Title: "Biogas Woodchip Drying Innovation for Reduced Bioenergy Production Cost"

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This research paper provides a detailed description of an innovative wood chip drying technology that requires a partnership between an agricultural producer that runs a biogas facility and a forest bioenergy firm, processing, storing and delivering wood chips in Southern Germany. In order to satisfy the growing demand for forest bioenergy in the residential and micro combined heat and power (CHP) markets, wood chip energy must satisfy relatively high quality requirements (cleanness) and contain low moisture levels and be cost competitive to alternative energy carriers (both renewable and fossil) and comply with requirements of the residential heat and CHP installations. Being a waste-product in the past, wood chips from residuals are now recognized as a product which - by standardization and conditioning - can enhance the value added. This perception is mainly driven through increased demand. Its diversity and therefore the differential use of wood chips is at best when the product is processed in a way it can be included into standardized industrial processes (Kuratorium für Waldarbeit und Forsttechnik e.V. 2013). This creates a challenge for the bioenergy firm in order to increase processing activities while also lowering costs of production.

This innovation presented in this paper satisfies this need. Given the proliferation of biogas facilities throughout central and southern Europe (more than 7500 facilities in Germany alone), it could be adopted and expanded in other areas, resulting in significantly lower costs of production and increased markets for wood chip energy throughout Europe (Fachverband Biogas e.V.,2013).

The cost information used in this paper refer to one single medium wood chips producing enterprise in South-West Germany, but can be seen as exemplary for the structure of the wood chips producing industry of central Europe. Nonetheless, one should be aware, that variations over such a large geographical region and between enterprises do exist.

Wood chips production supply chain

In order to produce high quality chips, the production process contains several steps (see Figure 1). After being chipped and transported to the terminal, the material is dried to lower moisture content down to the degree it is needed by the customers. Usually small scale customers as private households or micro combined heat and power plants (CHP) need clean wood chips of low moisture content, due to their facility conditions and smaller boiler sizes, which are considerably less efficient burning high moisture chips.
After the drying process, chips are sieved in order to exclude non-wooden components that may cause damage to the facility and – if needed – separate wood chips by size in order to satisfy different customer needs.

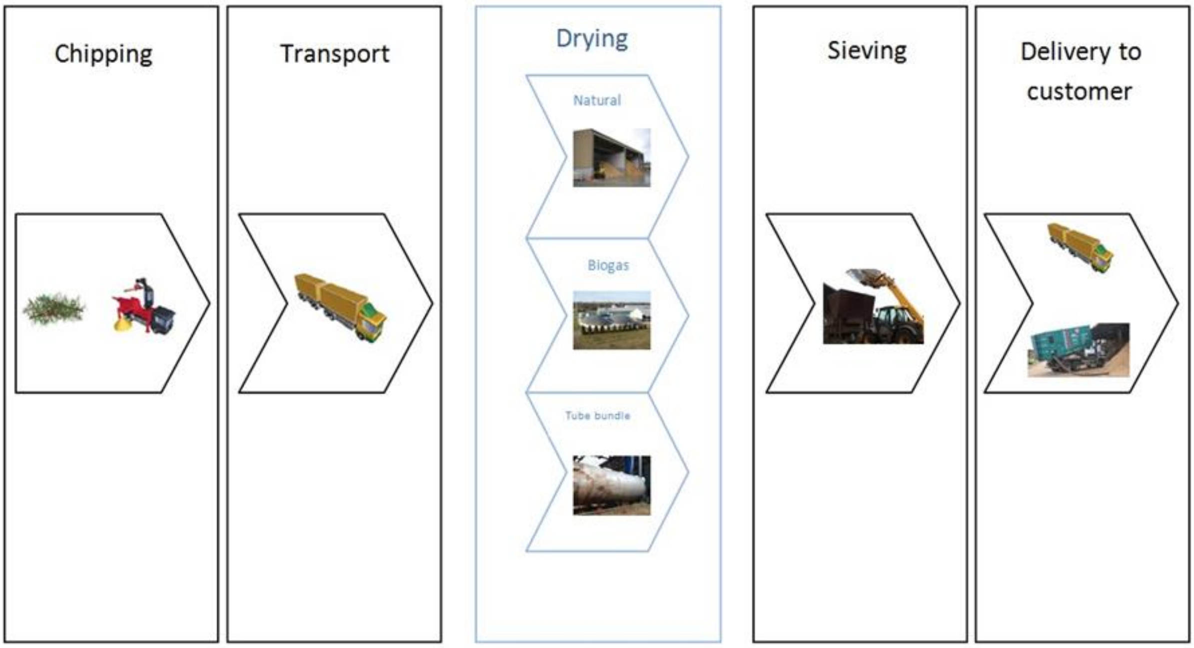


Figure 1: Supply chain for wood chips production

Conventional drying methods

The conventional drying process in Germany is conducted mainly in two ways. Either wood chips are dried naturally or by a drying machine, i.e. a tube-bundle dryer or drying conveyor. Nonetheless other drying approach do exist (AEBIOM 2008).
In the natural air-drying process, chips are piled onto a clean – often concrete – ground and covered with a fleece or similar to protect the material against rain, snow, wind and pollution.
Hereby the moisture content is reduced from about 50% to 35% within 3 months in summer time. Because of the influence of the ambient temperature on the fermenting process inside the pile, the drying time significantly increases in winter. The cost of air-drying depends on different parameters as the choice of covering material, manpower, machines and space. In the case of our project partner, an approximate value of 0,50 Euro per bulk meter is applied.

In the case of the tube bundle dryer – as used by our project partner – the heat exchanging device reaches a temperature up to 150°C and reduces the moisture content of one bulk meter of wood chips to 20% within an hour. According to given information the drying cost by this machine is approximately 3 to 3,5 Euro per bulk meter, depending on filling volume, energy cost, etc. Of course, with higher inlet temperatures more volume can be dried but at the expense of increased production costs due to the higher energy demand.

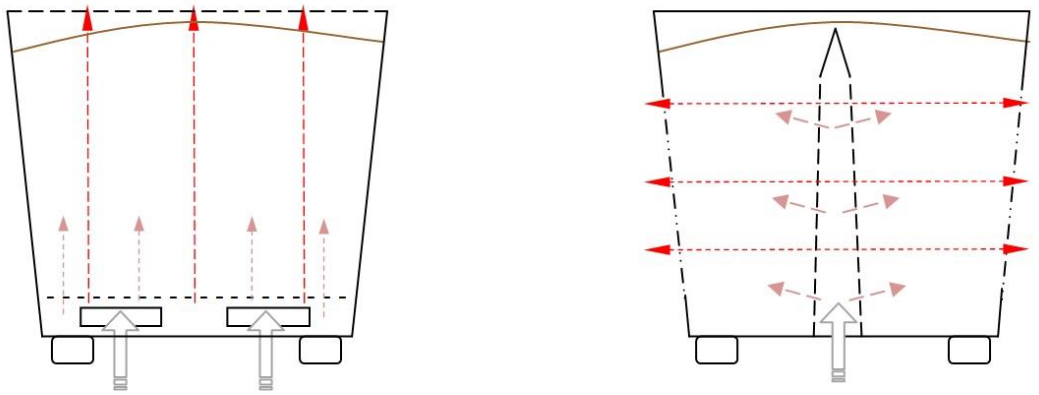
The major drawbacks of these two conventional drying techniques are the high dependency of seasonal ambient temperatures for natural drying and the low output per hour when chips are dried with the tube bundle dryer (approx. 1,5m³ per hour).

Biogas woodchip drying

Due to the amendment to the “Renewable energy act” (EEG) from 2012 (BMWi, 2014), operators of biogas-facilities need to fulfill certain requirements if they wants to receive a premium on the combined heat and power production by using the excess-heat. In order to receive the premium, a minimum 60% capacity utilization of waste heat per year is required of which maximally 25% may be used for fermentation purposes. 35 to 60% of the remaining waste heat has to be used for ulterior functions as i.e. heating of buildings or drying of loose material.

Since 1992 the number of biogas-facilities increased from 139 to 7515 in Germany alone (Fachverband Biogas e.V. 2013). Therefore it stands to reason that an alternative approach of drying wood chips refers to the usage of waste heat of biogas-facilities. During the process of producing biogas for electricity and heat, outside air is used to cool the system. This air in turn heats up and would be blown as excess heat into the atmosphere if not used for heating of buildings or drying of grain, digestates, split logs, wood chips, etc. (Thierer, M. et al 2012).

Because of easy-handling and relatively low investment costs drying containers are commonly used for this purpose. Generally these are conventional containers with a capacity of 32-35m³ which are modified by inserting a false floor with small holes or grooves and connections for flexible tubes. By conducting the warm air with a blower through the tubes into the container, the wood chips dry from the bottom to the top. The moisture level of wood chips reduces from approximately 50% down to approximately 10% within 3 days in summer time, while output may decrease by 50% in wintertime when the ambient temperature reaches values below freezing.
For the container solution with the false floor and a facility where 6 containers can be connected, a monthly drying volume of approximately 1400m³ can be reached in summer time and 1000m³ in winter time.
One disadvantage of this so-called vertical drying process is the unequal drying of chips from the bottom and chips on top. The warm ascending air cools down and condensates at the undried wood chips at the top. Since cool air absorbs less moisture, the container load must dry longer in order to reach a certain moisture level for all chips or the whole pile must be stirred. Both leads to higher production costs (Krämer,G. 2013).
To reduce the drying time and lower generation of condensate, an alternative approach is, instead of a false floor, to insert a perforated air-supply duct in the middle of the container for that the wood chips drying is conducted horizontally from the middle of the pile to the outside. An additional advantage is the equal drying of chips from the bottom and chips from the top and the more energy-efficient drying since the drying distance is reduced by leading the warm air through the middle of the pile horizontally to the sides. Due to the openings at the side, the container can be covered at the top against rainfall (See Figure 2) (Krämer,G. 2013).



Container with false floor and vertical drying

Container with centered air supply duct and horizontal drying

Figure 2: Vertical and horizontal drying systems (Source: Krämer,G. 2013)

Discussion

The biogas-drying option presented here, could offer a viable alternative to conventional tube drying of conventional wood chips, depending on the circumstance of each firm, their proximity to bio-gas producers and the customer location and demand. To be able to compare the cost competitiveness of the alternative drying options, different factors have to be taken into account, as investment costs, machine life and usage, operating costs, economies of scale, etc., that differ from firm to firm . In the case of biogas-drying, also location enters the considerations as transportation costs increase with the distance between the biogas-producer and the wood chips-producer.

In addition to that it has to be taken into consideration that the premium for biogas-producers works as a subsidy to achieve the political goal of promoting and strengthening the competitiveness of renewable energy. Therefore it is ambiguous how future policy changes concerning the premium may favor or abate the competitiveness of this wood chips drying approach.

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