Global Wood Chip Trade for Energy

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Task 40: Sustainable International Bioenergy trade

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1. Background and aim

Bioenergy currently contributes roughly 10% (around 50 EJ) to total global primary energy supply [1]. While the majority of this share is for traditional cooking and heating applications, 38% are regarded as 'modern' usage i.e. with higher conversion efficiency and for the production of high temperature heating, power, or road transportation [1-5]. Current policy frameworks, e.g. for GHG emission reduction or the diversification of energy supply, imply a trend towards an increased utilization of modern bioenergy. This includes a further replacement of traditional with modern bioenergy usage. An increasing use of modern bioenergy will inevitably be intertwined with large-scale international trading activities of bioenergy commodities. A recent global review by Lamers et al. [6] on international solid biofuel trade showed that net global solid biofuel trade grew sixfold from 56.5 PJ (3.5 Mtonnes) to 300 PJ (18 Mtonnes) between 2000 and 2010. Over this period, wood pellets have clearly become the dominant solid biofuel commodity on international markets [7]; whereas trade streams of wood waste, roundwood, and wood chips for energy have been significantly smaller and practically limited to Europe [6]. Europe remains the key region for international solid biofuel trade, covering around two thirds of global net solid biofuel trade by 2010 [6].

Task 40 under the IEA Bioenergy Agreement[1] contributes to the development of sustainable biofuel markets on short and long term and on different scale levels. It has published several studies on international biofuel trade in the past, among others, a review of global pellet markets (see [7]).[2] Wood chips are yet another relevant global commodity for energy (see e.g. [6]), but their trade flows are heavily interwoven with streams for other purposes (mainly pulp and paper production) and little understood. Nevertheless, wood chips, given their diverse origin (pulp wood, inferior wood, wood waste, etc.), range second to wood pellets in terms of total volumes traded for energy.

This report has been commissioned to identify and present global data on wood chip trade, to analyze the underlying trade patterns, and to conclude upon their interactions with bioenergy policies. At the centre of the analysis is direct trade of wood chips for modern bioenergy use in markets where respective policies are in place. Whereas associated trade flows where the initial reason is not directly related to energy usage, e.g., wood chips for pulp and paper of which a fraction ends up as black liquor and is used for energy (see [8] for a distinction in the case of Finland) are outlined to put the energy related trade into perspective, but not investigated in detail.

[1] http://www.ieabioenergy.com/

[2] See http://www.bioenergytrade.org/ for more details

2. Methodology

To dimension energy related wood chip trade, an upper limit was derived via international commodity databases of the UN (COMTRADE [9]) and the EU (EUROSTAT [10]) since they allow differentiations by trade code. FAO statistics [11] are not categorized by trade codes. So only code-similar data could serve as a benchmark to e.g. UN [9] statistics. Trade flow declarations on the import and export side often vary within and across databases. Hence, for the upper limit the respective maximum values (in any given year) were taken. International trade codes (up to digit-8-level) so far do not allow a differentiation by end-use. Reported volumes include energy related as well as other streams, e.g. for material purposes in the case of wood chips, and are therefore generally considered as a (often largely theoretical) upper limit of possible biofuel trade volumes. To obtain solely bioenergy related production and trade streams, we relied on anecdotal evidence via conference presentations, speeches, and/or interviews of internationally recognized experts in the field from academia, consulting, and private market parties.

It is important to highlight that international trade codes are so far only harmonized until digit-6-level. Hence, global trade volumes reported by international databases can only cover this level of detail. Regional differentiations can be made at a higher code level but were limited to the European Union (EU) since is covers the majority of energy related international wood chip trade (see [6]).

3. Classifications

3.1. *Commodity codes and definitions*

Wood chips vary in quality and application depending on their source material. High quality pulp chips are directly derived from roundwood; wood chips for energy purposes are mainly based on harvesting or processing residues i.e. branches, tree tops, thinnings, other inferior wood not suitable for material or pulp and paper production, and recovered wood. Bioenergy related trade streams may therefore fall under the trade code for wood chips (*HS 440120*), further defined into coniferous (*HS 440121*) or non-coniferous (HS 440122), or under the code for sawdust and waste wood (*HS 440130*). Technically, wood chips may also be transported as fuelwood (*HS 440110*) or roundwood (*HS 4403*) – prior to chipping and combustion.

Table 1. Selected details of chapter 44 of the harmonized trade code system.

CN/HS2	Chapter description	CN/HS4	CN/HS6	Code definition
44	Wood and articles of wood; wood charcoal	4401	440110	Fuel wood (logs, billets, twigs, faggots or similar forms)
			440121	Wood in chips or particles (coniferous)
			440122	Wood in chips or particles (non-coniferous)
			440130	Sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms
		4403	440320	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared coniferous
			440391	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared oak
			440392	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared beech
			440399	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared of other (poplar, eucalyptus, birch)

On EU level, no further differentiation is made for wood chips i.e. the 8-digit-codes are simply extended i.e. *CN 44012100* for coniferous and *CN 44012200* for non-coniferous chips. Other relevant 8-digit trade codes on EU level include *CN 44013080* for wood waste and scrap; the counterpart of *CN 44013020 (Pellets)*[3] which in sum makes *HS 440130.* This differentiation allows a better image of picture of energy related wood waste trade.

Roundwood aimed to be chipped on-site has typically been traded in the EU under trade codes covering 'wood in the rough, whether or not stripped of bark or sapwood, or roughly squared' [12]. Most often, these codes exclude sawlogs. Certainly though they exclude rough-cut wood blocks aimed for further processing (e.g. walking sticks, umbrellas, tool shafts), in the form of railway sleepers, boards, beams, or treated wood (i.e. with paint, stains, creosote or other preservatives). The 8-digit-code level differentiates between main tree species making the range of potential trade codes quite long: *CN 44032019, 44032039, 44032099, 44034100, 44034910, 44034935, 44034995, 44039190, 44039290, 44039910, 44039930, 44039959*, *44039995*.

[3] As of January 2012, pellets will be reported under a new international code: HS 440131 i.e. CN 44013100 in the EU.

3.2. *Industry standards*

The European Committee for Standardization (CEN), under technical committee TC335, has published 27 technical specifications (pre-standards) for solid biofuels during 2003 – 2006 [13]. The next step is to upgrade these technical specifications to full European standards. When European standards are in force, the national standards have to be adapted to these standards. Wood chips can be specified according to standard EN 14961-1 for general use. Demolition wood is not included in the scope of the EN 14961-1, but in the scope of EN 14588 (used wood arising from demolition of buildings or civil engineering installations). The EN 14961-1 includes also wood waste, if it is not containing halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating. The following characteristics are described for specification of wood chips, in the frame of EU 14961-1: origin (forest, plantation and other virgin wood; by-products and residues from wood processing industry; used wood; blends and mixtures), dimensions, moisture, ash content, nitrogen, chlorine, net calorific value, bulk density, ash melting behaviour.

4. Dimensioning global wood chip trade

As outlined in Section 3.1, there are several commodity codes under which wood chips may be traded for energy purposes. The historic trade volume developments of these codes have varied tremendously. Figure 1 highlights the relative importance i.e. varying volumetric dimensions of the commodities from Table 1.

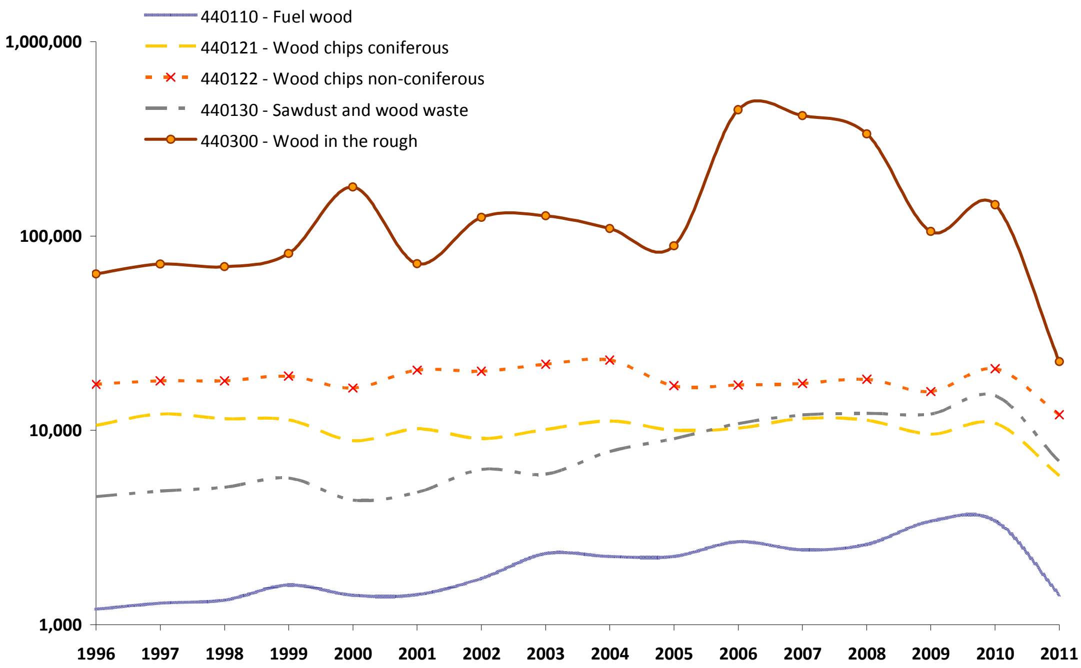

Figure 1. Trade streams developments linked to wood chips (> 1,000 ktonnes) in ktonnes based on import data from [9]

Note: Y-axis in logarithmic scale

Among the codes in focus, fuelwood (***HS 440110***) comprises of the lowest annual trade volumes. It is regarded a rather local product; with less than 1% of its production being traded annually according to official statistics. Informal cross-border trade though is often not included in such data as it is difficult to monitor or estimate. Due to the high share of traditional heating and cooking, it may however be significant.

In terms of modern fuelwood use for energy, the EU27 has been a key driver and importer over the last years, increasing its share of global trade from 50% between 2000-2004 to over 80% between 2005-2009 [6, 9]. Large-scale trading of fuelwood requires special handling in bulk transport. This reduces the bulk (energy) density and makes long distances less economically feasible. Most trade takes place cross-border i.e. short- or mid-range in bagged form, conglomerated in nets, or stacked on pallets [6]. Recorded trade streams outside Europe are between South Africa and its neighboring countries (foremost Swaziland and Namibia), Canada and the USA, and across South East Asia [9].

International wood chip trade under codes ***HS 440121*** and ***HS 440122***, the second largest absolute single trade streams (see Figure 1), mainly refers to high quality chips for pulp and paper production. Wood chip and pulp and paper production and trade volumes have correlated over the years and slightly declined after the global financial crisis in 2008/2009 [6]. The top wood chip producing nations over the last decade include Canada (37%), Australia (8%), Sweden (7%), Russia (6%), and China/Finland (each 5%) [11]. All countries are also large pulp and paper producers. A clear pulp and paper industry trend is the shift in production from the Northern to the Southern hemisphere. The upcoming top wood chip producing nations will be found in South America (e.g. Brazil) and South East Asia (e.g. Vietnam).

Pulp and paper related wood chip trade has been partly cross-border, e.g. within Scandinavia, Finland-Russia, Canada-USA, but is increasingly driven by net wood importing nations. In some years across the past decade, Japan has attracted over 50% of all globally traded wood chips [9]. Shares of aforementioned countries (Canada, Sweden, Finland) are an order of magnitude smaller (i.e. below 5% of global trade on average across 2000-2009) [9]. China is most likely going to become an even large wood chip importer than Japan over the coming years.

The EU has also been a net importer of wood chips; sourcing mostly from Russia, Uruguay, Brazil, and Canada [10]. Extra-EU trade streams have been largely directed to Austria and Italy [9]. Sweden and Finland, two other major importers source largely from within the EU or their border countries [10]. Top EU-exporters have been Germany, Latvia, and Estonia [10]. The majority of European wood chip trade is covered by high quality pulp chips. Bioenergy related trade though is believed to rank second [12, 14, 15].

The trade category ***HS 440130*** *Sawdust and wood waste and scrap* covers a large variety of woody residues. As stated earlier, the majority of energy related trade is linked to sawdust (and other processing residues) in the form of wood pellets. The second largest fraction though 'waste wood and scrap', which technically can be in the form of wood chips, has no standard definition (see Section 3.2). Thus, trade data might include a variety of streams from harvesting and processing residues, inferior (small diameter/low quality) roundwood to recycling/recovered wood [16].

Large scale international shipments of recycled wood for energy purposes are still rare but have been known to occur. The majority of wood waste though appears to have been landfilled, combusted locally, or traded short distances, mainly cross-border. The key region for international wood waste trade is currently Europe; primarily due to its differences in legal and bioenergy policy frameworks across the individual Member States (see [6] for a review). Wood waste is generally not chipped but rather crushed (at least partly) to minimize transportation costs [17].

As shown in Figure 1, roundwood (***HS 440300*** *Wood in the rough*) dominates international trade streams in terms of total trade volumes. Relative to production though (see Figure 2), less than 10% of globally produced industrial roundwood is traded annually. This indicates that industrial roundwood is primarily used locally and that the core producing centers are home to the world's major wood processing industries. The recent strong variation in trade (and production) can be attributed to the introduction of export duties on roundwood from Russia (in 2007) and the economic crisis in 2008/2009. The decline in Russian roundwood exports however went hand-in-hand with an increase in Russian fuelwood exports (not underlying tariff restrictions) [18]. Post 2008/2009, Russia also exported additional wood chip volumes; the majority of which went to Finland and China [9] where they are exclusively used in pulp and paper production [19]. The majority of global roundwood production and trade is not connected to wood chip trade for energy. Nevertheless, there is a large amount of associated trade in the form of wood processing residues (scraps, shavings) [8, 19].

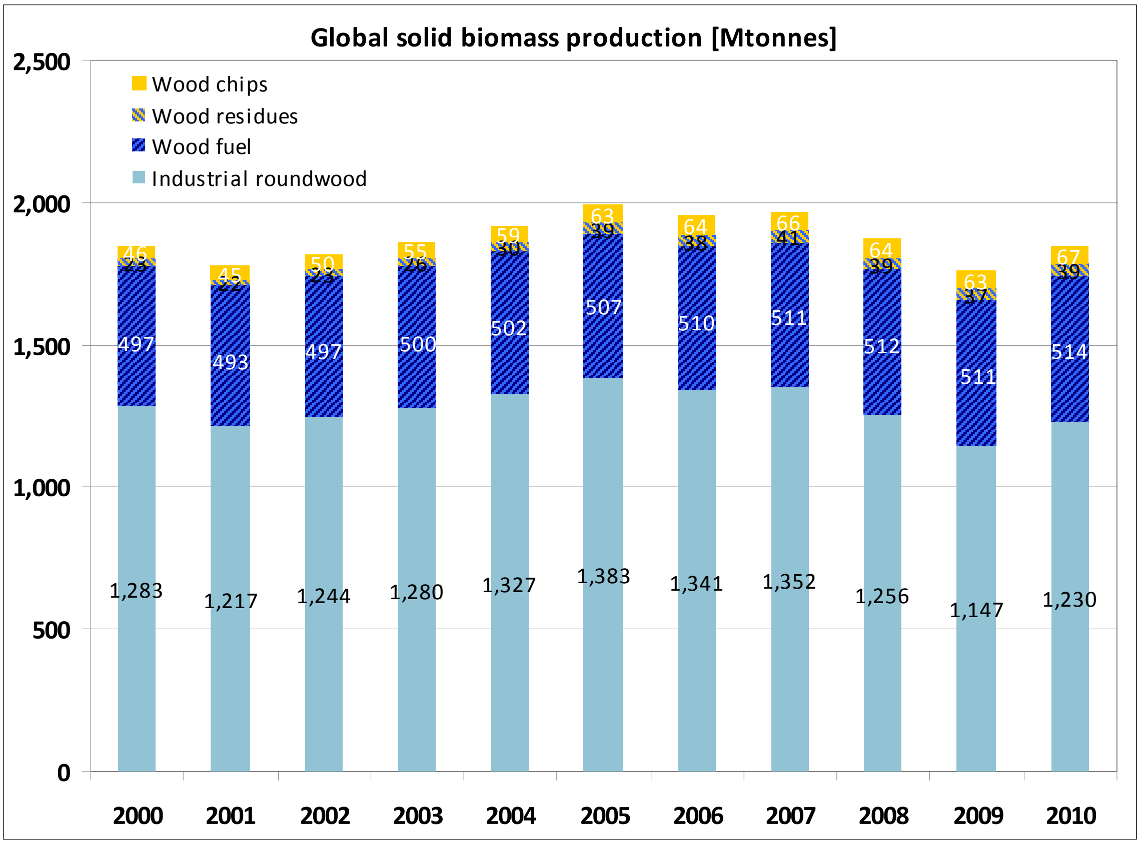

Figure 2. World production of selected solid biomass types in Mtonnes (Data: [11])

5. Global wood chip trade

5.1. *Europe*

Largely due to recent energy policies, but also price competitiveness of wood fuels in some regions, and a strong forestry sector, Europe has been the prime market for energy related biomass trade over the past decade. Trade in wood waste, roundwood, and wood chips for energy is practically limited to Europe [6].

5.1.1. Virgin wood chips

One can distinguish between two wood chip markets and thus major trade flows for energy production in Europe. The first comprises of states bordering the Baltic Sea, where Sweden and Denmark (to some extent also Germany) have been leading importers over the last decade, sourcing largely from the Baltic States and Russia [12, 14, 15]. The second, in the southern part, is primarily driven by facilities in Italy which source from neighboring countries, in particular the Balkan (see Figure 3) [20]. All countries use wood chips mainly in medium scale (CHP), fluidized bed installations. Sweden is most likely the largest EU consumer of wood chips for energy purposes [17]. While it tends to source them mostly domestically, imports rose sharply due to harsh winter conditions in 2010/2011 [14].

Between 2000-2005, wood chips were transported for energy from the US to Europe (primarily Italy); with annual volumes of up to 200 ktonnes [21]. When it became apparent that these streams were in violation of the EU requirements for phytosanitary measures, the trade came to a halt. The EU still requires phytosanitary measures for softwood chips from North America; essentially prohibiting the importation of softwood chips (Southern Yellow Pine). The restrictions have practically eliminated the largest of the softwood chip trade (utilizing Southern Yellow Pine) for both energy and pulp and paper production to Europe. [22]. As a result, softwood chip streams to other countries with less import restrictions have grown; primarily trade flows to Turkey and China.

Norway has previously imported (mostly hardwood) chips from Canada, Brazil and Africa, for pellet production [23]. Trade volumes were expected to reach around 330 ktonnes p.a. by 2011[23], but seem to have come to a halt [21]. The current largest international trade flows to the EU for energy purposes are rubberwood chips from Liberia, destined for co- and mono-firing facilities of the Swedish energy utility Vattenfall [24]. In 2011, 60 ktonnes were imported [10].

Generally, wood chips for energy purposes have been transported over shorter distances than e.g. wood pellets. Apart from vessel size restrictions in the Baltics, this is primarily due to the ratio between moisture content, heating value, and bulk density as compared to wood pellets [15, 20, 25].

European combustion facilities have been known to not only import virgin wood chips i.e. freshly chipped, previously unused, woody biomass (excluding tertiary residues) but also roundwood. This allows facilities to control chip sizes and quality, and there are also benefits in terms of storage (moisture, heating value) [12]. In the Baltic Sea region these two trade streams are closely interrelated since they are often traded/transported on the same vessel [17, 26]; apart from ending up in similar conversion facilities. Cold winters in Baltic Sea harbors though often lead to ice build up, reducing the capability of northern harbors to receive or export woody biomass. In some years this has led to increasing imports from Southern Europe to Denmark and Sweden [12]. So far though, no extra-EU imports of roundwood for energy purposes are known.

Wood chip and roundwood trade in Europe usually takes place directly between supplier and consumer. Combustion plants taking wood chips are often located close to waterways, allowing for a relatively economic transport of the comparatively moist biofuel. Low water levels – especially in Baltic harbors – do not allow the landing of large open-sea going vessels and therefore limit trade options primarily to short-sea shipping (3-10 ktonnes) [17, 20, 26].

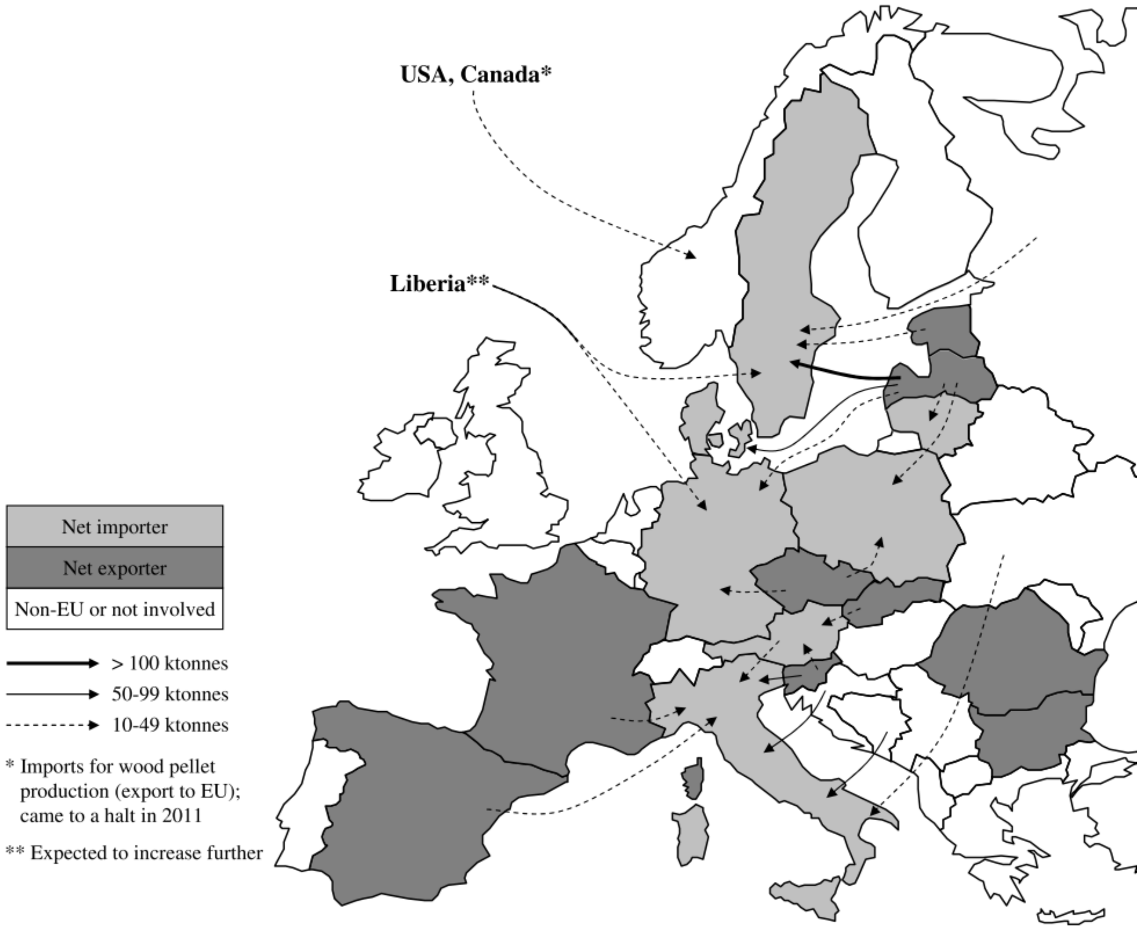

Figure 3. Dimensions of bioenergy related wood chip trade patterns in Europe based on [6, 9, 10, 14, 15, 17, 20, 23, 26]
Note: Trade streams towards Denmark, Germany and Sweden are also indicators for roundwood trade volumes and routes.

5.1.2. Wood chips from tertiary residues

Today waste wood combustion in dedicated plants or in co-combustion with wood chips and industrial pellets has become common practice in many EU Member States. Differences in renewable energy policy support schemes though have led to a flourishing EU-wide trade in which different waste wood streams are exchanged between the Member States (see Figure 4). Historically, Sweden was among the first states to attract large amounts of wood waste (see [6] for a review). Today, trade to other Member States is far larger. Top importing nations include Germany, Italy, and Belgium; the major exporters are clearly the Netherlands and the UK (see Table 2 and Figure 4).

The relatively balanced import-export relation of Belgium and Germany is largely related to national policy schemes which favor different streams of waste wood. The German renewable electricity feed-in scheme e.g. has provided strong incentives for the combustion of clean (non-treated) waste wood. Whereas, in the past, more contaminated waste wood had e.g. attracted higher subsidies in the Netherlands [27]. As a result, Germany imported eligible and exported non-eligible wood waste streams.

Table 2. Intra-EU trade in waste wood (*CN 44013080*) in ktonnes [Data: [10]].

	2009		**2010**		**2011**		**Market Share**	
Country	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Netherlands	175	1,003	152	943	170	850	6%	**22%**
United Kingdom	34	611	31	613	37	478	1%	**13%**
Germany	489	560	612	616	675	596	**22%**	**14%**
France	200	432	329	549	416	609	**11%**	**12%**
Belgium	253	286	377	327	487	350	**14%**	7%
Portugal	5	58	10	214	14	42	0%	2%
Poland	5	159	11	167	25	157	0%	4%
Austria	193	141	236	140	298	133	9%	3%
Slovenia	8	113	11	128	13	133	0%	3%
Czech Republic	15	125	31	99	44	81	1%	2%
Luxembourg	82	95	87	85	140	92	4%	2%
Denmark	159	57	110	52	170	82	5%	1%
Italy	293	43	378	37	499	51	**14%**	1%
Sweden	83	16	165	8	286	15	6%	0%
Finland	58	38	25	15	1	3	1%	0%
Other	102	502	115	459	137	529		
EU	**2,152**	**4,242**	**2,679**	**4,453**	**3,411**	**4,199**		

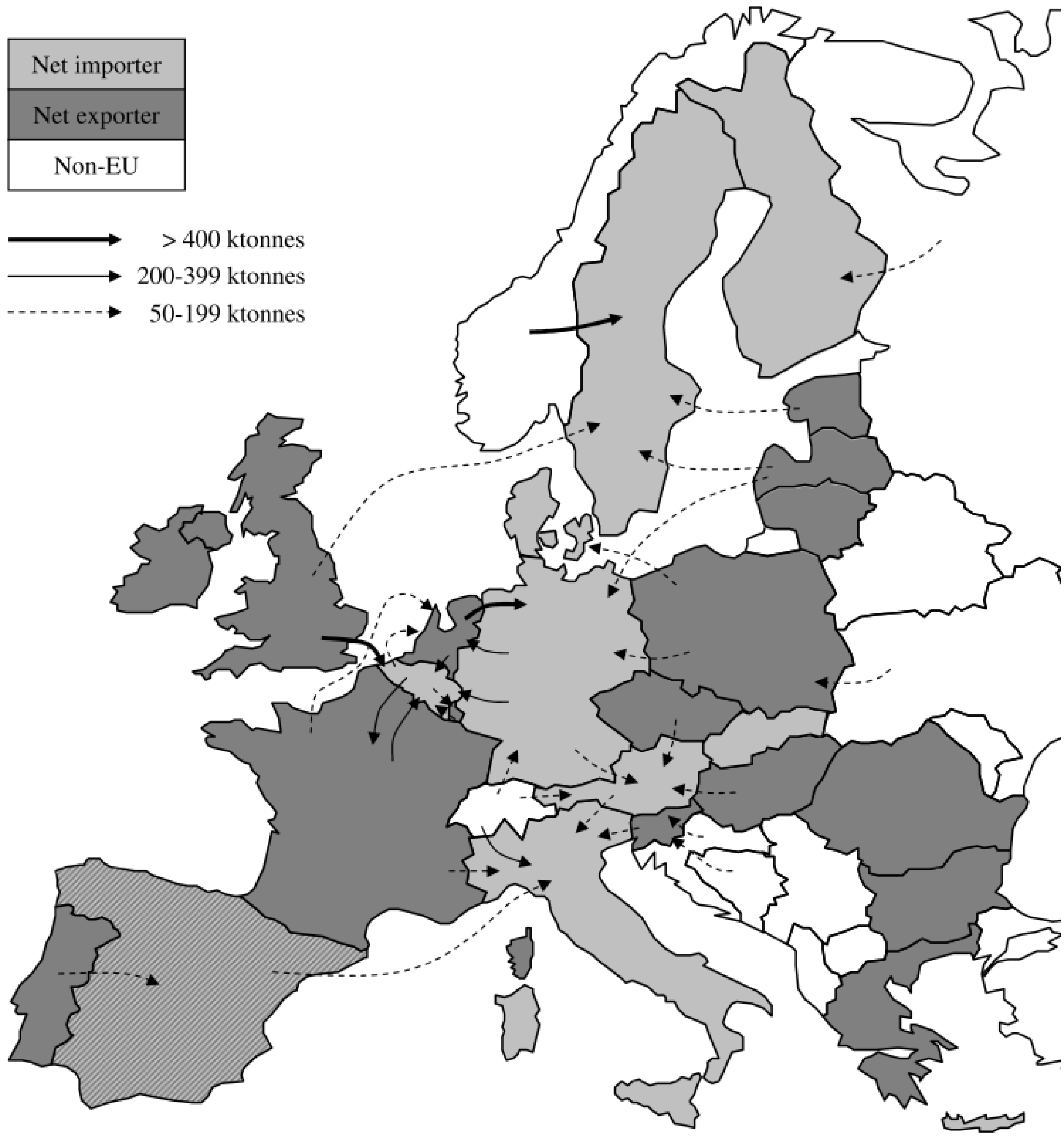

Figure 4. Dimensions of typical waste wood trade (> 50 ktonnes) across Europe based on [6, 10]
Note: Streams represent maximum annual volumes i.e. may be based on import or export data. Exports may include re-exports.

5.2. *Rest of the world*

Wood chips are typically used in fluidized-bed installations, technically also in combination i.e. co-combustion with coal. Such facilities are present all around the world. Outside Europe, the three main destinations for international wood chip trade include: Japan, Turkey, and China.

In 2010, there was a substantial increase in demand for wood chips in China. This country has evolved from being a net exporter of chips five years ago, to being a major chip consumer, having quadrupled imports in just two years. The country now imports over 28% of all chips traded in the Pacific Rim and is the world's second largest importer of wood chips after Japan. Trade of wood chips is still the highest in the Pacific Rim, accounting for almost 60% of the total global trade and over 95% of water-born trade.

So far, little is known about exact volumes entering China for energy purposes. Clearly though they are able to reach very large dimensions in the near future. Trade flows to China originate primarily in the Asian region. Potential, large wood chip supply countries include Australia, Vietnam, and Russia.

Japan has previously sourced wood chips from Canada. The current IEA Task 40 country report on Japan [28] notes that 300 ktonnes of wood chips for energy were imported in 2011; all by one single power plant (Chubu Electric). Previously (see [6, 29]), it was expected that wood chips for energy production would be solely derived from domestic demolition wood and that Japanese wood chip imports cover pulp chips exclusively.

In Europe, Turkey has been – and remains – the key destination for international softwood chip imports. As it does not apply strict import requirements, and does not form part of the European Union, it can and has imported large volumes of softwood chips from North America.

Over the past few years there has been a rapid, worldwide expansion in the consumption of renewable energy by the pulp and paper industry [30]. Numerous plants have made the strategic decision to invest in equipment needed to switch from fossil fuels to woody biomass. The annual consumption of biomass for energy generation by the global pulp industry in 2009 was an estimated 75 million tonnes. While the biggest increases have occurred in Latin America, Asia and Oceania, mills in North America and Europe are still the largest users of biomass, sourced mainly from forest residues and industry co-products.

In 2009, the financial crisis had a major impact on the Russian forest and woodworking sector [30]. Regardless of the poor investment climate and reduced availability of wood waste, the wood energy market was one of the branches of the forest and woodworking sector that has had rising demand and supply since 2007. In reaction to the investment malaise in the forest and woodworking sector, several regional governments have developed subsidizing mechanisms, which directly or indirectly stimulate the wood energy market. The increased export tariffs on unprocessed wood, and the decline in wood processing, resulted in a surplus of roundwood in 2009. Some of these logs were chipped and exported as wood fuel.

6. Phytosanitary measures

6.1. *Historic wood chip bans*

In 1984, pine wood chips from the US and Canada were found to be infested with pine wood nematodes which are considered to cause pine wilt disease. The wood chip embargo commenced in 1985 when Finland banned the importation of conifer chips and timber cut from softwood trees grown in areas of the world in which pine wood nematodes are present. The same year, the EU Plant Protection Organization (EPPO) recommended that Europe as a whole bans softwood products except kiln dried lumber from countries known to have pine wood nematodes (Bursaphelenchus xylophilus). Although the US government vehemently objected the ban, resulting in fact finding teams from Finland, Norway and Sweden visiting the US, it was implemented across the EU.

The prevailing argument was that the EU could experience a pine wilt disease epidemic similar to the one which occurred in Japan in 1969; and which was blamed on wood chip imports from North American trees killed by a pine wilt epidemic. That also was not found to be the case, nor was it the cause of tree dieback in Canada. In fact, pine wood nematodes are seldom, if ever, the primary cause of mortality of conifers in the forests of North America.

The current EU regulation for softwood imports from North America, which requires kiln drying, cannot be applied to wood chips as the drying process would result in the burning of the wood chips.

6.2. *The European Commission Standing Committee on Plant Health*

Under the EU Directive 2000/29/EC, the importation of wood chips for whatever purpose is regulated under the lumber standard of kiln drying which requires heat exposure of 56°C for 30 minutes. However, the international recognized (IPPO) standard of ISPM-15 allows for <6 mm packing material (soft or hardwood) to be shipped without further regulation. Despite the fact the Committee and the EU Health & Consumers Directorate acknowledge this inconsistency no actions have been taken so far to change it. Due to an outbreak of pine wood nematodes in Portugal in 2008 and more recent outbreaks in Spain in 2010, the EU has not been open to any further change in the Directive.

At the same time, the EU acknowledges the need for wood chip imports for power generation and the increasing need for wood fuel based power generation. There is no ban on the importation of wood pellets despite the fact that their heat treatment does not meet the kiln dried standard. However, wood pellets made from softwood, are literally exempt from any regulation and require no supportive scientific data for export to the EU.

6.3. *Recent US developments on eradicating nematodes in wood chips*

In 2010, a scientist at the University of Arkansas was contracted by a private company to develop a process using heat treatment that would eradicate the nematode in pine wood chips without degrading the quality of the chip and that would gain approval by the USDA. The USDA must issue a Phytosanitary certificate for each export shipment specifying the treatment. The results of the testing proved conclusive and the testing was moved from the lab scale to commercial scale. The USDA has approved the testing method and it is in the process of being patented. The patent pending process requires a special facility whereby the chips are batch processed using a specified regime of time and temperature. The process uses lower temperatures over a 2 ½ hour duration which does not degrade the wood chips but has been proven to kill the nematodes.

The private company that contracted the study at the University of Arkansas has the patent application in process and it will be proprietary to them. They will build the facilities which will have a 40,000 s/t per month capacity and receive a fee per ton for processing the wood chips which at this point would be cost prohibitive for the EU countries since the current market price for wood chips could not bear the additional expense of the heat treatment. The first commercial scale plant is scheduled to be built in Mississippi. The target market currently is the Far East, primarily China for use in fibreboard/mdf and paper production where importation of pine wood chips is allowed but must be fumigated with methyl bromide prior to importation. This has proved costly and many times ineffective when the wood is tested upon arrival resulting in load rejection until re-fumigation can take place.

Other processes for eliminating nematodes continue to be studied in the US. These include densification of the wood chips in briquette form to allow the fibers to stay intact as well as more cost effective heat treatment methods. Another University study is also examining the possibility that once in chip form, nematodes, if found in the chips, can not pose a threat to living timber.

7. Summary and conclusions

It is estimated that less than 10% of annually reported wood chip trade volumes are energy-related. The remaining, largest fraction is primarily destined for pulp and paper production, with some trade for other uses such as fibre and particle boards. Energy-related wood chip trade takes almost exclusively place to and within the European Union (EU), where respective policies promoting the use of renewable energy have stimulated wood chip use in the residential and industrial segment.

Wood chips for the EU residential market are primarily sourced locally. Hence, international wood chip trade is exclusively driven by the industrial sector, where chips are combusted in dedicated or converted co- and/or mono-firing installations (primarily fluidized-bed). Respective trade takes place in the form of chips (virgin wood chips), crushed (waste) wood, or as roundwood which is chipped at the plant. Official statistics indicate that wood waste volumes dominate the EU-related trade.

Outside the EU, wood chip trade is only known to occur to Japan and Turkey from Canada and the Southeastern US. Should respective policies be implemented in Asia, the region could become one of the key drivers for an increase in international wood chip trade for energy.

So far though, global wood chip trade to the EU is unlikely to increase significantly. North American imports to the EU underlie phytosanitary measures (pine beetle, and nematodes) which increases wood chip end prices and limits their use to the higher priced segments, primarily pulp and paper production. South America (esp. Brazil) and Asia are ramping up pulp and paper (and also pellet) production capacities. Hence, woody material such as chips (e.g. from Vietnam) will therefore be used mostly locally. Africa has increased wood chip production (driven e.g. by companies from Sweden and Denmark), also for energy use, but end-use markets remain off-shore and companies currently investing in Africa are expected to eventually turn chips into pellets prior to transport. The strong demand in Asia and the distance to Europe make Oceania also unlikely to become a large supplier of wood chips for energy to the EU. Oceania (primarily Australia and New Zealand) already supplies wood chips to Asian pulp and paper producers, e.g. in China, Japan, India. As said above though, should any of these countries create policy incentives to use wood chips for energy, total global energy related wood chip trade could increase significantly.

Key EU wood chip markets for energy lie in Scandinavia and Italy. Both regions currently experience an underutilization of pulp and paper production capacities resulting in an oversupply of wood chips; reducing the need for global supplies. However, additional resources could also be used for other industries, e.g. fibreboard or pellet production. One potential driver for increased EU wood chip trade could be extended Russian duties on roundwood; especially to Scandinavian markets.

In general, the key constraint for international wood chip trade for energy is economic viability. Margins are primarily influenced by production and transport costs, but also prices in and exchange rates to target markets. As production costs depend heavily on feedstock prices, it is not surprising that key wood chip producing and exporting regions have a long tradition in export oriented forestry, wood processing, and/or pulp and paper industries, and benefit from the availability of low/no cost feedstock and/or residues, infrastructure, and experience [6].

Facilities in Sweden and Denmark indicate that they would source wood chips globally but do stress the need for reasonable transport costs per load. Transport costs are determined by vehicle costs and availability (e.g. in the case bulk carrier vessels), and biofuel characteristics [6]. The current availability of shipping capacities for large international (i.e. open-ocean, long-distance) trade indicates that the limiting factor for significant international wood chip trade lies with the chips' characteristics. Without densification of the woodchips (a patented process developed in the US) woodchips require specialty vessels (woodchip carriers) in order to make the transportation on a long haul basis economically feasible. Pellets in comparison have better transport qualities: high homogeneity, high heating value and bulk density (thus high energy density per ship load), ability to be transported in standard sized vessels for greater ocean transportation economy, plus flexible end-use regarding combustion technology and scale (e.g. co-firing in pulverized coal combustion plants).

Hence, in comparison to wood pellets, global wood chip trade for energy remains small. While wood pellet production has already experienced replacement effects; e.g. in Austria, where an increase in regional biomass use for energy has led to increased (oversea) imports of the local pulp and paper industry [31]. Production and trade developments of wood chips for energy have not (yet) shown similar effects. The availability and importance of the respective solid biofuels remain linked and ultimately limited by the developments in their underlying sectors i.e. forestry/pulp and paper for wood chips and roundwood, construction/recycling for wood waste or food/fodder processing for residues. Apart from feedstock availability, new challenges on the supply side include increasing standardization and sustainability requirements.

On the demand side, the residential market has been less influenced by policies, due to the singularity of the support measures as compared to large-scale applications, where long-term framework conditions primarily aim at bridging the economic gap towards substitute fuels (esp. coal) [6]. Trade in the industrial market can therefore be based on longer-term pricing signals and has shown increasingly established trade routes. The latter is also supported by a growing vertical supply chain integration of large scale users [6].

Current statistical reporting make global wood chip trade patterns still hard to distinguish between energy and other end-uses. Anecdotal data remains essential to estimate and interpret trade flows. Future datasets of international institutions, we believe, should be streamlined and eventually allow reporting of global commodity trade streams beyond digit-6-level.

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Appendix

Table 3. Global wood chip data in ktonnes [Production data: [11]; Trade data: [9]]

	Production			Imports			Exports		
	2007	**2008**	**2009**	**2007**	**2008**	**2009**	**2007**	**2008**	**2009**
Australia	4,725	5,412	4,968	1	1	1	6,051	6,113	4,759
Chile	2,384	2,583	2,293	0	0	0	3,065	4,059	3,695
USA	1,513	1,925	1,650	214	98	57	2,996	2,861	2,849
South Africa	3,561	3,561	3,561	0	1	0	3,593	3,268	2,122
Latvia	751	1,024	783	20	80	7	1,693	1,557	1,449
Russia	3,273	2,420	2,035	4	3	2	850	932	1,377
Germany	821	776	860	489	341	395	1,794	1,613	1,278
Thailand	572	572	572	1	0	6	359	882	1,253
Brazil	2,405	1,921	1,921	1	0	0	1,419	1,414	1,025
Uruguay	352	628	315	0	0	0	959	1,697	860
Japan	1,280	1,430	1,556	14,337	14,722	10,478	0	7	0
China	2,680	2,752	3,536	1,140	1,056	2,766	215	73	7
Finland	2,579	2,188	1,596	1,661	2,432	1,908	110	143	227
Turkey	234	234	234	1,228	1,014	1,542	0	0	0
Sweden	4,840	4,538	4,263	1,545	1,547	1,345	518	577	293
Canada	20,725	20,725	20,725	2,051	1,975	1,312	721	551	443
Austria	1,510	1,472	964	1,017	992	1,007	440	313	166
South Korea	0	0	0	829	1,057	741	0	0	0
Italy	146	146	116	1,011	617	691	1	2	9
Norway	0	0	0	616	741	619	28	85	77
Other	7,566	7,533	7,429	4,047	4,430	3,429	3,980	3,657	3,307
World	**61,916**	**61,839**	**59,374**	**30,211**	**31,109**	**26,305**	**28,792**	**29,806**	**25,194**
						Data gap	1,420	1,303	1,110

Table 4. Conversion factors

	Applied in calculations			Ranges found in literature	
	Weight [tonne/m³]	**Heating value [GJ/tonne]**	**At moisture content**	**Moisture content**	**Bulk density [GJ/m³]**
Fuel wood / firewood logs[a]	0.275	18.75	20%	15-20%	5-9
Wood chips[a]	0.275	19.25	30%	15-50%	3-6
Wood residues[a]	0.3	19.25	57.5%	40-60%	3-5
Sawdust pellets[b]	0.7	18.30	9%	9-10%	10-13
Wood waste[c]	0.619	13.00	30%	20-50%	5-8
Palm kernel shells[c]	-	18.00	7%	6.5-8.4%	-
Charcoal[d]	-	22.00	4.5%	4.5%	-
Industrial roundwood[e]	0.8	18.40	30%	20-50%	7-15
Category *HS 440130*	0.3	19.25	50%		

a: [25]
b: [25, 32]
c: [33, 34]
d: [11, 32, 35]; 1 tonne of charcoal per 6 m³ industrial roundwood
e: [32, 36]
Others: [37]