IMPACT OF FUTURE SUSTAINABILITY CERTIFICATION SYSTEMS ON THE DESIGN OF A LARGE-SCALE BIOMASS BULK TERMINAL

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Abstract

The recent focus on sustainability in energy and transportation sectors has boosted the needs for renewable energy sources, such as biomass materials and products. With the growing international biomass trading market, more quantities of such cargos are shipped globally in bulk status, and more space and facilities on terminals in many seaports are required. Currently the need for a internationally recognized sustainable biomass certification is getting stronger, inevitably in the future terminals that handle biomass freights will need to comply such a system as other parties in the entire supply chain of biomass. The aim of this paper is to address the impacts from potential biomass sustainability certification systems on the design of a large-scale bulk terminal that handle biomass materials and products. An overview of recent developments and the expectation for such a system in the future is studied, and based on this possible development two case studies are presented to quantify the impact to the large-scale biomass bulk terminal design.

Keywords

Sustainability, biomass, bulk terminal, large-scale

1 Introduction

Due to the growing population on the earth and the trend towards industrialization, the demand for energy has increased significantly. As the majority of current economies and developments depend on fossil fuels, between 2004 and 2040 an 83% of overall increase in energy demand is expected OECD/IEA (2006). Fossil fuels are scarce resources that create greenhouse gas emissions and cause global climate change Chang & Lien (2007). For a more sustainable future, countries have been aiming towards using renewable energy, and the countries within the European Union are no exception. According to the Renewable Energy Road Map Commission of the European Communities (2007), the share of renewable energy will increase, in which biomass and bio-energy will play one of the key roles. The Biomass Action Plan Commission of the European Communities (2005) points out that an autarkic or self support approach to meet the EU needs is neither possible nor desirable. This suggests that international import is unavoidable to meet the EU directive targets for the future.

With growing demand all over the world, international biomass trade will become bigger and more mature in the long term future. Since import of biomass into the EU is required, a large-scale biomass bulk terminal to accommodate the import biomass flows and serves as a transshipment hub for the region is needed. The maximum throughput for such a large-scale biomass bulk terminal is set at 40 million tons per annum, including several different types of biomass being handled and stored at the terminal Wu et al. (2008a). In principle, not only solid and liquid feedstock materials (e.g. wood chips) can be traded, but also refined biomass (e.g. wood pellet) and biomass derived products (e.g. ethanol) can be imported. New material such as torrefied pellets and pyrolysis oil are expected to be traded in the future, since the torrefaction and pyrolysis technique will play a key role Wu et al. (2008b).

Main sources for producing biomass materials and products for energy and transportation uses are dedicated biomass energy crops, agricultural residues, and forest residues. Various negative effects brought by the production of biomass can happen, such as negative impacts on biodiversity, socio-economic impacts, competition with food Hamelinck et al. (2006); Zarrilli (2006); van Dam et al. (2008). With the expectation that substantial amount of biomass materials and products will be used in the future, sustainable production is a key issue and is currently considered as a possible requirement for market access Zarrilli (2006); van Dam et al. (2008). During the last few years, many efforts have been undertaken to work towards certification of imported biomass van Dam et al. (2008), this indicates that parties throughout the logistic chain of biomass materials and products all need to comply such a system in the not too distant future. The aim of this paper is to discuss the possible impacts brought by potential sustainability regulations, i.e. certification schemes a large-scale biomass bulk terminal needs to comply with. An overview of recent developments and the expectation for such a system in the future is studied, and based on this possible development two case studies are presented to quantify the impact to the large-scale biomass bulk terminal design.

2 POTENTIAL IMPACT FROMSUSTAINABILITY CERTIFICATIONS

Demand for sustainability certification systems that control large-scale biomass trade is due to the considerations of potential negative effects, such as competition between food and biomass production Lewandowski & Faaij (2006); Hamelinck et al. (2006). In this section, an overview of existing frameworks is given, and the proposed sustainability certification systems is discussed.

2.1 Existing frameworks of certification systems

At the moment, there is no concrete sustainable biomass certification system for sustainable biomass trade available Lewandowski & Faaij (2006). However, much work has been done in criteria, basic principles and processes of existing international certification schemes, indicator systems addressing sound resource management and responsible enterprise behavior van Dam et al. (2008). Existing certification systems suitable for developing a biomass certification system are the ones for forestry, agricultural products and electricity, as summarized in Figure 1.

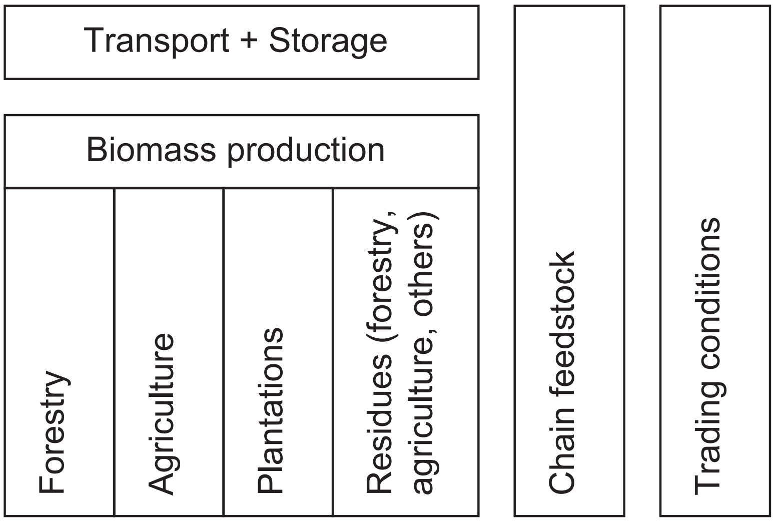

Figure 1: Existing areademanding criteria and indicator development for sustainable biomass trade Lewandowski & Faaij (2006); van Dam et al. (2008)

Various parties, such as national governments, non-governmental organizations (NGOs), companies (producers, industry), international bodies and initiatives, and intergovernmental organizations have shown their interests for biomass certification van Dam et al. (2008). Several criteria and indicators (e.g. biodiversity, economic prosperity, the environment) based on these interests have been set, and the more detailed overview of these developments can be found in Lewandowski & Faaij (2006) and van Dam et al. (2008).

2.2 Proposed biomass sustainability certification systems

Hamelinck et al. (2006) indicated that three types of certification systems can be used for following the biomass in the production and transport chain, namely:

- **Chain of custody (Track-and-trace)**
  In this certification system, the whole supply chain (i.e. from source to the last point of sale) is independently monitored, and the biomass is physically traceable. Information iscollected to map the whole chain of owners, and is registered in a database.

- **Temporary decoupling**
  The physical flow can not be followed exactly at some points in the biomass delivery chain. For instance, biofuels for transportation use are made of a blend of feedstock: biodiesel from soya, rapeseed oil and palm oil. In this case, when the concern for the sustainability of palm oil is raised, to declare that a fraction of the product is physically palm oil free is impossible, although on an administrative basis it can be done. Thus, when international shipments take place, the characteristics/composition of the product should be measured both in export and import ports in order to prove that the composition is the same.
- **Full decoupling**
  This is a sort of ”book-and-claim” system that decouples the physical product and the administrative process. In this case a certain quantity of sustainable product is place in the market and recorded in a central database. Independent of the actual origin of the physical product and the physical product itself, buyers for such product can buy and claim the sustainability.
  According to Hamelinck et al. (2006), the disadvantage of such system is that even though the product is not sustainable, by buying such a certificate, it is made sustainable by buying such a certificate.

From the point of views of Hamelinck et al. (2006), it is expected that the track-and-trace system will be set first, and in the longer run, shift to emporary decoupling system may be considered.

2.3 Potential impacts brought by possible biomass certification systems

It is quite possible that the sustainability certification system will be set for sustainable biomass trade; the next question is how to implement such system. Van Dam et al. (2008) proposed five different approaches, as illustrated by Figure 2.

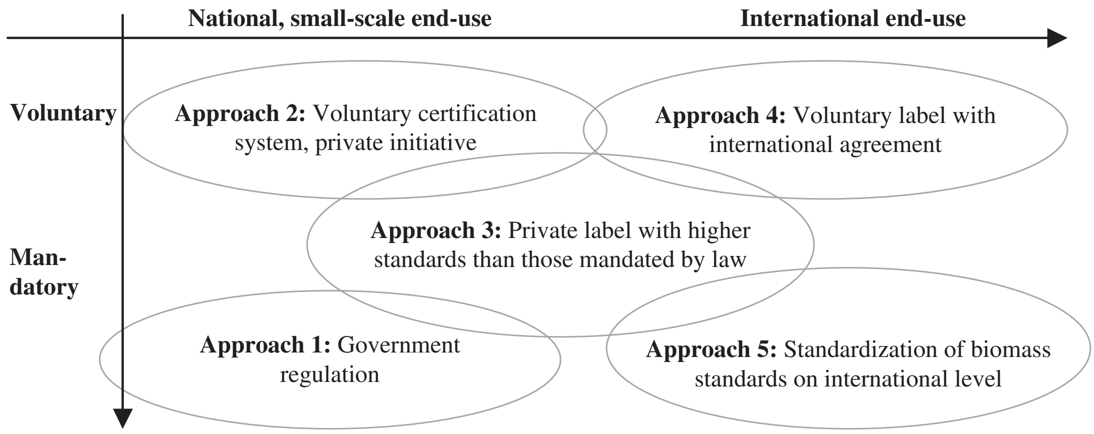

Figure 2: Proposed approaches for implementation of biomass certification van Dam et al. (2008)

Since a large-scale biomass bulk terminal fits in the ”international end-use” side of Figure 2, approach 3, 4, and 5 might be used as implementation methods. In this case, possibly it is mandatory to comply with such certification scheme. However, so far the implications for terminal are not identified in the studies of Lewandowski & Faaij (2006), Hamelinck et al. (2006), and van Dam et al. (2008).

Three possible certification systems as mentioned above, following potential impacts may be brought to the terminal:

- **Chain of custody (Track-and-trace)**
  In terms of terminal operations, this certification system brings impacts to information flow, handling processes and equipment, and separation during storage. Due to the requirement from track-and-trace system, more information flows are needed between the terminal, shipping companies, and the next cargo owners (e.g. power plants), this fact is supported by Lewandowski & Faaij (2006).
  Furthermore, products that are sustainable may need to be physically separated from those that are not. In a way the separation might bring lesser impacts to handling of solid biomass than to liquid biomass, and is easier to achieve for solid biomass. This is because it is easier to physically separate solid biomass compared to liquid biomass, and the cross-contamination is a big concern for liquid bulk handling. For instance, it is possible to separate wood pellets into two stockpiles yet still store them in the same shed, while it is impossible to put two different batches of liquid biomass in the same silo or
  tank.
  The need for separation will affect the land size and possibly the operation processes of the terminal.
- **Temporary decoupling**
  Since the test of cargo composition is one of the possible ways to make sure the product is the same between export and import ports, there should be test facilities available to perform such a test. This is no major different than the existing liquid terminal.
- **Full decoupling**
  Whether this type of certification system is suitable for sustainable biomass trade is highly uncertain due to its shortcoming, namely that the physical products are not really sustainable. However, this system brings the least impacts to the terminal in terms of operation processes, equipment, the layout of the terminal, and land use.

2.3.1 Case studies for chain of custody certification system

Previous section concludes that the Chain of custody system will impact the terminal design most. Therefore, the focus of the case studies presented here is also put on the Chain of custody system. These case studies are meant to give a rough quantitative indication of extra land needed due to physical separation of biomass, the two case studies do not express the more complicated issues id est layout optimization for storage.

Case 1: Assume the material stored is wood pellets, as depicted by Figure 3. The information on the stockpile 1 is:

- Angle of repose = $\alpha° = 36°$
- Height of the stockpile 1 = H = 6 m
- Width of the stockpile 1 = W1 = 100 m
- Length of the stockpile 1 = L

The land area required is:

$$A = L \times W1 = 100W$$

If 20% of the stored wood pellets is certified as sustainable and needs to be separated from the rest, extra space is needed. Assume that the angle of repose, the height and the length of the stockpiles are the same as stockpile 1, information on the two separated stockpiles is:

- Width of stockpile 2 = W2 = 26.6 m
- Width of stockpile 3 = W3 = 81.7 m
- Distance in between two stockpiles = 3 m

The difference in the total width of stockpiles is:

$$\Delta W = (W2+W3+3-W1) = (26.6+81.7+3)-100 = 11.3 \text{ m}$$

Thus, the percentage of extra land area is:

$$\frac{\Delta A}{A}\times 100\% = \frac{L\times\Delta W}{L\times W1}\times 100\% = 11\ \%$$

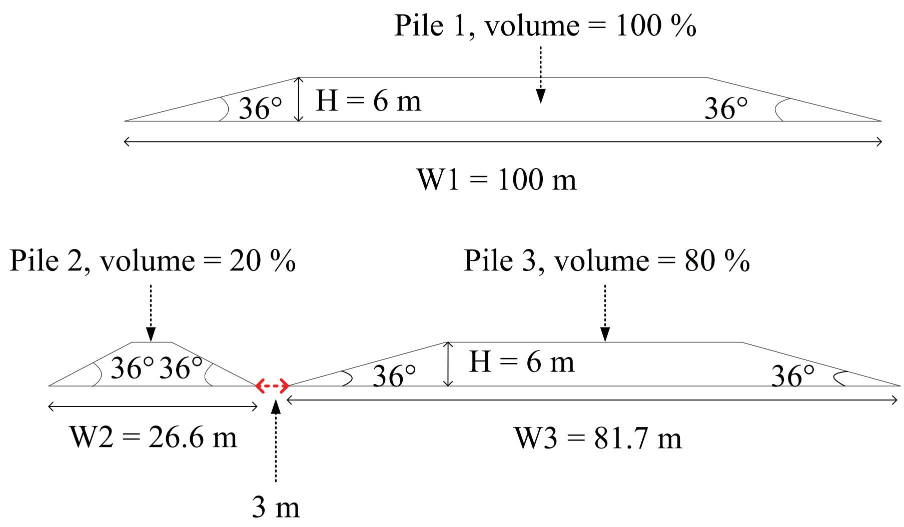

Figure 3: Case 1: Separation of storage stockpiles

Case 2: Assume the liquid biomass stored is rapeseed oil. The layout of tank farm is illustrated in Figure 4, and is a square shape area. The information on the storage tank is:

- Diameter of the storage tank = 80 m
- Height of the storage tank = H
- Safety distance between the storage tank and the border of tank farm = 15 m, as regulated by Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) in the Netherlands Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) (2008).

The required land area for the tank farm with one storage tank is:

$$A1 = L1\times W1 = 110\text{ m}\times 110\text{ m} = 12{,}100\text{ m}^2$$

However, if separation needs to be done, also assuming that 20% is certified and need to be stored separately. Two smaller storage tanks with the same height as the original big one are used: one is 20% capacity compated to the original big storage tank and the other storage tank is 80% capacity. Information on these two storage tanks is:

- Diameter of Tank A = 36 m, Tank A capacity is 20% of original big tank
- Diameter of Tank B = 72 m, Tank B capacity is 80% of original big tank.
- Safety distance between the storage tank and the border of tank farm = 15 m, as regulated by Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) in the Netherlands Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) (2008).
- Safety distance in between Tank A and Tank B = 10 m, as regulated by Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) in the Netherlands Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) (2008).

The required land area now becomes to:

$$A2 = L2 \times W2 = 148 \times 102 = 15{,}096 \text{ m}^2$$

Therefore the percentage of extra land needed is:

$$\frac{\Delta A}{A} \times 100\% = \frac{(A2\text{-}A1)}{A1} \times 100\% = \frac{(15096\text{-}12100)}{12100} \times 100\% = 25\ \%$$

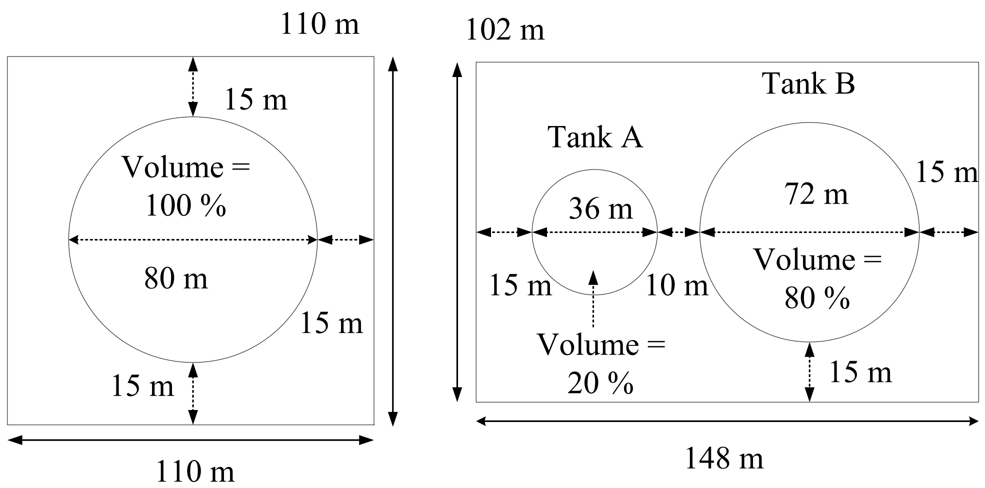

Figure 4: Case 2: Separation of storage tanks

In real life there might be more than just two separated stockpiles or two separated storage tanks needed for distinction between certified and uncertified materials. To make the optimal use of the storage area, many other factors need to be taken into account, such as material properties, environmental regulations, the handling process, the routing of internal transport of materials on the terminal and so on. This is out of the scope of this paper.

3 Conclusion

The aim of this paper is to discuss the possible impacts brought by potential sustainability regulations, i.e. certification schemes a large-scale biomass bulk terminal needs to comply with. Following conclusions can be drawn:

- Currently there is no concrete sustainability certification for biomass trade. However, many studies indicate that there is a need for such certification, and three certification systems can be used: Chain of custody (Track-and trace), Temporary decoupling, and Full decoupling.
- Among the three possible types of certification systems, full decoupling system brings the least impact to the large-scale biomass bulk terminal, while the other two types will affect the equipment and process deployed, and also the required land size.
- Case studies for the chain of custody systems show that impact on liquid biomass materials and products is larger than on solid ones. This is due to the environmental and satefy regulations.

It seems that the idea of sustainability certification system is to ensure the biomass trade is sustainable, yet to comply with such a system and to handle materials in a sustainable way causes unwanted side effects, i.e. more land is required, more equipment is needed, and more energy is consumed. The trade off between these phenomena needs to be considered carefully. It is recommended to use simulation models as a tool in order to quantify the impacts brought by the possible certification systems quantitatively. In addition, different scenarios (in terms of e.g. vessel sizes, equipment types, handling processes, certification system) should be used as input to see what the possible outcomes in terms of land size, terminal layout are. Furthermore, the impact brought by the certification system should also be extended to other parties in the logistic chain (e.g. shipping lines, transportation companies) to assess overall influence to the entire chain.

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