bioenergy for business

Supply of solid biofuels for mid-scale heat plants

European Commission
Horizon 2020
European Union funding
for Research & Innovation

www.bioenergy4business.eu

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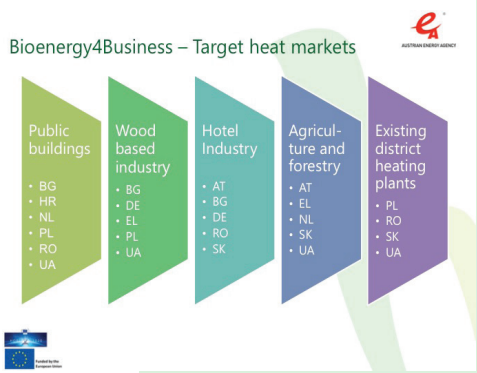
1. Bioenergy4Business

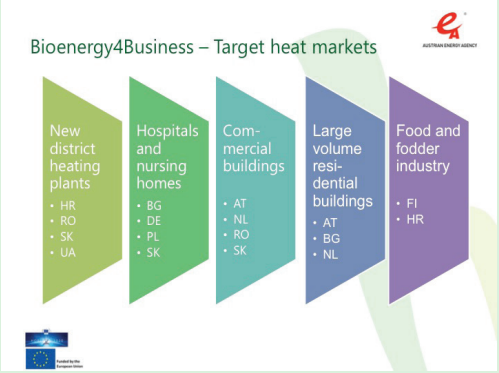
1.1 The project

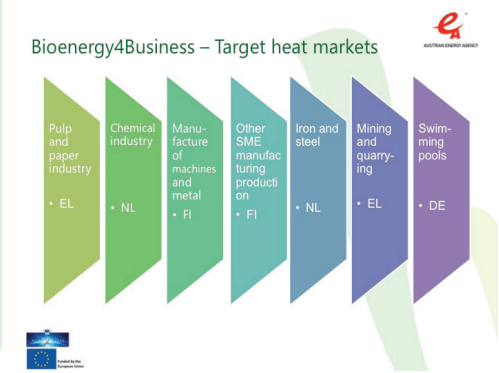
Bioenergy for Business is an EU funded "Horizon 2020" project supporting and promoting the uptake of solid biofuels in promising European heat market segments. The objective of the project is to increase the utilization of sustainably available solid biofuels instead of coal, oil or natural gas for heat supply in public and commercial medium scale heat sectors (> 100 kW to several MW heat load). **Bioenergy4Business** focuses on solid biofuels like by-products from wood-based industries, **forest wood-chips, straw, pellets** and solid agricultural waste utilized in existing and new medium scale heat-only plants with or without a district heating grid.

1.2 Promising heat markets

Among the project partners' countries, the following most promising market segments for heat-only utilization of solid biofuels were identified.







1.3 Supply-side basic rules for biomass heat plant

The biomass suppliers usually face the following challenges:

Low prices for oil and gas reduce the competitiveness of biomass heat plants. A tightening of the emission limits may require either the installation of precipitators - respectively dust collectors or the use of high-quality fuels. Both lead to additional costs.

- To represent an economical alternative, biomass-based heating concepts must be highly reliable, energy and cost-efficient and fuel delivery has to be cost-efficient and reliable as well.
- The development of solid biofuels markets in European Member States being advanced in biomass utilization shows that the implementation of bioheat technologies is a wide-spread success story. There are however many countries that do not (fully) exploit their sustainably available biomass potential to substitute fossil fuels with renewable ones.

Potential biomass heat plant investors want to focus on their core business and frequently request a full service (plant contracting service or an occasional biomass fuel delivery service). The reliability of the fuel supply and the use of regional fuels are important factors for investors to consider when making decisions.

- Concepts for long-term care should be developed in the very first stages of planning. For this purpose, investors or planners should contact the biomass suppliers with regard to the technical aspects of quick and reliable fuel delivery. Planning failures causing problems in fuel delivery (access to fuel storage, unloading and forwarding of fuel to storage) may lead to considerable unexpected costs for the whole lifetime of the project.
- Biomass suppliers should contribute with their experiences and knowledge to support the investors and planners, who have to take care of the coordination aspects of the project, guaranteeing a smooth planning and implementation of biomass schemes.

As wood-chips do not yet have an industry standard to guarantee uniform quality in terms of both fuel and delivery, a varying fuel quality may lead to malfunctions and therefore to higher operating expenses.

- Wood chip firing systems are designed for a certain bandwidth of fuel quality only. Therefore, the fuel should be delivered with consistent quality only. Fuel quality should be checked by the plant's operator before the delivery is accepted. In case the fuel does not meet the quality criteria it must be rejected.
- The higher the quality of the biomass fuel delivered is – mostly in terms of humidity, particle size and content of finings or impurities, the lower the cost for biomass furnaces to be constructed. Besides the fuel particle size (causing different feeding concepts) constant fuel quality is one of the main reasons why small pellet boilers can be cheaper than wood-chip boilers: standardization is possible in these cases. Wood-chip boilers, especially those being fuelled with moisture content of 50% or more, feature substantial refractory linings, which increases the cost of the furnace.

Some potential customers and the public are doubtful of the cost-effectiveness and sustainability of wood energy use.

- As there often is no level playing field between fossil and solid biofuels, the latter should get public financial assistance. Plants getting subsidies are looked at by society with a stronger interest. Therefore, it is necessary to carefully plan and implement biomass heat projects to guarantee that only sustainable biofuels are used, to inform

the local population about the project and to explain the social, environmental, climate and security benefits to them, like regional added-value, security of energy supply and labour, GHG-mitigation, having a highly resilient energy supply system.

2. Solid biofuels

2.1 Considered biomass fuels

- Wood-chips
- Pellets
- Straw

2.2 Origin of solid biomass fuels

Sources of raw materials for the production of solid fuels are:

- **Sawmill residues** accrue from wood processing from local sawmills. The bark and deciduous/ coniferous proportion is low, which allows for a use of premium wood chips. Furthermore, sawmill by-products (especially saw dust and shavings) are used as raw material for the production of pellets.
- **Roundwood** as part of a tree trunk, which is not utilized for material use, due to a small diameter. This biomass source has a relatively low proportion of bark and needle.
- **Wood residues** from forest management are residues from various activities of forest management (young stand tending, thinning or felling), which cannot be used as furniture wood or industrial timber, due to small diameters, for example the top of the trees and tree branches. Wood residues normally have a high proportion of bark and needles / leafs. The use for industrial chips is therefore the standard variant, only some batches are also available for premium goods.
- **Landscaping material / wood (LPM)** arising during measures in the field of

Raw material	Average Water content	Origin	Used for:
Saw mill residues	15 – 50%	Regional saw mills	Premium wood chips production, pellets
Round wood	20 – 50%	Forest, regional saw mills	Premium wood chips production
Forest residues	45 – 55% 30 – 40% if stored on forest street over summer	Private and municipal and federal forests	Industrial wood chips, and maybe premium wood chips
Landscaping material	45 – 60%	Private and municipal landscaping companies	Industrial wood chips
Short rotation coppices	45 – 55%	Short rotation coppices	Industrial wood chips, and premium wood chips
Stalk material	15 – 20%	Agricultural by-products	Straw fired plant

Table 1. Origin of raw material, characteristics and form of utilization

landscape and nature protection as well as of roadside vegetation maintenance. The woody residues usually have a high proportion of bark and needles or leaves. The biofuel is also often contaminated with soil or heavy metals, resulting from vehicle exhaust gases.

- **Wood from Short Rotation Coppices (SRC)** (mostly poplars or willows) can be used. Depending on the growth period and the rotation period, this can also be used for premium wood chips (benchmark: at least 5 years or a trunk diameter of > 10cm). Wood from SRC is also an alternative for pellet production.
- **Agricultural by-products** such as straw (stalks and leaves of threshed grains, legumes, oil and fibre plants) can make an important contribution to a sustainable energy supply.

2.3 Sustainability aspects

The market for solid biomass has been growing rapidly in recent years. A sustainable development is not limited to ecological considerations. Besides the environmental protection aspect, the job creation and world nutrition ones are important too.

Thus the strength of the energetic use of biomass regarding the regional added value should be an integral part of the communication strategy.

There is some controversy over the sustainability of bioenergy. To uphold the demand for solid biomass fuels, the concerns of the target groups should be addressed. Therefore, biomass suppliers should provide proof that the raw materials used meet the sustainability standards.

In order to continue to develop the biomass heating sector in a sustainable way, the following recommendations can be made:

- Utilise biomass (wood) from sustainably managed forests and ensure that new trees are planted in the place where forests have been harvested for bioenergy (SFM)
- Focus on the utilisation of wood left over from forestry or agricultural operations (thinnings, straw etc.) or industrial operations (industrial wood-chips, sawdust, etc.)
- Obtain proof of sustainable forest management through procurement from certified forests (FSC or PEFC). This will also stimulate the sector to certify the sustainability of the forest management further.
- Favour local resources; regionally available solid biofuels are the best choice as they:

  - Reduce transport distances and transport related GHG-emissions
  - Produce the highest possible local value added as they
    - Keep the money paid for energy services within the region instead of going abroad for fossil fuels
    - Enable and secure local labour security

and local infrastructure investments

o Help to enhance the stock value of local forests by financing proper forestry management

- Provide best conditions to build up sustainable, resilient and distributed energy systems
- Enhance local acceptance of green energy investments and of subsidies for them
- Ensure a high energy conversion efficiency to minimize resource demand and emissions

3. Biofuel production

3.1 Exemplary Supply Chains

3.1.1 Wood based materials – wood chips and pellets

3.1.1.1 Harvesting of wood based material

Wood chips from forest

Different scenarios for the production of wood chips exist. Figure 1 exemplifies the different process steps and locations for wood chip production from forest wood. Depending on the forest owner, the different process steps will be conducted in different ways.

Leaves and needles augment the water content and the storage risks (e.g. through fungus sporulation), so the trees and the logging residues usually rest for some months on the forest ground or on skid roads until needles and leaves have fallen off. Furthermore, leaves and needles contain a high amount of nutrients which should not be removed from the forest area.

In the next step, trees or branches are chopped on the skid or forest roads. Thereby extension, built-up-, self-propelled or attached hackers are used.

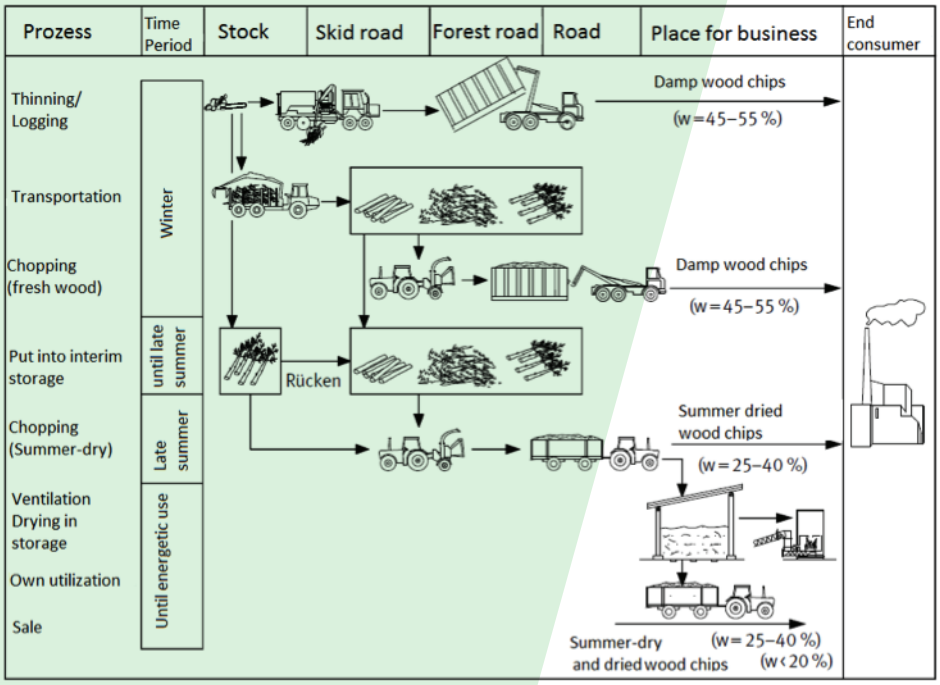


Figure 1. Procedure chain for the provision of wood chips with different water content (w) [1]

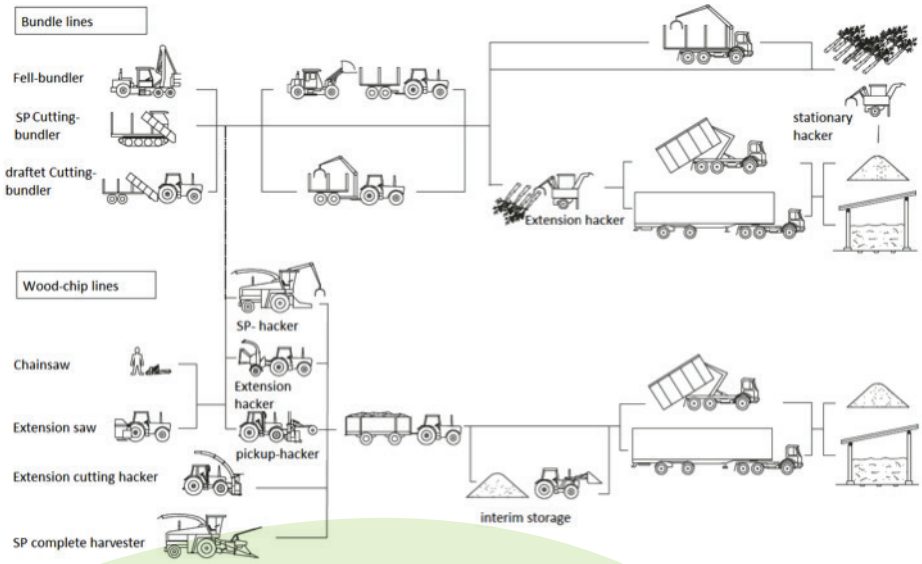


Figure 2. Provision of wood chips from short rotation coppices – procedure in bundle and wood chip lines (SP-self-propelled) [1]

In addition, some machines are able to harvest the whole tree and to directly produce wood chips from it. These machines are structured in a similar fashion to large-scale chippers. A processor handles the usual sawing, delimbing and crosscut operations. After achieving the border of refinement, the resting tree top is chopped. This is also practiced with whole trees if they have a small diameter.

In order to avoid damage to the soil, wood chips, not directly manufactured on the forest road, are transported with a high-level delivery tipping level trailer and shuttle vehicles to paved roads and, once there trans-shipped to larger transport units (tipper trailer, container etc.).

If the production of wood chips happens immediately before the delivery date, it's called a direct supply chain. In this case the water content of the fuel can only be regulated by choosing the best timing for harvesting (weather and season).

The raw wood chips are instead stored in the case of an indirect supply chain. In this case the water content can be influenced by natural or artificial drying processes. Above all, the logistical chain of wood chips is determined by the chosen harvesting method.

Wood chips from short rotation coppices

Wood from short rotation coppices can be processed into wood chips directly in the field (wood chip lines); alternatively, the whole tree is harvested, stored temporarily and afterwards transformed into wood chips (bundle lines). As it happens when small diameter trees are harvested, bundle lines can imply very different degrees of mechanization (eg. motorised, manual or fully mechanized processes). Thereby bundle lines are always set up step by step since further working steps (loading, transport, chopping) are necessary (Figure 2).

Bundle lines (step by step process)

While harvesting, whole trees, shoots and the grown material as a whole is separated from the stock and laid down in bundles or collected and transported to an unloading station. After being stored, the material is chopped at the field or at its edge, usually in a central processing yard, which can also be where the material is used to produce energy.

The advantage of harvesting the short rotation coppices step by step is a better storability and thus the better possibility for subsequent drying of the material. This can be a main economic benefit; if a low water content is necessary for a better exploitation of the material, complex wood chip dryers do not need to be installed. If the wood can be burned with a high water content, a continuous harvesting process is more favourable, as step by step harvesting means more technical and organizational effort: most services need to be outsourced and the availability of such special machines is low.

Wood chip lines

A harvester allows a single phase process (logging, chopping and loading in one work step). The advantage is an easy handling and transport of the harvested biomass as bulk material. Therefore, existing conventional machines (developed for green maize harvesting and adopted for wood-harvesting) can be used. If a longer storage period is needed (stocking of fresh biomass), there will be disadvantages due to the biodegradation of the organic material and fungal growth.

3.1.1.2 Processing of wood based material

Wood chip production

To produce a coarse or fine bulk material from wood residues or whole trees, high-speed hackers and shredders or slow-running cutters are used.

Star screens sieve the wood-chips into three fractions ("fines", "medium grain" and "oversize"), with uniform particle size. An advantage of the star screen as opposed to the drum screen is

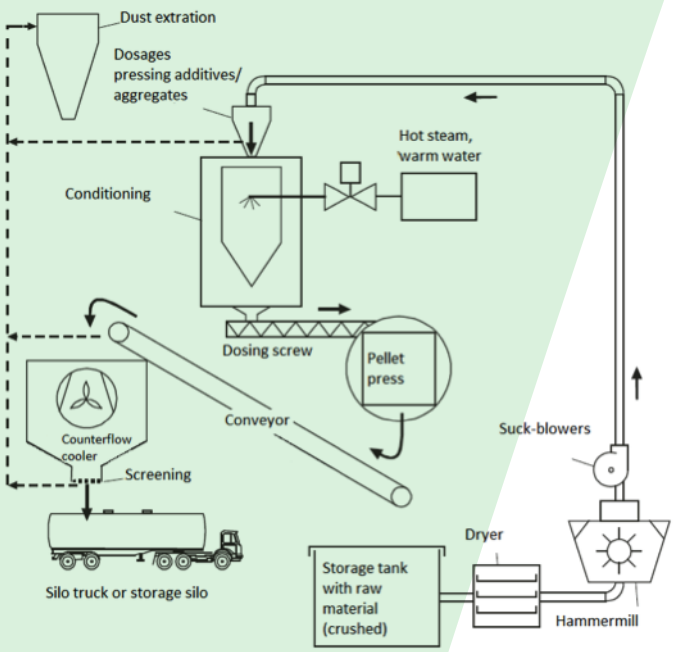


Figure 3. Principle of a pelletisation plant [1]

that it can be regulated in intensity and speed, and therefore the particle size can be varied. Moreover, vibrating screens have a role in sifting out fines, especially for dry materials.

Pellets

Pelletisation guarantees maximum homogeneity of the physical features of a solid biofuel. The major advantages of this technology are the high energy density and its favourable flowing and dosing properties. The storage, furnace and maintenance costs are lower than those of wood chip heating systems. The moisture of the raw material (mostly saw dust and shavings) will be reduced by a drying system and by compressing procedures to achieve a required moisture level of under 10%. In order to reduce energy demand, the raw material should be fine and dry. Figure 3 illustrates the main steps of the pelletisation process. For the pelletisation edge, mill squeezers or ring pelleting presses are used.

3.1.2 Stalk type biomass

Stalk type biomass originates from annual and perennial plants. Stalk type biomass are by-

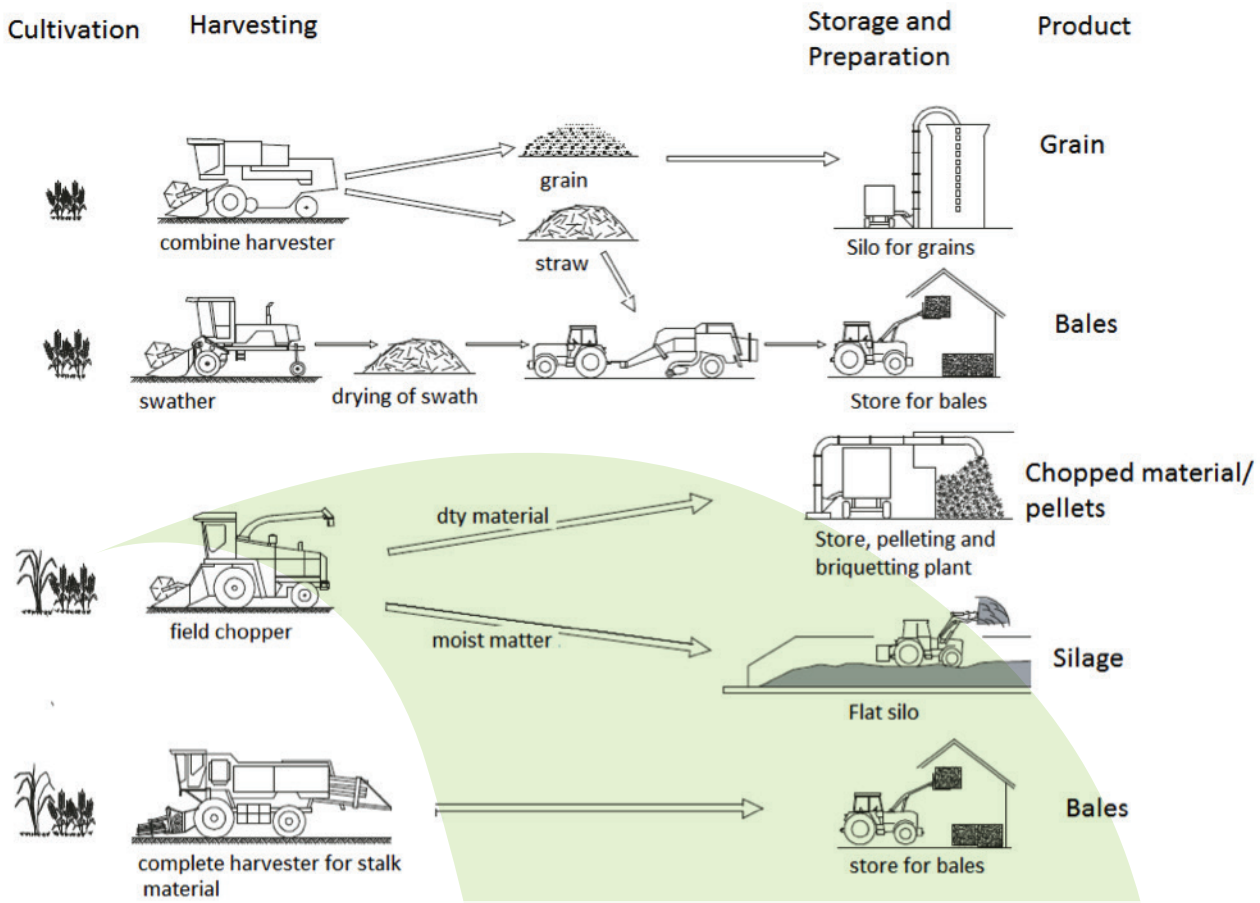


Figure 4. Simplified exemplary representation of harvesting process chain to provide stalk type biofuels [1]

products, residues (e.g. straw) or energy crops like elephant grass (miscanthus).

Cutting and Threshing

Cutting is an intermediate step, often combined with other process steps. The cutting step often takes place in the same material-shredding or bale-compression phases.

Using a combine is the most typical harvesting method for cereals, which can be threshed. This work step makes grain and rape straw available. The threshed straw is often chopped with the help of a straw chopper and widely distributed to be dug into the field later. If the straw will be used for energy it will be dropped down un-chopped onto the field.

The following working steps depend on the desired **form of preparation**. The production of biofuels from stalk material can be divided into the 3 different forms: **chopped materials, bales or pellets** (Figure 4).

Chopped material

Self-propelled machines are mostly used for producing chopped biomass from stalk material. An ejection channel transports the chopped material to a transport vehicle moving along with the machine. In order to avoid blockages in the feeding of biomass heating systems, the chop length should be 2-3 cm. Because of its low bulk density, chopped materials are unworthy of transport - long transport routes lead to high costs and should be avoided. The closer potential areas on the farm are the more attractive they are.

The chop quality is significantly influenced by

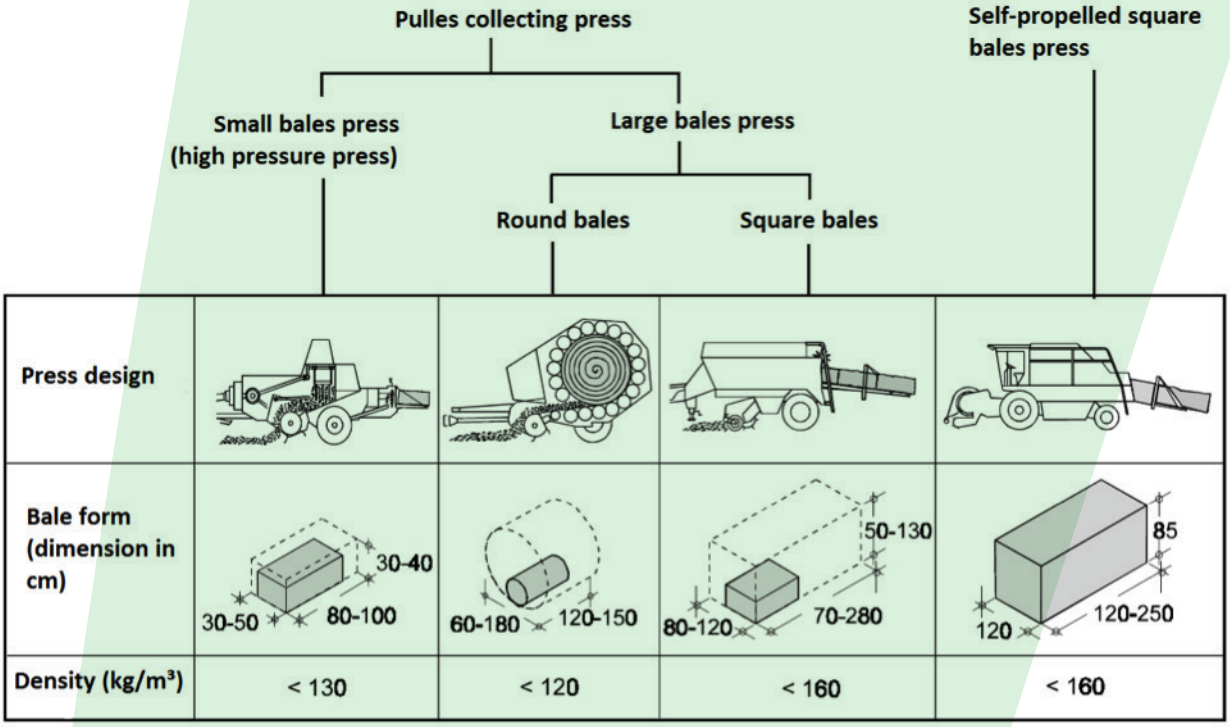


Figure 5. Typical bale presses and sizes of bales [1}

the sharpness of chopper blades. Dull blades significantly increase dust generation.

Bales

One-step or step-by-step harvesting processes can be actuated to produce bales from stalk biomass. Bales can be divided into small and large ones (Figure 5). Square or round bale presses are normally used.

Pellets

Due to the low energy density of the stalk material, the desire to establish uniform biofuel characteristics and a better transportability, stalk biomass can be pelletised. Self-propelled compacting machines which produce pourable pellets on the field still do not exist, So the pelletisation of stalk material is only practiced in fixed facilities.

3.2 Quality criteria

Wood chips

Fuel quality is key for a smooth plant operation flow. Wood-chip heating plants that are not specifically suited for wet fuel (water content > 35%) can have severe combustion problems, smoke emissions and energy losses. Large pieces of wood can block the screw feeder and stop operation. For a trouble-free operation, heating plants of 100kW+ need uniform particles, free of foreign substances. Homogenous particle size can be ensured by sharp blades and the right screen/sieve positioned after the blades (in the fuel discharge part of the chipper machine). In order to ensure efficient combustion, a homogeneous moisture content is required.

Categories and specifications for wood chips and their property parameters are set in standards. In 2014 the standard DIN EN ISO 17225 Part 4 "Classification of wood chips" came into force.

It represents the most valid ISO standard and replaces previously used standards, such as DIN EN 14961 part 4 and the Austrian ÖNORM M 7133.

The DIN EN ISO 17225-4 describes four quality classes (A1, A2, B1 and B2). For each of these classes, specific requirements concerning the raw material used and the physical fuel characteristics are described (e.g. water content, ash content, calorific value and bulk density).
An ongoing research project examines how the potential of fuel wood chips can be exploited to reduce emissions and raise regional value added. [2]

Pellets

The EU standard 14961-2 came into force in 2010 as the first Europe-wide standard for wood pellets. The standard classifies wood pellets into the three quality classes: classes A1 and A2, which are pellets intended for the end user – and class B, also called "industrial" pellets.

The European standard promotes certain properties of the pellets, as the determining parameters in terms of length, diameter, ash, water content and calorific value. Expressed in figures, this means, among other things: The pellet length is 40 mm, but five percent of the pellets may be longer, except if it has a length of more than 45 mm. The ash content may - in an ashing temperature of 550 ° C – be 0.7 percent for class A1 and class A2 and not exceed 1 percent. For pellets Class A1 applies an ash softening temperature of at least 1200 ° C, for A2 pellets of 1100 ° C. And the fines for both classes must not exceed one percent. Industrial pellets, which are marketed with the quality mark EN B, were not covered by EN*plus*.

Due to the certification programme EN*plus* the entire delivery chain of pellets is monitored from production to delivery and to the end user. Thus EN*plus* ensures high quality of the fuel and full transparency. As it has some stricter limits than the standard, this ensures EN*plus* has the control and labelling of premium pellets. [3]

Straw

Straw with too high or inhomogeneous water content may cause technical problems in the boiler (slagging, deposits, ash discharge) and an increase of pollutant and odour emissions. The calorific value of straw is also largely determined by the water content. Straw or other straw material with water content less than 20%, it is better at less than 15%. The riper and dryer the straw the more favourable are its fuel characteristics. Excellent for combustion plants is so-called "gray straw", which has been exposed to dew and rain for some days; thereby the alkali and chlorine contents in the straw are reduced. Straw should be collected and pressed in such a way that it does not contain impurities such as sand, mud and stones as well as foils or strings. [4]

4. Recommendations for suppliers

4.1 How to ensure fuel quality and cost efficiency

The easiest solution to ensure high fuel quality is if the fuel supplier is also responsible for a smooth plant operation. If many suppliers collaborate in a cooperative, every delivery of fuel needs to be weighed, humidity checked and the price adjusted to the energy content. Deliveries with too humid fuel must be rejected unless boilers for fuels with higher humidity are used. Even new CEN Standards for wood fuel need to be applied both in delivery contracts and in the contract with the boiler supplier

Wood-chips

Mobilization

Raw materials should be separated already in mobilizing in different levels of quality (according to water content, bark/leaf proportion, contaminant fraction) to subsequently allow the best respective recovery.

The exploitation of materials with inferior quality (e.g. Landscaping Material) can significantly reduce purchasing costs. This can happen, for example, through cooperation with the local authorities (maintenance of public areas).

The acquisition of wood residues from private forests can have a cost-saving effect, too.

The establishment of a broad network of suppliers enables flexible adaptation to changing prices or quality conditions. Reliable purchaser prices and regular inspections can result in a good trading environment. Before entering into a long-term contract, bear in mind, that timber prices are often exposed to fluctuations that may result in substantial fall in profits. [5]

Transport

The regional proximity to the sources of supply is a crucial factor for economic efficiency (low transport costs). The transportation of raw wood is more efficient (instead of more loose cubic metre per load), since it is more space saving. The amount of raw wood is then chopped as required. [6]

Piling and Storing

The piling and storing of raw wood or sawmill residues before chopping saves a large amount of drying energy. Log piles require significantly less space and inputs (Hall) as the storage of wood-chips. Although the storing of round wood binds financial resources, it also allows a demand-based production of wood-chips.

Chopping

Sharp knives and replaceable screens/sieves are essential for the production of premium wood-chips. Even at greater quantities, it is not yet of economic necessity to use your own wood-chipper. Good examples are biomass treatment works, which have a high load factor of their processing technology due to the high volume of woody biomass processed. The high volume also enables the biomass treatment works, to undertake a demand-based sorting.

Drying

The drying of raw materials is recommended if the supplied heating plants require low water content or a longer-term storage is intended.

The pre-drying of wood is carried out mainly

on wind-exposed open areas and usually last from the date of harvest to the next heating season. Dry storage surface for sun/air drying and/or rain coverage are the cheapest drying technologies and should be applied where possible before investing in equipment.

Storing freshly harvested wood over one summer normally enables humidity down to 30%, especially at sunny sites. The wood chips are most commonly used in small installations. However, large-scale plants may be procedurally designed so that dried wood chips bring no advantage or even lead to overheating.

Storage

The storage of fuel generates cost and causes energy loss due to biological processes (e.g. fresh wood- chips, covered ≈4%/year). Especially in the case of dense storage of fine and moist fuels biological and chemical processes can cause self-heating and - in exceptional cases - self-ignition of the stored fuel.

Just-in-time delivery (storage volume of 3 days of full-load operation due to weekends + one holiday) is sufficient. In some cases (slippery streets in winter prevent delivery) larger storages can make sense.

The storage of wood chips in heaps covered with a fleece is possible without rewetting, however, requires a careful construction (accumulation angle, soil aeration, etc.).

The close proximity of plants with different quality requirements on fuels is economically and logistically advantageous.

A lowering of the energy demand in the transport steps, chipping or drying reduces the production costs and emissions significantly.

Transport to customer

For the transport of wood chips for delivery to the customer trucks or agricultural machines are used. The seller bears the risk for transportation and impurities of the freight.

Pellet

The quality of wood pellets is determined not only by selection of raw materials and production methods. Even the transportation and handling in intermediate storage and collection of the pellets in the silo or the storage space of the customer affect the quality of wood pellets. Inccurring mechanical stress on the pellets (abrasion) may increase the fine fraction in the batch of pellets. Especially with the proper dimensioning of the filling pipes to the silo or pellet storage heating operators can create the right conditions for good storage.

Too high a proportion of fines in the pellet charge can lead to both disturbances at the screw conveyer as well as negative combustion and emission behaviour of the pellet. Leading pellet dealers filter the fines at the last loading point before delivery to the customer. Even blowing the pellets is carried out with simultaneous dust extraction.

Wood pellets are usually transported in a dry bulk silo to the consumer. The storage room can be filled easily and free of dust using a hose.

Straw

Due to the low mass / volume ratio straw / straw bales have a lower energy density and ergo a higher demand for transport and storage space. For this reason the transportability of straw and other straw material is limited. From one region to another straw rates may vary significantly; i.e. in regions with a strong presence of horse or cattle, chicken breeding and horse husbandry or vegetable growing meansignificantly higher prices can be achieved than in grain farming regions with low demand for straw. A national market for straw does not exist.

Measures to obtain a high quality fuel are [4,7]:

- Collect stones after sowing
- Avoid chlorine-containing fertilizers (subsoil liming, Fertilization in inventory)
- Prevent ripening retarding pesticide
- Thresh after reaching the full maturity of the grain
- Leave the swath for a few days in the field
- Set the pickup of the Press high to avoid impurities with stones, sand and clay
- Skip wet and place and field edges with a high content of weeds when harvesting straw
- Press with water contents below 15%
- Use roofed or covered straw storage with dry, solid ground
- Use large homogeneous batches
- Transmit quality requirements and instructions to the straw-providing farmers and the contractors commissioned, who are in charge of harvesting and pressing straw.

4.2 Technical requirements at the heat plant's site

The best preconditions to install a biomass plant are:

- 60-100% of the heat demand can be covered by biomass (installed boiler must not be operated below 30% of installed heat load at the minimum)
- Mostly constant heat demand over the year
- High acceptance for bioenergy plants on site
- Existing heating room with suitable chimney
- Possibility to attach an external fuel storage
  - Accessibility to plant and streets appropriate for (heavy duty) fuel supply vehicles (turning radius, road structure)
  - No barriers for unloading tip trucks
  - No barriers in storage room (e.g. concrete columns in the middle of a storage room
- Enough room for fuel storage with easy access in the existing cellar or in an external store at cellar level (large volume houses); in commercial DH sector the storage should be on ground level only
- Access to all plant components must be easily possible
- In large volume houses the basement walls and the ceiling have to be fire resistant, in general no electrical appliances, sockets, bulbs etc. are allowed in pellets storage rooms
- District heating pipes can be laid into soil (cheaper than laying them in streets)

4.3 Biomass supply contracts

Depending on the type of fuel, the number of suppliers and the willingness / ability of the plant operator to internalise labour there are differences with respect to the contract contents.

Here the several billing models are presented:

Volume	This method has the least effort. The volume can be determined from the dimension of the hold (bulk goods) or in case of straw bales of the number and the dimensions of the bales. In a clearing on volume, even the type of wood has to be considered. The accuracy of this method is low, because the bulk density of fuel assortments can differ, which have a major impact on the measurement result. Therefore this method is only recommended for homogenous fuel assortments.
weight and water content	The weight determination is done mostly with in-house scales and is often more complicated than the volume determination. Because of the disadvantages mentioned above this billing model is more suitable for inhomogeneous fuels. To increase the accuracy in the determination of the energy content an additional water content measurement is required. In a clearing on the weight and water content, the type of wood is negligible, as all wood species have an almost identical calorific value per kilogram of wood.
generated heat quantity	The advantages of this method are the reduced metrological effort at the fuel delivery (a quality control can usually not yet discontinued) and high measurement accuracy. However, systematic measurement errors may be occurring during the operation of the plant; contamination of the boilers´ flues can result in higher temperatures and thus in lower effectiveness. This method is only useful when the reference biomass is delivered exclusively from one supplier, since otherwise a clear assignment is gets difficult.

The essential contract contents of biomass supply contract can be found at www.bioenergy4business.eu/services/delivery-contract-model.

4.4 Public relations

In order to generate interest and demand for solid biomass fuels biomass suppliers should draw attention to themselves with presentations in villages and different events as well as advertising in agricultural and regional newspapers. Successful best practice show cases are another important means for motivating potential investors. It should be pointed out that projects of such nature are a real business case and have further additional useful value added (local value added, employment, green cycles, CO_2 reduction).

Key persons to get into contact with:

- Developer (Architect, coordinator of construction, consultant responsible for planning of heating system)
- Mayor of the village
- Locally committed farmers
- Village people and future residents - do not realize projects against residents' wishes

4.5 Services

Because of a lack of know-how of the key actors (planners, installers, architects, municipal employees which are responsible for construction projects), biomass suppliers should contribute their experiences and knowledge to them as well as to the operators of the biomass plants. Because the potential biomass heat plant investors mostly request a full service, following energy consulting and services could be offered:

Planning

- Consultations on the selection of appropriate fuels
- heating contracting, maintenance, financing, fuel supply contracts with long-term price guarantee
- Logistics of fuel shipments, also for external companies

Further Education

- Offer seminars on wood fuels and renewable energy, engineering, energy saving etc. for key actors (planners, installers, architects, municipal employees and for potential investors)
- Organize excursions to demonstration plants with potential operators as well as residents.

Ash disposal

For the sake of simplicity the customers often indenture the supplier to dispose of the ashes. However this is not necessarily the least expensive solution. Because the disposal of ash is not the core activity of the supplier and the delivery vehicles cannot be used for the removal of ash, the ash disposal by specialized companies is commonly more cost effective. However, the biomass supplier can take over the organization of the disposal.

But it is difficult to make a blanket statement, because there are differences in starting conditions in the EU-countries. For example in Denmark commissioning of a company that takes care of the ashes will increase the costs due to high costs of labour and taxes. So it is recommended to consider alternatives.

Balanced humus balances are also a precondition

for the energetic use of straw. In the case of thermal utilization, the ash recycling with the highest possible nutrient availability should be aspired to. The straw amount varies in the regions and farms greatly depending on the natural site conditions (soil and climate), crop rotation and the livestock. In order to determine the amount of straw which can be removed from the cycle, field-related humus balances have to be created.

More information about the "recovery and disposal of wood ashes" are summarized in a leaflet [8,9]

Heating service contract

Final recommendations if you want to realize contracting projects yourself to get started with projects that have very good preconditions for success:

- Make sure plant is well maintained
- Establish automatic alarm system (usually problems can be solved before customers become aware of it)
- The connection charge is based on the usual distant heating rates and is differentiated for new and renovated buildings.
- A separate rent agreement is made for use of the heating and fuel storage room.
- Heat consumption is measured by a calibrated heat meter owned by the heat supply cooperative.
- The heat is billed on the basis of a set heat rate (usual distant heating rate) – divided into a standing charge, a kilowatt hourly rate, and a metering charge – all is index-linked – standard heat supply contract
- Term of contract should be 15 years
- Insurance of the heating system and furnace is covered by the overall building insurance

4.6 Biomass supply cost

Wood chips

There are various processing chains to provide wood chips. Due to the "unit-mass-law" the performance goes up with increasing diameter of the trees. Three processing chains are presented:

- Variant I: Combined procedure chain (material/energetic use), partially mechanized , partially coupled and motor-manual harvesting, forwarding is carried out with a cable winch, special forest tractors or timber trailers with cranes, chopping on forest roads, truck transport.
- Variant II: residual wood (woody residues from timber harvesting) processing chain, partially mechanized , partially coupled, motor-manual harvesting already completed, delivering to skidding road with cable winch, forwarding is carried out with

Table 2. Procedural costs ex forest track € /m³ [10]

	Variant 1			Variant 2			Variant 3		
	Min	Median	Max	Min	Median	Max	Min	Median	Max
Felling	2	6	12				3	8	20
Forwarding	2	5	13	2	5	13	2	4	13
Chopping	2	4	5	4	4	5	2	3	4
Total	6	15	30	6	9	19	7	15	31

Table 3. Costs of storage of forest wood chips (incl. Transport to storage and loading) [1]

	€$_{2012}$ /t dry mass	
	Free storage on concrete slab	Bulk storage in buildings with base plate
Transport from the field to storage	4,5	4,5
Storage feeding	4,6	4,6
Storage construction costs (incl. maintenance and insurance)	10,4	19,3
Stock loss costs[1]	5,3	3,6
Total stock costs	24,8	32

[1]*Calculation of costs: Dry matter losses during storage (12%) multiplied by costs per ton free storage*

cable winch, special forest tractors or timber trailers with crane, chopping on forest roads, truck transport.

- Variant III: Combined procedure chain material/energetic use, fully mechanised partially coupled, harvesting and processing with harvester with standard harvester aggregate, forwarding is carried out with forwarder, chopping on forest roads, truck transport.

Table 4. Transport cost form storage to end user [1]

	Tractor + 2 trailers	**truck-trailer**
Transport distance (km)	€$_{2012}$ /m^3	€$_{2012}$ /m^3
5	1,3	0,8
10	2,5	1,1
20	4,9	1,4
50	12,1	2,2

Straw

The straw handling is divided into the following process steps: bailing of straw, loading, transport, unloading and storage. The high demands on the straw quality exclude field storage without coverage.

In case the storage is not at the same site as the heating plant, transport costs must be taken into account additionally. The transport costs for a tractor with two twin axle trailers are 0.65 €/ ton-kilometer. [12]

Table 5. Processing cost of straw [11]

Cost factor	**€/t raw material**
Raw material costs	17,90
Baling	17,40
Loading, transport with Transport with bale trailer (10km), unloading	10,90
Storage costs in-covered field stacks (Variant A)	20,10
Storage costs Machine hall 0x15m (Variant B)	38,20
Costs free storage	**66,30 -84,40**

Pellet

The pellet production from sawdust can be divided into the following steps: Drying, grinding, pelletization, cooling, storage. The costs for storage contain the investment costs

for its construction. The item "Personnel costs" contains the costs in production, marketing and administration.

Cost for construction, infrastructure and planning are subsumed under "general investment". "Peripheral equipment" includes expenses of costs of investment that cannot be directly allocated to one of the other items. This includes, for example, the required power for the motors of the screens and the feeding system.

Table 6: Calculation of pellet production costs (before taxes) [13]

Cost factors	$€_{2008}$/t
Drying	48.1
Grinding	2.70
Pelletization	9.2
Cooling	0.3
Storage	3.8
Peripheral equipment	3.5
Personnel	8.7
Raw material	58.7
General investments	1.6
Total	**136,60**

Table 7: Total cost of pellet distribution [14]

Cost factors	$€_{2008}$/t
Transport from production site to intermediate storage	3,4
Unloading truck and loading silo	3.0
Rent for intermediate storage	7.1
Sieving before truck loading	5.5
Truck loading	3,0
Transport from intermediate storage to end user	3,4
Total costs	**25,4**

The costs summarized in Table 5 are production costs free works. Cost for the distribution of pellets are listed in Table 6. To avoid high costs for the transportation of raw material the pellet production should be combined with the producer of raw material (e.g. sawmill). The transport costs per ton to potential markets (end-users) depend on the delivery distance and the ordered quantity.

5. Best practice example

To guarantee an undisturbed operation of a medium size heating plant, a consistent size of wood chips which is free of foreign substance is needed. The most efficient combustion can be reached with fuel which has homogenous moisture content.

The biotherm service GmbH produce high quality wood chips meeting the requirements of the identified target markets. The wood chips are distributed as thermochip® for furnances, as well as for power plants, district heating plants or heating plants. Thereby the thermochip® wood chips are defined by a high heating value (4,368 kWh/kg) and a homogenous and low moisture content. Furthermore the wood chips are analysed regularly by an external institute.

The company operates a biomass treatment work and an own biomass power plant based on waste wood Class AI and AII at Hagenow. The system of cogeneration is used to produce electricity and process steam for industrial customers as well for drying the wood chips.

A temperature and moisture controlled belt dryer guarantees a continuous constant moisture content of the fuel. At a temperature of 110 °C, the wood-chips are dried to the desired water content, while possible existing fungi and bacteria are also largely killed. Thus, the material is biologically inactive and cannot get mouldy or produce heat during storage.
The wood chips mainly stem from logs and wood residues from sustainably managed forests. Small quantities also come from the woody portion of the landscape materials. Waste wood from industrial processes is also bought and stored temporarily as raw material at a timber stockyard. If the amount of the raw material is higher than 1,000 cubic meters, an external company will do the chipping.

The high-quality wood chips are then processed at the site in Hagenow to the quality thermochip® wood chips. All other woody fractions (Shredder material) of the biomass treatment work are marketed directly to customers in the region.

The high-quality wood chips are then processed at the site in Hagenow to the quality thermochip® woodchips. All other woody fractions (Shredder material) are marketed directly to customers in the region.

According to a multistage sieving process the fine content of thermochip® wood chips is extremely small. Under- and over- sized chips of the denomination can be excluded and so an undisturbed and smooth operation of the machinery can be guaranteed. Furthermore the ash content can be minimized in this way. That leads to lower decommissioning and cleaning costs.
The thermochip ®with a calorific value of 4,368 kWh / kg allows a reduction in the amount of fuel as well as of the emissions and of the combustion residues.
The price for thermochip ® with an average humidity of 20% was € 120 per ton (including transport costs). For comparison only: In Germany the average biomass fuel(s) cost for this quality standard ranged from € 130 -140/ton at the end of the year 2015. [10]

6. Contacts and references

Contacts

Get in touch with your national B4B contact point:

AUSTRIAN ENERGY AGENCY (OSTERREICHISCHE ENERGIEAGENTUR) *Austria* http://en.energyagency.at	**AEBIOM (THE EUROPEAN BIOMASS ASSOCIATION)** *Belgium/Europe* www.aebiom.org	**CENTRE FOR RENEWABLE ENERGY SOURCESAND SAVING FONDATION (CRES)** *Greece* www.cres.gr/kape/index_eng.htm
DEUTSCHES BIOMASSEFORSCHUNGSZENTRUM GEMEINNUETZIGE GMBH (DBFZ) *Germany* www.dbfz.de/aktuelles.html	**KRAJOWA AGENCJA POSZANOWANIA ENERGII SA (KAPE)** *Poland* www.kape.gov.pl/index.php/pl	**ROMANIAN ASSOCIATION OF BIOMASS AND BIOGAS (ARBIO)** *Romania* www.arbio.ro/en/#all
SLOVENSKA INOVACNA A ENERGETICKA AGENTURA (SIEA) *Slovakia* www.siea.sk	**NACIONALNA ASOCIACIA PO BIOMASA (BGBIOM)** *Bulgaria* http://bgbiom.org	**SCIENTIFIC ENGINEERING CENTRE "BIOMASS" LTD (SCIENTIFIC ENGINEERING CENTRE)** *Ukraine* http://biomass.kiev.ua/en
ENERGETSKI INSTITUT HRVOJE POZAR (EIHP) *Croatia* www.eihp.hr	**MINISTERIE VAN ECONOMISCHE ZAKEN** *The Netherlands* www.rijksoverheid.nl/ministeries/ministerie-van-economische-zaken	**MOTIVA OY** *Finland* www.motiva.fi/en
	TEKNOLOGISK INSTITUT (DTI) *Denmark* www.dti.dk	

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The Horizon 2020 project Bioenergy4Business (B4B) aims at supporting and promoting the (partial) substitution of fossil fuels (such as coal, oil, gas) used for heating with available bioenergy sources (such as by-products of the wood-based industry, forest biomass, pellets, straw and other agricultural biomass products) in the project partners' countries and beyond.

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