Impact of promotion mechanisms for advanced and low-iLUC biofuels on markets

Wood Pellets from the US to the EU

IEA Bioenergy

Task 40: Sustainable International Bioenergy Trade

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List of Acronyms

AEBIOM	European Biomass Association
ARA	Amsterdam Rotterdam Antwerp
ATFS	American Tree Farm System
BCAP	Biomass Crop Assistance Program
BMP	Best Management Practices
CHP	Combined Heat and Power
CIF	Cost, Insurance and Freight
DA	Dowgwood Alliance
DECC	UK Department of Energy & Climate Change
EC	European Commission
ECF	European Climate Foundation
EEA	European Environment Agengy
EFI	European Forest Institute
EPA	US Environmental Protection Agency
EU	European Union
FOB	Free on Board
FSC	Forest Stewardship Council
GHG	Greenhouse gases
Ha	Hectare
IC	Imperial Colleage
IEA	International Energy Agency
IEA-ETSAP	International Energy Agency Energy Technology Systems Analysis Programme
IRENA	International Renewable Energy Agency
JR	Joanneum Research
JRC	Joint Research Centre
LCA	Life-cycle Analysis
Mt	Million tons
Mtod/a	Million oven-dry ton per year
NEN	Nederlands Normalisatie-Instituut
NREL	National Renewable Energy Laboratory
OSB	Oriented strand board
PIC	Pinchot Institute for Conservation
PJ	Peta Joules
REIT	Real Estate Investment Trust
REN21	Renewable Energy Policy Network for the 21st century
RFS	Renewable Fuel Standard
RPS	Renewable Portfolio Standards
SFI	Sustainable Forestry Initiative
TIMO	Timber Investment Management Organizations
USDA	US Department of Agriculture
USDA FS	US Department of Agriculture – Forest Service
WPAC	Wood Pellet Association of Canada
WPC	Wood paying capacity

1. Project Introduction

1.1. Background

With current discussions on indirect effects of biofuels (the 'indirect land use change or iLUC debate'), and the aim to broaden feedstocks to non-food biomass, policies are trying to put focus on biofuels from waste, residues and lignocellulose materials, so called 'advanced' biofuels with low iLUC impact. Next to the general biofuel incentives, these biofuels are getting extra support through specific promotion mechanisms. Examples are the double-counting mechanism for advanced biofuels in the EU, and the specific targets for advanced biofuels in the USA.

While technologically challenging lignocellulosic ('2nd generation') biofuels are developing slower than expected, markets so far seem to have focused on cheaper options, using waste and residues or cheap feedstocks in more conventional biofuel technologies to take advantage of these extra incentives. Typical examples are used cooking oil or animal fats which are used for biodiesel production in the EU, or sugarcane ethanol to fulfil advanced biofuels targets in the US.

However well these policy measures intended to be, some of these may create unintended effects. These promotion mechanisms induce market movements and also trading of specific biomass and biofuel types. Other applications relying on these (residue) materials - traditionally very cheap feedstocks - may be impacted by this, both in terms of available volumes, and in terms of feedstock prices.

1.2. Scope of the study

In this study, some typical cases are presented where promotion mechanisms for advanced biofuels have had an impact on markets and trade, or may be anticipated to impact markets and trade in the future.

The study focuses on some concrete cases. The selected cases are:

1. **Used cooking oils and animal fats for biodiesel**: impact of the double-counting mechanism for advanced biofuels in the European Renewable Energy Directive on market prices and trade flows, analysed for the Netherlands and Italy (see chapter 2).

2. **Sugarcane ethanol**: impact of the subtargets for specific advanced biofuels in the US Renewable Fuels Standard (RFS2), where sugar cane ethanol is classified as 'advanced biofuel'. This has had a clear impact on prices and trade patterns between Brazil and the US. (see chapter 3)

The other two are more prospective cases, where we can learn from a stimulated demand for straw or woody biomass in the past (for stationary bioenergy). With the introduction of advanced biofuel technologies (based on lignocellulosic feedstocks), these feedstocks may experience an additional demand for biofuels production (also stimulated by specific promotion mechanisms such as double counting):

3. **Crop residues (straw) for bioenergy**: straw may play an important role for advanced biofuels in the future. In countries such as Germany, Denmark or Poland, this is an emerging feedstock for energy and biofuels. There are already some experiences we

can take into account from the promotion of straw for stationary energy, e.g. in Denmark. (see chapter 4)

4. **International trade of US wood pellets for bioenergy in the EU**: Renewable Energy promotion in certain EU Member States is causing considerable trade flows from the US to the EU. There is clear that there are interactions with existing wood markets and forestry practises. In the future there may be additional effects when demand for cellulose-based biofuels enters these markets. (see chapter 5)

For each case, the specific relevant promotion mechanisms in place, volume and price evolutions of the specific feedstocks, emerging trade patterns and impact on other applications/markets are discussed. Impacts can be increased competition or additional pressure to ecosystems; however, it may also induce new possibilities and synergies for certain markets. Potential future impacts are also anticipated, e.g. on straw or woody biomass when advanced biofuel technologies get more mature. The case studies themselves are available as separate reports. All reports are available at:
http://bioenergytrade.org/publications.html#lowiluc

1.3. Scope of this report

This report is part of a set of 4 reports highlighting the potential impact of promotion mechanisms for advanced and low-iLUC biofuels on biomass markets. This report differs from the others as it uses a more exploratory approach: the pellet industry in the US Southeast and the respective trade to the EU is still comparatively new, so available hard evidence is quite limited yet. Accordingly, most likely issues and potential effects of this incipient market are discussed, not only with regard to in-depth reviews of volumes and trade, but as a holistic discussion on potentially most relevant effects, considering past growth and expected market development. Thus, the “recommendations for policy makers” are derived with regard to sustainable market development.

International pellet trade has sharply increased during last years mainly due to European demand for co-firing in large-scale coal-fired power plants. At global level, production capacity increased from about 28 Mt in 2010 (Cocchi et al. 2011) to about 40 Mt in 2012 (Vakkilainen, Kuparinen, Heinimö 2013) while production expanded from 14.4 Mt up to 22.4 Mt in 2012 (REN21 2013), with the EU a key player in the pellet market and respective trade. In addition to the EU domestic mobilization, several EU countries also rely on imports from third countries such as the US, Canada and Russia. The pattern of biomass consumption in terms of feedstock origin (domestic vs. imports) and volumes is highly dependent on policies.

Several studies have been carried out (or are ongoing) to estimate volumes and perspectives of international pellet trade and respective potentials for **imports to Europe** (see e.g. the BioTrade2020plus[1] project). Last estimates from IINAS, EFI, JR (2014) determined that 750 PJ of wood would be imported to the EU by 2030, based on the EC (2013) Reference scenario. This would represent a drastic increase compared to the about 110 PJ of woody bioenergy imported to the EU in 2010.

There are several issues that make the **US Southeast a promising** wood pellet export region, including: feedstock availability, techno-economical capabilities, stable context and relatively close distance to major EU harbors.

[1] www.biotrade2020plus.eu

Chapter 2 will first analyze the promoting mechanisms for woody bioenergy consumption in major EU countries. Next, in chapter 3, background information about forest and forestry sector in the US Southeast is provided and discussed. Finally, in chapter 4, potential actual and anticipated consequences of the promotion of this vibrant market will be investigated with special focus on providing recommendations for policy makers.

2. Promotion mechanisms for the use of wood pellets for bioenergy in the main EU importing countries

At global level, biomass is most used for "traditional" residential cooking and heating (Vakkilainen, Kuparinen, Heinimö 2013). In the EU, despite that new technological uses of biomass are increasing, woody biomass still plays a major role for heating in the building sector (IC et al. 2012). With the aim of meeting the 2020 targets (EU 2009), various (European) countries are developing different strategies regarding woody biomass in general and pellets in particular.

With regards to international pellet trade, the most likely final use is for power (and heat) production (Pellcert 2012). In other words, while pellet demand for European heating could be (mainly) supplied with domestic pellets (or pellets produced in nearby countries), large power plants are more likely supplied with international produced pellets. Nevertheless, last trade figures show that countries such as Italy are also sourcing from overseas produced pellets for heat (Junginger 2014). Figure 1 and Figure 2 show the different strategies by major European pellet consuming countries. Wood pellet use for power generation (co-firing in coal plants or dedicated biomass plants) is being promoted in countries such as BE, DK, NL, PL, and UK.

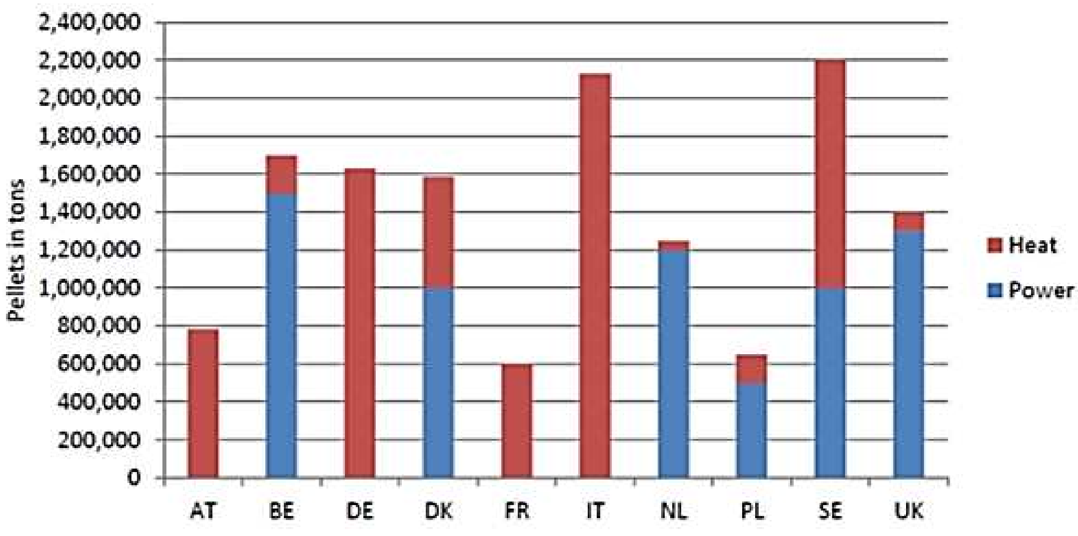

Figure 1. Final uses (heat/power) of pellet consumption in the highest consuming EU countries (2012)
Source: AEBIOM (2013)
Note: given the rapid growth of the pellet market this graph may not show the current situation of the sector in terms of volumes but serves for illustration purposes.

Co-firing biomass within Europe is one of the options to achieve the EU 2020 energy targets even if the context for co-firing in many EU countries - except the Netherlands and the UK - are not very favourable (Vakkilainen, Kuparinen, Heinimö 2013). Alternatively, woody pellets can also be used in repurposed coal power plants, which currently is one of the major uses of bioenergy. The global co-firing capacity was estimated to be about 400 PJ/a of biomass in 2009 with a biomass use about 200 PJ/a in 2011 (Vakkilainen, Kuparinen, Heinimö 2013). The US has some supporting policies for biomass co-firing as well (IEA-ETSAP, IRENA 2013) which may increase with the announced US EPA (2014) rulemaking on limits for CO_2 emissions from coal power plants.

The largest co-firing coal and dedicated biomass plants using imported bioenergy are located within few European countries: BE, DK, NL and UK. However, regarding electricity and CHP production with biomass in industry which is typically smaller-scale, the majority use local feedstocks (Vakkilainen, Kuparinen, Heinimö 2013).

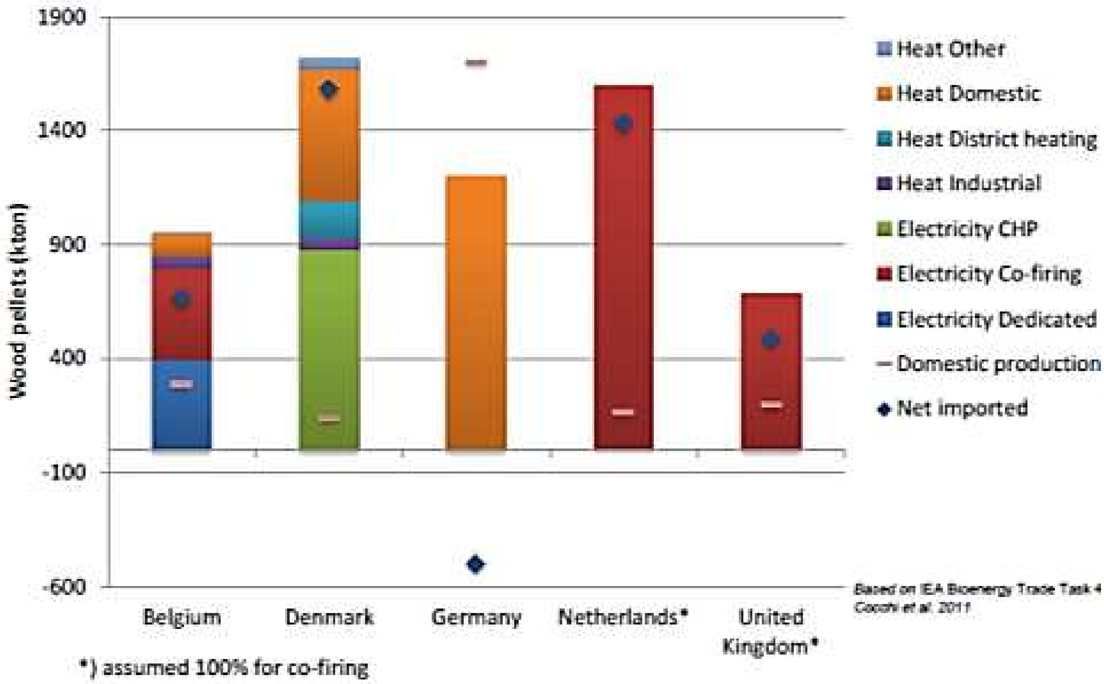

Figure 2. Use of wood pellets (production, import/export and consumption in 2010) in the EU: examples of 5 different markets

Source: Junginger (2013)

Note: given the rapid growth of the pellet market this graph may not show the current situation of the sector in terms of volumes but serves for illustration purposes.

Despite various initiatives by the EC to propose binding sustainability criteria for solid biomass, latest news indicate that in the near term, the EC will not suggest EU-wide harmonized (minimum) sustainability standards[2] for woody (and gaseous) bioenergy (Volpi 2014). Yet, several EU Member States and pellet importers - as described in the next sub-sections - have introduced or are working on introducing national binding sustainability requirements.

[2] For the ongoing discussion on sustainability criteria for woody bioenergy see www.biomasspolicies.eu, www.biotrade2020plus.eu and www.s2biom.eu as well as http://www.iinas.org/redex.html.

Belgium: In Belgium there are various schemes to promote heat, electricity and CHP (Goh, Junginger 2011; Pelkmans 2013) on the regional level. Sustainability of feedstocks is high on the agenda, including different measures: GHG and energy balances are taken into consideration for green certificates and in Flanders (regional) woody resources are not eligible for green certificates if they can be used by the wood processing industry (audit needed), and when biomass from waste can have a valorisation by recycling into materials, fodder, etc., it is not eligible as well.

The Netherlands: In September 2013, the National Energy Agreement for Sustainable Growth was approved in The Netherlands with the signature of more than 40 organizations (Nellen 2013). Among the provisions, a co-firing limit was established at 25 PJ (final energy consumption about 60 PJ of primary energy, meaning 2.5 – 3.0 Mt of wood pellet equivalents), with a current consumption of about 14 PJ. An Expert Group on Sustainability Criteria (composed of representatives from NGOs, utilities and policy makers) is leading the discussion on how to extent the requirements on sustainability from the NTA8080[3] to include, among others, sustainable forest management. The sustainability framework is expected to be published by the end of summer 2014.

The United Kingdom: The UK is currently leading pellet imports and has put special focus on co-firing and heat production in various regulation (i.e. Renewable Obligation for electricity, and Renewable Heat Incentive) and respective sustainability criteria were endorsed in 2013 (DECC 2013a+b).

Denmark: The Danish Energy Agency (2014) has confirmed the increase use of all types of biomass up to 2020 to meet the overall renewable energy target. Wood pellets and woodchips are expected to be imported and businesses should secure sustainable supply chains. The discussion on sustainability is ongoing and studies on life-cycle GHG emission data were made. At present, large scale users have in place a (draft) voluntary business agreement with a list of sustainability criteria (widely based on the Sustainable Bioenergy Partnership standard) coordinated by the Danish Energy Association (Evald 2014). However, there is no similar approach for small scale use (Evald 2014).

3. Wood pellets in the US Southeast (SE)

3.1 Overview of the forests and forestry sector in the US SE

This study focuses on the **Southern Region** of the US comprising the 13 states as illustrated in Figure 3.

The **forest stock in the** US South has shown an increasing trend during last years (Smith et al. 2009) due to high growth rates and investments in agricultural-style forestry (Wear et al. 2013) and it is expected to continue expanding (Malmsheimer et al. 2008). Furthermore, as shown in Figure 4, roundwood harvest grew notably from 1950 to late 1990s (Wear et al. 2013).

The US South is well known for both sawn timber and pulp and paper industry so that understanding the dynamics of these industries is required to determine the potential role

[3] The NTA 8080 is the Dutch voluntary norm developed for all biomass sources (NEN 2009) and includes social, economic and environmental criteria.

of pellets. The US housing market recession experienced in the last decade resulted in a decline of the demand for **industrial roundwood** from about 500 Mt to about 330 Mt in the period 2005-2011, representing a reduction of about 30 % (Forisk Consulting 2013). The **pulpwood** production in the US South was also affected; after a production peak in late 1990s there was a recession until the 2000s, with a pulpwood production almost constant during the 2000s. By 2011, the domestic production of pulpwood based on softwood reached again the levels of late 1990s (USDA FS 2013).

However, given the decreased wood residues availability from sawmills due to the US economic downturn affecting the housing sector, and considering that pulp production was fairly constant, pulp markets needed to purchase more roundwood to offset the limited availability of residues (Fledderman 2014; USDA FS 2013).

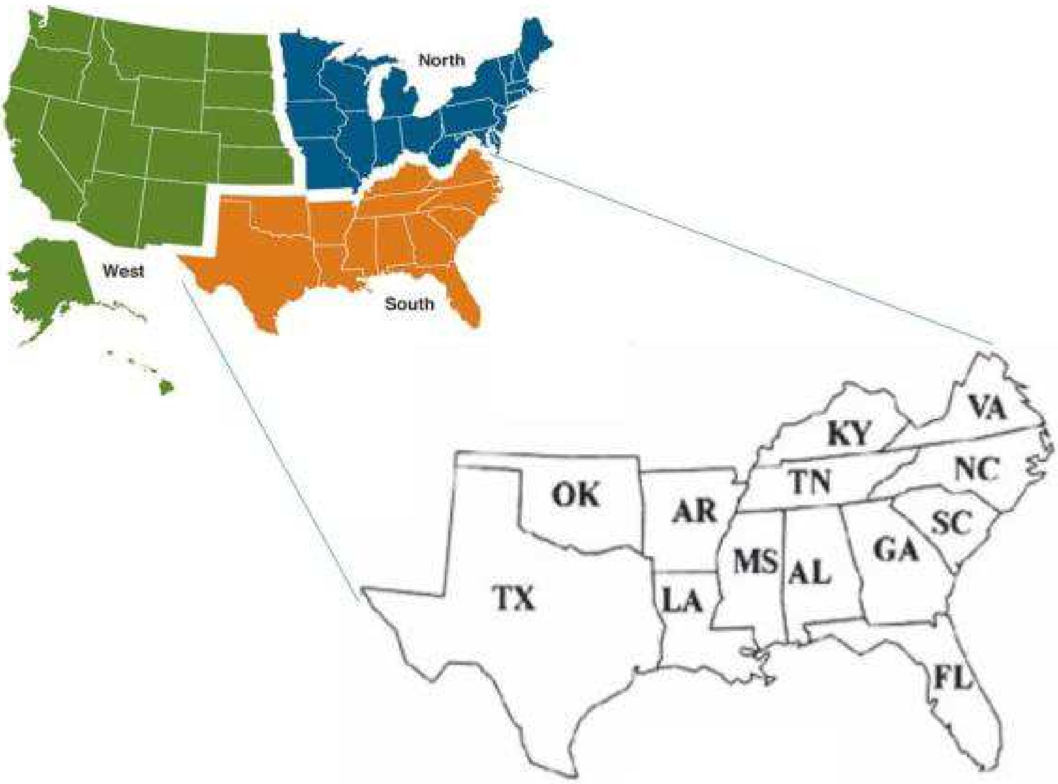

Figure 3. States in the Southern region of the US SE
Source: Own elaboration based on USDA FS (2009) and Ince, Kramp, Skog (2012)

Most forests in the US are of natural origin but in the US Southeast **plantations** represent 20 % of the forest area (USDA FS 2009) and provide 60 % of the national timber (Conrad et al. 2011). Pine plantations have historically marked the US South landscape (Fox, Jokela, Allen 2004) but in recent years, plantation area has levelled out in most US South States (Abt, Abt, Galik 2013; Macedo 2013). Despite that, the Southern Forest Futures Project forecasts pine-planted forests to represent between 24 and 36 percent of forest area by 2060 at the expense of naturally regenerated pine lands (Huggett et al. 2013).

Figure 5 shows, the "thinning echo" will correspond to the potential area available to supply thinned feedstocks which can be used for pulpwood (and pellet) production (Macedo 2013). During the early 2000s there was a significant fall off in planting which will led to lower feedstock availability from thinnings in the late 2020s. This change in planting might be attributed to changes in ownership (see below).

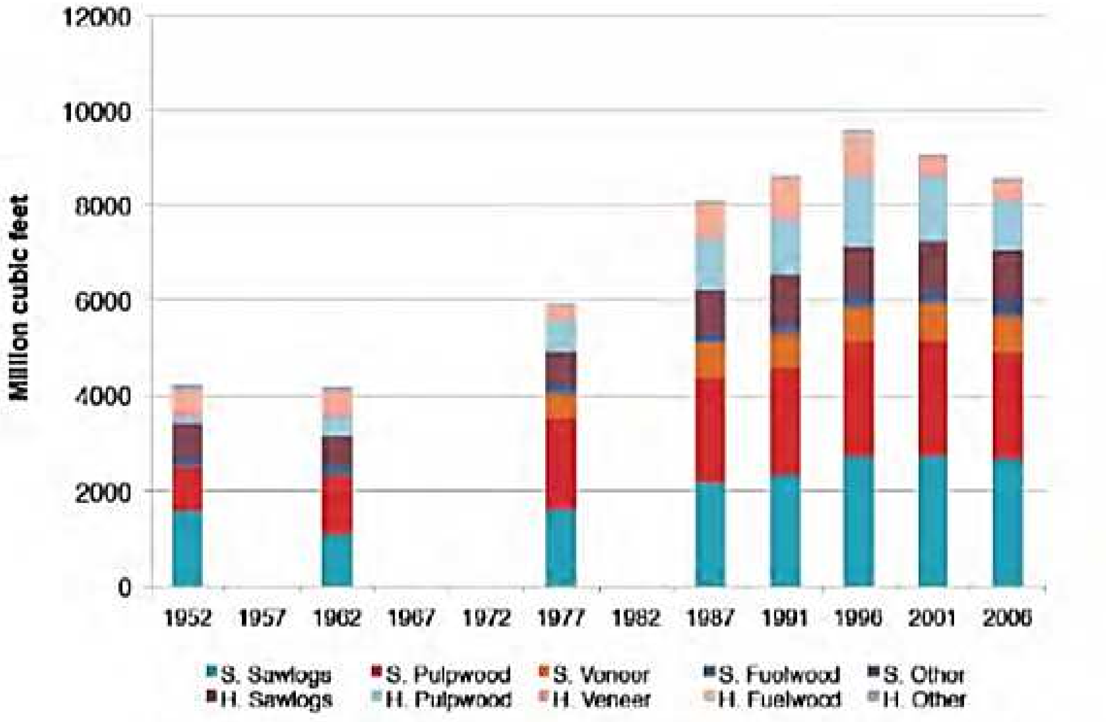

Figure 4. Roundwood harvests in the South by product, various years from 1952 to 2006
Source: Wear et al. (2013)
Note: S: softwood; H: hardwood. According to the authors (Wear et al. 2013), 2006 is the latest year for which comprehensive timber product output data are available
Typically, plantations are thinned at the age of about 15 years. As the shaded blue area in

Until early 1990s, most plantations in the US South were owned by large vertically-integrated forest product firms, but market and tax related drivers led industries to divest their holdings (Munsell, Fox 2010). Between 1998 and 2008, the forest products industry divested their ownership in favour of TIMOs (Timber Investment Management Organizations) and REITs (Real Estate Investment Trust - a type of legal structure) (Butler, Wear 2013). At present, 86 % of forestland is owned by private landowners and 67 % of private forestland is owned by **non-industrial private forest owners** (families or individuals), with a mean size of the family forest holdings of about 12 ha (Butler, Wear 2013).

Ownership patterns are relevant for biomass mobilization since many public holders and family foresters might not manage their forests mainly for market oriented activities. Nonetheless, about 80 % of the private forest land in the South is owned by individuals or organizations who have commercially harvested timber (Butler, Wear 2013).

Forest management has been characterized by population pressures that resulted in the parcelization of timber tracts and the reduction of harvest tract sizes (Conrad 2011) which cause effects on management purposes and respective harvesting costs. Logging operations increased their mechanization and productivity during the last two decades (Conrad et al. 2011), including whole tree harvesting. More intensive silviculture has dramatically increased plantation productivity from less than 100 m^3/ha to about 450 m^3/ha from 1950 to

2010 (Munsell, Fox 2010). The productivity of plantations is expected to continue increasing but the pace is quite uncertain (Wear et al. 2013).

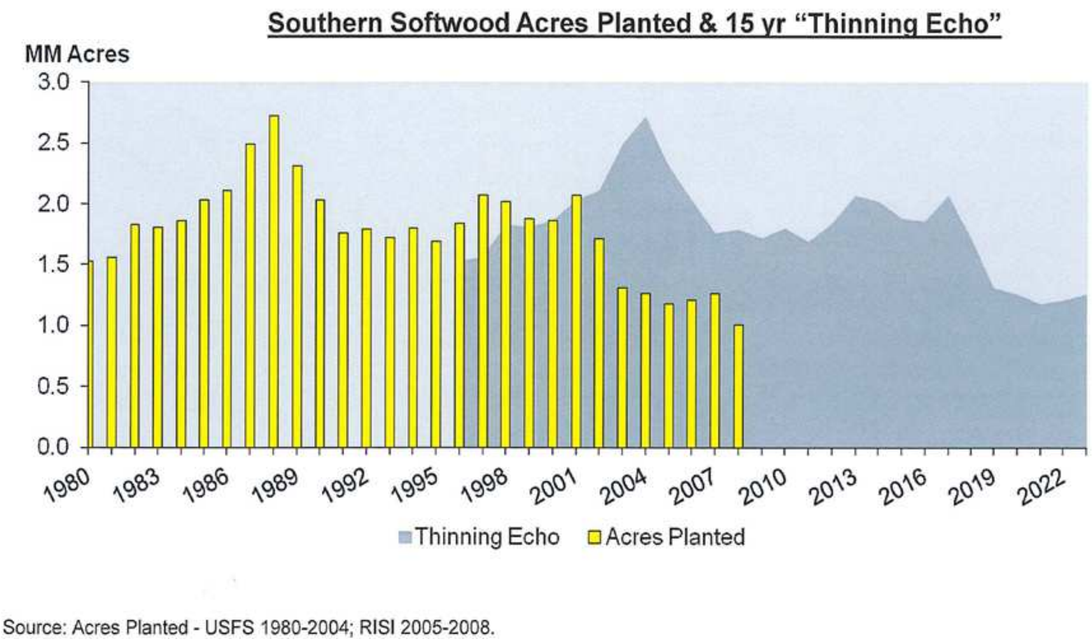

Figure 5. Southern Softwood Acres Planted & 15 years "Thinning Echo"
Source: Macedo (2013)

The **wood flows and end uses** for the US South are described in Figure 6. The sustainable wood supply potential totals 155 Mt_{od}/a. Pulp and Paper sector dominates the end use, with a consumption of 68 Mt_{od}/a while the panel industry uses 9 Mt_{od}/a. The amount of unmobilised fibre is 32 Mt_{od}/a although it would be worth exploring the assumptions supporting this result (the size of the tracts: harvesting in tracts smaller than 25 ha might be unprofitable; ownership: harvesting rate in public lands is very low; or species: harvesting hardwoods is typically more expensive). This reveals significant amounts of biomass technically available for additional uses but it is likely that not all these biomass could be mobilized.

Most sawmill residues are already consumed by several industries such as the composite panel and pulp and paper manufactures. As reported by Forest2Market (2014) the pellet mills just consume 5 % of the available secondary chips. Nonetheless, other woody assortments such as municipal tree trimming waste and storm damaged wood might be more likely to be consumed (Fledderman 2014). Much of this will depend on the paying capacity of the various industries (see Section 5.1).

Forest regulations - In the United States, forestry on private and state forests is regulated primarily at the **state level** (Manomet 2010). From an international perspective, the US is considered as low-risk country in the forestry context.

Best management practices (BMP) are one of the key programs related to forest management activities and 44 states have adopted them on a voluntary or mandatory basis (Biomass Research and Development Board, undated). BMPs refer to *a practice or usually a combination of practices that are determined by a state or a designated planning agency to be the most effective and practicable means (including technological, economic, and* *institutional considerations) of controlling point and nonpoint source pollution at levels compatible with environmental quality goals* (Biomass Research and Development Board, undated). Despite BMP differences in specifics by state, they are generally focused on ensuring that the soil resource is protected and stays in place on site but they are not specifically intended to protect biodiversity (Evans et al. 2013). In the particular case of the US South, most of the states have adopted BMPs on a voluntary basis with some potential enforcement (Kittler et al. 2012). Moreover, BMPs are unevenly implemented across the region, with a mean rate of implementation of 87 % (68-99 %) (Kittler et al. 2012).

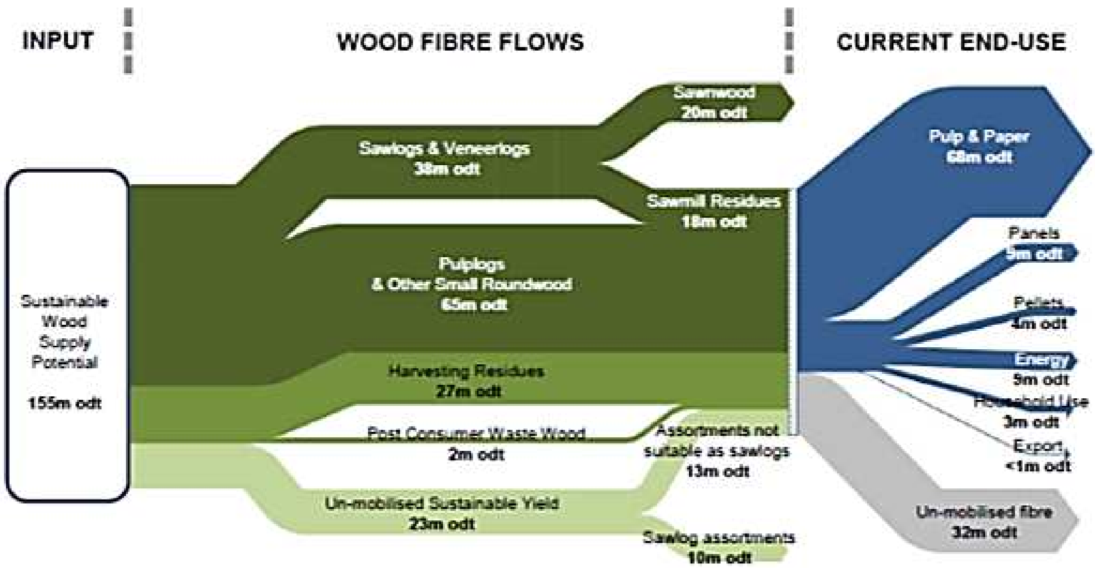

Figure 6. Wood flow in the US SE 2013
Source: Pöyry (2014)

Building on existing BMPs, several states have developed BMPs focused on biomass harvesting. In the Southern region, BMPs address streamside management zones, stream crossings, forest roads and skid trails, fertilizer and pesticide application, harvesting and reforestation as well as waste disposal. These BMPs might be adequate to protect water quality when biomass harvesting as long as they are adequately implemented (Barret 2013).

In contrast to European countries, Canada or the US North East, only 17 % of US South forest land area is **certified** by means of voluntary forest certification schemes (FSC 1 %; ATFS 6 %; SFI 10 %; see Kittler et al. 2012).

3.2 Promoting mechanisms

Today, generating wood-energy in the US South is more costly than from fossils fuels in most applications so the transition towards woody-based energy would be less likely in the absence of governmental mandates and incentives (Conrad 2011). A more cost-effective option for power generation from wood is repurposing small coal-fired power plants for woody bioenergy which is already in place in some locations (Fledderman 2014). Several options at federal and state governments are in place to encourage woody bioenergy use (Evans et al. 2013; Guo 2011).

Traditionally, most of the regulations have been focused in the biopower sector but more recently liquid biofuels have also gained momentum (Aguilar, Song, Shifley 2011) despite the revised reduced targets for advanced biofuels. Both RFS and Renewable Portfolio Standards

(RPSs) consider woody biomass but have **different definitions** to determine which feedstocks might be eligible (Abt, Abt 2013).

Alavalapati et al. (2009) list the following mechanisms that can be implemented at state level to promote woody bioenergy:

a) State Energy Plan

b) Regulatory Mechanisms
   RFS – Renewable Fuel Standard (Federal level)
   RPS – Renewable Portfolio Standards (State level) are key for domestic biopower but only two SE states have passed those, voluntary in Virgnia (Evans et al. 2013).

c) Incentive Based Polices
   Tax incentives
   Subsidies and grants
   Loans and loan-based policies

d) Support Based Policies
   Production and infrastructure development
   Extension and educational outreach
   Technology advancement policies

The **Renewable Fuel Standard** (RFS), a cornerstone of the renewable energy policy in the US, setting targets for first-generation and “advanced” biofuel production, but the target for “advanced” biofuels has been lowered several times. Despite uncertainties surrounding “advanced” biofuel production in the coming years, technological feasibility of producing increasing amounts of biofuels from different woody assortments (e.g. logging residues) is expected from 2015 onwards (Wang, Khanna, Dwivedi 2013). More particularly, the amount of logging residues for bioliquids production might reach 22 Mt_{od} and pulpwood assortments could be as high as 13 Mt_{od} by 2030 (Wang, Khanna, Dwivedi 2013). In any case, once advanced biofuels production takes off, the South region is expected to play a dominant role in the provision of any kind of woody feedstock.

The analysis of woody biomass policies in place up to 2008 performed by Guo (2011) demonstrated that these policies were very **diverse among states** and that even the states with more favorable investing policies could improve the business investment climate.

A key federal instrument is the **Biomass Crop Assistance Program** (BCAP) through which woody biomass from non-industrial private forestlands can be funded. BCAP basically consists of federal payments to eligible landowners and loggers/harvesters for specified biomass delivered to facilities. There are the following types of biomass support (USDA 2014):

- For establishing perennial energy crops
- To maintain the crop, it provides an annual payment up to 15 years for woody crops.
- To collect existing residues that are not economically retrievable. This includes harvesting and transporting

A key requirement of the program needs highlighting: it has to be demonstrated that woody feedstocks cannot be used as a higher value wood-based product (Kittler et al. 2012). Within

BCAP, the 2008 Farm Bill provides for matching payments at a rate of 1 USD for each 1 USD per dry ton paid by qualified biomass conversion facilities, up to 20 USD per dry ton for a period of 2 years (Biomass Magazine 2014a). The previous program considered up to $45 per dry ton for a period of 2 years (USDA 2010). For 2014, the Farm Bill has authorized $25 million for BCAP, allocating a maximum of 12.5 million US$ to matching payments and the remaining amount to technical assistance activities between 10 and 50 percent of the total funding to be used for harvest and transportation of biomass residues.

When considering the limited amount of funding, that BCAP has been extended to other parts of the country, that it is applicable also to Federal lands and has to be distributed between the landowners and harvesters/foresters, the impact of this programme in the US South is expected to be very limited (Fledderman 2014).

Furthermore, there are **generic state and local subsidies** for new business that increase employment in the state and that could be more effective measures for the development of pellet mills than BCAP (Fledderman 2014).

3.3 Woody bioenergy consumption in the US

Woody bioenergy has played and is expected to play an increasing role in the US, as illustrated in Figure 7. According to Forisk (2013), as of April 2013 there were 456 announced and operating wood bioenergy projects across the country, with a total potential use of 125 (green) Mt of wood from all types of feedstocks by 2013. However, analysis performed by Forisk Consulting (2013) states that just 293 projects could pass the basic availability screening, representing a demand of 75.4 (green) Mt when considering all woody feedstocks (pulpwood, logging and mill residues). CHP and pellet production were the leading projects in the wood bioenergy sector over the last 3 years (Forisk Consulting 2013).

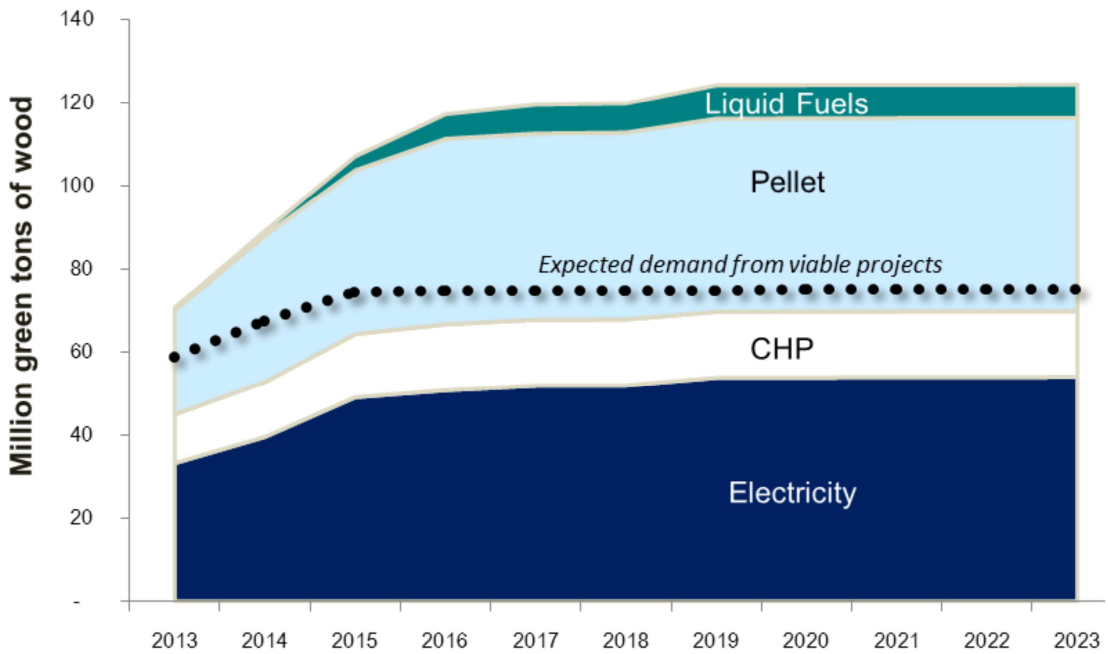

Figure 7. Projected demand of wood for bioenergy in the US, 2013-2023
Source: Forisk Consulting (2013)
Note: largely excludes cogeneration projects at forest products facilities.

Contrary to what occurs in the residential sector, woody bioenergy consumption in industry has been primarily driven by the output of the pulp and paper industry, without energy prices playing a major role (Aguilar, Song, Shifley 2011). Thus, the **industrial sector** dominates wood energy consumption, with the pulp and paper industry consumes 55 % of the total (Aguilar, Song, Shifley 2011).

The **pellet production capacity** has increased sharply during last years within the US from 0.4 Mt in 2007 (Cocchi et al. 2011) to almost 6 Mt in 2012 of which 3 Mt is concentrated in pellet plants with a capacity above 0.1 Mt/a (Bioenergy International 2013). Thus, this region concentrates some of the largest companies of the world, with some of them overpassing 0.5 Mt/a capacity and one with a production capacity of 1 Mt/a (Vakkilainen, Kuparinen, Heinimö 2013). The US South has the highest concentration of **export-oriented facilities** across the country (Lang 2013), as Figure 8 shows.

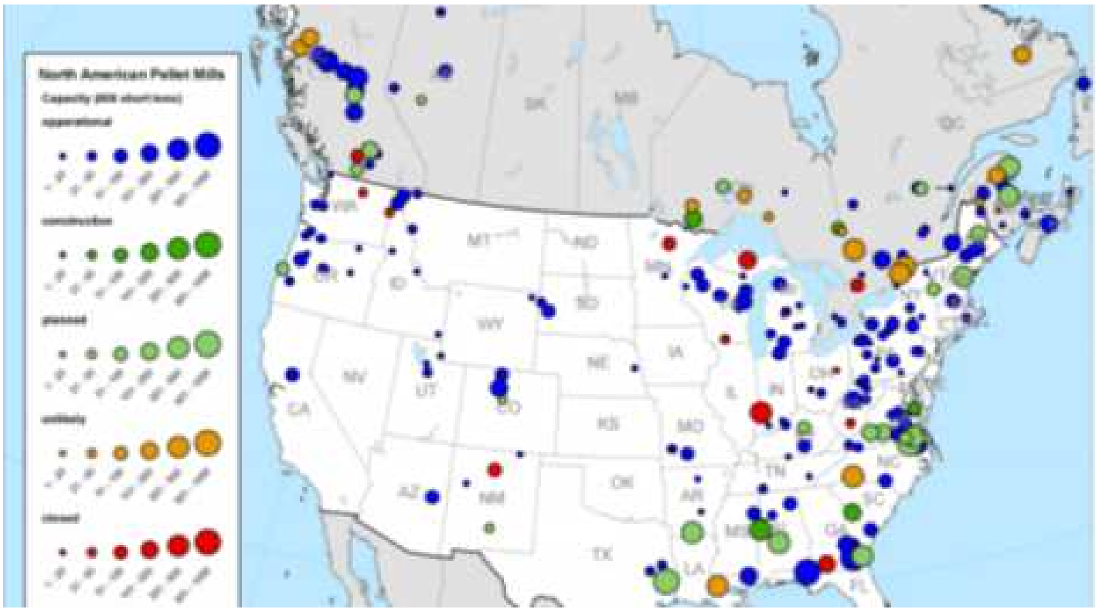

Figure 8. Wood pellet mills in North America
Source: Walker (2012)

However, in addition to exports, a significant share of the US pellet production is consumed **domestically** due to the various government supporting policies: from about 3 Mt consumed in 2009, an increase to almost 5 Mt is expected for 2017 (Walker 2012). In this respect, some *momentum* is being created and it is worth highlighting the role of the Biomass Thermal Energy Council[4] on this.

Within the various regions of the US[5], the South is the most promising region for **export-oriented pellet** production to the EU due to various reasons (Forisk Consulting 2013):

- Pellet plants reliability on known and proven technologies.
- The need of lower levels of capital investment in comparison to liquid fuel and large scale electricity projects (150 M$ or less vs. hundreds of millions of dollars).

[4] https://www.biomassthermal.org/

[5] Pellet supply in the Northeast region could also expand since some States such as Maine has relevant shares of certified forests, among other reasons.

- The response of investors and project developers to current demand in the EU.

For **illustration** purposes, the next figure shows the distribution of current and projected pellet production capacities within the US, although the particular projected capacity for the US South might be outdated, as discussed below. It is clear that the most relevant growth in the coming years in terms of industrial production capacity is in this region. Moreover, this was the region with largest announcements of new pellet in 2013 when new 29 plans were announced, of which 27 were export-related (Lang 2013). This means that 93 % of the new pellet capacity announcements is targeted to be exported to the (European) markets (Forisk Consulting 2013).

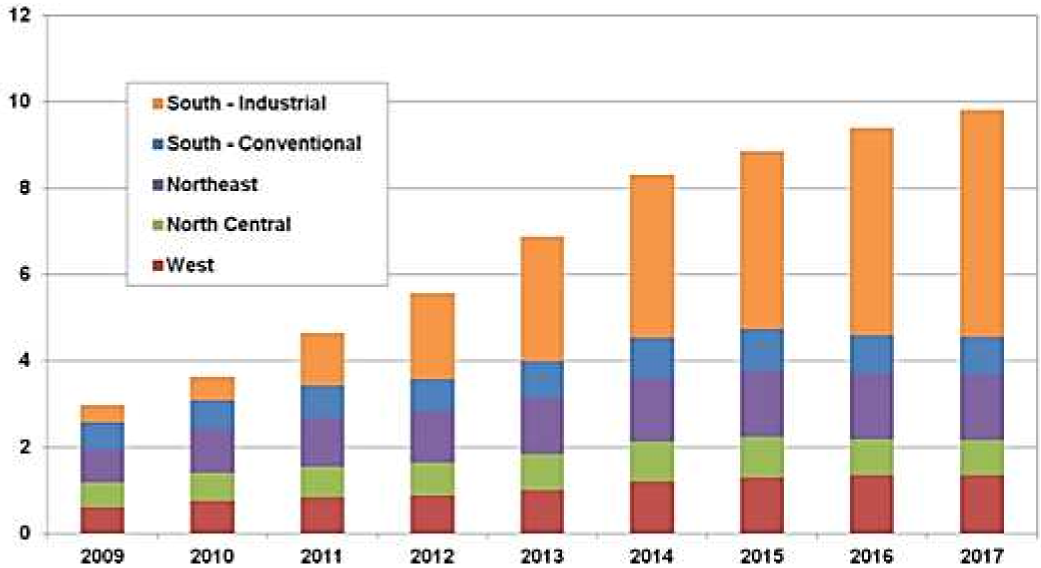

Figure 9. US Wood Pellet Production by region
Source: *Walker (2012); data given in Mt*

The total exports have increased from 0.8 Mt of pellet in 2011 to 2.9 Mt in 2013 (Market Watch 2014). The capacity of the operational pellet plants was 6.6 Mt and the total capacity of the operational, under construction and announced plants is 15.3 Mt pellets was in July 2014 (own calculations as July 2014 based on Biomass Magazine 2014b). In case all the announced plants were built, the production capacity and hence the feedstock demand would sharply increase in next years.

3.4 Wood pellet cost and Prices

Another advantage of the US wood pellet production is its competitive cost resulting in a good ranking in the international market (See Figure 11). Broadly speaking, the cost structure of the wood pellets can be broken down in three parts, as represented in Figure 10.

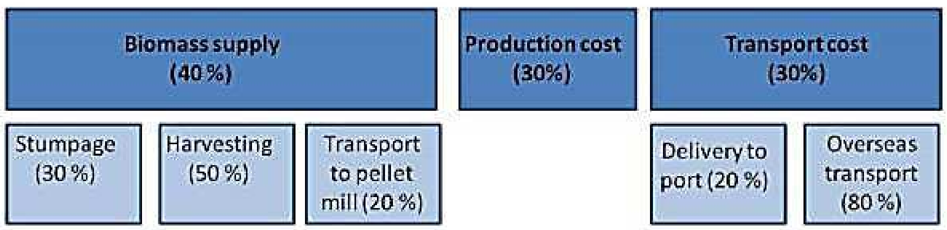

Figure 10. Typical Cost Breakdown for US SE Wood Pellets
Source: own elaboration based on Qian, McDow (2013) and Bradley et al. (2013)

The delivered CIF ARA costs of US South wood pellet are about 180 $/t, equivalent to 143 €/t[6] (Fritsche, Iriarte 2014), as shown in Figure 11. Among the major exporting regions, cost breakdowns are different for the various cost categories of wood pellets. The US South is well positioned in both the stumpage costs and overseas transport.

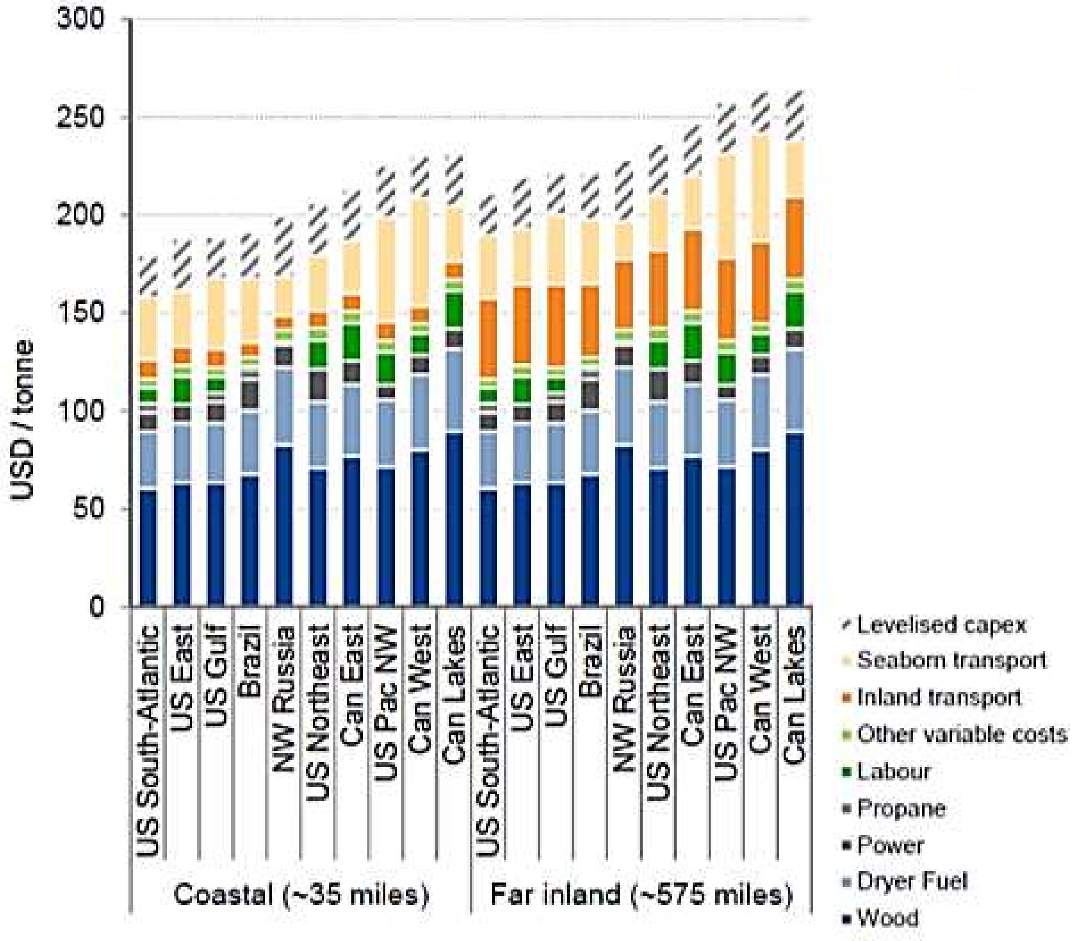

Figure 11. Pellet Supply Cost Breakdown Real 2011 CIF ARA
Source: Pöyry (2013)

4. Critical issues and risks

4.1 Interference with other sectors

The interaction of the wood pellet sector with other wood-based bioenergy sectors as well as with traditional forest industries or new ones (e.g. bioproducts) will greatly depend on the **geographical and temporal scales**. Today, the forest products market is the primary market for timber and the major competition is observed between traditional mills (Conrad et al. 2011).

The interference with other sectors will extensively depend on the evolution of the traditional forest industries and the penetration of new businesses and more particularly on the type of feedstock consumed which will subsequently depend to a great extent on the

[6] Exchange rate 1,25 $/€

paying capacity of the different industries. On the one hand, the more roundwood utilized in the sawmill industry, the larger the mill residue availability for the pellet industry as long as the demand of industries consuming mill residues keeps at current levels. On the other, the larger the demand for the same type of feedstocks by different types of industries (pulp and paper industry, panel board industry), the larger the competition for raw material.

As woody biomass sourcing is highly dependent on sourcing distances (hauling and transport) **the geographical distribution** of pellet and pulp and paper mills is highly relevant.

As consequence of increasing demand there could be **price reactions**. Most of this will depend on the paying capacity of the pellet mills in comparison with the pulp and paper and the cardboard industry.

Another consequence could be changes in traditional **forest management** aiming at optimizing the system in response to the new market conditions. A long term reaction could be forest intensification to achieve higher productivity, depending on how prices evolve. In any case, it takes time for such changes to happen.

4.2 Environmental impacts

4.2.1 Land use and Land use change

Increasing woody bioenergy demand can impact on land use and land use change in several ways:

- Converting natural forests into (pine) plantations.
- Converting (natural or plantation) forests into other land uses such as agriculture or infrastructure/development and,
- Converting agricultural (mainly pasture land) into forests or plantations.

Overall, the highest threat to forestland is the rise in land values for low density development since forest use value is by far lower than urban use value (Malmsheimer et al. 2008). Particularly “appetizing” might be converting forestland into urban land when forests are damaged (e.g. by wildfires, insects outbreaks, etc…) and need some investments (Malmsheimer et al. 2008). Depending on land quality, conversion to agricultural land might be also an option in some areas.

Private landowners have some capacity to react according to market prices for wood products, converting land to the most profitable use so additional revenues from the bioenergy assortments could prevent forest land conversion to agricultural uses. On the other hand, the promise of reliable wood markets could stimulate landowners afforestation.

Land use changes may pose ecological risks. When biomass sourcing is made from pine plantations the conversion of natural forests into plantations causes the highest environmental risk (Evans et al. 2013). In the longer run, more intensive management might be practiced and feedstocks could be produced on agricultural lands (Alavalapati et al. 2013; Evans et al. 2013) without impacting in the forest stocks.

4.2.2 Climate change

One of the major drivers to promote biomass for bioenergy in the EU are policies to mitigate climate change. However, effects of burning woody (forest) biomass on the climate are discussed among experts with different views[7]. Since the issue is complex and results depend on perspectives on e.g. reference systems and counterfactual scenarios as well as time horizons, the "right" approach to **GHG accounting** for woody bioenergy from forests is not discussed here[8].

However, it could be useful to see the effects of promoting woody pellets consumption on **forest carbon inventories**. Results of research carried out by Abt, Abt, Galik (2013) show that neither for natural forests nor for plantations significant differences in forest carbon were found for the baseline scenario and the one considering pellets. Nonetheless, as mentioned by these authors (Abt, Abt, Galik 2013), additional research is needed on the assumptions they made, including residue recovery response to prices, plantation productivity response to prices, and changes in pine plantation conversion from other forest types.

4.2.3 Biodiversity

The US SE forest contains large areas of high quality habitats. **Pine plantations** are less biodiverse than bottomland systems but there are concerns that woody biomass are sourced from wetlands (PIC 2013). From the conservation (and also GHG mitigation) point of view, change of natural forest stands into plantations is the highest concern in pine plantations, though (Evans et al. 2013).

Logging in forested **wetlands** is driven by sawntimber (hardwood) products being pulpwood quality wood a by-products. BMPs have to be followed and draining wetlands is prohibited under the Clean Water Act (PIC 2013). However, from the European side (regulations by various MS) there could be requirements to protect high biodiverse wetlands.

The specific impacts of woody biomass harvesting in the US South forests will depend on many variables and field research is still needed (Evans et al. 2013). The Forest Guild (2012) proposed a list of **recommendations** to reduce habitat impacts of biomass harvesting, including e.g. provisions regarding tree retention. However, the compliance with these recommendations are unknown (Evans et al. 2013).

For facilities sourcing large amounts of hardwood material (including bottomland and floodplain wetlands) primary wildlife concerns are associated with the effects of direct logging disturbance and increased residual removal.

5. Impact of promotion mechanisms on wood markets

The wood pellet promotion mechanisms are still very incipient and their limited history makes that results described here should be carefully considered. Many of the impacts on the traditional wood market products and their magnitude will depend on the scale of the demand, the spatial distribution of the facilities and extent of government programs promoting wood-based energy (Conrad 2011). In the end, assuming that most biomass will

[7] As an example of this it is worth noting the Joint Workshop on "Forests, bioenergy and climate change mitigation" organized by EEA, IEA Bioenergy Tasks 38, 40 and 43, IINAS and the EC JRC in Copenhagen May 19-20, 2014

[8] See e.g. Jonker, Junginger, Faaij (2014)

be sourced from roundwood, the paying capacity of the wood pellet sector in comparison with that of the pulp and paper or the panel board industry will determine the interactions among the various players. The relation between traditional markets and new energy markets can be:

- Complementary: as long as the wood-markets use feedstocks or are located in places where this does not cause interference with the traditional wood products. An example of this would be the manufacturing of pellets based on residues from timber production such as sawdust as long as they would not have an alternative market.
- Substitutive: in case that the demand for traditional forest products competing for same wood quality feedstocks (e.g. pulp and paper, particle board) would be reduced , pellet mills could take advantage of the demand potentially lost.
- Competitor: when both sectors compete for the same raw material. As consequence this may lead to displacements.

5.1 Impact in the past years

A first consequence of the introduction of the pellet mills is the increase in **biomass consumption**.

The amount of biomass used in the US South pellet mills increased from 2 Mt in 2012 to 4 Mt in 2013 (Pöyry 2013; 2014)[9]. Until 2010, mill residues represented the major feedstock for pellet production but since 2011, both softwood and hardwood pulpwood are also being used (Abt et al. forthcoming). Small wood-energy facilities typically rely predominantly on mill residues while large facilities use more **whole tree chips** (DA 2013) or **roundwood**. Thus, as reported by Abt et al. (forthcoming), in 2013, the proportion of pellet feedstocks sources was about 45 % from softwood pulpwood, about 15 % from hardwood pulpwood and the remaining 40 % from mill residues. It is expected that the share of pulpwood feedstock will continue to increase. All these facilities have to rely on outside sources of wood (dealers/loggers, gatewood or stumpage purchases directly from landowners, either through spot markets or contracts).

The geographical distribution of the various industries is key on the potential impacts that might occur. Figure 12 shows the distribution of various types of facilities in the US Southeast: paper mills and biomass facilities. Taking into account this scale, it is challenging assessing whether there would be competition for feedstocks since the sourcing influence of the various mills has to be assessed at a more local level. Nevertheless, this map indicates that wood sourcing areas of pellet mills and paper mills could overlap which might be translated in the need of larger sourcing areas and respective longer feedstocks transport distances as well as into displacement effects (Fledderman 2014).

Wood pellet prices have been stable over the last years (see Figure 6-13 and Figure 6-14). Since 2007, industrial wood pellets prices have ranged from 112 to 144 €/t CIF ARA (Koop, Morris 2012).

[9] The authors assumed that data provided by Pöyry (2013) refer to 2012.

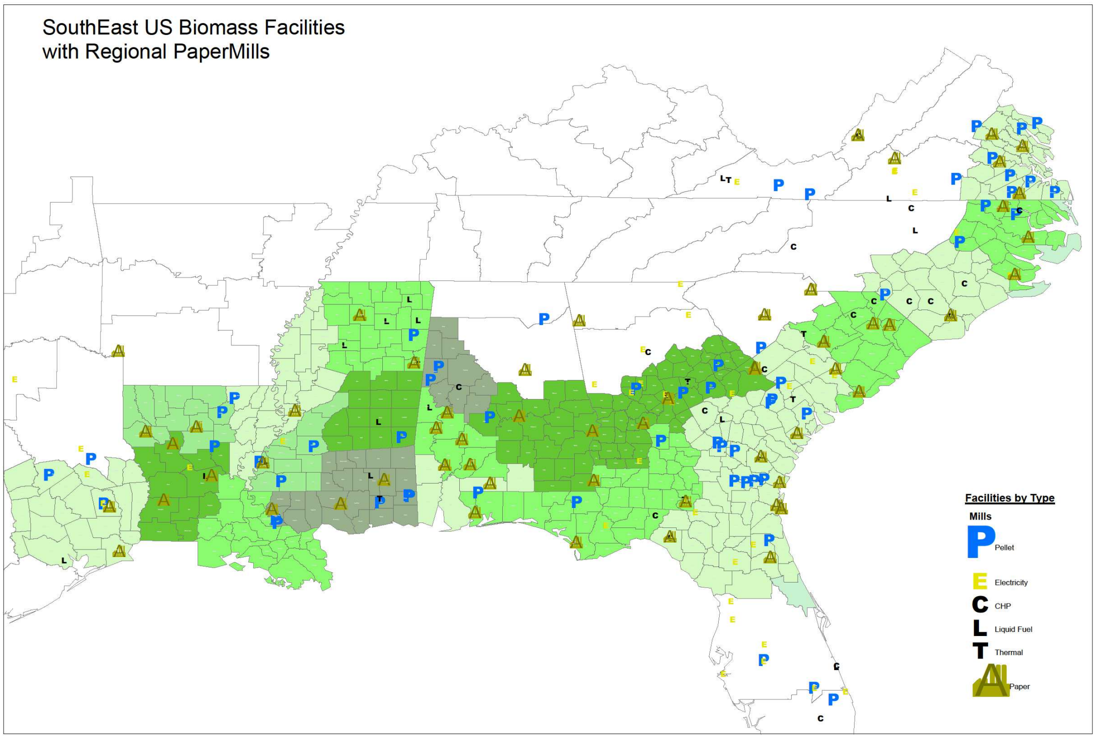

Figure 12. Geographical distribution Southeast biomass facilities with regional paper mills
Source: courtesy of MWV (2014)

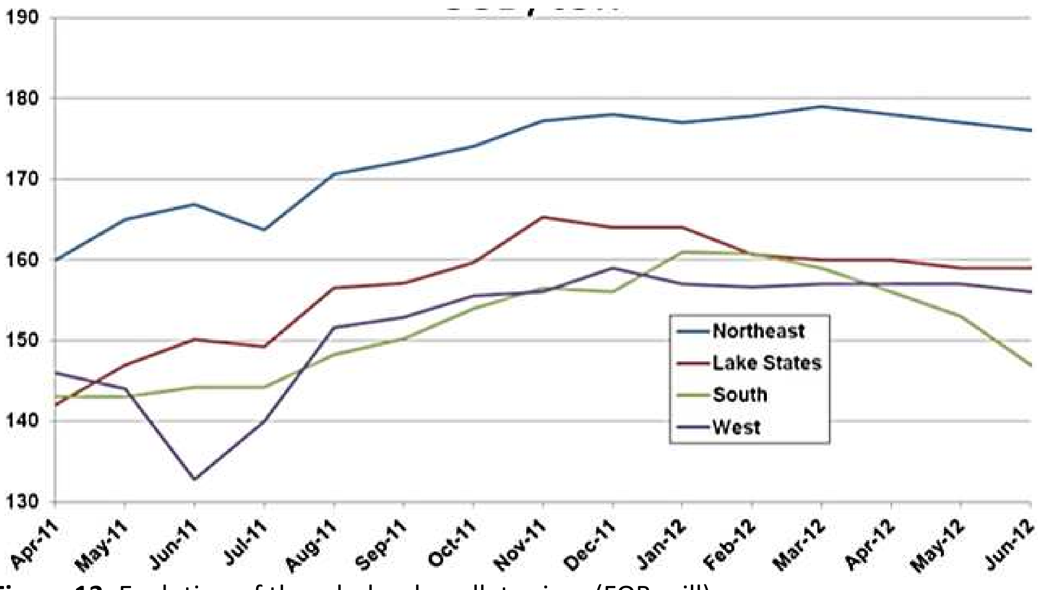

Figure 13. Evolution of the wholesale pellet prices (FOB mill)
Source: *Walker (2012); data given in US$/t*

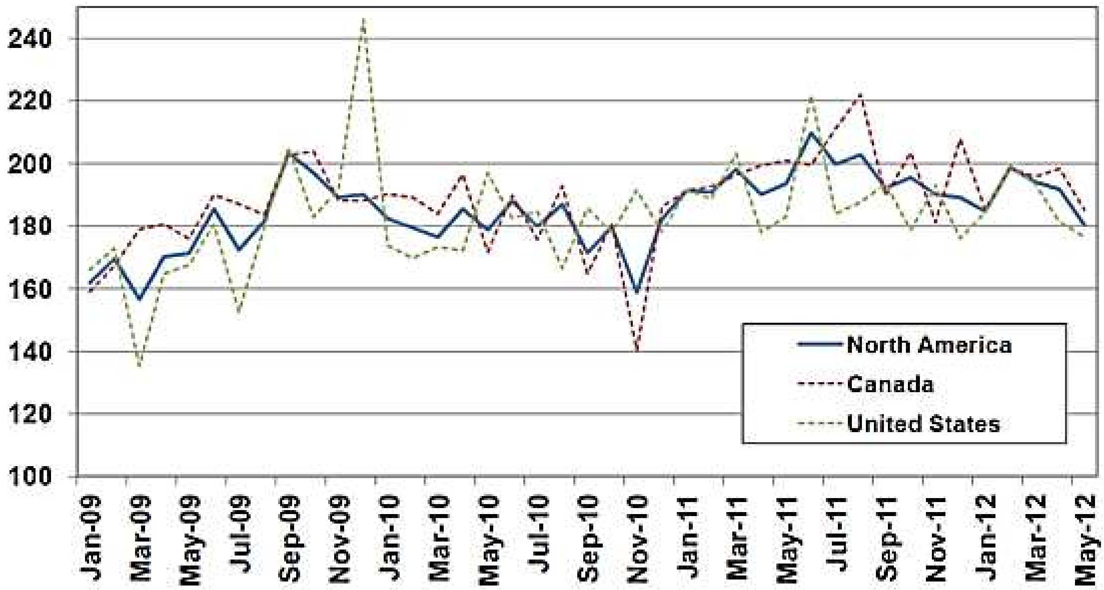

Figure 14. Average CIF EU prices ($/t) of North America Origin
Source: Walker (2012)

Historical real **stumpage prices** in the South (1977-2008) by main products are shown in Figure 15. Softwood prices were essentially flat until 1989, followed by an increase in the period 1988-1998 and then the prices felled. A closer look to the average pine pulpwood stumpage price from 1976-2013 (Figure 16) evidences the price recovery during last years. The spike in prices in late 90s coincides with the high demand of OSB panels. Later, the dip in prices might be associated to the decline in the US economy and so called "wall of wood"; in the late 1980s, the Conservation Reserve Program (a subsidy program from the US government with a contract period of 15 years) incentivize the plantation of trees on "erodable" soils, so there was notable availability of feedstocks in early 2000 (both due to the "thinning echo" or because farmers liquidated their contracts) (Fledderman 2014).

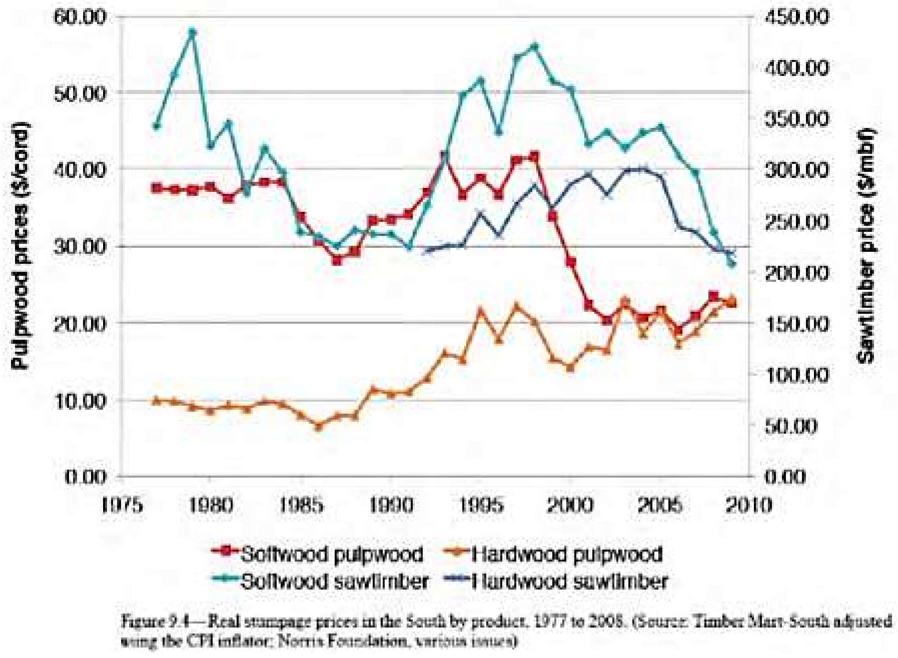

Figure 15. Real stumpage prices in the South by product 1977 to 2008
Source: Wear et al. (2013)

It is difficult to assess to which extent pellet production has influenced the rebound of pulpwood stumpage prices in last years. One likely reason why these prices have increased at regional level might be the increasing demand for thinning material because the sawntimber industry is not producing many residual chips (Fledderman 2014). Taking into account the limited demand of feedstocks for pellets with regards to the total forest production in the US South up to now and given the reasonably dispersed geographical scale of their production it seems quite unlikely that increasing prices might be attributed to pellet markets (Fledderman 2014). Nevertheless, in a few isolated areas there could be some effects on prices today that might be increasingly accentuated as long as the demand of feedstocks for pellets increase and the market is not able to assimilate the required supply (Fledderman 2014).

In the case of wood fuel, Forest2Market (2014b) attributes the increasing prices during last year (1Q 2013 – 1Q 2014) to the increasing demand of these feedstocks by dedicated bioenergy plants and pulp and paper mills (converting coal-fired boilers to biomass boilers) as well as the rainfall and difficulties in the related supply.

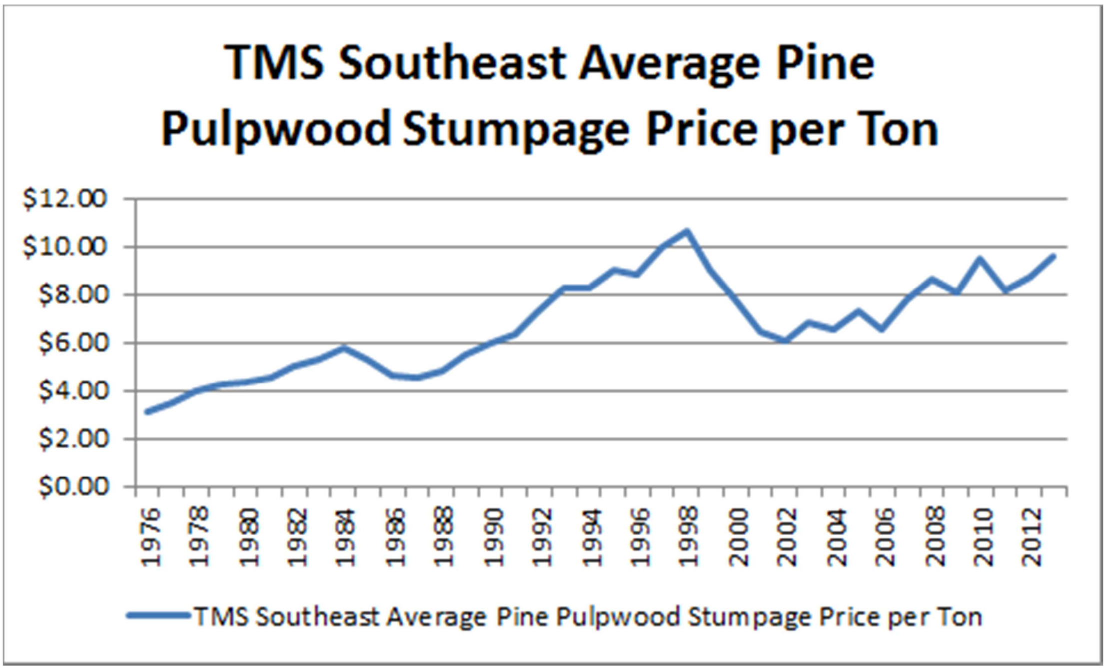

Figure 16. TMS (Timber Mart South) Average pine Pulpwood stumpage price from 1976-2013 ($/green short ton)
Source: courtesy of MWV (2014)
Note: 1 short ton equals 0.9072 metric tons

A key point affecting the competition between pellet mills and other forest industries is the **wood paying capacity (WPC)**. Figure 17 illustrates the WPC for US and Canada in general (left) and for the US South (right; based on a case study). The WPC of the pellet industry is lower than that observed for other wood products industry but may compete with the bioenergy industry. These findings are also shared by Forest2Market (2014) which report a WPC of the composite panel manufactures of 72 USD/t whilst that of the pellet manufacturers industry is 39 USD/t. The major drivers conditioning WPC are (Pöyry 2014): mill capacity, mill age and efficiency, level of integration, specific grade of end product, market price levels for end products and incentives available. The overall conclusion deducted from these results is that the wood paying capacity of the pellet mills is at the lower range of the various industries.

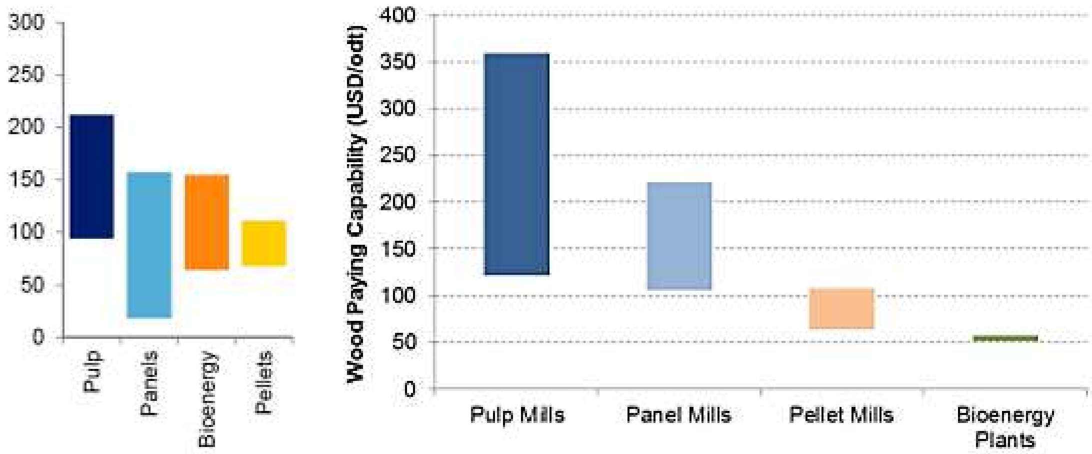

Figure 17. Paying Capability ($/odt) in the US and Canada (left) and in the US Southeast (right)
Source: Pöyry (2013) (left) and Pöyry (2014) (right)
Note: the figure on the right is based on a specific case study in North Carolina

5.2 Anticipated trends in the future

The international markets hold high hopes for the Atlantic ring and particularly for the US South to continue supplying wood pellets to the EU. Many of the potential impacts and their extent will depend on the **magnitude of the demand the supply response** given the particular location of the industries. Since it seems doable that old and new forest industries coexist, too big or too fast development could significantly impact forests, forest industries and markets.

The inelasticity of timber supply causes in the short term that an increased demand will have greater consequences on prices than on the harvest response (Abt, Abt 2013). Nonetheless, the elasticity of roundwood supply can evolve over time and with locations (Galik, Abt, Wu 2009). In this respect, Figure 18 provides an overview of the demand-supply curve in the Atlantic market aiming at highlighting the quite **flat supply curve** of the US South pellets both for 2012 and 2022. As it can derived from the figure for 2022, the global pellet supply could be up to about 20 Mt being the US the major supplier.

Some estimates foresee an export potential of about 5.5 Mt of pellets by 2015 (PIC 2013) and estimates for 2020 determine a **production pellet capacity** of about 21 Mt (assuming existing and planned mills capacity; Pöyry 2014). The pace of growth is uncertain and will be subjected to several variables such as the slow demand development in Europe and uncertainty regarding sustainability requirements (Pöyry 2014) or port access (Forisk Consulting 2013).

Even if all the announced mills were not operating at full capacity in the short term, the observed biomass demand trends and the expected biomass consumption by pellet mills would be relevant. Although traditional forest products will represent the vast majority of wood use in the short term (Forisk Consulting 2013), the biomass consumed by the pellet mills might be relevant most notably when compared with the demand from the "traditional" users (as noted in section 3.1, current pulp, paper and panel demand is about 77 Mt_{od}). Thus, the most likely interactions of the wood pellet sector could be with:

- Other bioenergy industries (e.g. power or heat generation, liquid biofuels, etc.). It is estimated that the US woody bioenergy demand including biorefineries will be 295 Mt_{od} by 2030 (IEA 2014), despite great uncertainties surrounding the development of bio-based products (NREL 2012). Cellulosic ethanol from woody biomass is still in its early stage of development with a few pre-commercial plants and some planned commercial-stage ones mainly in the US (Ecofys 2013), but once commercial there will potentially huge effects on the availability of solid biomass for pellets.
- The pulp and paper industry, depending on the demand evolution.
- The panel industry which is expected to expand in the coming years (Walker 2012).

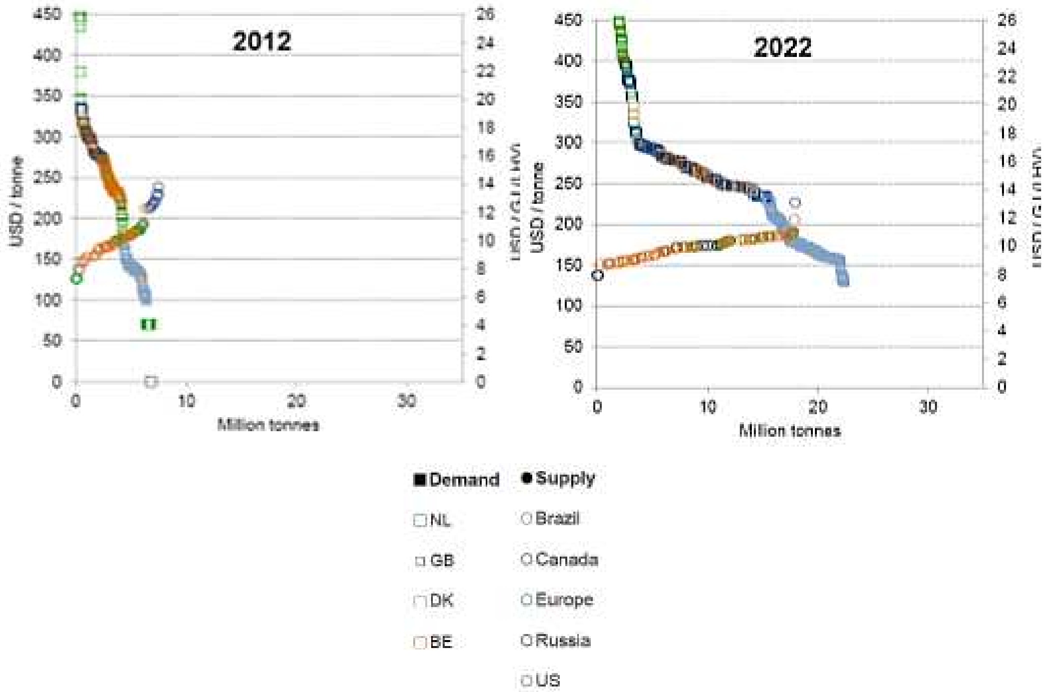

Figure 18. Atlantic market demand-supply curve
Source: Pöyry (2014)

Many of the effects will depend on the **supply** (and demand) **responses** (Abt, Abt, Galik 2012). In particular, a key issue will be the rate and time of residue use because it can impact the need for timberland as well as the mix of forest types and age class distribution (Abt, Abt 2013). The higher the residue consumption, the smaller the roundwood demand and, thus, the smaller the impact on established product markets. The residue availability depends on the demand for traditional forest products (which represents the major consumption at present, as discussed earlier), as thinning and harvest residues are by-products of traditional forest operations, and also on technical developments and economic parameters. Nevertheless, roundwood is expected to continue being the most relevant feedstock (Trømborg et al. 2013; Alavalapati et al. 2013).

Taking that into consideration, **some competition** among wood users for low-quality (and, hence, low-price) feedstock might be observed, depending on growth pace and respective availability of biomass ("thinning echo") as well as mobilization of both hard- and softwood sawntimber and respective primary and secondary residue availability and mobilization. Competition will most likely occur at more local levels (PIC 2013; Forisk Consulting 2013). The much more smaller size of the pellet market in comparison with pulp and paper demand makes clear that a slight change in the supply/demand of the later could imply significant effects for pellets.

Thus, the key point of interaction between the different types of industries will be **competition for raw material**. Spatial distribution of feedstock is of high importance for forest industries and even more for the wood-energy industries because of the low density of feedstocks and associated hauling and transport costs (Abt, Abt 2013). Competition for raw material starts with low value or non-commercial wood and will increase to more valuable wood assortments if demand increases respectively (Conrad et al. 2011). Much of this competition will depend on:

- **Subsidies** - there are many programs promoting wood-energy supply in the US South (such as BCAP) and several EU Member States stimulate demand.
- The **paying capacity** of the wood-energy industries, which partly depends on subsidies but also on climate change policies (e.g. CO_2 emission limits in the US, CO_2 price levels in the EU Emission Trading System).
- The **dynamics** of demand increase will also play a role (Abt, Abt 2013).

Feedstock competition could impose direct price impacts, and as growth in volumes increase, a higher price volatility is expected (WPAC 2012). The international pellet trade is based on long-term supply contracts which guarantees some price stability. Thus, stakeholders are discussing prices for 2015 which are in the range of 155-160 US$/t FOB US which means a 190-195 US$/t CIF ARA (Argus 2013). Nonetheless, these contracts usually include price escalators for increases in stumpage costs and transport fuel costs, so respective variations can impact final prices of pellets in the longer term (Fledderman 2014).

Figure 19 shows the estimated **industrial pellet trend prices** in the Atlantic Market up to 2030. A quite constant trend is expected for industrial wood pellets since most contracts are signed with fixed prices for several years (Koop, Morris 2012). Some variations may emerge in response to the oversupply in the market, and demand side (additional conversion capacity or expiration of incentives).

Moreover, a 20 % reduction of pellet production cost is expected by 2020 (ECF et al. 2010), but his could be offset by higher stumpage and transportation costs.

With the development of woody bioenergy markets, price for merchantable timber might increase (Ince, Kramp, Skog 2012; Alavalapati et al. 2013, Abt et al. forthcoming), leading to increased revenue for forest landowners (Alavalapati et al. 2013). This will depend also on the paying capabilities of pellet mills (and margins). Higher prices may imply displacement of traditional wood using industry in the short term while providing incentives for more intensive management, increase in forest acreage, and increasing residue utilization in the longer run (Abt, Abt 2013).

Near-term returns will definitely contribute to decisions made by investors (Munsell, Fox 2010). Institutional investment firms will adopt strategies that reflect opportunities for greatest financial returns (Munsell, Fox 2010). As previously mentioned, family owners respond to markets in different fashions than investment firms, and often seek for a combination of outputs and amenity goals (USDA FS 2009; Munsell, Fox 2010).

High wood energy demand may affect **forest management operations**. Wood-energy markets could provide an alternative for currently non-merchantable timber, and make some treatments such as pre-commercial thinnings profitable or at least less expensive (Conrad 2011), which could increase forest health (Conrad et al. 2011),. Still, their likelihood depends on profitability in comparison with traditional harvesting material, and subsidies on biomass mobilization or forest management. Also, another response could be high replanting density after harvesting to get relevant amounts of biomass early in the rotation with a subsequent shift to pulp and timber production (Backlund 2013). Higher prices induce increased planting which increases long run supplies (Abt, Abt 2013).

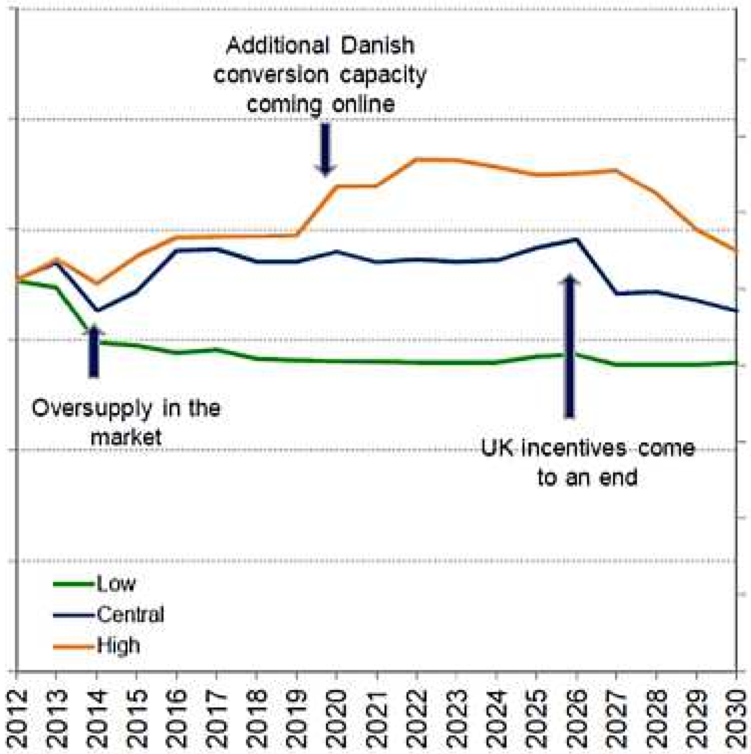

Figure 19. Industrial Pellet Price Trends (2012-2030) in the Atlantic Market
Source: Pöyry (2014)

Today, **intensive regimes** for bioenergy are not economically attractive so prices need to increase significantly to change management regimes (Munsell, Fox 2010). However, integrating management with traditional harvesting might increase returns to landowners (Munsell, Fox 2010).

A vibrant development of the wood energy market could also impact on **land use** in various ways: making more attractive (in financial terms) for landowners the maintenance of timberland as such and promoting the afforestation of pasture or agricultural lands for the promotion of bioenergy (Wang, Khanna, Dwivedi 2013; Malmsheimer et al. 2008; Munsell, Fox 2010). In general, though, it is not expected to greatly impact on land use changes.

Procurement practices might also change by the wood-energy market expansion including long term wood supply agreements (Conrad et al. 2011) as it is happens in the pellet mill – facility value chain.

The **behavior of forest owners** is of utmost importance since biomass availability mostly depends on their willingness to supply the wood-energy market. Forest owners are willing to sell timber to a bioenergy facility as long as the right price is offered (Conrad et al. 2011). However, landowners might not be keen to harvest more frequently, but could be willing to invest in intermediate treatments (Conrad et al. 2011). Additionally, family owners may face challenges such as the capital necessary for investment or technological knowledge to manage their stands for bioenergy (Munsell, Fox 2010).

As discussed in section 2 , the promotion mechanisms in the major importing countries are associated to the compliance of **sustainability** requirements. Given the lack of a EU-wide binding scheme, the major EU importers are developing national schemes (see section 2). Pellet mills and associated energy utilities in the EU are also making efforts to guarantee the sustainability of the pellet value chain, being the Sustainable Bioenergy Partnership[10] a flagship in this respect. Therefore, it would be of utmost interest to analyze the differences in terms of management that current forest practices and those practices needed to meet the sustainability requirements demanded by the EU market (in any fashion: mandatory or voluntary basis) would be, but this is out of the scope of this study.

Currently, biomass is delivered to the facilities in four major ways with regards to "sustainability" (Kittler et al. 2012):

1. Certified forest management (even if not specifically targeted to bioenergy production)
2. Controlled and mixed sourcing (certified procurement systems).
3. Inspected compliance for stewardship plans and best practices
4. Uninspected compliance with stewardship plans and best practices

None of these options fully addresses sustainability requirements but certified forest management offers the higher compliance even if it lacks of methodology to calculate GHG savings[11]. Given the limited forest area certified and the imminent demand of demonstrating compliance with sustainability, industries should work on processes to show compliance with the requirements, even on a voluntary fashion.

Given the US South forest context, in the absence of improved profitability in the traditional forest products industry, the expansion of the wood-market might be seen as a **window of opportunity** by fibermills and sawmills which could create partnerships with the energy sector (Conrad et al. 2011) just not for the utilization of downstream residues but for the mobilization of biomass, improve sustainable forest management and investments in the sector, for instance. These synergies could only be generated if a sound market considering the supply at the local scale and the timing is created.

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[10] SBP: http://www.sustainablebiomasspartnership.org/ Also, there are other initiatives that might apply such as International Sustainability Carbon Certification –ISCC- (http://www.iscc-system.org/es/) or Green Gold Label –GGL- (http://www.greengoldcertified.org/site/pagina.php?). This paper does not aim to discuss the particularities of these schemes (i.e. the sustainability indicators, the governance systems or the applicability) and hence their effectivity.

[11] Specific initiatives such as BiograceII particularly deal with GHG accounting issues of solid bioenergy. See: http://biograce.net/biograce2/

6. Conclusions and recommendations for policy makers

The wood pellet sector in the US is still in its infancy with limited evidences so many of the potential impacts are still unknown. Nevertheless, this section aims to reflect on issues relevant for sustainable market development.

European **demand of wood pellets** from the US South deems unquestionable in the coming years but the amount and pace of growth will be determined by policy decisions in the EU. From the 0.8 Mt of pellet exported from the US (South) to the EU in 2011 and the 2.9 Mt in 2013, estimated demand could reach up to 5.5 Mt of pellets by 2015 (PIC 2013) although other estimates point out this figure by 2020. Current pellet production capacity in the US South is 6.6 Mt that could reach 15.3 Mt if all announced plants would be built (own calculations as July 2014 based on Biomass Magazine) with estimates pointing to 21 Mt by 2020 (Pöyry 2014). Projected pellet capacity imply a sharp increase of feedstock consumption that may total about 25 % of the demand levels for small diameter trees from 2011 in the short term.

Pellet demand in the US South is driven by policies in Europe aimed to achieve various energy and climate related targets. Currently, wood-pellet industries in the US South **benefit from subsidies** such as the Biomass Crop Assistance Program (with limited effect) and state and local subsidies (mostly to generate employment) from the supply side (US) and the demand side (Europe), with different configurations among major countries (BE, DK, NL, UK). Governmental support would be needed to continue to boost woody bioenergy projects (Alavalapati et al. 2013).

The trend traditional forest industry and the readiness of other industries within the bioeconomy framework will dictate to a great extent the availability of feedstocks for the wood-pellet sector. The traditional forest industry is not expected to be dramatically altered but government policies promoting renewable energies in the US - such as the Renewable Fuel Standard and Renewable Portfolio Standards - as well as efforts on biorefineries might play a significant role on the availability of feedstocks for pellet production, assuming that the **domestic consumption** of resources would be preferred to export options.

The **pace of growth** is a relevant factor to take into account since rash decisions might result in an unstable market and hence undesirable effects. Strategic decisions considering the full picture, implementation aspects (pace of development) and interactions with respect to land use, energy, climate change, green economy, etc… are needed.

Given the significant biomass availability in the US Southeast, today and at regional level, relevant **displacement and competition** between the bioenergy sector and the pulp and paper sector for feedstocks has not been observed yet. However, at a more local level there are regions, particularly those located along the coast, where the demand for the pulp and paper sector is still quite high and hence interactions between the traditional forest sector and the pellet industry can still be observed (PIC, 2013). In the longer term, if the medium to higher levels of projected pellet production capacity expansion (8 to 20 Mt) are realized by 2020, there will be higher interaction among sectors and hence increased competition and displacement might occur. In this, the type of feedstocks used for pellet production will be key and will be dependent on the mobilization capacity of the forest resources (i.e. primary and secondary forest residues) and on the wood paying capacity of the pellet mills. Thus, the effects will greatly depend on the **supply responses**.

The **feedstocks prices** are expected to continue increasing, although there are several variables playing a role such as the demand, including the associated sustainability criteria, and the competition, generated by the inelastic response of the demand and supply sides (Abt et al. forthcoming). Nonetheless, making generalizations at the regional level is challenging and effects at the appropriate **geographical level** should be assessed.

Synergies between the traditional forestry operations and new forestry techniques as well as between the traditional wood markets and bioenergy markets are deemed achievable in the long term. Nevertheless, the short term perspective should not be forgotten and measures to avoid negative and unintended effects on ecosystems and markets put in place. Because of that, decision makers should aspire to promote approaches that result in industry complementary relation instead of competition. This refers to both the best allocation of the woody biomass resources and the effects on prices.

In this, given the long-term effects of **forest (or land-use) policies**, careful planning would be needed. For example, if policies aimed at pine reforestation or afforestation would be promoted biomass availability would only be ready after 12-15 years (first thinnings) and in that exact time demand of these feedstocks is needed to prevent any market disruption. Then long-term policies that assure and balance the supply and demand are needed.

It is necessary to acknowledge the **forest ownership** to better understand the real biomass availability and the mobilization as well as the potential impacts on forest management. Family owners, Real Estate Investment Trusts and Timber Investment Management Organizations will be key players in the supply of this market so their different realities have to be considered.

In many arenas, there is a broad discussion about the pros and cons of forest bioenergy promotion. This particularly refers to impacts on biodiversity and climate change. The scientific community is still discussing several issues since there are many uncertainties in various fields: e.g. GHG accounting of forest bioenergy or the amount of primary residues that might be extracted without adverse effects on ecosystems. Because of that, policy makers should consider **precautionary approaches** when such uncertainties still exist and encourage research to provide a sound answer to the open questions.

Forest regulations towards Sustainable Forest Management in the US might seem weak from the EU perspective. This reinforces the necessity to promote mechanisms to assure that woody biomass procurement is in accordance with the principles of SFM and that (EU MS) sustainability criteria are fully met. Additional mechanisms to BMPs are needed to protect biodiversity (Evans et al. 2013) although it is unlikely to happen since the US South culture is decidedly pro landowner rights (Fledderman 2014).

There are several uncertainties (Abt et al. forthcoming), including:

- How increased feedstocks prices might affect land use changes (natural forests to pine plantations or agricultural lands to pine plantations).
- How the sustainability criteria might affect the inventory available (and costs).
- The effects of prices on biomass mobilization (e.g. forest residues) and the viability of traditional timber users.

All in all, and aiming to make the most of this incipient market, decision-makers should consider short and long-term cross-cutting policies aiming to capture the complexity of the inter-linked systems and promoting the most efficient development.

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References

Abt R C, Abt K L 2013: Potential Impact of Bioenergy Demand on the Sustainability of the Southern Forest Resource;in: *Journal of Sustainable Forestry*, 32:175–194, 2013 http://www.srs.fs.fed.us/pubs/ja/2013/ja_2013_abt_001.pdf

Abt R C, Abt K L, Galik C 2012. Effect of bioenergy demands and supply response on markets, carbon, and land use; in: Forest Science vol. 58, pp. 523-539.

Abt B, Abt K, Galik C 2013: Southern Timber Markets and Forest Sustainability. Housing Starts and Timber Supply; Presented at The Transatlantic Trade in Wood for Energy: A Dialogue on Sustainability Standards and GHG Emissions 23-24 October 2013, Savannah Georgia (USA) http://www.pinchot.org/doc/468/

Abt K L et al. Forthcoming: Draft. Effect of policies on pellet production and forests in the US South. Gen. Tech. Rep. SRS-GTR-XXX. Asheville, NC: USDA-Forest Service, Southern Research Station. Forthcoming.

AEBIOM (European Biomass Association) 2013: European Bioenergy Outlook 2013. Statistical Report; Brussels. http://www.aebiom.org/blog/aebiom-statistical-report-2013/

Alavalapati J R R et al. 2009: Southern Bioenergy Roadmap; Southeast Agriculture & Forestry Energy Resources Alliance (SAFER), University of Florida; Blacksburg, etc. http://saferalliance1.files.wordpress.com/2010/12/roadmap_exec_sum.pdf

Alavalapati J R R et al. 2013: Chapter 10. Forest Biomass-Based Energy; in: Southern Forest Futures Project; USDA Forest Service Southern Research Station http://www.srs.fs.usda.gov/futures/technical-report/10.html#top

Aguilar F X, Song N, Shifley S 2011: Review of consumption trends and public policies promoting woody biomass as an energy feedstock in the U.S; in: Biomass and Bioenergy vol 35, pp. 3708-3718

Argus 2013: Argus Biomass Markets. Weekly biomass markets, news and analysis. 13k-035. Wednesday 28 August 2013

Backlund I 2013: Cost-effective Cultivation of Lodgepole Pine for Biorefinery Applications; Doctoral Thesis. Swedish University of Agricultural Sciences; Umea

Bioenergy International 2013: Pellets in the World 2012

Biomass Magazine 2014a: USDA to accept applications for BCAP matching payments http://biomassmagazine.com/articles/10510/usda-to-accept-applications-for-bcap-matching-payments (Accessed July 4, 2014)

Biomass Magazine 2014b: Pellet Plants; http://biomassmagazine.com/plants/map/pellet (Accessed July 4, 2014)

Biomass Research and Development Board, undated: Bioenergy Feedstock Best Management Practices: Summary and Research Needs. http://www.biomassboard.gov/pdfs/bioenergy_feedstocks_bmps.pdf

Butler B J, Wear D N 2013: Chapter 6. Forest Ownership Dynamics of Southern Forests; in: Southern Forest Futures Project; USDA Forest Service Southern Research Station http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178.pdf?

Cocchi M et al. 2011: Global Wood Pellet Industry Market and Trade Study; IEA Bioenergy Task 40: Sustainable International Bioenergy Trade; Florence etc. http://www.bioenergytrade.org/downloads/t40-global-wood-pellet-market-study_final.pdf

Conrad J L 2011: Anticipated Impact of a Vibrant Wood-to-Energy Market on the U.S. South's Wood Supply Chain; Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy In Forestry; Blacksburg

Conrad J L et al. 2011: Wood-energy market impact on competition, procurement practices, and profitability of landowners and forest products industry in the U.S. south; in: Biomass and Bioenergy vol. 35, pp. 280-287

DA (Dowgwood Alliance) 2013: The use of whole trees in wood pellet manufacturing; Ashville http://www.dogwoodalliance.org/wp-content/uploads/2012/11/Whole-Tree-Wood-Pellet-Production-Report.pdf

Danish Energy Agency 2014: Analysis of bioenergy in Denmark http://www.ens.dk/sites/ens.dk/files/energistyrelsen/Nyheder/2014/bioenergi_uk.pdf

DECC (UK Department of Energy & Climate Change) 2013a: Government Response (Part A) Biomass Sustainability Criteria for the RO; London https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/231102/RO_Biomass_Sustainability_consultation_-_Government_Response_22_August_2013.pdf

DECC (UK Department of Energy & Climate Change) 2013b: Government Response (Part B) Biomass Sustainability Criteria for the RO; London https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/230495/Part_B_response.pdf

EC (European Commission) 2013: EU Energy, transport and GHG emissions trends to 2050 - Reference Scenario 2013; Capros P et al.; Brussels http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2050_update_2013.pdf

ECF (European Climate Foundation) et al. 2010: Biomass for heat and power; Hogan M et al.; The Hague etc. http://www.europeanclimate.org/documents/Biomass_report_-_Final.pdf

Ecofys 2013: Low ILUC potential of wastes and residues for biofuels Straw, forestry residues, UCO, corn cobs; Utrecht http://www.ecofys.com/files/files/ecofys-2013-low-iluc-potential-of-wastes-and-residues.pdf

Endres J 2013: Barking up the wrong tree? Forest sustainability in the wake of emerging bioenergy policies; in: Vermont Law Review vol. 37, pp. 763-832

EU (European Union) 2009: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC; Official Journal of the EU, June 5, 2009 L 140 pp. 16–62

Evans J M et al. 2013: Forestry Bioenergy in the Southeast United States: Implications for Wildlife Habitat and Biodiversity http://www.nwf.org/~/media/PDFs/Wildlife/Conservation/NWF_Biomass_Biodiversity_Final.ashx

Evald A 2014: personal communication with Ander Evald; HOFOR; June 2014

Fledderman R. 2014: personal communication with Robert Fledderman; MWV; May-June 2014

Forest Guild 2012: Forest biomass retention and harvesting guidelines for the Southeast. Forest Guild: Santa Fe, NM http://www.forestguild.org/publications/research/2012/FG_Biomass_Guidelines_SE.pdf

Forest2Market 2014a: Current market for forest products manufacturing residuals. Prepared for American Forest & Paper Association/American Wood Council. Courtesy of Robert Fledderman

Forest2Market 2014b: Wood Fuel Prices in US South - 1Q2014; http://www.forest2market.com/blog/wood-fuel-prices-in-us-south-1q2014?utm_source=F2M+Newsletter+2014+06+Jun&utm_campaign=F2M+News+2014+06-Jun&utm_medium=email (Accessed July 7, 2014)

Forisk Consulting 2013: Update and Context for U.S. Wood Bioenergy Markets; Athens http://www.theusipa.org/Documents/NAFO-US_Bioenergy_Markets-FINAL-201306261.PDF

Fox T R, Jokela E J, Allen H L 2004: The evolution of pine plantation silviculture in the southern United States P. 63-82; in: *Southern forest science: Past, present, and future*, Rauscher, H.M., and K. Johnsen (eds.). USDA For. Serv., Gen. Tech. Rep. SRS-75, Asheville, NC. 394 p.

Fritsche U, Iriarte L 2014: Biomass Policies Task 2.4: Sustainable Imports; Cost supply curves for medium- to longer-term potentials for sustainable biomass and bioenergy (pellets, biomethane, liquid biofuels) imports to the EU-27; forthcoming; Darmstadt, Madrid

Galik CS, Abt R, Wu Y 2009: Forest Biomass Supply in the Southeastern United States—Implications for Industrial Roundwood and Bioenergy Production; in: Journal of Forestry vol. March 2009, pp. 69-77

Goh C S, Junginger M 2011: SolidStandards. Enhancing the implementation of quality and sustainability standards and certification schemes for solid biofuels (EIE/11/218); Copernicus Institute; Utrecht

Goh C S, Junginger M (eds.) 2013: Low Cost, Long Distance Biomass Supply Chains; IEA Bioenergy Task 40: Sustainable International Bioenergy Trade; Utrecht etc

Guo Z 2011: Forest Biomass Utilization in the Southern United States: Resource Sustainability and Policy Impacts; PhD diss.,University of Tennessee, 2011. http://trace.tennessee.edu/utk_graddiss/975

Huggett R et al. 2013: Chapter 5. Forecasts of Forest Conditions; in: Southern Forest Futures Project; USDA Forest Service Southern Research Station http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178.pdf?

IC (Imperial College) et al. 2012: Biomass Futures - Analysing Europe's Future Bioenergy Needs; Panoutsou C (project coordinator); London etc.

IEA-ETSAP (International Energy Agency Energy Technology Systems Analysis Programme), IRENA (International Renewable Energy Agency) 2013: Biomass Co-fi ring. Technology Brief E21; http://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20E21%20Biomass%20Co-firing.pdf

IEA (International Energy Agency) 2014: Energy Technology Perspectives 2014; OECD/IEA; Paris (forthcoming)

IINAS (International Institute for Sustainability Analysis and Strategy), EFI (European Forest Institute), JR (Joanneum Research) 2014: Forest biomass for energy in the EU: current trends, carbon balance and sustainable potential; commissioned by BirdLife Europe, EEB, and Transport & Environment; Darmstadt, Madrid, Joensuu, Graz http://www.eeb.org/EEB/?LinkServID=FE1EAF33-5056-B741-DBEF3F46BC26A1E1

Ince P J, Kramp A, Skog K E 2012: Evaluating Economic Impacts of Expanded Global Wood Energy Consumption with the USFPM/GFPM Model; in: Canadian Journal of Agricultural Economics vol. 60, p. 211–237

Jonker J G G, Junginger H M, Faaij A P C 2013: Carbon payback period and carbon offset parity point of wood pellet production in the Southeastern USA; in: Global Change Biology – Bioenergy; DOI: 10.1111/gcbb.12056

Junginger M 2013: The strategic importance of the Southeast US in global biomass trade; presented at The Transatlantic Trade in Wood for Energy: A Dialogue on Sustainability Standards and Greenhouse Gas Emissions, Savannah, GA, USA 23-24 October 2013 www.Pinchot.org/pellets

Junginger M 2014: personal communication with Martin Junginger; Utrech University and IEA Bio Task 40; June 2014

Kittler B et al 2012: Pathways to sustainability; Environmental Defense Fund and Pinchot Institute; Washington; http://www.edf.org/sites/default/files/pathwaysToSustainability.pdf

Koop D, Morris C 2012: Biomass. Historical price overview for wood pellets; Renewables International the magazine http://www.renewablesinternational.net/historical-price-overview-for-wood-pellets/150/515/33138/

Lang A 2013: Limits to Growth: Wood Pellet Production in the U.S.; Forisk Consulting http://pelletheat.org/wp-content/uploads/2010/01/Amanda-Lang-Forisk_-Bioenergy_limit_to_growth_PFI-20130730.pdf (Accessed July 14, 2014)

Macedo M 2013: International Paper. South Carolina Forestry Association Annual Meeting http://scforestry.com.jangostudios.biz/Portals/0/An.%20Mtg.%202013%20Mike%20Macedo.pdf

Malmsheimer R W et al. 2008: Forest Management Solutions for Mitigating Climate Change in the United States; Journal of Forestry ; April/May 2008, pp. 115-173

Manomet (Manomet Center for Conservation Sciences) 2010: Biomass Sustainability and Carbon Policy Study http://www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-full-hirez.pdf

Market Watch 2014: Wood Resources International LLC: Wood pellet exports from North America to Europe have doubled in two years with the US South accounting for 63% of the volume http://www.marketwatch.com/story/wood-resources-international-llc-wood-pellet-exports-from-north-america-to-europe-have-doubled-in-two-years-with-the-us-south-accounting-for-63-of-the-volume-2014-05-06 (Accessed July 4, 2014)

Munsell J, Fox T 2010: An analysis of the feasibility for increasing woody biomass production from pine plantations in the southern United States; in: Biomass and Bioenergy vol. 34, pp. 1631-1642

Nellen M 2013: Policy for sustainable biomass valorization in the Netherlands; Utrecht http://www.b2match.eu/system/sahyog/files/4_Nellen.pdf?1383141293

NEN (Nederlands Normalisatie-Instituut) 2009: Netherlands technical agreement. NTA 8080(en) Sustainability criteria for biomass for energy purposes; Delft

NREL (National Renewable Energy Laboratory) 2012: Biomass Resource Allocation among Competing End Uses; Golden

Pelkmans L 2013: Belgium – National Policy Landscape update; BiomassPolicies Project meeting Brussels, 25-27 November 2013

Pellcert 2012: Industrial Wood Pellets Report; Verhoest C, Ryckmans Y

PIC (Pinchot Institute for Conservation) 2013: The Transatlantic Trade In Wood For Energy: A Dialogue on Sustainability Standards and Greenhouse Gas Emissions; Savannah (GA) 23-24 October 2014; Washington DC; http://www.Pinchot.org/pellets

Pöyry 2013: Biomass Sourcing Strategies. Non-Technical Challenges of a Company Intending to Build a Demonstration/Flagship plant; presented at the European Biofuels Technology Platform 5th Stakeholder Plenary Meeting; 6th-7th February 2013; Lechner H; Brussels

Pöyry 2014: The Global Pellet Market Growth prospects and market dynamics; A presentation to the Working Group on Dutch Sustainability Criteria for Solid Biomass; 10th March 2014; Lechner H; Utrecht

Qian Y, McDow W 2013: The Wood Pellet Value Chain An economic analysis of the wood pellet supply chain from the Southeast United States to European Consumers; US Endowment for Forestry and Communities

REN21 (Renewable Energy Policy Network for the 21st century) 2012: Renewables 2013. Global Status Report; Paris http://www.ren21.net/Portals/0/documents/Resources/GSR/2013/GSR2013_lowres.pdf

Smith W B et al. 2009: Forest Resources of the United States, 2007. General Technical Report WO-78, USDA Forest Service, Washington, D.C. http://www.fs.fed.us/nrs/pubs/gtr/gtr_wo78.pdf?

USDA (US Department of Agriculture) 2010: Biomass Crop Assistance Program; Final Rule; Wednesday, October 27; Federal Register

USDA FS (US Department of Agriculture – Forest Service) 2009: U.S. Forest Resource Facts and Historical Trends; http://fia.fs.fed.us

USDA FS (US Department of Agriculture – Forest Service) 2013: Southern Pulpwood Production, 2011; Southern Research Station; Resource Bulletin SRS–194

US EPA (US Environmental Protection Agency) 2014: Carbon Pollution Standards http://www2.epa.gov/carbon-pollution-standards (Accessed July 7, 2014)

Vakkilainen E, Kuparinen K, Heinimö J 2013: Large Industrial Users of Energy Biomass; IEA Bioenergy Task 40: Sustainable International Bioenergy Trade http://www.bioenergytrade.org/downloads/t40-large-industrial-biomass-users.pdf

Volpi G 2014: Biomass sustainability: EU update; presented at the AEBIOM European Bioenergy Conference May 13, 2014 in Brussels

Walker S 2012: North American Wood Pellet Markets; Bedford, MA http://pelletheat.org/wp-content/uploads/2010/01/Walker.pdf

Wang W, Khanna M, Dwivedi P 2013: Optimal Mix of Feedstock for Biofuels: Implications for Land Use and GHG Emissions; Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013

Wear D N et al. 2013: Chapter 9. Markets; in: Southern Forest Futures Project; USDA Forest Service Southern Research Station http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178.pdf?

WPAC (Wood Pellet Association of Canada) 2012: Market data and trends from Argus conferences http://www.pellet.org/wpac-news/market-data-and-trends-from-argus-conference (consulted January 10, 2014)