Challenges and Opportunities for International Trade in Forest Biomass

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Chapter 8

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Highlights

- By 2020, the global demand for internationally traded wood pellets from boreal and temperate forests is expected to reach 15–26 million tonnes (264–458 PJ) per year.
- For the foreseeable future, critical demand markets will remain in the EU and, to a lesser extent, Asia.
- Several key importing countries, including the United Kingdom, the Netherlands, Belgium and Denmark, have developed or are in the process of developing sustainability requirements for woody biomass acquisition and consumption.
- At present, the United States, Canada and Russia are the most important suppliers of traded wood pellets from temperate and boreal biomes and this is not expected to change before 2020.
- Some of the key challenges facing countries from which wood pellets are exported include: limited incentives for small-holder SFM certification across the Southeast United States, cultural differences in forest and land management definitions between Canada and the EU, as well as concerns regarding the efficacy of SFM auditing/monitoring in Northwest Russia.

INTRODUCTION

Fossil fuels currently satisfy approximately 81% of global primary energy needs, with consumption projected to increase further, due to rising incomes and a growing population (IEA, 2012). However, fossil fuel combustion is one of the key sources of greenhouse gas (GHG) emissions and, thus, a major contributor to anthropogenic climate change (IPCC, 2007, 2014). One of the critical challenges for the energy sector this century will be to decouple energy supply from GHG emissions. Bioenergy has been proposed as one option to address this challenge (Creutzig et al., 2014).

In some markets (eg Scandinavia), industrial-scale use of forest biomass as a source of bioenergy has been part of the national energy strategy for several decades (see chapter: Comparison of Forest Biomass Supply Chains From the Boreal and Temperate Biomes). In most markets, however, large-scale modern bioenergy production is relatively recent (REN21, 2014). There are numerous objectives driving the increased use of bioenergy including, but not limited to, reduction of GHG emissions, enhanced energy security and diversification and support for domestic industries (agriculture, forestry, processing etc.). Within a single decade, these factors have contributed to a shift in the way bioenergy is viewed, from a largely domestic resource to a globally traded one (Chum et al., 2011; Lamers, 2014). Indeed, more than 300 PJ of woody biomass were directly traded for energy on the international market in 2010 (Lamers et al., 2012).

Over the past several years, most of the globally traded solid biomass has been used for energy production in the EU (Junginger et al., 2013; Lamers et al., 2014a, 2014b). Other key importing regions for internationally traded forest biomass include South Korea and Japan. Cross-border trade also exists (eg between the United States and Canada, between Norway and Sweden). South Korea, Japan and many EU countries are expected to remain net importers of forest biomass for energy production (Kranzl et al., 2014). Recent analyses suggest that the EU's total woody biomass imports for energy (including forest biomass and agricultural residues) could increase by over 400% between 2010 and 2020 (Lamers et al., 2015).

International trade in woody biomass from temperate and boreal forests could be an important element in the mobilisation of bioenergy. For example, the recent expansion of wood pellet production capacity in the United States and Canada has been directly linked to export market developments in Europe and Asia. At present, renewable energy targets in export markets appear to be among the key drivers for international woody biomass trade (Junginger et al., 2014). Although trade barriers (eg import taxes and duties) are common for liquid biofuels, they have not, to date, been applied to woody biomass on a large scale. The need for internationally recognised technical standards and uniform contracts has also been addressed in recent years. The key remaining requirements for the development of a mature, international-scale woody biomass trade include: development of phytosanitary restrictions (to prevent the spread of vermin and fungi), reduction in logistical costs and, most importantly, establishment of policy frameworks to ensure sustainable sourcing (Junginger et al., 2014).

Sustainability criteria for forest biomass may influence the type and volume of feedstocks available to producers (eg wood pellet companies) and traders exporting to high-demand markets. In other words, sustainability standards for forest biomass designated for international trade could pose challenges, but also opportunities, for all parties involved in the forest bioenergy market. This chapter aims at defining the key barriers and opportunities for international forest bioenergy trading, with a special focus on those that may arise due to sustainability requirements within existing or proposed legislative frameworks in key regions. It also sets out to derive quantitative estimates of the demand for and supply of woody biomass from boreal and temperate forests by 2020 and highlight areas where proposed sustainability frameworks could lead to conflicts.

With a focus on wood pellets derived from boreal and temperate forests, this chapter first identifies and quantifies the most important destination markets for globally traded wood pellets. Next, it identifies and quantifies the most important current and expected sources of wood pellets and characterises these regions in terms of their competitiveness (eg via cost of supply, state of the industry). Finally, it provides an overview of the sustainability requirements and initiatives (current and expected) imposed by key destination markets and the sustainability requirements and certification status (current and expected) of the major wood pellet source markets; it also discusses their implications for international trade.

DEMAND MARKETS

European Union

As laid out in RED 2009/28/EC, 20% of final energy consumption must be provided by renewable energy across all member states within the EU, by 2020. Individual member states' National Renewable Energy Action Plans (NREAP) describe technological and sector trajectories and policy frameworks that have been put in place to achieve this goal. According to the NREAPs, approximately 42% of the total renewable energy target must be achieved via combustion of biomass for electricity, heating and cooling by 2020. Most of this energy will be used for heating/cooling in the residential sector and come from solid biomass (AEBIOM, 2012). Until now, the vast majority of the EU's woody biomass demand has been supplied domestically. However, the EU has attracted most of the international trade in forest biomass over the past decade (Lamers et al., 2012). Wood chips, waste wood and roundwood have been imported from bordering countries, while wood pellets have been traded cross-continentally, particularly from North America and Russia (Figs 8.1 and 8.2).

The most important EU market for wood pellet imports is the industrial sector, that is large-scale (>5 MW_{el}) co-firing and dedicated heat and power installations. Because of anticipated increases in demand under current policy projections and inadequate regional resources (eg limited available land, high feedstock costs and unacceptable delays in mobilisation), the United Kingdom, the Netherlands, Belgium, Denmark and Sweden are expected to remain net importers of woody biomass until at least 2020 (Kranzl et al., 2014).

It is important to note that Sweden and Denmark source wood pellets primarily from countries around the Baltic Sea, including Estonia, Latvia, Russia and Germany (Fig. 8.2). Denmark has also imported wood pellets from Portugal.

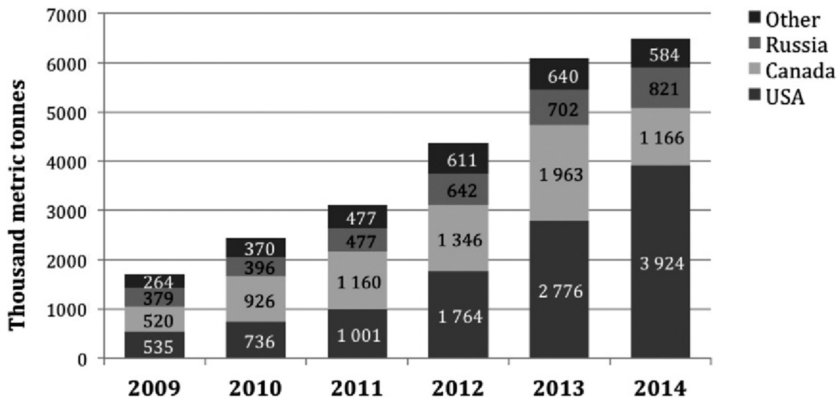

FIGURE 8.1 Extra-EU imports of wood pellets to EU member states. Note: Croatia became the 28th member state of the EU in 2014.

By contrast, the United Kingdom, the Netherlands and Belgium import wood pellets predominantly from the United States and Canada.

For the most part, the international trade of wood pellets for industrial use is negotiated directly between buyer and seller. Although there is generally little re-distribution of internationally traded wood pellets among European countries, trade streams (eg from the Netherlands to Germany or Denmark) have existed in the past (Fig. 8.2). Within the EU, there are strong differences in the patterns of trade in wood pellets for residential and industrial applications. Latvia, Estonia, Portugal and Finland are the largest exporting member states of industrial-use wood pellets (Table 8.1). Germany, Austria and the Balkan States have been the most important sources of wood pellets for Italy, which is the largest importer of pellets, predominantly for residential use. Denmark is the key importing member state of industrial-use wood pellets in the EU (Table 8.1), but Belgium, the Netherlands and the United Kingdom are also major importers of industrial-use forest biomass from outside the EU (Goh et al., 2013; Lamers et al., 2012). The demand for tradable solid biomass is expected to increase significantly in all of these countries because of proposed and/or existing policy measures that encourage the installation of large-scale co- and mono-firing plants for the generation of electricity (and heat) using solid biomass (Beurskens and Hekkenberg, 2010; Sikkema et al., 2011a).

Belgium

Belgium's current installed capacity of 280 MW_{el} per year is estimated to reach 730–900 MW_{el}/year (equivalent to approximately 3 million tonnes of wood pellets) by 2020. However, industry projections (Table 8.2) indicate that Belgium is unlikely to reach half of its initially projected NREAP level (2 GW_{el}). Current policy discussions indicate that subsidies from the national government will only be granted to power plants that provide full disclosure of their capital and operational expenditures.

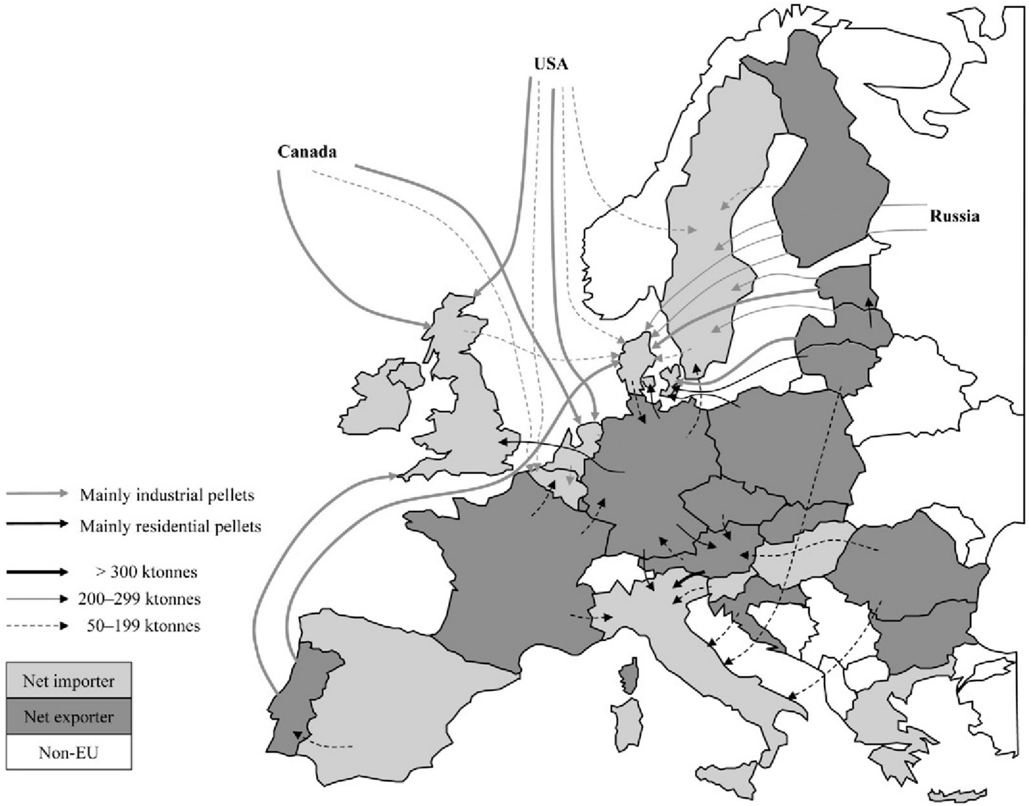

FIGURE 8.2 Annual wood pellet trade flows across the EU between 2010 and 2013.

TABLE 8.1 Intra-EU Trade in Wood Pellets (in Ktonnes)

Country	2012		2013		Market share		Dominant wood pellet type per application
	Imports	Exports	Imports	Exports	Imports (%)	Exports (%)	
Germany	265	515	273	517	6	11	Residential
Estonia	131	402	114	677	3	12	Industrial
Latvia	3	760	7	1216	0	22	Industrial
Austria	323	361	192	380	6	8	Residential
Portugal	2	371	9	474	0	9	Industrial
Finland	15	43	3	61	0	1	Industrial
Romania	1	212	1	355	0	6	Residential
Spain	17	38	15	74	0	1	Residential
Poland	91	84	35	192	1	3	Residential
Denmark	1434	140	1322	128	31	3	Industrial
Lithuania	15	165	41	184	1	4	Residential
Netherlands	305	100	245	118	6	2	Industrial
Sweden	351	148	375	126	8	3	Industrial
United Kingdom	296	129	304	117	7	3	Industrial
Belgium	288	21	174	103	5	1	Industrial
Italy	1034	3	957	19	22	0	Residential
Other	217	346	122	429			
EU	4790	3838	4190	5170			

TABLE 8.2 Expected Biomass Cofiring Capacity Developments in Belgium

Company	Plant	Completion date	Capacity (MW_{el})	Biomass demand (Mtonnes)
Electrabel	Max Green (phase-out)	–	(220)	
E.ON	Langerlo (conversion)	2015	400	1.25
BEE	Gent (new plant)	2017	180–200	0.75
E.ON	Antwerp (new plant)	2018	150–300	0.5–1
SUM			730–900	2.5–3

Denmark

Recent projections conducted by the Danish government suggest that wood pellet consumption will increase to approximately 50 PJ (heat and power sector) and 10 PJ (industrial sector) by 2020 (DEA, 2012a). Danish energy supplier Dong recently announced the conversion of two additional plants (Aalborg and Aarhus) to wood pellet use; however, the conversion of its Studstrup plant has been delayed until 2016 (Dale, 2013). In recent years, Denmark has imported between 1–2 million tonnes of wood pellet per year and estimates suggest that annual imports of wood pellets by the industrial sector could reach close to 3 million tonnes, by 2020 (Table 8.4).

The Netherlands

The Dutch Energy Accord (published in 2013) has set a maximum target of 25 PJ output, to be generated via co-firing in existing (Amer and Hemweg) and newer, more efficient power plants, by 2020. Older coal-fired power plants from the 1980s are slated for shut down by 2017. On a biomass basis, 25 PJ of electricity would equal close to 7 TWh, or 3.5 million tonnes of wood pellets. While it is not clear how industry will meet this target, we estimate a biomass demand of 3.5 million tonnes by 2020 (Table 8.4), assuming an efficiency factor for co-firing of 43% (using data for both old and new coal plants). Because funds from the Dutch Renewable Energy Subsidy Scheme (SDE +) have already been fully allocated for other renewable energy options until 2017, it is expected that large-scale co-firing will commence again in 2018.

Sweden

Woody biomass co- and mono-firing combined heat and power (CHP) installations in Sweden have traditionally sourced large shares of their demand from within Sweden and from neighbouring Norway and Finland. However, the price and availability of woody biomass feedstocks (eg the tops and branches generated during forest harvesting) are dependent on the timber, pulp and paper markets in those countries. Imports to Swedish CHP plants (which are considerably smaller than co-firing installations in the United Kingdom and the Netherlands) have been on ad hoc basis and in smaller volumes because of a preference for local suppliers and because of shipping size limitations for the Baltic Sea. Lately, imports of woody biomass for energy production have been reduced to a few large contracts from Russia, while smaller, ad hoc contracts have been cancelled (Hektor, B., 2014. RE: Member Representative Swedish Bioenergy Association SVEBIO, Stockholm, Sweden, Personal Communication). The Swedish pellet market is currently declining because most district heating companies have switched to wood chips (or municipal solid waste) to satisfy demand base loads and only use pellet boilers for peak loads (Olsson, O., 2014. RE: Stockholm Environment Institute, Personal Communication). These wood chips originate from raw forest material and from demolition/waste wood. In the past, Sweden has been a key importer of demolition/waste wood from within Europe, due to the market advantage of flue gas cleaning technologies (Lamers et al., 2012). However, demand for this material from other markets (especially in the United Kingdom) continues to increase. Thus, it is unlikely that Sweden will remain a significant importer of woody biomass for the industrial heating and electricity sector.

The United Kingdom

The current and anticipated UK policy framework is expected to trigger several new investments in electricity generation (Table 8.3). By 2020, up to 5130 MW_{el} of new mono- and/or co-firing capacity for biomass utilisation could come online (Blair, 2013). However, the UK support scheme is capped at 5 GW_{el} total biomass co-firing, with a 400 MW_{el} cap for installations without CHP generation (Harrabin, 2013). According to these requirements, only 3930 MW_{el} of the announced investments would qualify for subsidies and are, therefore, expected to utilise biomass. In a recent assessment of the country's electricity generation capabilities, the UK's Office of Gas and Electricity Markets calculated a biomass capacity of 3895 MW_{el} by 2018/2019 (OFGEM, 2013) (Table 8.4).

In Table 8.4, industry projections for each of the five countries described earlier are compared with policy projections made via the member states' respective NREAPs. For each country, the grid-connected heat production volume, that is the fraction of new capacity for biomass-based electricity production generated by CHP, was calculated using the relationship between electrical and grid-connected heat generation in the respective member states' NREAPs. The demand estimates outlined in Table 8.4 were employed for scenario analyses in Lamers et al. (2015), which focused on Northwest Europe and correspond to assumptions/scenario analyses by Pöyry (2014).

TABLE 8.3 Expected Biomass Cofiring Capacity Developments in the United Kingdom

Company	Plant	Completion date	Capacity (MW_{el})	Biomass demand (Mtonnes)
RWE	Tilbury, 2 units	2011	(Offline) 750	(Offline) 2–3
E.ON	Ironbridge, 2 units	2013	(Offline) 900	(Offline) 2–3
Drax	Drax, 3 of 6 units	2013, 2014, 2017	3 × 600	6–8
Eggborough Power	Eggborough, 4 units	2015	4 × 500	6–8
RWE	Lynemouth, 3 units	n/a	3 × 110	1
International Power	Rugeley, 2 units	n/a	2 × 500	2–4
TOTAL (theoretical)			5130	15–21
of which supported			3930	

Asia

China is expected to significantly increase its utilisation of biomass for the production of power and heat (Roos and Brackley, 2012), albeit exclusively from local agricultural and forest residues (Cocchi et al., 2011; Pöyry, 2011). Thus, it is not expected to become a strong competitor for internationally traded woody biomass. By contrast, international imports of tradable woody biomass are likely to expand in Japan and South Korea, where new policies are expected to increase the local demand for large- (Japan) and small-scale (South Korea) use. By 2020, Japan and South Korea are expected to consume a combined 22.66 million tonnes (399 PJ) of woody biomass, 15.65 million tonnes (275 PJ) of which could be supplied domestically. This leaves both countries with a combined supply gap of 7 million tonnes by 2020 (Japan: 3 million tonnes; South Korea: 4 million tonnes). Although both countries source globally, a large share of their import volumes have typically originated from within Asia (eg China, Vietnam, Malaysia) (Cocchi et al., 2011) and this is not expected to change. Unfortunately, there is little information available on future developments in wood pellet utilisation capacity across Southeast Asia. That being said, Vietnam is projected to export 3 million tonnes of pellets from wood industry processing residues by 2020 (Cocchi et al., 2011) and conservative estimates suggest that South Korea and Japan may, therefore, consume up to 4 million tonnes of wood pellets from Vietnam alone.

TABLE 8.4 RES-E Capacity and Biomass Demand From Dedicated Mono- or Cofiring Installations in Select EU Countries

	Solid biomass installations[a]	Cofiring capacity	NREAP projections (2020)			Industry projections (2020) wood pellet capacity and use		
	MW_{el} (by 2010)	MW_{el} (by 2012)	MW_{el}	GWh[b]	Mtonnes[c]	MW_{el}	GWh[b]	Mtonnes[c]
BE	727	280	2,007	9,575	5.8	910	4,341	2.6
DK[d]	1,168	(996)[e]	2,404	6,345	3.8	1,814	4,788	2.9
NL	992	413–551[f]	2,253	11,975	7.2	1,306	6,942	3.5
SE	3,823[g]	n/a	2,872	16,635	10.0	n/a	n/a	n/a
UK	2,097	208–338[h]	3,140	20,590	12.4	3,895	25,541	15.4

[a]*Data provided by member states in their 2010 status reports to the European Commission (EC) for all solid biomass power installations (excluding biogas and bioliquid installations).*
[b]*Gross electricity generation.*
[c]*Biomass demand; assumed energy content (LHV): 17.6 GJ/tonne.*
[d]*Total installed capacity for solid biomass of all sizes (excluding biogas and bioliquid installations).*
[e]*DEA (2012b), total installed capacity for solid biomass of all sizes.*
[f]*Agentschap-NL (2013); the lower value is large-scale installations only, the higher value represents the total installed capacity (ie installations of all sizes).*
[g]*Includes all municipal solid waste capacity (although only 50% can be accounted for as biomass).*
[h]*DECC (2013b); variation between 2011 and 2012 due to partial closure of Tilbury power station (RWE/Essent/npower) after a fire.*

North America

Across the United States, the demand for locally produced wood pellets is increasing, but not seriously threatening the supply of internationally traded wood pellets. Most large EU-based energy companies are either involved in the production of raw materials upstream (eg Drax in Mississippi, RWE/Essent/npower in Georgia) or specifically produce pellets for export markets overseas (eg Enviva, Fram Renewables, Enova and German Pellets) and can compete against the sale of pellets to domestic markets. Demand markets in the United States do not yet require sustainability criteria for forest biomass, but there are intense and ongoing discussions between the United States and Europe regarding the development of common standards for forest biomass production (Pinchot-Institute, 2013). The Renewable Fuel Standard (RFS2) and the Low Carbon Fuels Standard (for California) could be used as benchmarks for the development of such standards.

Several coal power plants in Ontario, Canada, have recently been converted for wood pellet use, suggesting that Canada could have a local pellet demand for up to 5 million tonnes, by 2019 (Dale, 2013). Wood pellet supply for Ontario is expected to come from within the province, although one station (Thunder Bay) has been converted to consume Steam Explosion Pellets (SEP)—otherwise known as black pellets or bio-coal, imported from Norway as of 2015. The main exporting regions for wood pellets can be found along the west and east coasts of the country (in the provinces of British Columbia, Quebec, New Brunswick and Nova Scotia). Given the long shipping distances and the limited number of water channels linking inland areas to deep-sea harbours, wood pellets currently designated for domestic use are not to become designated for export directly. However, the establishment of new routes for transporting pellets (eg from eastern Ontario to Quebec City by rail and then to the United Kingdom by boat) suggest that this is likely to change.

Global Demand by 2020

The global trade in woody biomass from boreal and temperate forests is driven largely by policy targets and supply costs. The total global demand for wood pellets for heat and power production is expected to reach 32–36 million tonnes by 2020, approximately double the demand in 2010 (Fig. 8.3). Estimates for Northwest Europe (Table 8.4) and calculations by Pöyry (2014) suggest that even high-demand regions, such as the EU, could supply sufficient biomass to meet domestic needs (Lamers et al., 2015). However, internationally traded woody biomass is often cheaper and, thus, preferred over more expensive locally produced biomass. That being said, the United States and Canada are expected to satisfy domestic regional demands due to low supply costs. Japan and South Korea are projected to import 4 million tonnes by 2020. Other regions of the world may require as much as 2 million tonnes of woody biomass per year, but this estimate was not included in Fig. 8.3 because of uncertainty in accounting for respective domestic supplies. In fact, the domestic supply of woody biomass

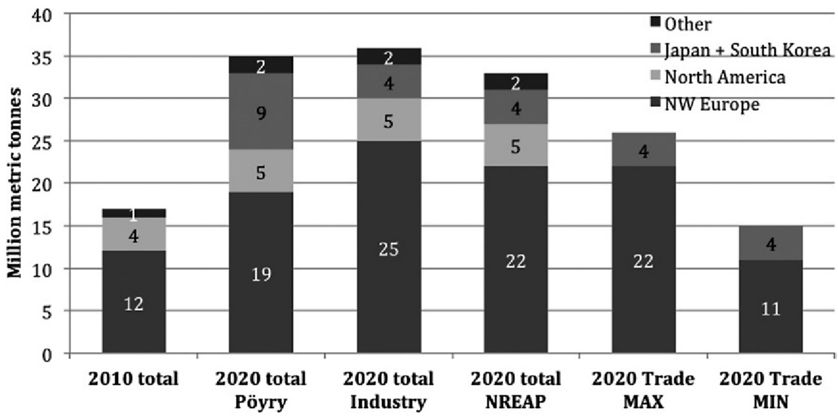

FIGURE 8.3 Estimated global woody biomass demand for large-scale heat and power generation by 2020. Note: Northwest Europe includes Belgium, Denmark, the Netherlands and the United Kingdom. Estimates of demand for woody biomass in Japan and South Korea only include that obtained from outside SE Asia. Pöyry 2020 is based on the 'Central scenario' in Pöyry (2014).

within the EU is the single largest uncertainty in predicting the demand for tradable woody biomass by 2020. Thus far, Northwest Europe has been predominantly import-oriented. By 2020, however, a larger fraction could be supplied from within the EU (eg the Baltic States). To account for this, Fig. 8.3 shows two estimates: one for 100% (MAX) and one for 50% (MIN) import dependency. The second estimate is in line with trade projections by Lamers et al. (2014a).

SUPPLY REGIONS

Key Regions of Woody Biomass Production up to 2013

As demonstrated earlier, the EU represents the largest demand market for woody biomass. Although the EU is capable of meeting most of its demand for residential wood pellets from domestic sources, it is heavily dependent on imports for industrial heat and electricity production. Without these imports, the EU would not be capable of meeting NREAP targets. The second largest markets for internationally traded woody biomass are Japan and South Korea, which require imported wood pellets for both residential and industrial use. Although most internationally traded wood pellets imported to Asia and Europe have originated in North America and Russia, Japan and South Korea have also obtained wood pellets from within Southeast Asia. There is limited local demand for wood pellets within Russia and North America. Therefore, the recent increase in wood pellet production in these regions (Fig. 8.4) must be driven by the growing demand from foreign markets. China has also ramped up pellet production from forest and agricultural residues in recent years, but consumption is largely domestic and the smaller fraction of traded material has been limited to shipments within Asia.

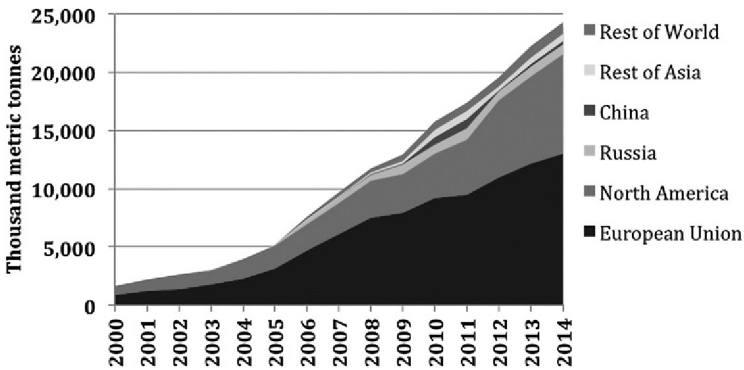

FIGURE 8.4 Global wood pellet production (AEBIOM, 2013; Goh et al., 2013; Hawkins-Wright, 2013; Lamers et al., 2012, 2014a; REN21, 2015).

Wood chips and roundwood have also been traded for the production of energy. Most of the trade in wood chips for energy (virgin and/or tertiary waste) is limited to Europe, Turkey and Japan (Lamers et al., 2012). Although the majority of the trade in roundwood is not connected to bioenergy, there is a large amount of indirect trade, in the form of wood processing residues (Heinimö, 2008; Heinimö et al., 2013). The direct trade in raw forest material for bioenergy (ie excluding waste wood) has been small, compared to the trade in wood pellets, because high quality raw wood chips and roundwood can achieve higher prices in the pulp and paper and timber markets (Lamers et al., 2014a). Both wood chips and roundwood are also less suitable for international trade than wood pellets because of their relatively high moisture content and low bulk density, which renders them more expensive to transport over long distances. As a consequence, the trade in wood chips and roundwood for bioenergy have largely been confined to regional and domestic markets.

Key Regions of Woody Biomass Production by 2020

By 2020, the greatest demand for woody biomass from boreal and temperate forests is expected to come from countries/regions with a limited local supply of forest biomass. Recent growth in the production of internationally tradable woody biomass has occurred in regions with a significant forested landbase and this trend is projected continue into the future. US forests cover over 300 Mha, Canadian forests cover over 310 Mha and Russian forests cover approximately 780 Mha (see chapter: Quantifying Forest Biomass Mobilisation Potential in the Boreal and Temperate Biomes). All three countries have seen a decline in markets for conventional forest products (ie timber, pulp and paper, engineered wood products) over the 2000–2010 decade. Demand from the energy sector for woody biomass is seen as a means of diversifying the forest product portfolios in these countries.

As previously mentioned, wood pellet production and trade in the industrial sector largely occurs directly between buyer and seller, with very limited brokerage activity. Production centres across North America and Russia are in direct price competition with each other. Production prices are influenced by:

- The availability of low cost woody biomass and/or residues from existing forestry, pulp and paper, or wood processing industries; and
- The export capacities of the forest or wood processing industries, including infrastructure for bulk shipments (railways, deep-sea harbours) and handling equipment (chippers, cranes, terminals etc.).

Table 8.5 illustrates expected free-on-board prices by 2020, across a selection of harbours, indicating the price advantage of harbours in the South-eastern United States and on the Baltic Sea, compared with Canadian inland shipments from Ontario.

As several independent projections show (Fig. 8.5), the United States (especially the Southeast) is poised to become the largest global producer of wood pellets by 2020. Projected estimates of wood pellet production in the United States vary from 5 to 11.5 million tonnes, depending on the assumed success rate of currently proposed expansion in wood pellet production capacity. By 2020, annual wood pellet production for export is expected to reach between 2.6 and 4.6 million tonnes in Canada and between 1.8 and 7 million tonnes in Russia.

TABLE 8.5 Expected Free-on-Board (FOB) Prices for Wood Pellets Across Selected Harbours in North America and Europe by 2020 (Lamers et al., 2014c)

Harbour	Country/region	FOB (€ tonne/WP_e)	FOB (€/GJ)
Halifax (Nova Scotia), Campbellton (New Brunswick)	Eastern Canada (coast)	117	6.65
Montreal (Quebec), Quebec City (Quebec)	Eastern Canada (inland)	131	7.44
Vancouver, Prince Rupert (British Columbia)	Western Canada (coast)	105	5.97
Sankt-Petersburg, Vyborg	North-western Russia (Baltic Sea)	123	6.99
Mykolaiv	Ukraine (Black Sea)	123	6.99
Portland (Maine)	North-eastern USA	117	6.65
Norfolk (Virginia)	Eastern USA	117	6.65
Savannah (Georgia), Mobile (Alabama)	South-eastern USA	108	6.14

Prices per GJ are based on a heating value of 17.6 GJ_{LHV}/tonne.

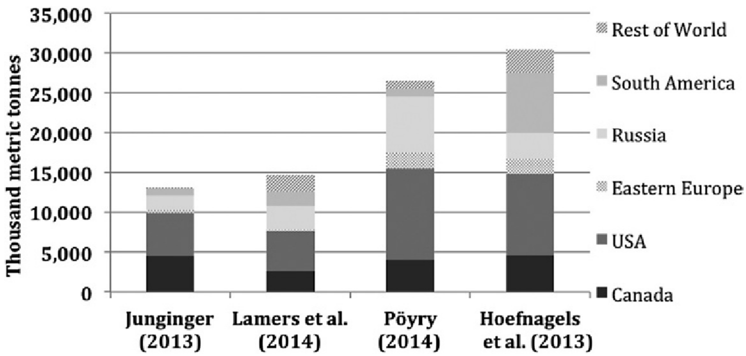

FIGURE 8.5 Expected annual wood pellet production for international trade by 2020 (Hoefnagels et al., 2013; Junginger, 2013; Lamers et al., 2014c, 2015; Pöyry, 2014). Note: The Pöyry (2014) projection is based on the assumption that 50% of the expected additional capacity by 2025 is already online by 2020. All additional production capacity by Pöyry (2014) is expected to be used for international supply/trade.

SUSTAINABILITY REQUIREMENTS AND CERTIFICATION STATUS

Sustainability and Certification Requirements in Key Industrial Demand Markets in the EU

In 2014, the European Commission announced that it will not pursue binding sustainability criteria to regulate the production of woody biomass for energy purposes before 2020 (EC, 2014). However, numerous regulatory initiatives already exist at the member state and company level. With the aim of importing wood pellets from overseas, large power and heat production utilities from across Northwest Europe (including Electrabel, Dong, Nuon, RWE/Essent/npower, Vattenfall, E.ON) initially formed the International Wood Pellet Buyers Initiative (IWPB), which has been institutionalised as the Sustainable Biomass Partnership (SBP). The SBP sets forth minimum quality requirements for wood pellets (Ryckmans, 2013), which are reflected in the voluntary schemes used by several large utilities, including Electrabel in Belgium (Laborelec scheme) and Essent/RWE/npower in the Netherlands (Green Gold Label).

Despite these initiatives, the European Commission's proposition (EC, 2010) that individual member states adopt solid biomass requirements similar to those for liquid biofuels in RED 2009/28/EC remains valid. Indeed, RED, or similar, criteria are likely to be adopted by individual nations across Northwest Europe and, in case of the United Kingdom, adoption of these criteria has already been proposed (DECC, 2013a; OFGEM, 2011). The Dutch energy industry and nongovernmental organisations (NGOs) have been working towards the development of a national energy accord since the beginning of 2014, and achieved principal agreement on sustainability criteria for solid biomass in March 2015. However, further discussions are required to define a timeline for compliance and to outline how compliance will be tested and monitored (ie which existing SFM certification systems will be used to assess compliance). In the Flemish region of Belgium, a proposal has been prepared to bring the sustainability requirements for woody biomass to the same level as bioliquids (Pelkmans, L., 2014. RE: IEA Bioenergy Task 40 Representative of Belgium, Personal Communication). In Denmark, an Industry Agreement was established in December 2014 to ensure that the use of wood pellets and wood chips for energy production is compliant with the same framework for sustainability (which addresses the environment, health, safety and climate) as CHP producers (Dansk-Energi, 2014).

Critics have claimed that the RED criteria are not adequate for forest biomass, primarily because the suggested GHG emission accounting rules (EC, 2010) would neglect a temporal imbalance between carbon sequestration and release from forest biomass (Searchinger, 2010; Zanchi et al., 2010). This concept, typically referred to as 'carbon debt', may be adopted by aforementioned initiatives that are already in place at member states or company level to augment RED requirements. While it is not entirely clear how such a criterion could impact biomass supply, a rather drastic proposition could be to exclude roundwood, including low-grade pulpwood, from bioenergy production via a feedstock blacklist (see also chapter: Environmental Sustainability Aspects of Forest Biomass Mobilisation). In this case, neither local nor imported wood pellets produced from such feedstocks would be eligible for use.

In an extreme case, the discussion around carbon debt may lead to the exclusion of all forest biomass as a source of energy in large-scale, non-residential applications. This could be achieved by imposing a temporal carbon criterion. In an effort to safeguard biodiversity, the exclusion of solid biomass from 'primary forests', as defined in the RED, could also preclude the use of wood from some Canadian and Russian forests for bioenergy because forestry operations are still sometimes conducted in stands that are 'inherited from nature' and have never been previously harvested on an industrial scale.

The United Kingdom

UK policy support schemes for which sustainability criteria development is relevant include the Renewables Obligation (RO), which is the main support mechanism for large-scale renewable electricity projects; the Renewable Heat Incentive (RHI), which includes domestic incentives for homeowners, private landlords, social landlords, self-builders and non-domestic incentives for industry, businesses and public sector organisations; the Contracts for Difference (CFD), which are long-term contracts to encourage investment in new, low-carbon energy generation; and the Renewable Transport Fuel Obligation, which supports the UK government's policy on reducing GHG emissions from vehicles by encouraging the production of biofuels.

The UK Bioenergy Strategy of April 2012 (DECC, 2012) is based on four principles:

- Policies that support bioenergy should deliver genuine carbon reductions that help meet UK carbon emissions objectives up to 2050 and beyond (a domestic GHG emissions reduction of at least 80% by 2050, against a 1990 baseline).
- Support for bioenergy should make a cost-effective contribution to UK carbon emissions objectives in the context of overall energy goals.
- Support for bioenergy should maximise the overall benefits and minimise costs (quantifiable and non-quantifiable) across the economy.
- At regular time intervals and when policies promote significant additional demand for bioenergy in the UK, policy makers should assess and respond to the impacts of this increased bioenergy consumption on other areas, such as food security and biodiversity.

Since 2012, the UK government has held a number of consultations to develop sustainability criteria for solid biomass and aims to bring in sustainability criteria for those supplying biomass (wood fuel) under the RO and RHI. These criteria were initially introduced as reporting requirements, beginning in April 2014, and as mandatory criteria, beginning in April 2015, for generators above $1MW_{el}$ capacity (OFGEM, 2014). These criteria will apply from the beginning of the CFDs and include:

- A minimum 60% GHG emissions reduction against the average EU fossil grid intensity by 2017, applying the methodology suggested in EC (2010), increasing to 75% by 2025; the methodology considers the emissions from the cultivation, harvesting, processing and transport of the biomass feedstocks. It also includes direct land-use change where the land use has changed category since 2008. It does not include indirect impacts such as displacement effects.
- Land criteria for raw wood and other non-waste biomass, as well as a requirement to source wood from sustainably managed forests, in line with the UK Timber Standard (DECC, 2014) and regardless of where the timber originated.

Since April 2015, all raw wood or biomass products made from raw wood have been managed according to SFM criteria that correspond to the land management criteria for these feedstocks. The SFM criteria are based on the UK Timber Procurement Policy, originally developed to define legal and sustainable timber procurement policies for governmental offices; these are being implemented by the Central Point of Expertise on Timber (CPET). The UK Timber Procurement Policy requires one of two types of evidence to demonstrate that at least 70% of all timber (or biomass) is legally and sustainably harvested:

- *Category A evidence*: certification either through the Forest Stewardship Council (FSC) or an accredited scheme under the Programme for the Endorsement of Forest Certification (PEFC), which currently includes the

Sustainable Forestry Initiative (SFI), the Canadian Standards Association (CSA) and the American Tree Farm System (ATFS).

- *Category B evidence*: bespoke evidence, including the use of a risk-based regional approach, to demonstrate compliance, which covers chain of custody from the forest source to the end-user and which relies on evidence gathered from forest management plans, applicable legislation, supplier declarations, second-party supplier audits and third-party verification.

The UK criteria allow for mixing of feedstocks with different sustainability characteristics at any step in the supply chain, for both Category A and Category B materials, using a mass balancing option.

It is important to note that the current set of UK criteria does not directly address the preservation of land/forest carbon stocks, except where biomass procurement would be classified as a direct land-use change. However, the issues of sustained land/forest carbon loss (carbon debt) and indirect land-use change (ILUC) are being investigated and respective criteria may be integrated in 2016/2017, under the UK Bioenergy Strategy Review (DECC, 2013a).

In a recent comparison of existing SFM certification schemes with the UK Category A and B evidence requirements, Sikkema et al. (2014a) showed that many schemes already comply with most (but not all) requirements (Table 8.6). The GHG emission savings calculations, required by the UK Category A and B evidence requirements, are not adequately addressed by many pre-existing SFM certification schemes. However, this information could be supplied via the OFGEM GHG calculation tool (https://www.ofgem.gov.uk/publications-and-updates/uk-solid-and-gaseous-biomass-carbon-calculator) or a suitable alternative.

Belgium

Currently, there is neither federal support nor binding sustainability requirements for the use of solid biomass to produce heat in Belgium. There is, however, federal support (in the form of support certificates[1]) for ensuring the sustainability of biomass used to produce electricity, including heat from combined heat and power stations. The principles and criteria used to ensure the sustainability of all renewable energy sources (including solid biomass) differ somewhat among the regional quota systems (green certificates) in Flanders, Wallonia and Brussels-Capital. Nevertheless, they all directly link to renewable energy use and GHG reductions based on quota obligations, with special conditions for each region. For example 8 and 15 TWh of renewable energy

1. In Belgium, there are two forms of support certificates. In Walloon and Brussels-capital regions, one support (green) certificate is issued for every MWh divided by the amount of CO_2 saved and the certificates are allocated by the regulatory authorities CWaPE and Brugel. In Flemish region, the amount of electricity to be produced for one certificate varies across technologies and is based on a technology-specific banding factor. In general, banding factor is 1 for an amount of 1 MWh of solid biomass use, but banding factor is set at 0.00496 for an amount of 20.161 MWh of biomass used in households and commercial units.

TABLE 8.6 Benchmarking SFM Certification Schemes Against Category A and B Evidence Requirements (Sikkema et al., 2014a)

	Certified biomass via programs for certified forest management areas (UK Evidence A)				Miscellaneous options		Complementary programs (UK Evidence B)		
			PEFC endorsed forest management frameworks			WWF gold standard			
	FSC forest management	PEFC international forest management	SFI forest management	CSA	ATFS	Complementary to FSC	FSC CW controlled wood	PEFC due diligence	SFI fibre sourcing
I. Legal sourcing: EU Timber Regulation (EUTR) (European Commission, 2010a)									
A. Basic compliance: prevention of illegal harvesting practices	✓	✓	✓	✓	✓	✓	✓	✓	×
II. Sustainable sourcing: EU Communications (European Commission, 2010b)									
A. GHG for forest operations, anticipating a GHG savings requirement	×	×	±	±	×	±	×	×	±

(*Continued*)

TABLE 8.6 Benchmarking SFM Certification Schemes Against Category A and B Evidence Requirements (Sikkema et al., 2014a) (*cont.*)

	Certified biomass via programs for certified forest management areas (UK Evidence A)					Miscellaneous options	Complementary programs (UK Evidence B)		
			PEFC endorsed forest management frameworks			WWF gold standard			
	FSC forest management	PEFC international forest management	SFI forest management	CSA	ATFS	Complementary to FSC	FSC CW controlled wood	PEFC due diligence	SFI fibre sourcing
B. No harvest from high biodiversity areas, including primary forest	✓	✓	✓	±	✓	✓	✓	✓	×
C. No harvest from high carbon stocks or from wetlands	±	±	±	×	×	✓	×	×	×
D. Sustainable harvest rates and carbon stocks	✓	✓	✓	±	±	✓	×	×	±

E. No deforestation (and natural regeneration and replanting practises)	✓	✓	✓	±	×	✓	✓	✓	×
F. Exceptional recovery of salvage trees (after natural disturbances)	✓	✓	×	±	×	✓	×	×	×
III. EU Waste Directive (post-consumer waste) (European Commission, 2008)									
A. Cascaded use of harvested wood products	×	×	×	×	×	×	×	×	×

Note: ✓, sufficient coverage via SFM or other programmes (or explicit intentions); ±, partly sufficient: this topic is not fully incorporated or it is not sure how any (stakeholder) consultation will fully cover this item; ×, coverage is insufficient.

must be used for electricity production in Wallonia and Flanders, respectively, to meet the target of 13% renewable energy use by 2020. These quota systems include principles of sustainable sourcing and supply chain management, measured via total energy balance (Flemish system) or CO_2 emissions (Walloon system) and requirements for audits that demonstrate compliance with sustainability principles.

There are no requirements to use a specific (voluntary) sustainability standard or certification scheme to prove compliance, although several are eligible. Producers of green electricity must obtain a guarantee of origin by approved certification bodies. However, requirements are verified by independent third parties who determine the amount of green certificates on a case-by-case basis, depending on the size and type of biomass suppliers and generators.

The Flanders region also forbids the combustion (for energy) of wood that could be able to be used for another purpose. In practice, green certificates are awarded for the generation of electricity based on specific waste materials. Waste materials that can be recycled or processed in a superior manner are not accepted for certification. Green certificates issued outside the Flemish Region are not accepted. Discussions on implementing similar wood cascading principles are ongoing in Wallonia.

The Netherlands

The Dutch Energy Accord (published in 2013) outlines a number of key requirements for the use of solid biomass:

- The share of renewable energy in final energy consumption must be 14% by 2020 and 16% by 2023.
- Sustainability criteria for the use of biomass during co-firing with coal are a prerequisite for continuing policy support.
- Co-firing of biomass, including wood chips and pellets, in coal plants is capped at 25 PJ, thus contributing a maximum of 1.2% to the total 2020 target of 14%.

In March 2015, the Dutch socio-economic council (SER) announced that industry and NGOs had reached an agreement on the sustainability criteria for biomass required to receive SDE+ subsidies (SER, 2015). The agreement includes the following criteria (NEA, 2015):

- Criteria for climate and bioenergy: reduction of net GHG emissions (eg a 70% reduction relative to EU reference values), conserving carbon stock reservoirs and preventing ILUC.
- Criteria for sustainable forest management, including criteria on legislation and regulation; ecological considerations (including biodiversity, soil, water, ecological cycles etc.); economic considerations and management considerations.
- Criteria on how to monitor the chain of custody.

- An assessment table (ie a positive/negative list) to include (low carbon debt risk) or exclude (high carbon debt risk) specific materials as bioenergy feedstock. This assessment table is unique within the EU.

Other elements of the agreement include the requirement that large forest management units (ie more than 500 ha) must meet these criteria as of 2015, while for small forest management units, for a limited time (which is not specified), for a number of criteria, a risk-based approach may be applied and only the pellet mill producing wood pellets from these small units needs to be certified. In addition, utilities must create a fund (using the revenues from co-firing wood pellets) to increase SFM certification in the sourcing areas. At the time of writing (Aug. 2015), there was no clarity on how compliance will be tested and monitored, for example which existing SFM certification system will be approved as proof of meeting which criteria, but work is underway to address these gaps.

Denmark

The Danish Energy Agreement (DMCEB, 2012) has set a target of 100% renewable energy use by 2050. To meet this target, a significant increase in the use of renewable energy is required in all sectors, but solid biomass is likely to account for over 50% of the expected total renewable energy consumption.

A voluntary sustainability assurance framework for solid biomass was established in Dec. 2014, based on an initiative by the Danish Energy Ministry, the Danish District Heating Association and the Danish Energy Association. These voluntary sustainability requirements and criteria were developed using the UK Timber Standard for Heat and Electricity (DECC, 2014) as a baseline and reflect the content of the Danish Ministry of the Environment's guidelines on securing sustainable timber in public procurements of goods and services and Forest Europe's criteria for sustainable forest management. The agreement aims to ensure 40 and 100% sustainable biomass use for bioenergy by 2016 and 2019, respectively. The agreement is supplemented by criteria guaranteeing minimum CO_2 savings, compared to fossil alternatives. Participating organisations are also required to evaluate the agreement in 2018 and ensure that it remains consistent with other sustainability frameworks, for example as common sustainability requirements are adopted within the EU or across the globe.

With regard to the production and purchase of wood pellets and wood chips the certification system developed by the SBP can be used, but other voluntary forest certification schemes, such as the FSC or PEFC, are also recognised by the Danish Nature Agency and are considered valid.

The agreement applies to all energy plants that generate heat and electricity using biomass. To ensure that the agreement does not incur disproportionately high costs for smaller facilities, only plants with an input rating exceeding 20 MW_{th} will be subject to documentation requirements, which

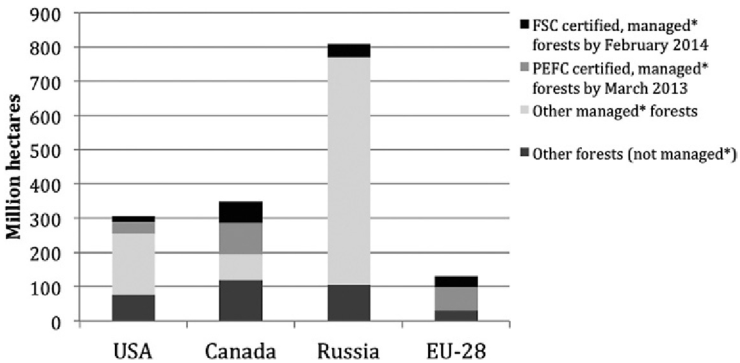

FIGURE 8.6 Forest area covered by certification in North America, Russia, and Europe (NRCAN, 2014; Sikkema et al., 2014a). Note: * Managed forests are defined as total forest minus protection forests, conservation forests and forests preserved for other social services.

will enter into force by August 2016 (Dansk-Energi, 2014). The agreement will be fully phased-in through 2019 and energy utilities which voluntarily participate in this agreement are required to submit annual compliance reports.

Supply-side Certification Status and Volume Estimates

Only a small fraction of the total global forest land mass has been certified (Rekacewicz et al., 2009). However, it is important to note that not all forested land is actively managed. Furthermore, the fraction of certified land varies greatly among countries (Fig. 8.6). The highest certification volumes are based in boreal and temperate forests in Northern Europe, Canada and the United States. By 2012, 151 million ha (Mha) of forest were FSC certified; 88% of this was temperate and boreal forest in North America, Europe and Russia (FSC, 2012). FSC certification covers 6% of the managed forest area in the United States, 18% of that in Canada, 5% of that in Russia and 32% of that in the EU-28. Russia aside, certification under the PEFC umbrella scheme (eg SFI in the United States and CSA in Canada) is much higher. PEFC certification covers 15% of all managed forest area in the United States, 39% of that in Canada and 68% of that in the EU-28 (Fig. 8.6).

Canada

Canadian forests are located predominantly on Crown land, owned and controlled by the government. About 66% of the total Canadian forest landbase of 348 Mha is classified as 'managed forest', that is forest that is under some form of management (NRCAN, 2014). However, the operational definition of 'managed forest' varies from province to province and can include forests in which harvesting has occurred; forests that have never yet been harvested but will be in the future; and forests that will not be harvested but will be protected from wildfires etc. Wood volumes or forested areas are typically allocated to private companies or other entities through contracts. Unlike most European forests, some ‘managed’ Canadian forests have not yet been harvested and/or are inaccessible by road. There are also vast stretches of forest that are classified as unmanaged although other industrial activities, such as mining, might occur. Most of the managed forest in Canada has been certified by at least one SFM scheme.

Depending on the manner in which the definition of ‘primary forest’ in the RED is interpreted and applied, biomass harvested from Canadian forests that have not previously been harvested or accessed by roads may be ineligible for use in energy production because they are considered ‘natural’. At the same time, Canadian regulations and third-party certification are in place to ensure that ecosystems with high biodiversity value are protected during forest management activities and that forests are managed to conserve characteristics of natural forests, at both the stand and landscape levels, for example by using forest management models that attempt to emulate natural disturbance patterns (Thiffault et al., 2015). Furthermore, a restriction on the use of wood from ‘primary forests’ for bioenergy is scientifically controversial (Lamers et al., 2013) because this material can still be used for other purposes, such as pulp and paper.

The controversy associated with the perception and definition of ‘primary forest’ highlights a wider issue, namely fundamental differences in forest management history and practices in Europe and North America. Forest management in Canada is generally conducted in forests inherited by nature and/or influenced by large-scale natural disturbances, such as wildfires. Canadian forestry practices and definitions reflect this reality and contrast strongly with those in Central Europe, where nearly all forests have been managed in an ‘unnatural’ condition for many decades. This conceptual disconnect could lead to differences in sustainability criteria on the two sides of the Atlantic which could, in turn, result in the imposition of trade barriers on forest biomass.

Most Canadian wood pellets are exported from the province of British Columbia, where feedstocks used to produce wood pellets include sawdust and shavings from timber processing, harvesting residues and salvaged wood. Salvaged wood comes predominantly from trees killed by a catastrophic outbreak of mountain pine beetle (*Dendroctonus ponderosae*), which have since become unmerchantable as timber (BC-MoF, 2010a, 2010b). Technically, this wood can be classified as ‘roundwood’, that is stemwood, but forest companies sell merchantable timber to the conventional wood products industry and unmerchantable trees (based on stem size, shape, or the presence of fungal stains) to wood pellet producers.

In the eastern Canadian provinces of Ontario and Quebec, increasing volumes of roundwood are used in the wood pellet industry due to the closure of pulp and paper mills. Stakeholders in these provinces are also considering the use of low-quality trees salvaged after natural disturbances (mainly wildfire and insects, for example spruce budworm, *Choristoneura fumiferana*) for pellet production (Barrette et al., 2015).

Numerous estimates of forest biomass availability have been calculated for Canadian forests (Paré et al., 2011), focusing primarily on residues, trees and tree parts that are not used by conventional forest industries. To date, these estimates have not included unutilised annual allowable cut, although these trees could also be considered as a potential source of bioenergy feedstock. A comprehensive analysis of biomass feedstocks for energy production in Canada was performed by Dymond et al. (2010), who considered the bioenergy potential of residues from clear-cutting (slash), forest fires, insect outbreak, stand break-up and self-thinning. Dymond et al. (2010) estimated that approximately 52 million tonnes of biomass is available each year from clear-cut residues, wildfires and insect disturbances. An additional 178 million tonnes per year may be available from stand break-up and self-thinning. Although a detailed sustainability assessment was not included, the authors did consider a 50% outtake ratio, that is 50% of all available biomass would remain in the forest (Dymond et al., 2010).

The United States

Certification in the United States is not as widespread as it is in Canada, due, in large part, to diverse patterns of forest ownership. Large areas with private, small-holder ownership are common in the Southeast. By contrast, large, continuous stretches of corporate-owned forests exist in the Northeast (eg Maine), the Northwest (eg Oregon and Washington) and in Texas and Louisiana (USFS, 2011).

SE United States currently supplies 60% of the total volume of wood harvested in the country and is expected to remain the key wood-producing region for the foreseeable future (DOE, 2011). Two-thirds of these forests are owned by non-industrial private forest landowners (Pinchot-Institute, 2013). Timberland owned and controlled by the forest industry is less common in this region. At a recent forest and trade workshop between industry, government and NGOs, participants noted that only 3% of non-industrial private forest landowners in the Southeast have a written forest management plan and only 13% have received forest management advice (Pinchot-Institute, 2013). To many of these landowners, income via timber harvesting is only one of several ownership objectives, which also include providing wildlife habitat and hunting revenues. Small-holder, non-industrial private forest land owners are reluctant to pay for voluntary forest certification, which is reflected in the relatively low overall SFM certification level of 17% (Pinchot-Institute, 2013).

SE United States is the current and expected primary sourcing region for wood pellet exports to the key demand regions as identified in the previous section (Fig. 8.7). By 2020, over 90% of the US wood pellet production capacity for export is expected to be in this region. While there has been reported use of hardwoods (http://wunc.org/post/advocates-report-critical-nc-wood-pellet-mill), the

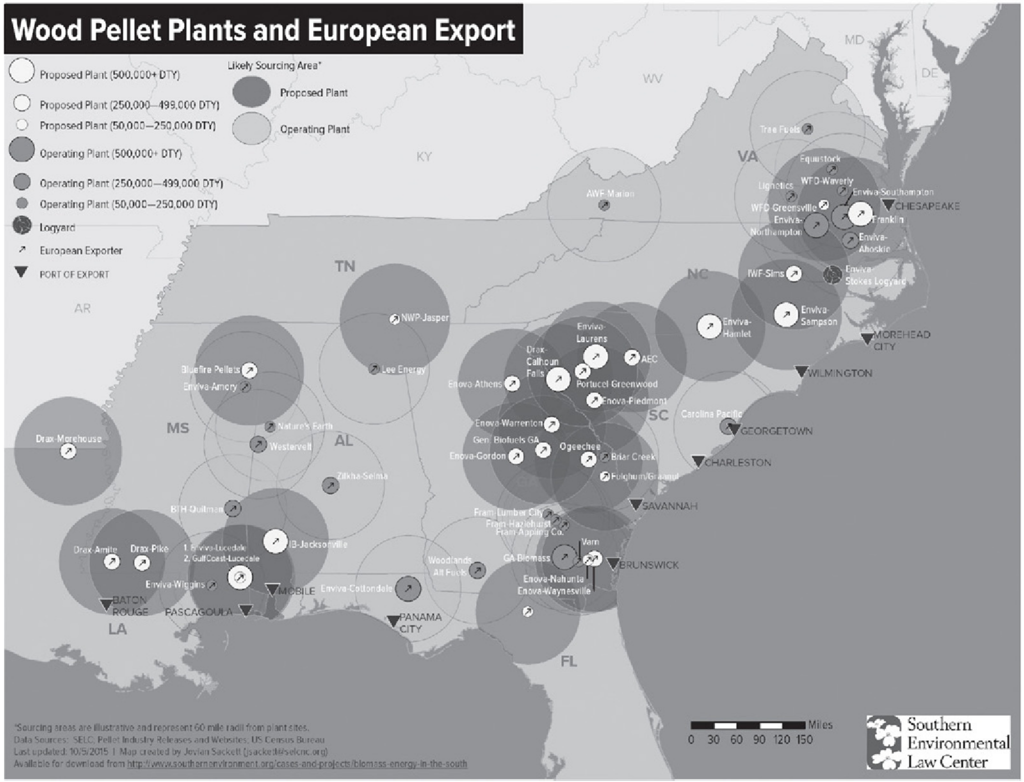

FIGURE 8.7 Current and expected US wood pellet production for export (http://www.southernenvironment.org/cases-and-projects/biomass-energy-in-the-south).

vast majority of the feedstock will be small diameter and pulpwood quality roundwood from pine plantations. Additional feedstock options include timber harvest residues, that is primary residues such as tops and branches (used, eg by Georgia Biomass) and, to a limited extent, also processing residues such as sawdust and shavings (used, eg by Fram Renewables). For an extended list of wood pellet plants and their capacities, see Hess et al. (2015).

Russia

One of the world's largest wood pellet plants is located in Vyborg, Northwest Russia, the country's main production region of wood pellets destined for export to Europe. In fact, between 30 and 50% of the total annual Russian timber production originates in Northwest Russia. This region has long-standing relationships with European export markets because of its proximity to the border and to shipping routes on the Baltic Sea (Thiffault et al., 2014). Wood pellet production for markets in Asia has also recently emerged in eastern Russia (Cocchi et al., 2011).

According to the Russian Federal Agency of Forestry, 120 Mha of forest are SFM certified; this represents approximately 25% of all Russian forests (Thiffault et al., 2014). By 2014, the majority of forest operations conducted by foreign companies across Northwest Russia were certified via voluntary SFM labels. However, management and harvesting practices within these certified forests are often not in compliance with respective SFM requirements (Thiffault et al., 2014), suggesting that third party SFM certification is generally weak. In some cases, the application of FSC standards has resulted in conflicts between Russian forest legislation and management practices on the ground (Thiffault et al., 2014). However, this apparent lack of effective SFM implementation may be improving. Since March 2013, for example the EU Timber Regulation (http://ec.europa.eu/environment/forests/timber_regulation.htm) has required traders in wood pellets to exercise due diligence (eg chain of custody reporting) for any wood imported into the EU. Wood for energy also falls within the application of the timber regulation, except when classified and traded under the respective trade code of 'waste wood'. Past uses of trade codes (including those for waste wood) have shown that definitions will eventually determine the effectiveness of respective trade regulations (Lamers et al., 2012).

Few peer-reviewed studies have been undertaken to estimate the volume of wood available for energy production in Russia, particularly in the context of sustainability restrictions. Based on the 2004 annual cut, Gerasimov et al. (2007) calculated that approximately 4 Mm^3 of thinnings, logging residues, non-industrial roundwood and secondary residues would be available for bioenergy in the St Petersburg region. The majority of this material (approximately 86%) was expected to come from non-industrial roundwood and felling residues, with the remainder from secondary/mill residues. Based on the results of this study, it may be possible to double the utilisation of forest resources for energy production, if the annual allowable cut (AAC) was fully harvested and thinnings utilised (Gerasimov et al., 2007). Goltsev et al. (2010) updated these

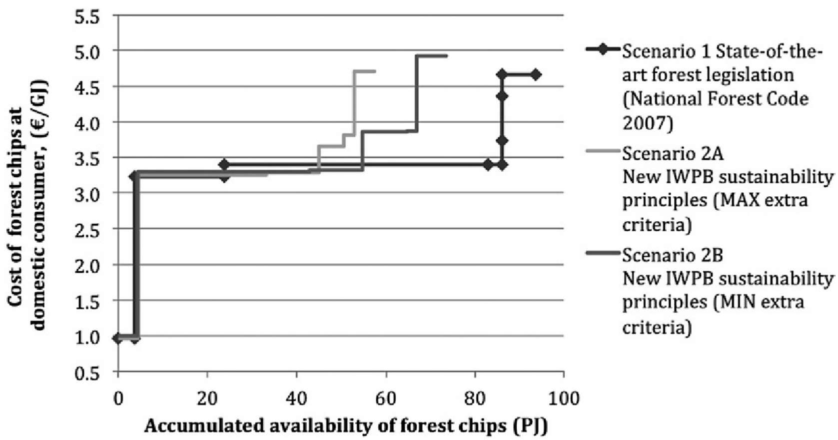

FIGURE 8.8 Cost supply curves for forest chips in the Leningrad region in 2006 (Sikkema et al., 2014b).

scenarios for several districts in the St Petersburg region and found that almost half the potential wood volume is cut annually and that the volume of biomass for energy could increase by 83%, should the potential cut volume be fully utilised. However, sustainability was not considered in their analysis.

Sikkema et al. (2011) estimated that 95 PJ (equivalent to 13 Mm^3, assuming 7.3 GJ/m^3 of solid content of wood chips) of energy could be produced from forest resources in the Leningrad region, if utilisation was limited by the criteria set of the SBP. Potential production was reduced to 54–58 PJ if additional criteria, such as limits on the use of roundwood, stumps and harvesting residues were applied, or if additional protected forests were set aside (Scenario 2A, Fig. 8.8). If roundwood was used for energy and ash was applied after stump and slash removal, however, potential production was only reduced to 74 PJ (Scenario 2B, Fig. 8.8).

DISCUSSION: SUPPLY LIMITATIONS AND POTENTIAL TRADE BARRIERS

In addition to the barriers to mobilisation observed in supply chains at the local and regional scale and discussed in previous chapters, at present, limitations on the supply of woody biomass available for international trade from Canada, the United States and Russia are related to potential trade restrictions, in the form of regulatory measures. The selection and definition of sustainability criteria will have a strong influence on regulatory trade restrictions.

Whether sustainability criteria, such as those outlined in the United Kingdom's Timber Procurement Policy, infringe on international agreements under the World Trade Organization (WTO), such as the Technical Barriers to Trade Agreement, has been discussed in the literature (Burrell et al., 2012; Mitchell and Tran, 2009). For the WTO, the concept of sustainability hinges on whether

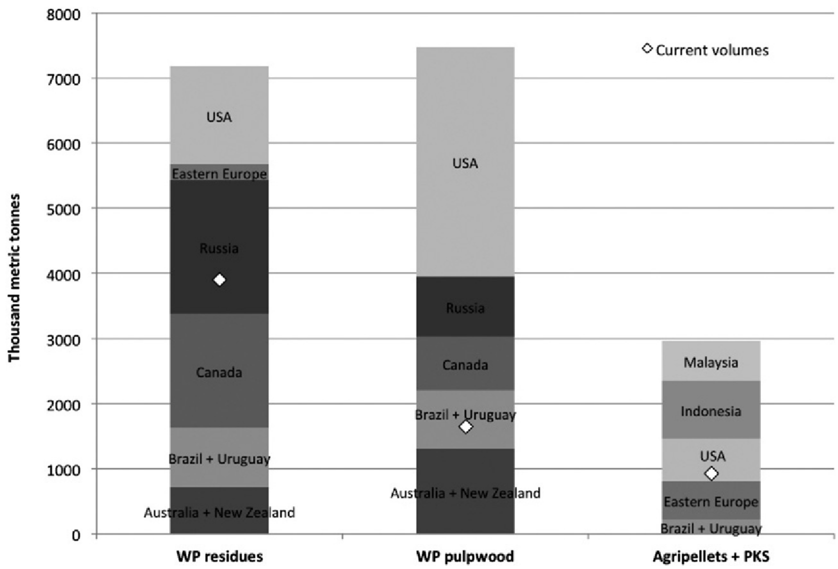

FIGURE 8.9 Global wood pellet *(WP)*, agripellet and palm kernel shell *(PKS)* production for energy export markets by 2020 (Lamers et al., 2015).

traded goods can be distinguished by how they are made [process and production methods (PPM)] or merely by their physical attributes (Goetzl, 2015). The applicability of WTO rules to products differentiated by PPM remains an issue of active debate that is largely unresolved (Goetzl, 2015; Mitchell and Tran, 2009).

The supply of woody biomass from Canada could be strongly affected by the imposition of specific sustainability criteria and definitions such as the description of 'primary forests' put forth in the RED 2009/28/EC (Thiffault et al., 2014). A prohibition on the use of roundwood could also reduce the quantity of Canadian wood pellets produced for export. In British Columbia, where a fraction of the wood pellets produced for export are currently from processing residues of mountain pine beetle-killed stands, but also from dead trees that are no longer of sawlog quality, this limitation could reduce the output of wood pellets by at least 1 million tonnes per year, by 2020 (Fig. 8.9).

In the United States, the minimum sustainability requirements put forward by the UK's Timber Procurement Policy may lead to an increase in SFM certification, or to the collection of similar evidence provided via Category B designations (eg forest management plans, applicable legislation, supplier declarations, second-party supplier audits, third-party verification). A feedstock blacklist that excludes the use of roundwood, including low quality pulpwood, would reduce the volume of absolute projected wood pellet production for export in the SE United States, from an estimated 5–6 million tonnes by 2020, down to 1–2 million tonnes (Fig. 8.9).

A recent analysis investigating the effect of international policies on the industry and forests in SE United States indicated that the key drivers for the continuous growth of local wood pellet production include the characteristics of the current forest inventory and EU definitions of sustainability (Abt et al., 2014). Requirements for minimum GHG emission reductions, land-use change avoidance and SFM certification will reduce the available inventory and increase feedstock prices (Abt et al., 2014). When the demand for wood pellet feedstock increases, the price-inelastic demand and supply response is expected to result in price hikes. The precise impact of feedstock shortages will depend on the capability of respective buyers to pay increased costs, on policy support schemes in Europe and on the demand in local US markets for timber.

In Russia, the imposition of sustainability criteria is expected to be a mix of the situations in Canada and the United States. An exclusion of 'primary forest' would limit the forest landbase from which feedstock could be gathered. At the same time, the UK requirements for SFM may encourage certification. Given that aspen and other residual trees that are typically not collected for use by the pulp and paper or timber industries will qualify as forest residues, Russia may still be able to generate 3 million tonnes of wood pellets for export, by 2020. However, a restriction on the use of pulpwood-quality roundwood would reduce the output volume at least by 1 million tonnes (Fig. 8.9).

Canada, the United States and Russia have strongly contrasting governance structures and forestry contexts. An analysis by Thiffault et al. (2014) of the potential impact of anticipated European sustainability criteria on the national and local regulations in these countries illustrates potential challenges including:

- Differences between jurisdictions in land definitions, delineation and reporting systems;
- a lack of a uniform paradigm for SFM; and
- difficulties in establishing efficient monitoring/auditing systems.

Consensus is emerging on the need to account for biogenic carbon emissions over time. However, the principles and outcomes considered necessary to do so vary considerably among stakeholders. While there appears to be agreement that the carbon emitted through the combustion of biomass for energy was and will again be sequestered from the atmosphere (if the quantity of biomass used can be associated with the regrowth of a forest in a SFM system), there is concern about the time lag between carbon release and carbon (re-) sequestration (see the chapter: Environmental Sustainability Aspects of Forest Biomass Mobilisation). This temporal carbon imbalance is particularly relevant for forest ecosystems that require longer rotation cycles, such as boreal forests.

The sustainable use of woody biomass for energy requires that GHG accounting considers alternative biomass and land uses and compares these with the systems using fossil fuels. This is particularly true for the combustion of roundwood. Such accounting exercises are less critical to justify the utilisation of residues or co-products from timber harvesting and/or wood processing industries, which operate independently from energy markets and incentives. A large fraction of these residues would either decay naturally or be burned, landfilled etc.

if they were not used for the production of energy (see the chapter: Quantifying Forest Biomass Mobilisation Potential in the Boreal and Temperate Biomes). Therefore, much of the biogenic carbon contained in these residues would be released back into the atmosphere relatively quickly, compared to carbon stored in wooden construction, for example. It will be critical to define these residues correctly because their increased utilisation for biomass may lead to unsustainable rates of harvest, or the use of less efficient processing technologies and greater waste.

Policy options to address biogenic carbon emissions include mechanisms that quantify associated emissions, such as the integration of forest carbon accounting in full life-cycle assessments. Preventative approaches include requirements for SFM that guarantee replanting and sustained carbon stocks/yields and actively discouraging the conversion of specific lands (eg peatlands, where drainage releases large amounts of GHG). Some stakeholders have also suggested feedstock/biomass blacklists and/or cascading policies. It should be noted, however, that the exclusion of certain feedstock fractions or non-SFM certified material does not prevent its leakage into other markets (eg pulp and paper) or regions with less stringent sustainability criteria (eg Asia).

SUMMARY AND CONCLUSIONS

The global annual demand for internationally traded wood pellets from boreal and temperate forests for heat and power generation is expected to reach 15–26 million tonnes (264–458 PJ) by 2020. The European Union, particularly the United Kingdom, the Netherlands, Denmark and Belgium will remain the key destination markets. Although demand from Asia (South Korea and Japan) will grow, this region will play a secondary role for the foreseeable future.

Adoption of RED, or similar, criteria is likely across all EU countries and, in the United Kingdom (the largest market for traded wood pellets), such criteria have already been proposed. As of 2015, only forest materials that achieve at least 60% GHG emissions savings against the EU fossil fuel electricity average can be used for bioenergy production and, furthermore, proof of SFM is required. Eligible SFM schemes for the UK market include FSC certification and schemes endorsed by the PEFC, such as the SFI and CSA. In the Netherlands, the energy industry and NGOs have been collaborating on the development of an Energy Accord since 2014 and recently achieved principal agreement on the sustainability criteria for solid biomass. While specific criteria have been laid out, key issues that remain include compliance testing and monitoring. In Flemish Belgium, a proposal is being prepared to bring the sustainability requirements for woody biomass to the same level as bioliquids. In Denmark, a voluntary industry agreement is set to ensure that 40 and 100% of all bioenergy production is conducted sustainably by 2016 and 2019, respectively.

At present, the key supply regions of traded wood pellets from temperate and boreal biomes are (in order of importance) the United States, Canada and

Russia and this is not expected to change by 2020. Among these, Canada offers the largest stretches of SFM-certified forests, but the US Southeast has seen the strongest increase in wood pellet production and export in recent years. Differences between Canada and the United States in the level of SFM certification are largely due to differences in forest ownership (ie public vs. private). The dramatic increase in pellet production in the US Southeast compared with other regions, for example Western or Central Canada, is linked to a number of factors, including available forest inventory (particularly pulpwood fractions) and competitive transport advantages along the eastern coast of North America and thus better access to EU markets. In addition to barriers to mobilisation identified at the local and national scales in previous chapters and related to policy, logistics, conversion technologies etc. supply limitations for international trade will also be influenced by regulatory measures, including sustainability criteria, which will restrict the use of some feedstocks and, thus, trade. In the US Southeast, an increased demand for wood pellets is expected to raise feedstock prices and EU sustainability criteria that limit feedstock options for producers exporting to Europe will further stimulate this trend. The biomass volumes that can eventually be mobilised will thus depend on each country's framework conditions, that is the respective forest biomass sustainability criteria and the underlying policy mechanisms, which define the energy utilities' willingness-to-pay for imported wood pellets. The sustainability definitions with the greatest potential consequences for woody biomass availability are those of 'primary forests' (imposed to protect habitats with a high biodiversity value) and 'residue' or 'co-products' (imposed to ensure the utilisation only of harvesting and processing residues with no alternative use).

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