



# The dynamics of the global wood pellet markets and trade – key regions, developments and impact factors

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**Abstract:** The global pellet market is growing but with different characteristics in different countries and regions. In this paper we trace developments between 2008 and 2016. For 2008, production was reported at 9.8 Tg, expanding globally to 14.3 Tg in 2010 and surpassing 26 Tg in 2015. Global hot spots are North America (production) and Europe (consumption). Sustainability certification was applied for about 9 Tg in 2016. Nevertheless, projections for future development are difficult as low pellet prices and uncertain sustainability obligations may hinder further expansion. In general, there is a strong dependency of the pellet market on the policy framework. © 2018 The Authors. *Biofuels, Bioproducts, and Biorefining* published by Society of Chemical Industry and John Wiley & Sons, Ltd.

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## Introduction

**W**ood pellets are a woody biofuel shaped in a cylindrical form with random length, typically 3.15 to 40 mm, with a diameter of about 6 or 8 mm, and broken ends (ENplus standards).<sup>1</sup>

They are typically based on sawdust and other milled woody material with additional defined properties such as moisture, chemical composition, energy density, mechanical durability, and particle size, laid down in the International Organization for Standardization standard

ISO 7225-2.<sup>2</sup> Their advantage, compared to the original biomass, lies in their higher energy density, homogeneous quality, improved handling and storage properties, and better applicability for different end uses. Starting in the USA in the 1970s, large-scale production took off in the 1990s.<sup>3</sup> Two main categories and corresponding markets can be discerned: industrial-grade pellets, aimed for medium- and large-scale application, and residential-grade pellets, mainly used in small-scale heating appliances.<sup>3</sup> This paper will elaborate on both, where applicable. A wide range of global and regional market surveys for

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wood pellets has been published (e.g. <sup>4–9</sup>). In 2011, Cocchi *et al.* <sup>10</sup> presented a first compilation of the global production and trading of wood pellets for energy with data from 31 countries in the Americas, Europe, and Asia, showing an estimated increase in consumption of about 110% between 2006 and 2010, reaching 13.5 Tg.

Since this time, markets have further expanded and diversified. Experts from the International Energy Agency (IEA) Bioenergy Task 40 have collected and analysed the market situation in all wood pellet related countries.<sup>11</sup> (IEA Bioenergy Task 40 focuses on sustainable biomass markets and international trade to support the biobased economy.) Beyond the development of the countries' policies, demands, and supply patterns, the question arises of how to describe the overarching development in the global pellet business during the last decade. This paper sheds light on the situation as of 2015–2016 and answers the questions on the most important market players (producers and consumers), their relations (import and export), and the drivers of their development. Price levels and mechanism, and the implementation of certified trade flows complete this analysis.

## Database and methods

### Database description

To establish a global overview of the wood pellet industry and markets an international team of 30 scientists collected data from 40 countries in North and South America, Europe, Australia, and Asia. This has been compiled into a report.<sup>11</sup> Being part of this international group, the authors of this paper base their work on the database, which has been extended by surveys for this paper to compile timelines and analyse the dynamics. Additional literature reviews, surveys, and interviews have been conducted to collect missing data and further information.

### Indicators

Country-specific data were compiled with regard to development between 2008 and 2016. Missing data in the early stage of implementation is marked. Missing data between the years is intrapolated. For the analysis of the market development we chose the following indicators:

### Production

Production is described by total production capacity and total annual production. A distinction is made between

industrial-grade and residential-grade pellets. A growth factor is given comparing 2008 to 2015/2016.

### Consumption pattern

Consumption is the country-specific annual consumption. The relationship between the industrial and the residential sectors is described, based on reported consumed volume, installed capacity, and qualitative statements where reliable figures were not available.

### Import-export ratio

The role of a certain country in the development of a global wood pellet market is described by the import-export ratio:

$$R = \frac{\text{imported amount}}{\text{exported amount}}$$

An import-export ratio of 1 means that the net amount of pellets produced in a certain country is also used in that country. Numbers higher than 1 indicate pellet-importing countries; numbers below 1 indicate pellet exporters. The import-export ratio is given for the countries annually.

### Price development for medium- and small-scale (residential) consumers

For medium- and small-scale utilization, price information have been retrieved from either the national statistical authorities or the publications of associations. The data have been harmonized as far as possible, considering the most important European residential wood-pellet markets. Value added tax has been deducted and delivery costs included. However, these prices do not reach the data quality levels of industrial prices.

### Price development for industrial consumers

The industrial wood-pellet market is limited to large-scale heat and power generation in a few European and Asian countries. Trade flows are mostly transatlantic and across the Baltic Sea region. The indicator is split into these two regions. Industrial wood pellet spot market prices for the transatlantic trade portion, reported at destination harbour price levels (Cost-Insurance-Freight in Amsterdam-Rotterdam-Antwerp: CIF-ARA), are taken from Argus Biomass Markets.<sup>12</sup> The PIX Nordic index (wood-based biomass price indice)<sup>13</sup> is used as a reference for spot-market trading prices across the Baltic Sea region. The majority of industrial wood pellets are traded



under long-term contracts between producers and energy utilities, which are confidential. Spot market prices are used as an approximation.

## Trade flows of pellets with sustainability certification

The development of wood-pellet consumption with sustainability certification in comparison to the overall development is used as an additional indicator. The history and data basis in countries with established schemes have therefore been analysed and discussed.

## Country selection

To identify the key regions of the global wood-pellet market and trade, we focus on the current top five countries in terms of quantity for (a) production capacities, (b) production, (c) consumption and (d) import/export ratio. These countries are then analysed over the period from 2008 to 2016, showing their development towards their current status and identifying their main drivers. The most dynamic countries will be identified, regardless of whether they belong to the current top five in the individual categories. The dynamic is calculated as proportional growth rate between 2008 and 2016.

## Results

### Current situation of the global wood pellet market

Global consumption reached more than 25 Tg in 2015, with trade dominating within Europe and between Europe and the USA.<sup>11</sup> Figure 1 gives an overview of the consumption, import, and export of individual countries in 2015. The USA is by far the largest pellet producer, with 7.4 Tg in 2015 (Food and Agriculture Organization estimate) and 6.3 Tg in 2016. Canada shows the most dynamic development with an increase in exports from 1.6 Tg in 2015 to 2.4 Tg in 2016. Germany (2.2 Tg) and Sweden (1.5 Tg) are further substantial pellet producers. On the consumption side, the United Kingdom stands out with 6.7 Tg pellets in 2015, followed by the USA with 2.9 Tg, Denmark (2.8 Tg), and Italy (2.1 Tg). New countries have entered the scene as fast-growing consumers in recent years, such as countries in South-East Europe and South-East Asia, especially Japan and South Korea.

### Development of production and production capacities

Production capacities have been reported for 27 of the 40 countries in this study, with figures ranging from 2012

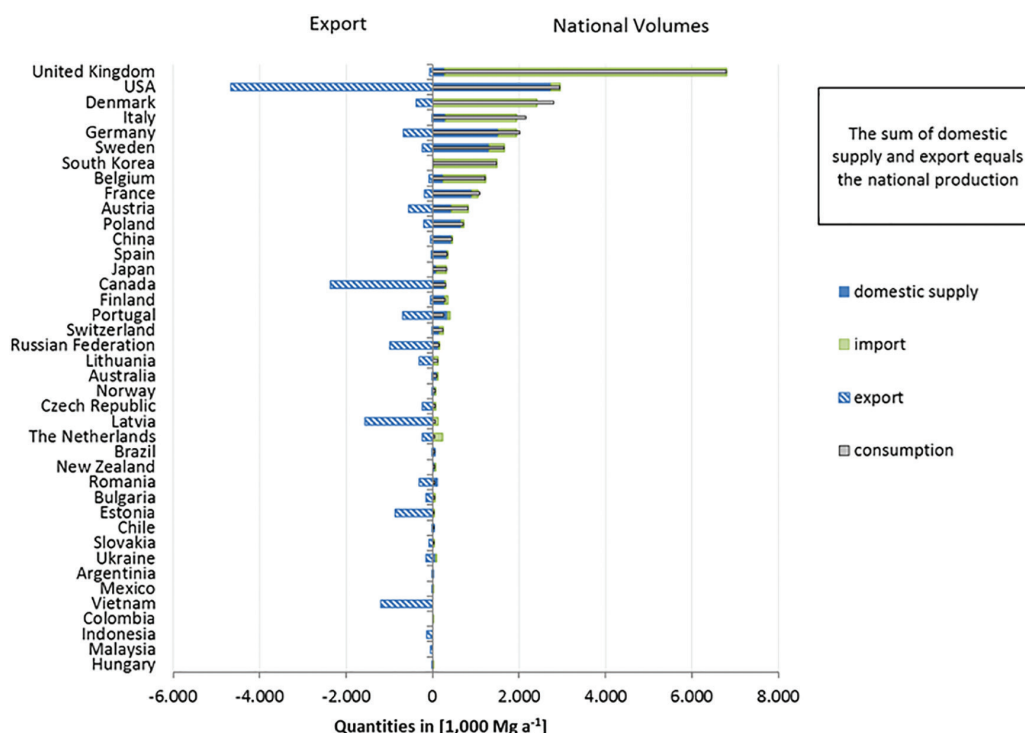


Figure 1. Domestic production and import/export per country for chosen countries in 2015.<sup>11</sup>



to 2016. The 27 countries cover 90% of global production quantity. Within this group, the top five account for 63% of the production capacity.

The USA shows the highest installed capacity with  $13.9 \text{ Tg a}^{-1}$  (2016), representing 32% of the total reported capacities. The other top five countries are Canada with  $4 \text{ Tg a}^{-1}$  (2015, 9%), the Russian Federation with  $3.5 \text{ Tg a}^{-1}$  (2016, 8%), Germany with  $3.2 \text{ Tg a}^{-1}$  (2016, 7%) and Sweden with  $2.4 \text{ Tg a}^{-1}$  (2015, 6%) (Fig. 2). The USA also dominated in terms of produced quantities, with  $7.4 \text{ Tg a}^{-1}$  (2015),

representing 28% of the reported quantities from all 40 countries. Due to higher utilization rates, Germany follows in second place with  $2.2 \text{ Tg a}^{-1}$  (2016, 8%), even though Canada and Russia feature the greater capacities. Latvia, showing exceptional utilization rates, enters the list as fifth largest producer with  $1.4 \text{ Tg a}^{-1}$  (2015, 5%). The third and fourth largest producers are Canada with  $1.9 \text{ Tg a}^{-1}$  (2015, 7%) and Sweden with  $1.5 \text{ Tg a}^{-1}$  (2015, 6%), respectively (Fig. 2).

From 2008 to 2016 the USA showed the highest capacity growth by a factor of 6.5. Production increased by a factor

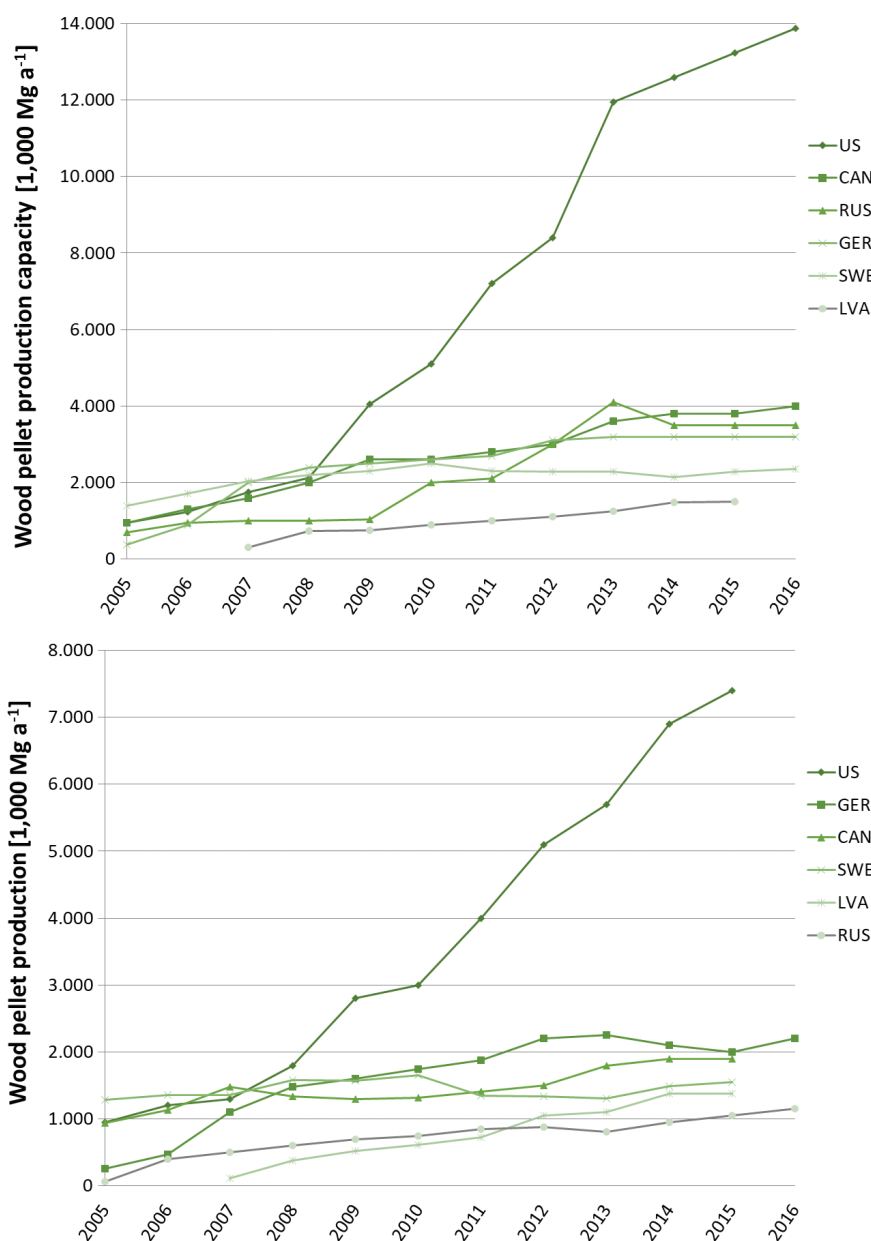


Figure 2. Development of pellet production capacities (upper graph) and production (lower graph) 2005–2016 of the global top five in production capacity; the top six are included for comparative reasons. Data source: 11.



of 4.1 (2015). The main driver of this development was the demand for wood pellets in the European Union (EU) as well as several strategic factors aligning especially in the south-east of the USA, such as proximity to EU markets and the availability of biomass resources, labour, infrastructure and knowhow. A minor growth factor has been the residential heating market.<sup>11</sup> Comparable frameworks account for the steady growth of capacities in Canada and in Russia. The main market driver has also been the demand from the EU but also from new markets in Asia, including Japan and South Korea. In Canada, 60% of the capacities are located in British Colombia, supporting trade with Asia. The domestic consumption is minor. In Russia, production is completely focused on export. In both countries, the residential heating market has so far not been supported by policy and shows marginal development.<sup>11</sup> Between 2008 and 2016, production capacity in Canada grew by a factor of 2.0 and actual production increased by a factor of 1.4. Capacity in Russia grew by a factor of 3.5 and actual production increased by a factor of 1.9.

In Germany, the policy framework supported investment in residential heating systems for wood pellets. The resulting constant growth was only interrupted by a temporary saw-mill industry crisis in 2014.<sup>11</sup> Production capacity grew by a factor of 1.3 between 2008 and 2016, and the produced quantities increased by a factor of 1.5. Unlike the other countries analysed above, Germany supplies mainly the internal market, which it created through its policy framework.

Like Germany, Sweden has a long tradition of government support for wood pellet utilization in small-scale heating but also in industrial application and combined heat and power (CHP) provision, and it produces mostly for the domestic market. Between 2008 and 2016, its production capacity increased by a factor of 1.1 and actual production was almost equal.

Latvia has entered the top five producers, showing a growth rate between 2008 and 2015 by a factor of 3.7. Even though there are national support schemes to promote domestic use, the pellet industry is export oriented towards other EU countries. Only 7% of the quantity produced is used domestically (2015).<sup>14</sup> The main drivers for the export are low production costs, large biomass potentials and large, accessible ports (Liepaya, Vetspils).<sup>11</sup>

## Development of consumption

The global top five countries in wood pellet consumption are the UK with 6.8 Tg a<sup>-1</sup> (2015), representing 25% of global consumption, the USA with 2.9 Tg a<sup>-1</sup> (2015, 11%), Denmark with 2.8 Tg a<sup>-1</sup> (2016, 10%), Italy with 2.2 Tg a<sup>-1</sup> (2016, 8%), and Germany with 2.0 Tg a<sup>-1</sup> (2016, 8%). Together, they represent 62% of the global market share (Fig. 3).

During the last 10 years, the consumption in the UK showed exceptional growth, by a factor of 9.1 (2008 to 2015). The UK has established several support mechanisms including Renewable Obligation (RO), the country's

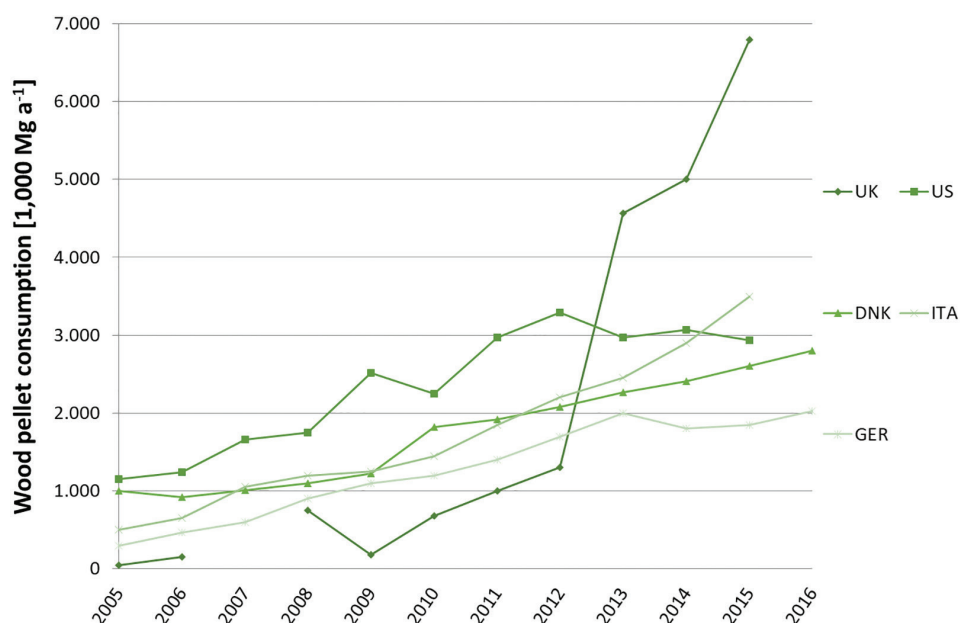


Figure 3. Development of total wood pellet consumption for the top five countries, 2005–2016. Data source: 11.





main support scheme to incentivize the deployment of large-scale renewable electricity generation in the past. From 2017 this was succeeded by the Contracts for Difference (CfD) scheme.<sup>11,15</sup> By the means of these regulations, the use of pellets in large-scale electricity generators dominates in the UK; 56% of the supply originates from the US.

The US is the second largest consumer but have shown only a moderate growth in consumption in the last years (by a factor of 1.7, 2008 to 2015); 37% of its production is being used domestically. Residential heating (wood heaters) accounts for almost all of the domestic consumption. Drivers have been regional price competitiveness with heating oil and propane, and advantages in comfort and automatic feed-in. Some support schemes have partially addressed wood pellet use but were not effective.

Denmark's policy toward renewable energy, aiming at fossil fuel independency in 2050,<sup>16</sup> led to a steady increase in wood pellet consumption (by a factor of 2.5, 2008 to 2016), and increasing imports. Units of all sizes are using wood pellets, yet the majority (70%, 2015) were processed by large-scale utilities for combined heat and power. All market segments (small, medium and large scale) show a continuous growth.<sup>11</sup>

Italy also achieved a constant growth in consumption (by a factor of 2.9, 2008 to 2015), but focused on the residential heating sector. The figures are based on surveys as well as estimates and carry an associated uncertainty, especially for data before 2011. The main drivers for the increasing consumption are government schemes providing tax incentives, grants (Conto Termico) and so-called white certificates which are tradeable securities certifying energy savings.<sup>11</sup>

Germany also features a continuous increase in consumption (by a factor of 2.3, 2008 to 2016) of mainly domestic pellets. One temporary obstacle to a further extension of consumption has been the mandatory standard ENplus. Foreign suppliers had difficulties adapting to this standard after its first enforcement. This led to stronger production within Germany. The subsequent certification of foreign producers strengthened imports again.<sup>11</sup>

## Development of import and export

The largest exporter globally is the USA with 4.7 Tg a<sup>-1</sup> representing a share of 29% of the wood pellets traded between countries (in 2015). The other countries in the list of top five exporters are Canada (1.6 Tg a<sup>-1</sup>, 10%, 2015), Latvia (1.6 Tg a<sup>-1</sup>, 10%, 2015), Vietnam (1.2 Tg a<sup>-1</sup>, 7%,

2015), and the Russian Federation (1.0 Tg a<sup>-1</sup>, 6%, 2016). Together, these countries represent 63% of global exports (Fig. 4).

Besides the UK with 6.5 Tg a<sup>-1</sup> (2015), the top consumers Denmark and Italy are also top importers with 2.4 Tg a<sup>-1</sup>, (15%, 2016) and 1.6 Tg a<sup>-1</sup>, (10%, 2016), respectively. South Korea, with almost no wood pellet production, and Belgium, with marginal production, enter the list of top five importers with 1.5 Tg a<sup>-1</sup> (9%, 2015) and 1.0 Tg a<sup>-1</sup> (6%, 2015), respectively. These countries are responsible for 83% of globally effected imports (Fig. 4).

The five countries with a balanced import/export ratio, indicating a levelled domestic supply and demand relation, are Finland (ratio of 1), Spain and The Netherlands (each with a ratio of 0.9) as well as France and Austria (each with a ratio of 0.7).

## Price development for residential consumers

Pellet prices for residential consumers (in Europe) are in general between 200 EUR Mg<sup>-1</sup> and 300 EUR Mg<sup>-1</sup> with the exception of Switzerland and France where pellet prices before value added tax are higher. Prices peaked in 2013 in Austria, Germany, Sweden, and Italy, and they kept increasing until 2014 for Swiss, French, and Spanish consumers. A certain integration between oil prices, gross domestic product and wood pellet prices can be outlined for these price growths at least for Germany and Austria.<sup>17</sup> In 2015 a strongly devaluing Swiss franc led to increasing prices for Switzerland in Euro. Prices dropped in all countries during 2016 due to an oversupply in small, medium, and industrial pellet markets. Regarding the heating market there have been three years of soft winters, which also caused dropping prices from 2014 in most of the countries, and in 2016 they were as low as around 2008 to 2010 (Fig. 5).

Prices in EUR Mg<sup>-1</sup> are, in general, higher in Sweden and Switzerland, due to higher production costs but also due to exchange rates of Swedish krona and Swiss franc to the euro. The consumption of wood pellets in France is still low (see Fig. 1) but it is rapidly expanding. Switzerland shows the largest price span between 2006 and 2016. Italy is mainly dependent on imports from Austria and Germany but also in large quantities via shipping routes from the USA. Its price development is thus exposed to external shocks including (dollar) exchange and shipping rate developments. To cover the risks, especially also the rapidly increasing demand of consumers with relatively small stocking opportunities

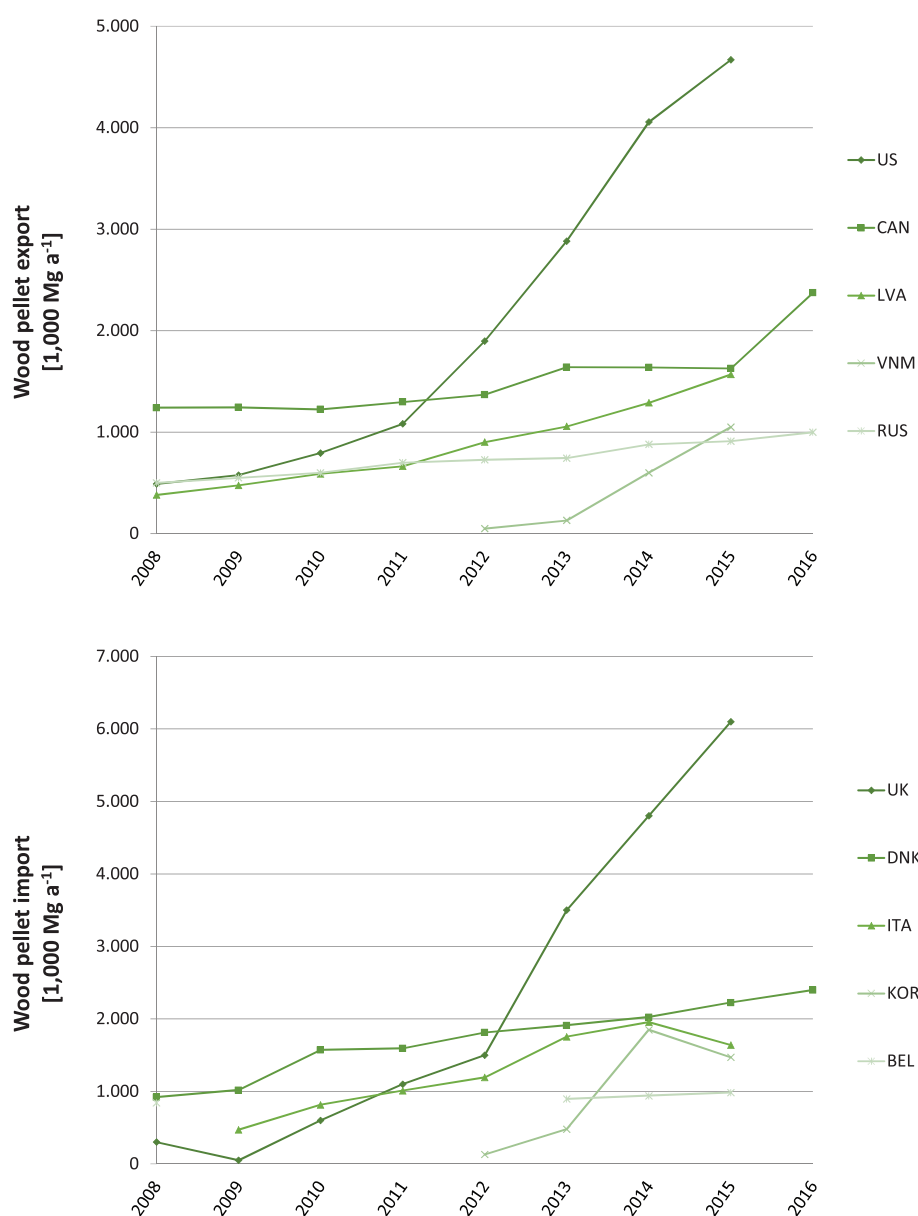


Figure 4. Development of the top five countries in wood pellet export (upper graph) and import (lower graph). Data source: 11.

(stoves without dedicated storages), Italian wood pellet traders have invested in storage in recent years.<sup>25</sup>

Pellet price analysis with data on a monthly basis can give further insights into the seasonality of wood pellet prices for residential heating: the highest prices occur in the winter months and the lowest in the spring months. Furthermore, special offers by pellet traders in Germany and Austria called storage prices ('Einlagerungspreise' – Wild M, private communication) are used to ensure that consumers fill up their storages between April and June.

Trade between small-scale heating markets but also in small-, medium- and industrial heating markets increased

significantly in the recent years but showed no equilibrating effect for end-user prices between the small-scale heating countries.<sup>25</sup>

### Price development for industrial consumers

Industrial wood pellet markets are characterized by a few central factors, crucial for price developments.

First, the industrial pellet market is demand driven, as bio-heat and power-generation levels depend on policy schemes including underlying remuneration levels and

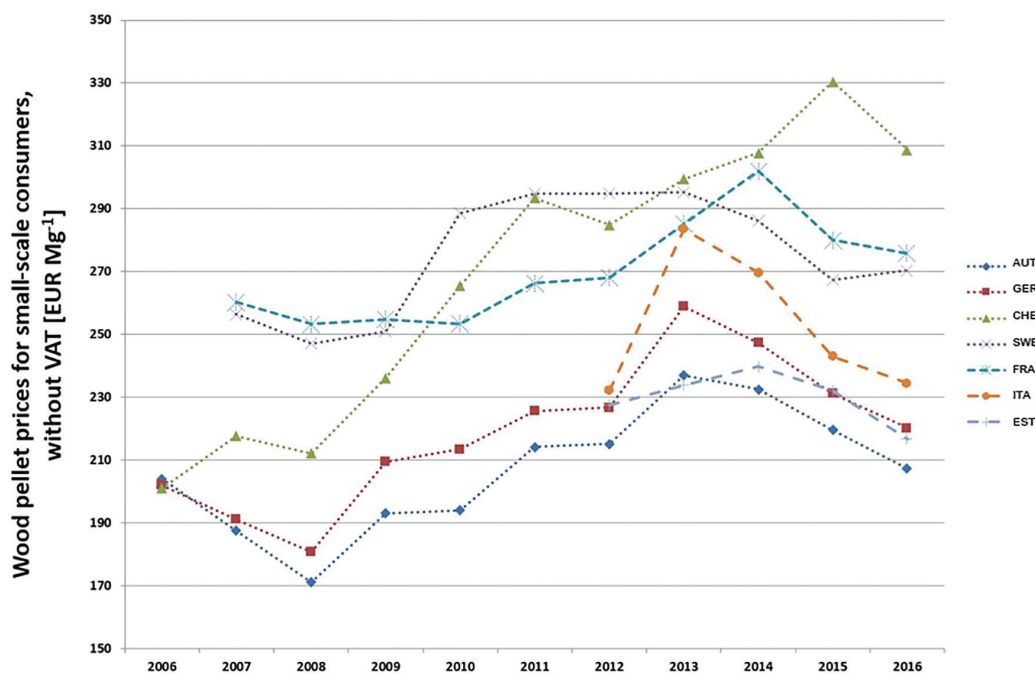


Figure 5. Comparison of wood pellet prices for small-scale consumers, delivered either in bulk or in bags. Source: authors' own illustration based on<sup>18–24</sup>

related regulations (e.g., sustainability criteria and reporting requirements). These policy schemes can take different forms such as carbon taxes, price guarantees or tradable renewable energy certificates. The purpose of these incentives is to enable wood pellets to be a viable alternative to fossil fuels. This policy dependence, however, has led to uncertainty in markets during phases of, for instance, policy renegotiations or administrative changes in the main European demand regions over the last decade.

*Second*, despite its growth, the industrial wood pellet market is still small compared to other biomass or energy markets such as grains or fossil fuels. In particular, it lacks the liquidity of true commodity markets, being dominated by a few market actors.<sup>26</sup> Individual companies or supply-chain events can affect global markets and hence spot market prices. Examples are fires at RWE's Tilbury power station in February 2012 and at Drax in December 2017, both resulting in general price decreases in Europe.

*Third*, international trade is a central element in the industrial market, as none of the largest consumers (the UK, Denmark, Benelux, Japan and South Korea) have any substantial production capacity of their own. Exchange-rate fluctuations can therefore influence economics of industrial pellet consumers who often purchase pellets in United States Dollar (USD) but receive their revenue (from electricity sales) in their respective local currencies.

The average spot market pellet price between 2009 and 2015 was around 169 USD Mg<sup>-1</sup>, which resembled pricing in a growing global market with overall balanced demand-supply volumes. Following a peak in mid 2014 at 185 USD Mg<sup>-1</sup>, spot prices dropped almost continuously due to policy uncertainty, for instance in the Dutch market, and a resulting global oversupply particularly throughout the second half of 2015 and 2016. This caused a historic minimum price in December 2016 of just under 113 USD Mg<sup>-1</sup> (Fig. 6). As outlined in Thrän *et al.*,<sup>11</sup> viable prices for producers in the industrial market are usually above 150 USD Mg<sup>-1</sup>.

In addition to global price influencing factors, regional aspects come into play. One example is the interaction between the industrial market (mainly for electricity generation) and the heating market, characterized by a large number of residential stoves or community-sized boilers. In the Baltic Sea region this interaction is quite strong, as industrial purchasers in both Denmark and Sweden are combined heat and power (CHP) plants that produce both electricity and district heating.

Regional particularities notwithstanding, a comparison of the two price graphs in Fig. 6 indicate that price fluctuations in the Baltic Sea region appear to be rather similar to those in the Amsterdam-Rotterdam-Antwerp (ARA) region. This could imply that the two markets are integrated. As the price data collection methodologies differ between the two price



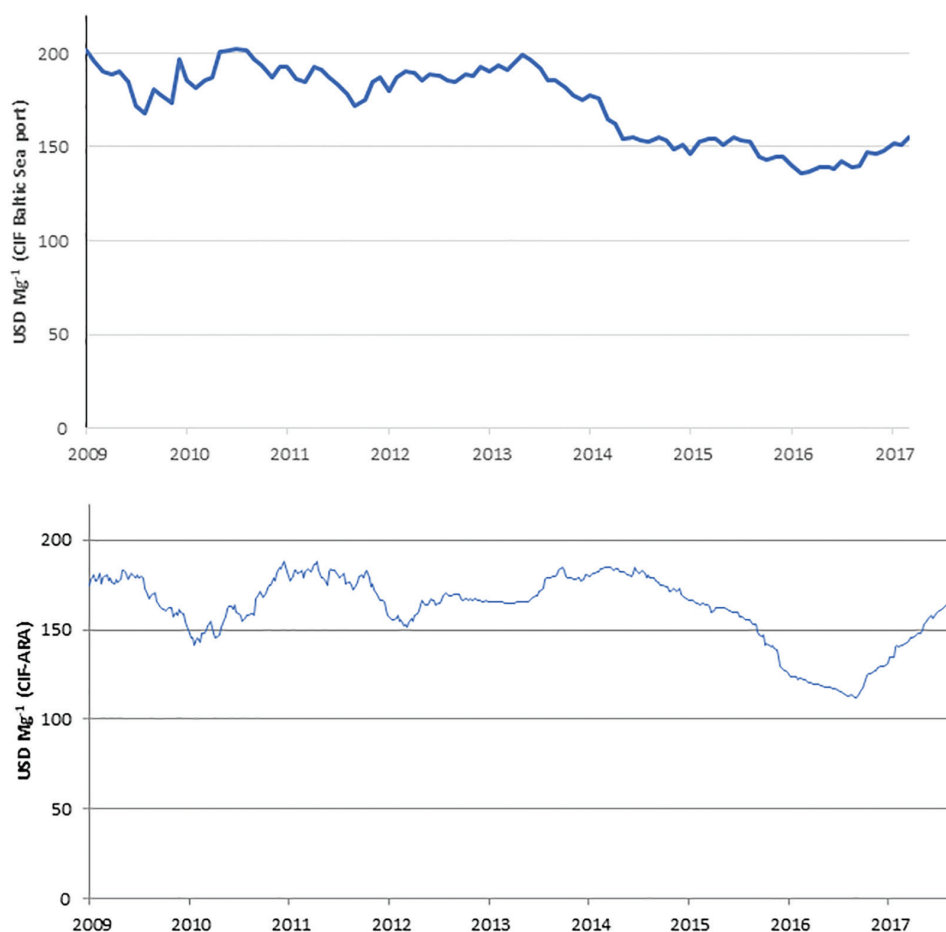


Figure 6. Industrial wood pellet prices 2009–2017 in the Baltic Sea region (upper pane) and the Amsterdam-Rotterdam-Antwerp (ARA) region (lower pane). Note the effects on ARA prices of the February 2012 Tilbury fire, as well the dampened prices in 2015–mid 2016 as policy uncertainty coincided with significant capacity increase. (The Baltic Sea prices have been converted from EUR MWh<sup>-1</sup> to USD Mg<sup>-1</sup> using an energy density of 4.7222 MWh Mg<sup>-1</sup> and monthly EUR/USD exchange rates from the Swedish Riksbank.)<sup>12,13</sup>

series, this assumption needs to be substantiated by further research.

## Data sources

Baltic Sea prices are provided by FOEX Indexes Ltd.<sup>13</sup> The ARA price graph shows the Argus Wood Pellets 90 Day Index (CIF-ARA balance per week).<sup>12</sup>

## Development of trade flows with proof of sustainability

Throughout the EU, binding sustainability criteria are only required for liquid biofuels (used in the transport sector) as laid down in the Renewable Energy Directive (RED) but not for solid biomass (used in the heat and power sector).<sup>27</sup> Given the lack of EU wide sustainability requirements for solid

biomass, Belgium, the UK, the Netherlands, and Denmark, the main importing countries of wood pellets for industrial use, have established sustainability criteria under national support and voluntary schemes. In the UK, sustainability criteria for small scale users and production of heat apply.<sup>28</sup> The vast majority of wood pellets with (at least in part) verified/certified sustainability are destined for these four markets. Typically, these criteria set thresholds for Greenhouse Gas (GHG) emissions emitted in the supply chain, and so-called 'land' criteria, which address issues related to land use (change), mainly relating to sustainable forest management (SFM).

Belgium was the first EU country to initiate support mechanisms, called Green Certificates (GCs), in 2002. Under the GC mechanism, the main sustainability requirement is the GHG emissions reduction and each region provides its own calculation method to verify this. Compliance



with SFM criteria is not mandatory but it can be voluntarily demonstrated using existing SFM certification schemes.

The UK has established, under the Renewable Obligation (RO), that solid biomass plants must report and meet land and GHG sustainability criteria. To demonstrate sustainability compliance, electricity generators need to provide annual sustainability reports approved by independent auditors. Compliance can also be demonstrated by using existing certification schemes recognized by the UK government.

The Netherlands Enterprise Agency (RVO) issued the 'Energy Accord for Sustainable Growth' (SDE+) stating that biomass used for co-firing and heat production must meet the most comprehensive criteria in the EU, including criteria on GHG emissions, carbon stock and other land use change, SFM, and chain of custody.

Denmark requires no binding sustainability requirements for the production of renewable energy. However, to ensure the sustainable use of wood pellets and wood chips, the Danish District Heating Association and the Danish Energy Association established a voluntary Industry Agreement, which was implemented in 2016. The sustainable requirements under the Industry Agreement were developed mainly based on the UK's RO mechanism. The combined heat and power producers are themselves responsible to document and demonstrate sustainability requirements through third-party certification.

Sustainable wood pellets are verified by national verification bodies established in Belgium, the UK and the Netherlands, or by certification schemes in the four countries. Popular certification schemes recognized are Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC) and Sustainable Biomass Program (SBP) for land use and SFM criteria. For GHG emission reductions calculation according to the method developed in the Biograce II project<sup>29</sup> is often applied.

Belgium recorded the first biomass data under the GC mechanisms in 2003 but details of the certified wood pellet imports were not published before 2010. The UK published the first statistics regarding sustainable wood pellets in 2011, the Netherlands in 2013, and Denmark in 2016. As shown in Fig. 7, the USA is by far the largest exporter of certified wood pellets to the EU (Canada, not shown separately, also supplies certified wood pellets, but lower amounts than the USA). Other European regions, especially the Baltic countries, also supply these four markets, but with a smaller quantity.<sup>28,35</sup> Figure 7 also shows a record of wood pellets with sustainability claims in 2016 with 6.5 Tg imported to the UK, 2.6 Tg to Belgium and 0.7 Tg to Denmark. In the Netherlands, the import decreased in 2014 and was negligible in 2015 and 2016 due to lack of a Stimulation of Sustainable Energy Production budget. The import in the Netherlands has increased again in 2017 and up to annually 3.5 Tg by 2020.

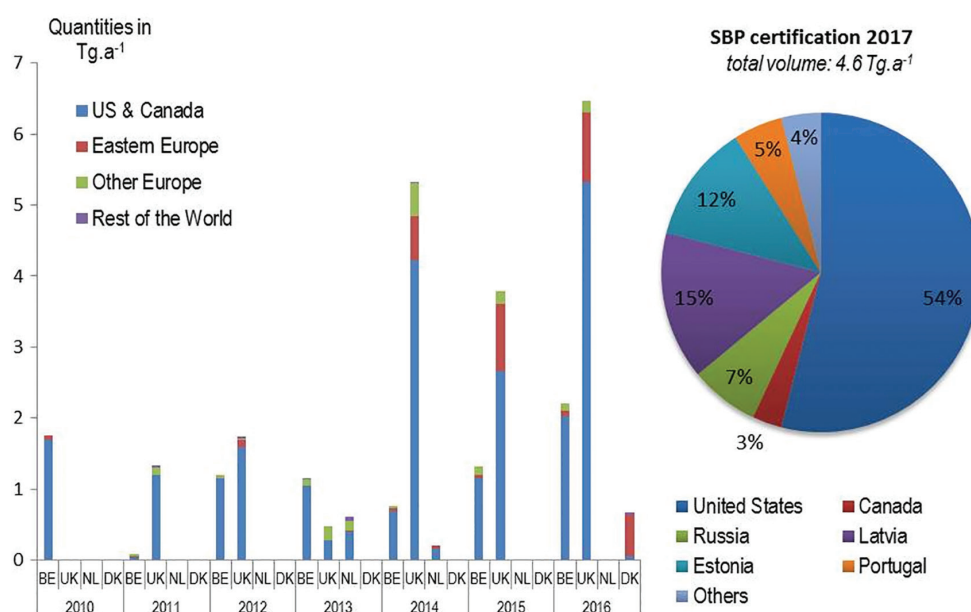


Figure 7. (left) EU import of wood pellets with sustainability claims. Data sources:<sup>29–34</sup> (right) Origin of wood pellets produced with SBP certification in 2017. Source: SBP Annual report 2018 (unpublished).



Figure 7 shows that, for all other years than 2016, only fragmented data was available and no comprehensive picture can be provided. Given the variety of criteria and verification requirements, it is impossible to distinguish between all wood pellets that are certified with existing SFM schemes, and which part (and which criteria) have been verified by an independent auditor. Thus, the degree of sustainability may vary significantly. This may change in the future, as the new certification system SBP is gaining significant market share. In 2017, about 4.7 Tg of SBP-certified pellets were produced, which – compared with the 9.3 Tg imported in 2016 by the UK, Belgium and Denmark – covers about 50% of the market.

## Discussion and conclusions

The global pellet market has grown dramatically and has diversified geographically during the observed decade. Nevertheless, there are still two comparably independent markets: the residential heating market and the industry-related power market. It is important to keep in mind that not only pellet qualities and actors but also different policies drive current and future demand:

- The residential heating market is a slowly developing market, depending on the attractiveness of other heat supply systems, such as fossil fuels but also renewables, which is different for each supply case. In addition, the replacement cycles span several decades. Typically, there are only minor support mechanisms, such as special loans or grants, for investment in pellet boilers. Those markets have been further developed in central Europe.
- The electricity market is mainly driven by engagement in GHG emission reduction in the energy sector. International agreements and clear national targets have led to dedicated instruments in some countries, which shifted the input in large-scale power production from fossils to wood pellets. During the last decade the global wood pellet market gained strong momentum from those policies in certain European and Asian countries.

A professionalization of the market can be stated, with differing roles of the participating countries: North America became the major exporter and certain countries in Europe became major importers. A particular partnership has been established between the USA and the UK. With their trade relationship dominating the market for industrial pellets, it is hence susceptible to major changes inflicted by the few main market partners.

Pellet prices and their comparisons have to be treated with care. This is mainly because the substitution of fossil-based commodities with this solid bioenergy carrier developed in different ways. Pellet prices for the largest consumers are confidential because they are part of bilateral, often long-term contracts. Prices still depend on single producers and a dedicated political framework in single consumer countries. For international trade there is a 'Baltic sea market' and a 'transatlantic market'.

The residential pellet market is less volatile but large price differences have been observed between the countries. It is therefore vital for market actors to work towards spatially equilibrated price developments (improving market efficiency), to increase access and affordability for end users in the long term. Important barriers to be tackled include (1) consumers intrinsically valuing regionality and pellet colour despite these factors being unrelated to the pellets' quality, and (2) relatively low market transparency. For the latter, the availability of pellet prices and other related data would have to be improved significantly, starting from harmonized approaches of collection and joint publication on multilingual homepages through to the development of price benchmarks for small-scale wood pellet heating.

Increased market maturity including higher integration of the spatial markets and higher integration between markets of different end uses (residential and industrial market) will result in lower price fluctuations and thus decreased risk for producers and consumers alike. Additional balancing options include financial support for improving storage capabilities<sup>25</sup> as well as financial mechanisms for buffering currency exchange rate risks.

One obstacle is the current uncertainty of bioenergy support at the EU policy level. Several national governments in Europe have strengthened their support, yet are waiting for clear signals from EU level under the Renewable Energy Directive II,<sup>36</sup> and the related targets for the renewable power and heat market.

Sustainability certification has been introduced in four consumer countries and was applied for about 9 Tg in 2016. Certification systems are still diverse, but harmonization is occurring in the market. Also here the negotiations on sustainability criteria under the Renewable Energy Directive II<sup>36</sup> are pending. However, certification is being discussed for combustion facilities with a thermal capacity of at least 20 MW. It is fairly certain that residential wood pellets will not require any proof of sustainable production whereas industrial users will have to meet increasingly stringent criteria and thresholds (e.g. up to 80% GHG emission reduction in 2026).



New market players have been identified. The next couple of years are destined to see an increase in short-term demand particularly from Japan and South Korea. In these emerging markets outside the EU, sustainability requirements may play an increasingly important role.

This additional demand for pellets with sustainability requirements is bound to swing the current conditions from a long (oversupply) to a short (undersupply) market. Overall, Asia is expected to provide the largest future growth opportunities in the medium- to long-term. In China, Australia and Canada additional policy measures for large scale wood pellet application are in discussion.<sup>11</sup>

In conclusion, the future development of production and consumption is highly uncertain. One reason is that policies will influence the markets also in the future. Coherent policies are strongly needed. Harmonization on sustainability standards is one step in this direction. The improvement of information on market volumes and price data is also strongly needed.

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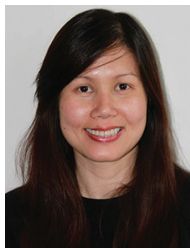
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