Is Bioenergy the Big Bad Wolf in the Forestry Sector? A discussion about the sustainable supply chain management role in bioenergy systems

Alessandro Sanches Pereira

PhD Student at Energy and Climate Studies Division, ITM/KTH, Stockholm, Sweden
Tel: +46 8 790 74 31, Fax: +46 8 20 41 61, E-mail: alessandro.sanches.pereira@energy.kth.se

Abstract: The paper's aim is to use a bioenergy supply chain management approach in order to reinforce sustainable development in a likely scenario of competition between bioenergy and the production of other goods extracted from wood. This competition is perceived as a threat because it may lead to an increase in raw material and energy prices and reduce the competitiveness of the European pulp & paper industry compared to other regions of the world. The key question is then: is bioenergy the big bad wolf in the forestry sector or an opportunity for improving the sustainability of biomass-based supply chains? The work assumes bioenergy as an opportunity because a systemic approach to bioenergy systems' optimization can lead to performance improvement beyond the boundaries of a single company and increase the sustainability aspects of the entire network. The results are based on content analysis conducted by a literature review and information gathering from relevant publications in the field.

Keywords: *Bioenergy Systems, Sustainable Supply Chain Management, Systems Analysis.*

1. Why sustainable supply chain management is important?

The energy price shocks of the 1970s served as a major incentive to revisit energy practices. As a result, several nations launched efficiency programs and tried to develop solutions to replace hydrocarbon fuels. However, for some time low oil prices has been a barrier and preventing renewable energy from taking up on large commercial scale [1]. More recently, renewables gained new momentum as a result of favorable policies, such as in the EU where the target is to reach 20% of renewables by 2020. Nevertheless, the development of renewables is by no means given. The increasing availability of gas and the delayed removal of fossil fuel subsidies could again hamper the competitiveness of renewables for many years to come [2].

At present, we are facing a new crisis based on the depletion of natural resources, expected scarcity of fossil fuels, increasing energy prices worldwide, increasing global competition for fuels, and global efforts to reduce greenhouse gas emissions. In this context, energy from renewable sources remains a key component to mitigate environmental risks and increase energy security. According to the International Energy Agency, renewable energy sources – such as wind power, solar energy, hydropower and biomass – responded for only 12.9% of the global primary energy supply and 18.7% of the global electricity production in 2008. IEA calculates that, without new policies in place, global primary energy demand could increase by 45% by 2030 compared to 2006 levels. Transportation could account for 57% of the global primary oil consumption, compared with 52% now and 38% in 1980. The agency emphasizes the need for policy actions in order to change the so-called *"business-as-usual"* scenario and foster an increased share of renewables in the future global energy mix [3].

Certainly, the need to shift energy systems towards renewable sources is well recognized. This tends to put a lot of emphasis on technology development. However, intensifying the use of renewable energy systems is not only a technological challenge. To optimally explore constrained renewable resources (e.g., forest-based biomass), technological management challenges have to be faced. This paper assumes that a strategic use of bioenergy supply

chains, in particular the use of the concept of sustainable supply chain management in the forest-based bioenergy systems can improve the sustainability aspects throughout the chain.

1.1. Sustainable Supply Chain Management

Lambert *et. al.* (1998, p.1) describes supply chain management (SCM) as *"the integration of key business process from end-user through original suppliers, that provides products, services and information that add value for customers and other stakeholders"* [4]. In 2001, Mentzer *et. al.* (2001, p.18) has outlined a complementary definition that defines SCM as *"the systemic , strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of individual companies and the supply chain as a whole"* [5]. Nowadays, the Council of Supply Chain Management Professionals (CSCMP) describes supply chain management as *"the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies"* [6]. Svensson (2007, p.263) and Cater & Rogers (2007, p.368) argue that in order to SCM become sustainable it should integrate and equalize economic profit, environmental and social goals to long-term performance of individual companies as well as their supply chains [7] [8].

In this context, the sustainable supply chain management concept in general is understood as the management of services, products and raw materials along the chain – from suppliers to manufacturer and/ service provider to final consumer and back again in the cycle – with improvements to the environmental and social goals. The interaction between suppliers and consumers is understood by this work as the flows of energy, materials, and greenhouse gases emissions from suppliers to consumers.

This study assumes that if forest-based biomass is to compete with fossil fuels, there is a need to create more reliable and constant supplies of bioenergy on a long-term basis and a more efficient distribution to points of consumption in more sustainable ways.

1.2. Methodological approach

The paper's originality is the use a bioenergy supply chain management approach instead of the commonly used *"Command & Control"* mechanisms (i.e., legal standards, taxation and/or subsidies) in order to reinforce sustainable development in a likely scenario of competition between bioenergy transformation (e.g., heat and electricity) and the production of other goods extracted from forest-based biomass.

In order to complete this work, the methodological approach was based on a content analysis conducted by a literature review and information was gathered from relevant publication found on hard copy publications and electronic journals provided by well-known publishers (e.g., Willey and Elsevier).

1.3. Work Structure

This paper is divided into 4 main sections. First section has introduced the sustainable supply chain management concept used in the paper and background information about the management challenge and the methodology used in the study. Second section presents the findings related to biomass as an important renewable source and the significance of adding

value along its production chains. The third section discusses the need to understand the re-distribution of available resources in an increasing competitive environment. Finally, the forth section indicates an option to shift from the perspective of bioenergy as a threat to the perception of opportunity in the forest-based supply chain.

2. Forest-based biomass: now and beyond

The EU RES Directive aims to promote the use of energy from renewable sources. Each Member State has to achieve a specific target so that, as a whole, the EU shall have 20% of the total energy based on renewables by the year 2020. The Directive sets a common vision for the EU. It also contains a roadmap to cut down 20% of the EU greenhouse gases emissions [9]. The Directive sets an important framework alongside with the European Strategic Energy Technology Plan (SET-Plan) for reducing the EU's oil dependence, which is also illustrated by the target set for the transport sector: 10 % biofuels by 2020. Although the EU is expected to fall short on the 2010 target of 5.75% biofuels, it is expected to reach beyond the 2020 target.

In this context, renewable energy is assuming an increased prominence among Member States, mostly motivated by security of supply as well as greenhouse gases emissions reduction objectives. Among the Member Countries, Sweden is often regarded as one of the frontrunners concerning the development, promotion and implementation of renewable energy policy and technology. The Swedish mandatory target for the share of energy from renewable source in gross final consumption of energy in 2020 is 49%. On the other hand, the proportion that is forecasted by the Swedish Energy Agency (SEA) sums up to 50.2% in the same period. This means that Sweden shall reach beyond the binding national target by 1.2% and this trend can be traced in the considerable expansion of renewable energy of the last years [10].

In 2008, the Swedish share of renewables was 44.1%. This corresponds to an excess of approximately 2.5% already above the indicated trajectory for 2011-2012 period [11]. A very important part of this success lies on the national expansion of the bioenergy sector during the last few decades [12].

The RES Directive is not the only driving force affecting bioenergy utilization. Ling and Silveira (2005) consider that current policies being applied in the EU enhance the condition but there are also other important forces such as internationalization of the bioenergy segment, integration of bioenergy systems with other transformation processes, and the fact that bioenergy is becoming a mainstream alternative. In line with this perception, a biomass study carried out by McKinsey and Pöyry for the Confederation of European Paper Industries (CEPI) indicates that meeting bioenergy targets set by the RES Directive could lead to a wood deficit of 200 up to 260 million m^3 in Europe by 2020. This has worried, for example, the pulp & paper sector which is afraid of potential competition in the markets for raw materials [13].

Bioenergy contribution has grown from the second largest source of energy in 2003 to the leading position in the final energy use in Sweden. In the last couple of years, the bioenergy share has increased from 28.6% in 2007 to 31.7% in 2009 and it is still growing. As a result, biomass is not just an alternative but has turned into a major reliable energy source [11].

An important aspect of the bioenergy segment in Sweden is the fact that most of the biomass used for heat and electricity generation in the country comes from forests. Despite of its importance in the transition to a long-term sustainable energy system, the strategic use of

bioenergy supply chain management and its overall impacts in the forestry sector are still very much restricted to cost effectiveness and excellence in customer service in pursuit of profit and competitive advantage [14] [15] [16] [7]. As a result, the majority of the current models for analyzing it do not consider the overall value of a supply chain [17]. They frequently focus on improving the individual performance of the various actors along the chain (e.g., company level approach). This is because there are a variety of flow structures and each one of them has a direct impact in the supply chain organization, which makes difficult to foster overall performance. Figure 1 presents a variety of flows based on the work of Haartveit *et al.* (2004) and their specific characteristics that directly define supply chain structure configuration and its complexety [18].

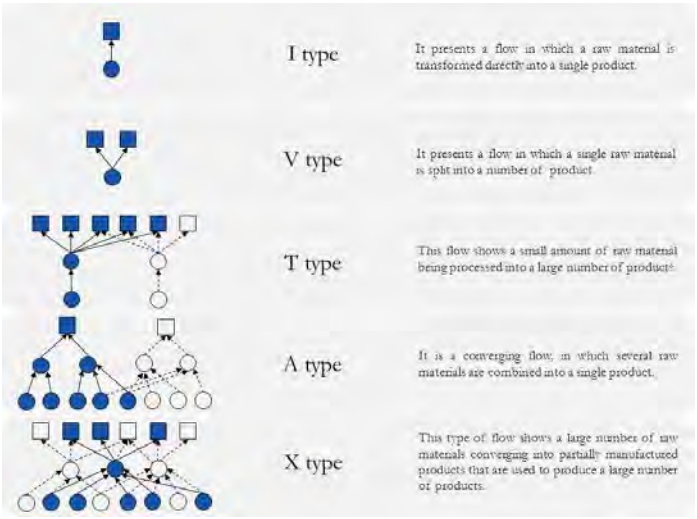

Fig. 1. Types of flows structures within a supply chain adapted from Haartveit et.al.(2004)

Independent from its configuration, the supply chain concept intuitively implies a network of actors divided into a variety of organizational structures operating at different stages/structures/levels and combining efforts in order to deliver products to customers. This means that management and control of flows involve collaboration among actors and, as any complex system structure, the supply chain might need several strategies and information flows operating at different structure levels. At an overarching level, this includes general information such as inventories, statistics, policy targets, etc. This information could be in the public domain while specific information (e.g., detailed information about a region) may require further investigation. At the company level, there are strategies related to the business model, market competition, planned production, price mechanisms, etc. These strategies are not in the public domain but reflect the response of various actors to opportunities in the market [17] [18]. As a result, an effective strategy for supply chain management depends on the specific characteristics and complexity of the chain under study.

It is clear that a renewable energy source can play a major role in addressing environmental degradation at large. This is because a renewable source such as biomass, if used in a sustainable way, is not depletable and produces less greenhouse gases emissions than fossil fuels. However, an important finding was that supply management improvements could add value along various production chains to reinforce, optimize, and operate the whole network and achieve a sustainable development.

3. From threat to opportunity: a discussion

Among the renewable energy resources, wood is one of the most important renewable sources for achieving the 2020's target in the EU. Today in Europe, wood already represents over 50% of the total renewables [19]. In addition, wood is expected to continue playing a key role in the development of renewables in the continent. However, increasing extraction of forest biomass for energy purposes could have impacts on other segments of the forestry sector as a whole. The current perception among some market actors is that meeting bioenergy targets set by EU will only be possible by increasing the biomass extraction from forest [20].

In the short term, strategies endorsing *status quo* practices could lead to enlarged extraction of forest resources. Although this could result in immediate direct positive benefits in the local economy (e.g., work generation and income), it could also lead to loss of biodiversity as well as environmental impacts on soil and water that can compromise the total resource productivity in the long run.

In the middle run, competition between bioenergy use and the production of other goods extracted from wood may induce to an increase in raw material and energy prices and reduce the competitiveness of the European pulp & paper industry compared to other regions of the world (e.g., South America, especially Chile and Brazil).

In the long term, intensified competition among different segments of the forest-based industry could lead to the closing down of industrial plants following on production relocations. This implies lay-offs, initially to rescue companies' productivity levels, but eventually to deal with competitiveness at an international scale.

By being a traditional and well-established sector from the start, the forestry sector – especially the pulp & paper companies – perceives bioenergy targets more as a threat than an opportunity. In this perspective, the RES Directive and, especially, forest-based bioenergy becomes *the big bad wolf in the forest*. If perceived negatively, there is risk that administrative barriers more than financial and technical obstacles may hold back or – at the least – delay further bioenergy development, above all in the pulp & paper segment.

Considering that a *"sustainable energy solution needs to be motivated beyond their technical performance and economic efficiency, and become attractive in the context of regional development, environmental and social benefits"* [21]. It is necessary to understand the re-distribution of available resources and the process along the bioenergy value chain network in order to tackle the potential obstacles (i.e., administrative barriers in the pulp & paper sector).

New actors and new configurations of value chains can be perceived as a threat by conservative segments because they can – in a very short time – increase the demand of raw materials, increase competition in an already aggressive environment, change land use, and create an uneven biomass supply. However, this is also an opportunity for creating new alliances, facilitating transitions, and opening new markets. In order to shift from the perspective of threat to the perception of opportunity, it is necessary to understand the process along the bioenergy value chain network and re-distribution of available resources. This is because a performance frontier of any given supply chain should be understood as a system performance due to its complexity and interconnected nature (see Figure 2). In doing so, the real competitive position or the performance frontier of a supply chain becomes based on the supply chain's weakest link [17].

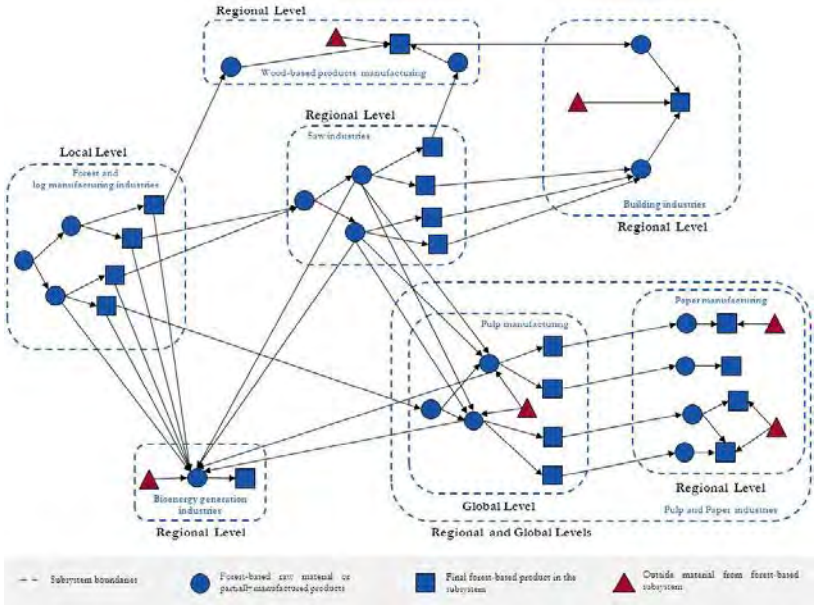

Fig. 2. Generalized structure of the forestry industry supply chain

As the Figure 2 has presented, the forestry industry supply chains are complex and characterized by multitude of flows resulting in many products and services, as well as by-products along the chain. In addition, Haartveit *et al.* (2004) describes that the roles of individual actors in the supply chain are highly dependent on the supply chain own structure and specific characteristics. This is because material and information flows, as well as the product flow can vary in levels (i.e., from local to regional and/or global levels) and structure.

The initial question is bioenergy is the big bad wolf in the forestry sector or an opportunity for expansion, given the uncertainty of future costs of oil. In any case – threat or opportunity – , it is clear that a systemic approach in such complex network makes the strategic configuration of the bioenergy supply chain a critical task for management decisions and a major administrative challenge [16] [7] (22].

4. Conclusion remarks: a way of getting through

The rapid expansion in global trade of biomass (i.e., wood pulp) is expected to continue over the next years. On the other hand, a likely new international biomass commodity (i.e., wood chips and pellets) could also rise as direct result of more countries favoring renewable energy and relatively inexpensive local supplies of biomass reaching their limits. In this respect, the new competition may well rearrange the forestry industry supply chain structure presented in Figure 2 by redefining the boundaries' levels.

In short, the devil is in the details. This is because forthcoming competitions will strength the need for actions. At the same time, external triggers (i.e., environmental and social standards) placed by governmental agencies, stakeholders and consumers are going to continue playing a major role. By doing so, a sustainable bioenergy system has to become focused more in a systemic approach process and less in single individuals' efficiency, which is currently in place. In other words, a systemic approach means that bioenergy systems' optimization must aim at the overall supply chain by asking for performance improvement beyond the boundaries of the single company in order to improve the sustainability aspects of the entire network. An increased system understanding will allow not only a better estimation of the potential effects of the RES Directive on existing supply chains but also an evaluation of the improvements that are necessary while planning future bioenergy supply chains. Moreover, it

would assist us in identifying challenges in the bioenergy sector and leverage points in its system that could be used to foster climate change mitigation and energy security.

This study is the starting point of the author's doctoral research and for that reason has its limitations which open opportunities for future research. Like all content analysis the empirical validity of the bioenergy as an opportunity to the forestry industry needs to be tested in case studies. Future studies should examine not only operations, logistics, structures and other activities but also the flows of material, energy and greenhouse gases emissions to comprehend if there are other important aspects to be considered by a sustainable supply chain management for bioenergy systems.

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