting				
Calorific value	0.58	1.44	MWh/t	Benefit – Plant **
Efficiency (combustion)	1	3	%	Benefit – Plant **
Plant revenues	0.3	2.6	eur/t	Benefit – Plant **
Price paid	11.5	28.8	eur/t	Benefit - Supply chain **
Forest area needed	550	1 000	hectares less	Benefit – Plant + Supply chain **
Annual transportation (50 km)	22 920	41 667	km less	Benefit – Plant + Supply chain **
Emissions (combustion)	900	1 650	CO2 ton less	Benefit – Plant + Surroundings **
Transportation cost	490 000	910 000	eur less	Benefit – Plant + Supply chain **
Disorders, damages etc.				
Plant costs	0.80	0.37	eur/MWh	Extra cost - Plant
Plant costs	400 000	185 000	eur/a	Extra cost - Plant
Fuel availability and purchasing				
Plant costs	2 940 000	1 837 500	eur/a	Extra cost - Plant

* = compared with harwesting stem wood ** = compared with 55 % moisture content

CONTENT

- Why a total quality-driven optimal biomass supply chain is needed ?
- What is a total quality-driven optimal biomass supply chain ?
- How much is the benefit / the value added ?
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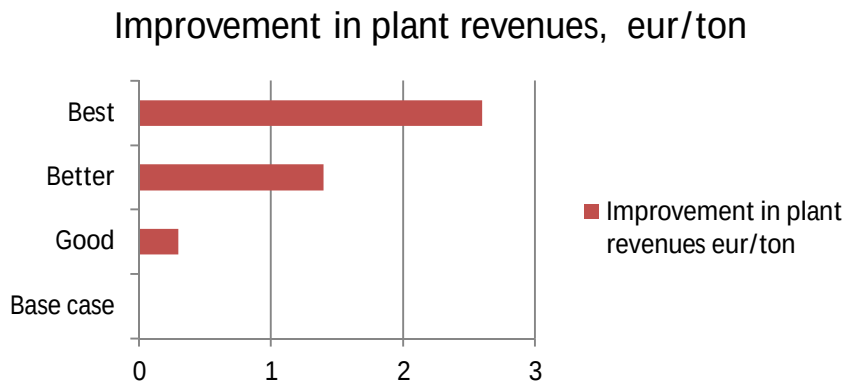
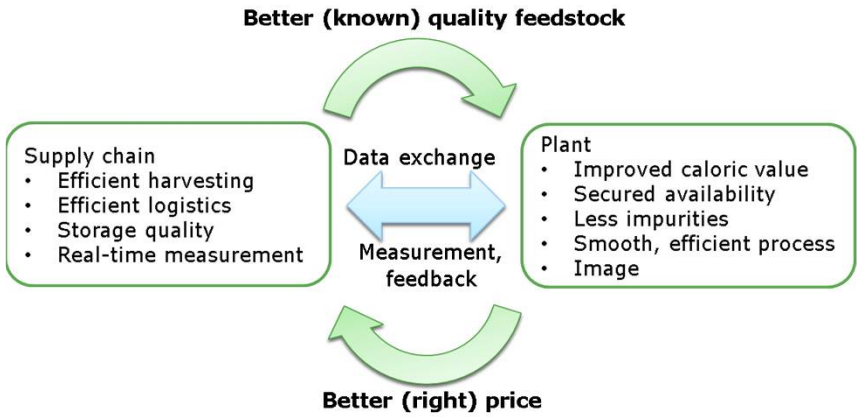
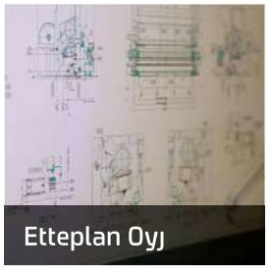
THE STUDY INDICATED A SIGNIFICANT ADDED VALUE

- A total quality-driven optimal biomass supply chain results to a better quality of the feedstock, a better performance in the supply chain and a more efficient procurement process
- Both the end customer (power / heat plant) and the various players the supply chain benefit economically, and a real win-win situation can be created
- The benefits can be estimated in euros via a special-purpose simulation model created in the study





CONTACT US



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