Working Papers of the Finnish Forest Research Institute 271
http://www.metla.fi/julkaisut/workingpapers/2013/mwp271.htm
ISBN 978-951-40-2424-5 (PDF)
ISSN 1795-150X

Conditions and prospects for increasing forest yield in Northern Europe

Ragnar Jonsson[1], Mika Mustonen[1],Tomas Lundmark[2], Annika Nordin[2], Yuri Gerasimov[3], Aksel Granhus[4], Eugene Hendrick[5], Jari Hynynen[3], Vivian Kvist Johannsen[6], Adam Kaliszewski[7], Virginijus Miksys[8], Thomas Nord-Larsen[6], Heino Polley[9], Liana Sadauskiene[8], Pat Snowdon[10], Birger Solberg[11], Erik Sollander[12], Arnor Snorrason[13], Mati Valgepea[14], Sheila Ward[10], Toms Zalitis[15]

EUROPEAN FOREST INSTITUTE
NORTH EUROPEAN REGIONAL OFFICE – EFINORD

norden
Nordic Council of Ministers

Future Forests

[1]The North European Regional Office of the European Forest Institute –EFINORD; [2] Swedish University of Agricultural Sciences (SLU); [3]The Finnish Forestry Research Institute (Metla); [4]The Norwegian Forest and Landscape Institute (NFLI); [5]The Programme of Competitive Forestry Research for Development (COFORD); [6]Department of Geosciences and Natural Resource Management (IGN); [7]Forest Research Institute, Poland; [8]Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry; [9]Thünen Institute of Forest Ecosystems; [10]Forestry Commission, United Kingdom; [11]Norwegian University of Life Sciences (UMB); [12]Swedish Forest Agency; [13]Icelandic Forest Research; [14]Estonian Environment Information Centre; [15]Latvian State Forest Research Institute (SILAVA)

METLA www.metla.fi

Working Papers of the Finnish Forest Research Institute publishes preliminary research results and conference proceedings.

The papers published in the series are not peer-reviewed.

http://www.metla.fi/julkaisut/workingpapers/
ISSN 1795-150X

Office
Post Box 18
FI-01301 Vantaa, Finland
tel. +358 29532 2111
e-mail julkaisutoimitus@metla.fi

Publisher
Finnish Forest Research Institute
Post Box 18
FI-01301 Vantaa, Finland
tel. +358 29532 2111
e-mail info@metla.fi
http://www.metla.fi/

Authors

Ragnar Jonsson, Mika Mustonen,Tomas Lundmark, Annika Nordin, Yuri Gerasimov, Aksel Granhus, Eugene Hendrick, Jari Hynynen, Vivian Kvist Johannsen, Adam Kaliszewski, Virginijus Miksys, Thomas Nord-Larsen, Heino Polley, Liana Sadauskiene, Pat Snowdon, Birger Solberg, Erik Sollander, Arnor Snorrason, Mati Valgepea, Sheila Ward, Toms Zalitis

Title

Conditions and Prospects for Increasing Forest Yield in Northern Europe

Year	Pages	ISBN	ISSN
2013	41	978-951-40-2424-5 (PDF)	1795-150X

Unit / Research Programme / Projects

Vantaa Unit

Accepted by

Taneli Kolström, Research Director, Professor, 14.6.2013

Abstract

Forests will play a crucial role in the transformation from an economy based on fossil fuels to one relying on renewable resources. Hence, besides being a source of raw material for the forest industry, in the future, forests are expected to increasingly contribute to the production of energy as well as providing a wide range of environmental and social services. Thus, the objective of the present study is to assess the short-term and long-term potential for increasing sustainable wood supply in the EFINORD countries. Present practices and prospects for intensive forest management have been assessed using information from a questionnaire complemented by compilation and evaluating of national forest inventory (NFI) data and other forest sector relevant information. The study indicates a striking variation in the intensity of utilisation of the wood resources within the EFINORD region. For the region as a whole, there seems to be a substantial unused (biophysical) potential. However, recent NFI data from some countries indicate that annual felling rates can be underestimated. If felling rates are higher than currently recognised then, given the increased demand for wood-based energy, there appears to be a need to discuss strategies for large-scale implementation of more intensive forestry practices to ensure that the availability of wood resources in the future can meet an increasing demand in the EFINORD countries.

Keywords

Forests, renewable, forest industry, energy, forest management, NFI

Available at

http://www.metla.fi/julkaisut/workingpapers/2013/mwp271.htm

Replaces

Is replaced by

Contact information

Mika Mustonen, The North European Regional Office of the European Forest Institute –EFINORD

Other information

layout: Anne Siika/Metla

Contents

Preface

The North European Regional Office of the European Forest Institute – EFINORD promotes research cooperation within the Nordic-Baltic Sea-North Atlantic region. The EFINORD Regional Office, located in Copenhagen, Denmark, was opened in late 2010. Within the framework of sustainable forestry, its two main interests are (i) biomass production and intensive forest management and (ii) ecosystem services. This report was conducted for Facts and Figures of the EFINORD Forest Sector, a baseline study for the EFINORD Work plan within the area of biomass production and intensive forest management. Coordinators of this study are Professor Tomas Lundmark, Swedish University of Agricultural Sciences (SLU) and Mika Mustonen, Head of office at EFINORD.

The study supports the Selfoss declaration on sustainable forestry, adopted by the Nordic forestry ministers in 2008, which aims to further increase sustainable biomass production in the Nordic Region. The work has been made possible through the financial support of the Nordic Council of Ministers and the Mistra-funded research program Future Forests.

Data collection and compilation were carried out by a consultant, Dr. Jonas Cedergren. Dr. Sauli Valkonen of METLA helped in designing the questionnaire. A draft of the study has been reviewed by Professor Jens Peter Skovsgaard of SLU and Professor Taneli Kolström of METLA. Professor Kolström and Dr. Vilis Brukas of EFINORD helped to improve the manuscript as work progressed.

Abbreviations

AEA	AEA Technology plc.
BIO-EX	Ukrainian Bio-fuel exchange (translation by lead author)
BMELV	The Federal Ministry of Food, Agriculture and Consumer Protection, Germany
CHP	Combined heat and power
CIA	Central Intelligence Agency of the United States of America
CSIL	Centre for Industrial Studies
DECC	Department of Energy and Climate Change, UK.
DKK	Danish Krone, national currency
EC	European Commission
EEA	European Environment Agency
EEIC	Estonian Environment Information Centre
EFINORD	European Forest Institute's North European Regional Office
EFISCEN	The European Forest Information Scenario Model
EFSOS	The European Forest Sector Outlook Study
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FAOSTAT	The Statistics Division of the FAO
GDP	Gross Domestic Product
Ha	Hectare
MELA	Metsälaskelma (Forestry Model and Operational Decision Support System; Finnish Forest Research Institute, METLA)
METLA	Finnish Forest Research Institute
NA	No information available
NFI	National Forest Inventory
NW Russia	Northwest Federal District of the Russian Federation
PJ	Petajoule
RES	Renewable Energy Sources
SLU	Swedish University of Agricultural Sciences
TPES	Total Primary Energy Supply
TWh	Terawatt-hour
vTI	von Thünen Institute, Germany
UK	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
UNECE	United Nations Economic Commission for Europe
USDA	United States Department of Agriculture

Tree species – Vernacular and scientific names

Vernacular name	Scientific name
Alder	*Alnus* sp.
Ash	*Fraxinus excelsior,* L.
Aspen	*Populus tremula,* L.
Beech	*Fagus sylvatica,* L.
Birch	*Betula* sp.
Black alder	*Alnus glutinosa,* L.
Black locust	*Robinia pseudoacacia* L.
Caucasian fir	*Abies nordmanniana, Steven, Spach*
Douglas fir	*Pseudotsuga menziesii* Mirb. & Franco
Larch	*Larix* sp.
Lodgepole pine	*Pinus contorta* Bol.
Northern red oak	*Quercus rubra* L.
Norway spruce	*Picea abies,* L. Karst
Oak	*Quercus* sp.
Poplar	*Populus* sp
Scots pine	*Pinus sylvestris,* L
Siberian larch	*Larix sibirica* var. *sukaczewii*
Sitka spruce	*Picea sitchensis,* Bong. Carr
White spruce	Picea glauca, Moench, Voss

1 Introduction

1.1 Background and objectives

Besides being a source of raw material for the forest industry, in the future, forests are expected to increasingly contribute to the production of energy as well as providing a wide range of environmental and social services.

Woody biomass is by far the largest source of renewable energy in Europe, accounting for over 50% of the renewable energy consumption in the European Union (Mantau et al. 2010). Projections of the European Forest Sector Outlook Study II (UN 2011a) indicate that if wood is to play its part in reaching renewable energy targets, the supply of woody biomass in Europe would have to increase significantly; by 2030, annual supply must increase by nearly 50%, or by more than 400 million m^3. The shift towards a post-petroleum bioeconomy-based society[1] can be expected to boost the demand for wood for material purposes. Hence, as an example, though the future of newsprint is bleak, the board and packaging segment of the paper industry – supported by trade, internet shopping, urbanisation, the need to store food properly and energy prices – is generally considered to have a better future (see, for example, Donner-Amnell 2010).

Hence, a major challenge is mobilising enough wood on a sustainable basis. The objective of the present study is to assess the short-term and long-term potential for increasing sustainable wood supply in the EFINORD countries. Ultimately, forest growth is limited by its biological production potential set by the availability of light, water and nutrients based on where the boundaries on a given site are. Within this framework, forests are managed in a way that is considered economically reasonable and at the same time acceptable to society. Our analysis focuses on factors related to forest growth and harvest in the EFINORD countries given the current economic and political restrictions. This therefore means that the biological capacity significantly exceeds the figures given in the report. Thus, it is worth noting that an increased demand for raw materials in relation to future supply can produce other economic and political conditions that allow a larger portion of the biological capacity to be utilised. However, to assess how large such an increase in forest growth can be was out of the scope of this report.

The main focus has been on the following general topics:

- Forest resources (forest area, growing stock, annual growth, age class distributions)
- Silvicultural practices (present ones and a compilation of experiences of more production-oriented practices)
- Present and potential fellings
- Forest industry and wood-based energy
- Policy issues (ownership, land use, forest policy)

Terms of Reference (mostly in Swedish) can be found in Appendix 1.

[1] http://ec.europa.eu/research/bioeconomy/policy/index_en.htm

1.2 Geographical scope

Figure 1 depicts the EFINORD region. The countries included, henceforth referred to as EFINORD countries, are Denmark, Estonia, Finland, Germany, Iceland, Ireland, Latvia, Lithuania, Northwest Russia, Norway, Poland, Sweden and the United Kingdom of Great Britain and Northern Ireland (UK).

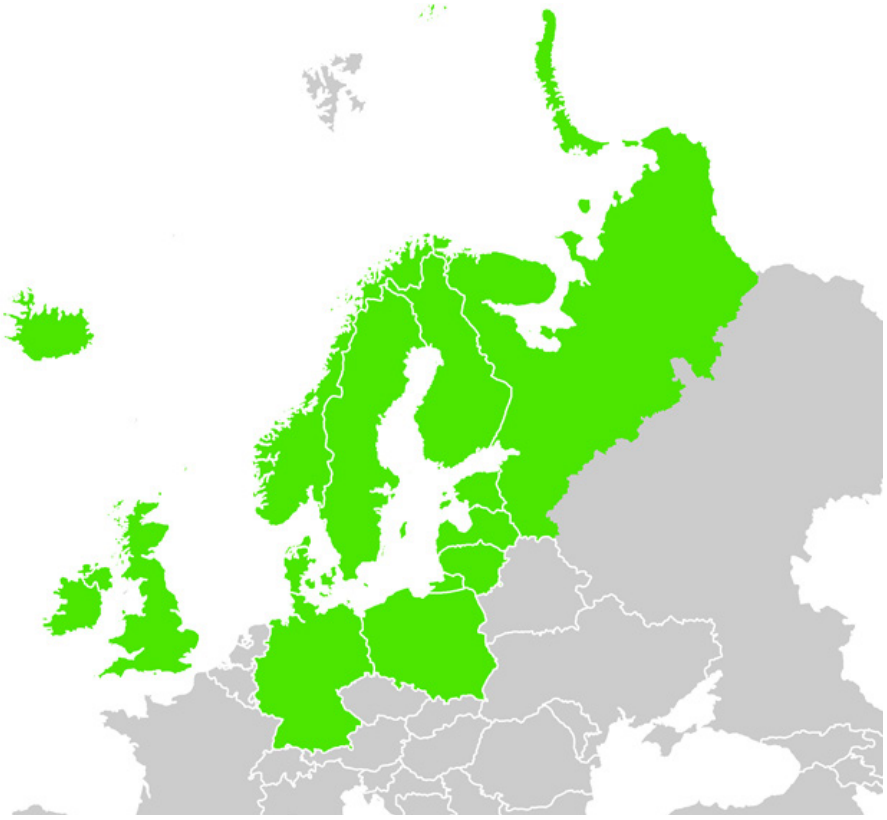

Figure 1. Geographical scope of EFINORD

2 Definitions, methods and delimitations

2.1 Definitions

The FAO definition of forest, also used by Forest Europe (FAO 2010 and UNECE & FAO 2011), is the one used in the current study. Forest resources in this study refer to total resources, unless stated otherwise. Other wooded land as defined by FAO (FAO 2010) is not covered by the report. Forest types proposed by the European Environment Agency (EEA, 2006) have been adopted for the study. Growing stock is measured in cubic metres (m^3) over bark.

In this report, forestry practices that increase forest yields refer to practices well described in the scientific literature i.e. forest fertilisation, ditch network maintenance, short-rotation forestry using broadleaved fast growing tree species, clonal forestry, short-rotation forestry using high quality breeding material and using highly productive exotic tree species.

Area Protection refers to the fact that there are varying degrees of restrictions on forestry set by legal jurisdiction. Total protection signifies that the only management actions permitted are those carried out in the interest of conservational and/or recreational values. Where possible, areas voluntarily protected by forest owners have also been included.

2.2 Methods and delimitations

In the current study, intensive forest management is used in the sense of a means to increase forest growth.

Conditions for intensive forest management have been investigated using a questionnaire sent to national representatives specially appointed for the study. Results in this respect rest entirely on replies to the questionnaire, complemented by statistical data that have been confirmed by the national representatives. The prospects for intensive forest management have been assessed using information from the questionnaire, complemented by statistical data and information on forest sector issues and other relevant processes. Observations have been confirmed by the national representatives. It is assumed that data provided by the questionnaire are the best available with 2010–11 as the reference year unless otherwise stated.

Data from Russia normally refer to the Northwest Federal District of the Russian Federation, including the Arkhangelsk, Kaliningrad, Leningrad, Murmansk, Novgorod, Pskov and Vologda regions, Republics of Karelia and Komi, city of St Petersburg and Nenets Autonomous Okrug. Much of the information on Northwest Russia is quoted from Karvinen *et al*. (2011). Russia is mainly referred to as NW Russia. Occasionally, data relate to the whole Russian Federation, then referred to as the Russian Federation.

Present fellings are the fellings reported to Forest Europe (UNECE & FAO 2010), some of which have been updated by national representatives. Potential fellings are derived from three sources: (i) national estimates as provided by national representatives, (ii) the study by Karvinen *et al.* (2011) as regards NW Russia and, lastly, (iii) results from simulations with the EFISCEN model (Verkerk and Schelhaas, in press) for the European Forest Sector Outlook Study (EFSOS) II (UN 2011a). Thus, no modelling or other independent assessments of potential fellings have been undertaken in the current study.

The questionnaire helped to elicit reasons why felling rates are at their present levels and the prospects of raising them. What is presented is thus the opinion of senior national experts. Names and affiliations of national representatives can be found in Appendix 2.

3 Conditions for intensive forest management

Demographic and economic data, together with forest sector specifics – forest resources, forest industry and wood-based energy, and forest ownership – affect the preconditions for forest management. In this chapter, such data is presented.

3.1 General country data

There is considerable demographic variation among the EFINORD countries. The same holds true for economic conditions. The average population density of the EFINORD countries, at 95 inhabitants per square kilometre excluding the Russian Federation (Table 1), is relatively high. However, the variation within the region is considerable.

Table 1. Basic demographic and economic data.

	Land area[1] (1000 ha)	Population[1] (1000)	Population density[1] (inhabitants per km^2)	Population: annual growth[1] (%)	Population: rural[1] (%)	GDP per capita: PPP[2] (USD)	GDP: annual growth[2] (%)
Denmark	4 243	5 458	129	0.2	13	37 000	0.8
Estonia	4 239	1 341	32	-0.1	31	20 400	7.6
Finland	30 409	5 304	17	0.4	37	36 000	2.7
Germany	34 877	82 264	236	-0.1	26	38 100	3.1
Iceland	10 025	315	3	2.3	8	38 100	3.1
Ireland	6 888	4 437	64	1.9	39	40 800	1.0
Latvia	6 229	2 259	36	-0.4	32	16 800	5.5
Lithuania	6 268	3 321	53	-1.0	33	19 100	5.9
Norway	30 427	4 767	16	1.0	23	53 400	1.5
Poland	30 633	38 104	124	-0.1	39	20 200	4.3
Sweden	41 033	9 205	22	0.5	16	40 700	4.0
UK	24 250	61 461	253	0.5	10	36 500	1.1
Total	229 521	218 236	95	0.2	22		
Russian Fed.	1 638 139	141 394	9	-0.4	27	16 700	4.3

[1] FRA 2010, main Report (reference year 2008). [2]Gross Domestic Product data are from CIA World Factbook (reference year 2011), stated in US Dollars (USD) Personal Purchase Parity (PPP). Annual growth stated as real growth rate, year-on-year and not compounded.

3.2 Forest resources

3.2.1 Forest area, growing stock, annual increment and fellings

The EFINORD countries (see Figure 1) have a total forest area of 182.3 million hectares, almost half of which is found in NW Russia (Table 2). Average growing stock per hectare is 134 m^3. It is worth noting that only Sweden reports annual fellings that exceed 80% of the annual increment (Table 2).

However, it is important to note that data on both annual increment and annual fellings from several countries can be uncertain. For example, more recent data from Estonia than that reported in Table 2 indicates fellings of 8.5 million m^3 for 2010 and 9.1 million m^3 as a provisional estimate for 2011 (Statistics Estonia, updated December 17, 2012). Further, sub-sample NFI data from Germany (vTI 2008), referring to the period 2002 to 2008, indicate an annual average increment of 118 million m^3, annual average fellings of 89.6 million m^3 and a total drain of 106.7 million m^3 as an annual average. Hence, annual fellings and natural losses account for ca. 90% of the annual increment. Finally, it may be that, for some countries, forest growth in forest reserves that is not harvested is left out from estimates of annual increments. For example, in Sweden, areas protected from forestry produce 8.5 million m^3 per year, which is not reported to UNECE & FAO 2011 for 2010 (Swedish Forest Agency 2012).

Table 2. Forest area, growing stock, increment and fellings: estimates for 2010.

	Forest area (mill. ha)	Forest area available for wood supply (mill. ha)	Growing stock (mill m^3 OB)	Growing stock per hectare (m^3)	Annual increment (mill. m^3 OB)	Annual increment/ growing stock (%)	Growth per ha and year (m^3)	Annual fellings (mill. m^3)
Denmark	0.6[1]	0.6[1]	113.4[1]	199[2]	5.8[1]	5.1	10.0[5]	2.4[1]
Estonia	2.2[1]	2.0[1]	441.4[1]	203[2]	11.2[1]	2.5	5.6[5]	5.7[1]
Finland	22.1[1]	19.9[1]	2207[1]	99[2]	91[1]	4.1	4.6[5]	59.4[1]
Germany	11.1[1]	10.6[1]	3492[1]	315[2]	107[1]	3.1	10.1[5]	59.6[1]
Iceland	0.03[1]	0.03[1]	0.45[1]	15[2]	0.02	4.4	NA	NA
Ireland	0.7[1]	NA	74.3[1]	101[2]	5.4	7.3	NA	2.8[1]
Latvia	3.4[1]	3.1[1]	633[1]	189[2]	25.3[7]	2.0	5.0[5]	12.4[1]
Lithuania	2.2[1]	1.9[1]	479[1]	218[2]	16.0[1]	3.3	5.7[5]	8.6[1]
Norway	10.2[1]	6.4[1]	997[1]	98[2]	21.9[1]	2.2	3.4[5]	11.0[1]
Poland	9.3[1]	8.5[1]	2304[1]	219[2]	70.0[6]	3.0	8.0[5]	40.7[1]
NW Russia	89[3]	NA	10096[3]	114[3]	134[3]	1.3	1.5[3]	46.9[4]
Sweden	28.6[1]	20.6[1]	3243[1]	119[2]	96.5[1]	3.0	4.7[5]	80.9[1]
UK	2.9[1]	2.4[1]	379[1]	132[2]	20.7[1]	5.5	8.6[5]	10.5[1]
Total	**182.3**	**–**	**24 459.6**	**–**	**591.9**	**2.4**	**–**	**340.9**

Sources: [1]UNECE & FAO (2010), data are estimates made by respective country for 2010, based on averages for 2008 and 2009. [2]FAO (2010), data are estimates made by respective country for 2010. [3]Karvinen *et al.* (2011), compilation of data in regional plans with reference years 2008 to 2010 except for Leningrad and Pskov Regions 2003. [4]Rosleshoz official statistics (reference year 2010). [5]UNECE & FAO (2011), data are estimates made by respective country for 2010. [6]Gerasimov & Karvinen (in press), reference year 2011. [7]UNECE & FAO (2011b), estimate by country for 2010, based on average for 2008 and 2009.

3.2.2 Conifers, broadleaves and forest types

On average, 75% of the forest land in the EFINORD countries is conifer-dominated. However, in Denmark, Latvia, Estonia, Lithuania, Germany and UK, the broadleaved share of the forest is between 40% and 50% (FAO 2010).

Excluding Russia, boreal, hemiboreal and nemoral coniferous and mixed forest account for ca. 65% of the forest land in the EFINORD countries. An additional 20% is covered by alder, birch or aspen forest together with mire and swamp forest (UNECE & FAO 2011, using forest types as defined by the European Environmental Agency (EEA 2006)).

3.2.3 Exotic species

The area planted with exotic tree species is quite small in the region (Table 3). Exotics are, however, not uncommon in Denmark, Iceland, Ireland and UK. Detailed data from NW Russia on exotics are missing. Species distribution data from NW Russia suggest that exotics account for a very modest share of the forest land (Karvinen *et al.* 2011).

3.2.4 Age class distribution

Table 4 depicts the age class distribution of forests for EFINORD countries (except NW Russia). Forests older than 100 years make up approximately 20% of the forest area in Finland, Germany, Norway and Sweden. The corresponding figure for the other countries is well below 10% (UNECE & FAO 2010).

Age class distribution data from NW Russia are not comparable to the rest of EFINORD and therefore presented separately in Table 5.

Table 3. Extent of exotic species in 2010.

	Exotic species[1] (1000 hectares)	Share of total forest area (%)	The three most common exotic species[1]
Denmark	286	50	Norway spruce, Sitka spruce & Caucasian fir
Estonia	1	0	
Finland	34	0	
Germany	441	4	Douglas fir, larch & northern red oak
Iceland	20.9	70	Siberian larch, Lodgepole pine & Sitka spruce
Ireland	513	73	Sitka spruce, Lodgepole pine & Norway spruce
Latvia	1.4	0	
Lithuania	4	0	
Norway	239	2	Spruce (partly exotic), Sitkaspruce & Lodgepole pine
Poland	46	1	Black locust & northern red oak. Data lacking for others
NW Russia	Na	Na	
Sweden	539	2	Lodgepole pine, other species of little significance
UK	1411	49	Sitka spruce, larch & Norway spruce

[1] UNECE & FAO (2011), data are estimates for 2010 made by the respective countries.

Table 4. Age class distribution of forests in EFINORD countries (except NW Russia).

	Area(1000 hectares)	<10	11-20	21-40	41-60	61-80	81-100	101-120	121-140	>140	Unspec.
Denmark	470	48	74	121	110	37	17	11	5	6	42
Estonia	1717	258	119	328	508	326	124	34	13	6	0
Finland	22084	2087	1702	3887	3948	3739	2706	1250	715	2050	0
Germany	11076	643	643	1778	2160	1541	1391	981	597	587	755*
Iceland	27	13	9	3	2	0	0	0	0	0	0
Ireland	573	170	208	165	22	5	2	1	0	0	0
Latvia	3162	370	252	712	783	560	275	126	86	NA	NA
Lithuania	2165	206	146	338	583	452	233	74	17	11	105
Norway	4438	706	568	718	672	367	355	370	378	304	0
Poland	9116	803	632	1523	2565	1705	1153	524	139	71	0
Sweden	22839	2863	2272	4911	3929	2590	2110	1482	1226	1456	0
UK	2881	251	282	733	546	331	170	102	82	91	293

Source: UNECE & FAO (2011). Data are estimates for 2010 made by the respective countries.*Includes areas without trees and inaccessible forests.

Table 5. Stand age and development classes for forests of NW Russia.

Development class	Conifers	Deciduous
Young	0–40 (9)*	0–20 (3)*
Middle-age	41–80 (7)	21–40 (6)
Maturing	81–100 (2)	41–50 (2)
Mature	101–160 (21)	51–80 (6)
Over-mature	161+ (see Mature)	81+ (see Mature)

Source: Karvinen et al. (2011). Compilation of data in regional plans with reference years 2008 to 2010 except for Leningrad and Pskov Regions 2003. *Numbers within brackets denote extent in millions of hectares of exploitable forest in the respective age classes, with the Mature and Over-mature classes merged.

3.3 Ownership structure, protected forests and goals for forest cover

3.3.1 Forest ownership

The typical ownership pattern among the EFINORD countries is that a substantial part of the forest area is publicly owned, with privately-owned holdings being either numerous and (very) small or few and large (see Table 6 for details). Large holdings owned by forest companies, here regarded as privately-owned forest, are uncommon except in Sweden and, to some extent, Finland. It is worth noting that empirical evidence indicates that the size of forest holdings is positively related to harvesting probabilities (McDonald *et al*. 2006), because of economies of scale (Row 1978; Butler 2008). Hence, small holdings are a disadvantage when it comes to wood mobilisation. Conservation and social values can be expected to be more prominent in publicly-owned forests, especially in densely populated countries with limited forest resources. Hence, harvesting potential generally decreases with increased population density (Wear *et al*. 1999), although this seems not to be the case for Germany.

The privately-owned share can be expected to increase somewhat as privatisation and afforestation of privately-owned arable land is currently in progress in Estonia, Lithuania, Iceland and Poland (afforestation only). Some publicly-owned forest land is sold in Norway. Forest land is actively traded in the UK. The questionnaire indicates that only in Estonia and Lithuania expect more than 5% changes in the share of ownership categories before 2020.

Table 6. Forest ownership structure (share of forest area).

	Privately owned (%)	Publicly owned (%)	Other (%)	Comments
Denmark	72	24	4	Out of a total of 4892 holdings, 2161 are 500 ha or larger, 1193 of which are publicly owned
Estonia	45	55		A third of the privately-owned forest land (by private individuals) is made up of holdings no larger than 10 ha. There are some 450 private holdings larger than 100 ha. In 2010, almost 15% of forest area was under status “ownership not defined” (here accounted for as publicly owned)
Finland	69	26	5	Companies own less than 10% of the forest area. 26% of private owners are full-time farmers owning an average of almost 60 ha. Average for all private forest holdings (> 2 ha) is 30 ha.
Germany	67	33		40% of the privately-owned area is made up of holdings up to 20 ha, with 20% of holdings larger than 1 000 ha.
Iceland	73	27		Holdings are mainly in the 20 to 50 ha range.
Ireland	45	55		Average private holding is 9 ha. Farmers own 70% of the private forest.
Latvia	50	50		A tendency for companies to acquire private forests. Larger holdings are generally state-owned.
Lithuania	38	62		Average private holding less than 5 ha. More land under privatisation
Norway	86	14		Average size of holdings owned by private individuals is 45 ha, average across owner categories is 56 ha
Poland	18	82		Average size of private holdings is 1.3 ha. 5% of the private holdings are 20 ha or bigger
NW Russia	0	100		Private ownership is extremely uncommon, but not unknown
Sweden	75	25		Average private holding 48 ha, company holding 2 582 ha, state holdings 6 441 hectares and other public 927 ha. Companies are major forest owners, particularly in the north.
UK	65	35		No up-to-date information on private sector holdings. There is an active market for woodlands and there is evidence that woodlands are increasing in value.

Source: EFINORD Questionnaire (2012). Forests owned by companies are regarded as privately owned.

3.3.2. Protected forest and goals for forest cover

National notes on policy goals regarding the extent of the forest area and protected forests are summarised in Table 7.

Table 7. Intended expansion of forest cover and currently protected forests.

Country	Goals for forest cover	Protected forests
Denmark	Plans to expand forest cover from 13% to 20–25% in 80–100 years. Afforestation will focus on urban areas.	1% strictly protected. Restrictions on forestry on 21% of the forest area. National parks are planned.
Estonia	No policy to increase or decrease forest area.	Almost 10% of the forest area strictly protected. About 15% is under various degrees of protection.
Finland	At the moment, there is no policy to increase or decrease forest area. Liberalisation of present forest legislation is under debate.	11% of the forest area is under protection of various kind, mainly in the north.
Germany	Federation of 16 states that differ in legislation and goals. There is a goal of having 10% of the publicly-owned forest area under "natural forest development".	About 25% of the forest is under some sort of protection (Natura 2000, nature protection areas, biosphere reserves, national parks). Increased area protection is being discussed.
Iceland	There are grants for afforestation. 30 000 km^2 are considered suitable for afforestation.	Natural birch woodlands are protected.
Ireland	An annual afforestation goal of 15 000 ha. Actual rate the last years has been 6–7000 ha. New forestry act under way.	15% of the forest area under protection, 1% strictly protected. Indigenous forests generally protected. Forests are mainly plantation-like.
Latvia	No evidence of forest area goals encountered More or less a balance between annual growth and annual fellings.	12% of the forest area under some kind of protection.
Lithuania	Afforestation to be continued, also on private land Broadleaves are encouraged in afforestation.	About 20% of the forest area under various forms of protection (FAO 2010). No plans to expand this.
Norway	No evidence of forest area goals encountered Forest policy is closely linked to regional policy.	2.3% of the forest land is under protection for conservation.
Poland	Forest cover to be expanded to 30% before 2020 and to 33% before 2050. Multiple use is stressed. Conversion of monocultures to mixed and/or stratified stands is encouraged.	38% of the forest area is under some form of protection.
NW Russia	There is a programme to increase the forest area over the next three years. Large areas not under management.	24% of forest area of the Russian Federation is under some form of protection.
Sweden	No policy to increase or decrease forest area. Some afforestation of arable land is taking place.	7.5% of the forest area under some form of protection. An increase is not unlikely.
UK	The policy is to expand forest area. In Scotland, the aim is to afforest 10 000 ha per year.	77% of the forest area is plantation.

Source: EFINORD questionnaire (2012).

3.4 Forest industry and wood-based energy sources

3.4.1 Forest industry

The importance of the forest sector in the national economy varies considerably, with the highest share of GDP being recorded in Finland, Latvia, Sweden, and Estonia (Table 8). The EFINORD countries also exhibit considerable variation in production terms.

Table 8. Production of key forest products in 2011.

Country	Forest Sector Share of GDP (%)	Roundwood, Total (1000 m^3)	Sawnwood, Total (1000 m^3)	Wood-Based Panels, Total (1000 m^3)	Wood Pulp, Total (1000 tonnes)
Denmark	0.9	2 583	372	456	5
Estonia	2.8	7 470	1 500	405	220
Finland	5.1	50 688	9 750	1 352	10 362
Germany	1.0	56 142	22 600	12 092	2 725
Ireland	0.5	2 627	759	738	None declared
Latvia	3.3	13 017	3 432	918	None declared
Lithuania	2.0	8 052	1 162	693	None declared
Norway	0.9	10 679	2 271	520	1 912
Poland	1.8	36 878	4 605	8 428	1 087
NW Russia	2.0	36 100	5911	2 743	3 833
Sweden	3.2	72 103	16 800	648	11 858
UK	0.5	10 021	3 279	3 384	234

Source: FAOSTAT (2012). NW Russia production data refer to 2010 and are quoted from Karvinen *et al.* (2011). The forest sector share of GDP in Iceland is 0.5%. Forest sector share of GDP for NW Russia refers to the Russian federation as a whole (UNECE & FAO 2011). Valgepea (2012) for sawn wood for Estonia. Note: Iceland has not reported any production of the products included.

3.4.2 Renewable energy policy

Most of the countries in this study have well-defined targets for the use of renewable energy (Table 9). The remarkably high share of renewable energy for Norway is explained by the prominence of hydropower. As for Russia, the federal programmes *Energy conservation and energy efficiency till 2020* and *Energy strategy of Russia till 2030* aim to increase the use of bio-fuel. There are, however, no clear targets for bio-energy use, save one, stated in *Energy conservation and energy efficiency till 2020*: "by the year 2020, 4.5% of electric energy must be produced from renewable energy sources" (Russian Federation Government 2010).

Table 9. Share of renewable energy in gross final energy consumption (%).

	2006	2007	2008	2009	2010	Target for 2020
Denmark	16.5	18	18.8	20.2	22.2	30
Estonia	16.1	17.1	18.9	23	24.3	25
Finland	29.9	29.5	31.1	31.1	32.2	38
Germany	6.9	9	9.1	9.5	11	18
Iceland	Na	Na	Na	Na	Na	Na
Ireland	2.9	3.3	3.9	5.1	5.5	16
Latvia	31.1	29.6	29.8	34.3	32.6	40
Lithuania	16.9	16.6	17.9	20	19.7	23
Norway	60.6	60.5	62	65.1	61.1	67.5
Poland	7	7	7.9	8.9	9.4	15
Sweden	42.7	44.2	45.2	48.1	47.8	50
UK	1.5	1.8	2.3	2.9	3.2	15

Source: Eurostat (2012) & Sollander (2012) (Swedish data).

3.4.3 Forest-based sources of wood for energy

Results from the questionnaire are summarised in Table 10. A general positive trend for forest fuel is evident, although there is a significant variation in the region.

Table 10. Forest fuel consumption and limiting factors.

Country	Traditional firewood (mill m^3)	Forest residues (mill m^3)	Stump extraction (mill m^3)	Limiting factors	Comments
Denmark	1.5–2.0	0.8	NA	NA	Forest fuel has increased 2000 – 2010, 19 – 51.5% of total harvest. Estimates include imports and wood from outside the forest.
Estonia	1.6–1.8	NA	Marginal	Economic and environmental legislation	Wood chip use is on the increase. Pellets are mostly exported.
Finland	4.7	2.2	1.0	None	A positive trend in forest fuel consumption
Germany	NA	NA	Not done	Environmental concern	Strong recent increase. Of 53 million m3 annually used for energy, more than half used in homes
Iceland	Marginal	Marginal	Not done	Thinnings dominate	Thermal energy important. Positive trend where this is available
Ireland	0.2	30 000 metric tonnes	Marginal		Positive trend
Latvia	1.2–1.5	Expanding	Marginal	Economics, lack of demand	Recent decrease because of natural gas. Increase likely in the future.
Lithuania	0.5 (state forests)	>0.1 in state forests	Not done	Economics	Centralised heating is likely to increase demand for forest fuel.
Norway	1.4	Expanding	Marginal	Economics	Increased use necessary to reach political goal on renewable energy
Poland	About 6.3	0.1 (state forest)	Marginal	Economics & environment	Increased use of forest fuel
NW Russia	4.3 (state forests)	Limited	Marginal	Cheap fossil fuel, lack of infrastructure	Increased exports to Finland
Sweden	6	10 (8.9 TWh)	Marginal (0.6 TWh)	Economics, logistics	Very strong positive trend, 7.5 TWh for other wood assortments
UK	0.4–1.0 (hardwood for heat)	0.9 for heat 1.5 Ktonnes for electricity.	Marginal		Tree surgery is a major source of firewood that cannot be accounted for in statistics.

Source: EFINORD questionnaire (2012), Eliasson (2012) (Forest Residues and comments on Denmark and Sweden, respectively).

3.4.4 National notes on forest industry and use of woody biomass for energy

Denmark

Forest industry

Denmark differs from the other Scandinavian countries because of its high population density, the dominance of agriculture and the small area of its forests. For most Danes, non-wood uses of forests (recreation, wildlife, biodiversity, protection of groundwater, landscape and cultural values) are probably more important than wood (Plum 1998).

Denmark is a net importer of all traditional wood products except for industrial roundwood, where the country has been a net exporter since 2005. Forestry alone contributes 0.24% to the Danish GDP, whereas the forest sector together with furniture industries contribute 3.7% to the GDP of the country (source: http://www.nordicforestry.org/facts/Denmark.asp#Sju). This is, to a large extent, due to a successful furniture industry.

Energy policy and energy use of woody biomass

Wood plays an important role in renewable energy use, accounting for one third of total Danish renewable energy production in 2010 (Danish Energy Agency 2011). Using the conversion factor from the EUwood project (Mantau *et al*. 2010), about 5 million m^3 of wood was used for energy generation. Wood pellets and wood chip are imported, in particular from eastern European countries and Canada, to cover the increasing demand for private small-scale, medium-scale (district heating plants) and large-scale (CHP and power plant) consumption. Firewood is imported from the Baltic area by boat or truck (Nikolaisen 2011). Using the conversion factor from EUwood (Mantau *et al*. 2010), around 3.8 million m^3 of wood for energy was imported in 2010, of which about 3 million m^3 was in the form of wood pellets.

Implications for woody biomass use

Denmark is far from self-sufficient in terms of woody biomass. Considering the already relatively large consumption of wood for energy and the ambitious plans for renewable energy (which the government hopes to fulfil via national initiatives), there seem to be both scope and need for increasing domestic woody biomass production in the short-term as well as the long run. As annual fellings only accounted for little over 40% of annual increment in 2010, there seems to be scope for increased resource utilisation in the near and medium term.

Estonia

Forest industry

The forest-based industry is export-oriented: 60% of the production was exported in 2009. The major export destinations are Finland, Sweden and Denmark. The Estonian forest-based industry comprises all of the main branches, but the pulp and paper industries are relatively small. The strongest sector is sawmilling. Value-added products, for example houses and furniture, are becoming more important (Valgepea 2012). There is also a sizeable wood pellets and briquettes industry using sawdust and planer shavings (EEIC 2011). Noteworthy is the strong increase in the production of wood chips and wood residues from 2008 to 2009, commodities often traded as bio-energy (Ibid.).

Energy policy and energy use of woody biomass

Estonia is apparently very close to achieving its national target for renewable energy (see Table 9). Wood plays a prominent role in renewable energy. Thus, some 51.6% of total woody biomass supply, 4.3 million m^3, was used for energy purposes in 2009, accounting for over 16% of total primary energy supply (TPES).

Implications for woody biomass use

The strongest wood-products sector, sawmilling, does not exhibit a rising trend in the decade from 1999 (FAOSTAT 2012). Wood-based bio-energy use shows a significant increase over the last few years. An increase in the wood use in Estonia is most likely to come from this sector. In the near and medium term, this increase in the supply of woody biomass can most likely be

accommodated within present forest management practices, as annual fellings are well below annual increment (even though recent data indicate that annual fellings are approaching annual increment: see section 3.2.1).

Finland

Forest industry

The Finnish forest industry is highly export-oriented: in most sectors of the industry, 65 – 90% of the production is exported (METLA 2011). Finland is a major exporter of sawn softwood, being sixth in the world in 2009, and eighth in the world for paper in 2009. Germany and the UK are the foremost importers of Finnish forest-industry products, together accounting for 29% of the total (Ibid.). Finland is also a major importer of wood raw materials, being fifth in the world in 2009 (FAO 2009).

The years 1994 to 1996 were the first in which annual wood consumption exceeded 60 million m³ and, since 1997, this has risen to more than 70 million m³. Industrial wood consumption is now levelling off due to cuts in capacity, particularly in the paper industries. In 2010, total roundwood consumption reached 71.7 million m³, of which industrial wood consumption accounted for 62.5 million m³. Imported roundwood (9.3 mill. m³) accounted for 15% of industrial wood consumption (METLA 2011).

Energy policy and energy use of woody biomass

Wood fuels and peat accounts for over 95% of the biomass fuels use in Finland (Heinimö & Alakangas 2011). In 2009, 41% of total woody biomass supply, some 30 million m^3, was used for energy purposes, which amounted for nearly 19% of TPES (UN 2011d).

Implications for woody biomass use

As already mentioned, domestic roundwood procurement in Finland has been rather stable since 1997. The cut in forest industry capacity has mainly resulted in a drop in roundwood imports. The potential for a pronounced increase in wood use in Finland rests with the bio-energy sector. However, barring the event of a rapid increase in exports of wood based bio-energy material, no drastic increases in the use of woody biomass for energy are expected up until 2030.

Germany

Forest industry

The forest sector in Germany employs over a million people in about 130 000 companies (Mantau 2009). Germany is Europe's largest paper manufacturer, producing nearly 23 million tonnes in 2011 (FAOSTAT 2012). The German sawmill industry produce about 25 million m3 of sawnwood (Ibid.). About one third of the production is exported (Ibid). Germany is also a major producer of wood-based panels (particle board being the largest sub-group), producing over 12 million m3 of panels in 2011 (FAOSTAT 2012), 40% of which are exported. The furniture industry, which employs some 100 000 people, constitutes an important segment of the German wood processing industry (German Timber 2007). Overall, around 77 million m3 are used for material purposes (Mantau 2009).

Energy policy and energy use of woody biomass

From around 66 million m^3 of the woody biomass used for energy generation (Mantau 2012), 33.5 million m^3 was used in private households in 2010. This mainly applies to unprocessed types of wood like firewood, that are not suitable for other material uses or could not be developed at competitive prices (BMELV 2011). Due to rising energy prices and the promotion of renewable energy sources, the demand for fuel wood has significantly increased, initiating intensified discussion on raw material competition between energy and material uses of wood (Ibid.).

Implications for woody biomass use

Consumption of wood resources in Germany has steadily increased over the last two decades (Mantau 2009). The use of coniferous wood has increased markedly, while that of hardwood has fallen (Ibid.). The available expert scenarios show that the demand for wood resources is on the rise in Germany (BMELV 2011) and NFI data indicates that the use of these resources has already increased (vTI 2008). The expected rise in demand for coniferous wood, coupled with a decline in the proportion of this type of wood in forests, could lead in the medium and long-term to shortages, challenging the forest industry's wood supply in Germany. In contrast, the proportion of hardwood trees in the forest area has steadily risen in recent decades. Forestry currently exploits 70% of this growth. For many types of hardwoods, there are still not enough processing options (BMELV 2011; EFINORD questionnaire 2012).

Iceland

Forest industry

Almost all forest products used in Iceland are imported, due to the very small domestic forest resource. There are, however, several small businesses using Icelandic wood in their production and, as the forest resource grows, these and other businesses will increasingly be able to rely on wood from thinnings in the plantations (Eysteinsson 2009).

Energy policy and energy use of woody biomass

Iceland has a small market for fuel wood. Forest resources are modest, while other renewable energy sources are plentiful.

Implications for woody biomass use

There is nothing that indicates a significant increase in the use of Icelandic wood in the short to medium term.

Ireland

Forest industry

In 2010, 2.7 million m^3 of roundwood was processed in the Republic of Ireland (FAOSTAT 2012). Private forest harvests grew by 356% over 2009 as result of increased demand levels. In 2010, there was a strong demand for wood fibre from sawmills, wood-based panel mills and from the emerging wood energy sectors. All pulp and paper used in the Irish market is imported.

Energy policy and energy use of woody biomass

The use of wood-based energy, which accounted for 23% of the use of renewable energy sources in 2009 (UN 2011d), is dominated by the forest products sector, which uses it for process drying

and for energy purposes. Since 2007, the use of forest-based biomass energy by commercial and domestic users has risen considerably (UN 2011b).

Implications for woody biomass use

As long as the Irish housing market continues to be depressed, no drastic increase in industrial wood use is to be expected. The greatest potential for increased use of woody biomass in the short to medium term is in the bio-energy sector, as the country is a rather long way from achieving its target for renewable energy use by 2020. As annual fellings in 2010 only made up slightly more than half of the annual increment, there should be room for increased woody biomass supply from Irish forests. However, given the age structure of Irish forests, with a large proportion of young forests (see Table 4), solely examining the felling rate is prone to overestimation of the sustainable supply potential.

Latvia

Forest industry

Sawnwood and roundwood make up the bulk of Latvia's exports of wood-based products. Sawnwood production in 2010 reached 3.1 million m^3 (FAOSTAT 2012), 68% of which was exported. The main export destinations are the UK and Germany (Bekeris 2011). The export volumes of roundwood have increased primarily due to the export of pulpwood. In 2010, pulpwood was exported mainly to Sweden, Finland and Estonia. Wood-based panels are the only wood product showing a significant increase in production the last decade: from 291 000 m^3 in 2000 to 918 000 m^3 in 2010 (FAOSTAT 2012). Plywood is being exported mainly to Germany, the UK and France. Particle board is exported mainly to the Russian Federation, Lithuania and Poland.

Energy policy and energy use of woody biomass

In the Latvian forest sector, the role of wood energy is increasing. However, up to now, logging residues have only been used to a limited extent. Over the last few years, the share of wood in total energy consumption has increased slightly. In 2010, it comprised one fourth of the total energy consumption, the main part of which were wood pellets used for heating in individual households. The share of wood pellets in the export has also increased and reached around 40% of the total volume of exported fuel wood in 2010 (UN 2011c).

Implications for woody biomass use

Wood-based energy production (wood pellets, wood chip, firewood and briquettes) is playing an increasing role in the Latvian forest sector. This is also where the potential for an increased use of woody biomass in the near and medium term is greatest. To a considerable extent, this is due to exports of forest-based bio-energy to other EU countries.

Lithuania

Forest industry

Value-added wood products, in the form of furniture, play a prominent role in the Lithuanian forest industry, accounting for nearly 65% of the export value in 2010 (Statistics Lithuania 2012). The years of independence have reversed the ratio of imports and exports. Apart from pulp and paper, exports from the Lithuanian timber industry have exceeded imports (Ibid.). The wood-based panel industry is dominated by the particle board industry (FAOSTAT 2012).

Energy policy and energy use of woody biomass

Wood plays an important role in Lithuanian renewable energy consumption: 81% in 2009. Thus, over 40% of total woody biomass supply in Lithuania, 3.4 million m^3, was used for energy purposes in 2009, accounting for 8.4% of total primary energy supply (TPES) (UN 2011d).

Implications for woody biomass use

The roundwood consumption of the wood-products industry has been fairly stable over the last decade. The likelihood of a rapid increase in woody biomass use seems rather low. Once again, any significant increase in the consumption of woody biomass in the near and medium term should come from the bio-energy sector, not least from exports of wood-based bio-energy.

Norway

Forest industry

The role of forestry and forest industry in the Norwegian economy has been steadily decreasing. This development is most pronounced for the pulp industry, whereas the sawmill industry has maintained, or even slightly strengthened, its position since the start of the new millennium.

The most important product in terms of export is newsprint (Trømborg & Solberg 2010), which is a matter of concern given the development of electronic media (e.g. Jonsson 2011). Production of industrial roundwood and wood-based panels has increased since 2000, whereas production of pulp and sawn goods has maintained a rather stable level (FAOSTAT 2012).

Energy policy and energy use of woody biomass

The share of renewable energy in domestic energy consumption in Norway is very high, to a large extent due to the prominence of hydropower. Production of bio-energy has increased by 50% from 1990 to 2010 (Statistics Norway 2010), of which 20% is the use of waste, bark and wood chips in district heating, 30% is the use of fuel wood, black liquor and waste in mainly the forest industry. Of the remaining 50%, the use of firewood in private households forms the major part (Ibid.). Total wood energy generation accounted for around 3% of total primary energy supply in 2009, which corresponds to around 4 million m^3 (UN 2011d).

Implications for woody biomass use

Fellings in Norway have, for the last two decades, rarely exceeded half of the annual increment. Hence, forest resources represent a major potential source for bio-energy. The sustainable potential use of biomass for energy production is estimated at 39 TWh (140 PJ), almost three times the current production (Trømborg 2011). Roundwood for energy offers the greatest scope of increase as it could more than double from the current level of around 25 PJ (see Trømborg 2011), 2.8 million m^3 using the EUwood conversion factor.

Poland

Forest industry

Poland is the fourth largest supplier of timber in the EU. In 2009, the total volume of timber removals amounted to 34.6 million m^3 (FAOSTAT 2012), mostly from state forests (nearly 96%). Timber removals are predicted to increase to between 36 and 38 million m^3 in 2020 and between 41 and 43 million m^3 in 2030 (USDA 2011). There has been a steady increase in the production of

most solid-wood products (sawnwood and wood-based panels) in Poland over the last ten years. The same can be said for pulp and, in particular, paper and paperboard (FAOSTAT 2012).

In spite of considerable wood resources, domestic demand exceeds domestic supply by about 3 to 5 million m^3 annually. The major users of wood in Poland are furniture manufacturers and the cellulose and paper industry. Poland is the fourth major furniture exporting country, after China, Italy and Germany (CSIL 2010).

Energy policy and energy use of woody biomass

Woody biomass is the dominant source of renewable energy in Poland, accounting for around 90% of the consumption of energy from renewable energy sources (Mantau *et al*. 2010). 8.5% of all removals (around 2.9 million m^3) were classified as fuel wood in 2009 (USDA 2011).

Implications for woody biomass use

An increased use of woody biomass by the wood-products industry is likely. To reach the target for renewable energy, increased use of woody biomass in the bio-energy sector is also highly probable. National forecasts, however, do not predict any drastic increases in removals up to 2030 though (see Table 17). Hence, reliance on imports can be expected to increase.

NW Russia

Forest industry

The production of value-added forest products is concentrated in the European part of the Russian Federation (Karvinen *et al*. 2011). The pulp and paper industry are the most significant and stable of the Russian forest industry branches. A remarkably high share of the larger production plants are located in NW Russia, which accounted for 3.8 and 4.4 million tonnes of the pulp and paper production respectively in 2010. Capacity utilisation is high and investments have been made to upgrade production and produce greater value goods (Karvinen *et al*. 2011). The Russian Federation is a net exporter of forest products. Pulp and paper is most important in value terms, accounting for 34% of the export value in 2010, followed by sawnwood. Newsprint is the most competitive paper product – over half of exported paper and paperboard is newsprint – whereas the majority of other paper products are sold domestically (Karvinen *et al*. 2011).

Energy policy and energy use of woody biomass

The wood-based energy sector is not yet well developed in the Russian Federation. There are, however, indications that development is about to begin in forest-rich NW Russian regions (Karvinen *et al*. 2011). The second generation of pellets producers, using western technology, is being challenged by energy wood supply as wood-processing by-products become more expensive. These pellet producers are now turning to roundwood instead (BIO-EX 2010). The third generation wood pellet plants, integrated into large-scale sawmills, are operating quite stably and efficiently (Karvinen *et al*. 2011). About 60% of the wood pellets are produced in the Northwest. So far, there are no export duties on wood pellets and most pellets producers intend to export to Western Europe, mainly Sweden and Denmark (Karvinen *et al*. 2011; EFINORD questionnaire 2012).

Implications for woody biomass use

There is apparently scope for increased wood use within NW Russia. In the short to medium term, exports of wood-based energy to the EU will play an important role. For example, shortages

of wood pellets to meet renewable energy targets within the EU are expected to be bridged by imports from nearby areas such as NW Russia (Clark 2011). The main bottleneck for woody biomass supply in the short to medium term is infrastructural shortcomings, notably the lack of forest roads (see, for example**,** Karvinen *et al*. 2011).

Sweden

Forest industry

Sweden plays a prominent role as a producer and exporter of forest products. The country is the world's second largest exporter overall of pulp, paper and sawn timber (Swedish Forest Industries Federation 2009). The Swedish forest industry is highly export-oriented, for example, paper exports amounted to 89% of the production in 2009 (Swedish Forest Industries Federation 2010). Europe is, by far, the most important market, not least the countries within the EFINORD region. There has been a steady growth in consumption of raw wood material by the forest industry: roundwood consumption increased from 51.7 million m^3 in 1975 to 70.6 million m^3 in 2010 (Swedish Forest Agency 2012). The roundwood consumption is fairly evenly divided between the sawmill industry and the pulp and paper industries (Ibid.).

Energy policy and energy use of woody biomass

A number of drivers have created favourable conditions for Swedish imports of biomass for energy use. Hence, policy incentives have, until recently, been more ambitious in Sweden than in most exporting countries, making it attractive to ship biomass to Sweden. This has been combined with a favourable cost level in the Baltic countries as well as in the Russian Federation (Hektor 2011). However, in the last few years, several of these conditions have changed. The supply of raw biomass material has tightened in the Baltic countries, Finland and Poland. Further, demand in other parts of Europe is emerging. All this has resulted in price increases to levels above those in Sweden. These factors should obviously reduce the imports of biomass for bio-energy to Sweden, but there are still no published statistical data available to illustrate the quantity and structure of that change (Ibid.).

Implications for woody biomass use

Sweden is quite close to achieving its national target for renewable energy. However, with fellings close to the level of increment, combined with decreased imports of bio-energy feedstock (Hector 2011), this should lead to an increased demand pressure on domestic wood resources. Hence, the Forest Agency and the Swedish University of Agricultural Sciences have been commissioned to develop a model for adaptive forest management, with the aim of increasing biomass production and improving environmental awareness (http://www.skogsstyrelsen.se/Myndigheten/Om-oss/Nyhetsarkiv/Nytt-regeringsuppdrag-om-adaptiv-skogsskotsel/).

UK

Forest industry

The UK is a major player in the forest-product markets, mainly in consumption terms. Hence, the UK was the largest importer of sawn softwood in the EU in 2010 (5.2 million m^3) and the third largest consumer (8.1 million m^3). In production terms, the country ranked eighth (3.1 million m^3). As for wood-based panels (FAOSTAT 2012), the UK is the third largest importer within the EU (2.7 million m^3), the fifth largest consumer (5.6 million m^3) and the fifth largest producer (3.4 million m^3). Finally, the UK is the second largest importer of paper and paperboard within the EU (6.8 million tonnes), the third largest consumer (9.9 million tonnes), but only eighth in production terms (4.3 million tonnes).

Energy policy and energy use of woody biomass

The UK Renewable Energy Strategy sets a goal of 15% of energy generation from renewable sources by 2020 (DECC 2012). Currently, bio-energy accounts for 3% of total primary energy consumption in the UK, with the majority (65%) being used in power generation (Ibid.). It is estimated that about 70% of UK demand for bio-energy may have to be met by imports (AEA 2011). In 2009, 4.9 million m^3 of wood was used for energy generation. 51% was used for power and heat generation, 35% for residential heating and 14% for industrial uses (UN 2011d).

Implications for woody biomass use

Should the UK wish to increase its self-sufficiency, there would be a considerable need for increasing the use of domestic woody biomass, especially considering that the country is a long way from achieving its target for renewable energy.

3.5 Forest management and silviculture

3.5.1 Silvicultural systems

Even-aged silviculture dominates in the region. There seems to be an increased interest in continuous cover forestry and uneven-aged forest management though, particularly in Denmark, Germany and Poland. These are also countries where conversion of even-aged single species stands to mixed and, occasionally, uneven-aged stands is being undertaken (Table 11). Selection cutting seems to be carried out at a very modest rate in the EFINORD region. Terminology differs between countries, so caution should therefore be exercised in interpreting Table 11.

Table 11. Silvicultural systems: practice and policy.

Country	Even-aged (% of managed forest)	Conversion to mixed and/or uneven-aged stands	Policy on uneven-aged management	Uneven-aged management, extent (000 hectares) and comments
Denmark	76	Yes, mainly in state forests	Mainly in state forests	12
Estonia	>95	No	No	Minor extent
Finland	>95	Limited extent	Seen as an option in legislation under way	Minor extent, may increase as 25% of forest owners have expressed interest
Germany	NA	Yes, partially	Yes	NA
Iceland	100	Not done	None	Very small scale in natural birch
Ireland	>90	Marginal	No national policy	
Latvia	76	On selected sites	Mandatory on some sites	12, mainly practiced on protected and protective forests
Lithuania	NA	No	No	NA
Norway	96	No	No	Small scale mainly in mountainous regions
Poland	NA	Yes, actively encouraged	Encouraged where suitable	NA
NW Russia	<10	No	No, but under discussion	0, most of the forest is not under management
Sweden	>90	No	Encouraged but not enforced	Minor extent, may increase
UK	Mainly even-aged for conifers	Yes, if the best way to deliver objectives	In state forests and on some site types.	Increasing

Source: EFINORD questionnaire (2012).

3.5.2 Regeneration methods

Planting and direct seeding dominate regeneration methods in most countries. Planting is often done using improved seedling stock. Site treatment is normally performed, although there is much variation in extent as well as in the methods used (Table 12).

Table 12. Regeneration methods.

Country	Regeneration methods (% of area regenerated)	Site preparation, extent (% of area regenerated) & methods used	Improved seedling stock (% of seedlings)
Denmark	Planting and direct seeding dominate Natural regeneration mainly in beech forests	NA From full ploughing to none	Used but exact extent is unclear
Estonia	Planting and direct seeding 90% Natural regeneration 10% Unassisted natural regeneration on about half the forest area	60 to 70% Disc trenching and some mounding	On the area actively regenerated 79% of pine seedlings 77% of spruce seedlings
Finland	Planting and direct seeding 82% Natural regeneration 18%	75% Mainly mounding (54%), disc trenching (29%) and patches (12%)	45 to 50% of the area annually planted and seeded Pine 19% Spruce 28% Birch 3%
Germany	Planting, direct seeding & coppicing 19% Natural regeneration 81%	NA NA	Marginal use
Iceland	Planting 100% Natural regeneration not used	90% Shallow spot or strip	75% of seedlings
Ireland	Planting 99% Natural regeneration	95% mounding 70, only windthrow harvesting slash and drain 30%	50% of Sitka spruce
Latvia	Planting and direct seeding 40% Natural regeneration 60%	30% Disc trenching	100% of spruce seedlings 60% of pine seedlings
Lithuania	Planting and direct seeding 64% Natural regeneration 36%	NA NA	44% of seedlings
Norway	Planting and direct seeding 50% Natural regeneration 50%	8% of planting sites & 25% of natural regeneration sites Trenching and patch treatment	75% of seedlings (95% in south east)
Poland	Planting 90% Natural regeneration 10%	90% Various methods	100% of seedlings in state-owned forests
NW Russia	Planting 75% Natural regeneration 25%	22% NA	Not used
Sweden	Planting and direct seeding 74% Natural regeneration 26%	86% Mostly strip scarring	80% of pine seedlings 50% of spruce seedlings
UK	Planting dominates	Most areas clear felled Mainly mounding	Generally used for Sitka spruce

Source: EFINORD questionnaire (2012).

3.5.3 Stand tending, rotations, typical yields and restrictions on final fellings

Pre-commercial thinning is generally carried out, although the extent differs from country to country. Rotations are generally 80 to 120 years, with oak rotations often considerably longer and, occasionally, conifer rotations as short as 60 years. Final felling operations typically yield 200 to 300 m^3 per ha. Early thinnings rarely yield more than 50 m^3 per ha and late thinnings typically yield around 70 m^3. Restrictions regarding final fellings vary considerably (Table 13).

Table 13. Extent of pre-commercial thinning, typical yields and final felling restrictions.

Country	Extent of pre-commercial thinning the first two decades of stand development (% or ha)	Typical rotations (years)	Restrictions on final fellings when done as clear cutting	Average yields in early thinnings, late thinnings and final fellings (m3/ha)
Denmark	Done regularly	Conifers 40–80 Broadleaves 40–150	No area restrictions	10% of total increment 40% of total increment 50% of total increment
Estonia	100% on state-owned forest 75% on privately-owned forest	Conifers 80–120 Broadleaves 30–130	Set of environmental restrictions in place	60–70 60–70 280–310
Finland	55% (decrease from 85)	Conifers 70– 50 depending on site and location	No area restrictions	40 (pine) 60 (spruce) 80 (pine) 100 (spruce) 250 (pine and spruce)
Germany	100% in state-owned forest, less in private	Beech & Oak 110– 80 Spruce 60–130 Pine 100–140	Permit required (area varies with state)	NA NA NA
Iceland	Unknown, but assumed to increase	90, great variation	Permit required	NA NA NA
Ireland	Hardly done, less than 5%	Spruce 37 Other conifers 50	< 15 ha Adjacent sites should differ at least 5 years in age	50 55 400–450
Latvia	100% in state-owned forest, less in private	70–100 Less for alder and aspen	< 5 ha, 10 ha with seed trees on mineral soils Width restriction on wet and peat soils	NA NA 230–250
Lithuania	13 000 ha/year in state-owned forest. No data for private	Conifers 70–100 Longer for “special purpose” forest	< 8 ha on production forest < 5 ha on protective forest Width restrictions and buffer zones	37 66 350–375
Norway	8%, the treatment is normally done later	80–130, mainly a bit more than 100	Size restrictions in certain urban areas and landscape protection areas	30 60 200
Poland	100% on state-owned forests and private forest on abandoned agricultural land	Conifers 100–120 Oak and ash 140–160 Shorter for other broadleaves	< 6 ha on pine and pine-birch < 4 ha other light demanders < 2 ha spruce stands Buffer zones required around water courses and lakes	NA NA NA
NW Russia	35%	Production forest Conifers 81–120 Birch 61–70 Aspen, alder 41–60 Protective forest Conifers 101–140 Birch 71–80 Aspen, alder 51–60	< 50 ha for clear-cutting; < 15–50 ha in protective forests < 30–100 ha in production forests subject to various types of selective fellings; width restrictions and buffer zones; Conservation restrictions Operational restrictions	6–17 50 205
Sweden	80%	110, national average	>0.5 ha permit required maximum area 20 ha Regulatory restriction Conservation restrictions	55 66 240
UK	Marginal	Highly variable Spruce constrained by windthrow risk	Site specific	Variable Variable Unthinned spruce >400

Source: EFINORD Questionnaire (2012). Note: NA= No answer.

3.5.4 Harvesting systems and mechanisation levels

Harvesting is mainly carried out using the cut-to-length system. A high rate of mechanisation in harvesting operations is critical for increasing wood mobilisation, especially in light of the expected increase in urbanisation (see UN 2012) which will lead to increased difficulties in attracting people to work in forestry (Blombäck et al. 2003). The mechanisation rate is high in both thinnings and final fellings in all countries except Lithuania, Poland and NW Russia (Table 14).

3.5.5 Intensive forest management practices

Intensive forest management practices are, apparently, sparingly practiced in the EFINORD region. Fertilisation is hardly done except in Finland and Sweden. Short rotation forestry is barely practiced at all and the same apparently holds true for clonal forestry. The main reason seems to be that it is not deemed to be economically justifiable (Table 15).

3.5.6 Forest health and major damage agents

Damage assessment differs between countries (Table 16). Damage is assessed in terms of area affected. The quantification of damage in terms of volume or value has only been sporadically encountered. The same holds true for quantification of damage effects.

Table 14. Harvesting systems and mechanisation levels.

Country	Harvesting systems used (% per system)	Mechanisation, final fellings (%)	Mechanisation, thinnings (%)	Comments
Denmark	64 cut-to-length	75	75	Estimates on mechanisation level
Estonia	Cut-to-length almost 100	98	75	Applies to state forest, lower mechanisation in private forest
Finland	>99 cut-to-length	>99	>99	One company uses the whole stem method
Germany	45 cut-to-length 55 whole stem	NA	NA	
Iceland	Cut-to-length dominates	Not yet happening	About 20	Final fellings are not yet carried out
Ireland	Almost 100 for cut-to-length	Almost total	85 – 90	Motor manual operations by some private owners
Latvia	Only cut-to-length	75	60	Estimates of mechanisation level
Lithuania	Only cut-to-length	22	22	Figures relate to state forests
Norway	90 cut-to-length	NA	NA	
Poland	35 cut-to-length	10	10	Rough estimates
NW Russia	70 cut-to-length	50	10	25% cut-to-length in the Russian Federation as a whole
Sweden	>99 cut-to-length	>95	>90	Some motor-manual fellings in self-owned forest
UK	Majority cut-to-length	Majority of conifers	Majority	

Source: EFINORD questionnaire (2012).

Table 15. Fertilisation, short rotation forestry, clones and hybrids: extent and regulations.

Country	Fertilisation, extent (ha) and regulations	Short rotation forestry, clones & hybrids, extent (ha or % of forest land) and regulations	Limiting factors
Denmark	Limited extent Forest fuel ashes to be recycled in the forest	4% of the forest area is Christmas tree plantations No regulations on clones and hybrids	Economic Environmental Public acceptability Legal
Estonia	Only in nurseries Forest land is not fertilised	Marginal extent There is a list of permitted exotic species and hybrids	Legal/environmental (forest land) Economic (afforestation)
Finland	25 000–50 000 ha per year Restrictions in place on amount of fertiliser applied Restrictions on timing and buffer zones	Less than 1000 ha Clones must be tested and registered Area restrictions per clone Rules on clone mixtures	Economic Environmental Legal Public acceptability
Germany	Marginal extent Use of wood ash and sewage sludge under discussion	Marginal, some 3000 ha Clones only recommended for “minor” species Some birch, larch and poplar hybrids are used	Public acceptability Economic Legal Environmental
Iceland	Often done when planting and during early phases of stand development No restrictions	Some Christmas tree plantations and clonal poplar plantations No official regulations, scientific advice is generally sought	No restrictions
Ireland	1300–1600 ha per year Comprehensive set of environmental and safety restrictions	Marginal extent No restrictions on afforested land	Economic Public acceptability
Latvia	Done in research only No restrictions other than that prescribed in the national certification standard	Marginal, but black alder management could be considered short rotation forestry (some 300 000 ha) No restrictions if domestic species are used	Economic Legal Public acceptability Environmental
Lithuania	Fertilisation is not done Rules for fertilisation with wood ash are being prepared	Some hundred ha Exotic species and hybrids are not permitted on forest land	Economic Legal Public acceptability Environmental
Norway	1000 ha per year some years before final felling Restrictions mainly in the national certification standard	Some 50 000 seedlings of Sitka & White spruce are planted annually Clones regulated by “Regulation for forest seed and seedlings” No regulation on use of hybrids	Economic Legal Environmental Public acceptability
Poland	Only in nurseries and in restoration General national legislation on fertilisation	4000 ha of short rotation forestry Regulations in “Act on Forest Reproductive Material”	Environmental Economic Public acceptability
NW Russia	Marginal extent Regulated by “Rules of Forest Tending 2012”	NA “Guidelines on Forest Seed in the Russian Federation”	Legal Economic Environmental Public acceptability
Sweden	30 000–60 000 ha per year Not permitted in south east Sweden Restrictions on amount applied per rotation in the other parts of the country	Very limited, Christmas tree and energy plantations are considered agricultural land Hybrids not regulated Clones on no more than 5% per holding, 20 ha always permitted. Approved material required. Notification to the Forest Agency required	Economic Others insignificant in comparison
UK	Very limited Summarised in UK Forest Standard	Some vegetatively propagated Sitka spruce used Regulations summarised in “UK Forest Standard”	NA

Source: EFINORD questionnaire (2012).

Table 16. Trend and threshold values for forest damage.

Country	Trends and quantification (m^3 or Euro)	Threshold values for recording damage
Denmark	Ash dieback and recent heavy storms No quantification encountered	Diseases are recorded in the NFI At least 10% of the trees or value affected
Estonia	Needle leaf pests on the increase and irregular storms reas affected probably underestimated. Some 3500 ha annually salvaged	5% of upper layer trees affected Insect damage on 25% of the needles/leaves of 20% of the trees Site conditions changed by flooding or pollution Fire damage on at least 0.1 ha
Finland	Root rot spreading north Fungal damage of about 50 million Euro per year	Group of at least 20 trees to be removed or 10% of the trees damaged
Germany	Fires on the decrease, at present about 900 ha per year Over the last 20 years about 25% of annual fellings are caused by storms, snow debris, insects or air pollution.	NA
Iceland	Increased insect damage on birch Damage from wildlife expected to become an issue No quantification encountered	NA
Ireland	Increased damage from deer 10 000 m^3 damaged by fire in 2010, wind damage not assessed	Not defined
Latvia	Ash dieback, root rot increasing, recent major windthrows No quantification encountered	Salvage fellings required when a certain share of basal area is damaged (dictated by species and height)
Lithuania	Ash dieback and recent storms Estimates are made following major windthrows No quantification encountered	More than 10% of the trees affected
Norway	As dieback and autumnal moth attacks on birch Impact of both considered modest. Moose browsing is locally a serious problem in young pine stands	5% of trees affected. Based on number of crop trees, site factors and stand age
Poland	Fires on the decrease, some insect predation In 2010, flooding caused losses of 31.5 million Euro. Salvage fellings normally in the 5 to 10 million Euro range.	10% of trees damaged for insect damage 20% of the trees damaged for wildlife damage 10% of the trees for air pollution No threshold for wind and fire
NW Russia	Fire the dominant agent of damage 1.8 million m^3 was burned in 2010	Norms for recording damage exist
Sweden	Damage from wind, wildlife and root rot on the increase. Ash dieback. Moose browsing a serious problem. More than 100 million m^3 lost through storm the last decade.	Damage recorded by NFI 30% of the trees affected as measured on NFI plots Freshly dead wood (>5 m^3) must be salvaged
UK	Windthrows, Phytophera and chalara increasing Quantification in progress	NFI outputs can be analysed to various thresholds

Source: EFINORD questionnaire (2012).

4 Prospects for increasing forest yields

4.1 Prospects for increased fellings

In Table 17, reported fellings can be compared with two estimations of potential fellings: (i) national estimates and (ii) results from simulations of the EFISCEN model for EFSOS II (UN 2011a). Both national estimates and EFISCEN results, which are generally quite close, suggest that there is considerable scope for increasing fellings in the EFINORD region, at least in purely biophysical terms.

Table 17. Reported and potential annual fellings (mill. m^3) for 2010.

Country	Reported	Potential – national calculations	Potential -EFISCEN	Comments on national calculations
Denmark	2.4[1]	No calculation done	3.2[5]	No calculation done
Estonia	5.7[1]	12–15 [3]	10.2[5]	Calculation based on NFI data and management restrictions.
Finland	59.4[1]	71.4[3]	73.5[5]	NFI data and MELA model
Germany	59.6[1]	100[3]	90.3	Fellings equal to max. annual growth
Iceland	NA	No calculation done	NA	No calculation done
Ireland	2.8[1]	2.1 [3]	2.5[5]	A model is used to calculate sustainable cut in state-owned forests
Latvia	12.4[1]	No calculation done	17.9[5]	No calculation done
Lithuania	8.6[1]	4 (in state-owned forests) [3]	9.5[5]	Calculated by the OPTIMA model for state forests
Norway	11.0[1]	16–17[3]	14[5]	Two calculations taking environmental considerations into account
Poland	40.7[1]	32.4 [3]	54.1[5]	Based on ten year plans for the forest districts (state-owned forests)
NW Russia	46.9[2]	112.7[4]	No calculation done	The potential is defined in the silvicultural regulations. Potential is calculated separately for clear cutting, selective cutting and thinnings.
Sweden	80.9[1]	94.7[3]	92.1[5]	Calculations done every 5 to 10 years
UK	10.5[1]	No calculation done	12.2[5]	No calculation done

Sources: Reported fellings: [1]UNECE & FAO (2010); [2]Rosleshoz official statistics; [3]EFINORD questionnaire (2012); [4]Karvinen *et al*. (2011); [5]Verkerk & Schelhaas (in press). Note: Modelled data are from forest area available for wood supply.

However, as mentioned in section 3.2.1, in Sweden and according to more recent data for Estonia and Germany as well, the wood resources are already intensively used. Hence, to assess the prospect for increasing forest yields by increasing annual felling rates, a more elaborate study of annual increments and fellings is needed.

4.2 General observations on intensive forest management in the EFINORD countries

Prospects for increasing forest yields by intensive forest management practices differ so much between EFINORD countries that it is difficult to make general statements. However, some general observations can be made:

- An increasing demand for bio-energy supports the implementation of forestry practices to increase forest yields.
- These forestry practices can be costly for the forest owner and, for their large-scale implementation, bio-energy markets need to increase prices for forest biomass or, alternatively, governmental subsidies need to be offered to ensure increased forest yields for the future.
- Data on forest resources are generally of high quality in EFINORD countries. Fresh national forest inventory data are being produced where they are missing. These data are im-

portant to support decisions on implementation of forest practices with the aim to increase forest yields.
- Property right regimes are well defined and land use conflicts are few. Reasonably new legislation exists or is under way in all EFINORD countries.
- The high proportion of small forest holdings may be an obstacle for introducing forestry practices that are costly.
- The mechanisation rates in the region are, in general, high, favouring the forestry practices analysed in this study.
- The present trend in some countries of favouring continuous cover forestry and so-called close-to-nature practice does not favour intensive forest management practices. There may well be conflicts between the interest in continuous cover forestry for recreational and biodiversity purposes and the production of woody biomass for energy.

4.3 National observations on the prospect of intensive forest management

In view of the general observations stated in the previous section, national notes and comments on prospects of introducing intensive forestry practices are presented in Table 18.

4.4 National bottlenecks

The respondents from each country were asked what action or change would be necessary to increase annual felling rates. The means to increase felling rates immediately include increases in thinning activities, change in markets conditions and/or regulations. Given ten years, the emphasis is on industrial development, regulatory framework and more intensive forest management. With a longer perspective, intensive forest management is seen as the main tool (Table 19).

Table 18. National notes and comments on prospects for introducing forestry practices to increase forest yields.

Country	Notes and comments on resources, policies, industry and management & silviculture
Denmark	"Close-to-nature" practices promoted on publicly-owned forests Conversion of monocultures to mixed and possibly uneven-aged forests Renewable energy set to increase, a possible conflict with the drive for close-to nature practices
Estonia	Many small holdings Unassisted natural regeneration on private land has led to a high share of broadleaves, particularly aspen Wood-based energy is important and will probably grow
Finland	Economically very important forest sector Uneven-aged forest management is an option in legislation under way and interest seems to be emerging Forest owners are well organised Industrial capacity has been reduced as regards paper production Increased demand for wood will most likely come from the energy secto Increased fertilisation is thought to be enough to cater for increases in woody biomass demand in the medium-term
Germany	A federation of states that may differ considerably in forest regulations and practices "Close-to-nature" practices are becoming increasingly prominent and monocultures are being converted Natural regeneration dominant regeneration method Forestry and wood industry are important sources of employment Competition between energy and material uses of wood Rising demand for coniferous wood, but declining supply
Iceland	Emerging resource base that could be expanded to about 30 000 km^2 Afforestation is the main activity
Ireland	Forests are generally plantations The forest sector has been hit hard by recession, demand for wood products is low
Latvia	Annual harvest in balance with annual growth with the forest sector accounting for 3% of GDP Higher age classes are increasing in area The share of broadleaved trees more prominent than in most of the EFINORD countries Wood-based energy has potential to increase, both in domestic consumption and export
Lithuania	Privatisation of forest land in progress. Afforestation promoted on private land Selected broadleaves and natural regeneration are promoted Wood-based energy has potential to increase, both in domestic consumption and export
Norway	The importance of the forest sector in the national economy has been steadily decreasing in the Norwegian economy Large volumes are available, should demand increase
Poland	Afforestation is in progress "Close-to-nature" practices promoted for publicly-owned forests Conversion of monocultures to mixed and possibly uneven-aged forests Average private holding is smaller than two hectares Forest industry imports of raw material, as well as annual fellings, are likely to increase Harvesting has not yet been mechanised
NW Russia	Huge forest areas that are publicly-owned, industry however is mainly privately owned Large areas are not under forest management and infrastructure is poor Use of wood-based energy to be increased, but a well-defined target is missing Wood-based energy is on the increase, domestic consumption as well as exports
Sweden	Annual harvest and growth almost in balance The forest sector is important to the national economy Comparatively large average holdings Well organised forest owners Emerging interest in continuous cover forestry Strong positive trends for wood-based energy Increased pressure on domestic forest resources
UK	Much of the forests are plantations of exotics with an afforestation rate of 10 000 hectares per year Major importer of forest products Forest land seems to increase in value Biofuel is imported Conservation aspects have grown in importance

Source: EFINORD questionnaire (2012).

Table 19. Scope for increasing felling rates.

Country	Immediately	In ten years	In the longer term
Denmark	More wood from better utilisation of harvest or from afforestation previously not harvested	Incentives to improve afforestation and reforestation, including using nurse trees to give early biomass production Mobilisation of small forest owners by establishing contact to forest entrepreneurs	Choice of species and genotypes and increase of the afforestation rate.
Estonia	Tax reductions on wood sales and cutting rights for all private forest owners. Truck total mass limit could be raised, for example to Scandinavian levels.	Better extension services for private forest owners. Trustworthy wood procurement, sales and forest management services for (small) private forest owners via forest owners associations or companies.	Improve image of the sector. At present, forests and wood are held in high regard whereas forest management is not.
Finland	Shorten rotations, particularly for Norway spruce. Increase thinning, particularly of peatland stands and young stands	In addition to the previous actions, increase forest fertilisation	In addition to the previous actions: Apply more intensive regeneration and young stand management Increased use of improved seed material in planting and sowing Take some of the arable land for energy wood production
Germany	No realistic means	Mobilisation in small-scale forestry (but this is already done significantly). New products and new markets for hardwood. Consideration of forest products in the second commitment period of the Kyoto protocol and post Kyoto agreements.	More acceptance for compatibility between intensive forest management and nature conservation. Better economy of short rotation plantations.
Iceland	Inventory to detect areas that can give roundwood from thinnings in the next 10 years and rank them by economic benefit.	Support to small wood industry that can use wood in more enduring way than immediate burning in ferro-silica ovens.	More robust forest law to ensure the sustained usage of the cultivated forest.
Ireland	Greater levels of harvest in privately-owned forest.	The level of roundwood production is set to double, coming mainly from the private sector in the period up to 2028.	Higher levels of harvest in existing forests and expanding the forest area through afforestation.
Latvia	Investments into forest infrastructure, including drainage systems.	Incentives to improve afforestation, taxation level support to forest regeneration and pre-commercial thinning, support to plantation forests and short rotation forestry, support to fertilisation of forests, forest drainage programme.	Improved genetic materials and silviculture methods, new species in managed forests, broader use and development of short rotation forests, development of capacities for processing of deciduous trees.
Lithuania	Increase of thinnings. Optimisation of protected areas. Increase of use of harvesting residues.	The beginning of harvesting of short rotation plantation. More intensively use private forests.	Choice of species and genotypes which produce more wood.
Norway	Economic stimulation, such as subsidies for harvesting operations or to establishment of bio-energy plants, but this will be difficult.	Stimuli to increase the demand of sawnwood or fibre in general (for example through high carbon taxes on fossil fuel).	Economic incentives to increase planting, fertilisation etc. in addition to demand increase mentioned earlier.
Poland	Probably impossible to raise felling rates immediately.	Development of fast growing plantations in agricultural lands increasing forest area. Improvement of the system of incentives for afforestation of agricultural lands is needed.	Gradual enlargement of allowable cut (mostly in mature tree stands, final felling) in forest management plans.
NW Russia	Introduction of intensive forest management.	Development of domestic forest industries.	Denationalisation of forest ownership.
Sweden	To increase the level of fellings would require changed market conditions. To immediately increase the potential harvesting level is not possible.	The potential harvesting level can, within 10 years, be raised through fertilisation.	Improved regeneration and management of young stands is still the largest possibility for improving long-term harvesting levels. After that, genetic improvement, fertilisation of young stands, ditch cleaning, reduction of browsing game populations and root rot control can also contribute.
UK	Increased thinnings	Skills and infrastructure investment	Increase extent and quality of raw material.

Source: The EFINORD questionnaire 2012.

5 Conclusions

This study indicates that there is a striking variation in the intensity of utilisation of the wood resources within the EFINORD region. For the region as a whole, there seems to be a substantial unused (biophysical) potential. However, recent data from some countries indicate that annual felling rates can be underestimated. If felling rates are higher than currently recognised then, given the increased demand for wood-based energy, there appears to be a need to discuss strategies for large-scale implementation of more intensive forestry practices to ensure that the availability of wood resources in the future can meet an increasing demand in the EFINORD countries.

It would be of interest to build on the current study and more thoroughly assess the biophysical potential for forest production in the EFINORD countries. In such a study, an analysis of the actual biological production capacity of the forests should also be included. Further, as using a larger proportion of biophysical potential than at present may entail trade-offs with the environmental and social values of forests, strategies for ensuring and combining all values and deliveries of all ecosystem services need to be discussed and developed. Another important aspect is the economics of often costly intensive forestry practices. EFINORD countries are dominated by private forest holdings. Hence, what is needed are policy instruments that provide incentives for these forest owners to intensify forestry, while at the same time safeguarding environmental and social values of the forests.

References

AEA Technology plc. (AEA) 2011. 2012 [Internet site]. UK and Global Bioenergy Resource, – Final Report to the UK Department of Energy and Climate Change. Didcot, Oxfordshire, UK. Available at: http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/policy/1464-aea-2010-uk-and-global-bioenergy-report.pdf. [Cited 21 May 2012].

Bekeris, P. 2011. Latvia's forests during 20 years of independence. Balti Group, Riga, Latvia.

BIO-EX. 2010. 2012 [Internet site]. Obzor runka. Available at: http://bio-ex.com.ua/bio-market_pellets.htm. [Cited 23 May 2012].

Blombäck, P., Poschen, P. & Lövgren, M. 2003, Employment Trends and Prospects in the European Forest Sector; Geneva Timber and Forest Discussion Paper ECE/TIM/DP/14. United Nations Economic Commission for Europe, Geneva, Switzerland.

BMELV. 2011. 2012 [Internet site]. Forest Strategy 2020: Sustainable Forest Management – An Opportunity and a Challenge for Society. Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (Federal Ministry of Food, Agriculture and Consumer Protection), Berlin, Germany. Available at: http://www.bmelv.de/SharedDocs/Downloads/EN/Publications/ForestStrategy2020.pdf. [Cited 21 May 2012].

Butler, B.J. 2008. Family forest owners of the United States, 2006. US For. Serv. Gen. Tech. Rep. NRS-27. 73 p.

CIA. 2012. 2013 [Internet site]. World Fact Book. Central Intelligence Agency, United States of America. Available at: https://www.cia.gov/library/publications/the-world-factbook/. [Cited 30 January 2013].

Clark, D. 2011. Forest Products Annual Market Review 2010–2011; Geneva Timber and Forest Study Paper 27. United Nations Economic Commission for Europe, Geneva, Switzerland.

CSIL. 2010. 2012 [Internet site].World furniture outlook 2010/2011. Centre for industrial studies: Milano, Italy. Available at: http://www.worldfurnitureAvailable.com/PDF/press-Outlook-2010.pdf. [Cited 24 May 2012].

Danish Energy Agency. 2011. 2012 [Internet site]. Energy statistics 2010. Danish Energy Agency, Copenhagen, Denmark. Available at: http://www.ens.dk/en-US/Info/FactsAndFigures/Energy_statistics_and_indicators/Annual%20Statistics/Documents/Energy%20statistics%202010.pdf. [Cited 21 May 2012].

DECC. 2012. 2012 [Internet site]. UK Bioenergy Strategy. Department of Energy & Climate Change: London, UK. Available at: http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/bioenergy/5142-bioenergy-strategy-.pdf. [Cited 22 May 2012].

Donner-Amnell, J. 2010. New rules, new players or a new setting? New factors changing the character of forest-related activities in the Nordic countries. Presented at 1st Nordic Conference on Forest Policy Science, Uppsala, Sweden, October 2010.

Estonian Environment Informatio Centre (EEIC). 2011. Estonian Forestry 2011. Estonian Environment Information Centre: Tartu, Estonia

EFINORD. 2012. Unpublished. Forest Sector Questionnaire 2012.

European Environment Agency (EEA). 2006. European Forest Types – Categories and Types for Sustainable Forest Management Reporting. EEA Technical Report No. 9/2006. EEA, Copenhagen.

Eurostat. 2012. Data on Share of Renewable Energy 2006 to 2010.

Eysteinsson, T. 2009. 2012 [Internet site]. Forestry in a treeless land 2009. Iceland Forest Service, Egilsstaðir, Iceland. Available at: http://www.skogur.is/media/utgafa/Forestry_in_a_treeless_land_2009_by_Throstur_Eysteinsson.pdf. [Cited 25 May 2012].

FAO. 2010. Global Forest Resources Assessment 2010. Main Report. FAO, Rome. ISBN 978-92-5-106654-6.

FAOSTAT. 2012. 2012 [Internet site]. ForesSTAT. Available at: http://faostat.fao.org/site/626/default.aspx#ancor. [Cited 23 May 2012].

Gerasimov Y., Karvinen S. (In press). Atlas of forest sector in Poland. Working papers of the Finnish forest research institute (ISSN 1795-150X)

German Timber. 2007. Forest and wood industries in Germany at a glance. German Timber Promotion Fund, Bonn, Germany.

Heinimö, J., Alakangas, E. 2011. 2012 [Internet site]. IEA Bioenergy Task 40 and EUBIONET III -Country report of Finland 2011.Available at: http://www.bioenergytrade.org/downloads/iea-task-40-country-report-2011-finland.pdf. [Cited 25 May 2012].

Hektor, B. IEA Bioenergy Task 40: Country Report Sweden 2011. 2012 [Internet site]. Available at: http://www.biomassinnovation.ca/pdf/Mission%20to%20Europe/Trade%20Mission%20copy/Country%20Profiles%20and%20Presentations/Sweden/iea-task-40-country-report-2011-sweden.pdf. [Cited 21 May 2012].

Jonsson, R. 2011. Trends and possible future developments in global forest-product markets–implications for the Swedish forest sector. Forests 2(1): 147–167.

Karvinen S., Välkky E., Gerasimov Y., Dobrovolsky A. 2011. Northwest Russian forest sector in a nutshell. The Finnish Forest Research Institute (METLA), Joensuu, Finland.ISBN 978-951-40-2343-9.

Mantau, U. 2009. Holzrohstoffbilanz Deutschland: Szenarien des Holzaufkommens und der Holzverwendung bis 2012 [Wood resource balance Germany: Scenarios of forest resources and timber use up to 2012]. Special issue 327 forest strategy 201; proceedings of the BMELV Symposium, 10–11 December 2008 in Berlin; pp. 27–36.

Mantau U. 2012. Energieholzverwendung in privaten Haushalten im Jahr 2010 [Wood energy use by households in 2010] Marktvolumen und verwendete Holzsortimente – Abschlussbericht. Hamburg University, Hamburg, Germany.

Mantau, U., Saal, U., Steierer, F., Verkerk, H., Lindner, M., Anttila, P., Asikainen, A., Oldenburger, J., Leek, N., Prins, K. 2010. 2013 [Internet site]. EUwood – Real potential for changes in growth and use of EU Forests (EUwood Final report). EUwood, Hamburg, Germany. Available at: http://www.unece.org/fileadmin/DAM/timber/meetings/20110321/euwood_final_report.pdf. [Cited 14 January 2013].

McDonald, R.I., Motzkin, G., Bank, M.S., Kittredge, D.B. , Burk, J. & Foster, D.R. 2006. Forest harvesting and land-use conversion over two decades in Massachusetts. Forest Ecology and Management 227:31–41.

METLA. 2011. 2012 [Internet site]. Forest Finland in brief. The Finnish Forest Research Institute, Vantaa, Finland. Available at: http://www.metla.fi/metinfo/tilasto/julkaisut/muut/metlaff2011.pdf. [Cited 21 May 2012].

Natural Resources Canada. State of the Forests - 1995. 2012 [Internet site]. Glossary of Forestry Terms. (Internet access: http://www.nrcan.gc.ca/cfs/proj/ ppiab/sof/sof95/toc.shtml). [Cited 23 May 2012].

Nikolaisen, L. 2011. 2012 [Internet site]. IEA Bioenergy task 40 – Country report 2011 for Denmark. Available at: http://www.bioenergytrade.org/downloads/iea-task-40-country-report-2011-denmark.pdf. [Cited 22 May 2012].

Plum, P. 1998. Denmark: non-wood forestry in a densely populated temperate country. In G. Lund, B. Pajari & M. Korhonen, (eds.) Sustainable development of non-wood goods and benefits from boreal and cold temperate forests, p.p. 125–130. Proceedings of the International Workshop, Joensuu, Finland, 18–22 January 1998. EFI Proceedings No. 23.European Forest Institute, Joensuu, Finland.

Row, C. 1978. Economies of tract size in timber growing. Journal of Forestry 76(9):576–582.

Russian Federation Government. 2010. The law of the Russian Federation: Energy saving and increasing of energy efficiency (in Russian). Government of the Russian Federation, Moscow, Russian Federation.

Statistics Lithuania. 2012. Statistical Yearbook of Lithuania 2012. Statistics Lithuania, Vilnius, Lithuania.

Statistics Norway. 2010. 2012 [Internet site]. Energy Statistics and Energy Balance 2010. Available at: http://www.ssb.no/energiS. [Cited 24 May 2012].

Stocker, N. 2003. 2012 [Internet site]. An Argument for Intensive Forest Management. FAO, docrep, Article, World Forestry Congress, XII/0750-B1.HTM. Available at: http://www.fao.org/docrep/ARTICLE/WFC/XII/0750-B1.HTM. [Cited 17 May 2012].

Swedish Forest Agency. 2012. Swedish Statistical Yearbook of Forestry. Swedish Forest Agency, Jönköping, Sweden.

Swedish Forest Industries Federation. 2009. 2012 [Internet site]. The Swedish Forest Industries–Facts and Figures 2008. Swedish Forest Industries Federation: Stockholm, Sweden. Available at: http://www.forestindustries.se/web/Publications_and_surveys.aspx. [Cited 21 May 2012].

Swedish Forest Industries Federation. 2010. 2012 [Internet site]. Pulp & Paper Statistics–Fourth Quarter and Total 2009. Swedish Forest Industries Federation: Stockholm, Sweden. Available at: http://www.forestindustries.se/web/Facts_and_figures.aspx. [Cited 25 May 2012].

vTI. 2008. Inventory Study 2008. 2012 [Internet site]. Johann Heinrich von Thünen Institut, Germany. Available at: http://literatur.vti.bund.de/digbib_extern/dn048141.pdf. [Cited 21 May 2012].

Trømborg, E. 2011. 2012 [Internet site]. IEA Bioenergy task 40 – Country report 2011 for Norway. Available at: http://www.bioenergytrade.org/downloads/iea-task-40-country-report-2011-norway.pdf. [Cited 23 May 2012].

Trømborg, E. & Solberg, B. 2010. Forest sector impacts of the increased use of wood in energy production in Norway. Forest Policy and Economics 12, 39–47.

UN. 2011a. European Forest Sector Outlook Study II: 2010–2030. United Nations. UNECE/FAO Timber Branch. Geneva Timber and Forest Study Paper 28. UNECE: Geneva, Switzerland. Available at: http://www.unece.org/fileadmin/DAM/timber/publications/sp-28.pdf. [Cited 21 May 2012].

UN. 2011b. 2012 [Internet site]. UNECE Timber Committee Market Report for Ireland 2011. UNECE: Geneva, Switzerland. Available at: http://www.unece.org/fileadmin/DAM/timber/country-info/Ireland.pdf [Cited 22 May 2012].

UN. 2011c. Latvia market report 2010. 2012 [Internet site]. UNECE: Geneva, Switzerland. Available at: http://www.unece.org/fileadmin/DAM/timber/country-info/Latvia.pdf. [Cited 23 May 2012].

UN. 2011d. 2012 [Internet site]. Joint Wood Energy Enquiry 2009-2011. Available at: http://www.unece.org/jwee2009.html. [Cited 24 May 2012].

UN. 2012. 2012 [Internet site]. World Urbanization Prospects: the 2011 Revision. United Nations, Department of economic and social affairs, Pop. Division, New York, NY, USA. Available at: http://esa.un.org/unup/. [Cited 22 May 2012].

UNECE & FAO 2010. Forest Europe, National reports.

UNECE & FAO 2011. State of Europe´s Forests 2011. Status and Trends in Sustainable Forest Management in Europe. Forest Europe, Liaison Unit Oslo.

UNECE & FAO 2011b. Forest Europe, National reports.

USDA. 2011. 2012 [Internet site]. Forestry situation and solid wood products in Poland (GAIN Report PL 1124). United States Department of Agriculture, Foreign Agricultural Service, Washington, DC, USA. Available at: http://static.globaltrade.net/files/pdf/20111031220345418.pdf. [Cited 21 May 2012].

Valinger, E. & Fridman, J. 1999. Models to assess the risk of snow and wind damage in pine, spruce, and birch forests in Sweden. Environmental Management 24, 209–217

Verkerk, H., Schelhaas, M.J. (in press) European forest resource development – A contribution to EFSOS II. Geneva Timber and Forest Discussion paper, ECE/TIM/DP/61. Geneva: UNECE.

Wear, D.N., Liu, R., Foreman, J.M. & Sheffield, R.M. 1999. The effects of population growth on timber management and inventories in Virginia. Forest Ecology and Management 118:107–115.

Appendix 1. Terms of reference (in Swedish)

Facts and figures of the EFINORD forest sector

Summary in English

A Swedish study (Larson et al. 2009) revealed a remarkable potential to increase the growth of forests using relatively tested methods, which could also be reasonably applied in other EFINORD countries' forests. However, the environmental impacts would also be considerable. To assess to what extent a more growth-oriented forestry could be applied within the EFINORD region, a study of the preconditions in respective countries is needed.

The project plan is to compile facts concerning forestry and forests in EFINORD countries. The compilation includes detailed facts on forest resources (areas, growing stock, increment, age class distribution etc.), forest ownership, policy and governance and other conditions for production forestry prevailing in the member countries

The aim of the study is to describe prerequisites for forestry and to discuss possibilities for intensive forest management and increased increment of forests in EFINORD countries in the short and long terms.

The work will be a desk study and the review will be compiled by a lead author from SLU. A network of contact points in countries will be set up. These experts will be called upon to review findings/conclusions regarding their respective countries, fill in missing, mainly statistical, information and to respond to special inquiries concerning silvicultural methods and forest policy.

Bakgrund

Under det närmaste århundradet kommer tillgången på odlingsbar mark med stor sannolikhet att vara en begränsande faktor för samhällets välfärdsutveckling med ökad konkurrens från olika markanvändingsformer som konsekvens (Harvey & Pilgrim 2011). Globalt förväntas behoven av livsmedel, energi och annan bioråvara att öka kraftigt. Förväntningarna på skogen är stora I Europa. Förutom att producera råvara till den traditionella skogsindustrin förväntas skogen även bidra till energiförsörjningen. Skogen har också en viktig roll för bevarande av biologisk mångfald och för många andra värden som rekreation och friluftsliv. En ännu icke publicerad rapport från FAO visar att efterfrågan på skogsråvara i Europa förväntas överstiga högsta möjliga avverkningsnivå med motsvarande ca 400 miljoner kubikmeter vedråvara redan om 20 år (Anon. 2011).

I Sverige har regeringen låtit SLU utreda möjligheterna till att öka skogsproduktionen genom ett intensivare skogsbruk (Larsson et al 2009). Förutom effekterna på skogens tillväxt skulle även

påverkan på miljö och andra värden än skogsproduktion belysas. Utredningen visar att det går att i det närmaste fördubbla tillväxten per hektar med relativt beprövade metoder men också att miljöpåverkan kan vara betydande. Utredningen visar således på att det finns betydande potential att öka skogens tillväxt vilket rimligen även borde gälla även i övriga EFINORD-länders skogar. För att kunna bedöma i vilken omfattning ett mer tillväxtinriktat skogsbruk skulle kunna tillämpas inom EFINORD behövs dock en ordentlig genomgång av förutsättningarna för skogsbruk i de respektive länderna.

Projektplan

För samtliga EFINORD-länder sammanställs fakta rörande skogsbruket. Sammanställningen innehåller förutom en allmän översikt mer detaljerade uppgifter om skogstillgångar (arealer, volymer, tillväxt, åldersklassfördelning etc.), ägarskap, politik och styrning, avsättningar för naturvård och annan markanvändning, hållbar avverkningsnivå med nuvarande skogsbruk samt en översikt av skogsindustrin. Ett särskilt avsnitt ägnas åt nuvarande skogsskötsel samt vilka erfarenheter som finns av ett mer tillväxtinriktat skogsbruk.

Målsättningen är att sammanställa och beskriva förutsättningarna för skogsbruk i EFINORD-länderna samt att diskutera möjligheterna till ökad skogstillväxt på kort och lång sikt. På så sätt kan också möjligheterna att öka tillgången av skogsråvara kvantifieras och analyseras.

Genomförande

Arbetet bygger i första hand på sammanställning av litteraturuppgifter och intervjuer av nyckelpersoner i de olika länderna. För detta arbete anlitas en konsult med erfarenhet från liknande arbete. I varje medlemsland utses en kontaktperson som bistår arbetet med faktasammanställningen. Dessa kontaktpersoner ingår dessutom i det core-team som ansvarar för skrivandet av en vetenskaplig rapport och en populärvetenskaplig rapport. Arbetet leds av Tomas Lundmark och Mika Mustonen.

Appendix 2. National representatives and their affiliations

Country	Representatives	Affiliation
Denmark	Thomas Nord-Larsen Vivian Kvist Johannsen	Department of Geosciences and Natural Resource Management (IGN)
Estonia	Mati Valgepea	Estonian Environment Information Centre
Finland	Jari Hynynen	The Finnish Forest Research Institute (Metla)
Germany	Heino Polley	Thünen Institute of Forest Ecosystems
Iceland	Arnór Snorrason	Icelandic Forest Research
Ireland	Eugene Hendrick	The Programme of Competitive Forestry Research for Development (COFORD)
Latvia	Toms Zalitis	Latvian State Forest Research Institute (SILAVA)
Lithuania	Liana Sadauskiene Virginijus Miksys	Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry
Norway	Aksel Granhus Birger Solberg	The Norwegian Forest and Landscape Institute (NFLI) Norwegian University of Life Sciences (UMB)
Poland	Adam Kaliszewski	Forest Research Institute
Russia	Yuri Gerasimov	The Finnish Forest Research Institute (Metla)
Sweden	Erik Sollander	Swedish Forest Agency
United Kingdom	Sheila Ward Pat Snowdon	Forestry Commission