Final report

Real potential for changes in growth and use of EU forests

EUwood

Project: Call for tenders No. TREN/D2/491-2008

Mantau, U. et al.

Date of report:
30 June 2010

EUwood team

University of Hamburg –
Centre of Wood Science

Udo Mantau

Head of Centre of wood science and project coordinator –
Expert in wood resource monitoring, balance and assessment

Ulrike Saal

Research Assistant –
Industrial wood residues

UNECE/ FAO –
Forestry and Timber Section

Kit Prins

Former Chief of Section –
Forest policy expert

Florian Steierer

Research Assistant –
Wood energy data specialist

EFI –
European Forest Institute

Marcus Lindner

Head of Programme Forest Ecology and Management

Hans Verkerk

Researcher –
Forest resources modelling specialist

Jeannette Eggers

Researcher –
Forest resources modelling specialist

Probos –
The Dutch Institute for Forestry and Forest Products

Nico Leek

Senior Consultant –
Wood Market

Jan Oldenburger

Consultant -
Forest Products and Statistics

METLA –
Finnish Forest Research Institute

Antti Asikainen

Researcher –
Forest Technology specialist

Perttu Anttila

Researcher –
Forest technology and forest biomass specialist

Citation of the Final report

Mantau, U. et al. 2010: EUwood - Real potential for changes in growth and use of EU forests. Final report. Hamburg/Germany, June 2010. 160 p.

Parts of final report

Mantau, U. 2010: Is there enough wood for Europe?. pp 19-34. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Mantau, U., Saal, U. 2010: Material use. pp 35-42. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Steierer, F. 2010: Energy use. pp 43-55. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Verkerk, H.; Lindner, M.; Anttila, P. & Asikainen, A. 2010: The realistic supply of biomass from forests. pp 56-79. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Oldenburger, J. 2010: Landscape care wood and other wooded land. pp 80-88. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Leek, N. 2010: Short rotation plantation. pp 89-92. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Leek, N. 2010: Post-consumer wood. pp 93-96. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Saal, U. 2010: Industrial wood residues. pp 97-107. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Prins, K. 2010: Policy options for more wood: Strategies and recommendations for a sustainable wood mobilisation. pp 108-126. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

Mantau, U. 2010: Wood Resource Balance fact sheets. pp 129-160. in: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

CONTENTS

TABLES

FIGURES

ANNEX

Abbreviations

Btl	Biomass to liquid
CEEC	Central and Eastern Europe
CEI-BOIS	Confederation of the European wood working industries
DG ENV	European Commission Directorate General Environment
DG TREN	European Commission Directorate General Transport and Energy
EFISCEN	European Forest Information SCENario model
FAO	Food and Agriculture Organisation of the United Nations
FAWS	Forest area available for wood supply
FRA	Forest Resource Assessment
FTP	Forest Technology Platform
GDP	Gross Domestic Product
GIEC	Gross inland energy consumption
GIS	Geographic information system
IEA	International Energy Agency
IEE	Intelligent Energy Europe
ISIC	International Standard Industrial Classification
IWR	Industrial wood residues
JFSQ	Joint Forest Sector Questionnaire
JWEE	Joint Wood Energy Enquiry
LCW	Landscape care wood
LOHAS	Lifestyle of Health and Sustainability
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MDF	Medium density fibreboard
NACE	Statistical classification of economic activities in the European Community
NFI	National forest inventory
ob	Overbark
oIWR	Other industrial wood residues
OSB	Oriented strand board
PCW	Post-consumer wood
R&D	Research and Development
RES	Renewable Energy Sources
RES Directive	EU Directive on the on the promotion of the use of energy from renewable sources
SBP	Sawmill by-products
SRC	Short Rotation Coppice
UNECE	Unites Nations Economic Commission for Europe
WPC	Wood plastic composites
WRB	Wood Resource Balance

Prefixes

k	kilo	(10^3)
M	Mega	(10^6)
G	Giga	(10^9)
T	Tera	(10^{12})
P	Peta	(10^{15})
E	Exa	(10^{18})

Units

bbl	Barrel
m^3 ob	m^3 over bark
M	Million
Mtoe	Million Tonnes Oil Equivalent
Odt	Oven dry metric tonnes
rwe	Roundwood equivalent
swe	Solid wood equivalent

Abbreviations of the Wood Resource Balance

HI	High – refers to high mobilisation scenario
ME	Medium – refers to medium mobilisation scenario
LO	Low – refers to low mobilisation scenario
TH	Theoretical – refers to theoretical availability
POT	Potential – refers to “real” availability under given constraints
DEM	Demand – refers to modelled or assumed demand
DIS	Disposed – refers to potential that is currently disposed
USE	Use – refers to potential that is or will be used
C	Coniferous - softwood
NC	Non-coniferous - hardwood

Country codes – International Organization for Standardization

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
ES	Spain

FI	Finland
FR	France
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
SE	Sweden
UK (GB)	United Kingdom (Great Britain)

Preface

The relevance of woody biomass in all sectors has substantially increased in the last decade. New consumers joined the market and new products were developed. Arising from higher ambitions and targets for renewable energy in general and wood in particular, the concern about availability of wood on a sustainable basis became more important. The upcoming competition between the demands for wood energy and traditional forest based industries increases the need for better information on woody biomass at European level.

Moreover, a new concept of calculating woody biomass demand flows - the “Wood Resource Balance” developed at the University of Hamburg - shows that the consumption of woody biomass from forests is already higher than recorded fellings and especially energy consumption is much higher than recorded fuelwood removals.

So far official statistics and market models on woody biomass cover only forestry and the forest based industries. The “Wood Resource Balance” though, presents also a framework to integrate all resource flows, including post-consumer wood and co-products, as well as the demand from the energy sector, all compiled in a comprehensive accounting system.

The need for a completely new reporting system for woody biomass brought together a number of stakeholders, researchers and international bodies to improve the situation. In particular, a task force on wood availability and demand hosted by the UNECE/FAO Forestry and Timber Section moved rapidly to gather available information and to make estimates. A new enquiry designed to measure the real level of wood energy supply and consumption was implemented jointly by UNECE/FAO and the International Energy Agency (IEA).

The first European “Wood Resource Balance” combining the results of the task-force and the Joint Wood Energy Enquiry was published in 2005. This first study as well as the workshop on wood resource balances demonstrated the lack of reliable data and the need for further research.

The EUwood project, financed by the IEE programme, continued this research and has created a more reliable and precise overview on future supply and demand. It brought together data and analyses from a wide range of sources in the comprehensive and structured framework of the Wood Resource Balance. Furthermore, the EUwood project offers a detailed and transparent estimate of future potential wood supply in Europe. The detailed information can be used by policy makers for energy and the forest sector, as well as other sectors, including agriculture, biodiversity and industry.

The build-up of the comprehensive work would not have been possible without generous cooperation and information and ideas from many sources:

We mainly express our gratitude to the “UNECE/FAO task force on wood availability and demand” for its pioneer work raising the awareness on the data problem. The Swedish “Future Forest“ project provided updated econometric projections of future demand and supply of forest products providing the basic data for future wood industry demand. This dataset makes the results of the EUwood study highly compatible and comparable with other studies, e.g. the upcoming UNECE/FAO European Forest Sector Outlook Study. Moreover, we received valuable input from EFORWOOD, another EU funded projects. We are greatly indebted to country

correspondents and national agencies that provided forest inventory data. Without these contributions analyses as carried out within EUwood are impossible.

As the coordinator of the EUwood project, I would like to express my gratitude to all members of the EUwood team for their committed contribution, communication and cooperation. The scientific interest in solving open questions and constructive criticism or feedback was a challenge and a pleasure to us and advancement for the EUwood project.

Finally, I would like to thank Mr. Kyriakos Maniatis and his team in DG ENER for their efficient, flexible support and guidance throughout the project.

Udo Mantau Hamburg, 30th June 2010

1 Wood Resource Balance results – is there enough wood for Europe?

Author: Udo Mantau

University of Hamburg, Leuschnerstr. 91, 21031 Hamburg, Germany

1.1 Introduction

This chapter summarises the overall EUwood results, which are presented, sector by sector in subsequent chapters. It is based on the Wood Resource Balance, which brings together in structured format all parts of supply and demand of wood. EUwood has made historical balances for 2005 and 2007, and projected balances for 2010, 2020 and 2030. The forecasts compare, on the supply side, the potential wood supply scenarios, from the forest and outside the forest, and on the demand side, future demand for wood raw material from the industry and for energy. All figures are based on scenarios and forecast methods described in detail in the methodology report. Conclusions may be drawn from the size and direction of the “gap” between the supply and demand sides of the Wood Resource Balance. However, the “gap” is based on scenario and forecasting assumption. Different scenarios and a sensitivity analyses point out the variance of the “gap”.

Every effort has been made to ensure consistency in the assumptions underlying the Wood Resource Balance calculations, but the nature of the different components must be borne in mind. In particular, for 2020 and 2030, the supply side is an estimate of potential, not likely future supply. On the demand side, raw material demand is an econometric projection while energy demand takes as it starting point the policy targets for renewable energies adopted by the EU and its member states. This is appropriate as the study aims to compare likely future demand, modified by policy decisions in the energy field with the real potential of EU 27 in the matter of wood supply

This chapter first briefly describes the balance in 2010, and then describes the scenarios for 2020 and 2030. Summaries by region and country of the main trends are in the annexes.

1.2 Total Balance 2010 – dimensions

Woody biomass has become highly demanded with several major uses. It is a renewable raw material, its production can have various positive by-effects for nature and recreation and it is a multi-purpose raw material. Due to its many different utilisation possibilities woody biomass is breaking into new markets and its carbon balance is often superior to those of other raw materials. However, how much biomass is there in the EU 27?

In 2010 the total supply of all woody resources in the EU 27 is about one billion cubic meters whereof almost 70% come from forest and 30% come from woody biomass from outside the forest. In oven dry tonnes this is about half a billion oven dry tonnes (odt) and equals about 8,500 PJ.

On the right side of the balance the sum is about 800 M m³ whereof 57% will be used for material purposes and 43% for energy. The energy consumption has always been higher than the reported “fuelwood”, because household consumption is only partly recorded in official statistics and “fuelwood” only refers to wood from forest sources. The assumed energy consumption in the year 2010 adds up to 3,017 PJ.

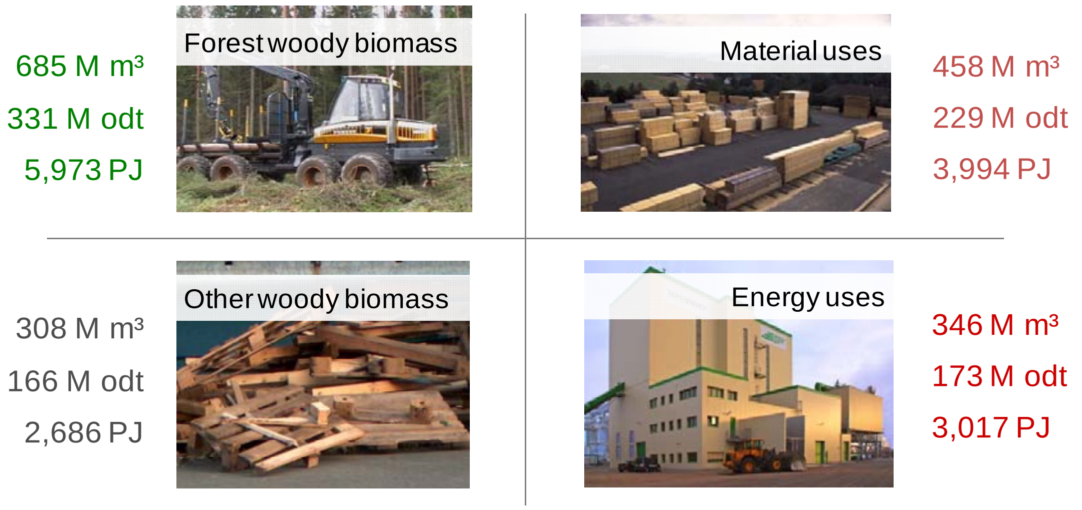


Figure 1-1: Dimensions of woody biomass in Europe (EU 27) in the year 2010

Note: All calculations in the Wood Resource Balance are based on solid wood equivalents. Thus, the volume of forest resources is reduces to about 92% because bark is converted into solid wood equivalent.

For better comparability of results, the following Table 1-1 gives an overview of applied conversion factors.

Table 1-1: Common wood resources conversion factors

From/to	**Mm³**	**Modt**	**PJ**	**Mtoe**
Mm³	1	0.50	8.72	0.21
Modt	2.00	1	18.18	0.44
PJ	0.11	0.055	1	0.024
Mtoe	4.76	2.26	41.87	1

Source: EUwood 2010

A closer look at the sectors of the balance is set out below:

The commonly used terms supply and demand have special meanings in the Wood Resource Balance. This is the reason why the prefix “potential” is use in the EUwood project. Potential supply is the calculated from the theoretical supply under technical and environmental constraints and some socio-economic constraints. Therefore as well the term “real” potential supply is used. The volume of the real potential supply will only be available on the market, when it is economically affordable to mobilise this potential. This is especially relevant for forest rest wood assortments where the price of mobilisation is under current circumstances often higher than the energy value.

The “potential demand” as a total is calculated on a forecasting model (EFSOS) for wood industry demand and a calculation approach for the energy demand under different assumptions, mainly that policy targets “20 by 2020” will be reached. The latter is more a “potential demand” because policy targets may not be reached. Even though the EFSOS calculations are based on an econometric model forecast, the overall demand includes elements of “potential demand”. It should be kept in mind, whenever the terms supply and demand are used in the context of the Wood Resource Balance it refers to their potential.

On the supply side, the potential supply from forests is estimated for three mobilisation scenarios (high, medium, low). Unless otherwise indicated, the results for the medium mobilisation scenario (ME) are shown. On the demand side two developments of gross national product (GDP) are calculated which are in line with the IPCC scenarios A1 and B2.

The potential supply of coniferous stemwood is about twice as much as that of non-coniferous stemwood. The 11.9 % available forest residues of the balance sum correspond to 17.2% of the total forest biomass, including bark. Landscape care wood is about 6% of the available biomass in 2010. The calculations have been made for the theoretical potential and for the usable potential for three different mobilisation scenarios. Short rotation plantation are available currently only on about 30.000 ha (chapter 5.3). The future development varies enormously. Therefore, this sector was not quantified in the EUwood project. It is seen as part of the solution for future needs (see chapter 6).

Potential in M m³	2010	in %	2010	in %	Demand in M m³
Stemwood C, ME	362	36.4	196	23.8	Sawmill industry
Stemwood NC, ME	182	18.3	11	1.3	Veneer plywood industry
Forest residues, ME	118	11.9	143	17.3	Pulp industry
Bark, ME	24	2.4	92	11.1	Panel industry
Landscape c. w. (USE) ME	59	5.9	15	1.8	Other material uses
Short rotation plantation	-	-	21	2.5	Producer solid wood fuels
Sawmill by products	87	8.8	86	10.4	Forest sector intern. use
Other industrial residues	30	3.0	83	10.1	Biomass power plants
Black liquor	60	6.0	23	2.8	Households (pellets)
Solid wood fuels	21	2.1	155	18.8	Households (other)
Post consumer wood	52	5.2	0	0.0	Liquid biofuels
Total	994	100.0	825	100.0	Total

Figure 1-2: Wood Resource Balance 2010 and market shares (A1 scenario)

Source: Mantau, EUwood - Wood Resource Balance 2010

The overall contribution of all by-products (sawmill by-products, other industrial wood residues and black liquor) from wood industry and material uses is 17.8%. Industrial wood residues are the most important drivers of cascade uses. They grow with wood industry growth and they are partly a further processed resource. Thus, their overall relevance in the resource provision is higher than the market share expresses.

Between the potential of other industrial residues and post-consumer wood some overlapping may occur. This is of course not the case, if other industrial residues are directly consumed at the production site, but may occur when other industrial residues are delivered to the disposal system. A specific sector of the balance is solid biofuels which are, generally speaking, pellets. If they did not appear in the balance, this would probably be considered as a disadvantage. Nevertheless, the relevance of pellets differs from other energy sectors in the balance. While all other sectors describe energy consumption, pellets are an interim product which is later consumed in another energy sector. On this account, pellets are not added to the energy consumption. Nonetheless, it is the objective of the Wood Resource Balance to illustrate the situation as a whole. In the balance pellets are included as both input and output. Calculating market shares of material and energy uses their specific feature in the balance have to be considered, though.

The overall woody biomass, including solid wood fuels adds up to one billion m³, which is a theoretical reserve of about 170 M m³ compared to the demand side. However, one should bear in mind that this is a potential amount, which will only be a market relevant volume if the mobilisation of the assumed amount is successful.

On the right hand side sawmill industry is the biggest consumer. Possibly less well-known, private households are the second biggest consumer group of woody biomass. Other material uses include only traditional other material uses like dissolving pulp, mulch and other roundwood (pools, sleepers). All new innovative products like plastic components, chemical resources are not quantitatively included (see chapter 2.3).

The potential in 2010 (994 M m³) is considerably higher than the demand (826 M m³) indicating that the wood supply of Europe is not being over exploited at present

1.3 Balances 2010 – 2030 – development

In the medium mobilisation scenario potential demand will overtake potential supply between 2015 and 2020. The growth of potential woody biomass supply is highly linked to a prosperous development of wood industry. The most significant change is the higher demand for energy wood to achieve targets "20 by 2020". As pointed out in the chapter on policy options: "even if all measures for increased wood mobilisation are implemented wood industry demand and renewable energy targets, can hardly be satisfied from domestic sources in 2020".

The development of the major sectors says something about the character of the resource as well as the calculation method. Forest resources represent a relatively stable potential supply of woody biomass in the medium mobilisation scenario. However, the woody biomass potential from forests differs between mobilisation scenarios. The effect of this is shown further below.

Other woody biomass increases over time because most of these potentials are industrial residues that become larger when the production of the main product increases (scenario A1). This is the reason why the increment of other woody biomass in the medium mobilisation scenario is almost the same as the increment of the development of the material sector.

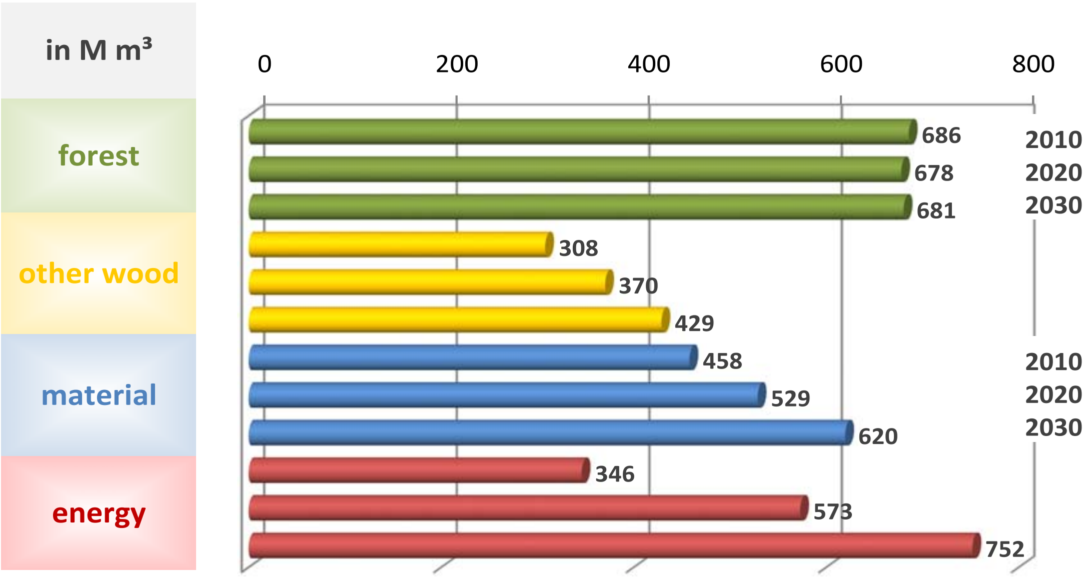


Figure 1-3: Development of the main sectors of the Wood Resource Balance in M m³ in 2010, 2020 and 2030

Source: EUwood 2010

The total demand for woody biomass is estimated to increase from almost 800 M m³ (A1) to nearly 1,400 M m³ in the A1 scenario and about 100 M m³ less in the B2 scenario.

The illustration makes clear that the demand scenarios do not differ a lot, even though the average growth in A1 with about +2.5% growth is significantly stronger than the growth in scenario B2. Surely, this is due to the fact that the consumption of energy wood does not depend on the scenarios but is influenced by the energy political objectives.

In the medium mobilisation scenario, which represents the maximum amount of biomass that can be extracted from forests according to current management guidelines, the demand will exceed the potential between 2015 and 2020. However, this is only valid in case the possible ecological and technical potential is, in fact, mobilised. Yet, this requires great political and economical efforts.

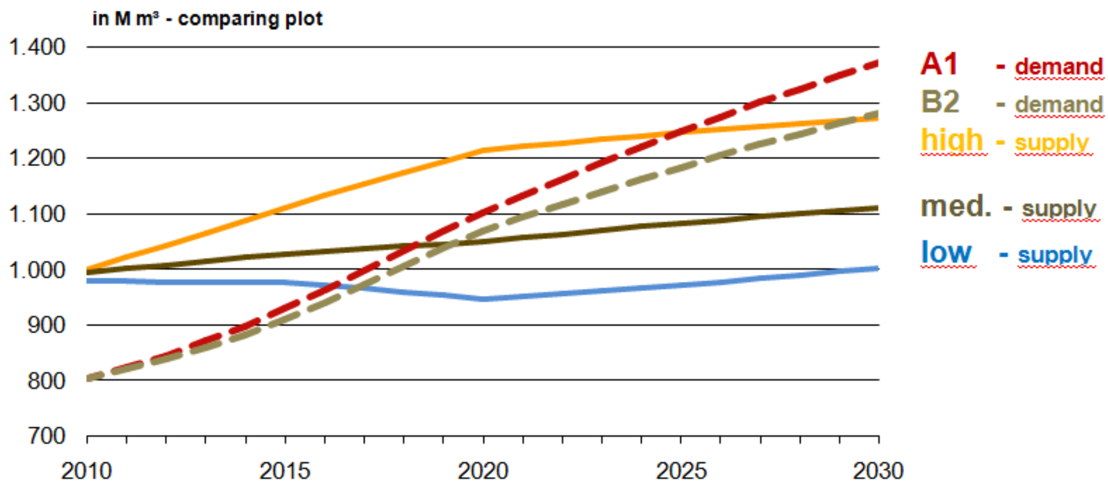


Figure 1-4: Development woody biomass potential demand and potential supply

Source: EUwood 2010

Only if one is ready to intensify wood production much more than at present can the described demand scenarios be achieved. The following graph illustrates this relation: it shows the difference between the A1 scenario and the three mobilisation scenarios.

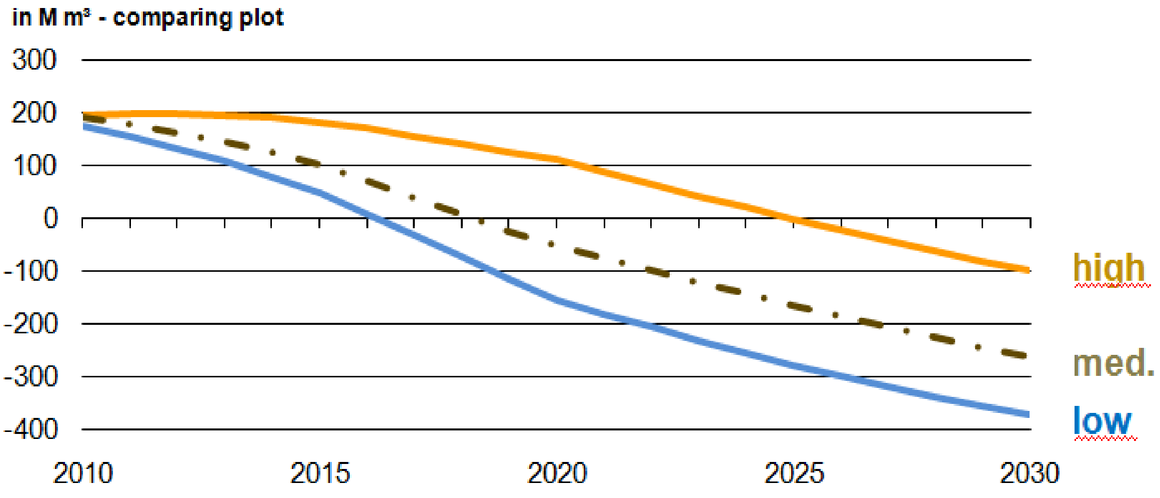


Figure 1-5: Difference between potential demand (A1 scenario) and potential supply of woody biomass (A1)

Source: EUwood 2010

1.4 Structural changes

If the energy demand develops approximately according to the policy targets - and assuming energy efficiency (+20%) and that biomass accounts for “only” 40% of renewable energy, – then, the demand for energy wood will more than double by 2020. With 750 M m³ the data already exceeds the wood supply potential of the forest with current utilisation intensity (medium mobilisation) of ca. 680 M m³. While the demand for energy wood more than doubles, the wood consumption for material uses rises by only 35%, from 458 M m³ to 620 M m³. The energy demand would exceed the material demand at some point between 2015 and 2020. The market share of material demand will drop from 55.5% to 43.5%, while the percentage of energy use increases correspondingly.

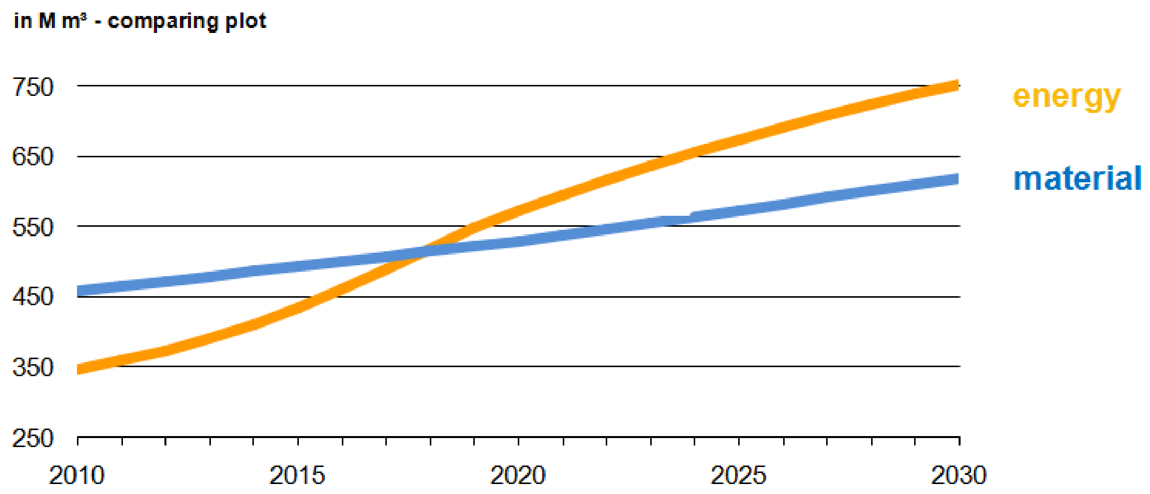


Figure 1-6: Development of material and energy uses of wood (A1)

Source: EUwood 2010

As already explained, the forest biomass potential remains in principle stable over the period considered. Major changes are dependent on which mobilisation scenario is being used. Presuming the medium mobilisation scenario, it is likely that the percentage of biomass not arising in the forest increases over time. Generally speaking, this tendency is expected. In scenario A1 the percentage of non-forest biomass goes up from 31% to 41%. If greater efforts are undertaken to lift forest management systems to a higher mobilisation scenario, however, the percentage of non-forest biomass will increase less or even decline.

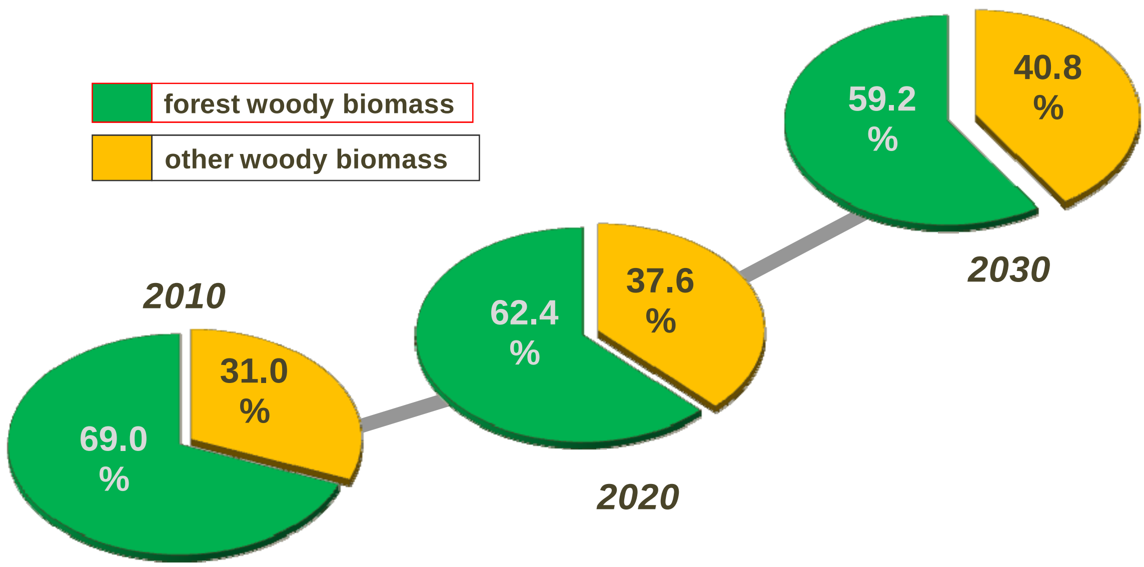


Figure 1-7: Share of forest and other woody biomass in potential supply (medium mobilisation, A1)

Source: EUwood 2010

1.5 Development by region

This section presents an overview of the trends by region, highlighting the main differences between regions. The four regions are shown in Figure 1-8 and detailed data are in the annex tables.

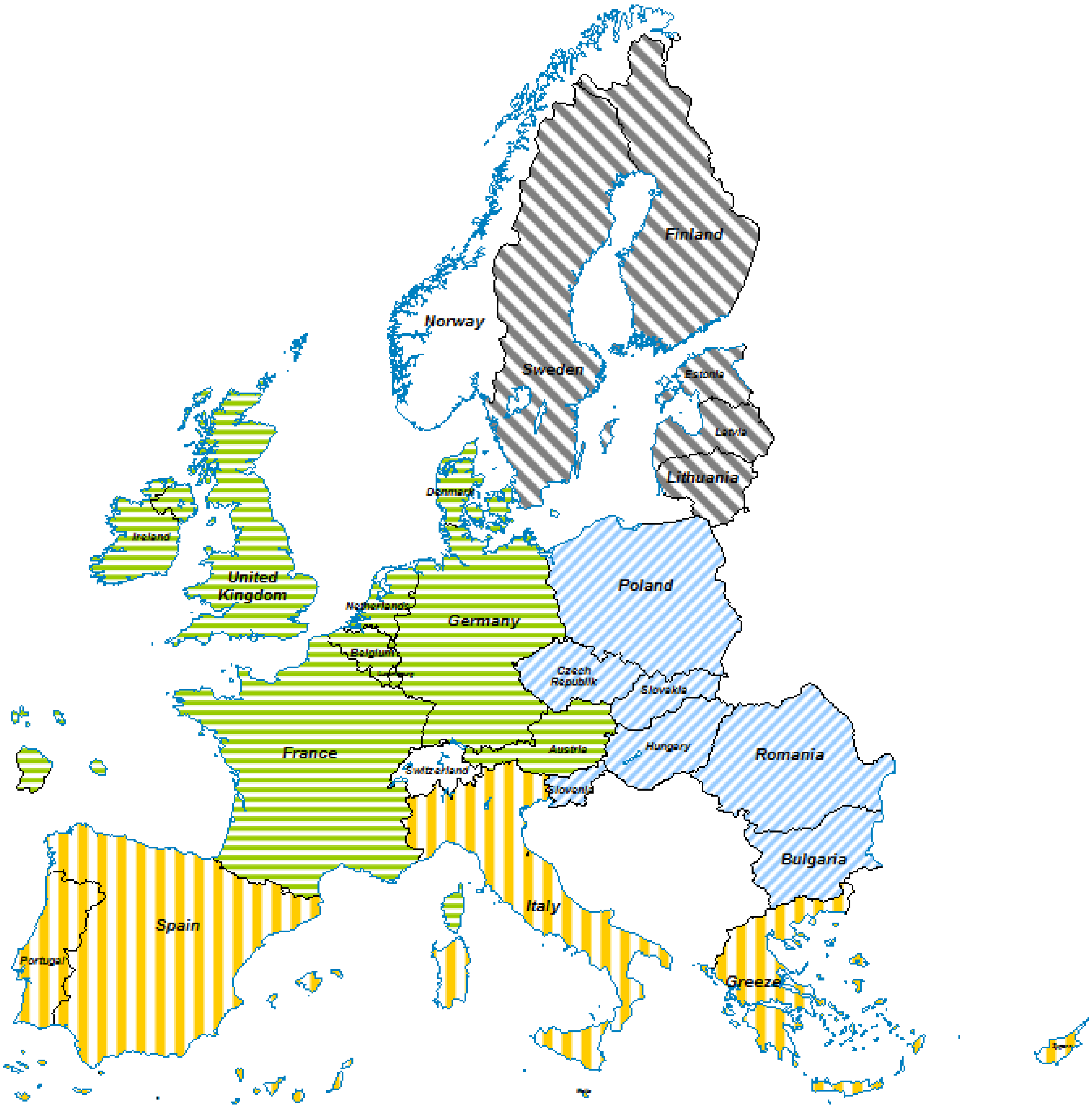


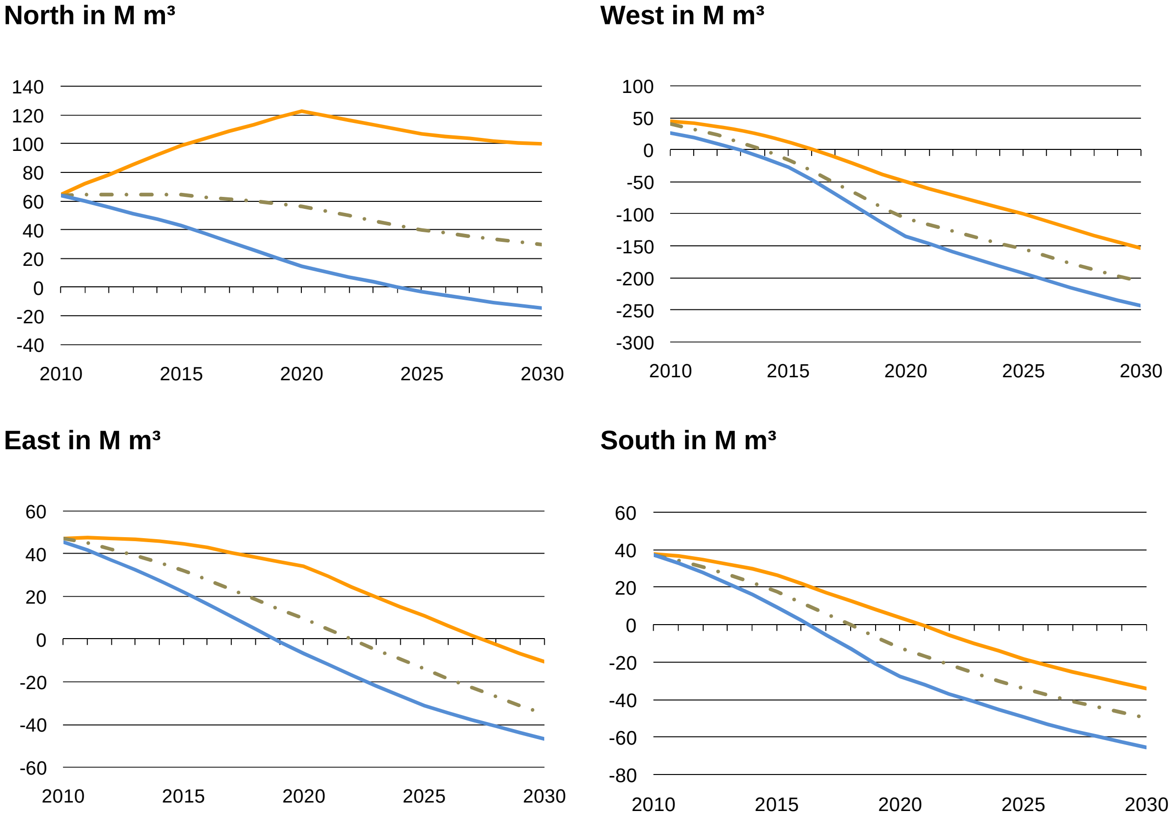
Figure 1-8: EUwood regions

The European regions show considerable differences concerning the outlook for the balance between wood supply potential and future wood demand. In northern countries (Estonia (EE), Finland (FI), Lithuania (LT), Latvia (LV), Sweden (SW)) the potential demand in the low mobilisation scenario slightly exceeds the resource potential until 2030. In the medium mobilisation scenario a positive difference between 20 and 40 M m³ remains until the end of the period. In the high mobilisation scenario, potential supply remains higher than potential demand all through the period 2010-2030, largely because this scenario assumes few constraints on site productivity and permits high residue use and stump extraction in northern Europe.

In western EU countries (Austria (AT), Belgium (BE), Germany (DE), Denmark (DK), France (FR), Ireland (IE), Luxembourg (LU), Netherlands (NL), United Kingdom (UK)), potential demand is mostly higher than potential supply, even with the high mobilisation scenario. On the one hand, this is because the potential is already intensively used. The supply situation is, on the other hand, easily tense in densely populated and relatively sparsely wooded countries. The supply deficit in western countries amounts in 2020 to ca. 125 M m³ and increases till 2030 up to 230 M m³.

The supply situation in eastern countries (Bulgaria (BG), Czech Republic (CZ), Hungary (HU), Poland (PL), Romania (RO), Slovenia (SI), Slovakia (SK)), on the contrary, remains largely stable in the medium mobilisation scenario until 2020. However, by 2030 potential demand will be more than 40 M m³ higher than potential supply, unless the mobilisation will head for the high mobilisation scenario.

The mobilisation scenario highly depends on the constraints for forest residue utilisation. The different effects of these constraints lead to higher or lower flexibility of mobilisation. this is shown in the following graph by the regions of Europe.



low, medium and high mobilisation scenario

Figure 1-9: Difference between demand (A1 scenario) and potential supply, by region, according to mobilisation scenario (+ = potential higher than demand, - = potential lower than demand)

Source: EUwood 2010

Especially countries in the western region display significantly higher quantities of energy use than of material use (France, United Kingdom). Those are enormously populous countries in comparison with their biomass potential. A high population leads at the same time to high energy consumption. Low material uses are traditionally found in those countries which have low levels of wood removals. If those intend to equally increase their current consumption this is impossible with domestic biomass. Either other renewable energies need to be advanced or large quantities of biomass have to be imported. The difference between material and energetic wood consumption is most significant in countries like Greece, Hungary, the Netherlands or the United Kingdom.

In contrast, the material wood use in countries with a traditionally higher production of timber products (AT, FI, SE) continues to exceed the use for energy; they can, furthermore, reach energy policy objectives more easily.

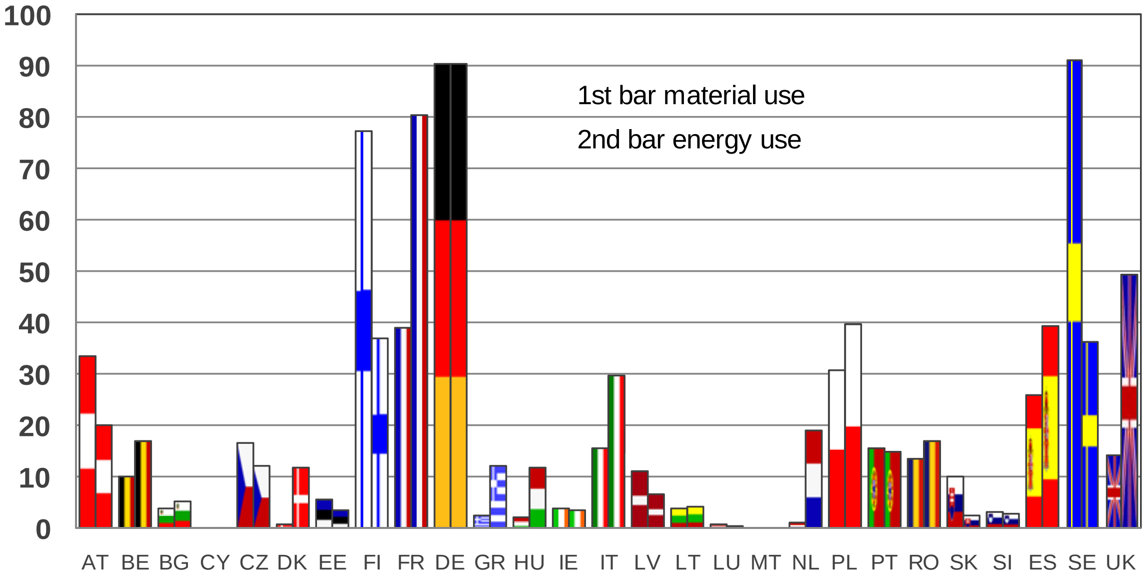


Figure 1-10: Total woody biomass consumption for material and energy use (2020, A1)

1.6 Summary of the results of the Wood Resource Balance

The calculations of the resource balance are extremely complex and are based on a huge data base. Hence, the data are presented in a compacted form. In the annex the most important results concerning regions and countries are depicted. The conclusion consists of four parts:

1. Wood Resource Balance
2. Summary by material and energy demand
3. Comparison by scenarios of potential and demand
4. Segmentation of demand sectors

The Wood Resource Balance reflects all sectors in detail for the years 2010, 2020 and 2030. Table 1-2 shows the comparison of the medium mobilisation scenario on the potential side of the balance with demand according to the A1 scenario and the central assumption regarding the renewable energy targets. The demand side reflects the scenario A1 with growth rates of the gross national product (GDP) between 2.0% and 2.5% for Europe.

Table 1-2: Wood Resource Balance by all sectors

Wood Resource Balance							
Region	**EU27**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	361.8	356.8	355.7	196.4	218.5	246.7	sawmill industry
stemwood NC, ME	182.3	178.1	181.0	11.4	14.2	17.3	veneer plywood
forest residues C+NC, ME	118.0	119.8	120.3	143.3	168.4	200.3	pulp industry
bark, C+NC, ME	23.7	23.3	23.4	92.3	110.1	135.7	panel industry
landsc. care wood (USE) ME	58.5	66.0	73.5	14.8	17.6	19.8	other material uses
				20.9	43.5	53.6	producer of wood fuels
sawmill by-products (POT)	86.6	96.0	107.8	85.5	98.3	113.9	forest sect. intern. use
other ind. res. reduced (POT)	29.7	34.9	41.7	83.2	242.0	377.1	biomass power plants
black liquor (POT)	60.4	71.3	84.9	23.2	68.8	81.5	households (pellets)
solid wood fuels (POT)	20.9	43.5	53.6	154.5	163.2	150.6	households (other)
post-consumer wood (POT)	52.0	58.7	67.3	0.0	0.8	29.0	liquid biofuels
total	**993.9**	**1,048.4**	**1,109.4**	**825.5**	**1,145.4**	**1,425.4**	**total**

HI	High – refers to high mobilisation scenario
ME	Medium – refers to medium mobilisation scenario
LO	Low – refers to low mobilisation scenario
TH	Theoretical – refers to theoretical availability
POT	Potential – refers to “real” availability under given constraints
DEM	Demand – refers to modelled or assumed demand
DIS	Disposed – refers to potential that is currently disposed
USE	Use – refers to potential that is or will be used
C	Coniferous - softwood
NC	Non-coniferous - hardwood

Source: Mantau, Wood Resource Balance, EUwood 2010

The Wood Resource Balance illustrated all relevant sectors of the wood market. Pellets have thereby an exceptional position since they are an intermediate product which occurs on both sides. Pellets are, however, not used as energetic end consumption and hence not added to energy consumption. In the conclusion of the balance according to raw material emergence and raw material utilisation pellets are thus not included. This explains the different balance sums.

Table 1-3: Wood Resource Balance by main sectors

Wood Resource Balance (without solid wood fuels)							
Region	**EU27**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	686	678	680	458	529	620	material uses
other woody biomass	287	327	375	346	573	752	energy uses
total	**973**	**1,005**	**1,056**	**805**	**1,102**	**1,372**	**total**

Source: Mantau, Wood Resource Balance, EUwood 2010

As already pointed out, the balances depict the medium mobilisation scenarios and the IPPC scenario A1. The blue bars reflect the development of resource potentials whose changes depend to a great extent to the chosen mobilisation strategy. The green bars illustrate the development of the demand according to the IPPC scenarios A1 and B2, and the renewable energy targets. By this, a clear insight into the Wood Resource Balance of a region is provided. By comparing the horizontal bars it becomes clear in which scenarios a potential is higher than demand, or lower. In 2020, it appears that a medium mobilisation could, more or less cover the expected demand. Results for 2030, however, show that the demand for both scenarios will exceed the potential by 61 to 153 M m³.

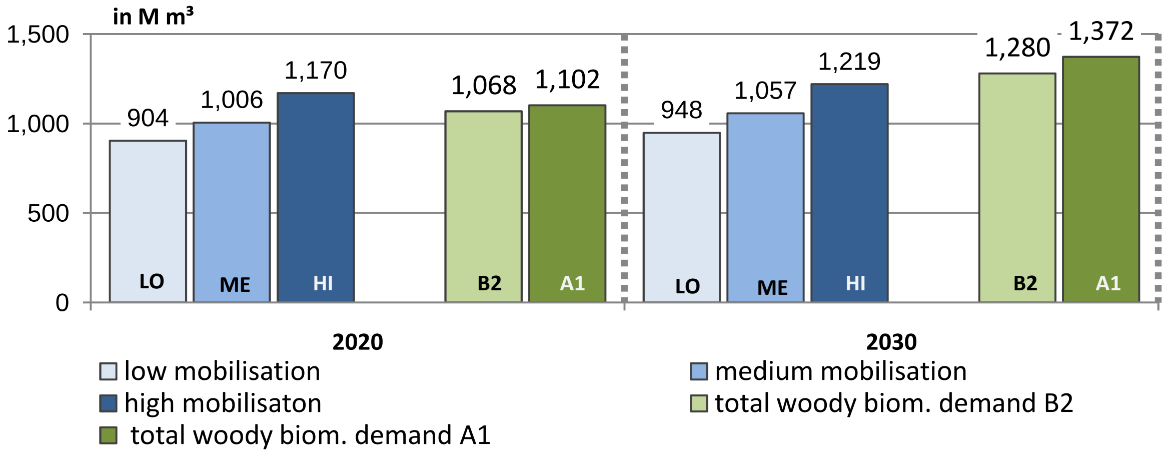


Figure 1-11: Development of scenarios of potential and supply, EU 27

Source: Mantau, Wood Resource Balance, EUwood 2010

The last graph illustrates the demand sectors in a slightly more differentiated way, clearly demonstrating that energy demand will rise much faster than material demand, if the targets are to be achieved. More detailed information is shown in comparison with the previous graph which contains also the maximum raw material potentials.

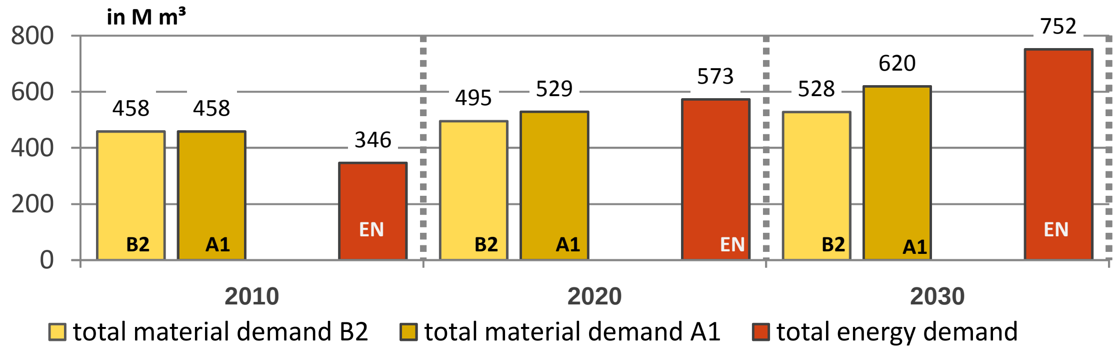


Figure 1-12: Development of material and energy demand

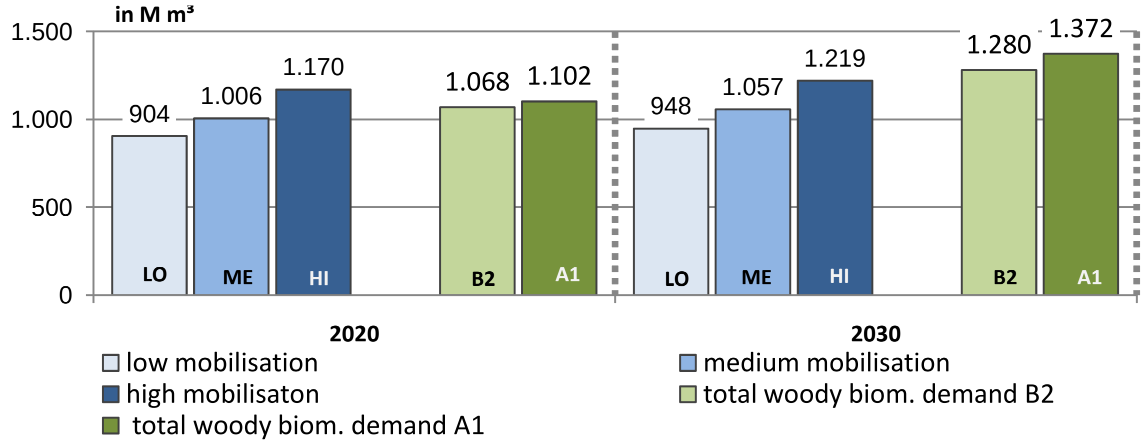
Source: Mantau, Wood Resource Balance, EUwood 2010

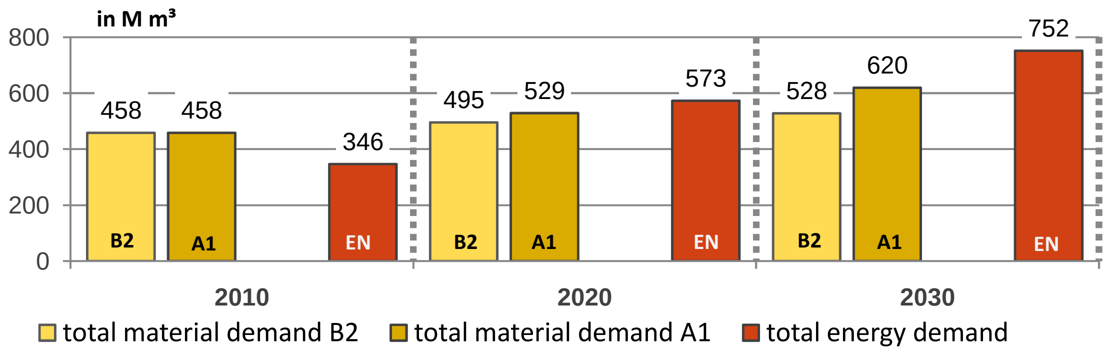
All tables and graphs are summarised in a fact sheet per region and country, respectively. The following example concerns EU 27 total, while the annex shows the four regions and 27 countries). As a result, this supplies a highly suitable overview to conclude the raw material situation of a region and its structure. Further background information is provided in the particular chapters of this report and in the methodology report.

Table 1-4: Fact sheet on Wood Resource Balance results for Europe (EU 27)

Wood Resource Balance							
Region	**EU27**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	361,8	356,8	355,7	196,4	218,5	246,7	sawmill industry
stemwood NC, ME	182,3	178,1	181,0	11,4	14,2	17,3	veneer plywood
forest residues C+NC, ME	118,0	119,8	120,3	143,3	168,4	200,3	pulp industry
bark, C+NC, ME	23,7	23,3	23,4	92,3	110,1	135,7	panel industry
landsc. care wood (USE) ME	58,5	66,0	73,5	14,8	17,6	19,8	other material uses
				20,9	43,5	53,6	producer of wood fuels
sawmill by-products (POT)	86,6	96,0	107,8	85,5	98,3	113,9	forest sect. intern. use
other ind. res. reduced (POT)	29,7	34,9	41,7	83,2	242,0	377,1	biomass power plants
black liquor (POT)	60,4	71,3	84,9	23,2	68,8	81,5	households (pellets)
solid wood fuels (POT)	20,9	43,5	53,6	154,5	163,2	150,6	households (other)
post-consumer wood (POT)	52,0	58,7	67,3	0,0	0,8	29,0	liquid biofuels
total	**993,9**	**1.048,4**	**1.109,4**	**825,5**	**1.145,4**	**1.425,4**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**EU27**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	686	678	680	458	529	620	material uses
other woody biomass	287	327	375	346	573	752	energy uses
total	**973**	**1.005**	**1.056**	**805**	**1.102**	**1.372**	**total**





Source: Mantau, Wood Resource Balance, EUwood 2010

1.7 Comparison to other studies

In most cases, earlier studies dealt with forest resources and wood industry consumption. Comparisons to forest resource studies are presented in the chapter 6. The first study on all resources and uses of woody biomass was done in a cooperation of UNECE timber section and University of Hamburg. It was based on the Wood Resource Balance 2005 and further calculation on the needs for woody biomass to fulfil the energy targets (Mantau, Steierer, Hetsch, Prins 2008). At that time the analysis was based on the available EFSOS-Study from 2002, the Wood Resource Balance 2005 and the available National Action Plans on renewable energy. The calculation resulted in a gap between woody biomass availability and potential demand for material and energy uses of roughly 300 M. m³ or 400 M. m³ depending the assumption that the energy goals for woody biomass were reached by 100% or 75%.

Calculations in the EUwood project based on the medium mobilisation scenario revealed a gap of roughly 100 M. m³. The difference of 200 M. m³ or 300 M m³ is of course a matter, which needs some explanation. In general it should be kept in mind that the calculations in 2006 and 2007 were carried out almost limited resources for broader research. Experts from different background brought together their knowledge within the framework of the Wood Resource Balance to fulfil the great needs for view on the woody biomass markets broader than forestry and wood industry. However, all assumptions were documented in the above mentioned report (2008). The difference in the gap can be explained by the following main aspects.

1. **Forestry**: For the EFSOS-study from 2002 available inventory data were used. In EUwood, for some countries new inventory data were used which in general tend to a higher availability of stemwood. For example German inventory data show an increase of the net annual increment from 8 m³/ha*a in the 1st NFI to 12 m³/ha*a in the 2nd NFI.

2. **Forestry**: Logging residues and stumps were not included in the EFSOS 2002 study. However, EUwood calculated a volume of up to 120 M. m³ for the EU27 in 2020.

3. **Other woody biomass**: In the Wood Resource Balance post-consumer wood, other industrial residues from end use sectors and landscape care wood were only calculated for the actual use, while EUwood developed a model for the potential of these resources. The difference is approximately 70-80 M m³ woody biomass.

4. **Energy demand**: EUwood assumes that the member states meet the energy efficiency targets (20%, 85 M. m³, in 2020) as well as a decrease of the wood energy contribution to energy from renewable sources form 50% to 40% (120 M. m³). These assumptions may be compared to the first approach (2008) where woody biomass targets were only achieved to 75% (100 M m³).

As mentioned above EUwood followed a broader analysis - still based on available data – but much more detailed and advanced models were applied. Thus the outcome of the two studies is not directly comparable. However, with a closer look it is not contradictory. The differences can be explained by the actuality of data, different assumptions and advanced models. Furthermore, in both studies the real potential of wood was calculated. Regarding biomass from forestry for example, the theoretical potential calculated in EUwood of 1,272 M m³ is reduced by several constraints to a volume of 747 M m³ ob for the medium mobilisation scenario.

Further, the conversion to wood equivalents which are included in the Wood Resource Balance results in a volume of to 678 M m³ (swe).

However, this is “real” naturally available potential under constraints. It is still not the available potential at forest road side at a specific time, since cost and price relations have not been modelled.

1.8 Conclusions

Final policy conclusions on strategies and recommendations for a sustainable wood mobilisation are drawn in chapter 6. This chapter draws general conclusions concerning the assessment of the Wood Resource Balance.

The EUwood study made a clear step forward in European woody biomass resource assessments. Progressive results could be achieved by projections on the potential future development of the forest-based sector and the most recent targets on renewable energy set by member states with a detailed assessment of the potential supply from forests as well as other sources of wood at the EU level. Hence, the results from the different assessments were combined in the Wood Resource Balance. The combined results suggest that the potential supply from forests and other sources of wood in Europe exceeds the potential demand until 2015 or 2025, depending on the mobilisation scenario. This means that without additional measures, forests and other sources of wood in Europe cannot maintain their large share as a renewable energy source without leaving a shortage for the forest-based industries.

In addition, the quantitative relations and segments of the forest-based industry were identified and have been made transparent in the Wood Resource Balance for the entire European Union. The determination of quantities in so far less known markets was based on existing knowledge complemented with further assumptions, which are documented in the methodology report. The same is true for the scenarios. The basis of future developments are transparently illustrated and can be freely inspected and evaluated.

The analyses showed that there is a large potential supply of wood from forests and other sources. However, it was not possible to assess in the Wood Resource Balance whether this potential could become economically available. Market models do include such considerations, but they often are limited to the forest-based industries. However, the analysis in EUwood showed that a large share of the potential supply lies outside forests, which currently and hence these potentials are not considered by market models. Furthermore, even the supply costs of certain biomass types from forests are typically not fully addressed by existing market models, due to limited data availability. The case study calculations for North Karelia (chapter 4.4.4) suggested that forest energy supply could be subject to very high price elasticities, when approaching the absolute minimum cost in which any wood chips can be delivered. At this moment, economic constraints could not be sufficiently integrated to the analysis at the European scale and it is recognised that this aspect deserves more attention in follow-up research.

The present study compared the potential demand for wood with the potential supply. It is however not clear whether the different types of wood that could be supplied are suitable for the needs of forest-based industries and energy use. The calculation of distribution channels between potentials and demand has not been resolved in this project. This is mainly a consequence of poor statistics of material flows especially the resource mix used by the energy users and to some extend by the forest-based industries. A detailed assessment of material flows would enable to pinpoint more clearly where potential gaps between supply and demand may occur and hence would enable clear insights in where measures could be taken to avoid such gaps.

The Wood Resource Balance offers such insight into current problems with an improved monitoring of sector developments. Improvement, basic knowledge of the raw material composition among the utilisation areas could enable a more reliable determination of how much wood is actually removed from forests and to which extent other potentials of woody biomass are exploited. To achieve this target more empirical studies on the resource mix in the demand sectors will be needed. Such information could help in the implementation sustainable resource utilisation policies.

2 Material uses

Author: Udo Mantau & Ulrike Saal

University of Hamburg, Leuschnerstr. 91, 21031 Hamburg

2.1 Introduction

Chapter 1 presented the overview contained in the Wood Resource Balance, chapters 2 to 5 present the different components which make up this balance. This chapter presents the outlook for “material uses”, defined as the consumption and production of forest products, including notably sawnwood, wood based panels, pulp and other material uses (dissolving pulp, mulch, other industrial round wood). There are two base scenarios, defined by IPCC, A1, which is a more globalised and economy oriented world and B2 which sees slower, more regional growth and more sensitivity to environmental issues.

2.2 Sector description

The developments for material uses are calculated based on econometric modelling by Jonsson (2010) (see chapter 2.4 of the methodological report). This econometric model projects the quantities of goods consumed and produced but not the raw material needs for the production, which has been calculated by the use of conversion factors.

In the year 2010 the wood consumption in solid wood equivalents for all material uses will be about 458 M m^3. It will increase by 15.4% to an equivalent of 529 M m^3 by 2020. From 2020 to 2030 the rate of increase is slightly higher than in the earlier period because of the recovery from the financial crisis. Between 2020 and 2030 wood consumption is expected to increase by 17.2% and thereby use overall 620 M m^3 solid wood equivalents.

However, the demand for energy uses would increase even faster. Therefore, the share of material uses in total wood consumption is expected to decrease from 55.5% in 2010 to 46.5% in 2020 and 43.5% in 2030. The higher rate of growth for energy uses may be attributed to political support for energy demand, and the slower growth for material uses, to the consequences of the financial crises.

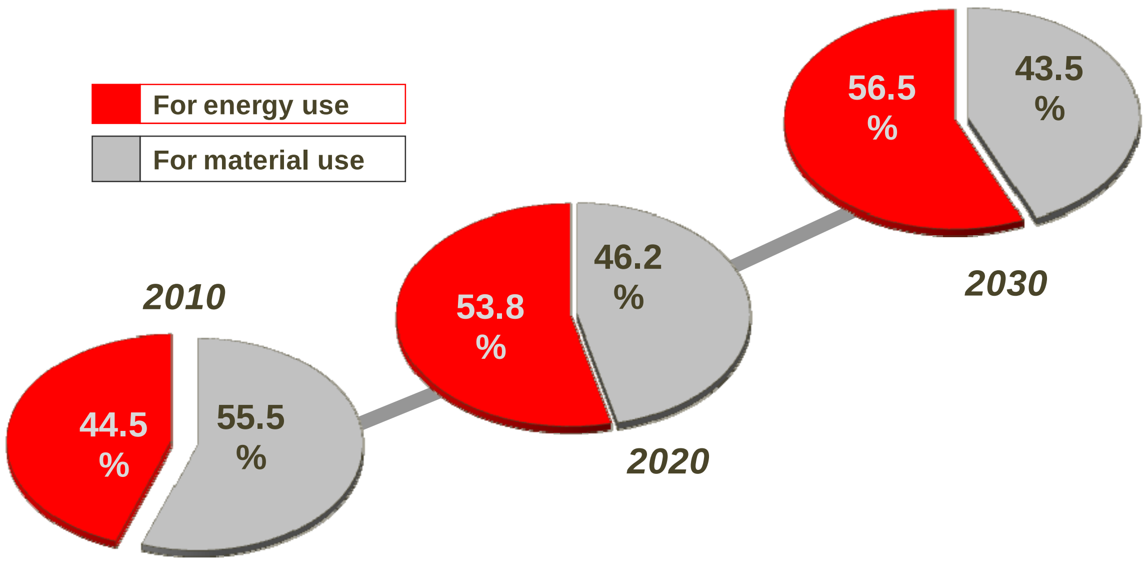


Figure 2-1: Market share of material and energy uses (A1, without pellet production)

Source: EUwood 2010

The following Table 2-1 describes the wood consumption of the different material use sectors by market volume and market share. The share of the different segments remains relatively stable. The sawmill industry is with about 40% the biggest user of round wood. However, the saw mill industry also supplies wood to other sectors. About 40% of the cut volume appears on the left hand side of the balance as saw mill by-product.

Table 2-1: Share of wood consumption taken by different material uses

material uses	2010		2020		2030	
	in M m³	in %	in M m³	in %	in M m³	in %
saw mill industry	196.4	42.9	218.5	41.3	246.7	39.8
veneer & plywood	11.4	2.5	14.2	2.7	17.3	2.8
pulp industry	143.3	31.3	168.4	31.8	200.3	32.3
panel industry	92.3	20.2	110.1	20.8	135.7	21.9
other material	14.8	3.2	17.6	3.3	19.8	3.2
total	458.2	100.0	528.8	100.0	619.8	100.0

Source: EUwood 2010

It has to be taken into account that the solid wood equivalent does not solely include solid wood from forest. As an equivalent it contains sawmill by-products and small amounts of post-consumer wood as well. About a third of the consumed wood demand is covered by other sources.

2.3 Development of material uses

Figure 2-2 illustrates the overall development of material uses over time. Between 1965 and 2030 the overall used volume of solid wood equivalents increased from less than 200 M m³ up to more than 600 M m³. Three phases of development are identifiable. Between 1970 and 1990 the demand increased only moderately with a total increment of +22% which corresponds to a yearly increment of +1.1%.

Between 1990 and 2007 there was a phase of strong growth. The overall growth rate for the whole period was +75%, which corresponds to a yearly increment of +3.8%. The reason for this recovery is based on the opening of the Eastern frontiers, which led to a breakthrough into new markets and caused investments. At the same time, the international demand was developed by reason of globalisation. Last but not least, the speculative real estate demand overstocked the market. The increase was in this respect even higher in 2008. The EFSOS projections foresee slower growth than in the past, but still positive. . In the period between 2010 and 2030 the wood consumption of material uses will rise up to +36% which equals an annual growth rate of +1.8 %.

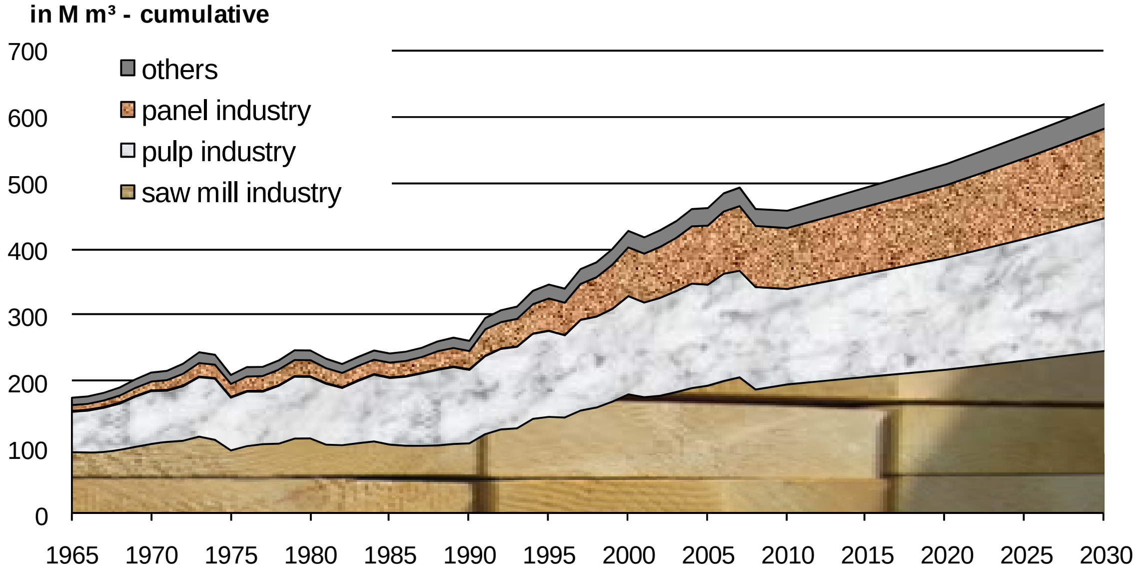


Figure 2-2: Development of material uses, cumulative (A1 scenario)

Source: Mantau, Wood Resource Balance, EUwood – team 2010 (Mantau/Saal: Wood industry; based on UNECE/FAO and Jonsson, R.: econometric modelling; others including veneer & plywood

The following illustration in Figure 2-3 compares the developments of the sectors with each other. The pulp industry had a continuous growth between 1965 and 2008 and then a sharp decline. In the long run a continuous growth is expected. However, it will take at least until 2015 and later to get back to the production volume of the year 2008.

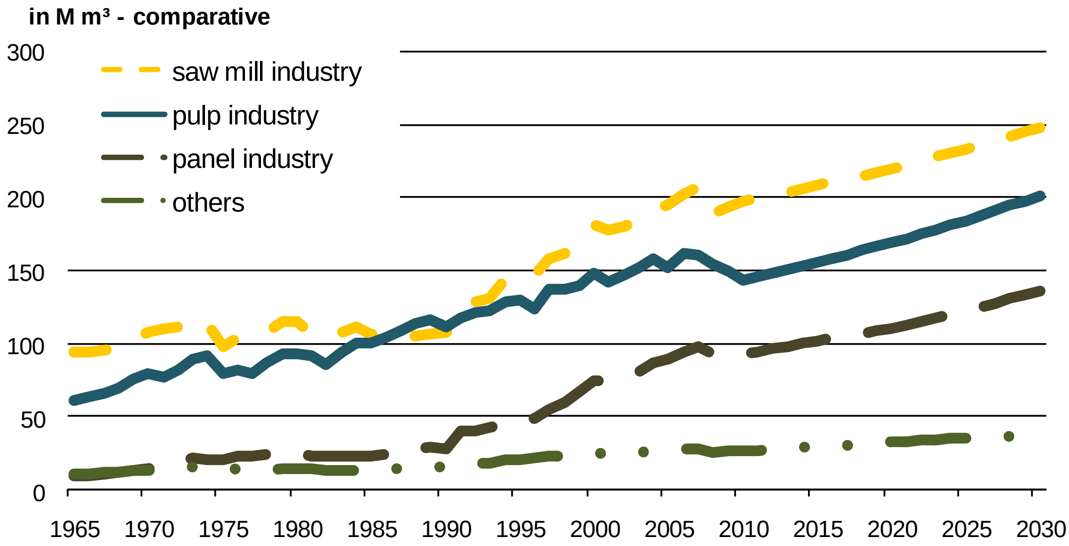


Figure 2-3: Development of material uses, comparative (A1 scenario)

Source: MANTAU, Wood Resource Balance, EUwood – team 2010 (MANTAU/SAAL: Wood industry; based on UNECE/FAO and JONSSON, R.: econometric modelling; others including veneer & plywood

The sawmill industry shows a different development. Until the year 1990 the branch stagnated with slightly declining production volumes. The recovery of the building market and the growth of the international demand bring the development forward, in times of globalisation. On top of that, the promotion of energy use and increasing energy prices transform former relatively low price sawmill by-products into a raw material with high demand. The development of the sawmill industry is very important for the resource sector for two main reasons. More than one third of the consumed stemwood flows back as a resource of high value. Because of the higher prices for sawnwood the sawmill industry is very important for the mobilisation of small sized stemwood and forest residues. Thus prices for large wood mobilise small wood because with the harvest of large wood most small wood is harvested complementary and even thinnings are done mainly because of the reason to produce high value logs. Thus the sawmill industry is the key industry for mobilisation. In other word supporting sawnwood end use sectors supports the mobilisation of forest resources.

For a long time the panel industry had a relatively low production volume mainly because it concerned only particle boards. With regard to the growing demand since 1990 and products like e.g. medium density fibreboards (MDF) and oriented strand boards (OSB) achieved strong growth after 1990, which was additionally forwarded by investments in Eastern Europe.

The above mentioned developments are based on the calculations of econometric modelling (Future Forest, Jonsson) for the A1 Scenario (see chapter 2.4 Methodology report). In the B2 scenario the GDP growth is slower (around +1% than in the A1 scenario (+2.5%). The following figure displays the different wood consumption for material uses. In the scenario with lower growth the wood consumption would be about 92 M m³ less in 2030 than in the A1 scenario with significant higher growth. Instead of 620 M m³ in 2030 the consumption would be 528 M m³ in scenario B2.

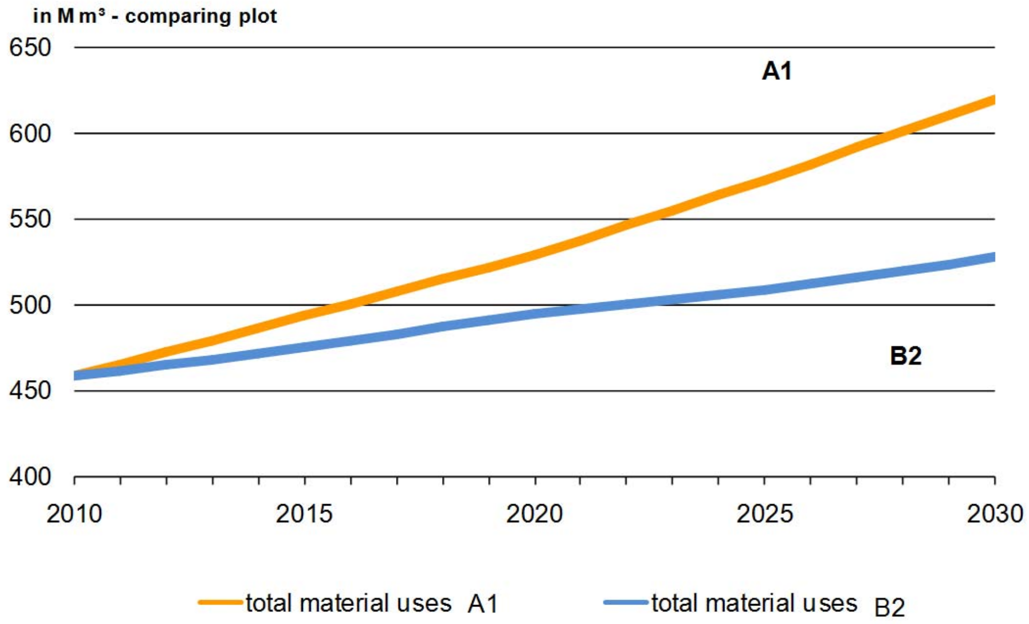


Figure 2-4: Market share of material and energy uses (A1 scenario)

Source: MANTAU, Wood Resource Balance, EUwood – team 2010 (MANTAU/SAAL: Wood industry; based on UNECE/FAO and JONSSON, R.: econometric modelling; others including veneer & plywood

Veneer and plywood as well as other materials are summarised in the previous illustrations. The following graph shows that they have a nearly equally high market volume and a similar development of domestic production. Veneer and plywood lost market share. On the one hand, this was caused by shifting the processing of tropical timber from industrial countries to developing countries. This development started in the 1970s as a consequence of efforts to keep refining processes in raw material countries. In addition, the production is labour intensive, not capital intensive so that industrial countries became less competitive also from an economic point of view. High quality niche markets remain. With the opening of the Eastern European frontiers production did recover.

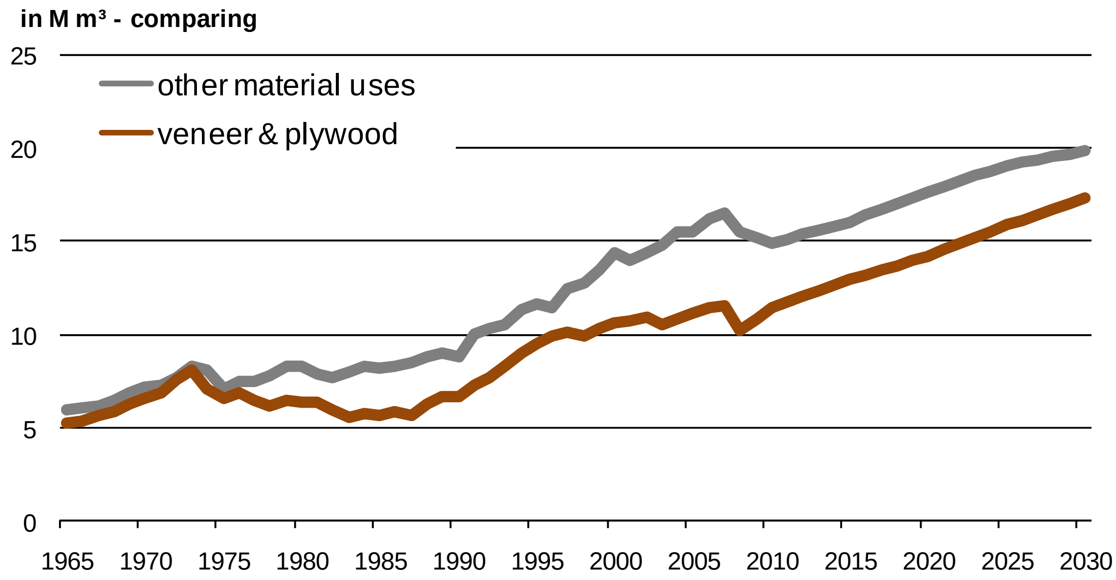


Figure 2-5: Development of other material uses (A1 scenario)

Source: MANTAU, Wood Resource Balance, EUwood – team 2010 (MANTAU/SAAL: Wood industry; based on UNECE/FAO and JONSSON, R.: econometric modelling; others including veneer & plywood

The sector "other material uses" is differentiated into traditional other material uses and new innovative "other material uses". Traditional other material uses include dissolving pulp, mulch and other industrial round wood sorted for special purposes (e.g. poles, sleepers and posts for harbour works or fencing, which are significant uses in some areas). Many new innovative products made of wood fibre are on their way to win market relevance, but are not included in the projections.

No quantitative calculations have been undertaken for innovative wooden products. Yet, this does not mean that the relevance of this sector is low, but its development is highly speculative. It could be 20 M m³ in 2030 or 100 M m³ in 2030. So far only a few quantitative estimates are known, like the ones for wood plastics components (WPC), but real empirical data is lacking. In contrast, this sector has a high potential for rapid growth.

In the clothing industry cellulose is applied as regenerated cellulose fibres (viscose), for example made of beech wood, cotton fibres and linen, respectively. In conjunction with additives functional textiles and increasingly also casual wear are produced. This combines excellently the marketing arguments sustainability and wellness and appeals thereby highly and with increasing success to the growing consumer group of the LOHAS (Lifestyle of Health and Sustainability).

Until now, wood plastic component products have only been used for high-quality household terrace building panels which do not have to be moulded. Many other applications for WPC are in development. Analyses have shown that the recyclability of WPC is excellent because the material can be reprocessed up to five times.

The field of new innovative products based on wood has huge growth potential. This ideally matches the trends of sustainability, wellness and recycling. Likewise, this trend possibly enhances the traditional wood industry to gain higher added values with innovative instead of traditional products. While cost pressure increases on the raw material side, the wood industry can use its competence in the field of raw material supply to become an active participant in this field.

Due to the search for subsidies of fossil raw materials a lot of methods of the material utilisation of wood has been resumed and developed further with highly modern techniques, in order to become competitive again. By this, it equally aims to become a major substitute to fossil raw materials in the chemical industry. Evidently, the pulp and paper industry has already begun to complement their portfolio with bio refinery plants and develop new basic material in the derived timber product industry. On top of this, completely new players enter the wood market, for instance the chemical industry which strives for a broader raw material supply and hence strongly focuses on renewable material.

In contrast, the field of material utilisation is as well likely to gain an increase in efficiency, both in existing production processes and totally new products which need fewer raw materials per cubic meter board. Thus, the field of innovation on both counts (new raw material utilisation; increase in efficiency) is not quantitatively analysed here but left to qualitative considerations.

2.4 Regional distribution

As Figure 2-6 illustrates, the regions north and west, on the one side, and south and east, on the other hand, rest on a comparable consumption level. In a regional comparison Northern Europe (+26.9%) grows between 2010 and 2030 slightly lower than Western Europe (+29.4%). In Southern Europe the wood consumption of material uses increases marginally stronger (+38.7%). Yet, the wood consumption of material uses increases most vigorously in Eastern Europe (+72.8%).

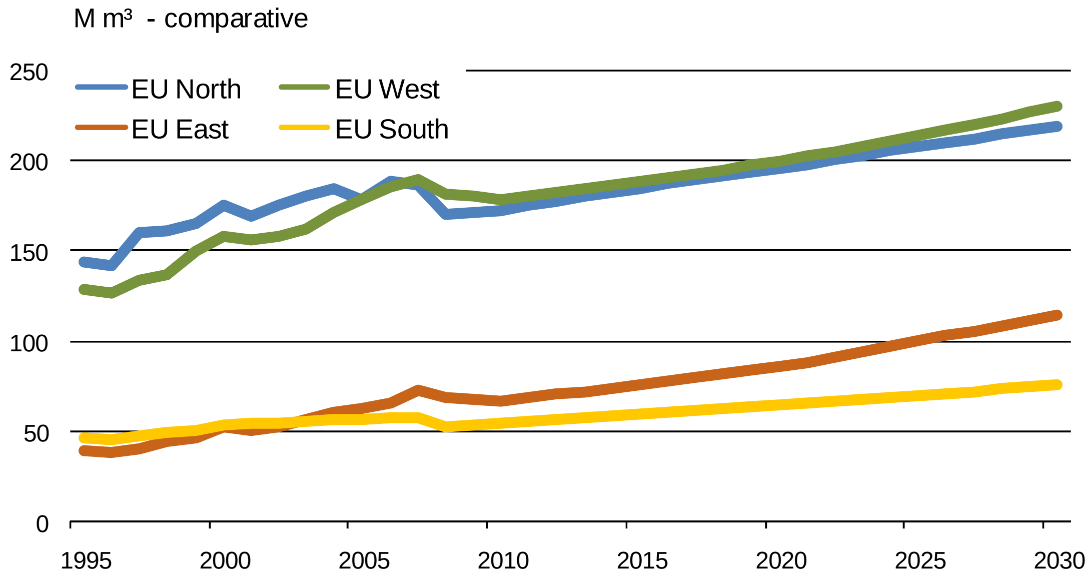


Figure 2-6: Consumption of wood for material use, by region (A1 scenario)

Source: MANTAU, Wood Resource Balance, EUwood – team 2010 (MANTAU/SAAL: Wood industry; based on UNECE/FAO and JONSSON, R.: econometric modelling; others including veneer & plywood

The following graph compares the consumption of wood for material use by country in 2010 and 2030. The three largest producers of timber products are Germany, Sweden and Finland. In terms of growth, those countries lie slightly below average.

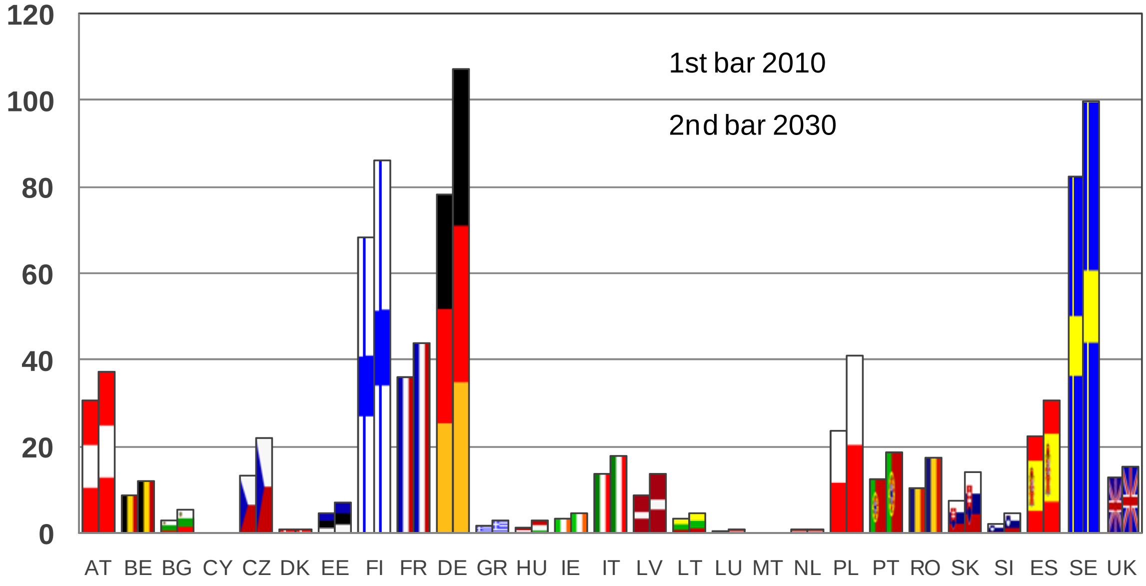


Figure 2-7: Consumption of wood for material use, by country, 2010 and 2030 (A1 scenario)

Source: MANTAU, Wood Resource Balance, EUwood – team 2010 (MANTAU/SAAL: Wood industry; based on UNECE/FAO and JONSSON, R.: econometric modelling; others including veneer & plywood

The strongest growth is reached by the Eastern European countries Slovenia where wood consumption almost doubles +97.1% or 3.5%/year) and Slovakia (+87.3% or +3.2%/year).

2.5 Summary and conclusions

From a period of slow growth between 1970 and 1990 the demand of wood resource from material uses increased moderately with a total growth of +22% which corresponds to an average yearly growth rate of +1.1%. In the phase of strong growth between 1990 and 2010 the overall growth rate of the whole period was +3.8%/year. The phase of the economic modelling prognosis (Future Forest, Jonsson) projects that the growth will decline again; yet, positive growth rates can be expected, though. Between 2010 and 2030 the wood consumption of material uses will grow at a rate of +36% which equals an annual growth rate of +1.8 %.The overall consumption of wood resources will increase in the A1 scenario by 160 M m³ and by 70 M m³ in the B2 scenario. The fastest growing region is Eastern Europe with an increase of almost 50 M m³ (A1). The differences between product sectors are not too large. A lot of new material uses from engineered wood, wood plastic components, chemical resources and other may grow fast if the pressure of rising oil prices increases. On the other hand, a tendency of resource saving product developments will increase as well when resource prices increase, too. The sector of material uses is projected to continue to grow. The growth will be less than in the wood energy sector but no decline is projected. About another 100 M m³ to 200 M m³ of wood will be needed, depending on the scenarios and the qualitative assumptions on new product developments.

3 Energy use

Author: Florian Steierer

UNECE/FAO Forestry and Timber Section, Palais des Nations, 1211 Geneva 10

3.1 Introduction

Energy supply has always been one of the main uses for wood, but slipped from view in Europe since the Second World War, with the exception of brief recoveries during energy crises in the 1970s, and 1980s. The high level policy interest in energy security, renewable energies and climate change combined to stimulate a strong policy interest in encouraging the use of wood as a source of energy. This interest, combined with the exceptionally high oil prices in 2008, has transformed the outlook for wood energy.

This chapter briefly describes the present situation as regards wood energy, and the policy targets agreed, and then estimates the volume of wood which would be needed to meet the policy targets. It analyses the factors which will determine whether these targets can be achieved

3.2 Current role of wood energy

The EU Directive on the on the promotion of the use of energy from renewable sources (called EU RES Directive hereafter) is likely to be the biggest driver of renewable energy in the period until 2020 and beyond. It sets legally binding targets for the role of renewable energy as well as the share of transportation fuels from renewable sources by 2020 separately for each member state.

Wood energy is an integral and in many countries the most important single source of energy from renewable sources such as hydro, wind, geothermal, solar power or other biomass and organic wastes. Thus, results of the EUwood project are of similar importance for both the forest and the energy sector.

The share of wood in renewable energy varies from country to country, but accounts on average (2004-2007) for slightly more than 50% of the gross inland energy consumption[1] from renewable energy sources in the EU 27 (see Figure 3-1). Energy use accounts for a major share of wood fibre consumption. The EUwood interim report indicates in its Wood Resource Balance 2007 that energy applications account for 42% of the entire wood fibres consumption in the EU 27.

---

[1] For data availability, consistency, historical trends as well as reliability reasons EUwood used Eurostat data on gross inland energy consumption (this term was also used in the EU White Paper COM(97)599 final (26/11/1997). The Directive 2009/28/EC uses the term “gross final consumption of energy” – which however is not yet entirely available from the Eurostat database in the details required. In its short description, Eurostat mentions that “It (share of renewable energy in gross final energy consumption) may be considered an estimate of the indicator described in Directive 2009/28/EC, as the statistical system for some renewable energy technologies is not yet fully developed to meet the requirements of this Directive.” (Eurostat as of 15 September 2010: http://epp.eurostat.ec.europa.eu/tgm/web/table/description.jsp). More information about the renewable energy shares calculation methodology and Eurostat's annual energy statistics can be found in the Renewable Energy Directive 2009/28/EC , the Energy Statistics Regulation 1099/2008 and in DG ENERGY transparency platform.

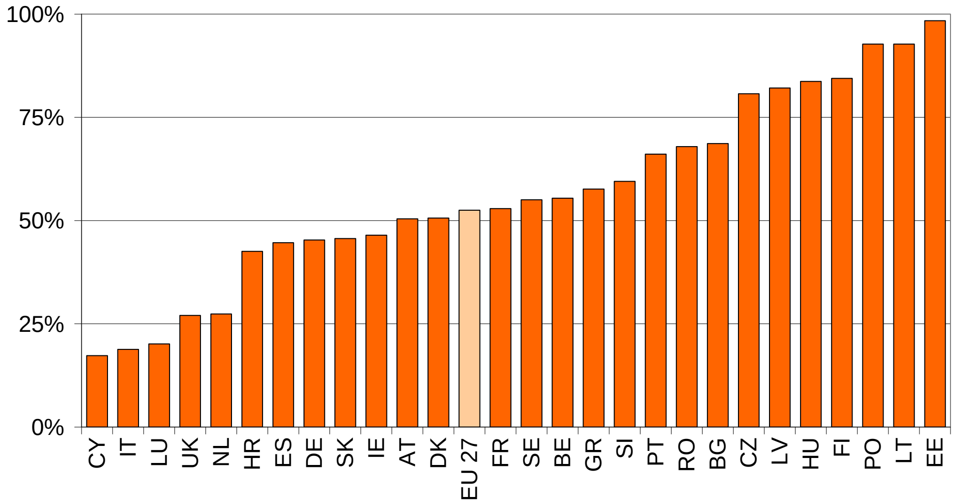


Figure 3-1: Share of wood energy in total renewable energy (EU 27)

Source: Data Eurostat, illustration EUwood

The EU RES Directive provides country specific targets for energy from renewable sources in 2020 and provides detailed guidance on the stepwise progress towards these targets. However it does not provide any information on the future gross inland energy consumption in the region or member states. The EU RES Directive refers only to energy efficiency gains of 20% in the future as an essential measure that will help reducing future energy consumption in the region and the member states. It has therefore been necessary for EUwood to make its own assumptions on these issues. The EUwood forecast of gross inland energy consumption assumes that countries will successfully implement these energy efficiency measures.

3.3 Total future demand for energy

EUwood calculated a gross inland energy consumption scenario of 61.6 EJ in 2020 and 51.8 EJ in 2030 in EU 27, on the basis of assumptions detailed in the methodology report. These amounts seem to come close to countries' projections. 12 member states (AT, BE, EE, ES, HU, IE, LV, PL, RO, SK, SE, UK) included such information in their forecast documents on the transparency platform of the Commission[2]. EUwood calculations for these countries are about 13% higher than these projections.

[2] Due to the timeline of the EUwood project, data from national reports on the transparency platform refer to the state of information as of 01 April 2010. It seems that very few changes have occurred since then, as the current set of forecast documents still have some blanks referring future energy consumption. Thus, an update is very likely to be not very different from the actual version.

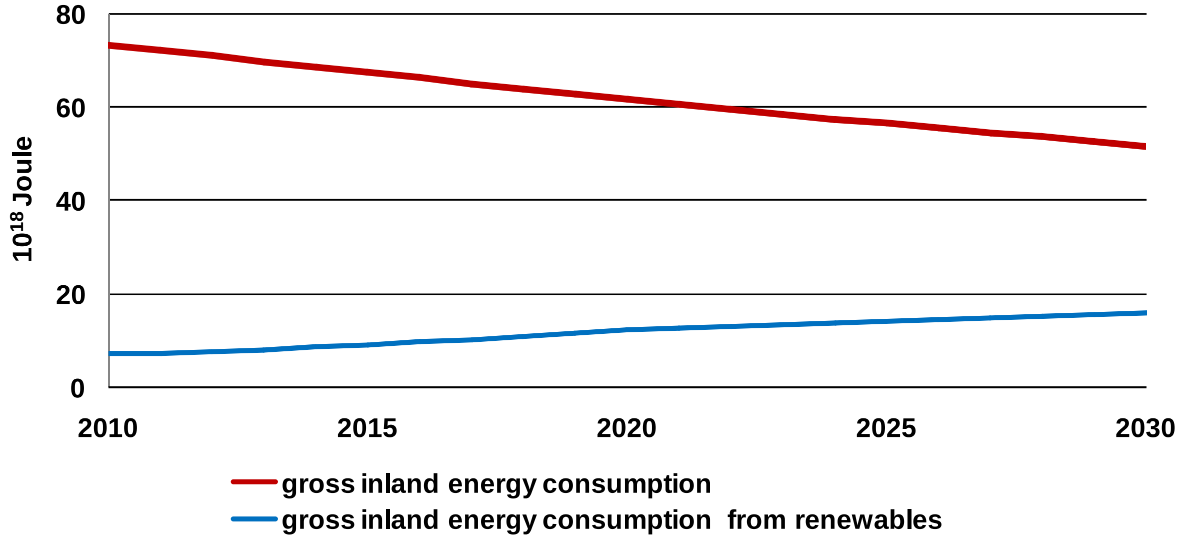


Figure 3-2: Future gross inland energy consumption (EU 27)

Source: EUwood

3.4 Future demand for renewable energy

The EU RES Directive sets country specific targets for the share of energy from renewable sources in each member state. Thus energy from renewable sources in the EU 27 is expected to increase as a share of gross inland energy consumption from 8.5% in 2008) to 20% in 2020.

The EUwood assumptions and calculations project energy consumption from renewable sources to increase from 7.2 EJ in 2010 to 12.2 EJ in 2020 and 16 EJ in 2030. If energy efficiency measures are successfully implemented, energy from renewables might less than double in absolute terms by 2020.

3.5 Future demand for wood energy

On the basis of the assumptions detailed in the methodology report (energy efficiency and renewable energy targets achieved, wood losing share of renewable energy), wood volumes for energy generation are expected to increase by 66% between 2010 and 2020. Wood consumption for energy generation is expected to grow from 346 million m^3 in 2010 (3.1 EJ) to 573 million m^3 (5 EJ) in 2020 and might reach 752 million m^3 in 2030 (6.6 EJ).

These results are based on the assumption that wood energy decreases its share in energy from renewable sources from 50% in 2008 to 40% in 2020[3]. The European Commission and the member states support research and development in other renewable energy technologies, while by comparison technology for wood combustion is relatively mature. EUwood assumes that these efforts will facilitate the realisation of the technological potential of other forms of renewable energy source, such as solar heat and power, geothermal, wind and hydropower. Chapter 3.6 assesses how this applied assumption attenuates demand for wood for energy generation in 2020 and 2030.

---

[3] This assumption could be clarified within a few months when all the 27 National Renewable Energy Actions plans have been submitted to the Commission and analysed by the Commission.

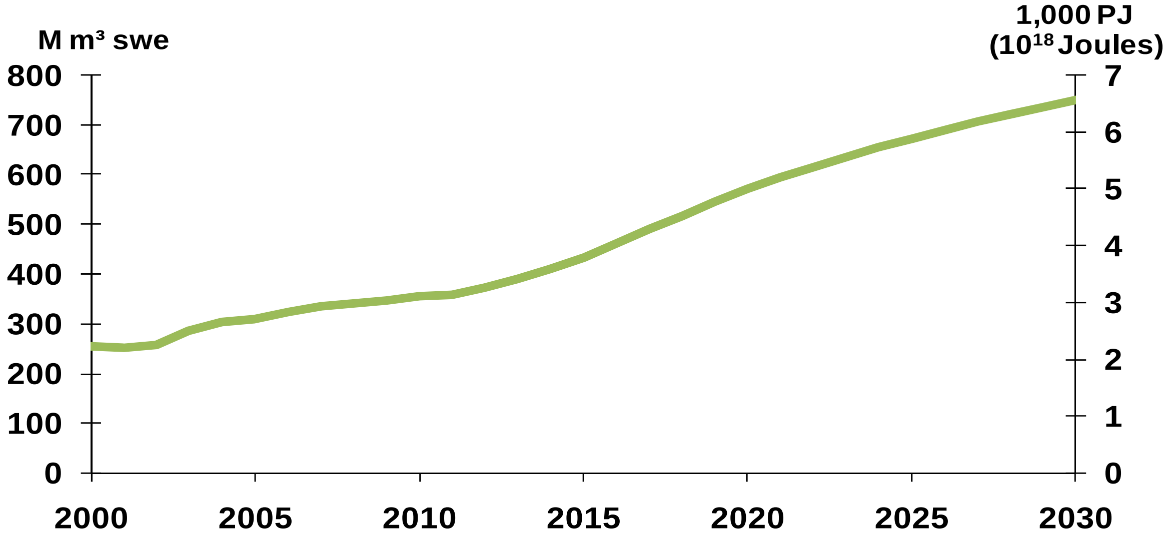


Figure 3-3: Current and future amounts of wood energy (EU 27)

Source: EUwood

1.2.4 Sector wise future demand for wood energy

The Forest Products Annual Market Review confirms that wood energy was the only forest related industry sector with steady economic growth in the in the economically difficult period 2008 – 2009. However, wood energy has many facets and differs in it use pattern as well as development from country to country. The UNECE/FAO Joint Wood Energy Enquiries 2005 and 2007, as well as EurObserv'ER's Solid Biomass Barometer 2009 indicate a steadily growing trend for wood energy in general and heat and power generation by main activity producer in particular.

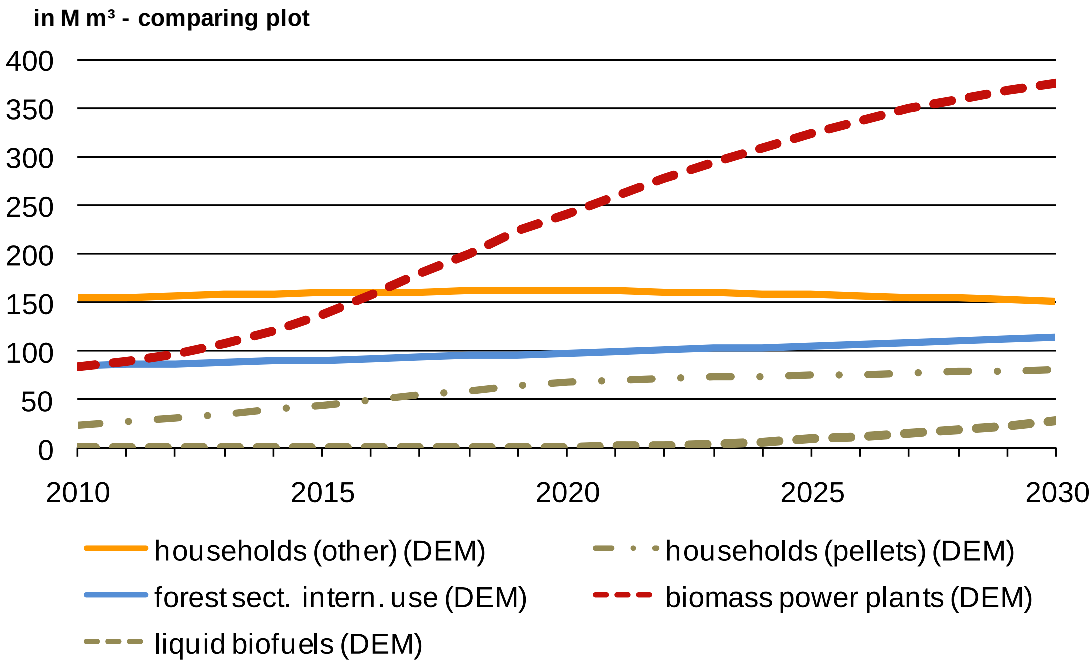


Figure 3-4: Current and future total amounts of wood energy, by consumer (EU 27)

Source: EUwood

The EUwood takes these variables incineration technologies and market developments of the different wood energy sectors and actors into account. EUwood modelled the different sectors separately for households, forest based sector internal use, main activity energy producer and second generation biofuels producer.

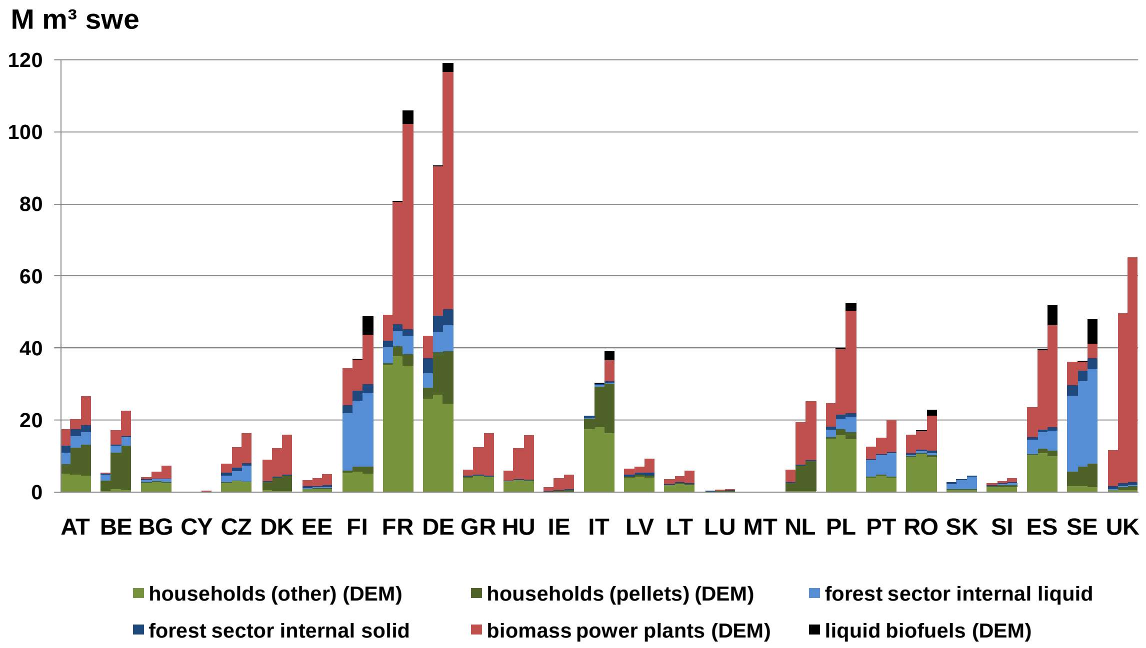


Figure 3-5: Current and future amounts of wood energy (by country and consumer sector)

Source: EUwood

Note: The bars above represent the years 2010, 2020, 2030 from left to right (biomass power plants in Italy, Slovakia and Sweden see comment in country sheets)

3.5.1 Households - except pellets (other)

Traditional wood fuel in the form of logs, round and split, mainly for heat and hot water production in private households is still the most important sector for wood consumption for energy generation in EU 27. According to the EUwood projections volumes are expected to increase from 155 million m³ in 2010 to 163 million m³ in 2020 and 151 million m³ in 2030. The share of wood energy consumption by private households in the total energy from woody biomass will decrease from 45% in 2010 to 29 % in 2020 and 20 % in 2030.

Private households use many different sources for their fuel procurement and empirical studies indicate that important quantities are traded on informal markets and often remain undetected by national and international energy and forestry statistics. Household studies in Germany (Mantau, 2000, 2005, 2007) have shown much higher wood energy consumption than in the fuelwood statistics and the Wood Resource Balance calculations in Germany uncovered the phenomenon of unregistered cuttings. Since the UNECE/FAO Forestry and Timber Section started its efforts to improve the data availability on wood energy sources and uses, many countries have conducted household surveys and empirical assessments. These data are already presented in the energy and forestry statistics in certain countries. Thus, the quality of data on wood energy consumption by private households is quite diverse – Therefore the EUwood project used only some country data of the volumes of wood consumed for energy by private households from international databases.

The majority of the households' wood energy consumption is generated on the basis of an indicator on forest area per rural inhabitant. The precise description can be found in the methodology report.

Results from empirical research in Germany (Mantau, internal calculations, 2010) found a high correlation between the current prices for light heating oil and households' wood energy consumption. The data for wood energy consumption are assumed to be already on a quite high level (oil price exceeding $US/bbl 140, July 2008) and they are expected to increase only slightly until 2020 by about 5% before they are expected to decrease again slightly below the level 2010. One reason for slower increase or even decrease in the future is the anticipated substitution by wood pellets as well as increasing legislative hurdles arising from air quality measures and regulations (see Figure 3-6).

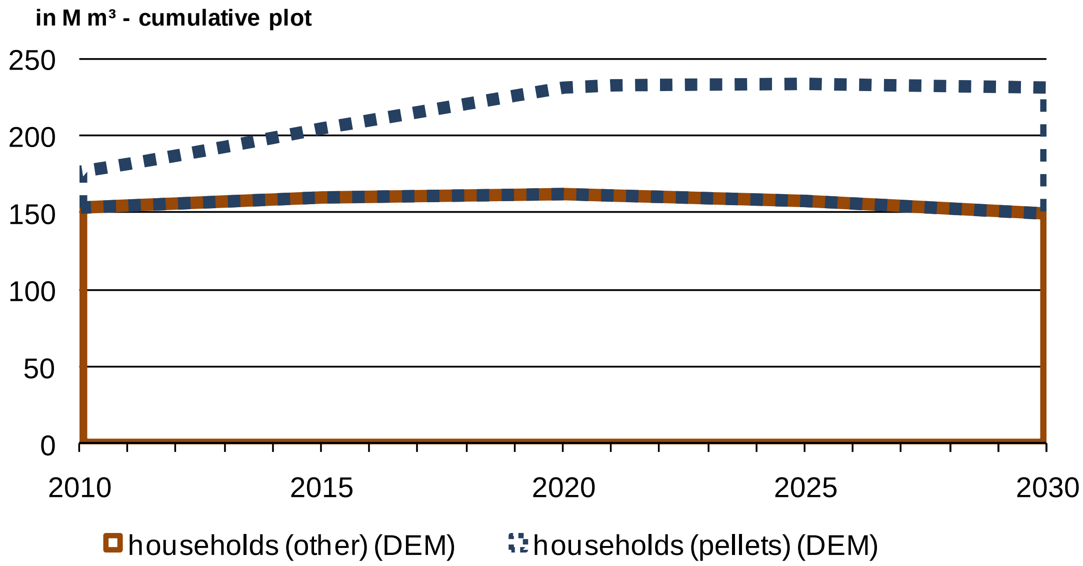


Figure 3-6: Wood for energy by private households (EU 27)

Source: EUwood

3.5.2 Households – pellets and briquettes

Markets for processed solid wood fuels, notably wood pellets markets rose strongly in the EU 27 member countries in recent years. It is assumed that wood briquettes will contribute a small share and their future market development is assumed to be much less dynamic than for pellets. The figures therefore include both commodities.

Calculating future consumption of wood pellets and briquettes represents quite a challenge as official long term market data do not exist. Wood pellets consumption by private households is expected to increase from 23 million m³ (12 million tonnes) in 2010 to 69 million m³ (35 million tonnes) in 2020 and to 82 million m³ (41 million tonnes) in 2030. The share of wood energy from pellets will increase from 7% in 2010 to 12 % in 2020 before its importance decreases slightly to 11% in 2030.

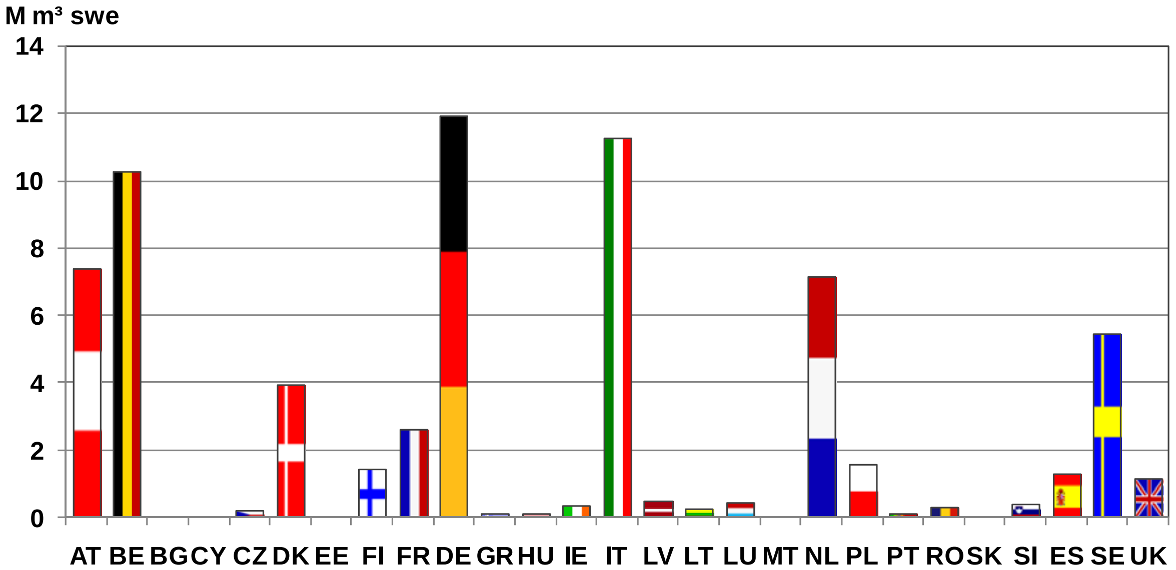


Figure 3-7: Pellets consumption by member states in 2020 (EU 27)

Source: EUwood

This certainly is a steep evolution of the market of wood pellets in Europe. However, it remains significantly below the projection made by the European Biomass Association (AEBIOM) in their pellets "roadmap". AEBIOM "estimated that the use of pellets for heating purposes in the residential, services and industrial sectors might reach 50 Mt (million metric tonnes) in 2020" This figure still excludes possible additional use of wood pellets for electricity production in power plants, whether co-firing or biomass only.

Pellets consumption is expected to evolve differently in different member states, and also in the four European regions. It is expected that the country group of Western Europe will consume 2/3 of the entire European wood based pellets consumption.

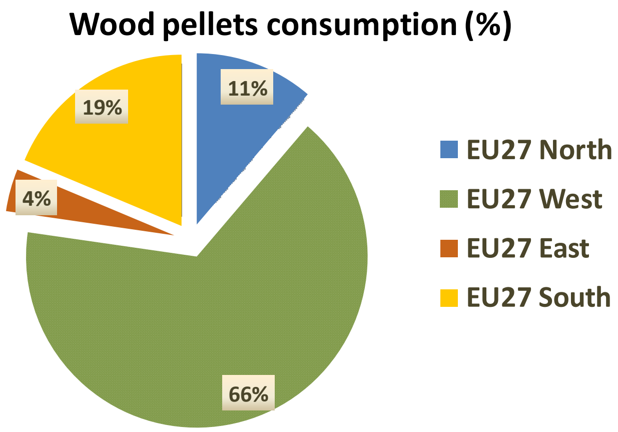


Figure 3-8: Projected shares of wood pellets consumption by EU regions (2020 – scenario A1)

Sawmill residues are the most important raw material source today for pellets, but pellet industries could change their raw material supply pattern drastically to small diameter roundwood according to market stakeholders. Therefore EUwood used the availability of sawmill residues as an indicator to calculate the future domestic production of wood pellets in each member state (see chapter 3.5.4).

EUwood calculated that 43 million m³ of the pellets consumption in 2020 might be produced from domestic sources whereas 22 million m³ might come from imports. In 2030 54 million m³ of the total consumption might be produced within the EU 27. Thus, the EU 27 will be an important net importer of wood based pellets and briquettes.

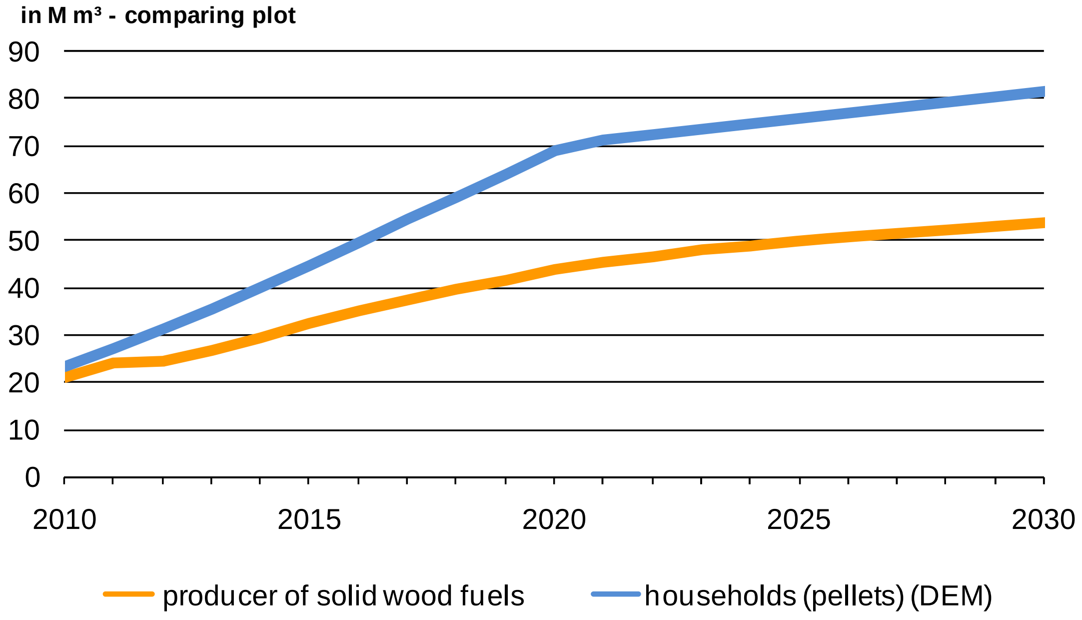


Figure 3-9: Wood based pellets production and consumption (EU 27)

Source: EUwood

3.5.3 Forest based industry internal energy use - liquid

The pulp industries, notably those applying the chemical pulping process, are often the biggest electricity producer from biomass in their countries. Chapter 5.5.4 (chapter 5.4.4 Methodology report) describes how black liquor arises as a co-product from the chemical pulping process. Its volumes are directly linked to the future development of chemical pulp production. The future development of the forest based sector is calculated to be much below the anticipated future development of the energy sector, the development of energy from black liquor is quite minor. Energy generation from black liquor is expected in scenario A1 to increase from 60 million m³ solid wood equivalents in 2010 to 66 million m³ in 2020 and 85 million m³ in 2030 (67 and 72 million m³ in scenario B2). The share of forest based industry internal liquid by-products in the total energy from woody biomass will decrease from 19% in 2010 to 14 % in 2020 and 12 % in 2030 (compare Figure 3-4).

3.5.4 Forest based industry internal energy use – solid

Compared to energy generation in the chemical pulping process, wood energy from processing residues plays a much lower role in other wood processing industries. Sawmills, wood based panel and veneer producer use wood internally for energy generation, notably for drying of their (semi-)finished products. The wood assortments used are to a big extent bark (notable sawmills) or low quality fibres that cannot be used in any downstream processes, such as dust, shavings, etc.

Energy generation from solid residues in the forest based industries is expected to increase from 25 million m³ solid wood equivalents in 2010 to 23 million in 2020 and 29 million m³ in 2030 in scenario a1 (33 and 45 million in scenario B2). These volumes are directly linked to the future development of the evolution of the different wood processing sectors other than chemical pulp (see chapter 5.5). The share of forest based industry solid products in the total energy from woody biomass will decrease from 6% in 2010 to 4 % in 2020 and 3 % in 2030.

3.5.5 Wood based liquid biofuels

The assumptions and description of future wood energy scenarios of the EUwood project are based on the World Energy Outlook (WEO) of the International Energy Agency (IEA). Additional and updated information on the development of liquid biofuels processes research and development as well as investment activities in the region can be found on the European Biofuel Technology Platform (www.biofuelstp.eu).

EUwood assumes that the production of liquid biofuels will not have any significant impact on wood markets before 2020 despite the political support and intensive research and development activities in this field. It is assumed that the production of liquid biofuels could account for about one million m³ solid wood equivalents in 2020 and could increase to up to 29 million m³ in 2030, which would represent about 4% of the wood volumes used for energy generation.

The future development of liquid biofuels from woody biomass has been calculated separately for two different conversion paths. Following the IEA World Energy Outlook, EUwood assumed that the biochemical conversion and the production of cellulosic ethanol from wood fibres will represent 80% of liquid biofuels production in the future, whereas the thermo-chemical (biomass to liquid - Btl) conversion will only account for 20 % of future liquid biofuels production in the future.

Biochemical conversion processes are expected to consume 0.8 million m³ solid wood equivalents in 2020 and 19 million m³ solid wood equivalents in 2030. The thermo chemical conversion processes are expected to consume 0.8 million m³ solid wood equivalents in 2020 and 6 million m³ solid wood equivalents in 2030.

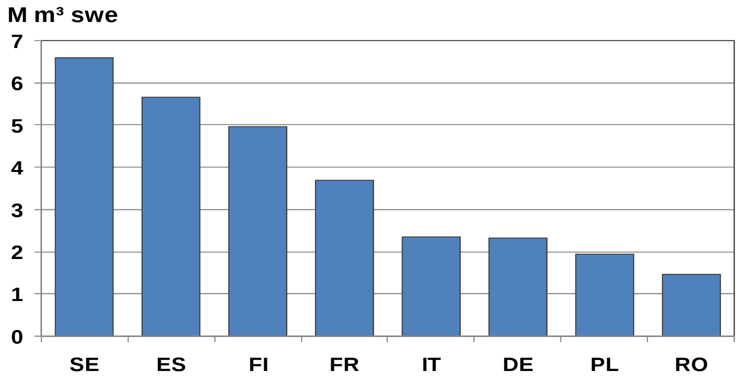


Figure 3-10: Wood demand for total liquid biofuels production in 2030 (EU 27)

Source: EUwood

3.5.6 Main activity producers

"Main activity producers" as defined by the IEA are heat and electricity producers whose main or sole activity is the production of energy for the market (i.e. similar installations producing heat or electricity for internal use by forest industries are not considered main activity producers).

Due to lack of time and resources, the EUwood project was not able to differentiate the sector any further e.g. by different power plant types and sizes. Thus this sector sums together the future consumption of wood by co-firing in large scale coal plants, large scale biomass power plants with mid and small scale combined heat and power plants. Incineration plants for treated and contaminated wood are similarly included when they produce heat and power for the market.

The results of the EUwood study indicate that wood energy generation by main activity producers is expected to see the biggest increase in absolute and relative terms. The consumption of about 83 million m³ in 2010 is expected to almost triple to 242 million m³ in 2020 and increase further to 377 million m³ in 2030.

Main activity producers are expected to replace private households as the biggest single wood energy consumers around 2020 (see Figure 3-11). In 2030 main activity producer are expected to be by far the biggest wood energy producer in the EU 27. The advantage of such a growing role of power plants is that they purchase their raw material through official distribution channels which are hence easier to assess statistically. This might facilitate the work of decision makers.

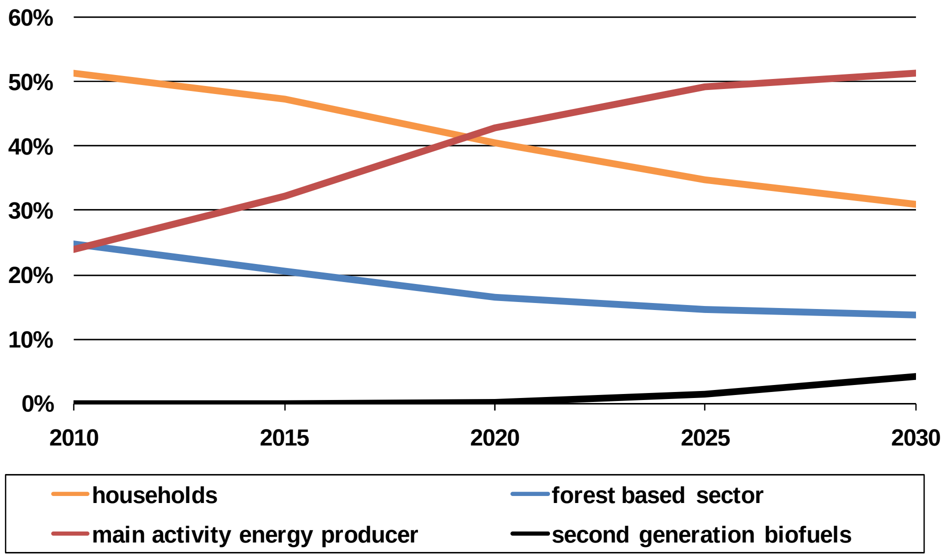


Figure 3-11: Current and future role of wood energy consumers (EU 27)

Source: EUwood

The big potential increase in wood consumption by the main activity producers also implies a threat of inefficient use of the raw material, if, for instance, wood were burned solely to produce electricity, at an efficiency about 40% rather than in a combined heat and power at an efficiency of over 80%. It is important to set the course for efficiency targets in wood burning applications by providing a stable framework for investments. This could imply linking investments to energy efficiency targets (either fixed or increasing over time).

3.6 Sensitivity analysis of assumptions

The results presented above have been calculated on the basis of certain key assumptions. However, these constraints and assumptions may vary and change in the future. The sensitivity analysis of the assumptions outlines briefly, how changing realities might change future wood demands for energy use in 2020 and 2030.

Table 3-1: Sensitivity of EUwood assumptions – energy

Assumption (base scenario)	Possible variation	Effect on EU 27 wood demand [million m³ annual difference with base scenario]	
		2020	**2030**
Member states meet the energy efficiency targets (20%)	Member states miss these targets and energy efficiency remains at 2010 level	+ 85	+ 130
Wood energy contributes 40% to energy from renewable sources	Wood energy accounts for the same share in energy from renewables as in 2010 (50%)	+ 120	+ 167
	Others RES develop fasten than anticipated and wood energy decreases to 37,5% of RES	- 47	- 63
Constant energy yield of net calorific value / combustion efficiency	Each 1% decrease		+ 7.5
	Each 1% increase		- 7.5

Source: EUwood

The demand for wood for energy could increase dramatically if countries do not meet energy efficiency targets and expect a maintained strong role of wood energy with 50% share in energy from renewable sources in the future. These framework conditions could increase the demand for wood energy (as presented in the results, see Table 3-1) by 205 million m³ in 2020 and in 2030 an even higher additional volume of 297 million m³ would be required at the level of the EU 27.

The future demand for wood energy in 2020 and 2030 could be further reduced compared to the above presented results, if countries successfully implement energy efficiency measures and at the same time if other renewables develop faster than already anticipated. If wood energy decreases its share of the renewable energy portfolio to 75% of its 2010 role (37.4% instead of 50%), wood demand could decrease compared to the above presented results, by another 47 million m³ in 2020 and by 63 million m³ in 2030.

It also matters, how efficient wood burning facilities make use of the net calorific value of wood. Highly efficient combustion units will decrease the amounts of wood necessary to satisfy the future (wood) energy needs. The results from the EUwood calculations suggest that every increase of the combustion efficiency by 1% could save up to 7.5 million m³ at EU 27 level. Thus it does make a difference whether countries aim for huge electricity-only biomass power plants or whether policies favour highly efficient combined heat and power plants, or central municipal heating systems or extremely efficient pellet stoves in private households.

3.7 Conclusions

Assumptions by EUwood about the framework conditions for renewable energies in general and wood energy in particular do not represent a business as usual future. The framework conditions on energy efficiency and the decreasing role of wood energy compared to other renewable energy sources will require targeted policy support from the energy sector. The sensitivity analysis indicates that wood demand for energy could increase by an additional 297 million m³ by 2030 if future realities diverge from the assumed framework conditions.

Successful implementation and achievement of energy efficiency targets will allow countries and industries to keep annual growth rates of renewables at a manageable level. It will further reduce the overall burden to energy from renewable sources.

Developing other renewables, such as solar, wind, tide, hydro or non-wood biomass faster than wood could reduce the pressure on wood supply for energy. Compared to the reference year 2005, wood energy could increase by 75% until 2020 and by another 31% in the decade between 2020 and 2030. However, different wood energy consuming sectors will evolve differently. Main activity producer are likely to become the biggest user of wood energy and could thus push private households to second position already before 2020.

Wood burning technology needs to be as efficient as possible. Each 1% increase in energy efficiency of wood incineration for energy purposes would reduce total demand in the EU 27 by 7.5 million m³.

Only continued empirical work in a structured monitoring framework can help to assess the *real* development of the different sectors and wood fuel assortments and may thus enable decision makers to minimise negative effects in time

References

Capros P., Mantzos L., Papandreou V., Tasios N.: Model-based analysis of the 2008 EU Policy Package on Climate change and Renewables. Primes Model - E3Lab/NTUA, Athen/Greece, January 2008. 914 p. http://ec.europa.eu/environment/climat/pdf/climat_action/analysis_appendix.pdf

EU Biofuels technology platform www.biofueltp.eu

EurObserv'ER. 2009: Solid biomass barometer. Systèmes solaires le journal des énergies renouvelables N° 194, Paris/France, December 2009. 22 p. http://www.eurobserv-er.org/pdf/baro194.pdf

European Biomass Association. 2008: A Pellet Road Map for Europe. Brussels, Belgium November 2008. 11 p. http://www.aebiom.org/IMG/pdf/Pellet_Roadmap_final.pdf

European Commission. 2009: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), European Commission Brussels, Belgium. 2009. 47 p. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

European Commison transparency platform. 2009: Member States' forecast documents, forecasting expected transfers of shares of renewable energy (import needs and export availability) as statistical transfers or joint projects. Brussels, Belgium December 2009. http://ec.europa.eu/energy/renewables/transparency_platform/forecast_documents_en.htm

Food and Agriculture Organisation of the United Nations Unified Bioenergy (FAO). (2004): Terminology – UBET, Rome, Italy. 58 p. ftp://ftp.fao.org/docrep/fao/007/j4504e/j4504e00.pdf

International Energy Agency. 2009: World Energy Outlook. Paris, France, 2009. 696 p.

Pellets@tlas. 2010: www.pelletcentre.info

UNECE/FAO Forestry and Timber Section. 2009: Joint Wood Energy Enquiry 2007 Background Data Analysis. Geneva, Switzerland 2009. 35 p. http://timber.unece.org/index.php?id=238

UNECE/FAO Forestry and Timber Section. 2009: Forest Products Annual Market Review 2008-2009. Geneva, Switzerland, August 2009. 188 p. ECE/TIM/SP/24 http://timber.unece.org/fileadmin/DAM/publications/Final_FPAMR2009.pdf

4 The realistic supply of biomass from forests

Authors: Pieter J. Verkerk[1], Perttu Anttila[2], Marcus Lindner[1], Antti Asikainen[2]

[1]European Forest Institute, Torikatu 34, 80100 Joensuu, Finland

[2]Finnish Forest Research Institute (Metla), P.O. Box 68, FI-80101 Joensuu, Finland

4.1 Introduction

This chapter estimates the realistic potential for forest biomass supply for the period 2010 to 2030. This estimation was carried out in three steps.

First, the maximum, theoretical availability of forest biomass from forests available for wood supply in the 27 European Union (EU) member states was estimated using the large-scale European Forest Information SCENario model (EFISCEN) (Sallnäs 1990; Schelhaas et al. 2007). These projections were based on recent, detailed national forest inventory data on species and forest structure and provided the theoretical biomass potentials for broadleaved and coniferous tree species separately from:

- stemwood;
- logging residues (i.e. stem tops, branches and needles);
- stumps;
- other biomass (i.e. stem and crown biomass from early (or pre-commercial) thinnings).

Second, multiple environmental, technical, and social constraints were defined and quantified that reduce the amount of biomass that can be extracted from forests for three mobilisation scenarios.

Third, the theoretical potential according to EFISCEN was combined with the constraints from the three mobilisation scenarios to assess the realisable biomass potential from European forests. It should be noted that this figure is for the potential of the forest, and is not a projection of supply. It is prepared independently of the of the demand side of the Wood Resource Balance. To assess the effect of various assumptions that had to be made, a sensitivity analysis was performed.

Finally, some further calculations were done related to requirements for workforce and machinery to extract the realistic potential and how procurement costs are affected by the different scenarios.

A detailed description of each of these steps is given by Verkerk et al. (2010). The results of each of these steps are described in the following sections, along with some conclusions.

4.2 Theoretical biomass supply from forests

The theoretical biomass potential from European forests in 2010 was 1,277 million m^3 per year including bark in 2010, according to projections with EFISCEN (Figure 4-1). This theoretical potential was based on the average volume of wood that could be harvested over a 50 year period, taking into account increment, the age-structure, stocking level and harvesting losses. The potential is expected to decrease by 1.8% to 1,254 million m^3 per year in 2030, but in general the potential is rather stable over time. This is mainly because the potential for each year is based on the average maximum harvest level that can be maintained throughout the next 50 year period.

About 52% of the total potential is in stems, while logging residues and stumps represent 26% and 21%, respectively. Other biomass, i.e. stem and crown biomass from early thinnings, represent only 1% of the total potential.

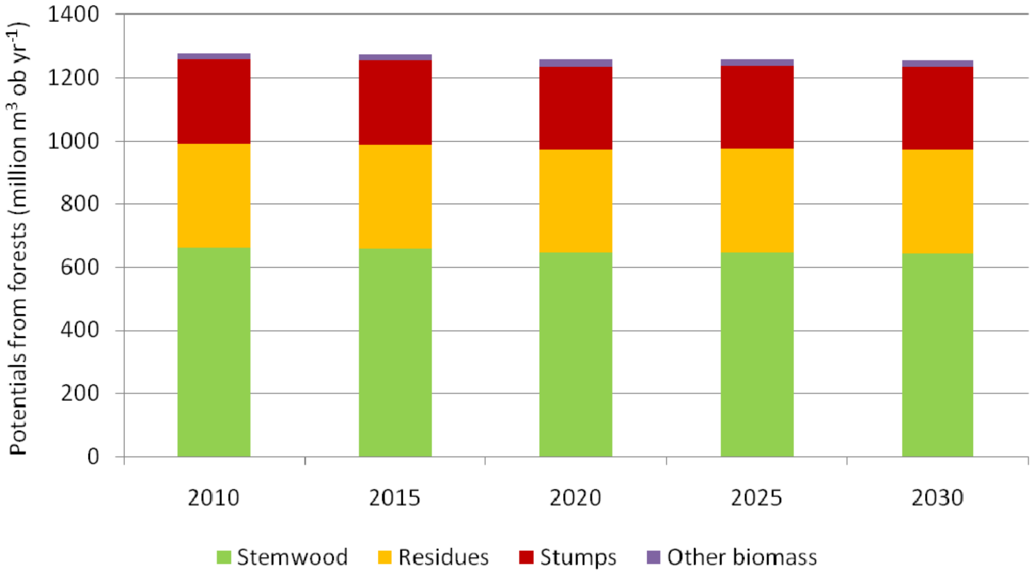


Figure 4-1: Theoretical biomass potential from forests available for wood supply in EU 27

4.3 Constraints on biomass supply from forests

The theoretical forest biomass potentials estimated by EFISCEN are higher than what can actually be supplied from the forest due to various environmental, social, technical, and economic constraints. The constraints on wood mobilisation applied in this study have been identified in different international processes, in which recommendations have been developed to overcome these constraints. These recommendations serve as a starting point for the mobilisation scenarios defined in this study. The scenarios project different degrees of success of how the recommendations will be implemented. The scenarios are defined as follows:

- In the ***high mobilisation scenario*** there is a strong focus on the use of wood for producing energy and for other uses. Recommendations by the abovementioned processes have been successfully translated into measures that lead to an increased mobilisation of wood. This means that new forest owner associations or co-operations are established throughout Europe. Together with existing associations, these new associations lead to improved access of wood to markets. In addition, strong mechanisation is taking place across Europe and existing technologies are effectively shared between countries through improved information exchange. Biomass harvesting guidelines will become less restricting, because technologies are developed that are less harmful for the environment. Furthermore, possible negative environmental effects of intensified use of forest resources are considered less important than the negative effects of alternative sources of energy (i.e. fossil fuels) or alternative building materials (e.g. steel and concrete). Application of fertilizer is permitted to limit detrimental effects of logging residue and stump extraction on the soil.

- The ***medium mobilisation scenario*** builds on the idea that recommendations are not all fully implemented or do not have the desired effect. New forest owner associations or co-operations are established throughout Europe, but this does not lead to significant changes in the availability of wood from private forest owners. Biomass harvesting guidelines that have been developed in several countries are considered adequate and similar guidelines are implemented in other countries through improved information exchange. Mechanisation of harvesting is taking place, leading to a further shift of motor-manual harvesting to mechanised harvesting. To protect biodiversity forests are being protected, but with medium impacts on the harvests that can take place. Application of fertilizer is permitted to limited extent to limit detrimental effects of logging residue and stump extraction on the soil.
- In the ***low mobilisation scenario***, the recommendations do not have the desired effect, because the use of wood for producing energy and for other uses is subject to strong environmental concerns. Possible negative environmental effects of intensified use of wood are considered very important and lead to strict biomass harvesting guidelines. Application of fertilizer to limit detrimental effects of logging residue and stump extraction on the soil is not permitted. Forests are set aside to protect biodiversity with strong limitations on harvest possibilities in these areas. Furthermore, forest owners have a negative attitude towards intensifying the use of their forests. Mechanisation of harvesting is taking place, leading to a shift of motor-manual harvesting to mechanised harvesting, but with little effect on the intensity of resource use.

4.3.1 Environmental and technical constraints

For stemwood, the main constraint was that only stemwood from the forest area available for wood supply was considered, which represents 87% of forests in the 27 European Union member states (range: 99% in Belgium, Germany, and Luxembourg to 0% in Malta) (MCPFE, UNECE and FAO 2007). It should be noted that the projections for EFISCEN were only done for the forest area available for wood supply. Hence, potentials from the forest area not available for wood supply (e.g. strictly protected forests) were excluded from the theoretical potential presented in Figure 4-1, as well as from all mobilisation scenarios. However, in the low mobilisation scenario the forest area available for wood supply was reduced by an additional 5% for strict protection, where no harvest is permitted.

For the other types of forest biomass, the potentials were limited as well to the forest area available for wood supply. This is because not harvesting stemwood results in no logging residues or stumps being available in the forest. For these other biomass types, we considered also additional constraints. The area affected by each individual environmental or technical constraint is shown in Figure 4-2. This whole area is affected by assumptions on the technical recovery rate; other constraints that affect 10% or more of the forest area are related to compaction risk, low site productivity and the forest area included in the Natura 2000 network. There are also large differences of the importance of various constraints for different countries, for example constraints related to site productivity affect 41% of the forest area and ranges from 1% in Greece and Slovenia to 91% in Finland.

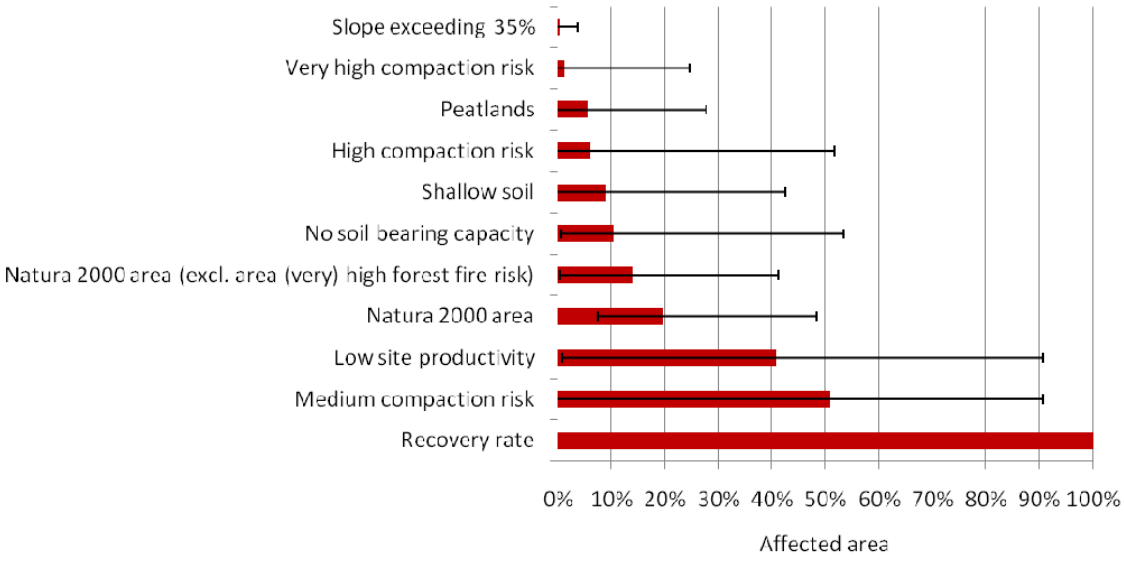


Figure 4-2: Forest area affected by various environmental and technical constraints in EU-27.

Note: Error bars indicate the minimum and maximum area affected in the different EU member states.

The total reduction due to environmental and technical constraints is different for biomass from early thinnings, logging residues and stumps (Figure 4-3 to Figure 4-5). This is due to overlap of the areas affected by each constraint and the importance of each constraint for different biomass types. The least strong constraints were defined for stemwood from early thinnings and logging residues from final fellings, whereas much stronger constraints were considered for the potential from stumps.

For most biomass types, the strongest reduction of the current and medium potentials were in Sweden, Finland, Denmark, Baltic countries, Ireland, Scotland, the Northern parts of Germany, the Netherlands and Poland, southwest France, East and North Spain, the Alpine area, Slovenia and Greece. In most of these regions, these reductions could be explained by constraints related to site productivity (poor soils) and in north Spain, the Alpine area, Slovenia and Greece as a result of restrictions to prevent erosion risk on shallow soils.

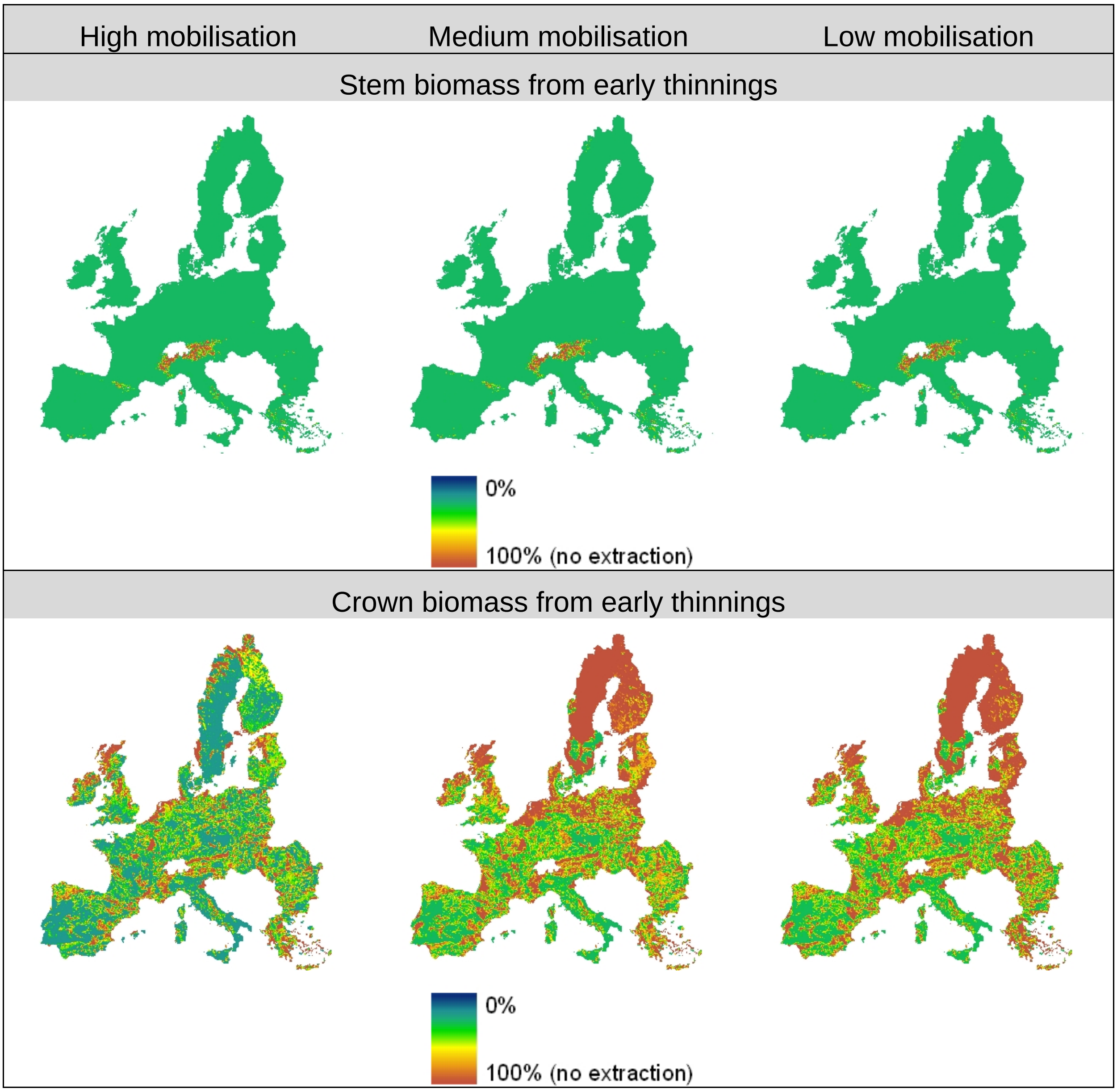


Figure 4-3: Reduction in biomass potential of stem and crown biomass from early thinnings due to environmental and technical constraints for three mobilisation scenarios

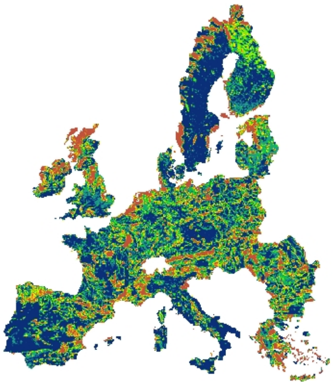
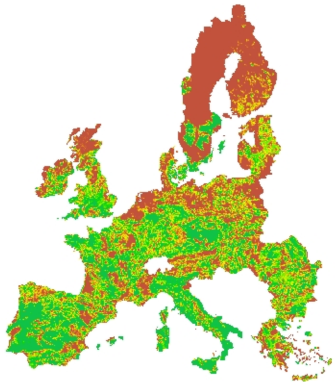
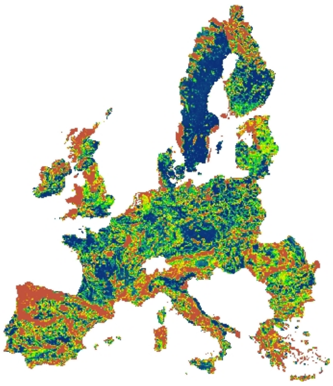
High mobilisation	Medium mobilisation	Low mobilisation
Logging residues from thinnings		
	  	No logging residue extraction during thinnings
Stumps from thinnings		
	No stump extraction during thinnings  	No stump extraction during thinnings

Figure 4-4: Reduction in biomass potential of logging residues and stumps from thinnings due to environmental and technical constraints for three mobilisation scenarios.

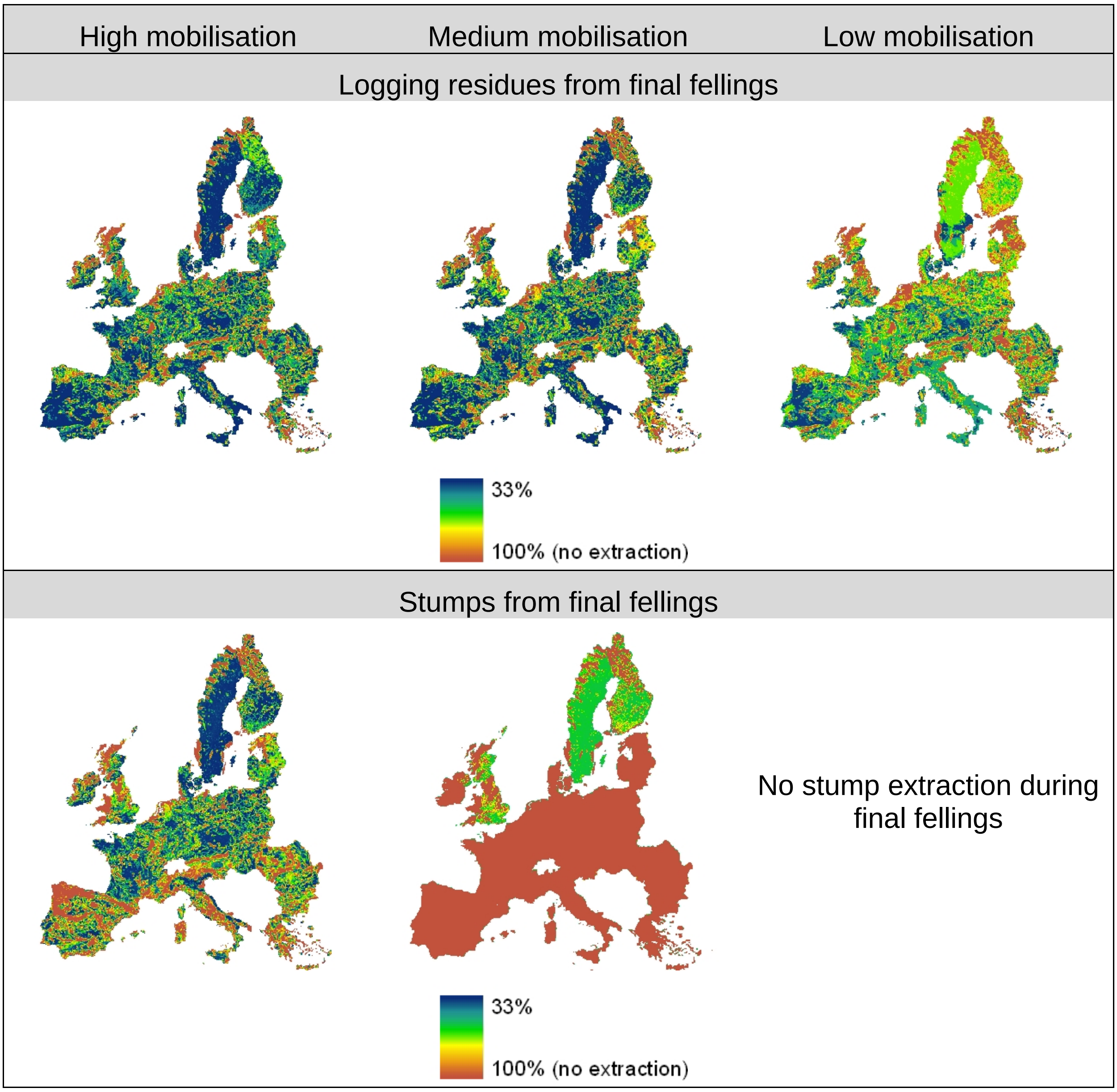


Figure 4-5: Reduction in biomass potential of logging residues and stumps from final fellings due to environmental and technical constraints for three mobilisation scenarios

4.3.2 Social constraints

The main social constraint that was considered related to the forest holding size and forest ownership structure. The underlying assumption was that the availability of wood is low on the very smallest private holdings and increasing rapidly when the holding size increased. Although in many countries the share of small private holdings of the total number of holdings is high, the share of the total area is generally low (on average one fifth of the total area of private forests). The countries with the largest shares of privately owned forest area in less than five-hectare holdings are Poland (73%), Romania (48%) and Slovenia (41%). In Germany 57% of private holdings were less than 20 ha, but further break-down was not available.

The effect on the availability of wood is not as heavy as these figures suggest. As it was assumed that the social constraints do not take effect on other than private land, the share of private forests of the total forest area was also considered. The share was less than 25% in Cyprus, Bulgaria, Poland, Romania and Czech Republic, and over 75% in Slovenia, Sweden, Austria, Norway and Portugal.

Based on these two factors, ownership structure causes the largest reduction on the forest biomass potential in Slovenia (15%), Portugal (13%) and France (10%) in the medium mobilisation scenario (Figure 4-6). The ownership structure has the least impact in Slovakia, Lithuania and Bulgaria, less than 2% in medium mobilisation scenario.

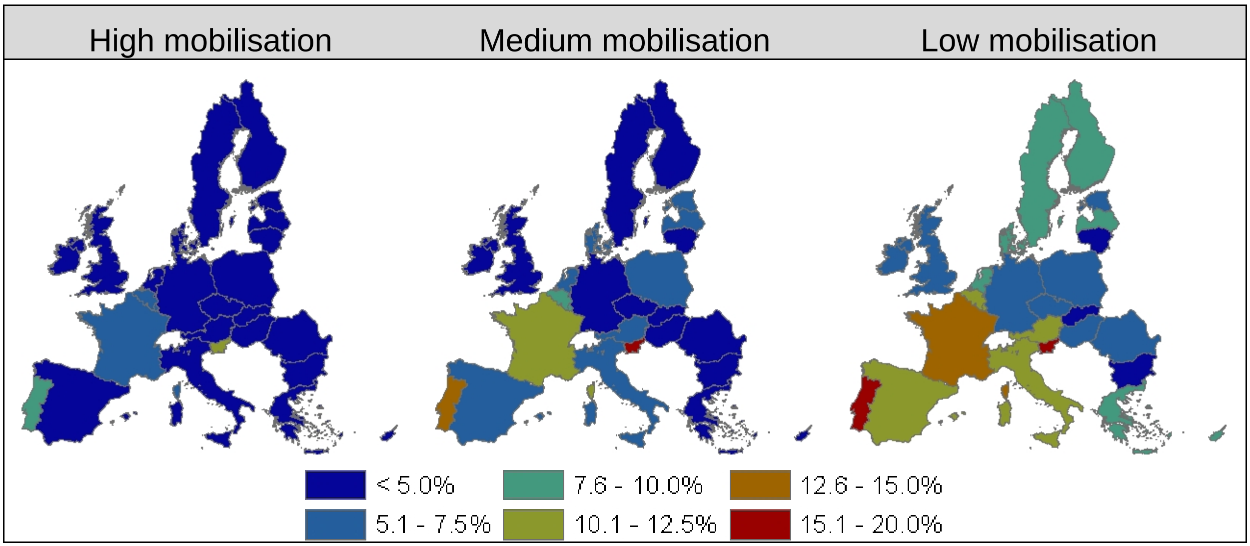


Figure 4-6: Reduction in biomass potential for all forest biomass types due to constraints related to forest holding size of privately owned forests for three mobilisation scenarios.

4.4 Realistic biomass supply from forests

4.4.1 Mobilisation scenarios

The realistic biomass potential from forests under the medium mobilisation scenario is estimated at 747 million m^3 per year overbark (ob) (Figure 4-7) in 2010. However, if less strict restrictions on biomass extraction are assumed, the biomass potential from forest could be increased to 898 million m^3 ob per year in the high mobilisation scenario in 2030. On the other hand, in the low mobilisation scenario, the biomass potential would be reduced to 625 million m^3 ob per year in 2030.

The environmental, technical and social constraints included in our analysis have a significant impact on the biomass potential from European forests. In the current situation, they are estimated to reduce the theoretical potential by 530 million m^3 ob per year, or 42%. Especially the potentials from logging residues and stumps are strongly reduced. The environmental, technical and social constraints that were included in our analysis reduce the theoretical potential by 231 million m^3 ob per year for logging residues to 103 million m^3 ob per year and by 256 million m^3 ob per year to 10 million m^3 per year for stumps. According to the high scenario, assuming less strict constraints could increase the realistic potential to 152 and 102 million m^3 ob per year in 2030 for logging residues and stumps, respectively.

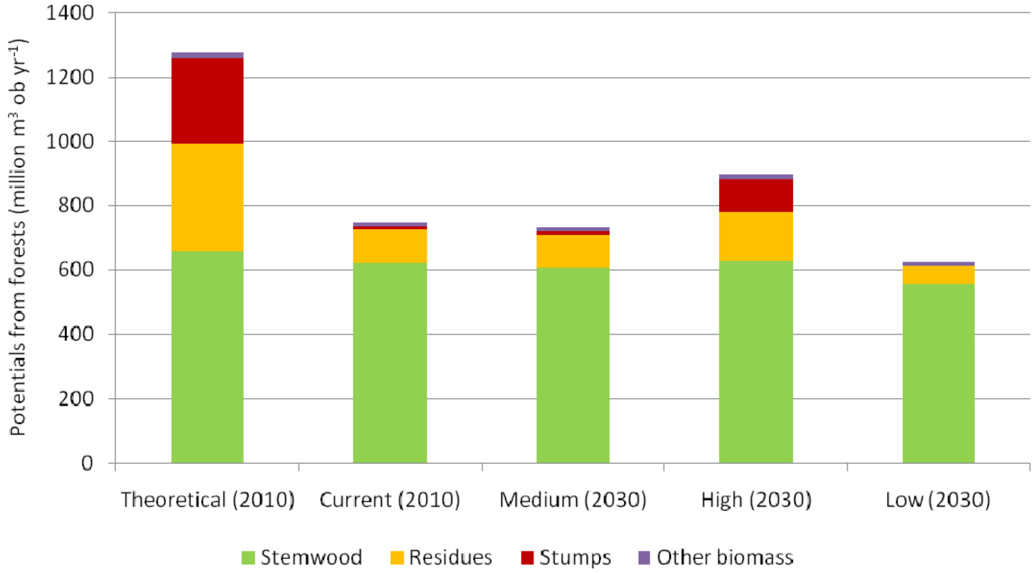


Figure 4-7: Comparison of biomass potentials from forests in EU-27 for different mobilisation scenarios in 2010 and 2030

Figure 4-8 shows the distribution of the biomass potentials from forests across Europe. The realistic potentials are not equally distributed between EU member states. The five countries that have the largest forest biomass potentials (Sweden, Germany, France, Finland and Italy) represent about 62% of the European forest biomass potentials. However, this is to large extent due to the size of the countries. The forest biomass potentials per unit of land (Figure 4-9) are generally highest in Central and Northern Europe, due to higher forest productivity (mainly Central Europe) and a higher forest cover ratio (mainly Northern Europe). Conversely, the biomass potentials per unit of land are generally low in Southern European countries due to lower productivity of the forest resources, as well as in countries that have only a low share of forest cover (Denmark, Ireland, the Netherlands, and United Kingdom).

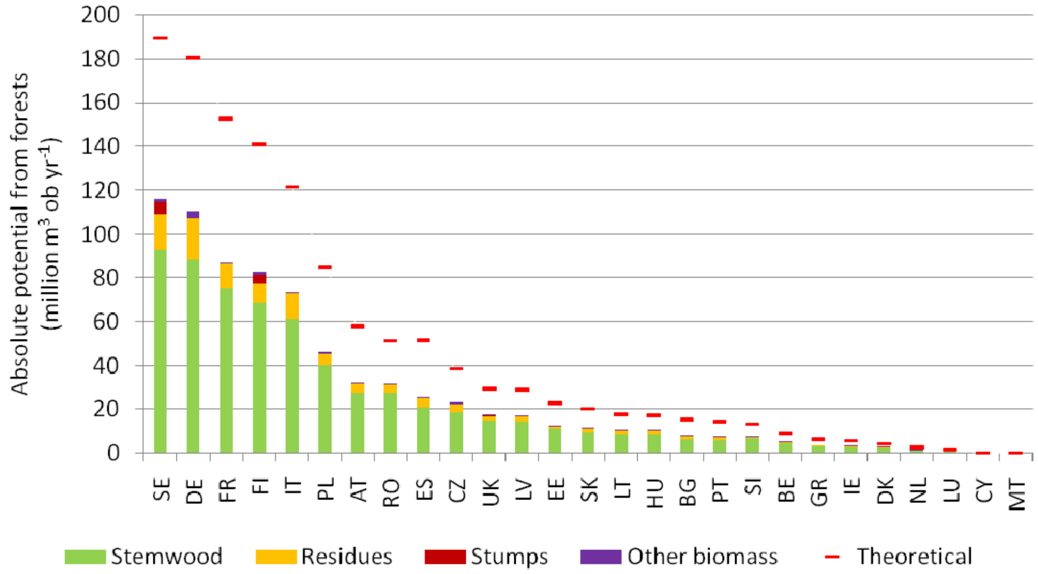


Figure 4-8: Distribution of the absolute forest biomass potential across EU member states in 2010.

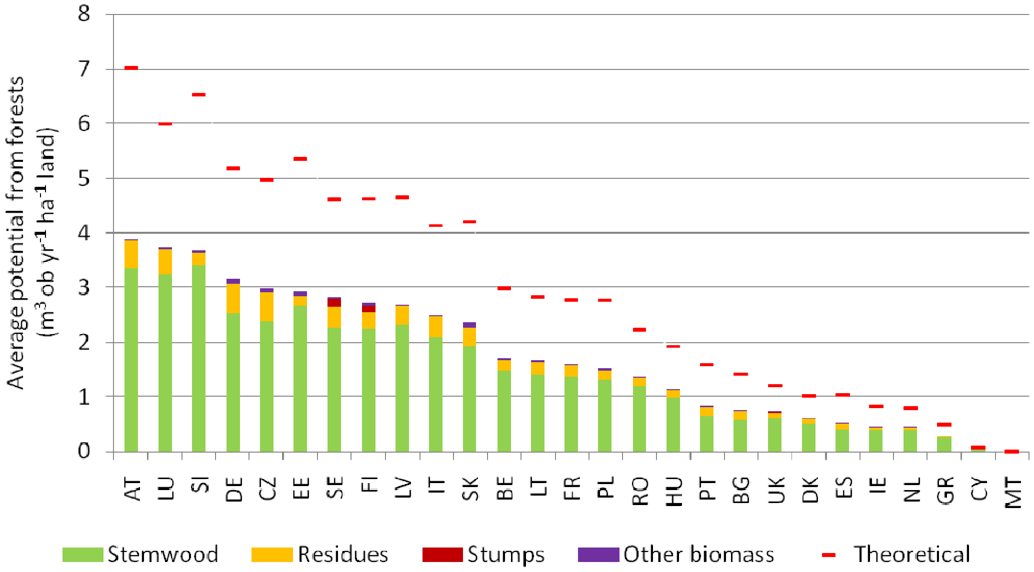


Figure 4-9: Distribution of the average forest biomass potential per unit of land across EU member states in 2010.

4.4.2 Sensitivity analysis

The realistic biomass potential from European forests is based on various assumptions made within the EFISCEN modelling framework, as well as in the quantification and definition of constraints. Sensitivity analyses were therefore performed to assess how our assumptions affected the estimated potentials.

In the EUwood mobilisation scenarios, it is assumed that forest area does not change and that forest growth does not change as a result of environmental/climate change. Sensitivity analyses were performed to analyse the impact on the realisable biomass potential if:

- the average annual change in forest area between 1990 and 2005 (calculated from MCPFE, UNECE and FAO 2007) would be continued;
- forest growth is assumed to increase or decrease by 4% per decade compared to growth unaffected by climate change

As shown in Figure 4-10, a continuation of the observed trends in forest area changes could lead to an increase of 10 million m^3 per year (+1.3%) compared to the biomass potential in the medium mobilisation scenario. This increase is rather small, because in 2030 the new forests would still be rather young and only a limited amount of biomass can be extracted from these areas. If forest growth is assumed to increase by 4% per decade in all countries compared to no climate change effects, the realisable potential would increase by 15 million m^3 per year (+2.1%). Conversely, a decreasing growth rate of 4% per decade could lead to a decrease of 25 million m^3 per year (-3.4%) compared to the biomass potential in the medium mobilisation scenario.

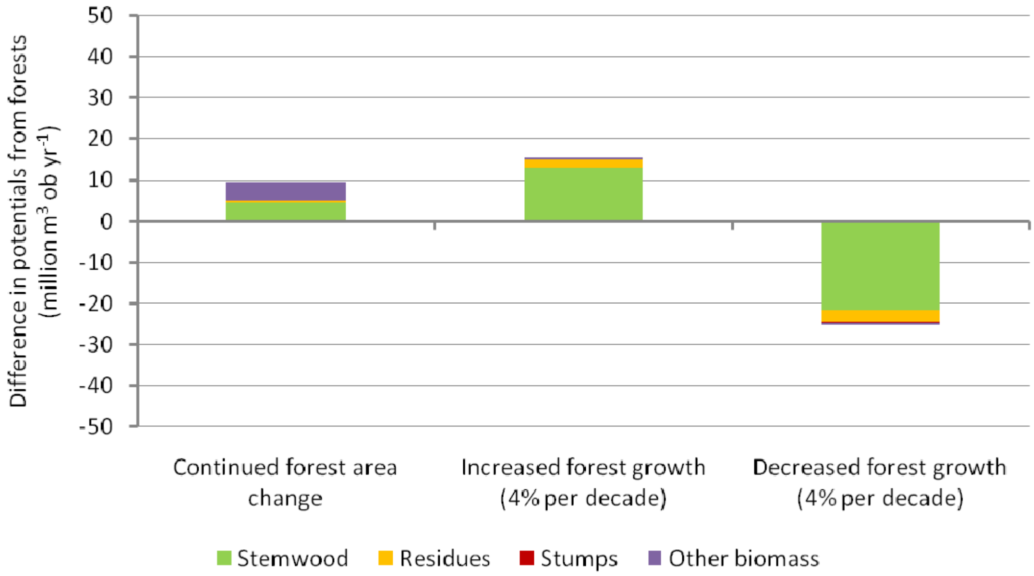


Figure 4-10: Sensitivity analyses for the impact of changes in forest area and growth on the biomass potential from forests in EU-27. The results are compared to the medium mobilisation scenario in 2030

Sensitivity analyses were also performed to analyse the impact of assumptions on constraints. In the low and high mobilisation scenarios, all constraints were changed at the same time compared to the medium mobilisation scenario. However, to determine the effect of each constraint separately, each constraint value was changed individually in the sensitivity analyses for different biomass types and for different harvesting activities..

The results of the sensitivity analyses are shown in Table 4-1. Constraints related to harvesting activities by private forest owners, as well as constraints related to forest protection affect the potentials from all forest biomass types. This is because they primarily affect the harvest of stemwood, but if stemwood is not harvested, there are also no logging residues and stumps that could be potentially available. Other constraints affect only particular biomass types and have limited impact on the overall potential from forests. For logging residues, constraints on extraction from sites with low site productivity can have an important effect. Allowing more residue extraction on poor soils could increase the overall biomass potential by more than 2% compared to the medium mobilisation scenario. For stumps, the main constraint in our analysis is related to the assumption that stumps are only extracted in Finland, Sweden and the United Kingdom in the medium mobilisation scenario, based on current practise. If stump extraction would be allowed in all EU member states, but still taking into account various other constraints, this would increase the potential from forests by 12 million m^3 per year.

There are also various constraints that appear to have little impact on the potentials. For example, if the restrictions on residue extraction on peatlands for environmental reasons were reduced (i.e. allow more extraction of residues), then in many countries it is technically still difficult to extract biomass from these areas due to the low soil bearing capacity, except in Finland and Sweden where harvesting on frozen soils is possible. This means that in the sensitivity analysis other constraints can become the main limiting factor and do not allow much more residues or stumps to be extracted.

Table 4-1: Sensitivity analyses for constraints on logging residue and stumps extraction in EU-27. The results are compared to the medium mobilisation scenario in 2030.

Sensitivity scenario	Target biomass type	Total potential	Absolute difference	Relative difference
		million m^3 ob / year	million m^3 ob / year	%
Medium mobilisation (reference)	-	733	-	-
Reduced harvest by private forest owners (-5%)	Stemwood	757	+24	+3.3
Increased harvest by private forest owners (+5%)	Stemwood	709	-24	-3.3
Increased forest protection (set aside 5% of FAWS)	Stemwood	697	-37	-5.0
Reduced residue removal on poor soils (35% instead of 67% extraction) during final fellings	Residues	717	-16	-2.2
Increased residue removal on peatland (33% instead of 0% extraction) during final fellings	Residues	735	+1	+0.2
Increased residue removal on soils with high compaction risk (50% instead of 25%) during final fellings	Residues	736	+2	+0.3
Reduced residue removal on sites with high compaction risk (0% instead of 25%) during final fellings	Residues	731	-2	-0.3
Increased residue removal on poor soils (67% instead of 0%) during thinnings	Residues	772	+39	+5.3
Increased residue removal on slopes up to 35% (67% instead of 35%) during thinnings	Residues	750	+17	+2.3
Increased residue removal on peatland in (33% instead of 0%) during thinnings	Residues	734	+0	+0.0
Increased residue removal on soils with high compaction risk (50% instead of 25%) during thinnings	Residues	735	+1	+0.1
Reduced residue removal on soils with high compaction risk (0% instead of 25%) during thinnings	Residues	732	-1	-0.1
Increased stump removal on poor soils (67% instead of 33%) and increased stump removal on slopes (67% on slopes up to 35% instead of 33% on slopes up to 20%) during final fellings	Stumps	743	+10	+1.4
Reduced stump removal on poor soils (0% instead of 33%) during final fellings	Stumps	725	-8	-1.1
Increased stump removal on slopes (67% on slopes up to 35% instead of 33% on slopes up to 20%) during final fellings	Stumps	735	+2	+0.2
Increased stump removal on peatland (33% instead of 0%)	Stumps	734	+0	+0.0
Increased stump removal on sites with high compaction risk (33% instead of 15%) during final fellings	Stumps	734	+0	+0.0
Reduced stump removal on sites with high compaction risk (0% instead of 15%) during final	Stumps	733	0	0.0

fellings				
Stump removal in all EU member states instead of only in Finland, Sweden and UK	Stumps	745	+12	+1.6

4.4.3 Needed labour and machinery

In addition to the above-mentioned constraints, the availability of skilled labour and machinery may pose restrictions to the realistic biomass potential. While the availability could not be taken into account as a constraint, the workforce and machinery required to mobilise the potentials was estimated, based on the level of mechanisation and average conditions in Finland.

The procurement of the stemwood actually removed in 2005 in EU, would have required 43,000 workers assuming the work was carried out with highly mechanised harvesting systems (Figure 4-11). To extract the biomass potential from the low mobilisation scenario in 2030 would require 61,000 workers, whereas the medium and high mobilisation scenarios would require 67,000 workers and 69,000 workers, respectively. This means an increase of 43%, 56% and 61% in the number of workers compared to the removal in 2005, respectively. When in addition to stemwood also other biomass types are considered, the corresponding labour needs would be 73,000; 89,000 and 123,000 workers, respectively. In fact real figures would be higher as Finnish labour productivity in harvesting is very high

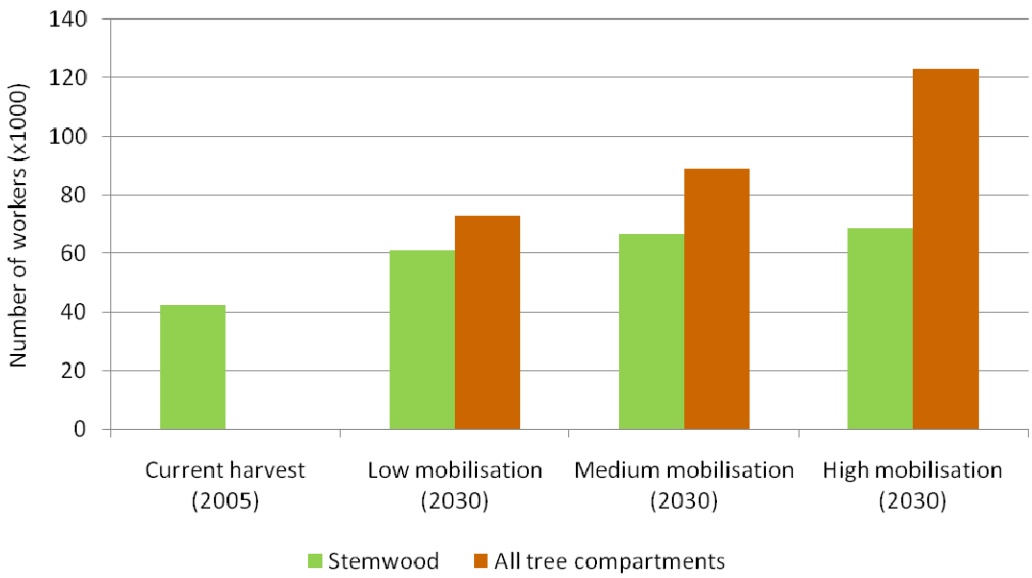


Figure 4-11: Needed number of workers for extraction/procurement of forest biomass

A vast number of machines would be needed to procure the biomass potentials. For the medium mobilisation scenario 24,000 forwarders, 17,000 harvesters, 5,500 timber trucks and 4,400 chip trucks, 4,200 chippers or crushers, 1,300 feller-bunchers and 700 excavators would be necessary (Figure 4-12). It has to be noted, that there are several optional supply chains available especially for energy biomass (e.g. bundling of logging residues or supply of loose residues and crushing at the plant). Their man power need, however, does not differ markedly from the supply chain presented here. If centralised crushing were used, the number of chippers would decrease. If the loose residues were transported to the plant for crushing, the number of trucks would increase due to lower pay load of residues compared with chips.

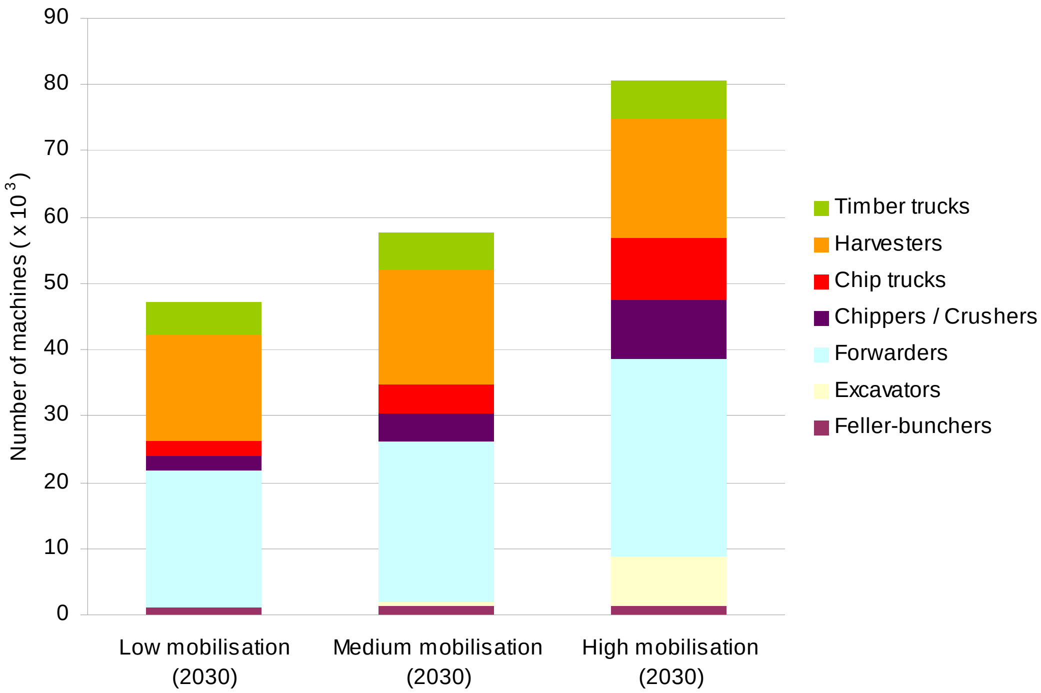


Figure 4-12: Needed number of machines for extraction/procurement of forest biomass

4.4.4 Impact of procurement costs

Similar to the availability of skilled labour and machinery, also procurement costs may pose restrictions to the realistic biomass potential. However, procurement costs could not be calculated, mainly due to a lack of data. The effect of procurement costs on the potentials was tested by estimating region-level cost-supply curves for logging residues from final fellings in the province North Karelia in Finland as an example.

The biomass potentials that were estimated for this region in the low, medium and high mobilisation scenarios in 2030 were 364,000; 725,000 and 844,000 m^3 per year, respectively. The impact of procurement costs in different mobilisation scenarios was studied in North Karelia by assuming the current size distribution of the heat and power plants using forest chips, but the potentials according to the three mobilisation scenarios in 2030 (Figure 4-13). The lower potential estimated in the low mobilisation scenario would result in an increase of about 10% of the supply costs when 300,000 m^3 per year was procured compared to the potential in the medium mobilisation scenario. The cost difference between the medium and high mobilisation scenario is much smaller due to a smaller difference in the potentials.

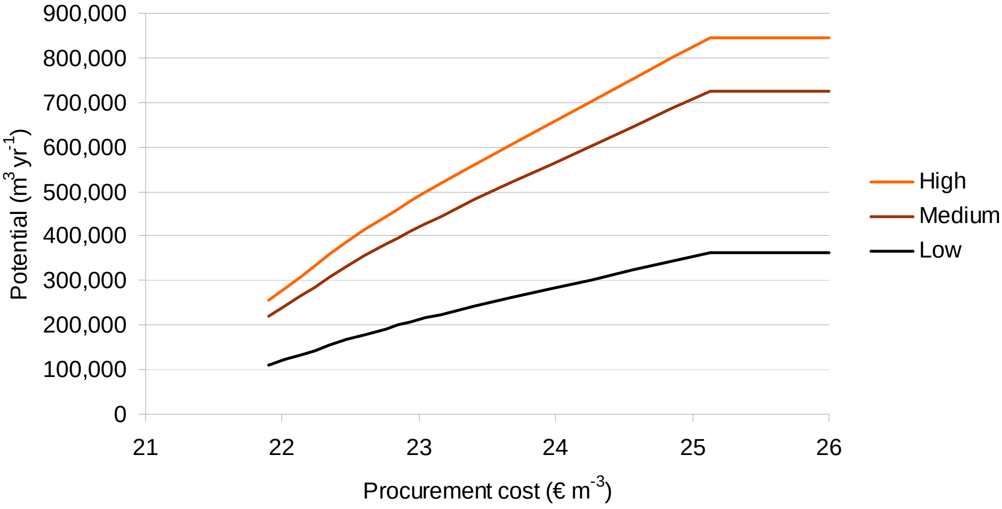


Figure 4-13: The impact of procurement costs on the potentials in different mobilisation scenarios in 2030, North Karelia

The biomass potential estimated for this region in the medium mobilisation scenario in 2010 was 735,000 m^3 per year. Based on the current plant size distribution, a bit more than 400,000 m^3 per year of chips could be procured with the marginal cost of 23 € per m^3 (Figure 4-14: The impact of procurement costs in 2030 on the potential in North Karelia assuming different plant size distributions). If the proportion of small plants were increased from the present 30% to 50%, 550,000 m^3 per year could be procured with the same marginal cost. However, if a large bio-refinery were assumed that would use 300,000 m^3 logging residues per year, then only 250,000 m^3 per year could be procured with the same marginal costs of 23 € per m^3 With the current and smaller plant sizes the whole current potential according to the medium mobilisation scenario, could be procured with a marginal cost of 25 € per m^3. With the bio-refinery, the respective cost would be 29 € per m^3.

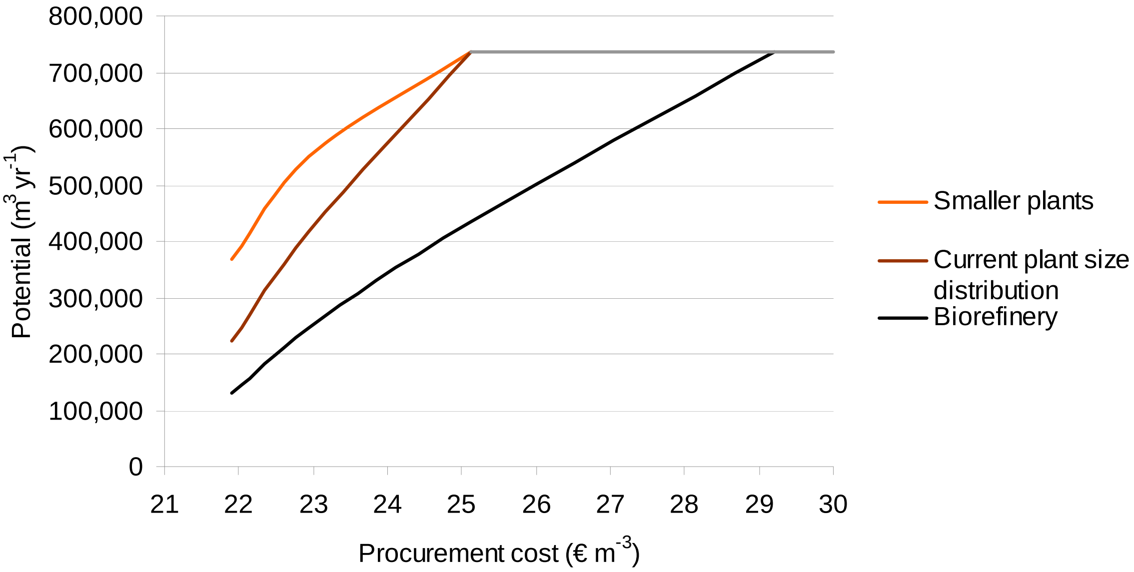


Figure 4-14: The impact of procurement costs in 2030 on the potential in North Karelia assuming different plant size distributions

4.5 Discussion

4.5.1 Overall results

The realistic potential from European forests is estimated at 747 million m^3 per year (overbark) in 2010 and could range from 625 to 898 million m^3 per year (overbark) in 2030. It is important to realise that the supply scenarios should be seen as the maximum amount of wood that can be supplied under given conditions as described in the mobilisation scenarios. Whether the wood will be harvested depends on the demand for wood for material and energy use. In case the potential supply exceeds the demand for wood, then part of the potential may be available still later in time and some more biomass could thus be harvested than estimated according to the mobilisation scenarios. Altogether, these results indicate that in a situation with a high demand, more wood could be made available by taking appropriate measures to mobilise biomass from forests.

According to FAO (2006), about 449 million m^3 per year (overbark) was removed from forests in the 27 EU member states in 2005. This estimate is probably still an underestimate of the wood that is removed in reality due to e.g. unregistered use of wood for household heating (Mantau et al. 2008). Nevertheless, to mobilise the biomass potentials from forests estimated in all scenarios, a significant increase in the harvest level is required compared to the current harvest level. This also implies a far more intensive use of the European forest resources compared to the current situation and may involve trade-offs in relation to other forest functions, e.g. biodiversity.

The constraints included in this study have an important impact on the biomass potentials that could be mobilised from forests. The constraints that were considered in this study reduced the theoretical potential by 28 to 50% in 2030 depending on the mobilisation scenario. The potential that can finally be implemented depends to large extent on the costs of the supply of biomass. Supply costs could not be estimated for all the compartments and for the whole EU, due to lack of detailed spatial data on end-use facilities and transport networks. To assess the impact of procurement costs on the potentials, procurement costs were calculated for a region in Finland as an example. The results of these calculations showed that if the ability to pay for logging residues dropped from 24 to 23 € per m^3 of logging residues (-4%), the potential that could economically be extracted would drop by 28%. In addition, information on the structure of the end use facilities was found to be very important for the procurement costs and subsequently the potential that could be economically realised. The procurement costs also affect the potentials of other compartments (stemwood, residues, stumps and other biomass). Although the results of our calculations cannot be applied to all biomass compartments in all European regions, these results do indicate that procurement costs have a big impact on the biomass potential that could be economically available from forests.

4.5.2 Uncertainties related to theoretical biomass potential from forests

The estimations of the future European potential wood supply depend to a large extent on the EFISCEN model. The model has been developed mainly for even-aged forests and application of the model to situations other than even-aged forests should be done with great care. For shorter periods, simulation of increment and growing stock are probably reasonable, but the age-class distribution will be unreliable and this will influences growth rates and growing stocks at the longer term, and thus thinning and harvesting possibilities. At the European level, about 17% of the forests are considered uneven-aged (MCPFE, UNECE and FAO 2007), but in e.g. Italy and France uneven-aged forests represent about 40% of the forest area. Our projections for Southern European countries where uneven-aged forests are more common should therefore be interpreted with care.

The impact of growth changes and large-scale disturbances due to environmental and/or climate change on the estimated potentials from forests were not included. We estimated the effect of an increase of the growth rate of 4% per decade compared to no climate change effects on growth in all countries and found only an increase of the harvest potential of 2% in 2030. This increase in growth rate is similar to the average change in growth rate for Europe estimated by Eggers et al. (2008), but there are large differences within Europe. Growth may decrease in Southern Europe due to reduced water availability, whereas growth in Northern regions may increase much more (e.g. Briceño-Elizondo et al. 2006). This means that the impact of growth changes on potential wood supply is probably very different across Europe. Furthermore, disturbances were also not included in the analysis, but could have an important impact. For example, increases in forest fires frequency and intensity could reduce the harvest potentials, whereas increases in storm events could lead to sudden availability of large amounts of wood from forests. The impact of growth changes and large-scale disturbances on potential wood supply is difficult to model and would require further investigation.

4.5.3 Uncertainties related to constraints on biomass supply from forests

The constraints on wood mobilisation applied in this study have been identified in different international processes, in which recommendations have been developed to overcome these constraints. A considerable effort was made to include all the relevant constraints that could be quantified and, at the same time, avoid overlap between the constraints.

There is uncertainty related to the constraints, mainly due to three reasons: First, there may be enough knowledge to quantify a constraint in principle, but there is lack of suitable data. For example, the resolution of elevation models with wide coverage may not allow the detection of small-scale slope variation. Consequently, areas with steep slopes may not be excluded leading to a possible overestimation of the suitable forest area. This can be partly compensated by calibrating the figures with expert estimates from selected countries.

Second, there may be enough knowledge to quantify a constraint for some types of forest biomass in some regions in Europe, but the knowledge for the other biomass types or regions is missing. The reason for this is that extensive use of other compartments than stemwood has just started or is about to start in the EU. Consequently, there is still lack of relevant research results and recommendations for production and harvest of residues, stumps and other biomass. Nordic research results of, e.g., recovery rate were therefore extrapolated to the rest of EU.

Third, there may not be any empirical data for the quantification of a constraint, although the existence of a constraint is known. For example, the reduction in the forest biomass potential due to forest holding size of privately owned forests was based to large extent on expert knowledge. Although the relationship between wood supply and size of forest holdings is considered to be a general challenge in mobilising wood (Schmithüsen and Hirsch 2009; Straka et al. 1984), there is no empirical data on this relationship for European countries. Nevertheless, the constraint was included in the analysis as it has a rather strong impact on the amount of wood that could be mobilised from Europe's forests.

4.5.4 Impacts of increased biomass extraction from forests

This study focused on the wood supply function of forests. It was out of the scope of this study to conduct a full impact assessment on the consequences of each wood supply scenario on other forest functions, although this would be a necessary step in further research. The consequences of increasing wood supply on other functions are not always clear, but mobilising more wood from forests will involve making trade-offs between the different elements of sustainable forest management.

All three mobilisation scenarios are sustainable from the wood supply point of view, in that the projected level of supply can be maintained for at least 50 years. Furthermore, all three scenarios include these basic assumptions:

- Areas which are at present (strictly) protected for conservation of biodiversity are maintained and not converted to forests available for wood supply
- There are no changes in species composition i.e. each type of forest is replaced by the same type of forest after final harvest. Slower growing species are not replaced by faster growing species even in the high mobilisation scenario.
- Constraints or corrective measures (e.g. fertilisation) are assumed, which would prevent site degradation whether through loss of nutrients or by physical processes such as compaction or erosion

However, as a greater part of the forest biomass is harvested in each of the mobilisation scenarios compared to the present situation, there will be less deadwood left behind in the forest than at present, which may have negative impacts on forest biodiversity (Verkerk et al. in press; Hjältén et al. 2010). Extracting more wood from forests may also affect other (environmental) forest functions. Especially the possible effects of stump extraction are still not well understood (Walmsley and Godbold 2010) and these impacts need to be further investigated.

On the other hand, additional labour and machinery would be needed to mobilise the potentials. This could also be considered a positive impact of intensified biomass extraction, because it could lead to increased employment opportunities. The same holds true actually for the whole value chain ranging from the production of forest machines to the end use of biomass, i.e., forest and energy industry. Furthermore, increased use of forest biomass could lead to additional revenues for forest owners. To mobilise the estimated potentials from forests, a significant increase in the labour workforce and machinery could be required. While the availability could not be taken into account as a constraint, the workforce and machinery required was estimated, based on the level of mechanisation and average conditions as in Finland. Assuming similar conditions may not be plausible for many other EU member states where currently a large share of harvests is carried out manually. Nevertheless, it is inevitable that changes are needed to harvest larger amounts of woody biomass. Harvesting has been increasingly mechanised in EU and the development is believed to continue (Asikainen et al. 2009). There is no comprehensive statistics on the machinery used in wood procurement in the EU at the moment. Because of present high share of manual harvesting, the increase in machine need is probably even higher than the calculations based on the actual removals in 2005 show. Therefore, the need for big investments on machines may pose a threat to realising the potentials. Furthermore, with more mechanised harvesting systems, more trained labour may be required to handle all machinery. This calls for increased training for the workforce.

4.6 Comparison of EUwood results with other studies - potential wood energy supply from forests

The realistic potential from European forests estimated within the EUwood project is 747 million m^3 per year (overbark) in 2010 and could range from 625 to 898 million m^3 per year (overbark) in 2030. This potential represents the total potential that could be supplied by forests in the EU, regardless whether it is used for material or for energetic use.

There are several other studies that have also attempted to estimate the potential from forests in Europe, but these studies mainly focused on the potential for energy use. Within the Biomass Energy Europe (BEE) project (www.eu-bee.org/), an overview was made of different studies that estimated the wood biomass potential from European forests (Rettenmaier et al. in prep.). EUwood did not calculate only the bio-energy potential from forests, but it is interesting to compare EUwood results –to the extent possible- to assess what EUwood results mean from the forest energy point of view.

To compare the potentials estimated within EUwood with potentials estimated by other studies, we used the review made by Rettenmaier et al. (in prep.). An overview of the studies included in the review is given in Table 4-2, in which the studies are characterised by:

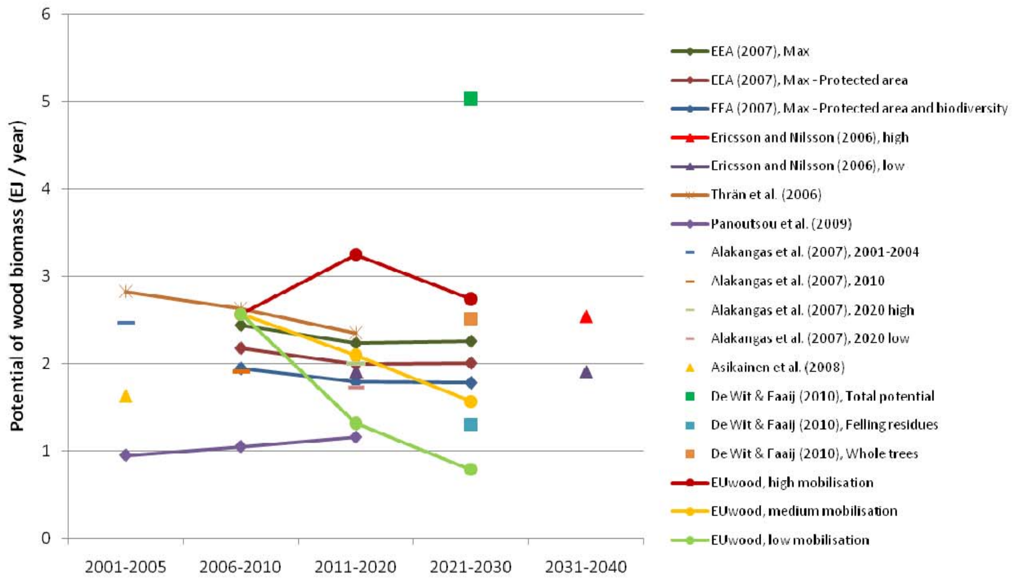
- Type of potential: the amount of wood which can be utilised under given conditions and assumptions;
- Approach: an approach defines the general focus of a biomass assessment:
    - A resource focused approach is applied in 'assessments that focused on the total bioenergy resource base and the competition between different uses of the resources (supply side) (Berndes et al., 2003);
    - A demand-driven approach is applied by studies which analyse the competitiveness of biomass-based electricity and biofuels, or estimate the amount of biomass required to meet exogenous targets on climate-neutral energy supply (demand side) (Berndes et al., 2003);
- Biomass sources: types of biomass included in the potential
- Geographical coverage: the area or countries for which the potential is estimated;
- Time frame: the period for which the potential is estimated;

Table 4-2: Characteristics of different studies that assessed the forest energy potential in Europe

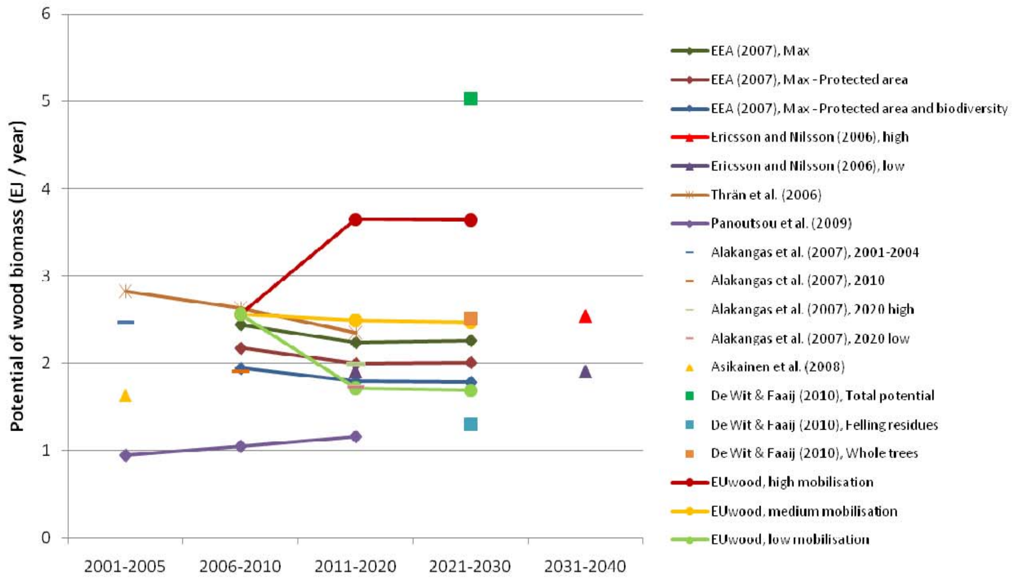
Reference	Type of potential	Approach	Biomass sources	Geographical coverage	Time frame
Alakangas et al. 2007	Technical, economic	Demand-driven	Stemwood, logging residues, stumps, early thinnings	EU20	2001-2004, 2010, 2020
Asikainen et al. 2008	Technical, economic	Resource-focused	Stemwood, logging residues, stumps	EU27	2005
De Wit and Faaij 2010	Technical (economic)	Demand-driven	Stemwood, logging residues	EU27 + Ukraine	2000-2030
EEA 2007	Sustainable	Resource-focused	Stemwood, logging residues	EU25	2010, 2020, 2030
Ericsson and Nilsson 2006	Technical	Resource-focused	Logging residues	EU25 + Belarus + Ukraine	Short term (10-20y), medium term (20-40y), long term (>40)
Panoutsou et al. 2009	Technical	Resource-focused	Stemwood, logging residues	EU27	2000, 2010, 2020
Thrän et al. 2006	Technical, economic	Demand-driven	Stemwood, logging residues	Germany, EU15, EU27 + Turkey	2000, 2010, 2020

Source: Rettenmaier et al. in prep.

For comparison of these studies at the EU level, the differences in geographical scope were accounted for by calculating the average potential (in EJ/ha) of the total area included in the original geographical scope and then multiplying with the total forest area of the 27 EU countries (Rettenmaier et al. in prep., Fig. 1). The potentials estimated in EUwood were added to this comparison, by subtracting the wood needed for material use from the total, realistic potential to arrive at the energy potential. This was done by estimating the needed roundwood, based on a very simple regression model using the demand for sawnwood, veneer and plywood as explanatory variables. The demand for these products was based on the IPCC A1 scenario as presented by Mantau and Saal (2010). Finally, the energy potential was converted to energy units by applying an average conversion factor of 7.2 GJ per m^3 (assumption: 1 m^3 = 2 MWh = 7.2 GJ). However, it is acknowledged that the energy density is dependent on species, tree compartment and moisture content (see e.g. Röser et al. 2008).



a)



b)

Figure 4-15: Comparison of EUwood forest energy potential for 2010, 2020 and 2030, assuming a) an increasing amount of wood allocated to material use based on the IPCC A1 scenario (Mantau and Saal 2010), and b) a constant amount of wood allocated to material use against potentials estimated by other studies

Source: adapted from Rettenmaier et al. in prep.

The estimations of biomass potentials vary reasonably at the European level; the difference between the smallest and largest estimate for the current potential (i.e. potentials estimated up to the year 2010) is 2.5 times the smaller potential. These differences can largely be explained by different types of potentials (technical, economical, sustainable), varying approaches (resource focused or demand driven), methods (scenarios, constraints), different datasets and conversion factors being applied and different biomass types covered by the assessments (for more details see Rettenmaier et al. in prep.).

As shown in Figure 1, the energy potential estimated within EUwood of 2.56 EJ for 2010 compares rather well with other studies. The low and high mobilisation scenarios represent more or less the minimum and maximum range reported by other studies. The total potential estimated by De Wit and Faaij (2010) is considerably higher, because they allocated the complete potential from stemwood to energy use instead of to material use. Altogether, the comparison suggests that the potential for energy estimated within EUwood provide a range of the energy potential in Europe: the potential would be at least 0.79 EJ and depending on policy decisions, the potential could be up to 2.74 EJ in 2030.

Similar to EUwood, the results of EEA (2007) and Thrän et al. (2006) are based on projections by EFISCEN (Table 1). However, the studies differed in many aspects: different constraints have been applied. Furthermore, forest inventory data underlying these projections have been updated in EUwood and sometimes show a higher increment compared to older inventory data. Finally, also the scenario assumptions are different; the forest energy potentials are generally calculated as the amount of wood available, excluding the amount needed for material purposes. Differences in estimations on how much wood is needed for material use (e.g. see the differences in material demand between the IPCC A1 and B2 scenarios (Mantau and Saal 2010)) could hence cause differences in the energy potential. To illustrate this, the wood biomass potential for energy use is shown in Figure 1b in case the harvest of roundwood would remain at the levels in 2010. The results of this calculation show that the energy potential would be 0.90 EJ higher if demand for wood would not change after 2010, compared to the projections presented by Mantau and Saal (2010).

The EUwood results represent the most comprehensive biomass resource potential assessment completed to date, whereas several of the earlier biomass resource assessments left out some biomass compartments and/or focused only on fewer factors influencing the biomass availability. The mobilisation scenarios produce a plausible range between high and low potentials. Future policy instruments will play a decisive role in determining the achievable level of the potential. However, even more important will be economical factors which so far are not adequately considered in the resource assessments.

4.7 Conclusions

The realistic potential from European forests is estimated at 747 million m^3 per year (overbark) in 2010, which represents 58% of the theoretical potential. The projections of future resource use suggest that the realisable biomass potential could range from 625 to 898 million m^3 per year (overbark) in 2030. The large range between the low and high estimates stresses the importance of mobilisation efforts in policy, society and practice.

The constraints included in this study have a big impact on the biomass potentials that could be mobilised from European forests. Environmental considerations related to soil productivity appears to be important when considering the increased use of biomass from forests. Furthermore, the attitude of private forest owners towards increased use of forest biomass is rather unclear and difficult to quantify. Yet, the presented calculation of resource potentials includes the most comprehensive assessment of constraints available to date at the European level. Due to data limitations economic constraints could not be fully integrated to the analysis at the European scale. However, it is recognised that this aspect deserves more attention in follow-up research.

The analysis showed that there are options to increase the availability of forest biomass significantly beyond the current level of resource utilisation. It should be recognised that intensifying the use of forest biomass would affect other forest functions. Implementing the most ambitious scenario would imply quite drastic changes in forest resource management across Europe.

References

Alakangas, E., Heikkinen, A., Lensu, T. and Vesterinen, P. (2007). Biomass fuel trade in Europe. Summary Report VTTR0350807. Jyväskylä, Finland, VTT: 57.

Asikainen, A., Liiri, H., Peltola, S., Karjalainen, T. and Laitila, J. (2008). Forest Energy Potential in Europe (EU27). Working Papers of the Finnish Forest Research Institute. Joensuu, Finnish Forest Research Institute. 69: 33.

Asikainen, A., Leskinen, L.A., Pasanen, K., Väätäinen, K., Anttila, P. & Tahvanainen, T. 2009. Metsäkonesektorin nykytila ja tulevaisuus [The present and future of forest machine technology sector]. Working Papers of the Finnish Forest Research Institute 125. 48 pp. Available at: http://www.metla.fi/julkaisut/workingpapers/2009/mwp125.htm. [In Finnish]

Berndes, G., Hoogwijk, M., van den Broek, R., 2003. The contribution of biomass in the future global energy supply: a review of 17 studies. Biomass and Bioenergy 25, 1-28.

Briceño-Elizondo, E., Garcia-Gonzalo, J., Peltola, H., Matala, J., Kellomäki, S., 2006. Sensitivity of growth of Scots pine, Norway spruce and silver birch to climate change and forest management in boreal conditions. Forest Ecology and Management 232, 152-167.

De Wit, M., Faaij, A. (2010). European biomass resource potential and costs. Biomass and Bioenergy, 34(2): 188-202.

EEA (2007). Environmentally compatible bio-energy potential from European forests. Copenhagen, European Environmental Agency: 54.

Eggers, J., Lindner, M., Zudin, S., Zaehle, S., Liski, J., 2008. Impact of changing wood demand, climate and land use on European forest resources and carbon stocks during the 21st century. Global Change Biology 14, 2288-2303.

Ericsson, K. and Nilsson, L. J. (2006). Assessment of the potential biomass supply in Europe using a resource-focused approach. Biomass and Bioenergy 30 (1): 1-15.

FAO, 2006. Global forest resources assessment 2005. Progress towards sustainable forest management. FAO forestry paper 147. Food and Agricultural Organisation of the United Nations, Rome, p. 320.

Hjältén, J., Stenbacka, F., Andersson, J., 2010. Saproxylic beetle assemblages on low stumps, high stumps and logs: Implications for environmental effects of stump harvesting. Forest Ecology and Management 260, 1149-1155.

Mantau, U., Steierer, F., Hetsch, S., Prins, C., 2008. Wood resources availability and demands - Part I. National and regional wood resource balances 2005 EU/EFTA countries. Background paper to the UNECE/FAO Workshop on Wood balances, Geneva, 31 March - 1 April 2008. UNECE, FAO, University of Hamburg. 65 pp.

Mantau, U. and Saal, U. 2010: Material use. pp 35-42. In: EUwood - Final report. Hamburg/Germany, June 2010. 160 p.

MCPFE, UNECE and FAO, 2007. State of Europe's forests 2007. The MCPFE report on sustainable forest management in Europe. MCPFE Liaison Unit Warsaw, UNECE and FAO, Warsaw. 247 pp.

Panoutsou,C., Eleftheriadis, J., Nikolaou, A. (2009). Biomass supply in EU27 from 2010 to 2030. Energy Policy 37 (2009) 5675–5686.

Rettenmaier, N. et al., (in prep.) Status of Biomass Resource Assessments, Version 2. Biomass Energy Europe, Deliverable Report 3.4. www.eu-bee.org

Röser, D., Asikainen, A., Stupak, I. & Pasanen, K. (2008). Forest energy resources and potentials. In: Röser, D., Asikainen, A., Raulund-Rasmussen, K. (Eds.), Sustainable use of forest biomass for energy. A synthesis with focus on the Baltic and Nordic region. Springer, Dordrecht, pp. 9–28.

Sallnäs, O. 1990: A matrix model of the Swedish forest. Studia Forestalia Suecica 183, 23.

Schelhaas, M.-J., Eggers-Meyer, J., Lindner, M., Nabuurs, G.-J., Päivinen, R., Schuck, A., Verkerk, P.J., Werf, D.C. v.d. & Zudin, S. 2007: Model documentation for the European Forest Information Scenario model (EFISCEN 3.1.3). Alterra report 1559 and EFI technical report 26. Alterra and European Forest Institute, Wageningen and Joensuu, p. 118.

Schmithüsen, F., Hirsch, F., 2009. Private forest ownership in Europe. Geneva Timber and Forest Discussion Papers 49. ECE/TIM/DP/49/SP/25 (preliminary draft) UNECE/FAO. Available at:

http://timber.unece.org/fileadmin/DAM/publications/sp-25-forApproval.pdf

Straka, T., Wisdom, H. & Moak, J. 1984: Size of Forest Holding and Investment Behavior of Nonindustrial Private Owners. Journal of Forestry 8 (82) pp. 495-496.

Thrän, D., Weber, M., Scheuermann, A., Fröhlich, N., Zeddies, J., Henze, A., Thoroe, C., Schweinle, J., Fritsche, U., Jenseit, W., Rausch, L. and Schmidt, K. (2006). Sustainable Strategies for Biomass Use in the European Context. Leipzig, Institute for Energy and Environment: 387.

Verkerk, P.J., Eggers, J., Anttila, P., Lindner, M., Asikainen, A. 2010: Potential biomass supply from forests. pp 71-96. In: EUwood - Methodology report. Hamburg/Germany, June 2010. 165 p.

Verkerk, P.J., Lindner, M., Zanchi, G., Zudin, S. Assessing impacts of intensified biomass removal on deadwood in European forests. Ecological Indicators (in press).

Walmsley, J.D., Godbold, D.L., 2010. Stump harvesting for bioenergy - A review of the environmental impacts. Forestry 83, 17-38.

5 Woody biomass supply from other sources

5.1 Introduction

This chapter presents the potential for woody biomass supply from outside the forest: landscape care wood, short rotation coppice, recovered wood and the residues of the forest industries. Each of these sectors has its own characteristics and supply is driven by different factors in each sector. Often data quality is extremely weak. This chapter brings together the best available estimates for each, derived from varying methods and data sources, in order to construct a truly comprehensive picture

5.2 Landscape care wood and Other wooded land

Author: Jan Oldenburger

Probos, Stichting Probos, Postbus 253, 6700 AG Wageningen

5.2.1 Introduction

The results in chapter 4 illustrate that forests are the main source of primary woody biomass within the EU 27. Wood from trees outside the forest is another important source of primary woody biomass. It becomes available during maintenance operations that are performed in order to keep the plantings in the desired state. In that way this biomass source differs from the forest. In forestry wood is regarded as a product whereas the wood from trees outside the forest is most often considered and/or treated as waste. The material is in many European countries referred to as landscape care wood. For this reason primary woody biomass from trees outside forests is in the EUwood study called "landscape care wood" (LCW). All fresh wood (e.g. roundwood, chips and branches) that is harvested from other sources than forests is included. It does not refer to post-consumer wood or industrial wood residues.

Landscape care wood comprehends plants or plant components, which accumulate within landscape care activities. It refers to woody residues from landscape care such as:

- Maintenance operations, tree cutting and pruning activities in agriculture and horticulture industry
- Other landscape care or arboricultural activity in parks, cemeteries, etc.
- Maintenance along roadsides and boundary ridges, rail- and waterways, orchards
- Gardens

Wood based solid fuel from agriculture such as from short rotation plantations are not considered.

An important source of landscape care wood that is not yet included in the above categories is "other wooded land[4] (OWL). For this reason this very important

[4] Other wooded land definition by FAO: "land not classified as forest, spanning more than 0.5 hectares; with trees higher than 5 m and a canopy cover of 5–10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use."

category is also included, but is treated separately in the analyses. These areas have a low productive potential and the wood that is extracted from the area, becomes available during management operations and not with the intention to produce wood. The other wooded land area within a country can be substantial and as a consequence still result in substantial amounts of wood per year. For instance the Mediterranean maquis / shrub in Greece, France and Spain can cover large areas. This category also includes the mountain tree belts and scattered trees in the boreal region.

5.2.2 Methodology

The landscape care wood potential within the EU 27 has been calculated by making use of five existing country biomass potential studies from France, Germany, United Kingdom, Netherlands and Slovenia. Based on the results of these studies a relationship has been build between the harvest volume from the forest available for wood supply (FAWS) within a country and the landscape care wood volume that is harvested from the non forest land area. This resulted in an average potential of landscape care wood per hectare of non forest land area per country. That is used to calculate the total potential for that country.

To calculate the potential from other wooded land, data on the area are derived from the State of Europe's Forests 2007 (MCPFE, 2007) and these are combined with an increment per hectare that was provided by the countries in the Forest resources assessment 2000 and an assumed harvest level of 75% of the increment. Some countries reported that no wood is harvested on the other wooded land area and that no harvest is expected in the future either. For those countries the potential is set to 0.0 m³.

5.2.3 Results

5.2.3.1 Total potential of landscape care wood in the EU 27

The potential of landscape care wood within the EU 27 is 86.7 million m³ each year (see Table 5-1). Large changes in this potential are not expected before 2030. The major changes will occur in the share of the potential that is actually used for energy production or possibly also in the wood based industry. In 2010 45% of the potential is (mainly) used as fuelwood, 20% goes to composting and the remaining 35% is unused (see Table 5-1). The use of 56.3 M m³ landscape care wood in 2010 (39 M m³ fuelwood and 17.3 M m³ composting) accounts for more than 7% of the total supply of primary woody biomass in the Wood Resource Balance for 2010.

Table 5-1: Landscape care wood potential in the EU 27 and EU 27 sub regions

Region	Total potential [M m³]	Fuelwood [M m³]	Composting [M m³]	Unused [M m³]
EU 27 North	11.7	5.2	2.3	4.1
EU 27 West	37.5	16.9	7.5	13.1
EU 27 East	18.7	8.4	3.7	6.5
EU 27 South	18.8	8.5	3.8	6.6
EU 27 Total	**86.7**	**39.0**	**17.3**	**30.3**

Source: EUwood

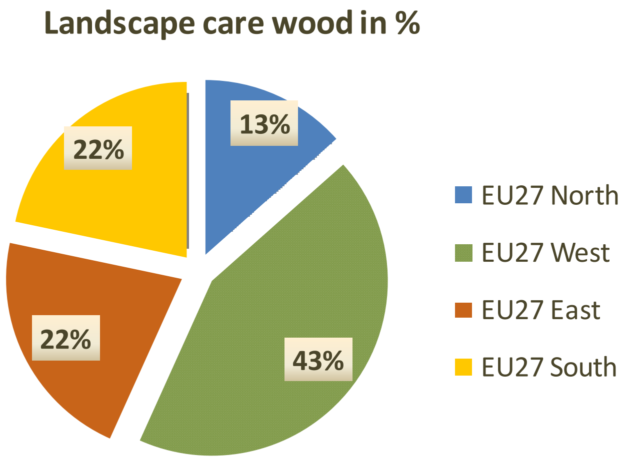


Figure 5-1: Distribution of the LCW potential over the four EU 27 regions

Source: EUwood

Regarding absolute values France has the highest potential of landscape care wood (18.7 M m³) within the EU 27 (see Figure 5-2). This is caused by the large country area in combination with the fact that 75% (47.7 M ha) of the country consists of non forest land area, the source of landscape care wood. In contrast 78% of Belgium consists of non forest land area, but due to the much smaller country area this corresponds to only 2.3 Mio ha and the resulting landscape care wood potential in Belgium is 0.9 M m³. Table 5-2 contains an overview of the landscape care wood potential of each member state.

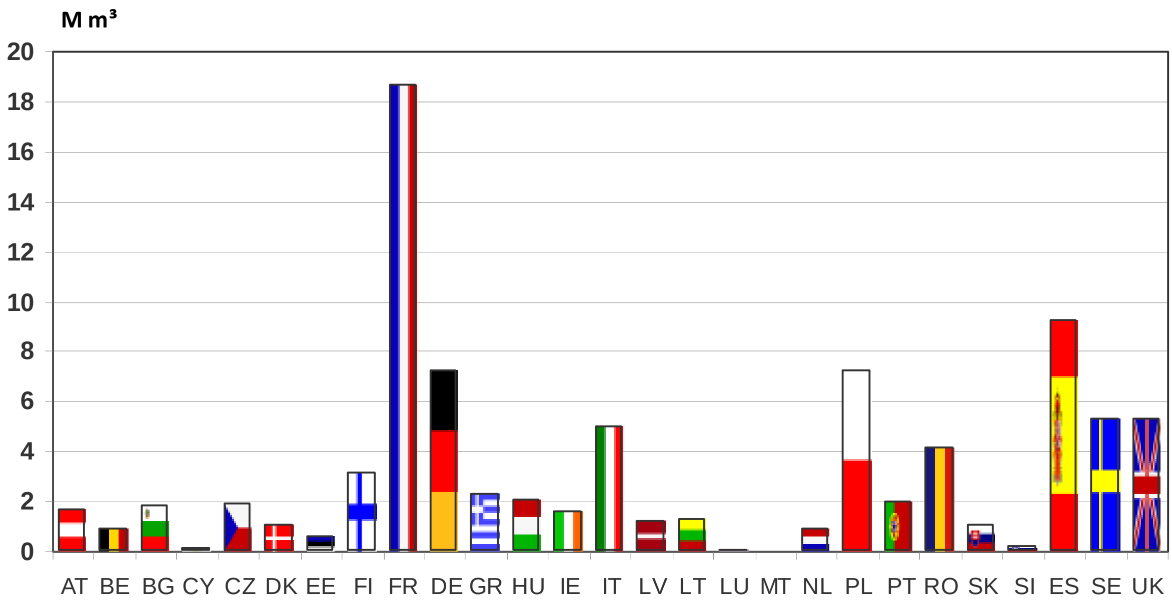


Figure 5-2: Landscape care wood total potential per EU 27 member state

Source: EUwood

Table 5-2: Potential and utilisation of landscape care wood in the EU 27 countries

Country	Potential			Utilisation		
	LCW from trees outside the forest [1,000 m³]	OWL – in countries with areas > 1 M ha OWL [1,000 m³]*	Total (LCW/OWL) [1,000 m³]	Current use (mainly fuelwood) [1,000 m³]	Composting [1,000 m³]	Not used [1,000 m³]
Austria	1,695	-	1,695	763	339	593
Belgium	897	-	897	404	179	314
Bulgaria	1,853	-	1,853	834	371	649
Cyprus	187	-	187	84	37	66
Czech Republic	1,929	-	1,929	868	386	675
Denmark	1,085	-	1,085	488	217	380
Estonia	632	-	632	284	126	221
Finland	3,160	0	3,160	1,422	632	1,106
France	18,137	531	18,668	8,401	3,734	6,534
Germany	7,267	-	7,267	3,270	1,453	2,544
Greece	2,285	0	2,285	1,028	457	800
Hungary	2,106	-	2,106	948	421	737
Ireland	1,604	-	1,604	722	321	562
Italy	4,858	137	4,995	2,248	999	1,748
Latvia	1,213	-	1,213	546	243	425
Lithuania	1,333	-	1,333	600	267	467
Luxemburg	43	-	43	19	9	15
Malta	10	-	10	4	2	5
Netherlands	963	-	963	434	193	337
Poland	7,286	-	7,286	3,279	1,457	2,550
Portugal	2,039	-	2,039	918	408	714
Romania	4,152	-	4,152	1,868	830	1,453
Slovakia	1,093	-	1,093	492	219	383
Slovenia	255	-	255	115	51	89
Spain	8,007	1,286	9,293	4,182	1,859	3,253
Sweden	5,002	319	5,321	2,394	1,064	1,862
United Kingdom	5,311	-	5,311	2,390	1,062	1,859
EU 27	**84,405**	**2,273**	**86,678**	**39,005**	**17,335**	**30,337**

* If (-) is reported, the potential from OWL, if available, is included in the LCW potential for that country.

Source: EUwood

5.2.3.2 Segments of landscape care wood

In order to give some insight into the share of different segments within the landscape care wood potential three of these segments are presented in this paragraph. These segments are: wood from horticulture, wood from urban areas and wood harvested from other wooded land. Due to the lack of data it was impossible to calculate the potential for the other segments separately and for this reason they are presented as the category other (see Table 5-3).

Table 5-3: Landscape care wood potential divided by segments

Segment	Potential [M m³]	Share [%]
Horticulture	16.0	18.5
Urban areas	22.0	25.4
Other wooded land	2.3	2.7
Other	46.4	53.5
Total	**86.7**	**100**

Source: EUwood

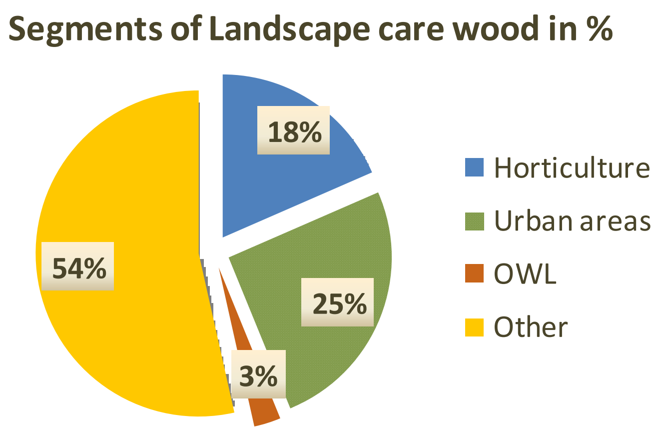


Figure 5-3: Share of different segments in the landscape care wood potential

Source: EUwood

5.2.3.3 Wood from horticulture

The total landscape care wood potential from horticulture is 16.0 M m³ per year. The wood becomes available during the management and reestablishment of olive trees, orchards and vineyards. As a consequence of the large areas of these plantings in Spain and Italy these countries have the highest potential for this segment within the EU 27 (see Figure 5-4. There still is a large unused potential within this segment, especially in countries with smaller areas of these plantings, because large amounts of this source are still burned on the fields instead of being brought to the market.

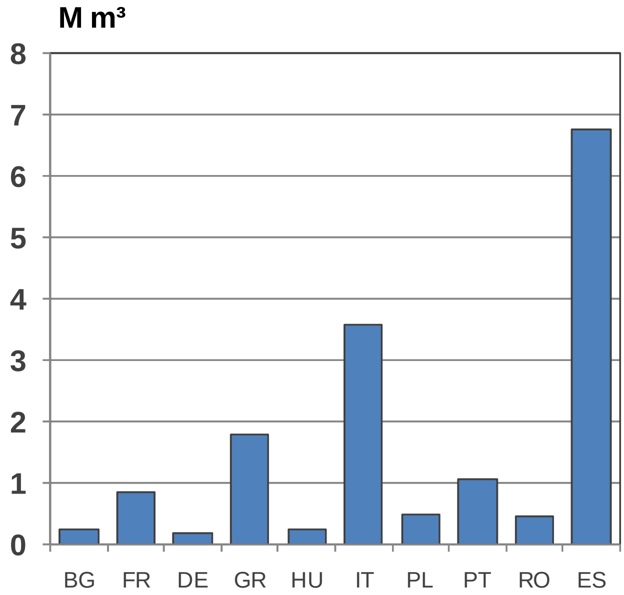


Figure 5-4: Countries with highest potential from orchards and vineyards

Source: EUwood

5.2.3.4 Wood from urban areas

As wood from urban areas becomes available as primary biomass outside the forest, it is included in the landscape care wood potential. Although, based on its origin, one would not immediately think of it as such.

The potential consists of wood from private gardens and wood from the maintenance of parks, roadside trees and other plantings in urban areas. The results of the EUwood study indicate a total potential of 22 M m³ per year in this segment.. The potential in a country is very much dependent of the number of inhabitants. This is illustrated by Figure 5-5 in which the countries with high population numbers have also high potentials within this segment.

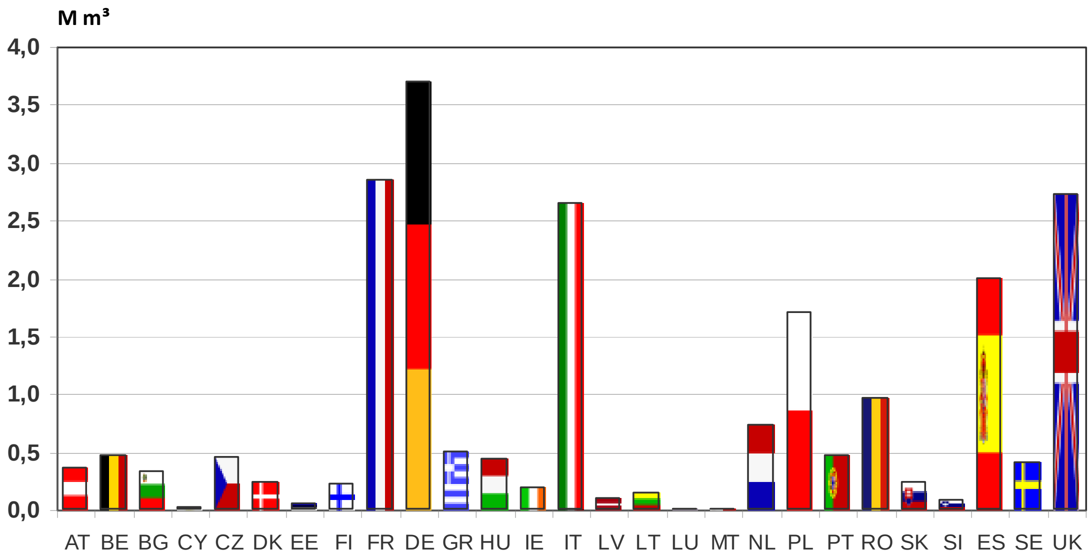


Figure 5-5: Wood from urban areas per EU 27 member state

Source: EUwood

The current use of the potential is very much dependent on the collection structures that are in place within a country. In countries such as the Netherlands and Germany the collection of garden waste is very well organised and for this reason the largest share of this potential is already utilised as fuel wood or as composting material.

Another important issue within this category is the large amount that is used by the “producers” of the material themselves and does not come to the market. Especially private households use the stemwood of trees that are felled in their private gardens as fuelwood themselves or give the wood away to people owning a wood stove.

5.2.3.5 Other wooded land

Although the potential of 2.3 M m³ from other wooded land is low compared to the potential in the other segments it is presented here. The reason for presenting this segment is the fact that the potential is concentrated in just four EU 27 member states. These member states are Spain, Italy, France and Sweden. Greece and Finland also has large areas of other wooded land, but according to these member states no wood is harvested within their other wooded land area. Table 5-4 gives an overview of the potentials for the four member states.

Table 5-4: Other wooded land areas and potentials

Member state	Area [1,000 ha]	Potential [M m³]
France	1,700	0.53
Italy	1,050	0.14
Spain	10,300	1.29
Sweden	3,060	0.32
Total	**16.110**	**2.27**

Source: EUwood

5.2.4 Developments in the use of landscape care wood

Three different scenarios (low, medium and high) have been used to account for the effect of different economic developments on the actual use of landscape care wood until 2030. As an example the results for the medium scenario are presented in Table 5-5. Under the medium scenario 60% of the potential is actually used as fuelwood, 15% goes to composting and 15% of the potential is still unused in 2030.

Table 5-5: Developments under medium scenario

	2010	2015	2020	2030
Total potential	86.7	86.7	86.7	86.7
Used	39.0 (45.0%)	43.4 (50.0%)	47.7 (55.0%)	52.0 (60.0%)
Composting	17.3 (20.0%)	15.9 (18.3%)	14.5 (16.7%)	13.0 (15.0%)
Unused	30.4 (35.0%)	27.4 (31.7%)	24.5 (28.3%)	21.7 (25.0%)

Source: EUwood

Figure 5-6 illustrates the development of the volume of landscape care wood that is used as fuelwood and for composting, under the three different scenarios in relation to the total landscape care wood potential within the EU 27. According to these scenarios, even under the high scenario, the total landscape care wood potential will not be used in the year 2030.

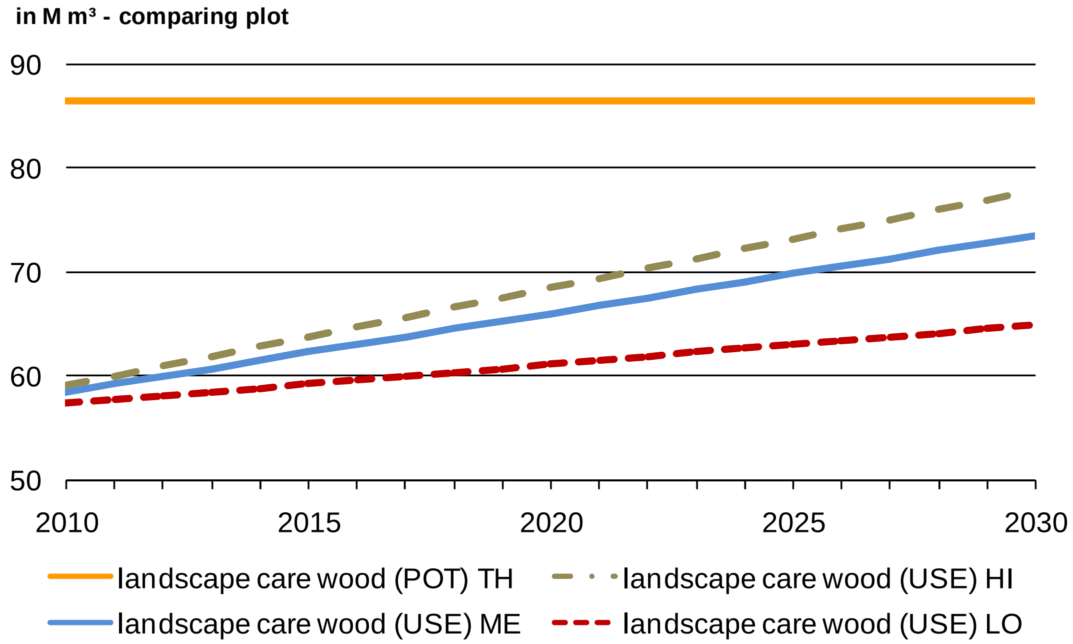


Figure 5-6: Development of LCW use (scenarios) in relation to the total potential

Source: EUwood, Oldenburger, J.F., Landscape care wood, 2010

5.2.5 Conclusion and discussion

Landscape care wood is an important source of primary woody biomass that becomes readily available within the EU 27. Due to the fact that it results from regular management operations it seems to be easy to fully utilise the potential. However due to the fact that the procurement costs for landscape care wood are in some cases rather high, a large share of the potential is still not utilised. The high procurement costs are caused by the nature of this biomass source. A large share of the landscape care wood becomes available in small volumes, at scattered locations and with a low density (e.g. branches instead of roundwood).

Due to the expected much larger demand from the energy sector and wood processing sector it is expected that the procurement costs will be reduced by the application of (new) technologies and by a better organisation of the collection chain. Next to this the higher demand will also result in higher prices that will be much closer to the procurement costs.

While calculating the potential a possible intensification of the management of the plantings outside forests and the establishment of new plantings with the aim of producing biomass, has not been taken into account. If this would happen the landscape care wood potential would of course be higher.

The calculation of the landscape care wood potential in EUwood is based on the assumption that this wood becomes available as a result of general management activities. The plantings from which landscape care wood is harvested are not considered as sources for wood production. This could change due to the large demand for wood in the coming decades. Rather than focussing on the challenge of fully utilising the available potential, it might be possible to change the management of these plantings to maximise the supply of wood. This might result in cost reductions and a stronger increase of the available potential. However, intensifying the management should not to lead to degradation of the other values of the plantings (e.g. source of biodiversity or part of historic landscape patterns).

5.3 Short rotation plantations

Author: Nico Leek

Probos, Stichting Probos, Postbus 253, 6700 AG Wageningen

5.3.1 Introduction

There are high expectations for the contribution of energy crops to the European feedstock demand for renewable energy. Both agricultural crops and woody perennials are subject for different studies. The EUwood project concentrates on the future contribution of short rotation plantations.

Short rotation plantations are defined as plantings established and managed under short rotation intensive culture practices. They can be established with fast growing tree species like poplar, willow, black locust (Robinia *pseudoacacia* L.) and eucalypt. These species have rotation cycles of 10 to 15 years or can be managed as a coppice system with 2 to 4 year rotation. Plantations with rotations from 10 to 15 years are mainly used for fibre production for the pulp and paper industry. This management system includes most often replanting. For energy purposes short rotations of 2 to 4 year with coppice management are more in favour. The EUwood study focused on the future perspectives of short rotation coppice (SRC).

However, no data are available for the area of short rotation plantations (rotation 10 to15 years) in the EU countries. These plantations are either registered as forest area or are part of trees outside the forest (and not registered). Existing wood production is included in those categories.

An exception can be made for the area of short rotation coppice, especially because these plantations are more or less established as an energy producing crop system. A first analysis of literature shows that the existing area of SRC is estimated to be about 30,000 hectares. Only Sweden and UK have a substantial area of SRC, while countries like Poland, Austria and Denmark exploit 1,000 to 1,500 hectares. In the other countries there are no or smaller areas planted, which however, are trial plantations to estimate local or regional productivity.

Assuming a mean productivity of 8 oven dry tonnes (odt) per hectare for the EU 27 countries the SRC plantations produce about 240,000 odt of wood in the EU 27 annually. For the moment that is a relatively small contribution to the total woody biomass supply.

5.3.2 Benchmarks from existing studies

The main uncertainty at the moment is not what kind of bio-energy crops should be planted for renewable energy (heat, electricity and fuels), but rather how much land will be devoted to energy production.

In recent years different studies have been made for the EU Commission on modelling the future area of bio-fuel crops in Europe. The results of these studies show great variations in the area, which could become available from agriculture and used for bio-energy crops in the next two decades.

Table 5-6 presents the main results of the analysed studies in which the potential land area available for bio-energy crops in Europe has been estimated based on different modelling processes. These modelling studies do not focus solely on woody crops, but take woody crops as one of the large variety possible bio-energy crops.

The results show big differences in the area available for energy production in Europe. The highest potentials are found in Eastern European countries.

Table 5-6: Land area for bio-energy crops in Europe in 2030 based on different studies

Study	Available land area [M ha]	Remark
Van Dam et al., 2006	44.0	For CEEC
Hetsch, 2009	8.5	4.3 M ha set aside land, 4.2 M ha fallow land without subsidies
EEA, 2007	16.0	
Hellman & Verburg, 2009	20.16 0.008	Agricultural crops Woody crops
Fischer et al., 2009	2.7 – 16.4 19.7 – 29.3 22.4 – 45.7	EU 15 EU 12 EU 27
De Wit and Faaij, 2009	41.0 – 90.0	
Biomass Action Plan (Germany), 2009	1.3	Germany, 11% of arable land area

5.3.3 Discussion

The rather small contribution of SRC at the moment and the large variation in the outcomes of the studies performed to estimate the available land area for bio-energy crops in the future, make it highly speculative to include potentials from short rotation coppice in the EUwood projections. Therefore EUwood decided not to include future potentials from these kinds of plantations in the Wood Resource Balance, but to take them into account in the discussion of the overall situation.

Although land use is decided by landowners, the perspectives of short rotation coppice are strongly influenced by agricultural policies of the EU as well as on the competitiveness of woody biomass with agricultural crops. According to van Dam et al. (2006) the production of lignocellulosic crops and willow in particular, best combines high biomass production potentials and low biomass production costs.

Short rotation coppices are one of the options to compensate for the resource deficits in 2030 that are predicted by the EUwood projections (low, medium and high mobilisation scenarios and scenario A1). To give an idea of the area of SRC needed to compensate for these deficits, this area of SRC is estimated by applying two imaginary, but realistic, productive coppice systems (low: 4 odt/ha*a and high 12 odt/ha*a).

Table 5-7: Land area needed for SRC to compensate for the resource deficits under the three forest mobilisation scenarios and scenario A1 by applying a low and high productive coppice system

Levels of mobilisation	Resource deficit in 2030 [M m³ rwe]	Area demand for SRC for two production rates [M ha]	
		4 odt/ha*a	12 odt/ha*a
LOW	424	42.4	14.1
MEDIUM	316	31.6	10.5
HIGH	153	15.3	5.1

Source: EUwood and Mantau, U.: Wood Resource Balance, 2010

According to these calculations the minimum area needed to fulfil the wood demand for energy in 2030 lies between 5.1 and 15.3 million hectares of agricultural land (high mobilisation scenario) (see Table 5-7). The demand for woody energy plantations would be considerable higher (14.1 to 42.4 million hectares) under the low mobilisation scenario.

The medium mobilisation and a medium productive coppice system (20 m³/ha*a) are used to illustrate the implications of using SRC to fulfil the large demand for wood in the future. Under the medium mobilisation scenario the resource deficit is 316 M m³. To compensate for this deficit 26 million hectares of SRC would be required if the medium productivity coppice system is applied. These 26 M ha equal 24% of the total arable land area in the EU 27. The German government comes to the same order of magnitude in its Biomass Action Plan (BMU and BMELV, 2009) Based on these figures it can be concluded that large efforts are needed if SRC is chosen to compensate for the expected large demand of woody biomass in the decades to come.

References

BMU and BMELV, 2009. Nationaler Biomasseaktionsplan für Deutschland. Beitrag der Biomasse für eine nachhaltige Energieversorgung. Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz and Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin, 32 p.

Dam, J. van, A.P.C. Faaij, Lewandowski, I. and Fischer, G., 2007: Biomass production potentials in Central and Eastern Europe under different scenarios. Biomass and Bioenergy 31 (2007), 345-366 pp.

EEA, 2007: Environmentally compatible bio-energy potential from European forests. European Environment Agency, Copenhagen, 53 p.

Fischer, G., Prieler, S., van Veldhuizen, H., Lensink, S.M., Londo M. and de Wit, M. 2009: Biofuel production potentials in Europe: Sustainable use of cultivated land and pastures, Part 2: Land productivity. Biomass and Bioenergy 34 (2010), 173-187 pp.

Hellmann, F., P.H. Verburg, 2008: Spatially explicit modeling of biofuel crops in Europe, Biomass and Bioenergy 32 (2008), 1-14 pp.

Hetsch, S, 2009, Potential Sustainable Wood Supply in Europe, Geneva Timber and Forest Discussion Paper 52, UNECE/FAO Timber Section, Geneva, Switzerland, 44 p.

de Wit, M., Faaij, A. 2010: European biomass resource potential and costs. Biomass and Bioenergy, 34 (2010) 188-202 pp.

5.4 Post-consumer wood

Author: Nico Leek

Probos, Stichting Probos, Postbus 253, 6700 AG Wageningen

5.4.1 Introduction

Post-consumer wood (PCW) includes all kinds of wooden material that is available at the end of its use as a wooden product ("post-consumer" or "post-use" wood). Post-consumer wood mainly comprises packaging materials, demolition wood, timber from building sites, and fractions of used wood from residential (municipal waste), industrial and commercial activities.

The primary sources for post-consumer wood are:

- Municipal solid wood waste mainly from households
- Construction waste and demolition wood
- Fractions of used wood from industrial and commercial activities (primarily packaging materials, including pallets).

Waste statistics in general and the data on wood waste generation in particular are rather weak, although they have improved considerably since 2004. There is no reliable international and up to date database available for the production and trade of post-consumer wood.

Most information about post-consumer wood in the countries of the EU 27 was collected by the COST E31 group. This group estimated the available amounts of recovered wood for 17 EU 27 member states, based on a country inquiry carried out by the COST E31 participants. The COST E31 group found large differences between countries. The results for Austria, Germany and the Netherlands are based on research projects and are considered as most reliable. Results present an amount of supplied post-consumer wood of 96.0, 72.0 and 76.0 kg per capita, respectively. The data for the other European countries are mainly based on estimates.

As no complete dataset for the reference year 2007 is available Steierer (in Mantau et al., 2009) combined and analysed all available data for the year 2007 to update the Wood Resource Balance 2007 to construct a reliable dataset. The dataset is constructed by using 2006 Eurostat data on generated wood waste volumes and amounts of recovered wood waste[5], data from the former COST Action E31 (2005) as well as a global extrapolation of results from empirical research in Germany and the Netherlands (100kg as average theoretical potential volume of wood waste generated by citizen/year – of which 3/2 appear in waste streams). Partial information on post-consumer wood is also derived from the GESbois questionnaire as well as the Joint Wood Energy Enquiry.

5.4.2 Volumes of Post-consumer wood in 2007 for EU 27

To make an estimation of the volume of post-consumer wood that is expected to be generated in the EU 27 in 2030 it is in the first place necessary to start with the most

[5] Excluding ISIC sectors wood working industries and pulp sector - these volumes are considered under wood residues

reliable data for the present situation. For this reason the dataset constructed by Steierer (in Mantau et al.,, 2009) is used to provide default values for the amount of post-consumer wood in 2007 for most EU 27 countries. The data for Belgium, Estonia, Finland and Sweden were adjusted by the author. In the UK and Netherlands data from studies that have been performed in the year 2008 were used to update the dataset for the year 2007.

The total supply of post-consumer wood in 2007 in the EU 27 is estimated to be 55.4 M m³. Because of the different data basis in the A1 and B2 scenario the starting value for post-consumer wood in 2010 in scenario A1 was 52.0 M m³. Differences in the volumes of post-consumer wood between the countries of the EU 27may occur due to the influence of the number of inhabitants. Moreover, there are regional differences regarding the potential volume per capita: Eastern and Southern European countries generate lower volumes of post-consumer wood at the moment (see table 5-8).

Table 5-8: Regional differences for post-consumer wood per capita

Region	Volume [kg/cap]
Northern countries	110.0
Western countries	75.0
Southern countries	60.0
Eastern countries	55.0

Another difference between the European regions is the recovery rate of post-consumer wood i.e. what share of the generated wood waste is actually used. In the year 2007 36 M m³ post-consumer wood were used for panel production and for energy. Thus, about two thirds of the generated post-consumer wood is recovered. Especially clean waste wood is recovered for the particle board production (18.1 M m³) and 16.9 M m³ is used in the energy industry.

One third of the total generated post-consumer wood is not used at the moment in the EU 27. That accounts for a volume of 20.4 M m³. In Eastern- and Southern European countries as well as in UK and Ireland the majority of post-consumer wood, approximately 17.5 M m³, is landfilled. The Northern and Western European countries have a high rate of re-use of post-consumer wood. The post-consumer wood in these regions is used as a resource for the panel industry or other material uses or for the production of energy. Only a small part (3.0 million m³) is land filled or incinerated in these regions.

5.4.3 Projection of volumes of Post-consumer wood

The relation between the solid wood consumption per capita and the share of post-consumer wood in the total national solid wood consumption in 2007 was used for the prediction of the future post-consumer wood supply in the EU 27 countries. The national solid wood consumption (sawn wood and panel consumption) was calculated for the years 2010, 2015, 2020, 2025 and 2030 from the data sets of econometric modelling (Future Forest, Jonsson) both for the scenarios A1 and B2. The total potential of post-consumer wood for each country of the EU 27 in 2010 and 2030 is shown in Figure 5-7.

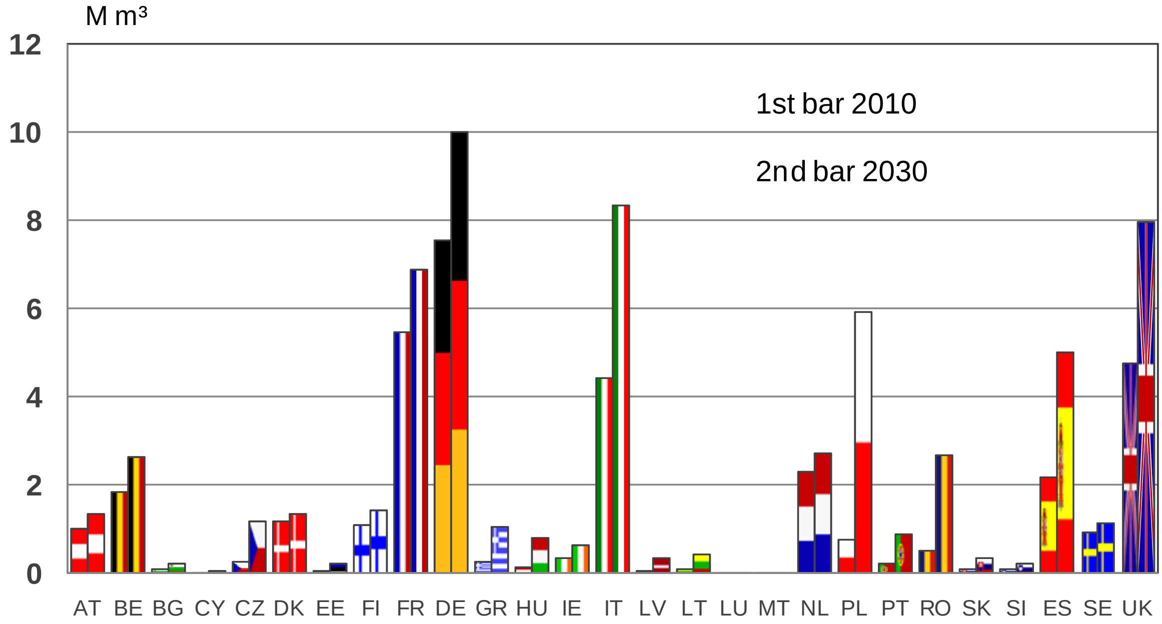


Figure 5-7: Estimated supply of PCW for the EU 27 countries in 2010 and 2030 – scenario A1

Source: EUwood

The total supply of post-consumer wood for the EU 27 in 2030 is estimated for the A1 scenario at 67.3 M m³ and for scenario B2 at 58.6 M m³. Compared to the supply of post-consumer wood in 2010 this equals a growth of 29% for the period up to 2030 for A1 and 12.7 % growth for B2.

As can be expected from the population distribution in the EU 27 half of the post-consumer wood is generated in the western region, shown in Figure 5-8.

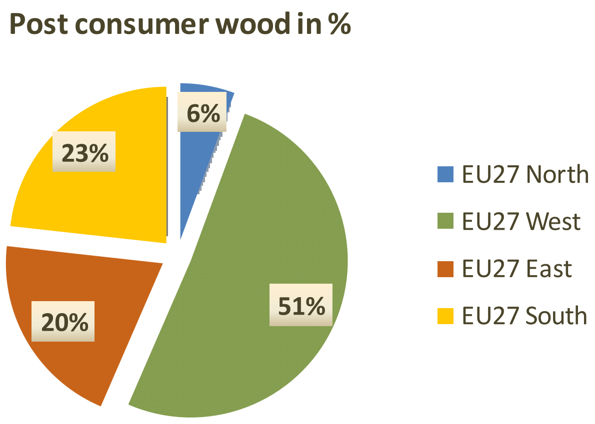


Figure 5-8: Projected shares of the EU regions of the total PCW volume in 2030 – scenario A1

Source: EUwood

The growth of the post-consumer wood volume from 2010 to 2030 is illustrated in Figure 5-9.The graph shows the development of post-consumer wood in total (=POT), of post-consumer wood recovered (=USE) and post-consumer wood landfilled or incinerated (=DIS).

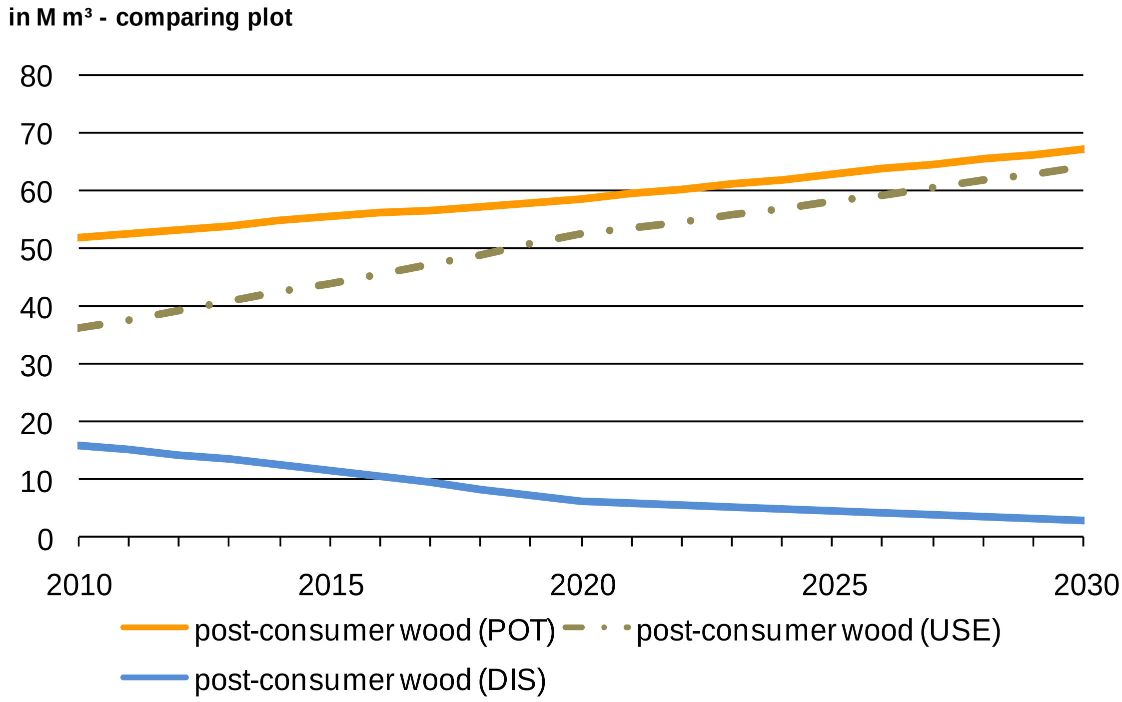


Figure 5-9: Potential, use and disposal of PCW for the EU 27 countries– scenario A1

Source: EUwood, Leek: Post-consumer Wood, 2010

It is obvious that the volume of post-consumer wood, which is landfilled will decrease strongly in the coming years. The EU Landfill Directive 1999 set targets for the quantity of biodegradable municipal waste (BMW) that each EU member state can send to landfill. The UK for instance is required to reduce the amount of BMW sent to landfill by 2010 to below 75% of its 1995 level. Moreover, for the year 2013 the UK is required to reduce the volume by 50 % (2020, 35%) of the 1995-level. As a consequence of this EU Landfill Directive the quantity of wood waste that is recycled will increase in the future, but the generated total volume of wood waste is not influenced by it.

The targets in the Landfill Directive seem to be very promising, but the process has been delayed and some countries are only now starting the process of reducing their share of land filled waste. For this reason the share that goes to disposal is not set to zero in 2030. In the calculations for 2030 it is assumed that still 5% of post-consumer wood is land filled. Another reason for this is the fact that especially the wooden parts in municipal waste are not easily separated from the rest of this waste stream and is for this reason not identified as such.

References

Mantau, U., Saal, U., Lindner, M., Verkerk, P.J., Eggers, J., Goltsev, V., Asikainen, A., Anttila, P., Leek, N., Oldenburger, J., Prins, K., Steierer, F., 2009:. Real potential for changes in growth and use of EU forests. State of the art report of the EUwood project for DG ENER (unpublished). 173 pp.

5.5 Industrial wood residues

Author: Ulrike Saal

University of Hamburg, Leuschnerstr. 91, 21031 Hamburg

5.5.1 A source that grows with production

Supply of industrial residues is directly dependent on the input of raw material and the output of products in the forest industries. The source grows irrespective of further distribution and competition of energy and material use. It can be considered as a reliable supply source for future needs. Modelling and calculations of the particular segments of industrial wood residues in the EUwood study results in a volume of about 188.07 M m³ swe in 2007. The applied method made it possible to consider different structural conditions in the forest industry sector in the EU 27 countries. Thus, results on all industry structures, from traditional sawmill to large size panel mills are reflected.

5.5.2 Saw mill by-products

5.5.2.1 Segment

Volumes of sawmill by-products (SBP) of a unit (sawmill, region or country) differ considerably. The amount of sawmill by-products is dependent on factors describing the material balance as well as other influencing factors. The material balance mainly comprises recovery rate and the species sawn (coniferous/ non-coniferous).

The recovery rate describes the ratio of roundwood input to sawnwood output of the considered unit. Influencing parameters are the sawn species, sawmill size and technology applied. Considering larger units such as a country, the recovery rate is further dependent on the country's sawmill size structure as well as special characteristics of vegetation respectively roundwood characteristics (e.g. log dimensions, shape and species composition).

Moreover, the mentioned factors have an important effect on the shares of particular sawmill by-product assortments (compare Saal, 2010 in EUwood, 2010, tables 5-11 and 5-12). The produced volumes of sawmill by-product assortments, especially slabs and chips differ considerably, dependent on sawn species and sawmill technology applied.

To estimate the volumes of sawmill by-products, EUwood used a model to assign a recovery rate to each country of the EU 27 and classify each country according to a particular sawmill size structure

Necessary assumptions for modelling include assumptions on technology, vegetation as well as sawmill sizes and size structures.

5.5.2.2 Results

Recovery rate

The following Figure 5-10 shows the assigned recovery rates of coniferous and non-coniferous sawmills as well as the resulting shares of sawmill by-product assortments.

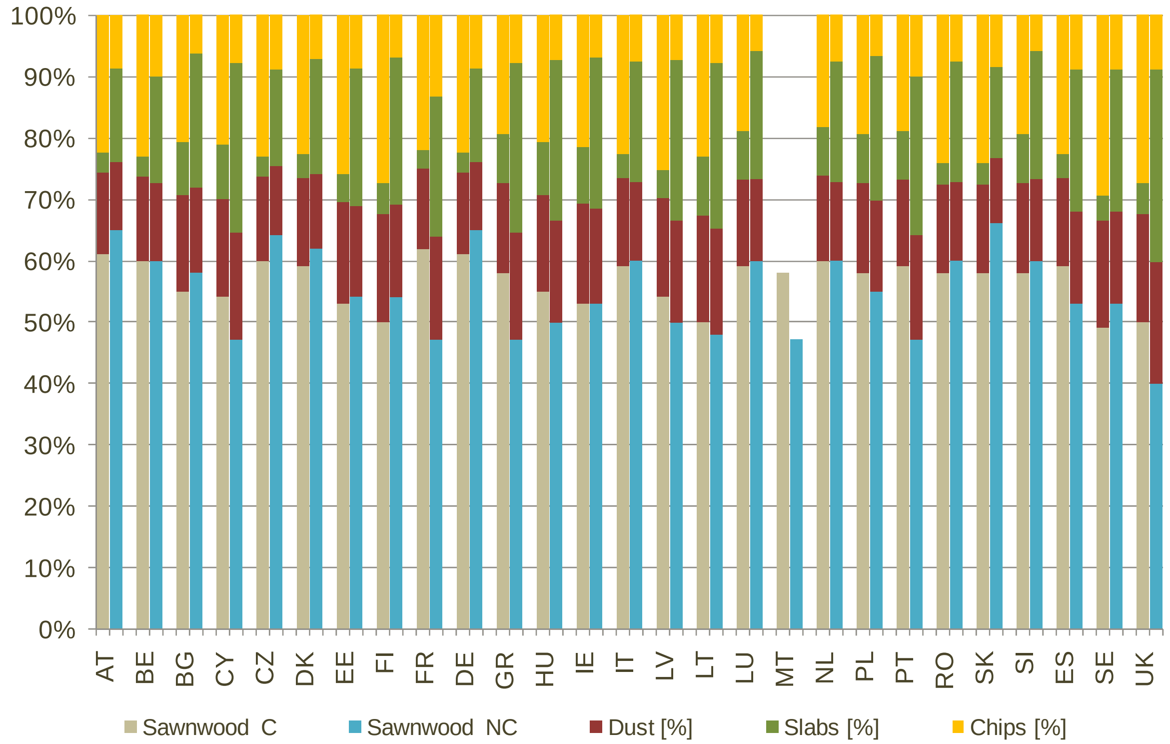


Figure 5-10: Material recovery from C/NC sawnwood production and SBP shares [%]

Source: EUwood

Sawmill size structure and sawmill by-product assortments

Due to different size structures within the EU 27 countries, three different size classes where defined. Based on several criteria, the EU 27 countries are classified into three groups (A, B, C) according to the structure of their sawmilling industry. Countries of structure type A are characterised by mostly large and very large (> 500,000 m³) sawmills, type B by large but no very large mills, whereas type C is characterised by medium and small sawmills only. The following Table 5-9 shows a few examples of the classification.

Table 5-9: Examples of classification of EU 27 countries by structure type

Coniferous sawmill size structure type			Non-coniferous sawmill size structure type		
A	**B**	**C**	**A**	**B**	**C**
Austria	Denmark	Bulgaria	Austria	Romania	Bulgaria
Czech Rep.	Finland	Greece	Germany	Estonia	Finland
Germany	Latvia	Ireland	Slovakia	Netherlands	Hungary

Source: EUwood

Shares of sawmill by-product assortments

The respective share of sawmill by-product assortments depends on the sawmill size structure of a country. The following table gives an overview about the differing shares of the assortments within the three size classes.

Table 5-10:Shares of sawmill by-product assortments

Coniferous				Non-coniferous			
Type	Dust	Slabs	Chips	Type	Dust	Slabs	Chips
A	33.32	4.53	62.15	A	31.66	43.40	24.97
B	35.26.	4.93	59.82	B	32.12	48.84	19.09
C	35.05	11.49	53.48	C	32.97	52.12	14.96

Source: EUwood

The structures, which are assumed to describe the national sawmill industry size and structure may be subject to changes. National economics (demand/supply/ownership issues) natural effects or technical development influence the structure and thus, the resulting shares of sawmill by-products.

The economic development since the end of the year 2008 has led to significant reductions in sawmilling capacity in Europe. Especially in Finland and Estonia, many large size sawmills closed or decreased their annual capacity to < 500,000 m³. In turn, a shift in production towards large and extra-large sawmills due to growing economy would affect the resulting volumes of sawmill by-products as well as the shares of the assortments.

Positive economic development may further influence the classification by size structure type (compare Saal, U., in Mantau, et al. 2010).

Shifts within size structures may change the shares of assortments can considerably. An increase in chips (decrease of slabs) supports and influences the material flow and directions of further processing and utilisation of sawmill by-products. However, these considerations do not influence the total volume of sawmill by-products. Only a change of the material recovery (recovery rate) would influence the volumes. These changes could occur in case of changes in the total sawmill industry structure of a unit.

Projection of sawmill by-products potential 2010 - 2030

As already mentioned, the resource grows with production. This effect becomes obvious from Figure 5-11, which shows the projected growth of the sawmill by-products.

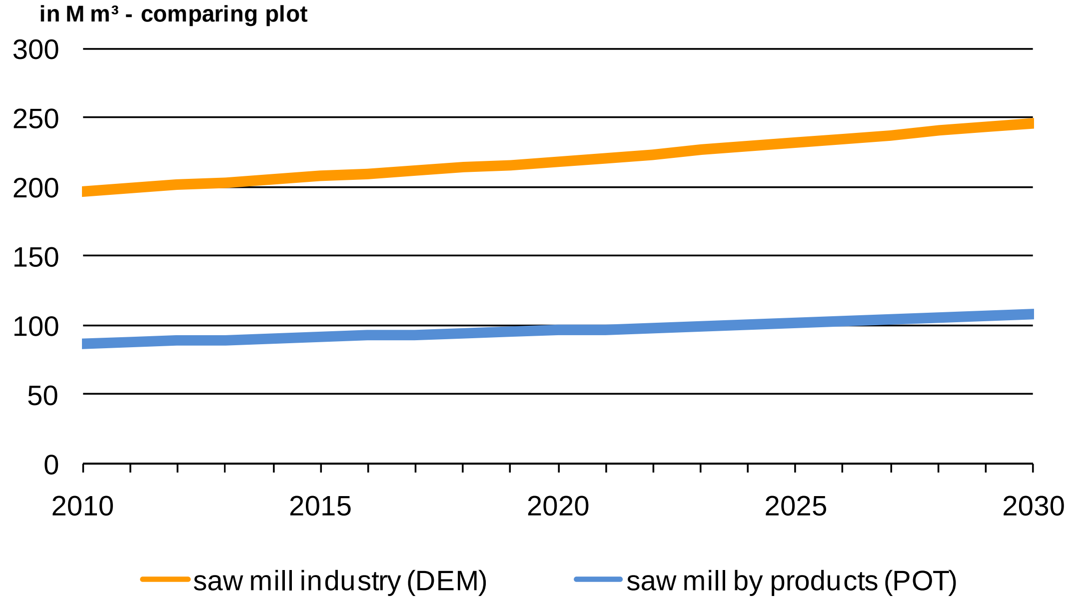


Figure 5-11: Projection of growth – sawmill industry demand and by-products

Source: Saal, U. Industrial residues and by-products, 2010 and Mantau, U.: Wood Resource Balance, 2010 based on Jonsson, R.: Econometric modelling, 2010

5.5.3 Other industrial wood residues

5.5.3.1 Segments

The segment of other industrial wood residues (oIWR) includes wood residues arising during production of semi-finished wood products as well as during their further processing (resawing, planing) and the production of manufactured wood products (construction, furniture, etc.). By origin, other industrial wood residues clearly have to be separated from sawmill by-products. Further reasons for a differentiated consideration are that sawmill by-products are a natural resource without additives and have their origin in one specific industrial source, whereas other industrial wood residues often contain additives/contaminants and have a wide variety of scattered sources.

Particular assortments of other industrial wood residues are small fractions such as dust and shavings from planing, milling and drilling. Other assortments are trimmings, rejects, peeler cores or offcuts. Following, the main results for the segments of semi-finished and manufactured wood products are presented below.

5.5.3.2 Residues from semi – finished products

Coefficients of shares and material recovery rates for different wood-based panels are given by the updated life cycle analysis for wood products (Mantau & Bilitewski, 2010). Concerning the composition of wood-based panels, the coefficients cover density differences of input raw material and output products by means of considered compression. Data by Mantau & Bilitewski (2010) are supplemented and combined with conversion factors by Fonseca (2010) (see Table 5-11).

Table 5-11: Coefficients for wood-based panels

Product	Factor m³rw/m³p (Mantau, 2010)	Factor m³rw/m³p (Fonseca, 2010)	Share of wood residues per m³ roundwood input
Particle board	1.48	1.51	3.94%
OSB	1.47	1.63	9.80%
MDF	1.80	1.68	9.61%
Hardboard		2.03	11.61%
Insulation board		0.83	4.75%
Veneer/ Plywood		1.87	45.00%

Source: Mantau & Bilitewski, 2010, Fonseca, 2010, EUwood

Basically, a similar production technology for wood-based panels is assumed throughout the EU 27 countries. Moreover, due to less detailed available data, the production process of hardboard and insulation board is assumed to be similar to the production of MDF. Different densities and raw material input are set in relation. Figure 5-12 shows the shares of considered wood-based panels on production and their share on the total volume of other industrial wood residues.

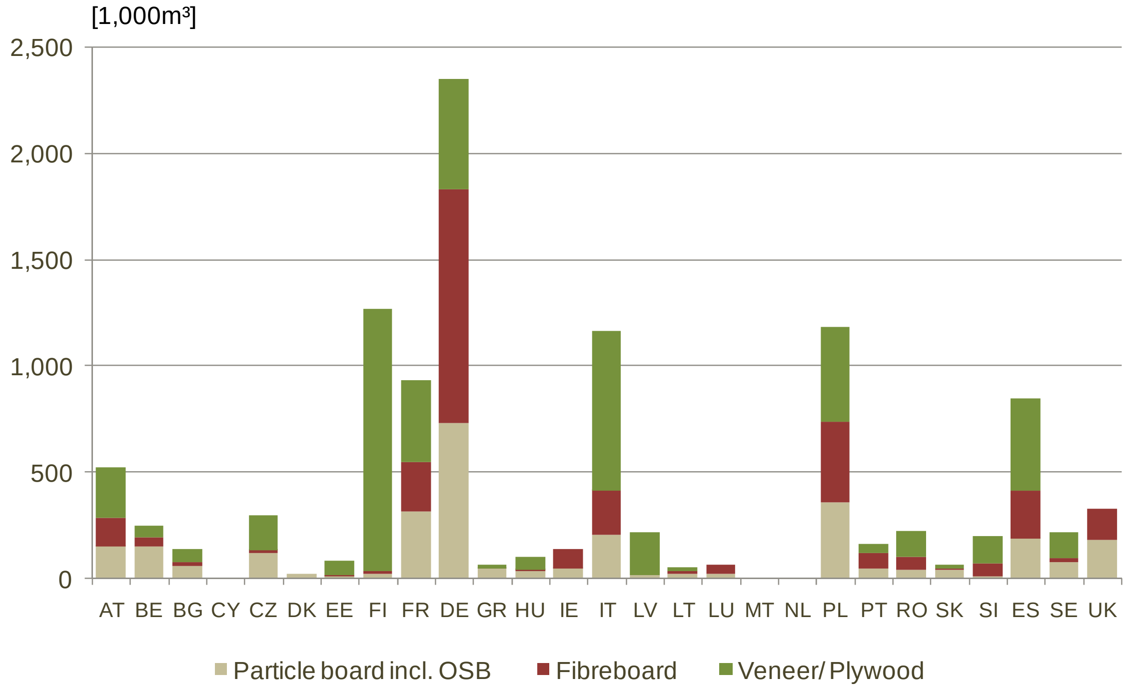


Figure 5-12: Volumes of oIWR in the wood-based panel industry segments

Country differences can be explained by the volumes of wood-based panel production. The relatively high share of residues from plywood production (recovery rate of 45%) does not correspond to its market share, since production volumes are considerably lower, while the recovery rate is considerably lower (see Figure 5-13).

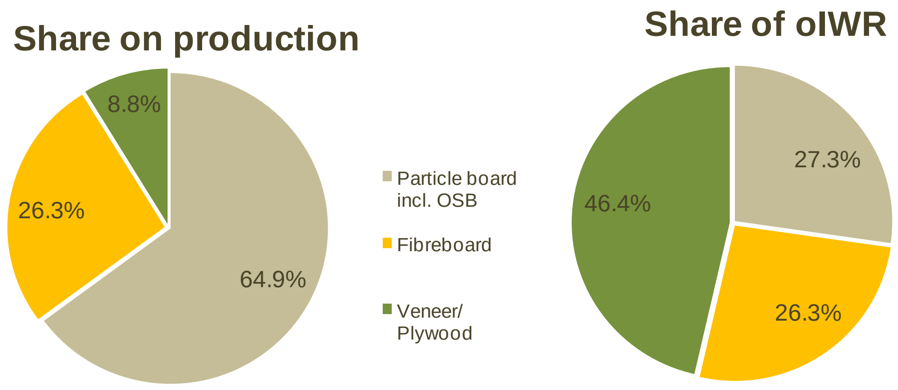


Figure 5-13: Wood-based panel products' share of production and residues

5.5.3.3 Residues from manufactured wood products

Other industrial wood residues from further processing derive from the utilisation of sawnwood and wood-based panels in construction, furniture industry, packaging and other processing of semi-finished wood products. Other industrial wood residues, which arise during further processing include dust, shavings, trimmings rejects or offcuts. Compared to the production of semi-finished wood products the share of wood residues from manufacturing processes is higher. Moreover, since the volumes of processed raw material input cover sawnwood and wood-based panels the output of other industrial wood residues in further processing is considerably higher.

The objective of modelling industrial wood residue volumes from further processing was firstly to model the consumption of the four industry branches. Secondly, based on given shares of produced residues in the four branches (Mantau & Bilitewski, 2010), the residue volumes could be calculated, considering different national industry (consumption) structures. Data on turnover by industrial activities (in €) given by Eurostat as well as wood consumption data given by FAOSTAT formed the basis for calculations.

The calculated **Consumption** of wood-based panels and sawnwood in construction, furniture industry, packaging industry and other further processing industry by m³ rwe is shown below (Figure 5-14). Moreover, the figure displays the structures of the respective national further processing industry by the division of the bars.

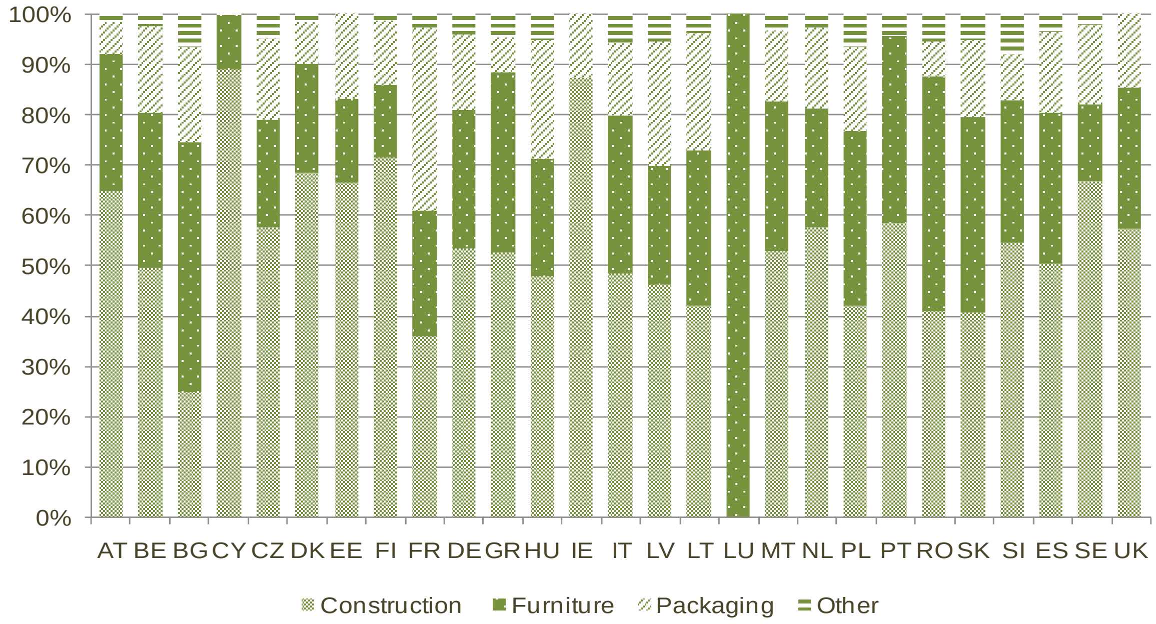


Figure 5-14: Share of consumption by m³ rwe (calculated based on turnover)

Next to the average distribution of wood consumption in the further processing industry Figure 5-15 shows two diverse country examples on the shares of consumption of wood-based panels and sawnwood.

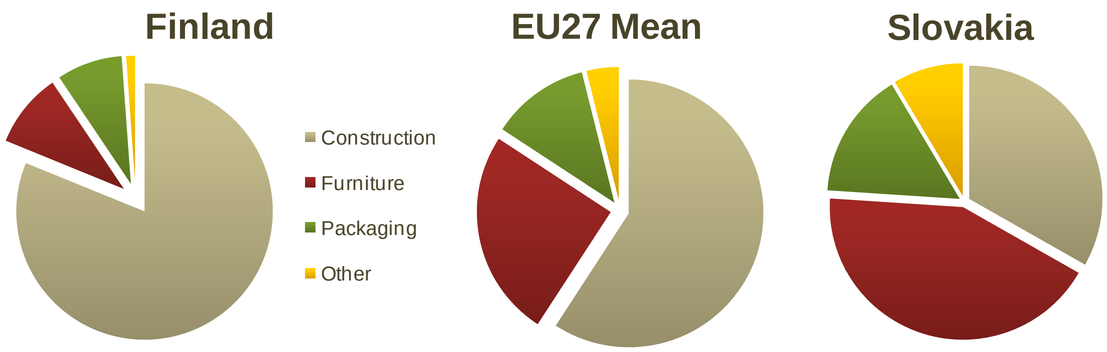


Figure 5-15: Average shares of consumption of further processing industry by consumption

Following, the **shares of other industrial wood residues** from construction, furniture industry, packaging industry and other further processing industry can be found from Table 5-12.

Table 5-12: Shares of residues in the further processing industry branches

Industry branch	Share [%]
Construction	10.3
Furniture industry	18.4
Packaging industry	9.7
Other	13.0

Source: Mantau & Bilitewski, 2010

The volumes of other industrial wood residues from all four manufacturing processes are finally calculated based on the given shares and the wood consumption per sector

5.5.3.4 Results on semi-finished and manufactured wood products

Figure 5-16shows the projection of growth of the two segments of other industrial wood residues. Due to high material recovery in the particle board and fibreboard production, the total volume of residues they produce is low. The high share of resulting residues in plywood and veneer production (45%), however, does not influence the volume of other industrial wood residues in the wood-based panel industry.

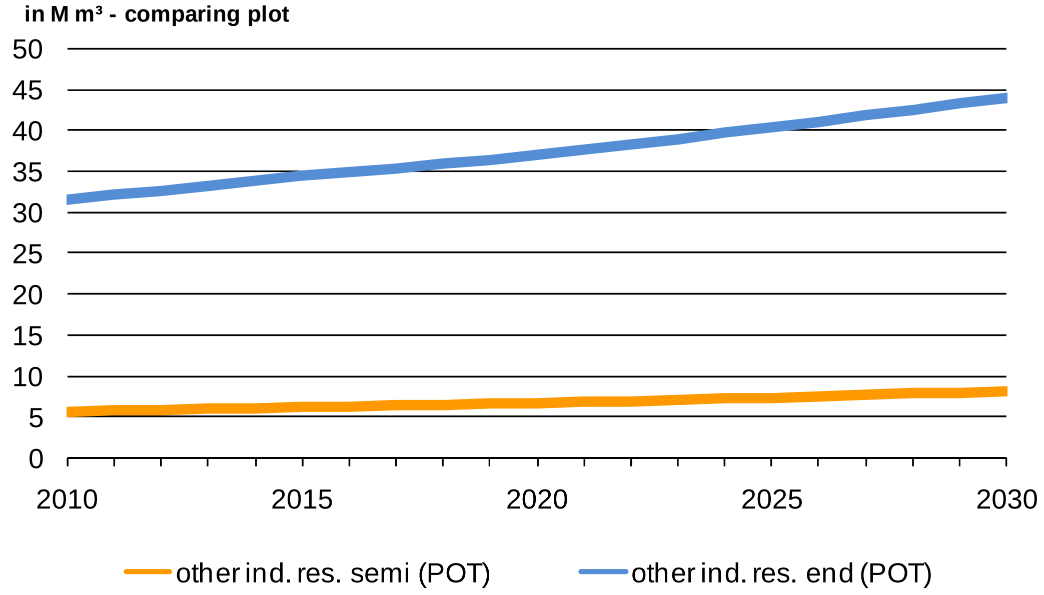


Figure 5-16: Projection of growth and comparison of the segments

Note: Legend indicates the potentials of other industrial wood residues of semi-finished and manufactured wood products (end)

Source: Saal, U. Industrial residues and by-products, 2010 and Mantau, U.: Wood Resource Balance, 2010 based on Jonsson, R.: Econometric modelling, 2010

5.5.4 Black liquor

Black liquor is a by-product from the production of wood pulp for paper making. The pulping process residues mainly consist of lignin and hemicelluloses, cooking chemicals (for pulping) and water. Black liquor results from chemical pulping processes when wood is “cooked” with appropriate chemicals to separate cellulose fibres from lignin and other wood components.

Approximately 40 to 50% of the input wood raw material is recovered as usable fibre in the chemical pulping processes (Smook, 1992). The other “half” of the wood input along with an equal amount of spent caustic cooking chemicals, forms the black liquor.

Results

The modelling approach and further evaluation of the results of black liquor volumes is based on the assumption that the entire volume is used internally in the pulp and paper industry. The volumes account for the internal energy use, e.g. process energy for drying chips or black liquor recovery processes. Future assumptions on the utilisation and distribution of available volumes of black liquor need to cover also shares for new products.

Figure 5-17 presents the results of modelled black liquor volumes for the pulp producing countries in the EU 27. In regard to the modelling bases the respective shares of assumed different raw material input of coniferous and non-coniferous roundwood as well as the volumes of black liquor are displayed.

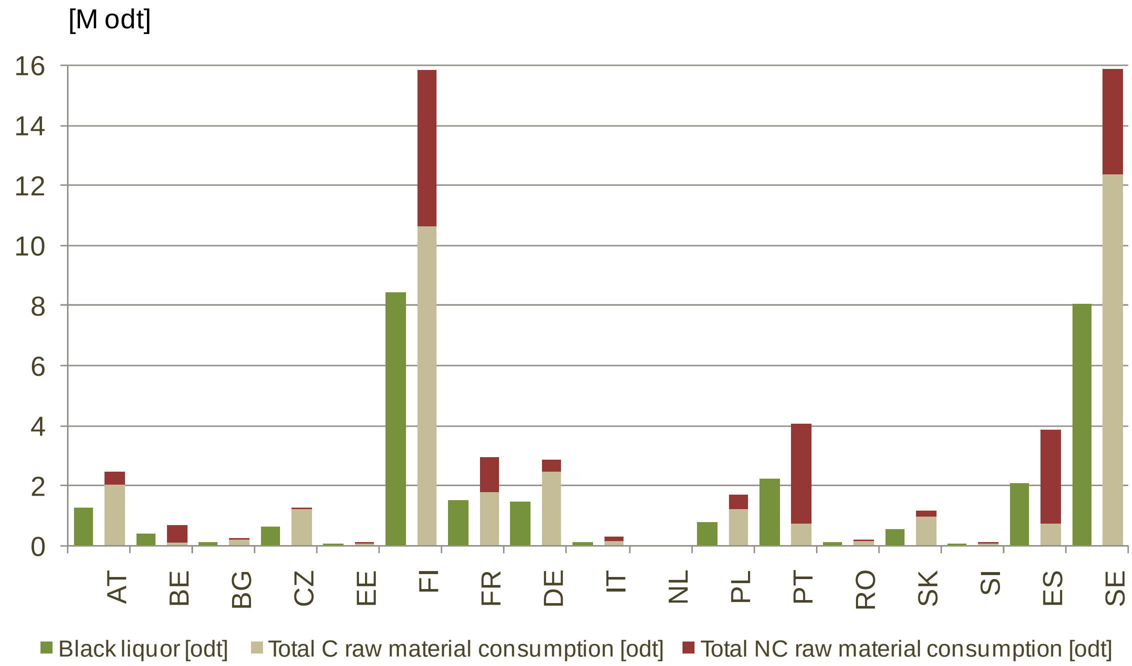


Figure 5-17: Volumes of black liquor and raw material input

Source: Saal, Industrial residues and by-products, 2010 based on Jonsson, Econometric modelling, 2010

5.5.5 Results for total industrial wood residues

Projection and comparison of segments

The projection of potential volumes of industrial wood residue segments is displayed in Figure 5-18. Moreover, the segments of industrial wood residues can be compared within the total volume of industrial wood residues.

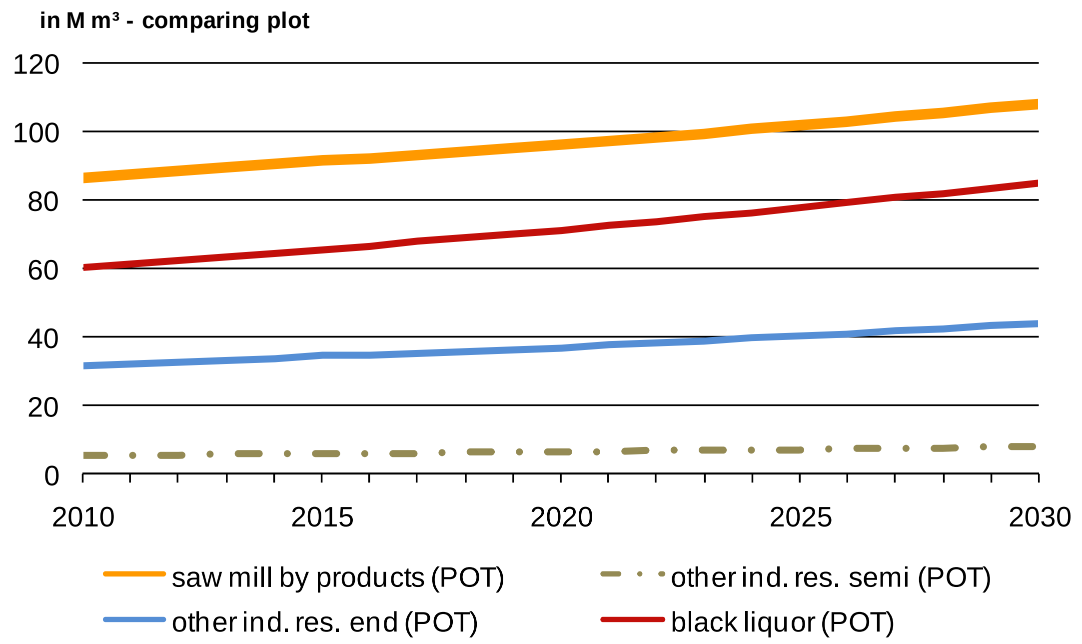


Figure 5-18: Projection of total potential wood residue volumes – 2010 -2030

Source: Saal, Industrial residues and by-products, 2010 based on Jonsson, Econometric modelling, 2010

Relevance of industrial wood residues

Figure 5-19 shows the relevance of industrial wood residues related to the potential available stemwood (medium mobilisation scenario) as well as in comparison to potential volumes of other woody biomass from landscape care activities and post-consumer wood.

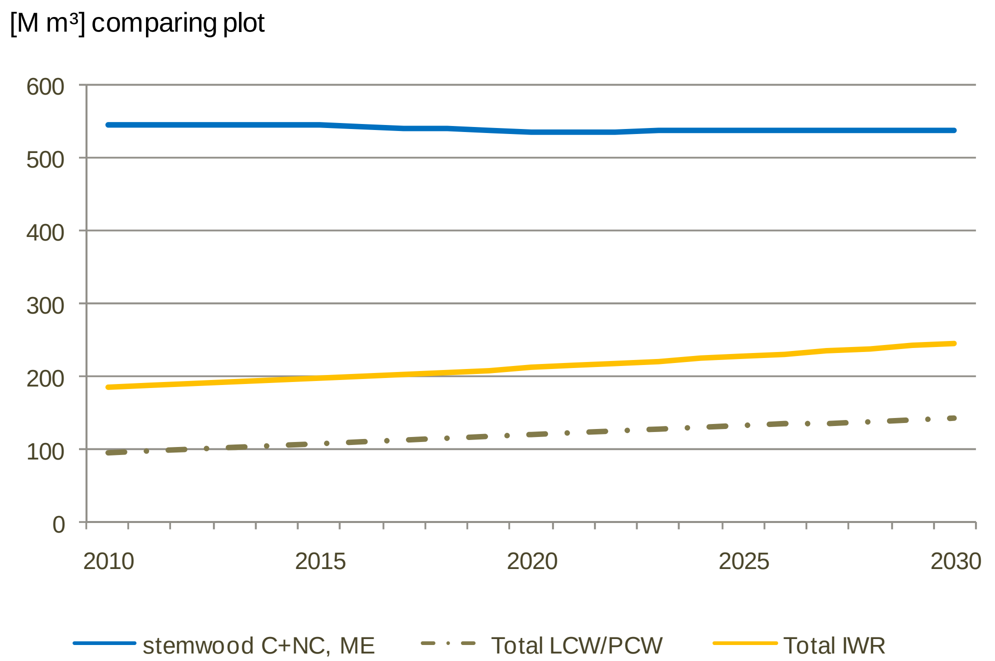


Figure 5-19: Comparison of IWR shares with PCW and LCW

Source: Saal, Industrial residues and by-products, 2010; Oldenburger: Landscape care wood 2010 and Leek: Post-consumer wood 2010, based on Jonsson,: Econometric modelling, 2010, Verkerk et al., 4 The realistic supply of biomass from forests, 2010

5.5.6 Conclusions

The resource of industrial wood residues becomes available and grows with production. This resource is dependent on the material recovered and thus, dependent on the efficient use of the raw material.

EUwood did not analyse the potential for increasing supply of industrial wood residues as this could only be achieved if some residues are not at present being used. However, all calculations and modelling approaches are based on the assumption that residue volumes arising in the forest industries in Europe are already used to a great extend, for material or energy, inside or outside the forest industries. Nevertheless, residues in some further processing branches may form an unused potential.

References

Eurostat, 2010 Database, to be found from: http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/data/database, last access 2010/06/30

FAOSTAT, 2009: ForeSTAT forestry statistics, to be found from: http://faostat.fao.org/

Fonseca, M.A., 2009: Forest Product Conversion Factors for the UNECE region – Draft. Geneva Timber and Forest Discussion Paper 49.

Jonsson, R. 2010: Econometric modelling. pp 33-45 in: Mantau, U. et al. 2010: EUwood - Real potential for changes in growth and use of EU forests. Methodology report. Hamburg/Germany, June 2010. 165 p

Leek, N.: 2010: Post-consumer wood. pp 119-123 in: Mantau, U. et al. 2010: EUwood - Real potential for changes in growth and use of EU forests. Methodology report. Hamburg/Germany, June 2010. 165 p

Oldenburger, J.: 2010: Landscape care wood. pp 98-111 in: Mantau, U. et al. 2010: EUwood - Real potential for changes in growth and use of EU forests. Methodology report. Hamburg/Germany, June 2010. 165 p

Mantau, U. & Bilitewski, B., 2010: Stoffstrom-Modell- Holz 2007, Rohstoffströme und CO_2-Speicherung in der Holzverwendung, Forschungsbericht für das Kuratorium für Forschung und Technik des Verbandes der Deutschen Papierfabriken e.V. (VDP), Celle, Germany, p. 75

Mantau, U. et al. 2010: EUwood - Real potential for changes in growth and use of EU forests. Methodology report. Hamburg/Germany, June 2010. 165 p.

Saal, U. 2010: Industrial wood residues. pp 124-145. in: Mantau, U. et al. 2010: EUwood - Real potential for changes in growth and use of EU forests. Methodology report. Hamburg/Germany, June 2010. 165 p..

Smook, G.A., 1992: Handbook for pulp & paper technologists. 2nd edition.

6 Policy options for more wood: Strategies and recommendations for a sustainable wood mobilisation

Author: Kit Prins

UNECE/FAO Forestry and Timber Section, Palais des Nations, CH – 1211 Geneva 10

6.1 Introduction

On the basis of the EUwood analysis and strongly involved team work of the EUwood team, this chapter identifies emerging problems. On this basis, strategies and recommendations are presented, addressed to the Commission, but also to governments of member states, international organisations, the private sector, civil society and the research community. Both the strategy and the recommendations take a holistic approach, going beyond the forest sector to address polices and framework conditions for other sectors which have a major influence on the outlook for wood availability and demand. Particular attention is paid to the assumptions underlying the various estimates and scenarios which make up the EUwood study, as it is these assumptions which show where action is needed, or to what developments the scenarios are exposed.

6.2 Emerging problems

The results of the EUwood analysis show that, on a ***medium mobilisation scenario,*** the expected demand is likely to exceed the potential before 2020. Even if all measures for increased wood mobilisation are implemented, wood demand, from industry and to meet the renewable energy targets, can hardly be satisfied from domestic sources in 2020. This applies to Europe as a whole although the situation differs according to region and country. On the ***high mobilisation scenario,*** it is difficult, but not impossible in 2020 but not in 2030 to supply enough wood to satisfy the needs of the industry and to meet the targets for renewable energy on a sustainable basis. However, to achieve the high mobilisation would require long term commitment and investment, a comprehensive approach, numerous specific policy measures, and favourable framework conditions, many in areas not directly controlled by the forest sector policy makers.

Furthermore, **forests are not only suppliers of wood, but have many other, equally important, functions and ecosystem services**, notably conservation of biodiversity, protection of water, landscape and infrastructure, provision of recreation and sequestration of carbon. Wood supply functions cannot be given absolute priority over the other parts of sustainable forest management.

The challenge is to achieve a “win-win” outcome, which will satisfy the needs for wood raw material and wood energy, while maintaining sustainability and fulfilling the many other functions and services of the European forest. If this were not achieved, a “lose-lose-lose-lose” trade-off could not be excluded, whereby forest biodiversity is threatened, not much carbon is sequestered, renewable energy targets are not met and insufficient raw material is available for the forest industries.

Any solution to this challenge must be comprehensive in approach, addressing both supply and demand of wood and other forest functions, as well as developments for other sectors than the forest sector. In particular, any solution must also keep in mind the overall objectives of mitigating climate change and adapting to its consequences. Many of the measures to be taken will arise outside the forest and energy sectors, necessitating excellent communication, and high visibility for the issue, so that the forest sector perspective is not “drowned” in the discussion of broader issues, such as climate change, agriculture policy or energy security.

Moreover, **solutions will differ according to national and local priorities and conditions of the forests and their ecosystems**. Thus, while it is important to develop strategies and guidelines to address the issue, practical solutions need to be considered and applied to respond to the needs of the forest under consideration, maintaining the correct balance between all the functions, services and activities

6.3 Policies which influence wood availability

EUwood is intended as a tool for policy makers, and has therefore identified the policies which may influence wood availability and demand, and, to the extent possible, what the consequences of those policies are. It has also linked the policies to the key elements of the Wood Resource Balance. The analysis has generated the following detailed tables, which are reproduced in the methodology report:

- Links between policies and wood availability (see chapter 6.1 of the methodology report)
- Status at present of policies which influence wood availability and demand (partial coverage) (see chapter 6.2 of the methodology report)

It should be pointed out that linking policies in the broadest sense to wood availability is a relatively new area of research - the EUwood project is playing a pioneer role here: the information base is not yet properly organised, and some of the links have not yet been investigated in depth. Nevertheless, EUwood believes these tables are a realistic representation of the main relationships and a good basis on which to generate the conclusions about strategies.

To simplify, the policies may be grouped into four categories, according to whether they influence wood supply or wood use, and whether the influence is positive or negative. Drawing on the analysis in chapter 6.1 and 6.2 of the EUwood methodology report, the following overview in Table 6-1 sums up the situation.

Table 6-1: Overview of policies which influence wood supply and demand in Europe

Ref.[6]	Policy	Strength of effect (est.)
	Policies which increase wood supply	
1.8	Adapt management of European forests to expected climate change	+
3.1	Encourage afforestation	+
3.3	Develop rural infrastructure	+
4.2	Put in place stimulus measures influencing the forest sector	+
5.2	Implement trade measures which restrict imports of wood raw material	+
5.3	Implement trade measures which restrict exports of wood raw material or products	+
6.1	Implement favourable fiscal treatment of income from wood sales	++

[6] Numbers refer to Table 6.1 in the methodology report which presents the linkages in more detail

6.3	Implement favourable fiscal treatment of certain management actions, e.g. stand establishment, thinning	+
7.3	Reduce immissions of pollutants to forests	+
7.5	Promote recycling, improve waste disposal systems	++
8.2	Improve education and training of workforce and forest owners	+
9.1	Implement national forest programmes	+
9.2	Provide support for forest owners	++
9.3	Provide support for improvement of forest and transport infrastructure	+
9.4	Provide support for forest management planning	+
9.5	Provide support for silvicultural measures	+
9.6	Provide support for improved organisation of wood raw material markets, better market information and coordination	+
9.9	Prevent forest fires	+

	Policies which decrease wood supply	
1.1	Promote carbon sequestration in forests	-
3.2	Support rural incomes (reduces need for forest-based income)	-
6.2	Implement non-targeted measures giving fiscal advantages for forest owners (e.g. reduction of succession tax, without linking to specific silvicultural measures)	-
7.1	Increase areas protected for biodiversity	-
7.2	Protect biodiversity in forests without specific protection status	-
7.7	Protect soil and site fertility	--
7.9	Promote payment for ecosystem services	-
9.8	Regulate harvesting and transport methods (nutrients, compaction etc.)	-

	Policies which increase wood demand	
1.2	Promote cascaded use of wood i.e. first as raw material, then energy	++
1.3	Promote carbon storage in harvested wood products,	+
1.4	Promote use of wood energy to replace non-renewable energy	+++
1.5	Promote use of forest products to replace non-renewable products	+++
1.6	Introduce a carbon tax	++
1.7	Further develop emission trading for carbon	++
1.8	Promote use of wood energy to replace non-renewable energies	++
2.1	Include wood energy in biomass action plans	+++
2.2	Promote renewable energies through pricing	+++
2.3	Promote renewable energies by supporting R&D	++
2.4	Promote renewable energies by supporting investment (e.g. in wood burning stoves)	++
4.1	Manage for long-term economic growth	+
4.2	Put in place stimulus measures influencing the forest sector	+
4.3	Implement regional policy (specifically through investment support for forest	+

	industry)	
5.1	Implement trade measures which protect domestic forest industries	+
5.4	Promote exports of forest products	+
7.4	Promote “green building”	+
7.6	Implement sustainability provisions in public procurement policies	+
8.1	Improve R&D funding to support competitiveness of the forest sector value chain	++
9.7	Promote the sound use of wood	+
9.10	Communicate and educate on forest issues	+
9.11	Promote certification systems	+

	Policies which decrease wood demand	
2.5	Encourage energy efficiency	--
5.2	Implement trade measures which reduce protection of domestic producers	-
7.8	Limit emissions of micro-particles, notably from wood burning boilers	-

Note: For more information on the policies see tables 6.1 and 6.2 in the methodology report

Each of these policy areas has its own objectives, and ensuring a sustainable supply/demand balance for wood in the future is often not the priority. However to achieve the goal of a sustainable supply/demand balance, it is necessary to coordinate these policies in a single coherent strategy.

6.4 Elements of a strategy

6.4.1 Introduction

EUwood has drawn up a strategy for a win-win solution for a sustainable supply/demand balance for wood, taking account of both material and energy needs. Its main characteristic is that it takes a comprehensive approach, addressing both supply and demand issues. The main approaches can be schematically presented as follows:

- SUPPLY
  - Mobilise more wood from **existing forests**
    - Raise harvest levels
    - Use more parts of the tree (above ground and below ground biomass)
  - Increase supply of wood from **outside the forest**
    - Industry residues
    - Landscape care wood, trees outside the forest
    - Post-consumer wood
  - **Expand forest area** (short rotation coppice)
  - Increase **imports** from other regions
- DEMAND

- Promote **energy efficiency**
- Promote **use of renewables other than wood**
- Use wood **more efficiently**, in industry and for energy

These broad lines are commented below, with rough estimates, of their relative importance in terms of cubic metres of wood. The next section lays out in more detail the policy measures which would be needed to achieve these objectives.

6.4.2 Supply

6.4.2.1 Mobilise wood from existing forests

Woody biomass from existing forests is the largest component of wood supply and will remain so, according to all scenarios. Wood supply from existing forests accounts at present for 69% of wood supply, according to the Wood Resource Balance, and the volumes supplied could increase by 150 million m^3 in the high mobilisation scenario

6.4.2.1.1 Raise harvest levels

The potential scenarios for stemwood do not show big differences and vary only by 15 M m^3. To achieve this mobilisation would require a wide range of policy measures, as well as close cooperation between the various stakeholders. The most important constraints to expanding stemwood supply from existing forests are economic and social, and have been identified in a number of studies and workshops.

6.4.2.1.2 Use more parts of the tree (above ground and below ground biomass)

If all the potential for using more of the harvested tree, including branches, tops and stumps, were realised, an additional 140 million m^3 or a total of 260 million m^3 could be supplied, the highest growth potential of all resources. The constraints to expanding this source are mostly environmental and economic

6.4.2.2 Increase supply of wood from outside the forest

Until recently, wood supply from outside the forest received little attention, at the academic or policy level, as these flows were frequently internal to the industry, small, informal or local. Recent work, notably on the Wood Resource Balance, has shown that taken together, these flows are significant, accounting for one third of the total, and that some have the potential for significant growth. Furthermore, because of the fragmented nature of these sources, knowledge and understanding is patchy at best, and the drivers and constraints differ widely, as do the necessary policy measures.

6.4.2.2.1 Industrial residues

Industrial residues are already a major source of raw material and energy, about 18 % of the total. Their supply grows in parallel with material uses of wood, and they play a central role in the cascaded use of wood. They are an excellent source of high quality material which may serve as energy when not needed for material purpose. Future supply of industry residues is included in the Wood Resource Balance calculations.

6.4.2.2.2 Landscape care wood, trees outside the forest

Large volumes of wood arise as a result of operations in parks, small stands, roadside trees, sparse forests, orchards, vineyards and olive groves and other trees outside the forest. This source of wood is little known or understood because of its variety and scattered nature, and because the wood often "arises" as a result of operations (tending, pruning etc.) whose primary focus is not wood supply. Furthermore, this wood is often not marketed, although it is often used, for energy, horticultural purposes, raw material or other uses. EUwood estimates that this source could be expanded, from 13 million m³ at present to nearly 80 million m³, but work is needed to improve understanding of the resource, for instance how it is used (what other uses exist for the material?), how collection should be organised and the measures needed to mobilise it.

6.4.2.2.3 Post-consumer wood

EUwood has demonstrated that in certain countries, post-consumer wood is already a significant source of energy and raw material, while at the same time this use provides a solution to waste disposal problems. This has been made possible in the leading countries by a combination of favourable economic factors, a well organised recycling industry and supportive policy, notably the forbidding of landfills according to the EU Directive. If all countries were to achieve their potential to recycle post-consumer wood, the volume supplied could rise from just over 40 million m³ at present to over 65 million m³.

6.4.2.2.4 Expand forest area (short rotation coppice)

The establishment of large areas of short rotation coppice, or any other highly intensive silviculture, could make a major contribution to wood supply. At present this is of marginal importance in Europe, with the exception of some eucalyptus, willow and poplar plantations. If the entire "gap" in 2030 expected by the Wood Resource Balance were filled by the establishment of very productive short rotation coppice forest (say 15 m³/ha), then about 2 million ha would be needed in the high mobilisation scenario, but 35 million ha in the low mobilisation scenario. However, major uncertainties surround this potential, which are still not well understood, about competition with agriculture and food supply, relative land prices and social preferences, consequences for biodiversity etc. Such a development would represent a major change to Europe's landscape and would certainly be controversial: it should be the subject of an open and transparent public debate which would establish society's priorities for the use of a non-extendable resource, rural land.

6.4.2.2.5 Increase imports from other regions

If insufficient wood is available in Europe to cover the continent's needs, the missing volume could in theory be imported from other regions, whether from fast growing plantations in the tropics or traditional temperate/boreal suppliers such as Canada or Russia. However, this option is also surrounded with major uncertainty, notably about the sustainable potential of other regions, and competition from other wood importing regions, such as China. There should be assurance that supplies are truly from sustainable sources, and do not unfairly undercut European producers. To explore these issues properly would require a different approach[7] than that chosen by EUwood. The EUwood team focused primarily on wood supply from Europe, although trade is always included in the calculation of apparent consumption. For the

[7] For instance the FAO's series of regional and global outlook studies, as well as work by IIASA, CINTRAFOR and others.

projections, EUwood uses the neutral assumption that the trade balance will stay at approximately the same level as in 2010, when Europe was a net exporter of wood and forest products[8]

6.4.3 Sustainability of the wood supply scenarios

How sustainable is the high mobilisation scenario[9] for wood supply? It is not possible to provide definitive answers on this, given the uncertainty and the necessity for judgment in making tradeoffs between criteria. However, thanks to the explicit assumptions underlying the EFISCEN scenarios, it is possible to list the following characteristics of the high mobilisation scenario as regards forests:

- The level of harvest can be maintained indefinitely
- Strictly protected conservation areas are assumed not to decline in area
- Management of non-protected areas would intensify considerably
- Measures would be taken to protect site productivity, including the possibility of fertilising
- No change in species composition is assumed
- Dead wood in the forest would decline as wood extraction increases
- Stump harvesting would increase significantly
- Growing stock would decline from present levels in some countries or areas.

Industrial residues and post-consumer wood represent a disposal problem if not used, so the EUwood supply estimates may be considered sustainable for these assortments

Finally, sustainability of forest management should be seen in the wider context of sustainable development, and it may be necessary to accept tradeoffs, for instance between biodiversity in forests and renewability of energy supply. Such questions are beyond the scope of EUwood, but should be investigated in more depth.

6.4.4 Demand

6.4.4.1 Promote energy efficiency

The renewable energy targets are expressed as a percentage of gross inland energy consumption (GIEC), so the level of energy consumption determines the value of the target. Therefore, making energy use more efficient, by reducing gross inland energy consumption, makes it much easier to reach the target (20% of GIEC to come from renewable energy). The EUwood results assume that the energy efficiency targets are met. If the energy efficiency targets were **not** met, more wood would be required to meet the renewable energy targets. If energy efficiency did not improve by 2030, but stayed at its 2010 level, an extra 130 million m^3 of wood would be required to meet the renewable energy targets, compared to the WRB energy use scenario.

---

[8] Excluding imports of further processed products such as joinery, furniture and toys, notably from China, which have been expanding

[9] If the high mobilisation scenario is sustainable, it is likely that the others are also sustainable

6.4.4.2 Promote use of renewables other than wood

Likewise, the EU targets are for renewables as a whole, not for wood, or even for biomass, alone[10]. Thus, if other renewables, such as solar, wind, tide, hydro or non-wood biomass, are developed and deployed faster than wood, there will be less pressure on wood supply. The EUwood base scenario assumes that the share of wood in renewable energy will decrease to 40% in 2020, from 50% in 2010. If the share of wood in renewable energy were to stay at its present level, 120 million m3 more would be needed. If the share fell to 37.5%,– a plausible assumption - , 47 million m^3 of wood less would be needed.

6.4.4.3 Use wood more efficiently, in industry and for energy

The base scenario assumes no change in the overall efficiency of wood use, whether for the forest industry or energy generation, chiefly because very little reliable information exists on this question. However, increases in efficiency of use could make a significant contribution, notably in the energy field: it makes a great difference whether wood is burnt in a conventional power station, say co-firing with coal, or in an efficient combined heat and power plant[11]. It is not possible to quantify this, but strategies should aim to use all wood in the most efficient way possible

6.5 Policy measures to implement the strategy

6.5.1 General

To meet the challenge in a sustainable way, according to the broad lines of the comprehensive strategy outlined above, a number of different policy measures should be implemented, which are outlined below. It must be stressed that this is not a list of alternatives from which to choose: to achieve the goals: **all** of these measures should be implemented, without, of course, forgetting the necessity to maintain sustainable forest management in all of its aspects, including biodiversity and recreation. It should be repeated that this strategy addresses wood supply and demand issues, and does not claim to be a complete forest sector policy, which was not in the EUwood mandate.

It is not sufficient to consider only policies for the forest sector: all policies which influence wood availability, listed in table 6.1 of the methodology report have been taken into consideration.

The list of necessary policy measures is structured according to the elements of the strategy.

6.5.1.1 Mobilise wood from existing forests[12]

6.5.1.1.1 <u>Land tenure, management, co-ordination and planning:</u>

---

[10] Although national biomass action plans are developing plans and strategies for both biomass and wood energy

[11] Some countries forbid the use of biomass energy if there is low efficiency of use, as in a conventional power station.

[12] This section draws heavily on the Good Practice Guidance on the sustainable mobilisation of wood in Europe, issued by UNECE, Forest Europe and European Commission DG Agriculture. See http://www.timber.unece.org/fileadmin/DAM/publications/wood-mobilisation-good_practice-guidance.pdf

- improve organisation of forest owners, by creating and strengthening forest owner associations, sharing information between forest owners;
- enhance co-operation between forest management units;
- consolidate land management units

6.5.1.1.2 Transport and logistics

- raise axle weight limits on forest roads and on public roads between the forest and the mills;
- improve accessibility to the forest, in particular in mountain areas;
- optimise logistical planning so as to maximise loads and minimise haulage distances;
- improve technology and transport systems for new energy-wood assortments, while taking full account of constraints, notably environmental

6.5.1.1.3 Markets and marketing: organisation and transparency

- Establish public-private partnerships to jointly develop markets for all wood assortments, especially those which are weak and disorganised at present, as frequently occurs for energy wood;
- Promote the market for sawmill end-use products, because sawmill industry is the key industry for wood mobilisation.
- improve market transparency, so that buyers and sellers can find each other more easily and prices can be set in an efficient and fair way;
- establish long-term partnerships, between wood suppliers and between suppliers and users;
- facilitate access to basic information on forest ownership, to help authorities and potential buyers contact forest owners who are not managing their forests actively, to offer them the option of more intensive management;
- establish sustainable wood-energy supply chains, with contractual relations, logistics and infrastructure and adequate capital;

6.5.1.1.4 Improved recovery channels

- Set up programmes and courses to improve and sustain safety, efficiency and sustainability in wood mobilisation and marketing.
- Increase attractivity of forest sector jobs, by improved forest working conditions and remuneration,
- Carry out public relations and information campaigns to improve the image of the forest sector as a whole and of forest management and work.

6.5.1.1.5 Sources of and mechanisms for financing

- Develop incentive systems for wood mobilisation, without market distortion and taking advantage of existing support schemes, e.g. the European Agricultural Fund for Rural Development (EAFRG) and forest-related measures in national and regional rural development programmes (RDPs).

- provide grants and other incentives from existing EU, national and regional programmes as well as from other sources, in order to implement the measures in this list
- create legal entities for wood mobilisation which will be recognised by financial institutions
- Identify financial institutions which offer favourable terms for loans and other mechanisms which support investment in wood mobilisation

6.5.1.1.6 Legal and fiscal measures

- Remove legal constraints to wood mobilisation, e.g. to restructuring and optimising forest ownerships and encouraging association and forest owner cooperatives
- Put in place fiscal measures to help stimulate increased mobilisation, e.g. tax relief for forest owners who actively engage in wood mobilisation and utilisation.

6.5.1.1.7 Silvicultural measures

- Improve forest reproductive material and its application to given site types
- Shorten rotations
- Carry out more pre-commercial thinning
- Intensify forest management, for instance through better regeneration, using best available seedlings, choosing fast growing tree species, restoring ditches, cleaning, fertilising and preventing forest damage[13]

6.5.1.2 Increase supply of wood from outside the forest

6.5.1.2.1 Industry residues, landscape care wood, trees outside the forest

- Carry out a comprehensive inventory of wood sources outside the forest, and develop strategies for each type and location, taking account of social and environmental constraints, and working in close cooperation with relevant stakeholders for each type, including farmers, horticulturalists, managers of urban parks, open spaces and roads etc.
- Coordinate strategies and incentives for wood based energy plants with local supplies of wood, including from outside the forest, taking account of location, quality, market structures etc. A partnership approach, including forest owners, suppliers of non-forest wood/biomass, energy consumers and energy suppliers has been used in many areas[14]
- Coordinate policies and incentives for preventing forest fires with policies for wood energy, so that “fuel” removed from Mediterranean forests to prevent or minimise wildland fire risk is put to good use to supply renewable energy.

6.5.1.2.2 Post-consumer wood

[13] These examples are from Sweden (see Good Practice Guidance). Different measures may be appropriate elsewhere.

[14] For instance see Wood Energy Business Scheme led by the Forestry Commission in Wales, one of many examples in the UK and elsewhere

- Standardise the classification categories of post-consumer wood, including contamination limits, as a basis for carrying out inventories and to facilitate the use of post-consumer wood. At present the absence of classification schemes for this material in most European countries (or the existence of inconsistent classifications) is hindering the rational development of markets, as all recovered wood may sometimes be treated as “contaminated”, thus only possible to burn in expensive and limited waste disposal plants, rather than standard boilers. An objective and widely accepted classification, as exists for recovered paper would help each type of post-consumer wood find the appropriate market,
- Accelerate implementation of the Landfill Directive, so that wood waste from demolition, transport etc. is directed to energy use rather than landfill
- Support the formation of efficient recovery and recycling circuits and markets, for instance through increased transparency, and better links between wood users and the recovery circuits.

6.5.1.2.3 Expand forest area (short rotation coppice)

- Strategies for future rural land use should be developed between all stakeholders, taking full account of the goals for agriculture, energy, landscape, biodiversity and rural development.

6.5.1.2.4 Increase imports from other regions

- Take measures to ensure that wood supplies from other regions are truly sustainable, so that European demand (especially if it is large scale, like large biomass power plants near the sea reliant on imported wood) is not subject to excessive risk, and does not export Europe’s carbon emissions to other, possibly more vulnerable, regions.

6.6 Framework conditions

6.6.1 Introduction

The EUwood study has focused on its mandate, which is to estimate the realistic potential wood supply, in the likely future conditions of wood shortage. However, wood supply and demand do not exist in isolation, but are largely determined by trends outside the sector, such as economic growth and prosperity, rural development, public finance etc. Wood availability will not be at the centre of these wider policies; however those who are responsible for forest sector policy should monitor developments in these broader policy areas, and take them into account. In particular if wider trends differ significantly from the assumptions underlying EUwood scenarios, those scenarios should be adjusted. For instance, economic growth which is significantly below the projected rates (or significantly above), a return to cheap and abundant energy, or severe reductions in public financing, would all necessitate fundamental revisions of these calculations. However, as the assumptions are explicit in most cases, and the methodology is now relatively well understood, it should not pose severe problems to revise the projections.

There are a number of framework conditions regarding non-forest sector policy which must be satisfied if a sustainable balance between wood supply and demand is to be maintained. These should be considered necessary but not sufficient conditions to achieving the goals set out in the EUwood project. Forest sector policy makers should monitor conditions in these areas, and if developments diverge from the

EUwood policy assumptions, work to modify the framework conditions, or, if this is not possible, review strategies for the forest sector.

The framework conditions necessary to achieve a satisfactory and sustainable supply/demand balance in the future are outlined below. They are based on the list of policy measures influencing wood availability in the methodology report, although for reasons of clarity, they do not follow that list in detail.

6.6.2 Energy efficiency

The full implementation of energy efficiency policies, in all countries, is not only good in itself, it also lowers the targets for wood energy, which are expressed as a percentage of Gross Inland Energy Consumption. The EUwood calculations assume that the energy efficiency target of 20% improvement in energy efficiency by 2020 is achieved. If energy efficiency does not meet these objectives, it will be almost impossible to meet the renewable energy targets for wood. If the energy efficiency targets are achieved, the targets for wood energy may be reached.

6.6.3 Renewable energies other than wood

Wood is at present, by far, the largest source of renewable energy. Other forms include solar, wind, hydro, non-wood biomass (municipal solid waste, agricultural residues), geothermal, all of which, with the exception of hydro, are relatively undeveloped and have huge potential to increase supply, providing certain economic and technical constraints are overcome. EUwood already assumes that wood will decrease its share of the renewable energy market. However, if other renewable energies fail to meet an increasing share of the demand for renewables it will be more difficult to meet the energy targets and supply the raw material needs of industries.

6.6.4 Stability of prices

If suppliers of wood are to make the significant investment and take the necessary commercial risks to increase their wood supply capacity, they must be confident that they will receive an adequate return on their investment. Periods when prices (for energy or raw material) are below costs, or when price volatility is excessive, have in the past prevented wood energy from achieving its potential, and harmed the profitability of the forest sector. Therefore, EUwood assumes implicitly that wood prices, for raw material or energy, are at a sufficiently high level to provide stable and adequate remuneration for the land, capital and labour which is being invested. Instruments to promote price stability include increased market transparency, long term contracts, incentives and subsidies, and may involve market participants and governments. Without confidence that wood prices will stay at an adequate level, in the medium and long term, mobilisation will not occur. The world energy price will play an important role in this respect, as it effectively puts a floor or lower limit to the price of wood in the medium term.

6.6.5 Level of financial support to the forest sector

Financial support to the forest sector is significant but not well monitored or understood[15]. It takes many forms, including direct subsidy for certain silvicultural actions, but also of income support, initiatives by state forest services, regional development and fiscal measures in favour of forest owners, and many others. It is provided at the EU, national, sub-national and local level. Some measures are precisely targeted and their efficacy can be monitored, but for many it is hard to evaluate success, as objectives are not specific or quantified (EFI, 2003). Despite the admitted shortcomings of the system of financial support to the forest sector, and the weak understanding of its mechanisms and consequences, it is very likely that if the level of financial support were reduced, it would be hard to maintain present levels of wood supply, let alone increase them. Therefore the likely cuts in public expenditure in many European countries would probably reduce countries' ability to mobilise wood on a sustainable basis, alongside the many other consequences of these measures.

6.6.6 Developments for international trade

Trade is not the focus of EUwood analysis, which assumed no significant changes in international trade. However, its quantified conclusions are vulnerable to changes in the international trading pattern. For instance:

- Reduction of wood exports by suppliers, like the export tax on logs by Russia, would tighten the supply of wood
- Necessary phytosanitary measures, e.g. for the pinewood nematode, could also limit supply by restricting imports from other regions
- Weaker performance than in the past by Europe's exporters would reduce the competition for wood between the industry and energy
- China's rapid growth in exports, especially of secondary forest products such as furniture, joinery etc. has weakened European producers. If this trend were to change, perhaps because of supply problems for China, or refusal in Europe to import goods from non-sustainable sources, demand for European wood could be strengthened

When considering policies such as tariffs and other trade restrictions for forest products (including secondary products), competitivity of exporters, or phytosanitary regulations, the consequences for wood availability should be considered. Likewise, those responsible for wood availability should monitor structural trends in international trade

6.6.7 Sustainability provisions in public procurement, green building

Increasingly, there are sustainability provisions in public procurement. In addition, "green building" codes are increasingly popular, with public and private owners. Most of these codes lay down rules for the use of forest products (for instance that they be certified as coming from sustainable sources), even if non-forest products, such as aluminium or plastics are not covered by the codes. The overall effect of these rules on long term growth in consumption of forest products is not yet clear. However

[15] An exception was the EFFE study (EFI, 2003), which unfortunately has not been repeated

EUwood considers that the existence and application of sustainability provisions and green building codes which treat forest products fairly, without excessive penalisation compared to their competitors, is a necessary condition for the long term healthy development of forest products markets. If these provisions were applied in a discriminatory way, leaving forest products at a disadvantage, demand for wood would be reduced, and less sustainable products would replace it. Currently, those provisions are not necessarily favourable to wood, as for instance they focus very much on energy efficiency and carbon emissions of the building in the so called phase II of the building cycle (use of the building) and do not necessarily reflect the impact of materials in phase I (extraction) and phase III (dismantlement/recycling) where wood has a higher performance than other construction materials.

6.6.8 Research and development

The share of turnover invested in R&D in the forest sector has been low, especially as regards forestry and wood supply. This has probably reduced the sector's competitivity compared to other sectors. Recently, notably in the context of the Technology Platform for the Forest Based industries (FTP), a strategic research agenda has been drawn up and is being implemented. One focus is on the development of "bio-refineries" which would also compete with traditional industries and energy for raw material[16]. The consequences for the forest sector of a research led increase in competitivity are not specifically analysed in EUwood, which assumes no change in this respect. They are however being explored as part of the EFSOS programme (UNECE/FAO, 2005). One focus of R&D in the traditional forest industries has been efficient use of raw material, whether by developing new fibre based products or by process improvements. Therefore R&D could contribute to reducing wood input per unit of output. If R&D spending in the forest sector (whether privately or publicly financed) either rose or fell significantly, the likely future wood demand would be affected. Thus adequate R&D expenditure should be considered a necessary condition for achieving a sustainable raw material balance in the future.

6.6.9 Political will

The strategy outlined above is ambitious, and implies a significant change in forest and other sector policies to address an emerging problem. To achieve these goals, it will be necessary to generate, and maintain over a long period, sufficient political will, at the level of the Union, member states and sub-national authorities, to put in place the necessary measures, and defend them against other urgent concerns. It will also be necessary to balance long term wood supply objectives with shorter term concerns.

This political will is also important as it also a part of a society's shift towards more sustainable production and consumption patterns overall that would lead to an increase in the use of wood as a more sustainable material and source of energy. This shift needs to be prompted by governments' action, as also part of the transition towards greener economies.

---

[16] The first « biorefinery" is expected to be built in 2-3 years, but to replace a pulp mill in its raw material needs, rather than adding to the wood demand.

6.7 Two major policy tradeoffs

6.7.1 Some tradeoffs will be necessary

The EUwood work has focused on the intensification of the management of the forest sector to achieve the “realistic potential” wood supply, and has not addressed the question of choices between forest functions, or of areas where there are clear tradeoffs between functions. Some major objectives of sustainable forest management, notably enhancing biodiversity, but also carbon sequestration in forests, go in an opposite direction to maximising sustainable wood supply. Finding the appropriate mix between wood supply, biodiversity, carbon sequestration and other functions is a policy choice, beyond the scope of EUwood, although the next European Forest Sector Outlook Study (EFSOS) study planned to published by UNECE/FAO in 2011 will explore the broader consequences of different policy choices,. In the EUwood quantitative analysis, biodiversity aspects have been solely treated as “constraints” on reaching the realistic potential wood supply.

The two major areas where a tradeoff between policy objectives seems necessary are very briefly outlined below. Both are too complex to be analysed in depth here, although EUwood has contributed an important quantification and clarity, which will be useful to the discussion in future.

6.7.2 Wood supply and biodiversity

The figures for “realistic potential wood supply” calculated by EUwood take account of many “constraints” linked to biodiversity and nature conservation: no harvests from protected areas or steep slopes, limited use of stumps, site specific restrictions on use of harvest residues etc. However, to achieve this potential from existing forests available for wood supply, it would be necessary to put in place a much more intensive management system: harvesting more trees, more often, with more parts of the tree, bringing unmanaged forest under management by mobilising private forest owners etc. This intensification would make it difficult to *increase* the biodiversity of Europe’s forests, whether by increasing the areas protected for biodiversity conservation or by introducing more “close to nature” silviculture[17]. Perhaps more important, mobilising wood supply implies bringing under management forests which are at present hardly managed at all, and which are thereby becoming more and more attractive for biodiversity. There are many win-win solutions to this dilemma at the local level, with intensified management to produce both wood and biodiversity, taking care of biodiversity hot spots, forest edges, species mix, timing of forest operations etc. Nevertheless, it would be naive to suppose that it is possible to expand indefinitely both wood supply and biodiversity conservation, so some tradeoffs are inevitable.

At present most governments and forest managers are committed to the idea of multi-functional forest management, often implicitly assuming that all functions (wood supply, biodiversity, protection, recreation etc.) should be supplied from each forest stand, although the relative importance of the functions will vary between stands. An alternative approach is an increased segregation of forest functions, with some areas specialised in wood supply and other areas managed for high levels of biodiversity,

[17] In some cases, more intensive management can improve biodiversity e.g. by bringing in more light, creating more edge conditions etc.

intensive recreation and so on. This approach would make it possible to raise wood supply by converting certain forests into specialist, intensive wood supply regions, while others are specialised in biodiversity or recreation. This approach raises many issues, which should be discussed in a wide consultation of all stakeholders, as in many regions such a specialisation would represent a significant departure from present practice. However, it should be pointed out that the proposals to set up short rotation coppice on agricultural land do imply, *de facto*, the establishment of specialist, intensive wood supply “forests” as the proposed short rotation coppicing methods leave little room for biodiversity and recreation.

These decisions are of course the responsibility of the political process. EUwood believes that these tradeoffs should be decided in the light of comprehensive information at the local, national and European level, of the consequences for both biodiversity and wood supply. The relative weighting of the two objectives is a matter for social discussion and high level policy choice.

6.7.3 Wood supply and climate change

Forests and wood contribute to climate change mitigation in several different ways, including carbon sequestration in forests, carbon sequestration in harvested wood product, substitution of non-renewable energies and substitution of more carbon intensive materials (Prins, et al., 2009). Clearly carbon which is sequestered in the forest cannot simultaneously substitute for non-renewable energies or raw materials. If incentives are put in place for carbon sequestration in forests, they could (depending on the level and structure of the incentives) discourage harvesting and wood supply, by encouraging owners to increase the growing stock, until it reaches some maximum level. Through Article 3.4 of the Kyoto Protocol, such incentives are in place to account for forest management, but there are limitations due to the Marrakesh Agreement and several countries have not chosen to commit under this article.

When governments draw up their strategy for forests in climate change mitigation, they should weigh carefully the different contributions which can be made by forests, and choose the appropriate combination for their circumstances. Adaptation of forests to climate change, including proactive risk management for forests facing climate change, as suggested by the 2009 Uppsala conference on adaptation to climate change, also has consequences for wood supply.

6.7.4 Overview of policy measures and framework conditions

To summarise, EUwood considers, on the basis of detailed analysis of scenarios for future supply and demand for wood in Europe, that it may be possible to supply future raw material needs of the forest industry and meet the targets for renewable energy, if a number of conditions are met, in the context of a strategy which addresses both supply and demand aspects. This is a comprehensive and holistic approach, whose components are interdependent, but the main features may be summarised as follows:

- Mobilise more wood from existing forests, along the lines of the Good Practice Guidance recently issued by UNECE/Forest Europe/DG AGRI
- Intensify silviculture and use more parts of the tree, within ecological constraints

- Develop circuits and mechanisms for the economic and sustainable supply of wood from trees outside the forests (landscape care wood), agriculture, horticulture, Mediterranean scrub and post-consumer wood
- Establish short rotation coppice on agricultural land

Equally important is the satisfaction of a number of necessary conditions, mostly on the demand side, and in particular:

- Achieving the energy efficiency targets
- Developing renewable energies other than wood
- Maintaining price stability and at least the present level of financial support for the forest sector
- Achieving consensus and maintain political will on the tradeoffs between wood supply, biodiversity and climate change policy

6.8 Improving knowledge and understanding

EUwood has aimed to present a comprehensive and realistic view of potential wood supply. To do so, it has had to make many estimates and assumptions, some of which are based on weak data or poor understanding of fundamental aspects. The EUwood team believe that the data in this study are at present the best possible estimate of the realistic potential wood supply. However, considerable work is needed to improve the reliability of the estimates.

In particular, more **information and statistics** are needed. At present partial information is available on many of the parameters mentioned below, often for only a few countries, and EUwood has had to extrapolate from these countries to others: however, this is not sufficient for reliable Europe- wide evaluation of the potential, as extrapolation from those countries with data is often unreliable and based on very simple assumptions. Areas where information is unsatisfactory are as follows:

- Resource mix and flows of woody biomass to the consumer
- The consumption of wood and forest products, especially as energy for households and power plants
- Flows of landscape care wood and post-consumer wood (potential, actual use, origin, destination, volume, quality) as well as monitoring of short rotation plantations.
- Removals from the forest: unreported removals, share of bark, residues etc. (to provide accurate comparison with inventory data).
- Wood and fibre supply from other wooded land, including landscape care wood, Mediterranean scrub, agriculture and horticulture
- Harvesting costs, taking account of location and tree component
- Forest industry conversion factors/availability of residues, including past and likely future trends

For all of these, some international data improvement work is in hand or contemplated. What is needed is more resources for communication and harmonisation and above all, national level investment in better quality data by carrying out surveys, putting statistical systems in place etc.

Further **analysis and research** are needed on:

- Wood flow analysis for better understanding of cascade uses and the consumption of woody biomass assortments
- Bringing together wood flow analysis with the statistics of the disposal sector and thereby determine the actual carbon sequestration in wooden products and the interlinkage of carbon sequestration in forest and in energy and material uses.
- Consequences of stump harvesting for biodiversity, carbon stocks and flows, and water
- Determinants of land use change on the agriculture-forest interface (economic drivers, social factors, policy interactions), differentiated by region, in order to estimate how much land might be converted from agriculture to the supply of fibre for energy, at different energy prices (wide variation between existing studies)
- An economic supply curve for wood from Europe's forests, with explicit and geo-referenced consideration of supply shifters such as site, species, ownership (public, different types of private owners), legal framework etc.
- An ambitious attempt to bring together the elements listed above into a comprehensive approach to link wood supply to economic, technical, social and environmental influences and constraints and policy choices
- A closer and more detailed analysis and projections of the sustainable supply of wood and or other materials and energy, with specific analysis of the interfaces between them, to avoid unnecessary duplication or competition for limited resources, notably of land.

6.9 Conclusion

EUwood has shown that with a high mobilisation scenario, it is difficult, but not impossible, to supply, on a sustainable basis, enough wood to satisfy the needs of the industry and to meet the targets for renewable energy in 2020. On a medium mobilisation scenario the expected demand is likely to cross the potential before 2020 if all the potential can be mobilised. There is definitely not enough wood to satisfy the combined needs from the forest based industries and the wood energy producers from domestic sources in 2030. However, to generate more wood would require a long term commitment and investment, and a comprehensive approach as well as favourable framework conditions, many in areas not directly controlled by the forest sector policy makers. A large number of policy measures should be implemented to mobilise wood from the forest, trees outside the forest and post-consumer wood, in the context of a much more intensive management of the sector. The policy measures are of a technical, social and economic nature and must be based on a sound understanding of the vulnerability of natural ecosystems, to avoid damage to soils, sites and ecosystems. To reach this objective will also involve resolving a number of complex tradeoffs, notably with increasing biodiversity and carbon sequestration in forests.

All of these are complex and difficult issues, requiring significant input of time and political will: if Europe wants enough wood supply for both material and energy purposes in 2030, action according to a comprehensive strategy should start now.

References

European Forest Institute (EFI) 2003: EFFE: European Forest Finance. Joensuu : s.n., 2003.

Prins, K. et al. 2009: Forests, wood and climate change: challenges and opportunities in the UNECE region. UNECE. *UNECE Annual Report 2009.* Genève : United Nations, 2009.

UNECE/FAO: 2005. European Forest Sector Outlook Study. New York and Geneva : United Nations, 2005.

Annex

Further explanation on scenarios based results

Energy sector – decline of biomass power plant capacity in a few countries in 2020?

In the project the decision was taken, that wood consumption by biomass power plants would not be calculated separately. This has been calculated as a residual: overall energy consumption has been derived from the targets and national situations, whereas the individual components of biomass energy supply (other than biomass power plants) have each been estimated according to its own methodology, described in the methodology report. These estimation methods by sector are not necessarily completely consistent with each other or the total, which is based on a policy, not a technical assumption. EUwood believes this method, despite its obvious weaknesses, has provided the best possible estimates at the present time. There is no specific estimation method for biomass power plants which are calculated as the difference between the sum of estimates for the other components and the overall policy targets. As different estimation methods were used, some anomalies have arisen, notably minor negative numbers for wood consumption by biomass power plants in some countries. These have been adjusted by reducing estimates of consumption by the other wood energy sectors.

But there are other countries where this approach leads to an apparent drop in the capacity of biomass power plants between 2010 and 2020, followed by an increase between 2020 and 2030, in most cases to levels above those of 2010. However these “drops” are an artefact of the estimation process and not an independent forecast or projection by EUwood, especially as they occur in countries with well developed forest sectors. Possible explanations would be that the “other” sectors in these countries are already well advanced and so will not grow so fast as the optimistic rates made for the European average might imply. It has not been possible, with the data and time available to EUwood to revise the estimation system, which in any case focuses on total wood demand, not the breakdown between energy consuming sectors. Nor would it have been acceptable to “adjust” certain data on subjective grounds. Therefore the figures for biomass power plants have been retained unchanged, despite their anomalous nature, while readers’ attention has been drawn to the problem.

Annex table 1-1: Countries where estimation method leads to apparent reduction of biomass power plant capacity [M m³] in 2020

Region	2010	2020	2030
Northern Europe	21.6	16.6	27.5
Austria	4.4	2.7	7.9
Finland	10.2	8.9	13.5
Latvia	1.7	1.4	3.6
Sweden	6.6	2.5	4.0

Source: EUwood

Country balances

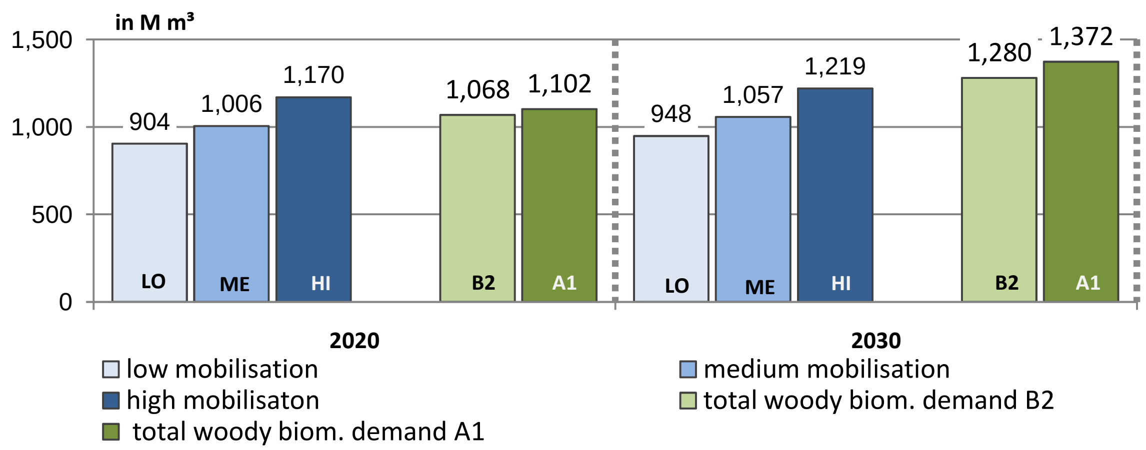
List of abbreviations of the Wood Resource Balance

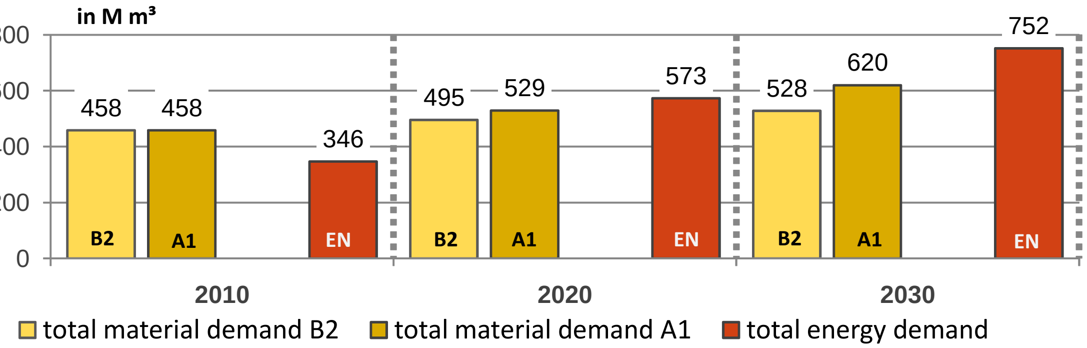
HI	High – refers to high mobilisation scenario
ME	Medium – refers to medium mobilisation scenario
LO	Low – refers to low mobilisation scenario
TH	Theoretical – refers to theoretical availability
POT	Potential – refers to “real” availability under given constraints
DEM	Demand – refers to modelled or assumed demand
DIS	Disposed – refers to potential that is currently disposed
USE	Use – refers to potential that is or will be used
C	Coniferous - softwood
NC	Non-coniferous - hardwood

Annex 1-1: Fact sheet on Wood Resource Balance results for Europe (EU 27)

Wood Resource Balance							
Region		**EU27**		**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	361.8	356.8	355.7	196.4	218.5	246.7	sawmill industry
stemwood NC, ME	182.3	178.1	181.0	11.4	14.2	17.3	veneer plywood
forest residues C+NC, ME	118.0	119.8	120.3	143.3	168.4	200.3	pulp industry
bark, C+NC, ME	23.7	23.3	23.4	92.3	110.1	135.7	panel industry
landsc. care wood (USE) ME	58.5	66.0	73.5	14.8	17.6	19.8	other material uses
				20.9	43.5	53.6	producer of wood fuels
sawmill by-products (POT)	86.6	96.0	107.8	85.5	98.3	113.9	forest sect. intern. use
other ind. res. reduced (POT)	29.7	34.9	41.7	83.2	242.0	377.1	biomass power plants
black liquor (POT)	60.4	71.3	84.9	23.2	68.8	81.5	households (pellets)
solid wood fuels (POT)	20.9	43.5	53.6	154.5	163.2	150.6	households (other)
post-consumer wood (POT)	52.0	58.7	67.3	0.0	0.8	29.0	liquid biofuels
total	**993.9**	**1,048.4**	**1,109.4**	**825.5**	**1,145.4**	**1,425.4**	**total**

Wood Resource Balance (without solid wood fuels)							
Region		**EU27**		**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	686	678	680	458	529	620	material uses
other woody biomass	287	327	375	346	573	752	energy uses
total	**973**	**1,005**	**1,056**	**805**	**1,102**	**1,372**	**total**

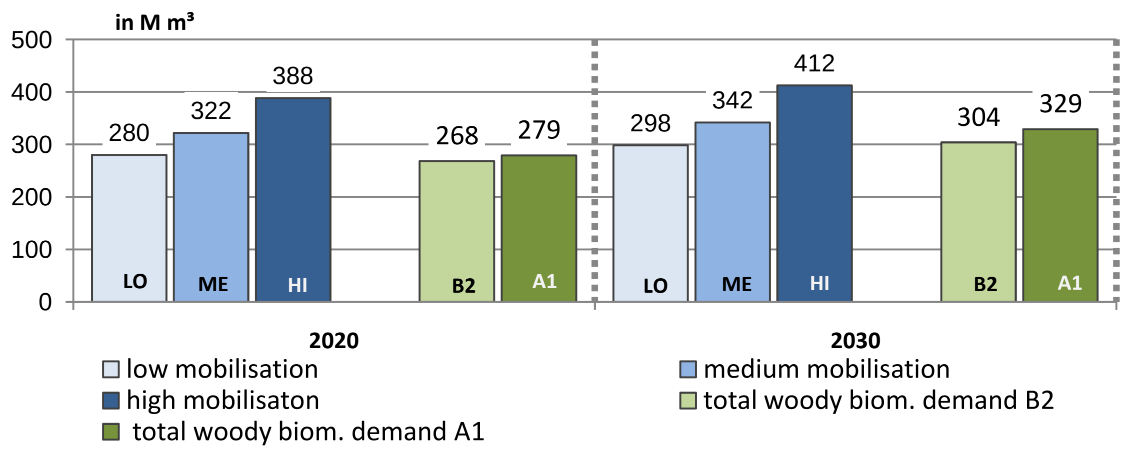


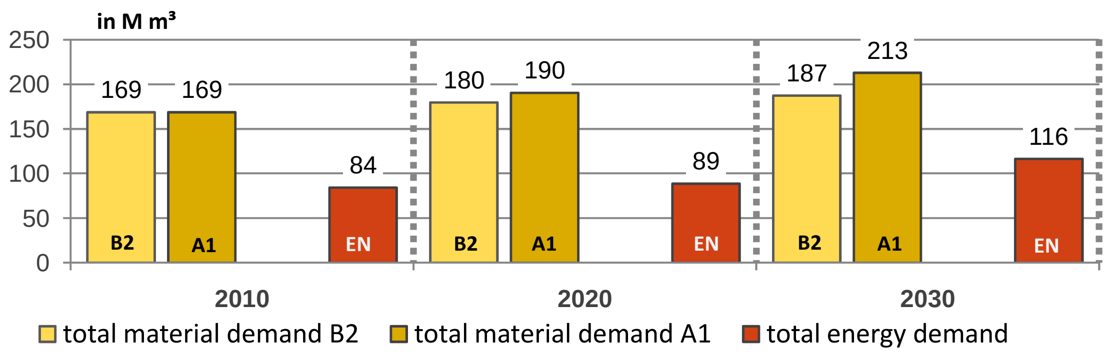


Annex 1-2: Fact sheet on Wood Resource Balance results for Northern Europe

Wood Resource Balance							
Region	**EU27 North**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	141.7	137.3	138.1	75.8	83.1	91.2	sawmill industry
stemwood NC, ME	32.0	35.8	41.7	3.6	5.0	5.9	veneer plywood
forest residues C+NC, ME	40.3	42.2	43.7	84.1	96.0	108.1	pulp industry
bark, C+NC, ME	7.4	7.4	7.7	3.6	4.3	5.2	panel industry
landsc. care wood (USE) ME	7.9	8.9	9.9	1.6	2.0	2.2	other material uses
				6.9	13.5	16.7	producer of wood fuels
sawmill by-products (POT)	37.4	41.0	44.9	43.6	49.1	54.5	forest sect. intern. use
other ind. res. reduced (POT)	5.5	6.6	7.5	21.6	16.6	27.5	biomass power plants
black liquor (POT)	34.7	39.5	44.3	4.7	7.7	9.0	households (pellets)
solid wood fuels (POT)	6.9	13.5	16.7	14.1	14.9	13.7	households (other)
post-consumer wood (POT)	2.9	3.3	3.8	0.0	0.3	11.5	liquid biofuels
total	**316.7**	**335.4**	**358.2**	**259.6**	**292.6**	**345.8**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**EU27 North**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	221	223	231	169	190	213	material uses
other woody biomass	88	99	110	84	89	116	energy uses
total	**310**	**322**	**341**	**253**	**279**	**329**	**total**





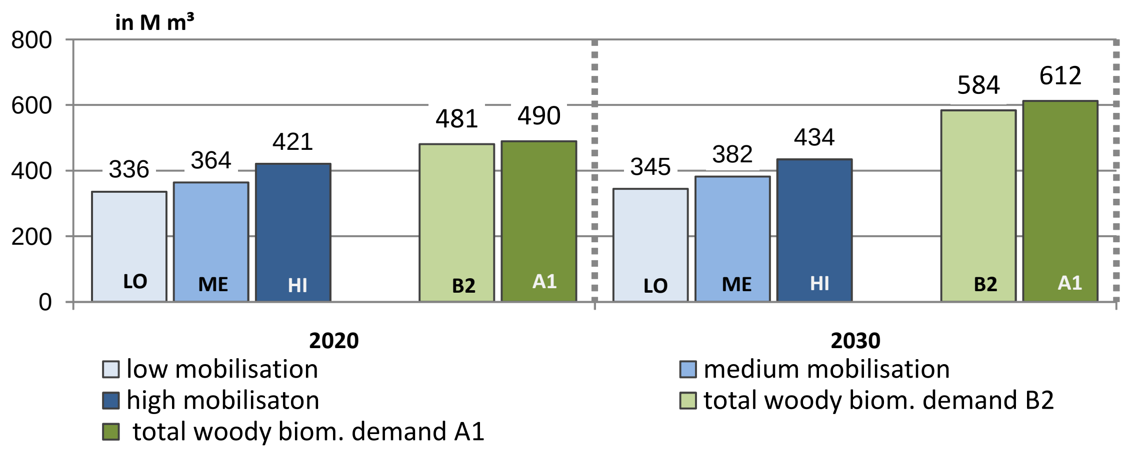
Annex 1-3: Fact sheet on Wood Resource Balance results for Western Europe

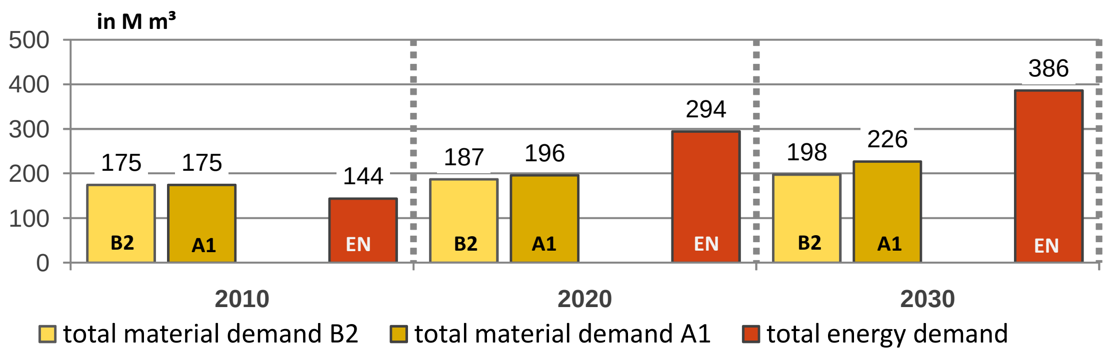
Wood Resource Balance

Region	EU27 West			IPCC Scenario:			A1
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
stemwood C, ME	120.3	121.0	123.1	82.1	92.0	104.8	sawmill industry
stemwood NC, ME	69.1	68.3	68.1	2.7	2.9	3.1	veneer plywood
forest residues C+NC, ME	39.7	39.9	40.1	29.0	33.0	39.9	pulp industry
bark, C+NC, ME	8.3	8.3	8.4	51.9	58.4	68.2	panel industry
landsc. care wood (USE) ME	25.4	28.6	31.9	8.9	9.7	10.4	other material uses
				8.1	19.8	24.6	producer of wood fuels
sawmill by-products (POT)	33.2	37.1	42.1	22.1	24.6	28.1	forest sect. intern. use
other ind. res. reduced (POT)	14.0	15.6	17.9	38.8	152.0	231.8	biomass power plants
black liquor (POT)	11.1	12.7	15.4	14.5	45.4	53.8	households (pellets)
solid wood fuels (POT)	8.1	19.8	24.6	68.3	72.0	66.3	households (other)
post-consumer wood (POT)	30.1	32.1	34.5	0.0	0.2	6.0	liquid biofuels
total	**359.3**	**383.2**	**406.1**	**326.5**	**509.8**	**637.0**	**total**

Wood Resource Balance (without solid wood fuels)

Region	EU27 West			IPCC Scenario:			A1
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
forest woody biomass	237	237	240	175	196	226	material uses
other woody biomass	114	126	142	144	294	386	energy uses
total	**351**	**363**	**381**	**318**	**490**	**612**	**total**

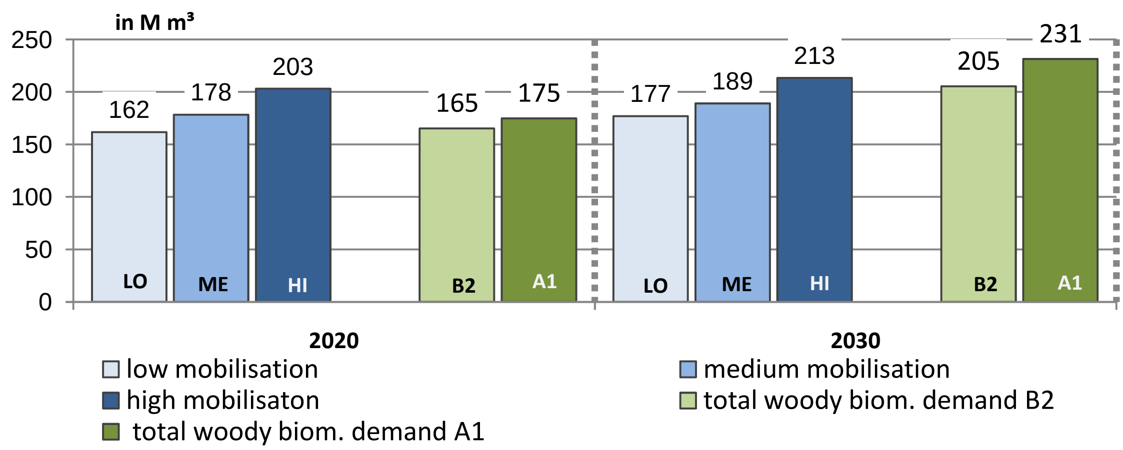


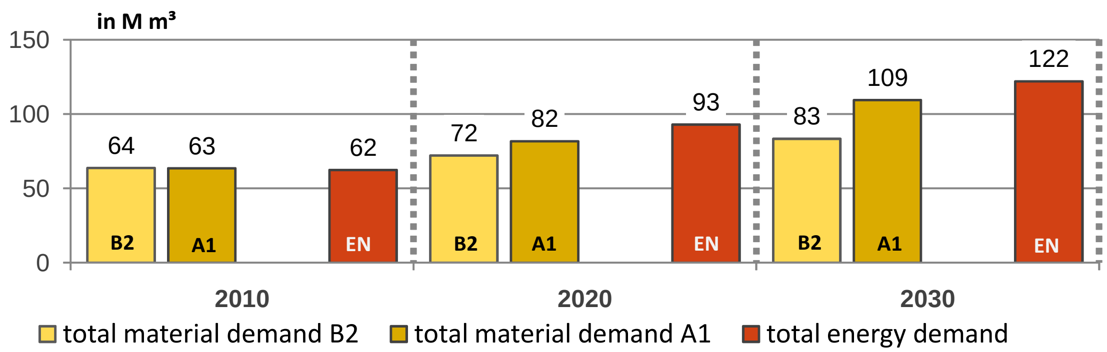


Annex 1-4: Fact sheet on Wood Resource Balance results for Eastern Europe

Wood Resource Balance							
Region	**EU27 East**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	62.1	61.6	59.4	27.1	31.2	37.5	sawmill industry
stemwood NC, ME	41.2	39.7	39.0	2.2	3.0	4.2	veneer plywood
forest residues C+NC, ME	19.8	20.1	19.5	12.9	19.2	29.0	pulp industry
bark, C+NC, ME	4.6	4.5	4.3	18.7	24.7	33.9	panel industry
landsc. care wood (USE) ME	12.6	14.2	15.9	2.5	3.7	4.8	other material uses
				3.0	6.0	7.4	producer of wood fuels
sawmill by-products (POT)	11.2	12.8	15.4	9.1	12.4	17.3	forest sect. intern. use
other ind. res. reduced (POT)	5.5	7.0	9.3	16.7	39.5	62.6	biomass power plants
black liquor (POT)	5.9	8.9	13.4	0.9	2.8	3.3	households (pellets)
solid wood fuels (POT)	3.0	6.0	7.4	35.7	38.2	35.4	households (other)
post-consumer wood (POT)	7.0	9.3	12.9	0.0	0.1	3.4	liquid biofuels
total	**172.9**	**184.2**	**196.3**	**128.8**	**180.7**	**238.7**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**EU27 East**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	128	126	122	63	82	109	material uses
other woody biomass	42	52	67	62	93	122	energy uses
total	**170**	**178**	**189**	**126**	**175**	**231**	**total**

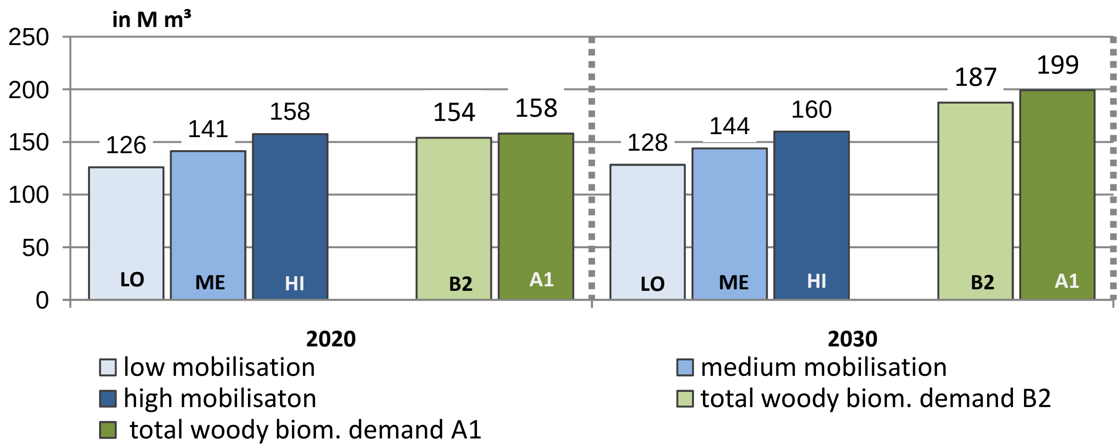


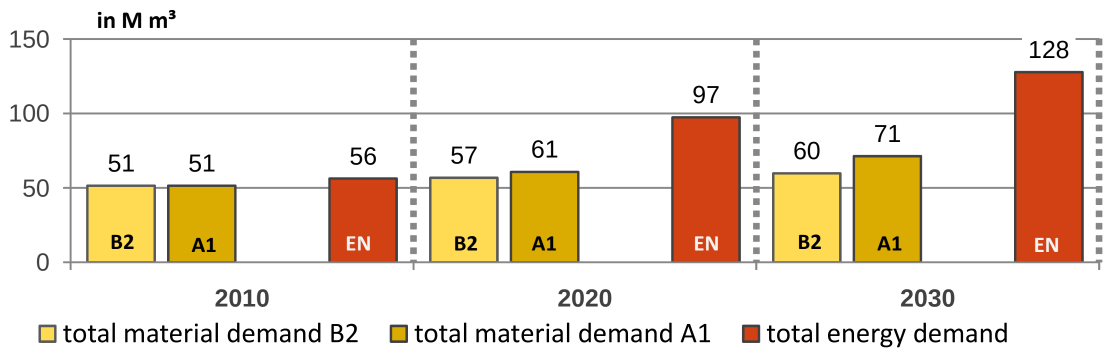


Annex 1-5: Fact sheet on Wood Resource Balance results for Southern Europe

Wood Resource Balance							
Region	**EU27 South**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** (M m³)	**2030**	**2010**	**2020** (M m³)	**2030**	**demand**
stemwood C, ME	37.7	36.9	35.2	11.4	12.2	13.1	sawmill industry
stemwood NC, ME	40.0	34.3	32.2	2.8	3.4	4.0	veneer plywood
forest residues C+NC, ME	18.2	17.6	17.1	17.3	20.2	23.3	pulp industry
bark, C+NC, ME	3.5	3.2	3.0	18.1	22.8	28.4	panel industry
landsc. care wood (USE) ME	12.6	14.2	15.9	1.8	2.2	2.5	other material uses
				2.8	4.3	4.9	producer of wood fuels
saw mill by products (POT)	4.8	5.1	5.5	10.6	12.3	14.0	forest sect. intern. use
other ind. res. reduced (POT)	4.7	5.7	7.0	6.1	33.8	55.2	biomass power plants
black liquor (POT)	8.7	10.2	11.9	3.2	12.9	15.3	households (pellets)
solid wood fuels (POT)	2.8	4.3	4.9	36.4	38.2	35.2	households (other)
post-consumer wood (POT)	12.1	14.0	16.2	0.0	0.2	8.0	liquid biofuels
total	**145.0**	**145.5**	**148.8**	**110.5**	**162.3**	**203.9**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**EU27 South**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** (M m³)	**2030**	**2010**	**2020** (M m³)	**2030**	**demand**
forest woody biomass	99	92	87	51	61	71	material uses
other woody biomass	43	49	56	56	97	128	energy uses
total	**142**	**141**	**144**	**108**	**158**	**199**	**total**

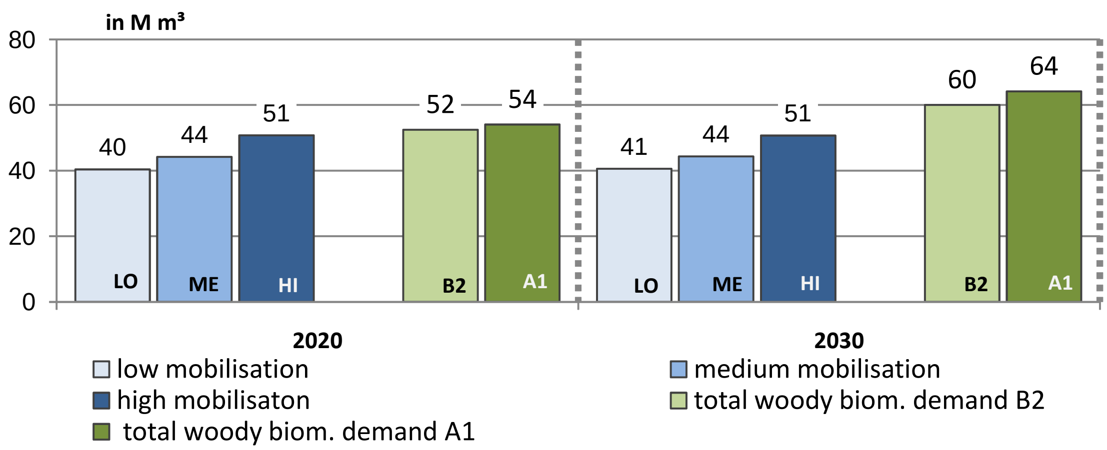


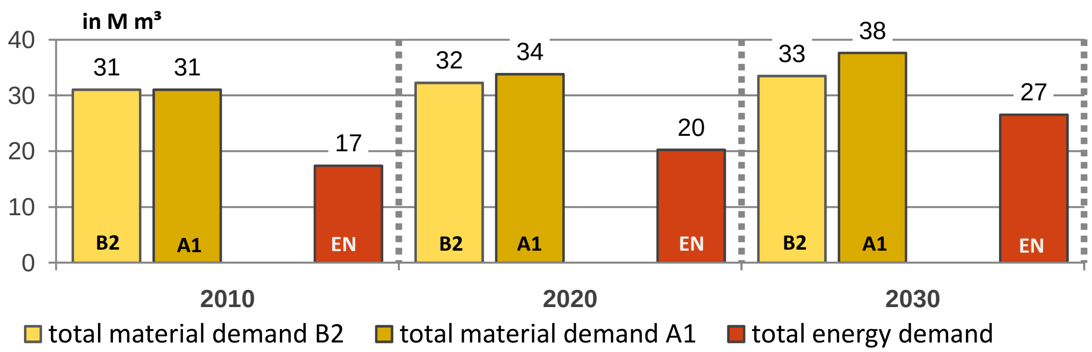


Annex 1-6: Fact sheet on Wood Resource Balance results for AUSTRIA

Wood Resource Balance							
Region	**AUSTRIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	21.6	20.8	19.3	18.3	20.2	22.1	sawmill industry
stemwood NC, ME	2.9	3.2	3.5	0.4	0.4	0.5	veneer plywood
forest residues C+NC, ME	4.2	4.1	3.9	5.7	5.7	6.5	pulp industry
bark, C+NC, ME	1.0	1.0	1.0	5.2	5.8	6.7	panel industry
landsc. care wood (USE) ME	1.1	1.3	1.4	1.5	1.7	1.8	other material uses
				2.0	4.5	5.2	producer of wood fuels
sawmill by-products (POT)	7.3	8.1	8.8	5.1	5.1	5.5	forest sect. intern. use
other ind. res. reduced (POT)	2.0	2.2	2.5	4.4	2.7	7.9	biomass power plants
black liquor (POT)	2.4	2.4	2.6	2.9	7.4	8.7	households (pellets)
solid wood fuels (POT)	2.0	4.5	5.2	5.1	5.0	4.5	households (other)
post-consumer wood (POT)	1.1	1.3	1.4	0.0	0.0	0.0	liquid biofuels
total	**45.8**	**48.7**	**49.6**	**50.4**	**58.5**	**69.4**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**AUSTRIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	30	29	28	31	34	38	material uses
other woody biomass	14	15	17	17	20	27	energy uses
total	**44**	**44**	**44**	**48**	**54**	**64**	**total**

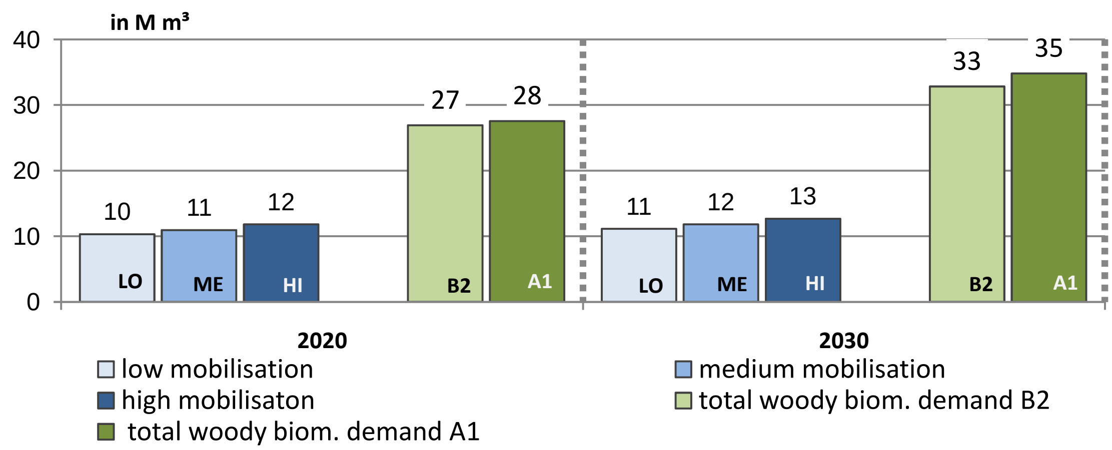


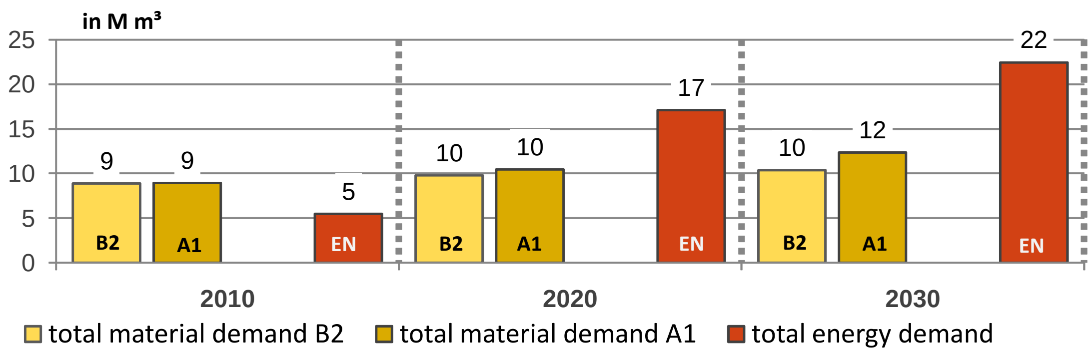


Annex 1-7: Fact sheet on Wood Resource Balance results for BELGIUM

Wood Resource Balance							
Region	**BELGIUM**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	2.5	2.8	2.7	2.2	2.6	2.9	sawmill industry
stemwood NC, ME	1.4	1.1	1.0	0.3	0.3	0.4	veneer plywood
forest residues C+NC, ME	0.6	0.6	0.6	2.5	3.1	3.8	pulp industry
bark, C+NC, ME	0.2	0.2	0.2	3.7	4.3	5.1	panel industry
landsc. care wood (USE) ME	0.6	0.7	0.8	0.2	0.2	0.2	other material uses
				0.7	0.8	0.9	producer of wood fuels
sawmill by-products (POT)	0.9	1.0	1.2	1.8	2.2	2.6	forest sect. intern. use
other ind. res. reduced (POT)	0.7	0.9	1.0	0.3	3.8	6.9	biomass power plants
black liquor (POT)	1.2	1.4	1.7	2.9	10.3	12.2	households (pellets)
solid wood fuels (POT)	0.7	0.8	0.9	0.4	0.8	0.7	households (other)
post-consumer wood (POT)	2.1	2.3	2.7	0.0	0.0	0.0	liquid biofuels
total	**10.9**	**11.7**	**12.7**	**15.1**	**28.4**	**35.7**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**BELGIUM**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	5	5	4	9	10	12	material uses
other woody biomass	6	6	7	5	17	22	energy uses
total	**10**	**11**	**12**	**14**	**28**	**35**	**total**

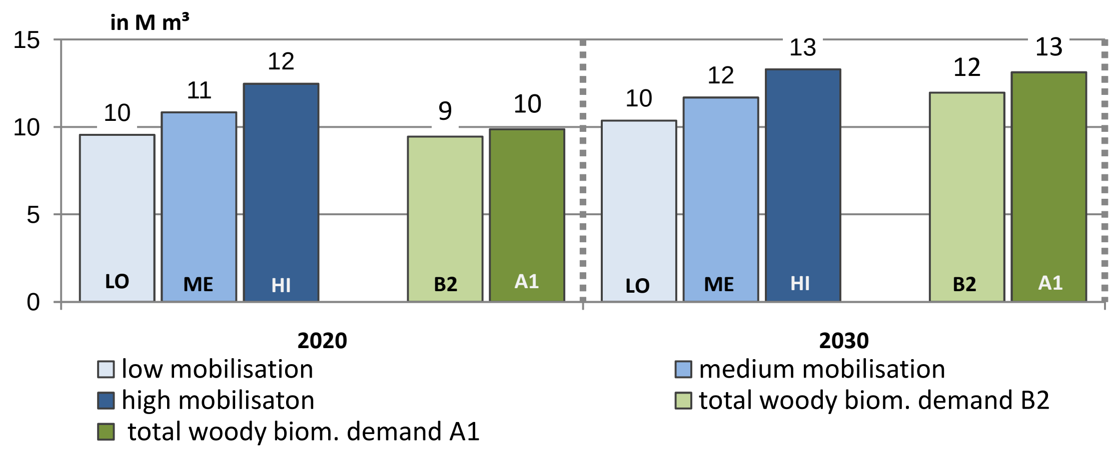


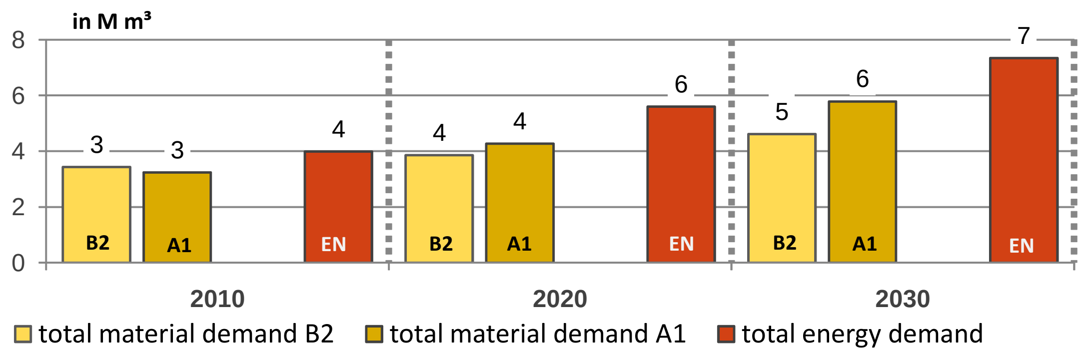


Annex 1-8: Fact sheet on Wood Resource Balance results for BULGARIA

Wood Resource Balance							
Region	**BULGARIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	2.3	2.5	2.6	1.1	1.3	1.6	sawmill industry
stemwood NC, ME	3.3	3.2	3.2	0.1	0.2	0.3	veneer plywood
forest residues C+NC, ME	1.7	1.7	1.7	0.8	1.1	1.6	pulp industry
bark, C+NC, ME	0.3	0.3	0.3	1.1	1.5	2.1	panel industry
landsc. care wood (USE) ME	1.3	1.4	1.6	0.1	0.1	0.2	other material uses
				0.1	0.3	0.4	producer of wood fuels
sawmill by-products (POT)	0.5	0.6	0.7	0.6	0.8	1.0	forest sect. intern. use
other ind. res. reduced (POT)	0.3	0.4	0.6	0.6	1.8	3.5	biomass power plants
black liquor (POT)	0.4	0.6	0.8	0.0	0.0	0.0	households (pellets)
solid wood fuels (POT)	0.1	0.3	0.4	2.8	3.0	2.8	households (other)
post-consumer wood (POT)	0.1	0.2	0.2	0.0	0.0	0.0	liquid biofuels
total	**10.2**	**11.1**	**12.1**	**7.3**	**10.2**	**13.5**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**BULGARIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	8	8	8	3	4	6	material uses
other woody biomass	3	3	4	4	6	7	energy uses
total	**10**	**11**	**12**	**7**	**10**	**13**	**total**

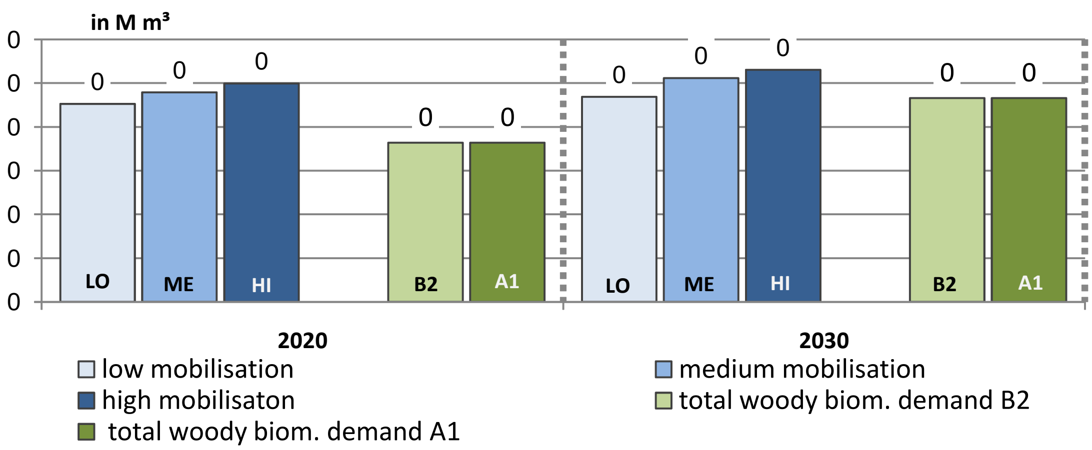


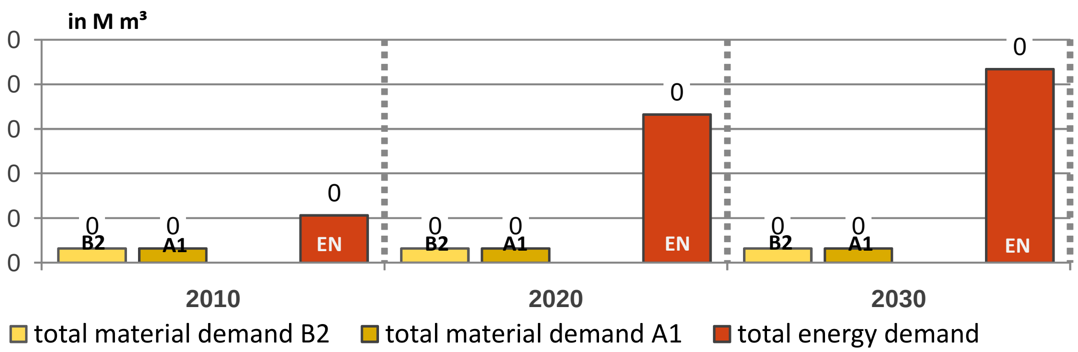


Annex 1-9: Fact sheet on Wood Resource Balance results for CYPRUS

Wood Resource Balance							
Region	CYPRUS			IPCC Scenario:			A1
potential	2010	2020 M m³	2030	2010	2020 M m³	2030	demand
stemwood C, ME	0.0	0.0	0.0	0.0	0.0	0.0	sawmill industry
stemwood NC, ME	0.0	0.0	0.0	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	0.0	0.0	0.0	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.0	0.0	0.0	0.0	0.0	0.0	panel industry
landsc. care wood (USE) ME	0.1	0.1	0.2	0.0	0.0	0.0	other material uses
				0.0	0.0	0.0	producer of wood fuels
sawmill by-products (POT)	0.0	0.0	0.0	0.0	0.0	0.0	forest sect. intern. use
other ind. res. reduced (POT)	0.0	0.0	0.0	0.0	0.1	0.2	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.0	0.0	0.0	households (pellets)
solid wood fuels (POT)	0.0	0.0	0.0	0.0	0.0	0.0	households (other)
post-consumer wood (POT)	0.1	0.1	0.1	0.0	0.0	0.0	liquid biofuels
total	**0.2**	**0.2**	**0.3**	**0.1**	**0.2**	**0.2**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	CYPRUS			IPCC Scenario:			A1
potential	2010	2020 M m³	2030	2010	2020 M m³	2030	demand
forest woody biomass	0	0	0	0	0	0	material uses
other woody biomass	0	0	0	0	0	0	energy uses
total	**0**	**0**	**0**	**0**	**0**	**0**	**total**

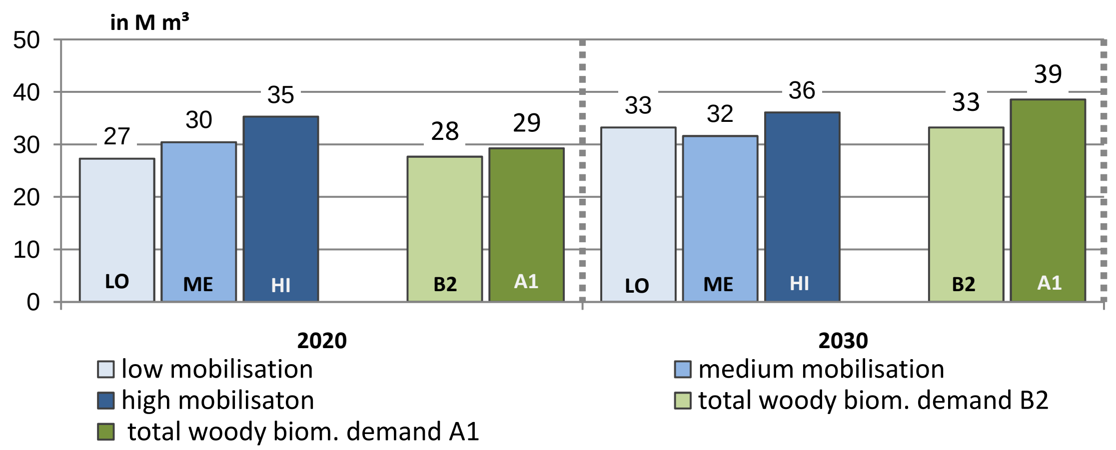


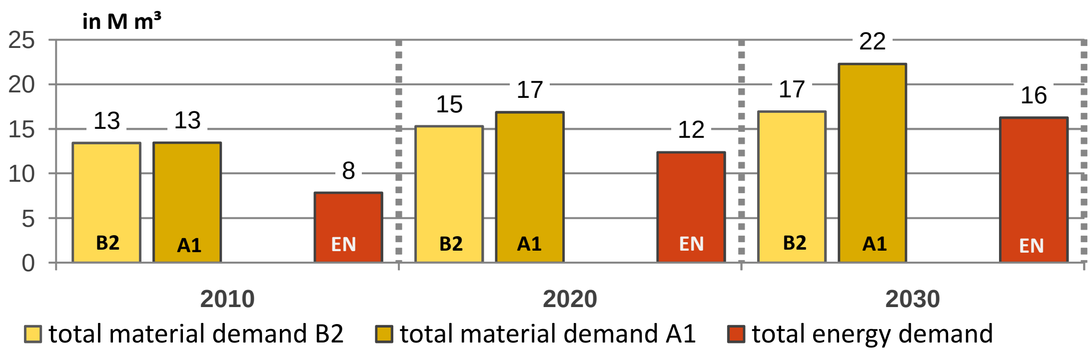


Annex 1-10: Fact sheet on Wood Resource Balance results for CZECH REPUBLIC

Wood Resource Balance							
Region	**CZECH REPUBLIC**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	13.0	12.5	11.5	7.5	8.1	9.4	sawmill industry
stemwood NC, ME	3.4	3.5	3.4	0.4	0.5	0.7	veneer plywood
forest residues C+NC, ME	4.4	4.4	4.2	3.3	5.2	8.0	pulp industry
bark, C+NC, ME	0.7	0.7	0.6	2.1	2.9	4.1	panel industry
landsc. care wood (USE) ME	1.3	1.5	1.6	0.1	0.2	0.2	other material uses
				0.3	0.9	1.2	producer of wood fuels
sawmill by-products (POT)	3.1	3.4	3.9	2.5	3.6	5.1	forest sect. intern. use
other ind. res. reduced (POT)	0.9	1.0	1.3	2.5	5.7	8.2	biomass power plants
black liquor (POT)	1.6	2.5	3.8	0.1	0.2	0.3	households (pellets)
solid wood fuels (POT)	0.3	0.9	1.2	2.7	2.9	2.7	households (other)
post-consumer wood (POT)	0.7	1.0	1.3	0.0	0.0	0.0	liquid biofuels
total	**29.3**	**31.3**	**32.8**	**21.6**	**30.1**	**39.8**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**CZECH REPUBLIC**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	21	21	20	13	17	22	material uses
other woody biomass	8	9	12	8	12	16	energy uses
total	**29**	**30**	**32**	**21**	**29**	**39**	**total**





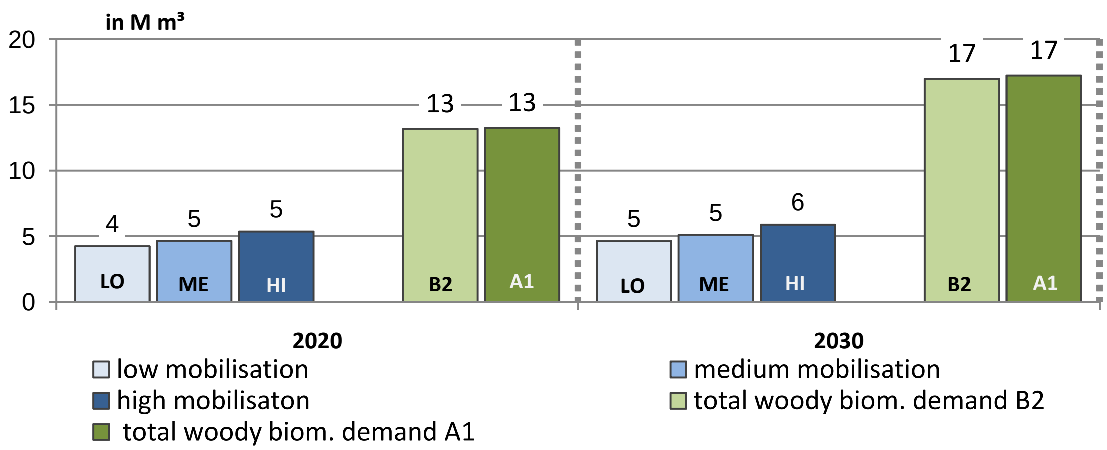
Annex 1-11: Fact sheet on Wood Resource Balance results for DENMARK

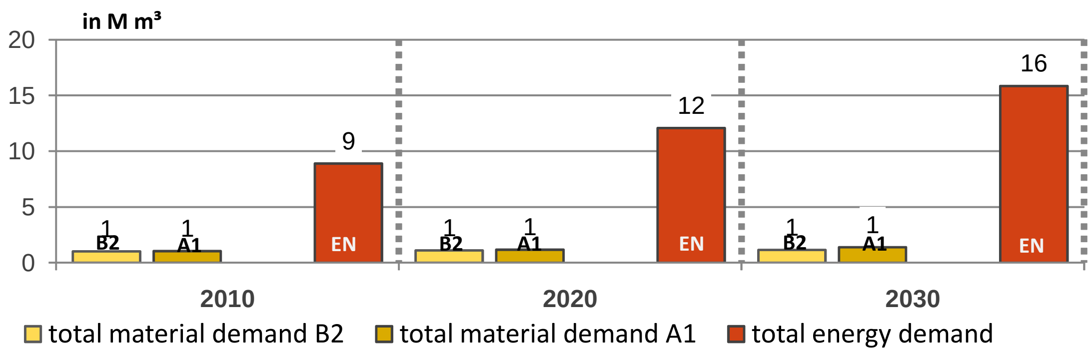
Wood Resource Balance

Region	DENMARK			IPCC Scenario:			A1
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
stemwood C, ME	1.3	1.3	1.4	0.4	0.5	0.7	sawmill industry
stemwood NC, ME	0.6	0.4	0.6	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	0.4	0.4	0.4	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.1	0.1	0.1	0.5	0.6	0.6	panel industry
landsc. care wood (USE) ME	0.7	0.8	0.9	0.1	0.1	0.1	other material uses
				0.4	0.6	0.7	producer of wood fuels
sawmill by-products (POT)	0.2	0.2	0.3	0.1	0.1	0.1	forest sect. intern. use
other ind. res. reduced (POT)	0.1	0.1	0.1	5.9	7.7	10.9	biomass power plants
black liquor (POT)	0.0	0.0	0.0	2.5	4.0	4.6	households (pellets)
solid wood fuels (POT)	0.4	0.6	0.7	0.5	0.4	0.3	households (other)
post-consumer wood (POT)	1.3	1.3	1.4	0.0	0.0	0.0	liquid biofuels
total	**5.1**	**5.2**	**5.8**	**10.3**	**13.8**	**18.0**	**total**

Wood Resource Balance (without solid wood fuels)

Region	DENMARK			IPCC Scenario:			A1
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
forest woody biomass	2	2	2	1	1	1	material uses
other woody biomass	2	2	3	9	12	16	energy uses
total	**5**	**5**	**5**	**10**	**13**	**17**	**total**

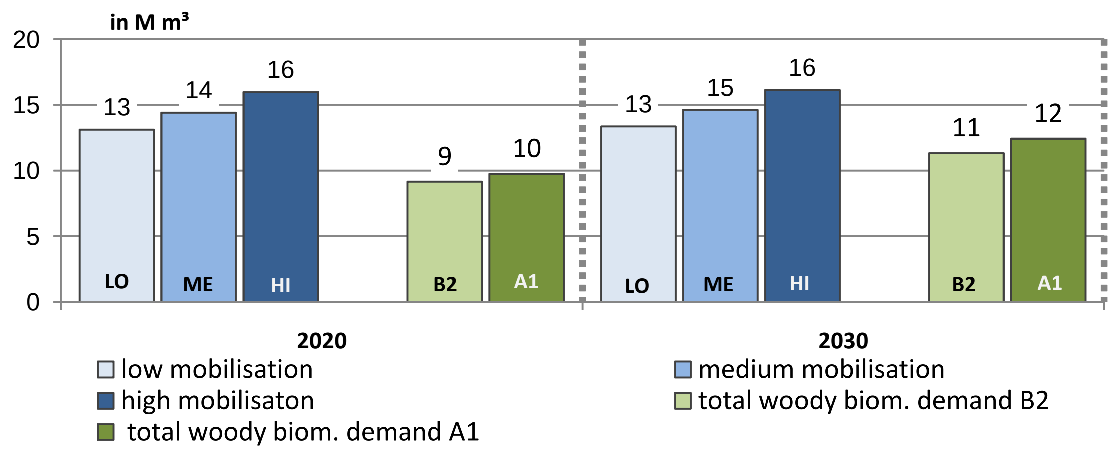


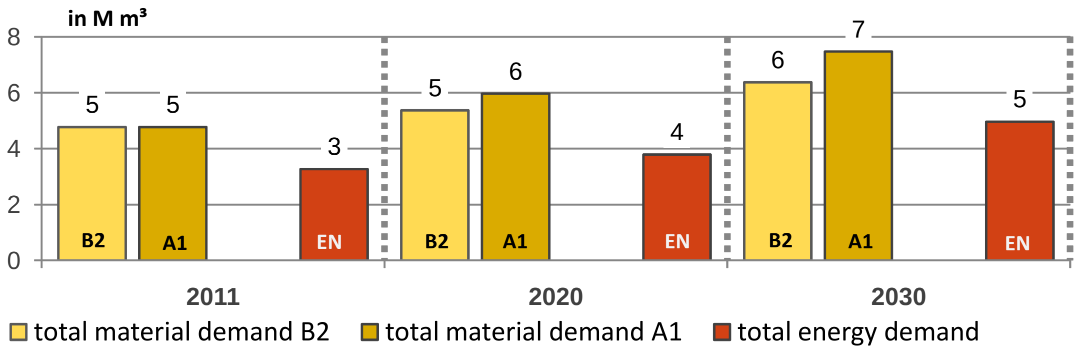


Annex 1-12: Fact sheet on Wood Resource Balance results for ESTONIA

Wood Resource Balance							
Region	**ESTONIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	4.6	4.7	4.6	3.7	4.5	5.4	sawmill industry
stemwood NC, ME	5.3	4.9	4.6	0.2	0.2	0.3	veneer plywood
forest residues C+NC, ME	0.9	0.9	0.8	0.3	0.5	0.7	pulp industry
bark, C+NC, ME	0.5	0.4	0.4	0.5	0.7	1.0	panel industry
landsc. care wood (USE) ME	0.4	0.5	0.5	0.1	0.1	0.1	other material uses
				0.9	1.6	1.9	producer of wood fuels
sawmill by-products (POT)	1.7	2.1	2.5	0.5	0.6	0.7	forest sect. intern. use
other ind. res. reduced (POT)	0.3	0.4	0.5	1.7	2.0	3.1	biomass power plants
black liquor (POT)	0.2	0.3	0.4	0.0	0.0	0.0	households (pellets)
solid wood fuels (POT)	0.9	1.6	1.9	1.1	1.1	1.1	households (other)
post-consumer wood (POT)	0.2	0.2	0.3	0.0	0.0	0.0	liquid biofuels
total	**15.0**	**16.0**	**16.5**	**8.9**	**11.3**	**14.3**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**ESTONIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	11	11	10	5	6	7	material uses
other woody biomass	3	3	4	3	4	5	energy uses
total	**14**	**14**	**15**	**8**	**10**	**12**	**total**





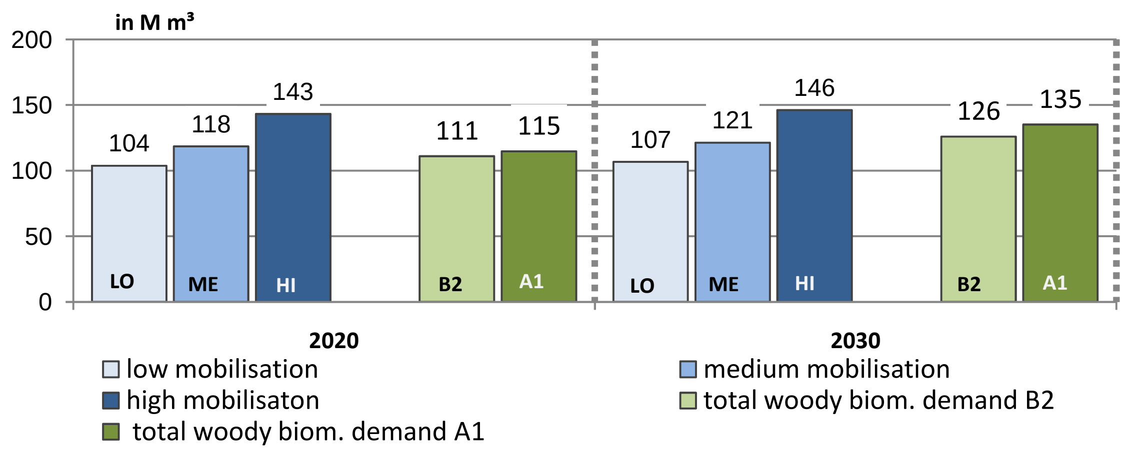
Annex 1-13: Fact sheet on Wood Resource Balance results for FINLAND

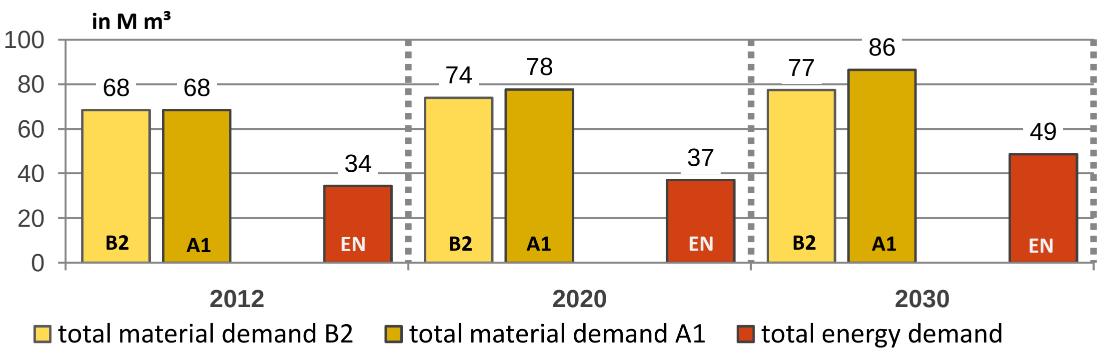
Wood Resource Balance

Region	FINLAND			IPCC Scenario:			A1
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
stemwood C, ME	51.6	50.6	46.9	25.9	27.8	29.8	sawmill industry
stemwood NC, ME	9.3	11.9	14.4	2.7	3.8	4.4	veneer plywood
forest residues C+NC, ME	13.2	14.0	14.1	38.8	45.0	51.1	pulp industry
bark, C+NC, ME	2.6	2.7	2.6	0.9	0.9	0.9	panel industry
landsc. care wood (USE) ME	2.1	2.4	2.7	0.2	0.2	0.3	other material uses
				1.2	3.7	4.9	producer of wood fuels
sawmill by-products (POT)	12.9	13.9	14.9	18.4	20.9	23.2	forest sect. intern. use
other ind. res. reduced (POT)	2.5	3.0	3.4	10.2	8.9	13.5	biomass power plants
black liquor (POT)	16.2	18.6	20.8	0.5	1.5	1.7	households (pellets)
solid wood fuels (POT)	1.2	3.7	4.9	5.4	5.7	5.2	households (other)
post-consumer wood (POT)	1.2	1.3	1.5	0.0	0.1	5.0	liquid biofuels
total	**112.8**	**122.2**	**126.2**	**104.1**	**118.5**	**140.0**	**total**

Wood Resource Balance (without solid wood fuels)

Region	FINLAND			IPCC Scenario:			A1
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
forest woody biomass	77	79	78	68	78	86	material uses
other woody biomass	35	39	43	34	37	49	energy uses
total	**112**	**118**	**121**	**103**	**115**	**135**	**total**

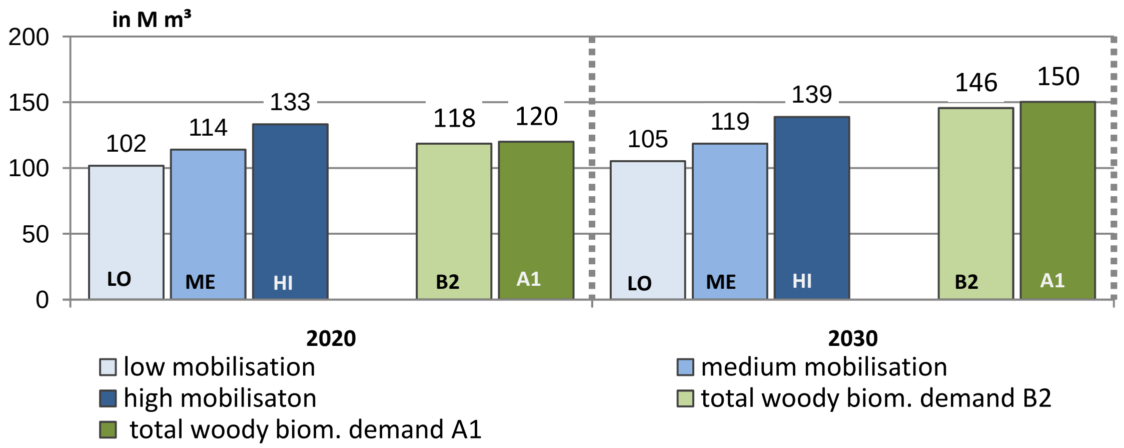


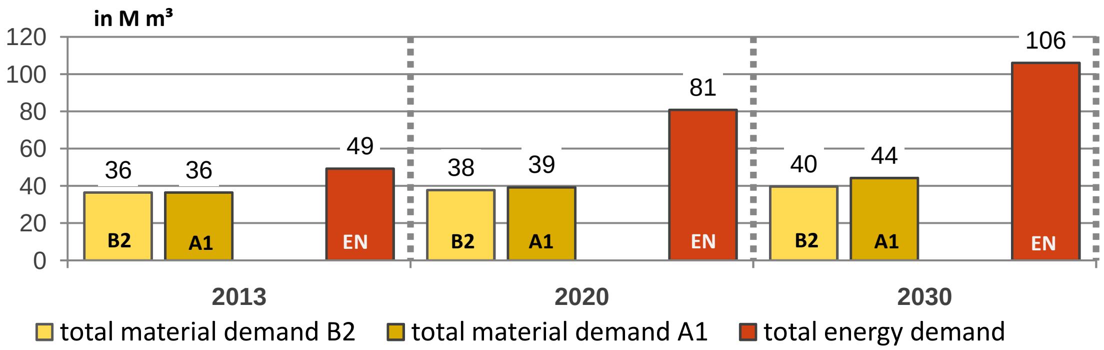


Annex 1-14: Fact sheet on Wood Resource Balance results for FRANCE

Wood Resource Balance							
Region	**FRANCE**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	32.5	31.3	32.6	16.9	17.9	19.2	sawmill industry
stemwood NC, ME	33.6	33.5	32.9	0.9	0.9	0.9	veneer plywood
forest residues C+NC, ME	11.5	11.1	11.4	8.8	8.9	10.5	pulp industry
bark, C+NC, ME	3.0	2.9	3.0	9.2	10.8	12.9	panel industry
landsc. care wood (USE) ME	12.6	14.2	15.9	0.7	0.7	0.7	other material uses
				0.6	2.0	2.8	producer of wood fuels
sawmill by-products (POT)	7.1	7.4	7.8	5.9	6.1	6.9	forest sect. intern. use
other ind. res. reduced (POT)	2.7	3.0	3.4	7.4	34.1	57.1	biomass power plants
black liquor (POT)	3.8	3.9	4.6	0.6	2.6	3.2	households (pellets)
solid wood fuels (POT)	0.6	2.0	2.8	35.4	37.8	35.1	households (other)
post-consumer wood (POT)	6.3	6.6	7.0	0.0	0.1	3.7	liquid biofuels
total	**113.5**	**116.0**	**121.3**	**86.4**	**122.0**	**153.0**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**FRANCE**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	80	79	80	36	39	44	material uses
other woody biomass	32	35	39	49	81	106	energy uses
total	**113**	**114**	**119**	**86**	**120**	**150**	**total**

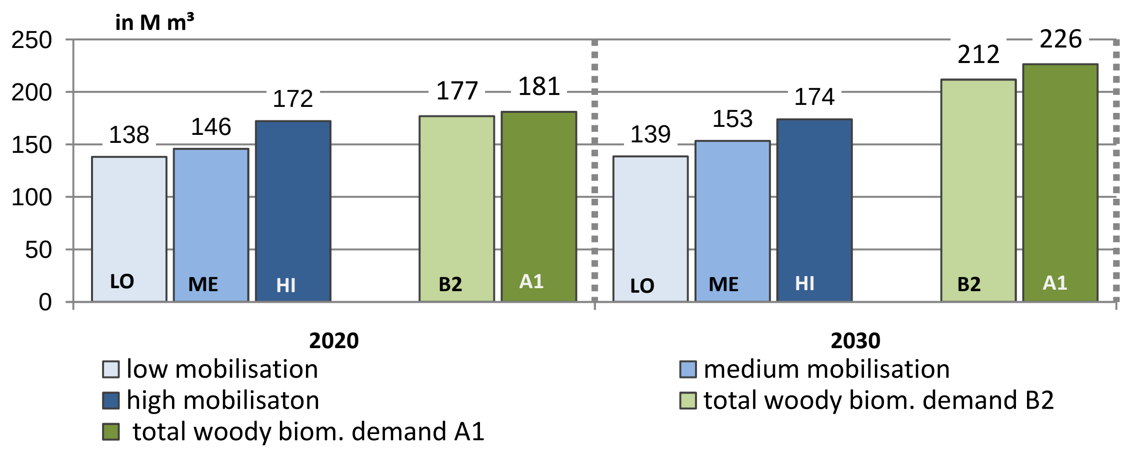


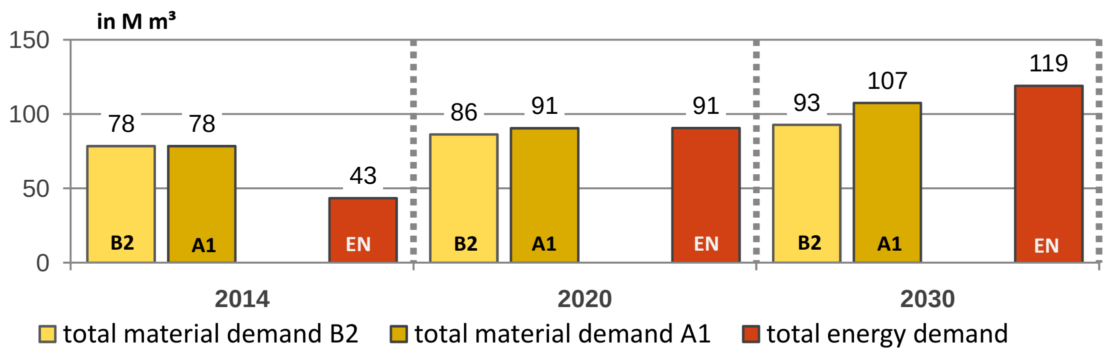


Annex 1-15: Fact sheet on Wood Resource Balance results for GERMANY

Wood Resource Balance							
Region	**GERMANY**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	49.8	51.6	52.2	35.7	41.7	50.0	sawmill industry
stemwood NC, ME	25.7	26.4	26.1	1.2	1.2	1.4	veneer plywood
forest residues C+NC, ME	20.1	20.8	20.7	10.7	13.6	17.1	pulp industry
bark, C+NC, ME	3.3	3.4	3.4	25.7	28.4	33.0	panel industry
landsc. care wood (USE) ME	4.9	5.5	6.2	5.2	5.6	6.0	other material uses
				3.5	9.8	12.3	producer of wood fuels
sawmill by-products (POT)	13.8	16.2	19.4	8.3	10.1	12.0	forest sect. intern. use
other ind. res. reduced (POT)	6.9	7.6	8.8	6.3	41.6	65.7	biomass power plants
black liquor (POT)	3.6	4.9	6.3	2.9	11.9	14.2	households (pellets)
solid wood fuels (POT)	3.5	9.8	12.3	25.9	27.0	24.8	households (other)
post-consumer wood (POT)	8.7	9.4	10.1	0.0	0.1	2.3	liquid biofuels
total	**140.3**	**155.5**	**165.6**	**125.3**	**190.9**	**238.7**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**GERMANY**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	99	102	102	78	91	107	material uses
other woody biomass	38	44	51	43	91	119	energy uses
total	**137**	**146**	**153**	**122**	**181**	**226**	**total**

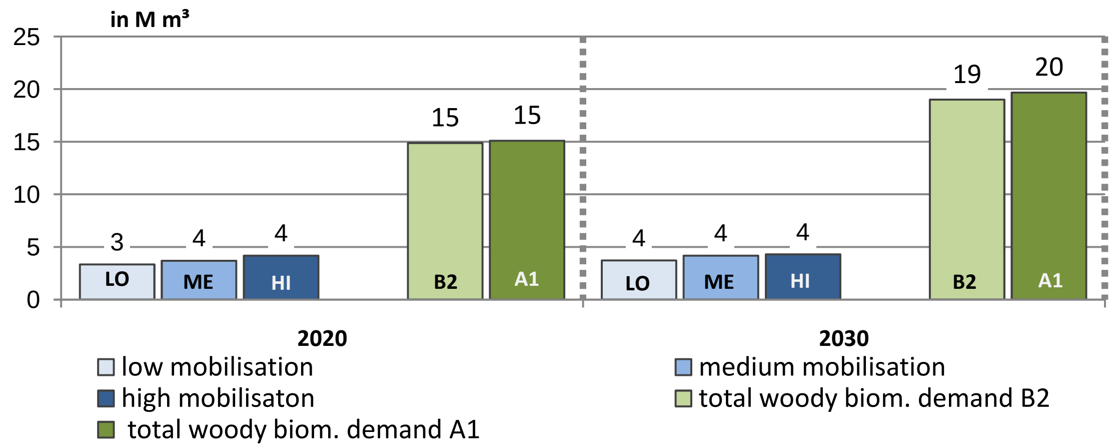


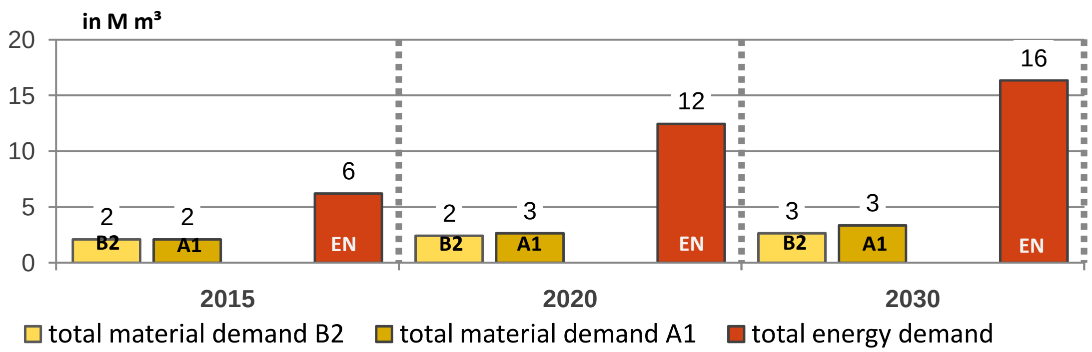


Annex 1-16: Fact sheet on Wood Resource Balance results for GREECE

Wood Resource Balance							
Region	**GREECE**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	0.0	0.0	0.0	0.3	0.4	0.4	sawmill industry
stemwood NC, ME	0.0	0.0	0.0	0.1	0.1	0.1	veneer plywood
forest residues C+NC, ME	0.4	0.4	0.4	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.0	0.0	0.0	1.5	1.9	2.5	panel industry
landsc. care wood (USE) ME	1.5	1.7	1.9	0.2	0.3	0.3	other material uses
				0.2	0.4	0.4	producer of wood fuels
sawmill by-products (POT)	0.2	0.2	0.2	0.1	0.1	0.1	forest sect. intern. use
other ind. res. reduced (POT)	0.2	0.3	0.4	1.7	7.5	11.7	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.0	0.1	0.2	households (pellets)
solid wood fuels (POT)	0.2	0.4	0.4	4.4	4.7	4.4	households (other)
post-consumer wood (POT)	0.9	1.0	1.2	0.0	0.0	0.0	liquid biofuels
total	**3.5**	**4.1**	**4.6**	**8.5**	**15.5**	**20.1**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**GREECE**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	0	0	0	2	3	3	material uses
other woody biomass	3	3	4	6	12	16	energy uses
total	**3**	**4**	**4**	**8**	**15**	**20**	**total**

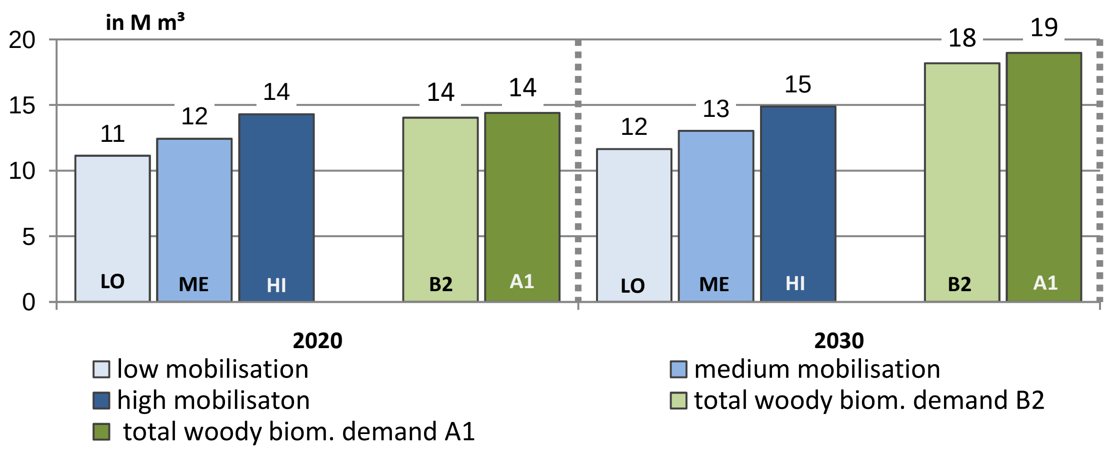


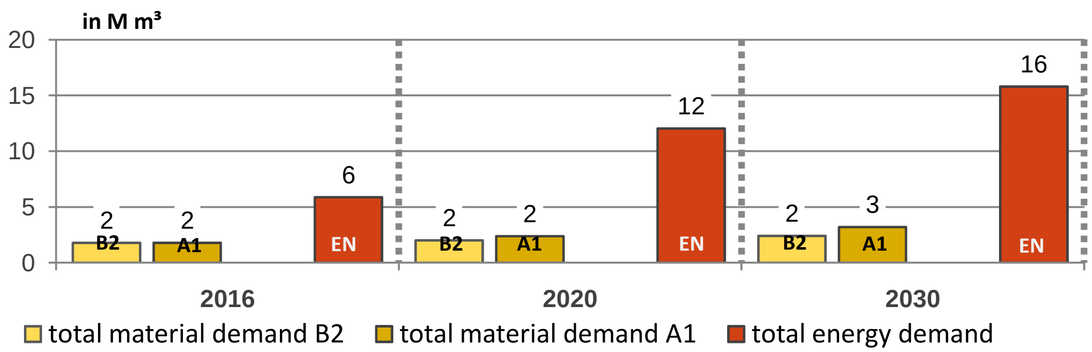


Annex 1-17: Fact sheet on Wood Resource Balance results for HUNGARY

Wood Resource Balance							
Region	**HUNGARY**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	1.1	1.2	1.3	0.4	0.6	0.7	sawmill industry
stemwood NC, ME	6.5	6.5	6.4	0.1	0.2	0.2	veneer plywood
forest residues C+NC, ME	1.4	1.5	1.5	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.4	0.4	0.4	1.0	1.3	1.8	panel industry
landsc. care wood (USE) ME	1.4	1.6	1.8	0.2	0.3	0.4	other material uses
				0.0	0.1	0.1	producer of wood fuels
sawmill by-products (POT)	0.2	0.3	0.4	0.1	0.1	0.1	forest sect. intern. use
other ind. res. reduced (POT)	0.2	0.3	0.4	2.6	8.4	12.4	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.0	0.1	0.1	households (pellets)
solid wood fuels (POT)	0.0	0.1	0.1	3.2	3.4	3.2	households (other)
post-consumer wood (POT)	0.5	0.7	0.9	0.0	0.0	0.0	liquid biofuels
total	**11.8**	**12.5**	**13.2**	**7.7**	**14.5**	**19.1**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**HUNGARY**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	9	10	10	2	2	3	material uses
other woody biomass	2	3	3	6	12	16	energy uses
total	**12**	**12**	**13**	**8**	**14**	**19**	**total**

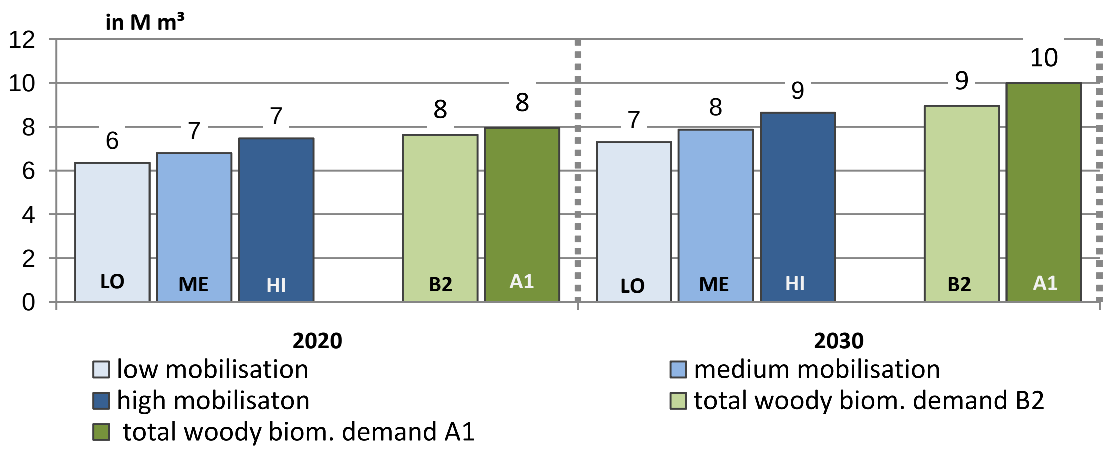


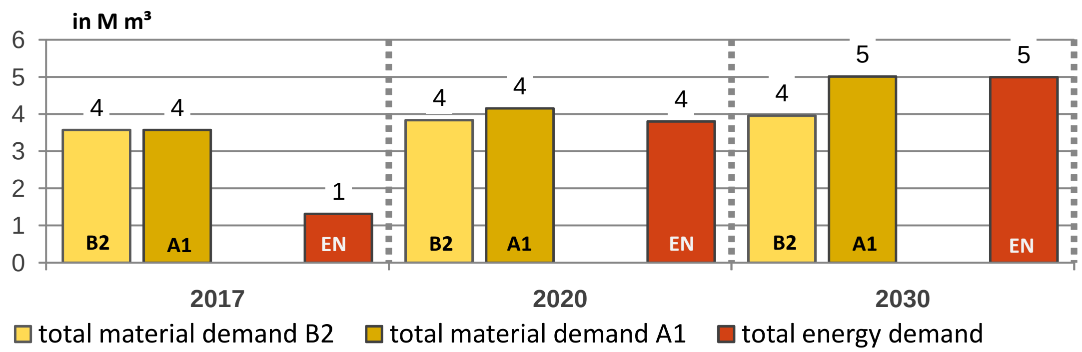


Annex 1-18: Fact sheet on Wood Resource Balance results for IRELAND

Wood Resource Balance							
Region	**IRELAND**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	1.7	2.5	2.9	2.0	2.3	2.6	sawmill industry
stemwood NC, ME	0.7	0.4	0.6	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	0.3	0.4	0.4	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.1	0.1	0.1	1.4	1.6	2.2	panel industry
landsc. care wood (USE) ME	1.1	1.2	1.4	0.2	0.2	0.2	other material uses
				0.0	0.2	0.2	producer of wood fuels
sawmill by-products (POT)	1.0	1.1	1.3	0.2	0.2	0.2	forest sect. intern. use
other ind. res. reduced (POT)	0.3	0.4	0.5	0.9	3.1	4.2	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.1	0.4	0.5	households (pellets)
solid wood fuels (POT)	0.0	0.2	0.2	0.1	0.1	0.1	households (other)
post-consumer wood (POT)	0.6	0.6	0.7	0.0	0.0	0.0	liquid biofuels
total	**5.8**	**7.0**	**8.1**	**4.9**	**8.1**	**10.2**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**IRELAND**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	3	3	4	4	4	5	material uses
other woody biomass	3	3	4	1	4	5	energy uses
total	**6**	**7**	**8**	**5**	**8**	**10**	**total**

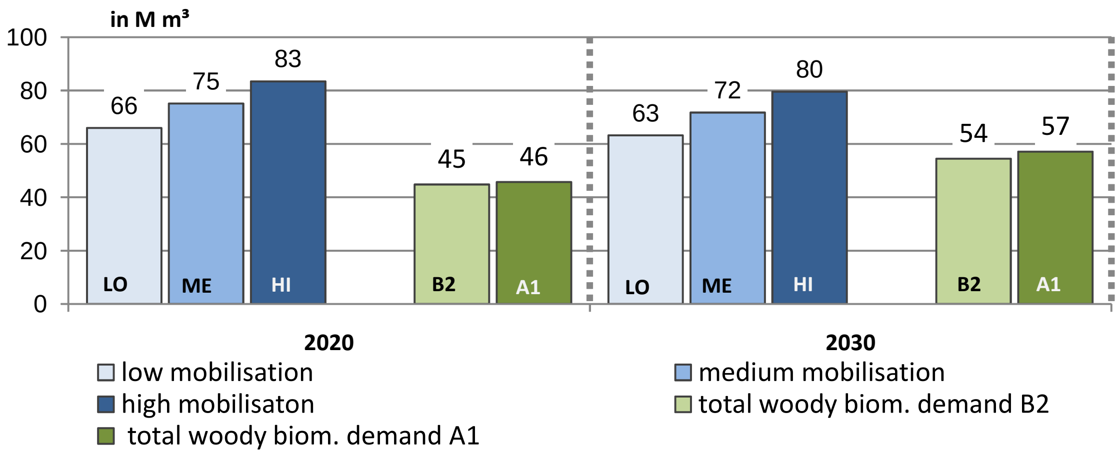


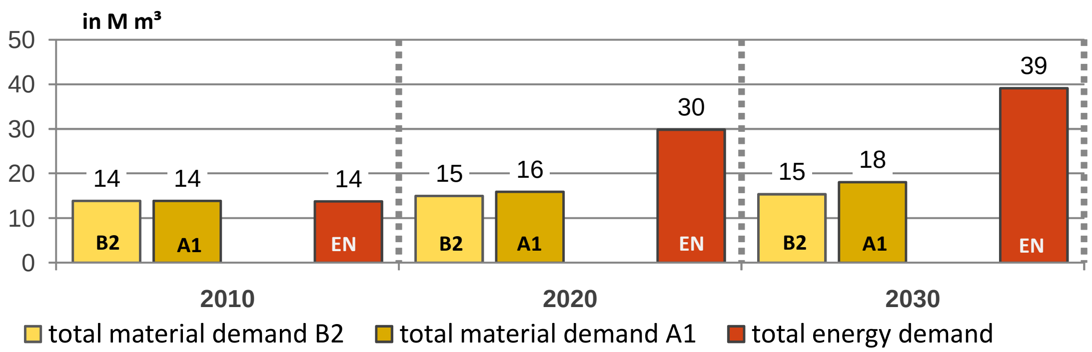


Annex 1-19: Fact sheet on Wood Resource Balance results for ITALY

Wood Resource Balance							
Region	ITALY			IPCC Scenario:			A1
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	21.9	19.6	17.9	2.8	2.9	3.1	sawmill industry
stemwood NC, ME	31.9	27.8	25.1	1.7	2.0	2.4	veneer plywood
forest residues C+NC, ME	11.7	10.9	10.1	1.3	1.4	1.4	pulp industry
bark, C+NC, ME	2.5	2.2	2.0	7.2	8.5	9.9	panel industry
landsc. care wood (USE) ME	3.3	3.7	4.1	0.9	1.1	1.2	other material uses
				2.1	2.5	2.7	producer of wood fuels
sawmill by-products (POT)	1.1	1.2	1.3	0.6	0.9	0.9	forest sect. intern. use
other ind. res. reduced (POT)	2.0	2.4	2.8	0.0	0.0	5.9	biomass power plants
black liquor (POT)	0.1	0.2	0.1	1.8	11.2	13.4	households (pellets)
solid wood fuels (POT)	2.1	2.5	2.7	11.4	17.7	16.4	households (other)
post consumer wood (POT)	6.2	7.2	8.5	0.0	0.1	2.4	liquid biofuels
total	**82.7**	**77.7**	**74.5**	**29.7**	**48.2**	**59.9**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	ITALY			IPCC Scenario:			A1
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	68	61	55	14	16	18	material uses
other woody biomass	13	15	17	14	30	39	energy uses
total	**81**	**75**	**72**	**28**	**46**	**57**	**total**

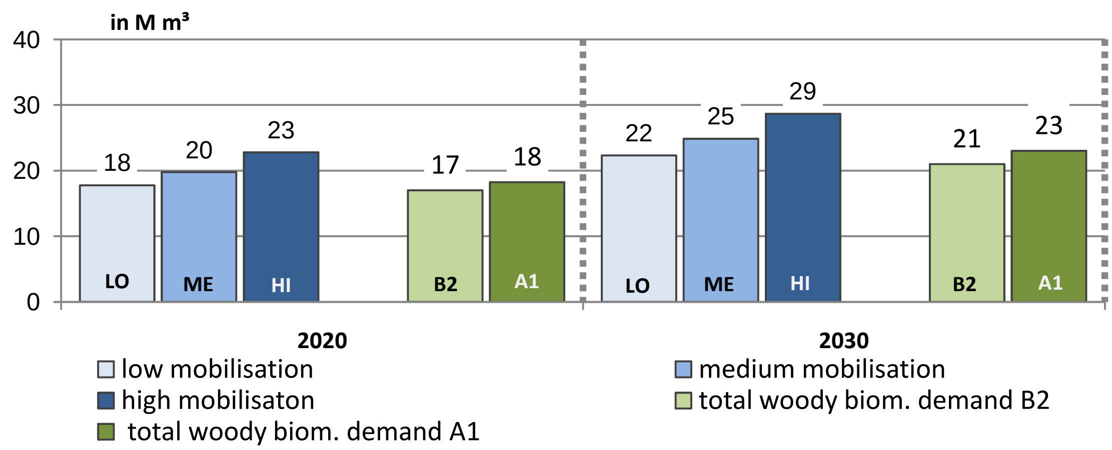


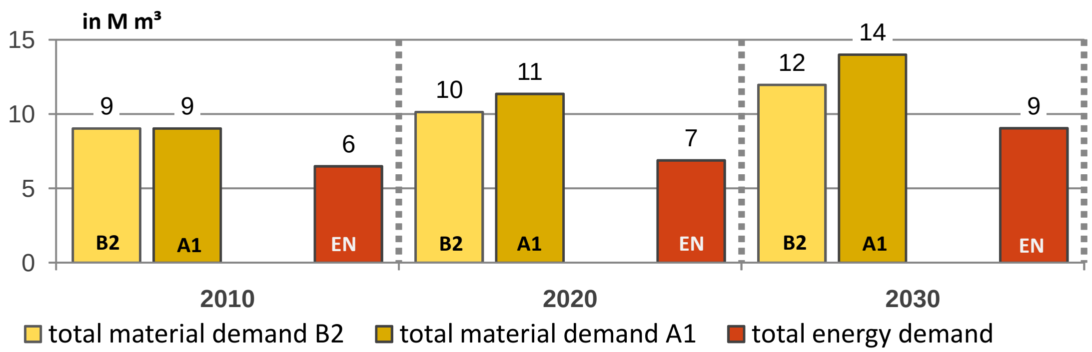


Annex 1-20: Fact sheet on Wood Resource Balance results for LATVIA

Wood Resource Balance							
Region	LATVIA			IPCC Scenario:			A1
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	7.3	5.0	6.2	7.4	9.2	11.3	sawmill industry
stemwood NC, ME	5.4	6.2	8.1	0.4	0.6	0.8	veneer plywood
forest residues C+NC, ME	2.1	1.9	2.3	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.6	0.5	0.7	0.3	0.4	0.5	panel industry
landsc. care wood (USE) ME	0.8	0.9	1.0	0.9	1.2	1.4	other material uses
				1.3	3.1	3.9	producer of wood fuels
sawmill by-products (POT)	3.4	4.2	5.1	0.6	0.6	0.8	forest sect. intern. use
other ind. res. reduced (POT)	0.6	0.8	1.0	1.7	1.4	3.6	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.1	0.5	0.6	households (pellets)
solid wood fuels (POT)	1.3	3.1	3.9	4.1	4.4	4.0	households (other)
post-consumer wood (POT)	0.3	0.3	0.4	0.0	0.0	0.0	liquid biofuels
total	**21.8**	**22.9**	**28.7**	**16.8**	**21.4**	**26.9**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	LATVIA			IPCC Scenario:			A1
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	15	14	17	9	11	14	material uses
other woody biomass	5	6	8	6	7	9	energy uses
total	**21**	**20**	**25**	**16**	**18**	**23**	**total**

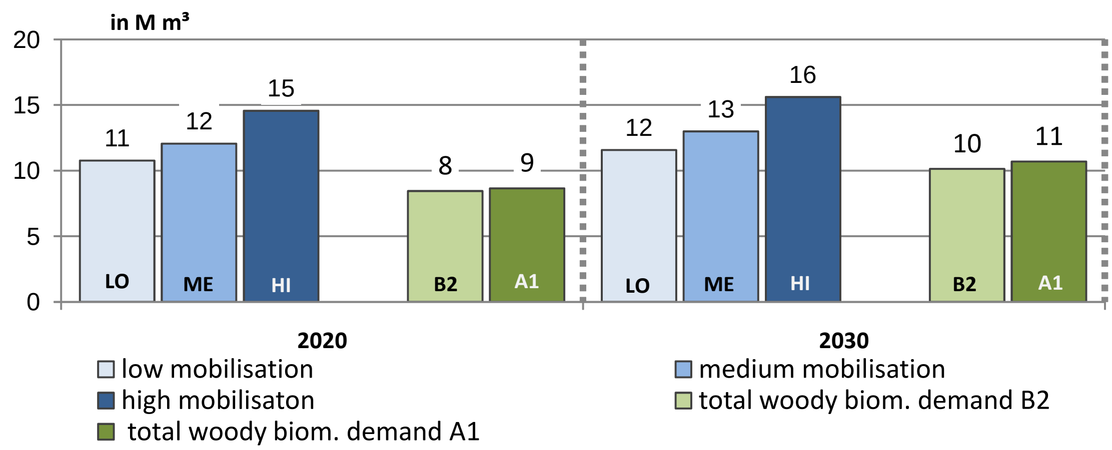


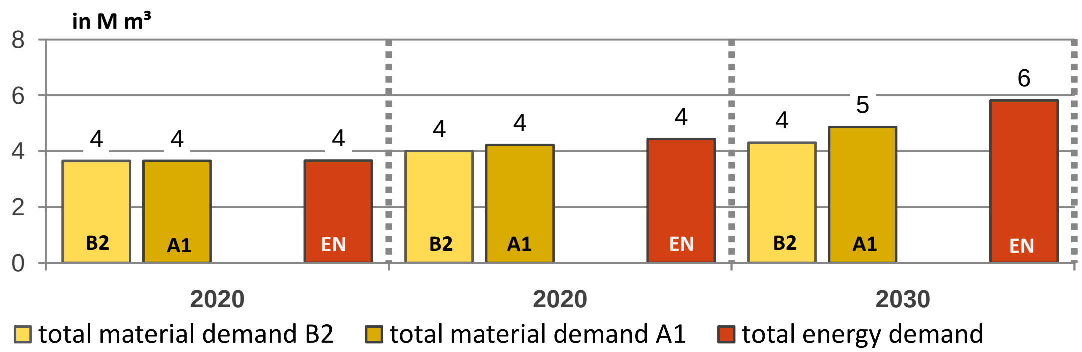


Annex 1-21: Fact sheet on Wood Resource Balance results for LITHUANIA

Wood Resource Balance							
Region	**LITHUANIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	5.1	4.6	4.5	2.7	3.1	3.6	sawmill industry
stemwood NC, ME	2.7	2.6	3.1	0.1	0.1	0.1	veneer plywood
forest residues C+NC, ME	1.5	1.4	1.5	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.3	0.3	0.3	0.9	1.0	1.2	panel industry
landsc. care wood (USE) ME	0.9	1.0	1.1	0.0	0.0	0.0	other material uses
				0.3	0.8	1.0	producer of wood fuels
sawmill by-products (POT)	1.2	1.4	1.6	0.2	0.2	0.3	forest sect. intern. use
other ind. res. reduced (POT)	0.3	0.4	0.4	1.4	1.8	3.3	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.1	0.3	0.3	households (pellets)
solid wood fuels (POT)	0.3	0.8	1.0	2.0	2.1	2.0	households (other)
post-consumer wood (POT)	0.3	0.4	0.5	0.0	0.0	0.0	liquid biofuels
total	**12.6**	**12.9**	**14.0**	**7.6**	**9.5**	**11.7**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**LITHUANIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	10	9	9	4	4	5	material uses
other woody biomass	3	3	4	4	4	6	energy uses
total	**12**	**12**	**13**	**7**	**9**	**11**	**total**

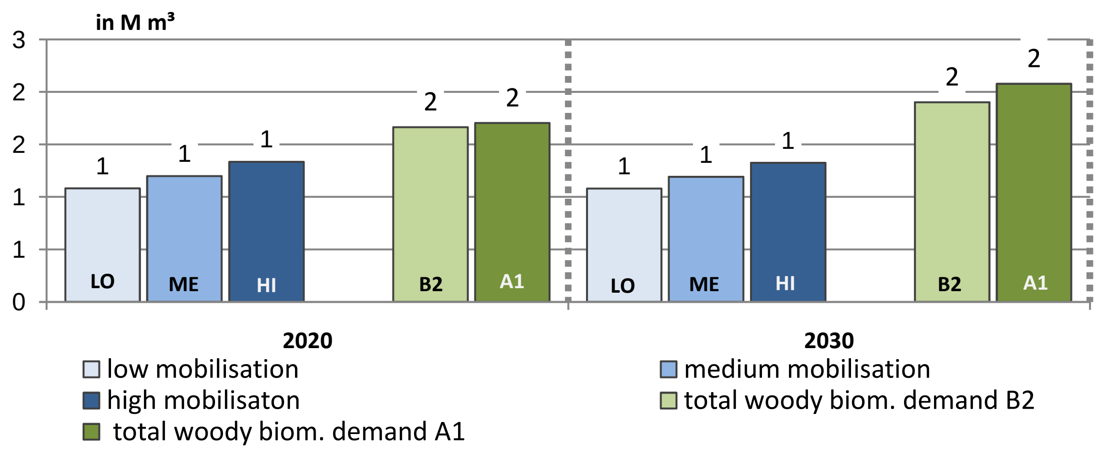


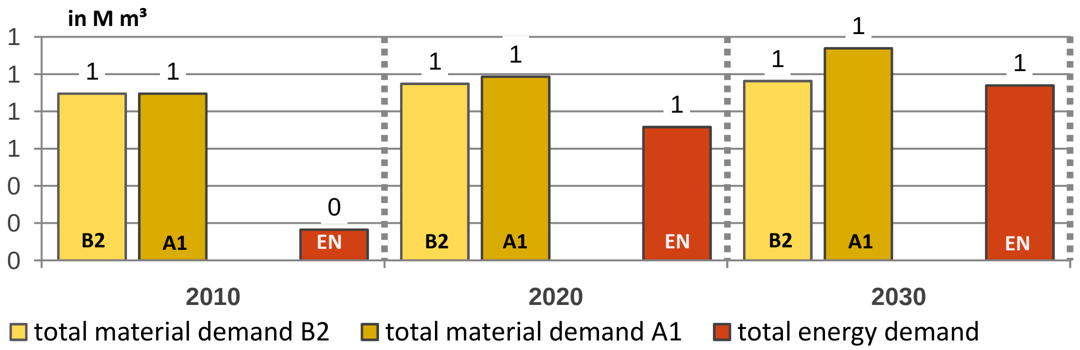


Annex 1-22: Fact sheet on Wood Resource Balance results for LUXEMBOURG

Wood Resource Balance							
Region	**LUXEMBOURG**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	0.2	0.3	0.4	0.2	0.3	0.3	sawmill industry
stemwood NC, ME	0.5	0.4	0.3	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	0.1	0.1	0.1	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.0	0.0	0.0	0.7	0.7	0.8	panel industry
landsc. care wood (USE) ME	0.0	0.0	0.0	0.0	0.0	0.0	other material uses
				0.0	0.0	0.0	producer of wood fuels
sawmill by-products (POT)	0.1	0.1	0.1	0.0	0.0	0.0	forest sect. intern. use
other ind. res. reduced (POT)	0.2	0.2	0.2	-0.1	0.2	0.3	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.1	0.5	0.6	households (pellets)
solid wood fuels (POT)	0.0	0.0	0.0	0.1	0.0	0.1	households (other)
post-consumer wood (POT)	0.0	0.0	0.0	0.0	0.0	0.0	liquid biofuels
total	**1.2**	**1.2**	**1.2**	**1.1**	**1.7**	**2.1**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**LUXEMBOURG**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	1	1	1	1	1	1	material uses
other woody biomass	0	0	0	0	1	1	energy uses
total	**1**	**1**	**1**	**1**	**2**	**2**	**total**

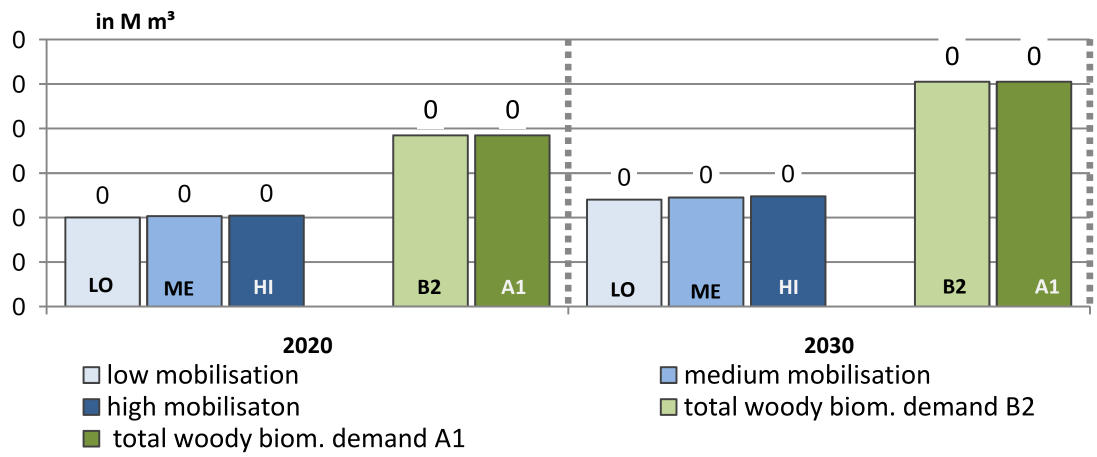


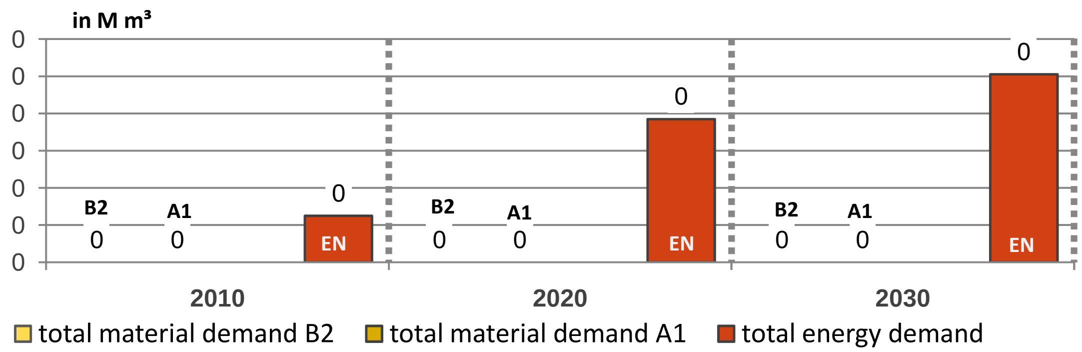


Annex 1-23: Fact sheet on Wood Resource Balance results for MALTA

Wood Resource Balance							
Region	MALTA			IPCC Scenario:			A1
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	0.0	0.0	0.0	0.0	0.0	0.0	sawmill industry
stemwood NC, ME	0.0	0.0	0.0	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	0.0	0.0	0.0	0.0	0.0	0.0	pulp industry
bark, C+NC, ME	0.0	0.0	0.0	0.0	0.0	0.0	panel industry
landsc. care wood (USE) ME	0.0	0.0	0.0	0.0	0.0	0.0	other material uses
				0.0	0.0	0.0	producer of wood fuels
sawmill by products (POT)	0.0	0.0	0.0	0.0	0.0	0.0	forest sect. intern. use
other ind. res. reduced (POT)	0.0	0.0	0.0	0.0	0.1	0.1	biomass power plants
black liquor (POT)	0.0	0.0	0.0	0.0	0.0	0.0	households (pellets)
solid wood fuels (POT)	0.0	0.0	0.0	0.0	0.0	0.0	households (other)
post-consumer wood (POT)	0.0	0.0	0.0	0.0	0.0	0.0	liquid biofuels
total	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	MALTA			IPCC Scenario:			A1
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	0	0	0	0	0	0	material uses
other woody biomass	0	0	0	0	0	0	energy uses
total	**0**	**0**	**0**	**0**	**0**	**0**	**total**

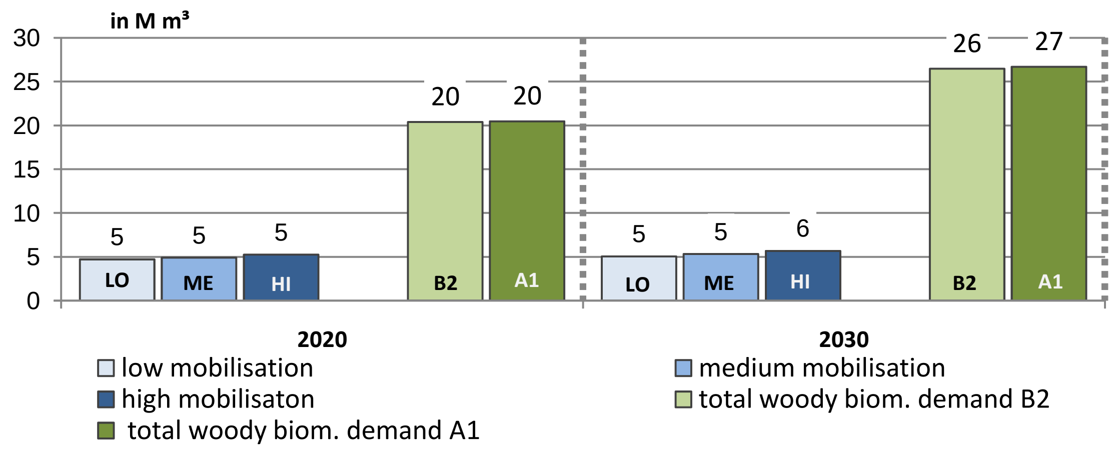


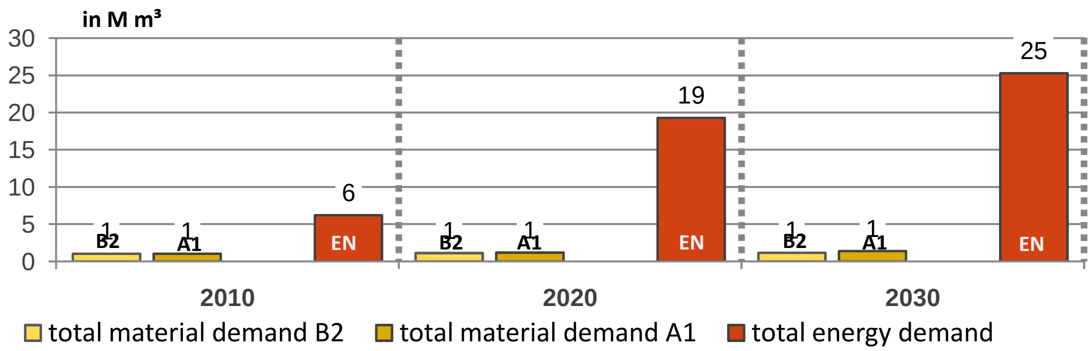


Annex 1-24: Fact sheet on Wood Resource Balance results for NETHERLANDS

Wood Resource Balance							
Region	**NETHERLANDS**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	0.7	0.7	0.7	0.5	0.5	0.6	sawmill industry
stemwood NC, ME	0.5	0.5	0.5	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	0.1	0.1	0.1	0.4	0.5	0.6	pulp industry
bark, C+NC, ME	0.1	0.0	0.1	0.1	0.1	0.1	panel industry
landsc. care wood (USE) ME	0.7	0.7	0.8	0.1	0.1	0.1	other material uses
				0.5	0.7	0.8	producer of wood fuels
sawmill by-products (POT)	0.2	0.2	0.2	0.1	0.1	0.1	forest sect. intern. use
other ind. res. reduced (POT)	0.0	0.0	0.1	3.6	11.7	16.4	biomass power plants
black liquor (POT)	0.0	0.0	0.0	2.2	7.1	8.4	households (pellets)
solid wood fuels (POT)	0.5	0.7	0.8	0.4	0.4	0.4	households (other)
post-consumer wood (POT)	2.5	2.6	2.8	0.0	0.0	0.0	liquid biofuels
total	**5.2**	**5.6**	**6.1**	**7.8**	**21.2**	**27.5**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**NETHERLANDS**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	1	1	1	1	1	1	material uses
other woody biomass	3	4	4	6	19	25	energy uses

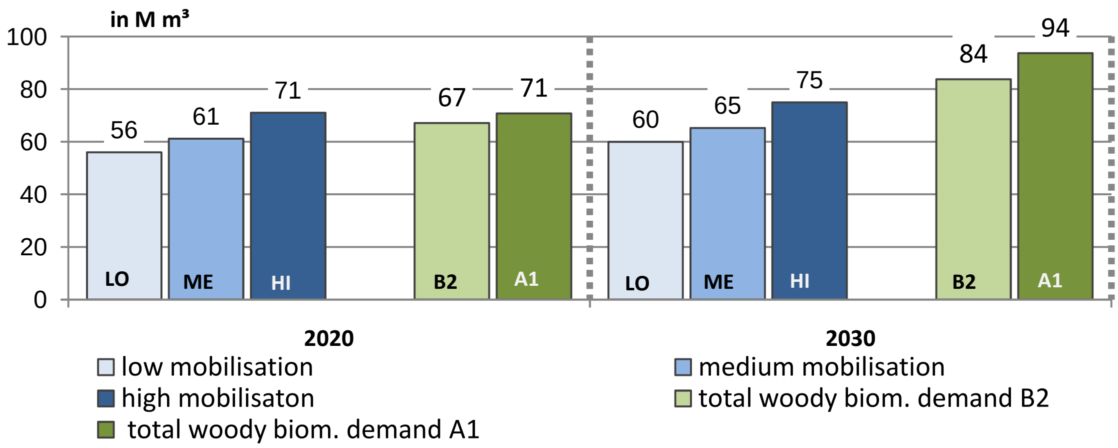


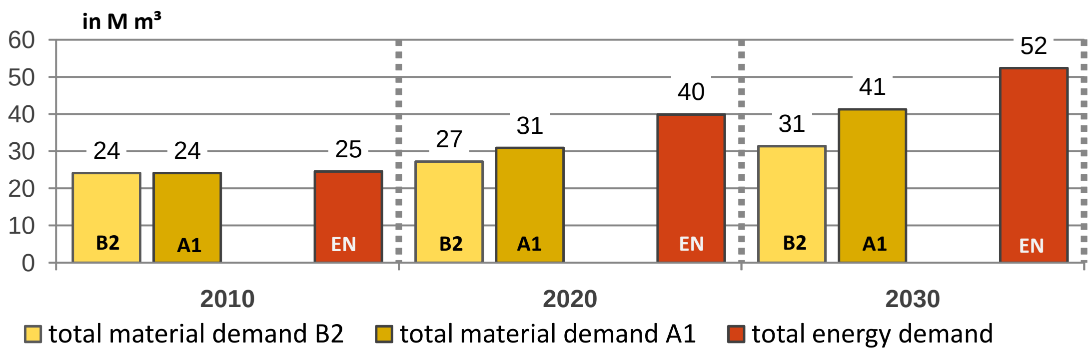


Annex 1-25: Fact sheet on Wood Resource Balance results for POLAND

Wood Resource Balance							
Region	**POLAND**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
stemwood C, ME	27.2	26.9	25.7	5.9	6.2	6.9	sawmill industry
stemwood NC, ME	8.2	7.7	7.8	0.9	1.3	1.8	veneer plywood
forest residues C+NC, ME	5.9	5.9	5.6	4.5	6.7	10.2	pulp industry
bark, C+NC, ME	1.5	1.5	1.4	11.1	14.3	19.2	panel industry
landsc. care wood (USE) ME	4.9	5.6	6.2	1.6	2.4	3.2	other material uses
				1.6	2.1	2.4	producer of wood fuels
sawmill by-products (POT)	2.5	2.6	3.0	2.9	3.9	5.4	forest sect. intern. use
other ind. res. reduced (POT)	2.6	3.2	4.1	6.4	18.5	28.4	biomass power plants
black liquor (POT)	2.0	3.0	4.5	0.4	1.6	1.9	households (pellets)
solid wood fuels (POT)	1.6	2.1	2.4	14.8	15.8	14.7	households (other)
post-consumer wood (POT)	3.5	4.7	6.7	0.0	0.1	1.9	liquid biofuels
total	**59.9**	**63.2**	**67.6**	**50.3**	**72.9**	**96.0**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**POLAND**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** M m³	**2030**	**2010**	**2020** M m³	**2030**	**demand**
forest woody biomass	43	42	41	24	31	41	material uses
other woody biomass	15	19	25	25	40	52	energy uses
total	**58**	**61**	**65**	**49**	**71**	**94**	**total**

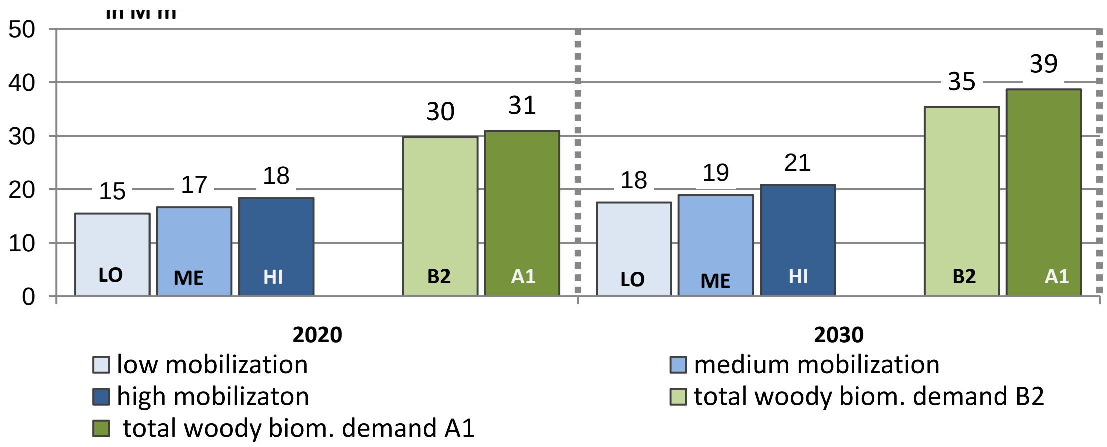


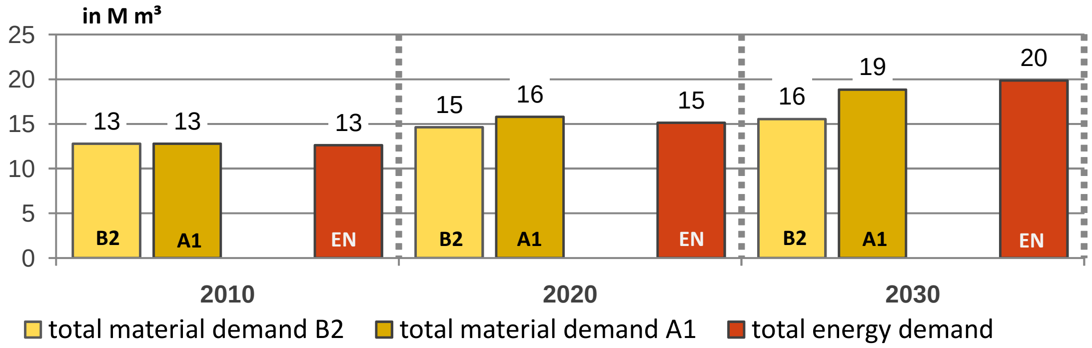


Annex 1-26: Fact sheet on Wood Resource Balance results for PORTUGAL

Wood Resource Balance							
Region	**PORTUGAL**			**IPCC Scenario:**		**A1**	
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
stemwood C, ME	1.8	2.4	2.2	1.9	2.3	2.7	sawmill industry
stemwood NC, ME	3.5	2.7	3.5	0.1	0.1	0.2	veneer plywood
forest residues C+NC, ME	1.6	1.7	1.7	8.6	10.3	11.8	pulp industry
bark, C+NC, ME	0.2	0.2	0.3	2.0	2.8	4.0	panel industry
landsc. care wood (USE) ME	1.4	1.6	1.7	0.2	0.2	0.2	other material uses
				0.3	0.7	0.9	producer of wood fuels
sawmill by-products (POT)	0.8	1.0	1.2	4.9	5.9	6.7	forest sect. intern. use
other ind. res. reduced (POT)	0.5	0.7	0.9	3.4	4.5	8.7	biomass power plants
black liquor (POT)	4.6	5.6	6.4	0.0	0.1	0.2	households (pellets)
solid wood fuels (POT)	0.3	0.7	0.9	4.3	4.6	4.3	households (other)
post-consumer wood (POT)	0.7	0.9	1.0	0.0	0.0	0.0	liquid biofuels
total	**15.5**	**17.4**	**19.8**	**25.7**	**31.7**	**39.6**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**PORTUGAL**			**IPCC Scenario:**		**A1**	
potential	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**demand**
		M m³			**M m³**		
forest woody biomass	7	7	8	13	16	19	material uses
other woody biomass	8	10	11	13	15	20	energy uses
total	**15**	**17**	**19**	**25**	**31**	**39**	**total**

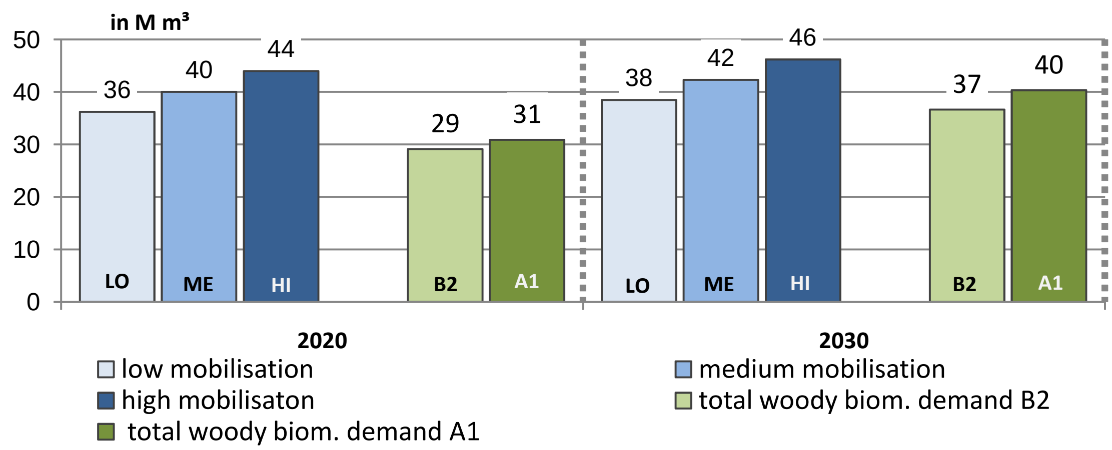


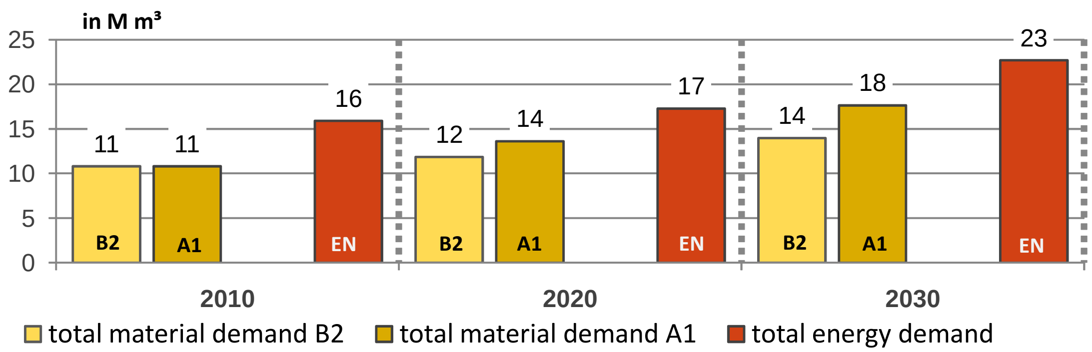


Annex 1-27: Fact sheet on Wood Resource Balance results for ROMANIA

Wood Resource Balance							
Region	**ROMANIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** (M m³)	**2030**	**2010**	**2020** (M m³)	**2030**	**demand**
stemwood C, ME	10.0	10.7	11.0	7.5	9.4	11.7	sawmill industry
stemwood NC, ME	14.1	13.1	12.7	0.4	0.5	0.7	veneer plywood
forest residues C+NC, ME	3.9	4.2	4.1	0.9	1.0	1.4	pulp industry
bark, C+NC, ME	1.1	1.1	1.1	1.6	2.2	3.1	panel industry
landsc. care wood (USE) ME	2.8	3.2	3.5	0.4	0.6	0.7	other material uses
				0.5	1.9	2.4	producer of wood fuels
sawmill by-products (POT)	3.1	3.9	4.8	0.9	1.0	1.3	forest sect. intern. use
other ind. res. reduced (POT)	0.9	1.2	1.6	5.1	5.4	9.8	biomass power plants
black liquor (POT)	0.4	0.4	0.6	0.1	0.3	0.4	households (pellets)
solid wood fuels (POT)	0.5	1.9	2.4	9.8	10.5	9.7	households (other)
post-consumer wood (POT)	1.7	2.3	3.0	0.0	0.0	1.5	liquid biofuels
total	**38.6**	**41.9**	**44.7**	**27.2**	**32.8**	**42.8**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**ROMANIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** (M m³)	**2030**	**2010**	**2020** (M m³)	**2030**	**demand**
forest woody biomass	29	29	29	11	14	18	material uses
other woody biomass	9	11	13	16	17	23	energy uses
total	**38**	**40**	**42**	**27**	**31**	**40**	**total**

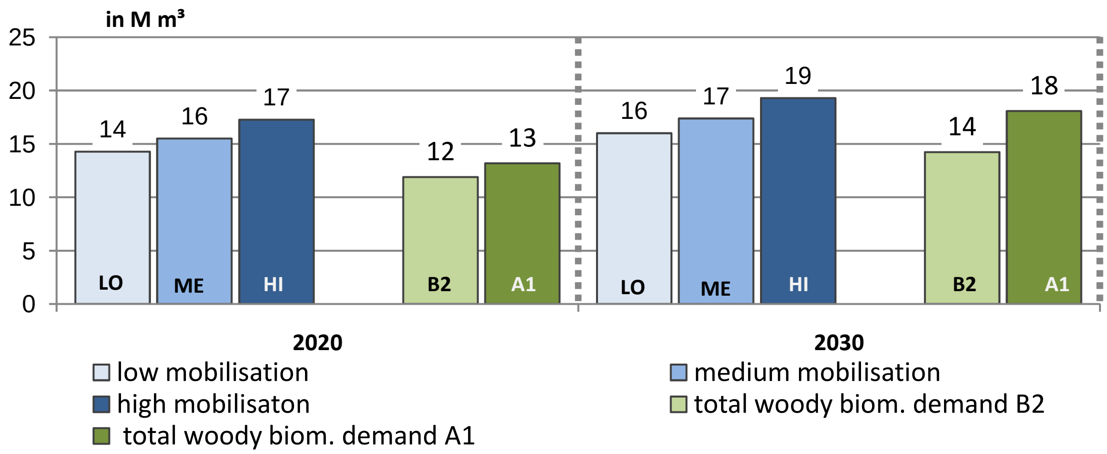


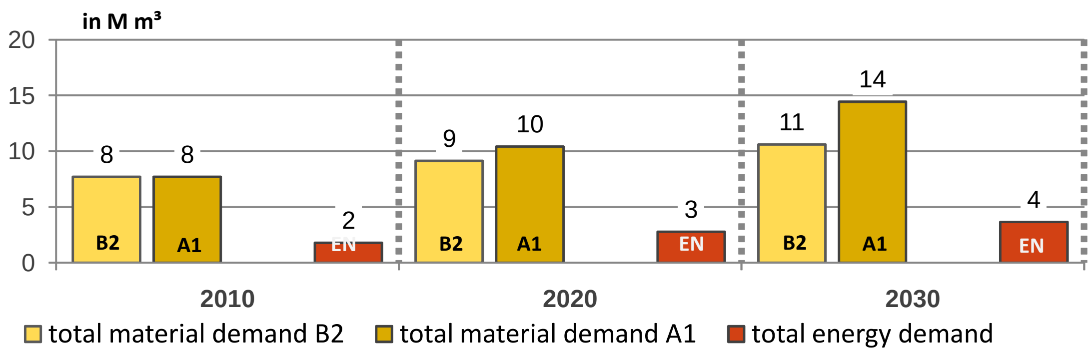


Annex 1-28: Fact sheet on Wood Resource Balance results for SLOVAKIA

Wood Resource Balance							
Region	**SLOVAKIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	4.5	4.2	4.1	3.7	4.4	5.6	sawmill industry
stemwood NC, ME	3.6	3.6	3.7	0.1	0.1	0.1	veneer plywood
forest residues C+NC, ME	1.9	1.8	1.9	2.8	4.3	6.4	pulp industry
bark, C+NC, ME	0.4	0.4	0.3	1.1	1.5	2.1	panel industry
landsc. care wood (USE) ME	0.7	0.8	0.9	0.0	0.1	0.1	other material uses
				0.1	0.1	0.1	producer of wood fuels
sawmill by products (POT)	1.5	1.7	2.2	1.3	2.3	3.1	forest sect. intern. use
other ind. res. reduced (POT)	0.5	0.6	0.8	0.0	0.0	0.0	biomass power plants
black liquor (POT)	1.3	2.1	3.1	0.0	0.0	0.0	households (pellets)
solid wood fuels (POT)	0.1	0.1	0.1	0.4	0.5	0.6	households (other)
post-consumer wood (POT)	0.2	0.3	0.4	0.0	0.0	0.0	liquid biofuels
total	**14.8**	**15.6**	**17.5**	**9.6**	**13.3**	**18.2**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**SLOVAKIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	10	10	10	8	10	14	material uses
other woody biomass	4	5	7	2	3	4	energy uses
total	**15**	**16**	**17**	**9**	**13**	**18**	**total**

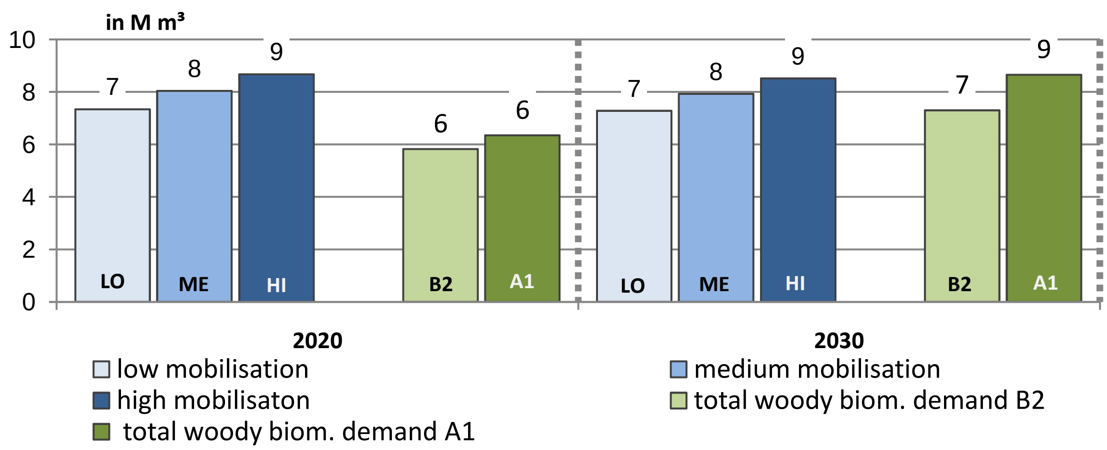


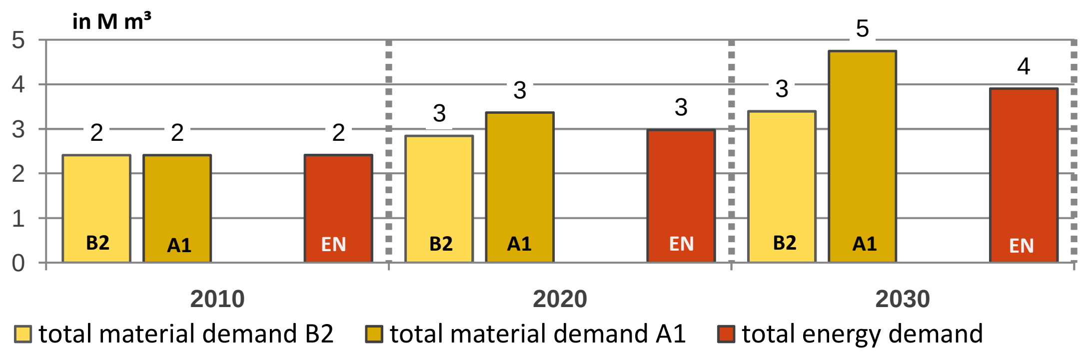


Annex 1-29: Fact sheet on Wood Resource Balance results for SLOVENIA

Wood Resource Balance							
Region	**SLOVENIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** (M m³)	**2030**	**2010**	**2020** (M m³)	**2030**	**demand**
stemwood C, ME	4.1	3.6	3.1	0.9	1.2	1.6	sawmill industry
stemwood NC, ME	2.0	2.0	1.9	0.2	0.3	0.4	veneer plywood
forest residues C+NC, ME	0.5	0.6	0.5	0.6	0.9	1.3	pulp industry
bark, C+NC, ME	0.3	0.2	0.2	0.7	1.0	1.4	panel industry
landsc. care wood (USE) ME	0.2	0.2	0.2	0.0	0.0	0.0	other material uses
				0.4	0.5	0.7	producer of wood fuels
sawmill by-products (POT)	0.4	0.5	0.7	0.4	0.5	0.7	forest sect. intern. use
other ind. res. reduced (POT)	0.3	0.4	0.5	0.4	0.5	1.3	biomass power plants
black liquor (POT)	0.2	0.4	0.5	0.3	0.4	0.5	households (pellets)
solid wood fuels (POT)	0.4	0.5	0.7	1.4	1.5	1.4	households (other)
post-consumer wood (POT)	0.1	0.2	0.2	0.0	0.0	0.0	liquid biofuels
total	**8.4**	**8.5**	**8.6**	**5.2**	**6.8**	**9.3**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**SLOVENIA**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** (M m³)	**2030**	**2010**	**2020** (M m³)	**2030**	**demand**
forest woody biomass	7	6	6	2	3	5	material uses
other woody biomass	1	2	2	2	3	4	energy uses
total	**8**	**8**	**8**	**5**	**6**	**9**	**total**

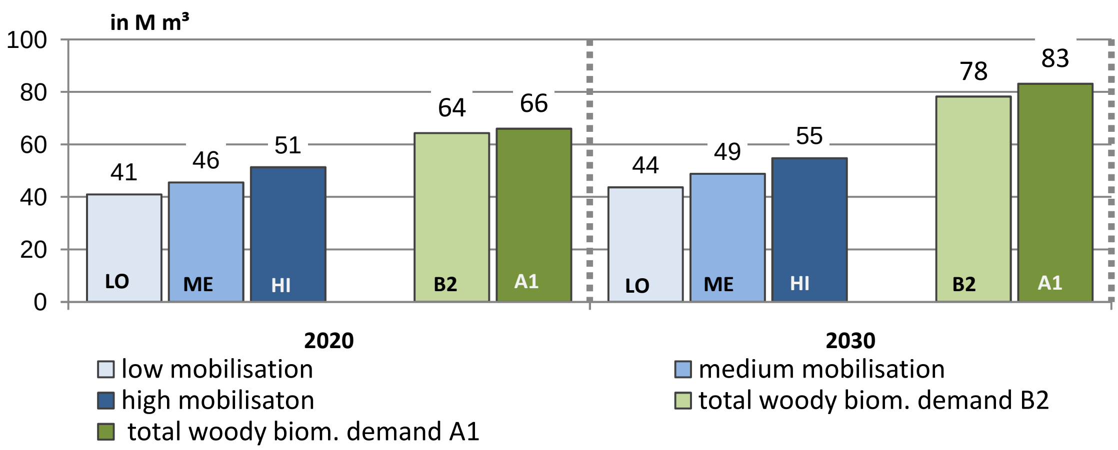


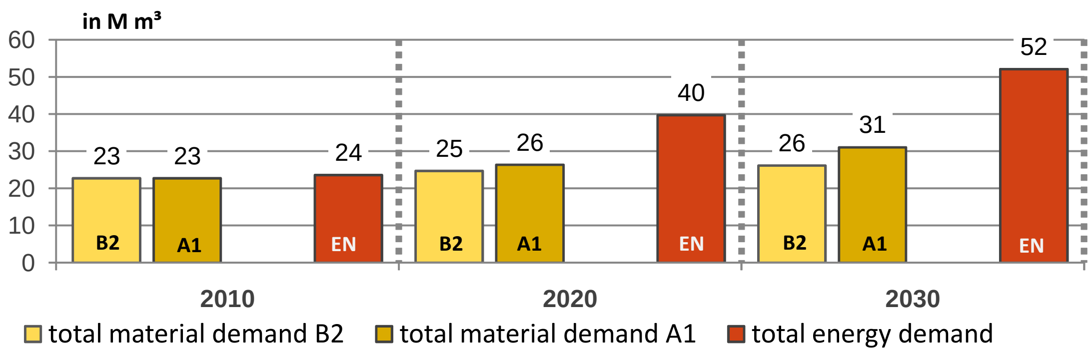


Annex 1-30: Fact sheet on Wood Resource Balance results for SPAIN

Wood Resource Balance							
Region	SPAIN			IPCC Scenario:			A1
potential	2010	2020	2030	2010	2020	2030	demand
		M m³			M m³		
stemwood C, ME	14.0	14.8	15.1	6.4	6.6	6.9	sawmill industry
stemwood NC, ME	4.6	3.8	3.6	1.0	1.1	1.3	veneer plywood
forest residues C+NC, ME	4.5	4.6	4.8	7.4	8.5	10.1	pulp industry
bark, C+NC, ME	0.8	0.8	0.8	7.4	9.5	12.0	panel industry
landsc. care wood (USE) ME	6.3	7.1	7.9	0.5	0.6	0.7	other material uses
				0.2	0.7	0.9	producer of wood fuels
sawmill by-products (POT)	2.7	2.8	2.9	4.7	5.4	6.3	forest sect. intern. use
other ind. res. reduced (POT)	1.9	2.4	2.9	8.3	22.0	28.5	biomass power plants
black liquor (POT)	3.9	4.5	5.3	0.3	1.3	1.6	households (pellets)
solid wood fuels (POT)	0.2	0.7	0.9	10.2	10.8	10.0	households (other)
post-consumer wood (POT)	4.2	4.8	5.4	0.0	0.2	5.7	liquid biofuels
total	**43.1**	**46.2**	**49.7**	**46.4**	**66.7**	**84.0**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	SPAIN			IPCC Scenario:			A1
potential	2010	2020	2030	2010	2020	2030	demand
		M m³			M m³		
forest woody biomass	24	24	24	23	26	31	material uses
other woody biomass	19	22	24	24	40	52	energy uses
total	**43**	**46**	**49**	**46**	**66**	**83**	**total**

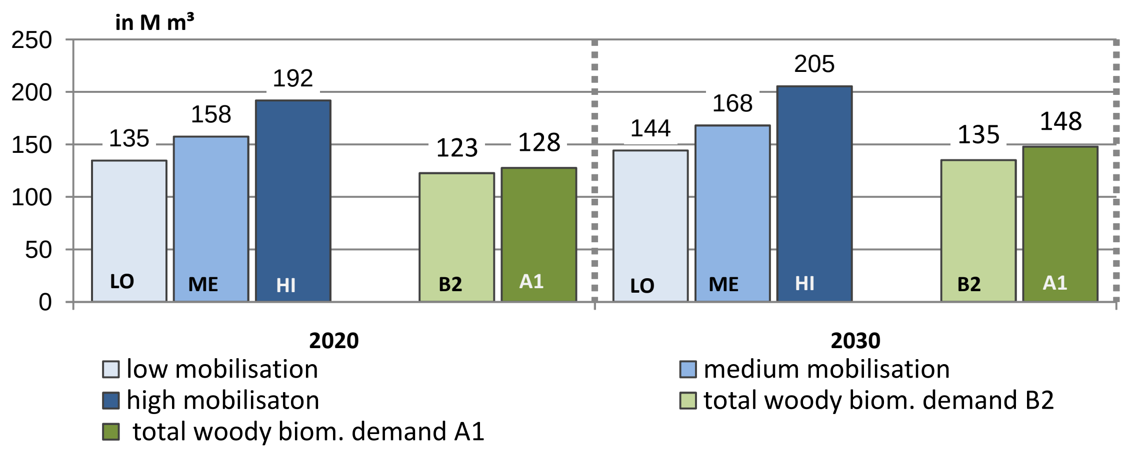


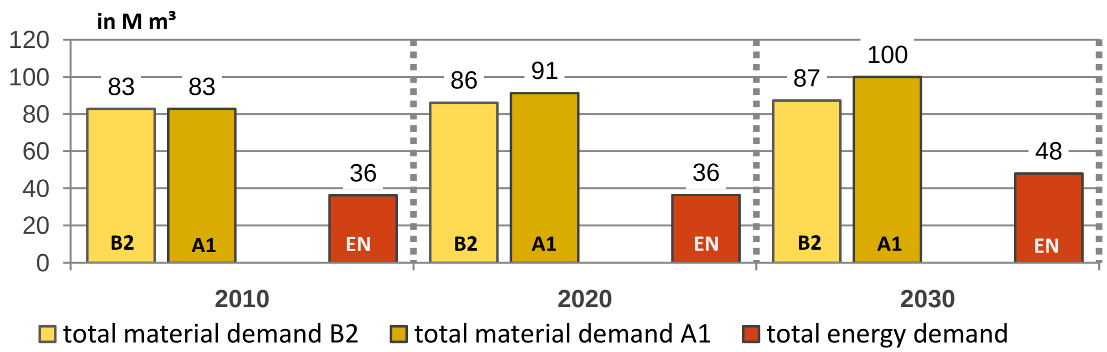


Annex 1-31: Fact sheet on Wood Resource Balance results for SWEDEN

Wood Resource Balance							
Region	**SWEDEN**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	73.1	72.5	75.9	36.1	38.6	41.1	sawmill industry
stemwood NC, ME	9.2	10.1	11.6	0.2	0.3	0.3	veneer plywood
forest residues C+NC, ME	22.6	24.0	24.9	44.9	50.5	56.3	pulp industry
bark, C+NC, ME	3.4	3.5	3.7	1.0	1.4	1.7	panel industry
landsc. care wood (USE) ME	3.6	4.1	4.5	0.4	0.5	0.5	other material uses
				3.2	4.2	5.0	producer of wood fuels
sawmill by-products (POT)	18.4	19.7	21.0	24.0	26.7	29.6	forest sect. intern. use
other ind. res. reduced (POT)	1.8	2.0	2.2	6.6	2.5	4.0	biomass power plants
black liquor (POT)	18.3	20.6	23.1	4.0	5.5	6.3	households (pellets)
solid wood fuels (POT)	3.2	4.2	5.0	1.6	1.6	1.4	households (other)
post-consumer wood (POT)	1.0	1.1	1.2	0.0	0.2	6.6	liquid biofuels
total	**154.6**	**161.7**	**173.0**	**122.2**	**131.9**	**152.8**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**SWEDEN**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	108	110	116	83	91	100	material uses
other woody biomass	43	47	52	36	36	48	energy uses
total	**151**	**158**	**168**	**119**	**128**	**148**	**total**





Annex 1-32: Fact sheet on Wood Resource Balance results for UNITED KINGDOM

Wood Resource Balance							
Region	**UNITED KINGDOM**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
stemwood C, ME	10.0	9.8	11.0	5.8	6.1	6.4	sawmill industry
stemwood NC, ME	3.3	2.4	2.6	0.0	0.0	0.0	veneer plywood
forest residues C+NC, ME	2.4	2.2	2.5	1.0	1.2	1.5	pulp industry
bark, C+NC, ME	0.6	0.5	0.6	5.5	6.1	6.8	panel industry
landsc. care wood (USE) ME	3.6	4.1	4.5	1.0	1.0	1.1	other material uses
				0.4	1.3	1.7	producer of wood fuels
sawmill by-products (POT)	2.9	3.1	3.2	0.7	0.7	0.8	forest sect. intern. use
other ind. res. reduced (POT)	1.1	1.2	1.3	10.1	47.1	62.4	biomass power plants
black liquor (POT)	0.1	0.1	0.1	0.3	1.2	1.4	households (pellets)
solid wood fuels (POT)	0.4	1.3	1.7	0.6	0.5	0.5	households (other)
post-consumer wood (POT)	7.5	7.9	8.5	0.0	0.0	0.0	liquid biofuels
total	**31.7**	**32.6**	**36.0**	**25.3**	**65.2**	**82.4**	**total**

Wood Resource Balance (without solid wood fuels)							
Region	**UNITED KINGDOM**			**IPCC Scenario:**			**A1**
potential	**2010**	**2020** **M m³**	**2030**	**2010**	**2020** **M m³**	**2030**	**demand**
forest woody biomass	16	15	17	13	14	16	material uses
other woody biomass	15	16	18	12	50	65	energy uses
total	**31**	**31**	**34**	**25**	**64**	**81**	**total**