European Commission

Study on Technical Assistance in Realisation of the 2016 Report on Renewable Energy, in preparation of the Renewable Energy Package for the Period 2020-2030 in the European Union

RES-Study Task 3: Analysis of the biofuels, biomass and biogas used for renewable energy generation

ENER/C1/2014-688

Client: European Commission DG Energy

Freiburg, 20 December 2017

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Table of Contents

List of Figures

List of Tables

Glossary

Abbreviation	Explanation
EED	Directive 2012/27/EU: Energy Efficiency Directive
EIA	Environmental Impact Assessment
ETBE	Ethyl Tert-Butyl Ether
ETS	Emissions Trading System
ETOH	Ethyl Alcohol
FAEE	Fatty Acid Ethyl Esters
FAME	Fatty Acid Methyl Ester
GIS	Geographical Information System
GHG	Greenhouse Gas
GW	Gigawatt
ha	Hectare
HVO	Hydrotreated Vegetable Oils
IFL	Intact Forest Landscapes
ILO	International Labour Organisation
ILUC	Indirect Land Use Change
IUCN	International Union for Conservation of Nature and Natural Resources
kcal	Kilocalorie
km	Kilometre
Ktoe	Kilotons of Oil Equivalent
kW	Kilowatt
kWp	Kilowatt Peak
LandSHIFT	**Land S**imulation to **H**armonize and **I**ntegrate **F**reshwater Availability and the **T**errestrial Environment
LCA	Life Cycle Analysis
LUT	Land Utilization Type
NGO	Non-Governmental Organisation
NREAP	National Renewable Energy Action Plan
m^3	Cubic meter
MS	Member States
Mt	Million tons
Mtoe	Million tons of Oil Equivalent
MW	Megawatt
R&D	Research and Development
RED	Directive 2009/28/EC: Renewable Energy Directive
RES	Renewable Energy Sources
RES Directive	Directive 2009/28/EC: Renewable Energy Directive
RES-E	Renewable Energy Sources in Electricity
RES-HC	Renewable Energy Sources in Heating and Cooling
RES-T	Renewable Energy Sources in Transport
RES-share	Renewable Energy Sources Share (on gross final energy consumption)
SRC	Short Rotation Crops
TJ	Tera Joule
UCO	Used Cooking Oil
UNFCCC	United Nations Framework Convention on Climate Chang
WDPA	World Database on Protected Areas
AT	Austria
BE	Belgium
BG	Bulgaria
HR	Croatia
CY	Cyprus

CZ	Czech Republic
DK	Denmark
EE	Estonia
FI	Finland
FR	France
DE	Germany
EL	Greece
HU	Hungary
IE	Ireland
IT	Italy
LV	Latvia
LT	Lithuania
LU	Luxembourg
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SK	Slovakia
SI	Slovenia
ES	Spain
SE	Sweden
UK	United Kingdom
USA	United States of America
EU-28	EU-28

Abstract

The objective of this study is to provide technical assistance in the preparation of the 2016 Report on Renewable Energy, in preparation of the Renewable Energy Package for the Period 2020-2030 in the European Union related to bioenergy consumed in EU Member States, required for the Commission's Renewable Energy Progress Report according to Article 23 of the RES Directive. Key findings are:

Biomass energy use in EU-28 Member States has been growing steadily, with a short decline in 2011. The EU has been a prime market for energy related biomass trade over the past decade. The consumption and trade of biomass energy in the form of wood pellets has increased significantly since 2008. The development of the biogas industry EU Member States is in direct correlation with the governments' support policies in the given country. The consumption of biofuels in the transport sector in 2015 increased by about 2 % compared to the previous year. The consumption of bioethanol in the EU stagnated in recent years.

Negligible impacts of biofuel production on the environment are reported by the Member States except for Germany. This is due to the fact that the production quantities are relatively small but also because statistical data and research results often do not exist. While at national level only small land use changes regarding forests and wetlands were observed in 2013 and 2014, the loss of grassland was evident in many Member States. Regarding biodiversity impacts, there is a risk that the production of biodiesel and bioethanol feedstocks in third countries – main biofuel and biofuel feedstock suppliers to the EU – might take place on areas that provide important ecosystem services from biodiversity. Biofuel feedstocks are often cultivated on soils with low suitability for agriculture, that are potentially more exposed to soil degradation risks.

Synthèse

La présente étude vise à fournir une assistance technique pour l'élaboration du Rapport 2016 sur les énergies renouvelables, en préparation du « paquet énergies renouvelables » 2020-2030 de l'Union européenne concernant les bioénergies consommées dans les États membres de l'UE, en vue de l'élaboration du rapport de situation de la Commission relatif aux énergies renouvelables, conformément à l'article 23 de la Directive sur les énergies renouvelables. Les principales conclusions de cette étude sont les suivantes :

L'utilisation de l'énergie biomasse a augmenté régulièrement dans les États membres de l'Union européenne, avec toutefois un léger recul en 2011. L'Union européenne a été l'un des principaux marchés pour la biomasse destinée à la production d'énergie au cours des dix dernières années. La consommation et le commerce de l'énergie biomasse sous forme de granulés de bois ont considérablement augmenté depuis 2008. Le développement de l'industrie du biogaz dans certains États membres de l'Union européenne est directement lié aux politiques gouvernementales de soutien mises en œuvre dans ces pays. En 2015, la consommation de biocarburants dans le secteur des transports a augmenté d'environ 2 % par rapport à l'année précédente. La consommation de bioéthanol a stagné dans l'Union européenne ces dernières années.

L'impact de la production de biocarburants sur l'environnement est déclaré négligeable par les États membres, à l'exception de l'Allemagne. Ceci est dû au fait que les quantités produites sont relativement faibles, mais aussi que les données statistiques et les résultats de la recherche sont souvent inexistants. Alors qu'au niveau national, seuls des changements mineurs d'affectation des

sols forestiers et des zones humides ont été observés en 2013 et 2014, la perte de prairies apparaissait comme évidente dans de nombreux États membres. Concernant l'impact sur la biodiversité, il existe un risque que la production de matières premières destinées au biodiesel et au bioéthanol dans les pays tiers – les principaux fournisseurs de l'UE pour ces matières premières – ait lieu sur des zones qui fournissent d'importants services écosystémiques du fait de leur biodiversité. Les matières premières destinées aux biocarburants sont souvent cultivées sur des terres peu adaptées à l'agriculture et qui sont potentiellement plus exposées aux risques de dégradation des sols.

Executive Summary

The objective of this study is to provide technical assistance on the 2016 Report on Renewable Energy, in preparation of the Renewable Energy Package for the Period 2020-2030 in the European Union. Related to bioenergy consumed in EU Member States, the package is required for the Commission's Renewable Energy Progress Report according to Article 23 of the Renewable Energy Directive (RED). This document includes:

- an assessment of impacts on energy supply including a quantity structure and associated land use for bioenergy in the EU Member States from agriculture and forestry including the progress in the availability of bioenergy from waste, residues, non-food cellulosic and ligno-cellulosic material (Task 3.1);
- an assessment of environmental impacts associated with the consumption of bioenergy in the EU (Task 3.2);
- an assessment of economic and social impacts associated with bioenergy use of EU Member States (Task 3.3).

Data sources

For this project, data were collected from the Member States' Progress Reports and additional data sources, e.g. Eurostat, FAOSTAT, Word Bioenergy Association, USDA Foreign Agricultural Service and the OECD. Reported values may not always be fully consistent or may not correspond with figures from other sources. Furthermore, we gained data by modelling impacts from land use and land use change in Member States and main third countries with LandSHIFT, a simulation model used to generate land use maps.

Summary of Task 3.1: Impacts on energy supply

Biomass energy use in EU-28 Member States grew between 2004 and 2015, with a short decline in 2011. Since 2011 the growth has stabilized or slowed down considerably. The main user of biomass for energy (70 %) was the heating and cooling sector (RES-H/C). In 2015 17 % of the biomass was used in the renewable transport sector (RES-T) and 13 % in the renewable electricity sector (RES-E).

Biomass energy includes three subcategories:

- **solid** biomass that includes all solid organic components like wood, wood waste, chips and particles, wood pellets, residues, etc.;
- **biogas** that is produced through anaerobic fermentation from residues, waste, sewage sludge or energy crops;
- **biofuels or bioliquids** like bioethanol or biodiesel that are produced from different types of biomass.

The use of solid biomass is dominated by wood: About half of Europe's renewable energy consumption is wood. It is mainly used for heating and electricity - in 2014 77 % of the primary energy of both sectors origin from forest wood. Thereof 91 % arise from domestic production, 6 % from trade within the EU and 3 % are imported from non-EU countries (see Table 1-2). Around 23 % of the EU total wood production is used for energy (fuel wood).

The solid biomass consumption decreased in 2014, and its domestic production decreased even more sharply, which means the rate of imports increased.

The consumption of wood residues increased from 52 million tonnes in 2011 to 64.9 million tonnes in 2015. The largest producers are France, Sweden and Poland. According to BASIS 2015 project the overall wood chips consumption for Bioenergy production at the European level in 2013 ranged around 51 million of tonnes a year. The five main wood chips bioenergy producers are representing around 70 % of the general consumption (BASIS 2015).

Biomass imports were mostly based on wood pellets, which increased steadily between 2012 (14 million tonnes) and 2015 (19.8 million tonnes). Thus the European Union remains the largest pellet producer, consumer and destination for traded wood pellets in the world. Approximately half of the global trade of wood pellets is internal trade within and among EU Member States. Major external trading partners of the EU are the United States, Canada, and Russia. In contrast to wood pellets, roundwood and wood chips for energy purposes are currently transported over shorter distances. Therefore, third countries of origin play a smaller role.

The main **biogas** consumers within the EU are Germany, the UK and Italy. The majority of biogas is used to generate electricity and/or heat and increasingly for co-generation. While the share of biogas in heating and cooling sector was negligible in 2004 (0.7 Mtoe or 1 %), in 2015, 3.3 Mtoe (4 %) of heat was produced from biogas. In electricity sector the share rose from 0.9 Mtoe in 2004 to 6 Mtoe in 2015. In contrast, until today biogas does not play a prominent role in the transport sector on EU-28 level (0.1 Mtoe in 2004 to 0.4 Mtoe in 2015).

The most important biogas sources are landfill biogas and farm biogas (anaerobic digestion of crops, crop residues and slurry). Biogas from sewage sludge and biowaste play a minor role. Biogas production has been driven by feed-in tariffs (e.g. in Czech Republic) as well as by funding and environmental goals/regulations, e.g. Denmark has the goal to use 50% of livestock manure for biogas production or France public aid mechanisms comprise the heat fund. Other fundings are production or investment aid for biogas. Nevertheless, the sector confirmed the loss of impetus sparked by the biogas policy changes of the European Union’s main producer countries, Germany and Italy.

Biofuel production had experienced a strong growth in the last decade, both at European and global levels, but its growth slowed down since 2012. The consumption of **biofuels** in the transport sector increased by about 3 % in 2015 over the previous year, which was lower than the average increase of about 9 % since 2008.

As reported by the Member States, **biodiesel** is the main biofuel used for transport in the EU, representing 60 % of total use in 2015. 2013 showed a drop in biofuels consumption that could be linked to the expected changes in the European legislative framework. In 2014 the consumption returned to the same level as in 2012, and provisional estimations for 2015 show that this trend is likely to continue at a moderate level. The main consumers of biodiesel are France, Germany and Italy, with over 1 Mtoe consumed each year since 2009.

The EU is a net importer of biodiesel, main importers being Spain, Germany, Italy and the United Kingdom. In 2014 3.3 Mtoe biodiesel were imported from third countries and about 2.5 Mtoe were traded between EU Member States.

Likewise, the consumption of bioethanol in the EU has stagnated since 2010. As reported by Member States, the **bioethanol** / ETBE share of all biofuels consumption was stable between 2010 and 2012, when it represented 20 % of all biofuels and then started to decrease in 2013, reaching 15 % in 2014. Main consumers in 2015 were e.g. Germany, the UK and France.

The EU is also a net importer of bioethanol. According to Eurostat the EU Member States imported 1.3 Mtoe bioethanol in 2014 of which only 30 % originated from EU Member States. The main importers for bioethanol are Germany and the United Kingdom.

According to the 2015 ILUC amendments to the RED, the contribution of biofuels produced from feedstocks listed in Annex IX can be double counted (on an energy content) against the renewable transport target. The majority of double counted biofuels in the EU is biodiesel. The highest consumption was reported in the United Kingdom, Germany, and Sweden. For other Member States no data exist or they did not apply double counting.

The use of renewable electricity in transport has increased steadily to 1,670 ktoe in 2015, an increase of about 8 %. Hydrogen produced from renewables for use in transport has not been reported in the Progress Reports.

In 2012, the EU-28 generated 2.514 million tons of biogenic waste. The total amount of treated biogenic waste amounted to 2.302 million tons (92 %). 46 % were subject to recovery other than energy recovery. 42 % were subject to deposit onto or into land.

As documented in the Member States Progress Reports, the total amount of land used for the production of energy crops in 2014 was about 5.8 million hectares. In 2013 the area was about 4.7 million hectares; however France and Lithuania did not report their areas. The largest part of land was used for the production of common arable crops and oilseeds (97 %). The land used for short rotation trees decreased in the reporting period from 2013 to 2014 by about 4 %, land used for “other energy crops” by about 1 %. Finland for instance, reduced land use for other energy crops nearly by half. The largest amounts of land use dedicated to biofuel production in the reporting period were reported by Germany (37 %) and France (19 %). The monitoring of land use changes for the production of bioenergy within the Member States has improved in terms of completeness in contrast to the previous years. But there are still improvements needed, particularly regarding common methods of data collection.

Summary of Task 3.2: Environmental impacts

In order to be accounted towards the EU renewable energy targets and to be eligible for public support, biofuels have to comply with the binding environmental sustainability criteria of the RED, and the compliance has to be verified by a national or EU-wide sustainability certification scheme. In principle, the EU sustainability criteria avoid direct land-use impacts of biofuel production e.g. conversion of primary forests, protected areas, highly biodiverse grassland, forests, wetlands and peatland. However, negative impacts may appear due to indirect effects. For this reason, the 2015 amendments to the RED limit the contribution of crop-based biofuels to 7 %.

Impacts on soil and water are not addressed in the RED. Furthermore, no reliable data relating land use change dynamics to bioenergy cultivation exist. Therefore, potential impacts of agricultural production on the environment were assessed through the following three approaches:

(1) Analysis of environmental impacts reported in Member State reports. Except Germany, the Member States indicated only negligible impacts of biofuel production on the environment. This is due to the fact that the production quantities are relatively small (e.g. Cyprus reported no biofuels production from domestic biomass, Denmark reported a limited biofuels production) but also because statistical data and research results often do not exist (e.g. Greece, Lithuania, Latvia).

(2) Analysis of land use change data reported by EU Member States under UNFCCC. Under the UNFCCC reporting, Member States have reported only small land use changes regarding forests and wetlands in the period 2013 – 2014. In contrast to forest and wetlands, the loss of grassland was evident (e.g. Lithuania losses 1.6% in 2013 and 2.4% in 2014 [CRF 2016 dataset]).

However, a direct causal relationship between the loss of grassland area and an increase in the area of cropland used for the production of bioenergy appears to be unlikely in EU Member States for that period. The loss of grassland area is more likely a result of an increase in settlements, forest areas and cropland areas for non-energy crops.

(3) Modelling of impacts from land use change in EU Member States and main third countries. The modelling focused on the environmental impact categories of biodiversity loss, soil quality, water stress, and carbon loss. The assessment was carried out on the basis of modelled spatial patterns on land use and land use change between 2007 and 2014 using the LandSHIFT model. It must be stated clearly that this assessment is partly based on reported data and partly on model algorithms. Furthermore, no direct relation between biofuel consumption within the EU-28 and land use pattern in main third countries and EU Member States can be drawn. Only impacts from the production of crops that can potentially be used as bioenergy feedstocks were analysed. The covered crops are soy bean, oil palm and other oil seeds applicable for biodiesel production and wheat, other cereals, maize and sugar cane for bioethanol production.

- Under the RED, biodiversity-rich areas are excluded from the cultivation of biodiesel and bioethanol feedstocks and therefore direct risks of biodiversity loss are effectively avoided. However, the modelling suggests that there is a risk of indirect impacts on areas important for **biodiversity** in third countries, particularly in Indonesia, Malaysia, Guatemala and Peru.
- Under the RED, only raw material produced in the EU is subject to soil protection requirements included in the EU cross-compliance criteria. The analysis for main third countries showed that biofuel feedstocks are often cultivated on **soils** with low suitability for agriculture, that are potentially more exposed to soil degradation risks. This is the case for both, already existing and newly established cropland. Model results show that soil suitability was generally lower in cases of bioethanol feedstocks compared to biodiesel feedstocks. However, this analysis gives no information on whether existing risks are adequately addressed, but rather emphasizes the need for risk-reducing measures.
- The RED does not include specific requirements on **water** protection, e.g. related to water consumption or water quality, because of the difficulty to set objective global thresholds as the impacts vary according to local conditions. According to the literature available, biofuel production can be associated with regionalized impacts on water consumption in some countries, including maize production in the US and EU and sugarcane production in Pakistan and Peru. The modelling results based on maps of water stress were calculated by the global hydrology model WaterGAP. Modelling results show that high water stress appears to be much more related to single main third countries rather than to biofuel feedstocks, e.g. a high proportion of cropland with high water stress could be found in Peru and Pakistan.
- Direct GHG emission savings are covered by the RED (minimum GHG saving thresholds, exclusion of areas with high carbon stock). Greenhouse gas emissions from land use change result from diminishing carbon stocks in soil and vegetation when carbon rich ecosystems are converted to agriculture. As about 90 % of the biofuels utilized in EU-28 comply with the RED, only about 10 % of these biofuels are associated with a risk of high GHG-emissions due to direct land use change. The modelling for GHG-emissions

associated with land conversion towards cropland between 2007 and 2014 is calculated for main biofuel and biofuel feedstock suppliers to the EU-28. Greenhouse gas emissions are calculated in relation to RED, Article 17.2. The modelling results show that greenhouse gas emissions related to the additional land conversion for the cultivation of agriculture commodities mostly showed values above 50 g CO_2-Eq/MJ and reached values up to 250 g CO_2-Eq/MJ. GHG-emissions associated to land conversion from production of cereals were generally lower compared to oil crops and values above 50 g CO_2-Eq/MJ have been modelled for oil crops. In case of sugar cane CO_2 was stored after land use change as sugar cane is a perennial crop with a high productivity. The modelling could not verify the linkage of deforestation of sensitive forests in main third countries and the use of biofuels in the EU-28.

Indirect land use change impacts (ILUC) are not addressed by the binding sustainability requirements in the RED (Art. 23 (5)). Directive EU-2015/1513 (ILUC Directive) requires extended reporting obligations regarding ILUC in its Report on Renewable Energy. Fuel suppliers report on emissions from ILUC, but these are not included in the sustainability criteria for biofuels or the GHG calculation methodology.

The Directive was published on 9 September 2015 and Member States are obliged to transpose the Directive into national legislation by 10 September 2017. Hence, in this reporting period information on ILUC is not yet reported in compliance with the ILUC Directive.

The results of the literature review on ILUC emission estimates shows that the highest risk is still associated with biofuels based on agricultural crops. ILUC emissions still range widely for specific feedstocks, especially for sugar cane, palm oil and soybean oil, reflecting uncertainty on assumptions. Advanced biofuels show significantly lower ILUC risk. The highest ILUC risk results from peatland oxidation and deforestation in well-known regions.

Summary of Task 3.3: Economic and social impacts

Under Article 23 (5) b and Article 17 (7) of the RED, the European Commission is required to report on the impact of increased demand for biofuel on environmental sustainability in the Community and in third countries, including economic impacts (Art. 23 (5) b), impacts on feedstock availability and food prices impacts on wider development issues (Art. 17 (7) 2), impacts on security of supply (Art. 23 (5) a), impacts on commodity price changes and food security (Art. 23 (1)) and impacts on biomass using sectors (Art. 23 (5) d).

The analysis of the Member States' reports was supplemented by information gathered from a literature review.

Economic impacts can be framed in terms of investment in new installations of RES technologies and employment rates. Although biofuel investment was more or less stable at a global level in the past two years, it shows brisk ups and downs at a national level. These can be related to biodiesel and ethanol markets that are vulnerable to policy and regulatory changes as well as shifting patterns in international trade. The biofuel sector is the second biggest employer in the renewable energy industry worldwide, right after photovoltaics. Biofuel employment in Europe increased slightly in the period 2012 – 2014. France, Germany, Spain and Belgium are the top employers in Europe. At a global level, market ups and downs are reflected by the employment rate which decreased by 6 % from 2013 to 2014.

The **wider development issues** were classified into rural and social development, land tenure, capacity development and technology transfer and gender issues. Only few Member States reported on specific measures of **rural and social development** and potential synergies that can be expected. The monitoring of impacts of biofuel use on rural development in third countries were still fragmentary due to lack of data and clear indicators.

Recent results of voluntary certification schemes showed a declining trend of certified production of biofuel feedstocks. Issues of land acquisition and **land tenure** still exist, especially for undocumented land holders with insecure tenure rights. **Capacity-building** measures in the biofuel sector were found to be underrepresented compared to other renewable energy technologies and therefore should be enforced. Regarding **gender issues**, particularly more women need training in order to enable them to get higher qualified jobs and decision-making positions.

No information on the **security of supply** was reported by Member States.

Impacts on **commodity prices changes** reported by the Member States were limited due to the fact that bioenergy use represents a very small share of the total agricultural activity in the Member States. Price shocks are less influenced by tax exemptions or biofuel mandates but more through import duties or climate anomalies. The Organization for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO) concluded that the recent period of high agricultural commodity prices is most likely over. The OECD-FAO 2016 Agricultural Outlook stated that the increased demand for food and feed for a growing and more affluent population is projected to be met mostly through productivity gains, with yield improvements expected to account for about 80 % of the needed increase in crop output.

EU Member States reported limited or no **impact on** prices and **food security** due to their domestic biofuel production. Therefore the analysis based on literature review, stated that food security is expected to be largely unaffected by the use of crop residues and perennial crops grown on marginal land. Therefore policies should prioritise the use of residues and wastes for energy purposes. However, as these feedstocks can also be used as materials, there can be indirect effects (also on food crop production) associated with an increased use for energy.

The literature review showed that a transformation of existing structures of bioenergy and biofuels production towards a wider industrial material use of biomass and added value need incentives, e.g. by including industrial material use of biomass in the RED overall quotas and also in the fuel quota.

Regarding the **availability of feedstocks** and relations to **food prices**, most EU Member States did not report impacts of the use of biomass for biofuels on agricultural commodity prices, but rather associated price fluctuations with world market prices. The influence of biofuels on agricultural commodities on the world market is discussed rarely and also inconclusively. The analysis showed that assumptions and methodologies of studies often differ significantly, not allowing for clear conclusions on the subject. For future investigations it is not only crucial to find a consensus on the scientific approach, but also to consider wider implications of the usage of biomass for biofuels on food security, such as yield increases due to mechanization or the transition of low-level subsistence farming households towards more stable sources of income.

Only a few Member States reported on **impacts of bioenergy use on other biomass-using sectors,** mostly on wood sector as a traditional bio-economy sector. Emerging sectors like the use bio based chemicals or materials seem to be hindered by EU biofuel policies. The promotion of waste use as a raw material for bioenergy production can trigger regional competition over land use which triggers rising land prices (as e.g. Germany reported). Poland reported that the production of by-products from biofuel production resulted in an increased use of animal feed production.

Résumé

L'objectif de cette étude est de fournir une assistance technique sur le Rapport 2016 sur les énergies renouvelables, en préparation du « paquet énergies renouvelables » pour la période 2020-2030 dans l'Union européenne. Concernant les bioénergies consommées dans les États membres de l'UE, ce paquet est requis pour le rapport de la Commission sur les progrès accomplis dans le secteur des énergies renouvelables, conformément à l'article 23 de la Directive sur les énergies renouvelables. Ce document comprend :

- une évaluation de l'impact sur l'approvisionnement en énergie, dans les États membres, comprenant la structure quantitative et l'utilisation associée des sols pour les bioénergies, à partir de l'agriculture et de la sylviculture, incluant les progrès réalisés dans la mise à disposition de la bioénergie produite à partir de déchets, de résidus et de matières cellulosiques et lignocellulosiques non alimentaires (tâche 3.1) ;
- une évaluation des impacts environnementaux associés à la consommation de bioénergie dans l'Union européenne (tâche 3.2) ;
- une évaluation des impacts économiques et sociaux associés à l'utilisation de la bioénergie par les États membres de l'Union européenne (tâche 3.3).

Sources de données

Les données utilisées dans le présent projet proviennent des rapports de situation des États membres et d'autres sources de données, notamment Eurostat, FAOSTAT, Word Bioenergy Association, USDA Foreign Agricultural Service et l'OCDE. Il se peut que les valeurs déclarées ne soient pas tout à fait cohérentes entre elles ou ne concordent pas avec des valeurs en provenance d'autres sources. D'autre part, nous avons obtenu des données en modélisant les impacts de l'utilisation et du changement d'affectation des sols dans les États membres et dans les principaux pays tiers au moyen de LandSHIFT, un modèle de simulation utilisé pour générer des cartes d'utilisation des sols.

Résumé de la tâche 3.1 : Impacts sur l'approvisionnement en énergie

L'utilisation de l'énergie biomasse a augmenté entre 2004 et 2015, dans les États membres de l'Union européenne, avec toutefois un léger recul en 2011. Depuis 2011, la croissance s'est stabilisée ou a ralenti considérablement. Le premier utilisateur de la biomasse destinée à la production d'énergie (70 %) était le secteur du chauffage et du refroidissement. En 2015, 17 % de la biomasse a été utilisée dans le secteur du transport et 13 % dans le secteur de l'électricité renouvelable.

L'énergie biomasse se subdivise en trois sous-catégories :

- la biomasse solide qui comprend tous les éléments organiques solides tels que le bois, les déchets de bois, les copeaux et particules, les granulés de bois, les résidus, etc. ;
- le biogaz qui est produit par fermentation anaérobie à partir de résidus, de déchets, de boues d'épuration ou de cultures énergétiques ;
- les biocarburants ou bioliquides tels que le bioéthanol ou le biodiesel qui sont produits à partir de différents types de biomasse.

La biomasse solide utilisée est majoritairement composée de bois : environ la moitié de la consommation d'énergie renouvelable en Europe provient du bois. Celui-ci est principalement utilisé pour le chauffage et l'électricité – en 2014, 77 % de l'énergie primaire de ces deux secteurs provient du bois forestier. Ce dernier se décompose à son tour de la façon suivante : 91 % est issu de la production nationale, 6 % du commerce au sein de l'UE et 3 % est importé de pays extracommunautaires (voir tableau 1-2). Environ 23 % de la production totale de bois de l'Union européenne est utilisé pour l'énergie (combustible ligneux).

La consommation de biomasse solide a diminué en 2014 et la production intérieure a diminué encore plus fortement, ce qui a impliqué une hausse des taux d'importation.

La consommation de résidus de bois est passée de 52 millions de tonnes en 2011 à 64,9 millions de tonnes en 2015, les principaux producteurs étant la France, la Suède et la Pologne. Selon le projet BASIS 2015, la consommation totale de copeaux de bois pour la production bioénergétique, en 2013, au niveau européen, se situait autour de 51 millions de tonnes par an, les cinq principaux producteurs de copeaux de bois pour l'énergie représentant environ 70 % de la consommation générale (BASIS 2015).

L'importation de biomasse était principalement basée sur les granulés de bois, dont les quantités ont augmenté régulièrement entre 2012 (14 millions de tonnes) et 2015 (19,8 millions de tonnes). L'Union européenne demeure donc le premier producteur et consommateur de granulés de bois ainsi que le premier importateur de granulés commercialisés dans le monde. Près de la moitié du commerce mondial de granulés de bois est un commerce interne, s'opérant au sein des États membres de l'Union européenne ou entre ceux-ci. Les principaux partenaires commerciaux extérieurs de l'Union européenne sont les États-Unis, le Canada et la Russie. Contrairement aux granulés de bois, le bois rond et les copeaux de bois à visée énergétique sont actuellement transportés sur des distances plus courtes. Par conséquent, les pays tiers d'origine jouent un rôle moindre.

Les principaux consommateurs de biogaz au sein de l'UE sont l'Allemagne, le Royaume-Uni et l'Italie. Le biogaz est majoritairement utilisé pour produire de l'électricité et/ou de la chaleur mais aussi, de plus en plus, pour la cogénération. Alors qu'en 2004, la part du biogaz dans le secteur du chauffage et du refroidissement était négligeable (0,7 Mtep soit 1 %), elle est passée en 2015 à 3,3 Mtep (4%) pour la production de chaleur. Dans le secteur de l'électricité, cette part est passée de 0,9 Mtep en 2004 à 6 Mtep en 2015. En revanche, jusqu'à présent, le biogaz ne joue pas un rôle prépondérant dans le secteur des transports au niveau de l'UE (0,1 Mtep en 2004 - 0,4 Mtep en 2015).

Les sources de biogaz les plus importantes sont le biogaz de décharge et le biogaz agricole (digestion anaérobie des cultures, résidus de culture et lisiers). Le biogaz issu des boues d'épuration et des biodéchets joue un rôle mineur. La production de biogaz a été dynamisée par les tarifs d'achat (en République tchèque, notamment) ainsi que par les objectifs et réglementations en matière de financement et d'environnement. Par exemple, le Danemark a pour objectif d'utiliser 50 % des effluents d'élevage pour la production de biogaz ; la France propose un dispositif de soutien public à travers le fonds chaleur. Il existe d'autres financements tels que les aides à la production ou à l'investissement dans le domaine du biogaz. Néanmoins, le secteur a accusé une perte de dynamisme due aux changements de politique des deux principaux pays producteurs de l'Union européenne, à savoir l'Allemagne et l'Italie.

La production de biocarburant a connu une forte croissance au cours des dix dernières années, tant au niveau européen que mondial, mais le rythme a ralenti depuis 2012. La consommation de biocarburants a augmenté d'environ 3 % dans le secteur des transports entre 2014 et 2015, ce qui est inférieur à la hausse moyenne d'environ 9 % constatée depuis 2008.

Selon les rapports des États membres de l'UE, le biodiesel est le principal biocarburant utilisé pour le transport dans l'Union Européenne, puisqu'il représente 60 % de la consommation totale en 2015. L'année 2013 a vu une baisse de la consommation de biocarburants qui pourrait être liée au projet de modification du cadre législatif européen. En 2014, la consommation est revenue au même niveau qu'en 2012 et les estimations provisoires pour 2015 montrent que cette tendance devrait se poursuivre, bien qu'à un niveau modéré. Les principaux consommateurs de biodiesel sont la France, l'Allemagne et l'Italie avec plus de 1 Mtep consommé annuellement depuis 2009.

L'Union européenne est importatrice nette de biodiesel : les pays qui importent le plus sont l'Espagne, l'Allemagne, l'Italie et le Royaume-Uni. En 2014, 3,3 millions de tonnes de biodiesel ont été importées de pays tiers et environ 2,5 millions de tonnes ont été échangées entre les États membres de l'UE.

De même, la consommation de bioéthanol dans l'UE stagne depuis 2010. Selon les rapports des États membres, la part du bioéthanol/ETBE était stable entre 2010 et 2012, représentant 20 % de la consommation totale de biocarburants, puis elle a commencé à décroître en 2013 pour atteindre 15 % en 2014. En 2015, les principaux consommateurs étaient notamment l'Allemagne, le Royaume-Uni et la France.

L'Union européenne est aussi importatrice nette de bioéthanol. Selon Eurostat, les États membres ont importé 1,3 Mtep de bioéthanol en 2014, dont seulement 30 % provenaient de l'UE. Les principaux importateurs de bioéthanol sont l'Allemagne et le Royaume-Uni.

Conformément aux modifications apportées en 2015 à la directive EnR en lien avec le changement indirect d'affectation des sols (CASI), la contribution des biocarburants produits à partir des matières premières énumérées à l'annexe IX est considérée comme égale à deux fois leur contenu énergétique, par rapport à l'objectif d'énergie renouvelable dans les transports. Le biodiesel est majoritaire dans les biocarburants comptabilisés deux fois au sein de l'UE. Les consommations les plus élevées ont été déclarées au Royaume-Uni, en Allemagne et en Suède. Dans d'autres États membres, il n'existe aucune donnée ou ceux-ci n'ont pas appliqué le double comptage.

La consommation d'électricité renouvelable a augmenté progressivement dans les transports, atteignant 1 670 ktep en 2015, ce qui représente une hausse d'environ 8 %. Aucune production d'hydrogène à partir de sources d'énergie renouvelables pour utilisation dans les transports n'a été déclarée dans les rapports de situation.

En 2012, l'UE a généré 2 514 millions de tonnes de déchets d'origine animale ou végétale. Sur ce total, 2 302 millions de tonnes (soit 92 %) ont été traitées. 46 % ont fait l'objet d'une valorisation autre qu'énergétique. 42% ont été déposés ou enfouis en décharge.

Comme indiqué dans les rapports de situation des États membres, la superficie totale des terres utilisées pour la production de cultures énergétiques était, en 2014, d'environ 5,8 millions d'hectares. En 2013, cette superficie était d'environ 4,7 millions d'hectares ; cependant, la France et la Lituanie n'avaient pas déclaré leurs chiffres. La majeure partie des terres était utilisée pour la production de cultures arables communes et d'oléagineux (97 %). La superficie des terres utilisées pour les taillis à courte rotation a diminué d'environ 4 % au cours de la période considérée (2013-2014) et celle des terres utilisées pour les autres cultures énergétiques a baissé d'environ 1 %. La Finlande, par exemple, a réduit de près de moitié l'exploitation des terres pour les autres cultures énergétiques. Les plus grandes superficies consacrées à la production de biocarburants au cours de la période considérée ont été déclarées par l'Allemagne (37 %) et la France (19 %). Par rapport aux années précédentes, le suivi des changements d'affectation des sols pour la production de bioénergie s'est amélioré, en termes d'exhaustivité, au sein des États membres. Mais des améliorations sont encore nécessaires, notamment en ce qui concerne l'élaboration de méthodes communes de collecte des données.

Résumé de la tâche 3.2 : Impacts environnementaux

Pour être pris en compte dans les objectifs de l'UE en matière d'énergies renouvelables et pouvoir prétendre aux aides publiques, les biocarburants doivent respecter les critères de durabilité environnementale contraignants définis dans la directive EnR, et leur conformité doit être vérifiée par un système de certification de la durabilité, au niveau national ou européen. En principe, les critères de durabilité de l'UE ne prennent pas en considération l'impact des changements indirects d'affectation des sols liés à la production de biocarburants (par exemple la conversion de forêts primaires, de zones naturelles protégées, de prairies riches en biodiversité, de forêts, de zones humides et de tourbières). Cependant, des impacts négatifs peuvent apparaître, dus à des effets indirects. C'est pourquoi les modifications apportées en 2015 à la directive EnR limitent à 7 % la contribution des biocarburants issus de cultures agricoles.

L'impact sur les sols et l'eau n'est pas pris en compte dans la Directive EnR. De plus, il n'existe aucune donnée fiable associant la dynamique du changement d'affectation des sols aux cultures bioénergétiques. Par conséquent, les effets potentiels de la production agricole sur l'environnement ont été évalués selon les trois approches ci-dessous :

(1) Analyse des impacts environnementaux déclarés dans les rapports des États membres. À l'exception de l'Allemagne, les États membres n'ont déclaré que des impacts environnementaux négligeables associés à la production des biocarburants. Ceci s'explique parce que les quantités produites sont relativement faibles (par exemple, Chypre n'a pas déclaré de production de biocarburants à partir de la biomasse domestique, le Danemark a déclaré une production limitée) mais aussi parce que les données statistiques et les résultats de la recherche sont souvent inexistants (Grèce, Lituanie, Lettonie).

(2) Analyse des données de changement d'affectation des sols rapportées par les États membres dans le cadre de la CCNUCC. Dans le cadre des rapports de la CCNUCC, les États membres n'ont déclaré que des changements mineurs d'affectation des sols liés aux forêts et aux zones humides, entre 2013 et 2014. En revanche, la perte de prairies apparaissait évidente (par exemple, la Lituanie a perdu 1,6 % de ses prairies en 2013 et 2,4 % en 2014 [Base de données du Cadre commun de présentation, 2016].

Cependant, il semble toutefois difficile d'établir une relation directe entre l'augmentation de la superficie des cultures utilisées pour la production bioénergétique et la perte de zones de prairies dans les États membres de l'UE, au cours de cette période. La perte d'hectares de prairies est plus probablement due à une augmentation des implantations urbaines, des zones forestières et des terres cultivées pour les cultures non énergétiques.

(3) Modélisation des impacts du changement d'affectation des sols dans les États membres de l'UE et les principaux pays tiers. La modélisation s'est focalisée sur plusieurs catégories d'impacts environnementaux : perte de biodiversité, qualité des sols, stress hydrique et perte de carbone. L'évaluation a été réalisée sur la base de modèles spatiaux sur l'usage et le changement

d'affectation des sols, entre 2007 et 2014, à l'aide du modèle LandSHIFT. Il convient de préciser que cette évaluation repose en partie sur des données statistiques et en partie sur des algorithmes. D'autre part, aucune relation directe ne peut être établie entre la consommation de biocarburants au sein de l'UE et les modèles d'utilisation des sols dans les principaux pays tiers et dans les États membres. Seuls les impacts de la production de cultures pouvant éventuellement être utilisées comme matières premières énergétiques ont été analysés. Les cultures concernées sont le soja, le palmier à huile et divers oléagineux adaptés à la production de biodiesel ainsi que le blé, d'autres céréales, le maïs et la canne à sucre pour la production de bioéthanol.

• En vertu de la directive EnR, les zones riches en biodiversité sont exclues de la culture de matières premières destinées à la production de biodiesel et de bioéthanol, ce qui permet d'éviter les risques directs de perte de biodiversité. Cependant, la modélisation semble indiquer qu'il existe un risque d'impact indirect sur des zones importantes pour la biodiversité dans les pays tiers, notamment en Indonésie, en Malaisie, au Guatemala et au Pérou.

- En vertu de la directive EnR, seules les matières premières produites dans l'UE sont soumises aux exigences relatives à la protection des sols comprises dans les critères d'éco-conditionnalité de l'UE. L'analyse des principaux pays tiers a montré que les matières premières destinées aux biocarburants sont souvent cultivées sur des sols peu adaptés à l'agriculture et qui sont potentiellement plus exposés aux risques de dégradation des sols. C'est le cas aussi bien pour les terres cultivées existantes que pour les terres nouvellement établies. Les résultats de la modélisation montrent que la qualité des sols est en général moins bonne pour les matières premières destinées au bioéthanol que pour celles destinées au biodiesel. Cependant, cette analyse ne donne aucune information permettant de savoir si les risques existants sont correctement pris en compte mais souligne plutôt la nécessité d'adopter des mesures visant à réduire les risques.
- La directive EnR n'inclut pas d'exigences spécifiques en matière de protection de l'eau, notamment des exigences liées à la consommation d'eau ou à la qualité de l'eau, en raison de la difficulté à fixer des seuils mondiaux objectifs car les impacts varient en fonction des conditions locales. Selon les travaux disponibles, la production de biocarburants peut avoir des incidences régionales sur la consommation d'eau ; c'est par exemple le cas avec la production de maïs aux États-Unis ou dans l'UE et avec la production de canne à sucre au Pakistan et au Pérou. Les résultats de la modélisation basés sur des cartes de stress hydrique ont été calculés au moyen du modèle hydrologique global WaterGAP. Ces résultats montrent qu'un stress hydrique élevé semble être beaucoup plus lié à certains pays tiers qu'aux matières premières destinées à produire des biocarburants (par exemple, on observe au Pérou et au Pakistan une forte proportion de terres cultivées soumises à un important stress hydrique).
- Les réductions directes des émissions de GES sont couvertes par la directive EnR (seuils minimum de réduction des émissions, exclusion des zones renfermant un stock de carbone important). Les émissions de gaz à effet de serre issues des changements d'affection des sols résultent de la diminution des stocks de carbone dans les sols et la végétation lorsque des écosystèmes riches en carbone sont convertis à l'agriculture. Puisqu'environ 90 % des biocarburants utilisés dans l'Union européenne sont conformes à la directive EnR, seuls 10 % présentent un risque d'émissions de GES élevées dues à un changement direct d'affectation des sols. La modélisation des émissions de GES associées à la conversion des terres en parcelles cultivées, entre 2007 et 2014, est calculée pour les principaux fournisseurs de biocarburants et matières premières associées, de l'Union européenne. Les émissions de gaz à effet de serre sont calculées conformément à la directive EnR, (Art.

17.2). Les résultats de la modélisation montrent que les émissions de gaz à effet de serre liées à la conversion supplémentaire de terres pour la culture de produits agricoles présentaient des valeurs supérieures à 50 gCO2Eq/MJ et atteignaient jusqu'à 250 gCO2Eq/MJ. Les émissions de GES associées à la conversion des terres de production de céréales étaient généralement inférieures à celles des cultures oléagineuses, ces dernières présentant des valeurs modélisées supérieures à 50 gCO2Eq/MJ. Dans le cas de la canne à sucre, du CO2 a été stocké suite au changement d'affectation des sols, car la canne à sucre est une culture pérenne avec une productivité élevée. La modélisation n'a pas permis de vérifier le lien entre la déforestation de zones boisées sensibles dans les principaux pays tiers et l'utilisation de biocarburants dans l'UE.

Les critères de durabilité contraignants de la directive EnR (article 23(5)) ne prennent pas en compte l'incidence des changements indirects d'affectation des sols. La directive UE-2015/1513 (dite « directive CASI ») impose à la Commission des obligations de déclaration élargies en ce qui concerne les changements indirects d'affectation des sols, dans son rapport sur les énergies renouvelables. Les fournisseurs de carburant déclarent les émissions dues aux changements d'affectation des sols, mais ces émissions ne sont pas incluses dans les critères de durabilité des biocarburants ni dans la méthodologie de calcul des GES.

La directive a été publiée le 9 septembre 2015 et les États membres étaient tenus de la transposer dans leur législation nationale avant le 10 septembre 2017. Par conséquent, au cours de la période couverte par le présent rapport, les informations sur les changements indirects d'affectation des sols n'ont pas encore été communiquées conformément à la directive CASI.Par conséquent, au cours de la période couverte par le présent rapport, les informations sur l'ILUC n'ont pas encore été communiquées conformément à la directive ILUC.

Les résultats des travaux de recherche sur les estimations d'émissions liées aux CASI montrent que le risque le plus élevé est toujours associé aux biocarburants basés sur les cultures agricoles. Les émissions liées aux CASI sont encore très variables pour des matières premières spécifiques, notamment la canne à sucre, l'huile de palme et l'huile de soja, reflétant l'incertitude sur les hypothèses émises. Les biocarburants avancés présentent beaucoup moins de risques de changement indirect d'affection des sols. Le risque le plus élevé résulte de l'oxydation des tourbières et de la déforestation dans certaines régions bien connues.

Résumé de la tâche 3.3 : Impacts économiques et sociaux

En vertu de l'Article 23, paragraphe 5, point b) et de l'article 17, paragraphe 7 de la directive EnR, la Commission européenne est tenue de rendre compte de l'incidence de l'augmentation de la demande de biocarburants sur la durabilité environnementale, dans la Communauté et les pays tiers, en incluant les impacts économiques (Art. 23 (5) b), l'incidence sur la disponibilité des matières premières et sur les prix des denrées alimentaires ainsi que sur d'autres questions générales liées au développement (Art. 17 (7) 2), l'incidence sur la sécurité d'approvisionnement (article 23 (5) a) l'incidence sur l'évolution du prix des produits (Art. 23 (1)) et l'incidence sur les secteurs exploitant la biomasse (Art. 23 (5) d).

L'analyse des rapports des États membres a été complétée par des informations issues des travaux scientifiques.

Les impacts économiques peuvent être formulés en termes d'investissement dans de nouvelles installations renouvelables et en termes de taux d'emploi. Bien que l'investissement dans les biocarburants soit demeuré plus ou moins stable au niveau mondial au cours des deux dernières années, il connait des hauts et des bas au niveau national. Cette situation peut être liée aux marchés du biodiesel et du bioéthanol qui sont soumis aux aléas politiques et aux changements de réglementation, ainsi qu'à l'évolution des tendances dans le commerce international. Le secteur des biocarburants est le deuxième plus gros employeur mondial, au sein des filières des énergies renouvelables, juste après le photovoltaïque. L'emploi européen dans les biocarburants a légèrement augmenté au cours de la période 2012-2014. La France, l'Allemagne, l'Espagne et la Belgique sont les premiers pays pourvoyeurs d'emplois en Europe. Au niveau mondial, les fluctuations du marché se reflètent dans le taux d'emploi qui a baissé de 6 % entre 2013 et 2014.

Les autres questions générales liées au développement concernent le développement rural et social, le régime foncier, le renforcement des capacités et le transfert de technologies et les questions liées à la problématique hommes-femmes. Seuls quelques États membres ont rendu compte de mesures spécifiques de développement rural et social et des synergies potentielles qui peuvent être attendues. Le suivi de l'impact de l'utilisation des biocarburants sur le développement rural dans les pays tiers était encore parcellaire du fait de l'absence de données et d'indicateurs clairs.

Les derniers résultats des systèmes de certification volontaires ont révélé une tendance à la baisse des productions certifiées destinées aux biocarburants. Des problèmes d'acquisition de terres et de régime foncier subsistent, en particulier pour les propriétaires terriens sans papiers dont les droits fonciers ne sont pas garantis. Les mesures de renforcement des capacités ont été considérées comme sous-représentées dans le secteur des biocarburants par rapport aux autres filières renouvelables et devraient donc être mises en œuvre. Quant aux questions liées à la problématique hommes-femmes, les femmes ont particulièrement besoin de formations afin de pouvoir accéder à des emplois plus qualifiés et à des postes décisionnels.

Aucune information concernant la sécurité d'approvisionnement n'a été rapportée par les États membres.

Les incidences sur les prix des produits rapportées par les États membres sont limitées car l'utilisation des bioénergies y représente une très faible part de l'activité agricole totale. La flambée des prix est moins influencée par les exonérations fiscales ou l'obligation d'incorporation des biocarburants que par les droits d'importation ou les anomalies climatiques. L'Organisation de coopération et de développement économiques (OCDE) et l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) estiment que la récente période de prix élevés des produits agricoles est très probablement terminée. Selon les Perspectives agricoles 2016 de l'OCDE et de la FAO, le surcroît de demande d'aliments pour nourrir une population plus nombreuse et plus aisée devrait être satisfait en majeure partie grâce à des gains de productivité ; l'amélioration des rendements attendue devrait ainsi représenter environ 80 % de la hausse de la production végétale.

Les États membres de l'Union européenne ont déclaré un impact limité ou nul de leur production intérieure de biocarburants sur les prix et la sécurité alimentaire. Ainsi, selon l'analyse des travaux existants, la sécurité alimentaire ne devrait quasiment pas être affectée par l'utilisation des résidus de culture et des plantes pérennes cultivées sur des terres peu productives. Par conséquent, les politiques devraient privilégier l'utilisation des résidus et des déchets à des fins énergétiques. Cependant, ces matières premières pouvant également être utilisées comme matériaux, leur utilisation accrue pour l’énergie peut avoir des effets indirects (comme sur la production de cultures alimentaires).

L’analyse des travaux existants a montré qu’une transformation des structures actuelles de production des bioénergies et des biocarburants en faveur d’une utilisation industrielle plus large de la biomasse et d’un accroissement de la valeur ajoutée nécessite des incitations, notamment en incluant l’utilisation de la biomasse pour les matériaux industriels dans les quotas globaux de la directive EnR et également dans les quotas de carburants.

En ce qui concerne la disponibilité des matières premières et le lien avec les prix des denrées alimentaires, la plupart des États membres n’ont pas déclaré d’incidence de l’utilisation de la biomasse pour les biocarburants sur les prix des produits agricoles, mais plutôt sur les fluctuations des prix mondiaux. L’influence des biocarburants sur les produits agricoles, sur le marché mondial, fait l’objet de débats rares et peu concluants. L’analyse a montré que les hypothèses et les méthodologies des différentes études étaient souvent extrêmement divergentes, ne permettant pas de tirer des conclusions claires. Pour les recherches futures, il est non seulement fondamental de trouver un consensus concernant l’approche scientifique, mais aussi d’envisager les implications plus larges de l’utilisation de la biomasse pour les biocarburants sur la sécurité alimentaire, comme les augmentations de rendement dues à la mécanisation ou la transition de l’agriculture de subsistance de bas niveau vers des sources de revenus plus stables.

Seuls quelques États membres ont signalé les impacts de l’utilisation de la bioénergie sur d’autres secteurs exploitant la biomasse, principalement celui du bois en tant que secteur bioéconomique traditionnel. Les secteurs émergents tels que ceux basés sur les matériaux ou produits chimiques biosourcés semblent être freinés par les politiques de l’UE en matière de biocarburants. La promotion de l’utilisation des déchets comme matières premières pour la production de bioénergie peut créer une concurrence régionale dans l’utilisation des terres ainsi qu’une hausse des prix du foncier (comme l’a déclaré l’Allemagne, par exemple). La Pologne a déclaré que les sous-produits issus de la production de biocarburants entraînaient un recours accru à la production d’aliments pour animaux.

1. Analysis of the biofuels, biomass and biogas used for renewable energy generation

This section provides information about the quantity structure of EU-28 bioenergy consumption of solid, liquid and gaseous biomasses.

The section provides a quantity structure and associated land use of bioenergy types used in the EU Member States originating from agriculture and forestry, including the progress in the availability of bioenergy from waste, residues, non-food cellulosic and ligno-cellulosic material. The analysis considers types and origin of bioenergy feedstocks. The reported sectors are renewable energies in heating and cooling (RES-H/C), electricity (RES-E) and transport (RES-T). The analysis breaks down the use of biomass in these sectors.

Table 1-1: Data sources

Data	Variables	Main sectors	Dataset	Years available	Comments
Gross inland consumption, imports, exports	liquid biofuels, biogasoline, biodiesel, other biofuels and bio jet kerosene	Transport	Eurostat nrg_107a	1990-2014	No countries of origin available for imports
Gross final energy consumption	Solid, liquid and gaseous biomass	Heating & cooling; electricity; Transport	Member State Progress Reports 2015 or Eurostat SHARES 2014	2004/09 - 2014	No information on imports available
Imports distinguished by country of origin	biogasoline, biodiesel, bio jet kerosene and other liquid biofuels	Transport	Eurostat nrg_126a	1990-2014	Only information on final products given, not on feedstocks
Feedstocks used for biofuel production in EU-28	*bioethanol, biodiesel, advanced biofuels, biogas, wood pellets*	*Transport, Heat, Power*	*USDA FAS*	*<=2016*	*Only information on feed stocks given, not on origin*
Main countries of origin	*List of countries*	*Transport, Heat, Power*	*USDA FAS*	*<=2016*	*only punctual information given*
Imports into EU-28 by country of origin	agricultural commodities / feedstocks		US Comtrade	<= 2014	No information available on which share of commodity used as feedstock for biofuel production

Source: own compilation

Data disclaimer on data quality and data consistency

In the course of this project an attribution of biomass quantities as reported in the Member States' Progress Reports has been done as carefully as possible. Due to the nature of different reporting formats it is, however, not possible to guarantee completeness and consistency at all instances.

For this project data were collected from the Member States' Progress Reports and additional data sources (i.e. [1], [6], [22, 23], [24], [25], [26], [27, 28]). Reported values may not always be fully consistent or do not correspond with figures from other sources.

In view of future reporting obligations it seems worthwhile to note that electronic reporting in standardised formats could increase information quality and consistency of reported data allowing for a more consistent analysis.

1.1. Impacts on energy supply

Summary

Biomass energy use in EU-28 Member States has been growing steadily, with a short decline in 2011. Since 2011 the growth stabilized or slowed down considerably. The main user of biomass for energy is the heating and cooling sector (70 %) (RES-H/C). 17 % of the biomass is used in the renewable transport sector (RES-T) and 13 % in renewable electricity sector (RES-E) in 2015.

In the past decade biofuels were promoted within the EU to enhance the security of supply or reducing GHG emissions. EU biofuel policies, originally strictly aimed at promoting domestic industry, had significant impacts on world biofuel production and trade patterns. In introduction of blending mandates and the phase-out of tax exemptions in several Member States led to a higher share of imports as blenders were interested in keeping biofuel costs to a minimum and prefer cheaper imports (e.g. palm oil for biodiesel) [29]. Further observed impacts of EU biofuel policies are [29]:

- EU biofuel directive: Biodiesel dominates the EU fuel matrix;
- RED: sustainability standards increase the demand for GHG-efficient biofuels (including imports);
- EU trade regime, varying tariff and duty free levels: EU tariffs favour cheaper imports (e.g. from Brazil or US), duty free imports of palm oil increase incentives for triangular trade;
- Lack of feedstock production potential in export countries.

The gross final energy consumption of all biomass categories in RES-H/C increased by about 2 % in EU from 73,485 ktoe in 2014 to 75,303 ktoe in 2015. The current share of liquid biomass amounts to 0.4 %, gaseous biomass forms 4.4 % and solid biomass 95.2 %.

Biodiesel is the main biofuel used for transport in the EU representing 60 % of total use of biofuels in transport in 2015. 2013 shows a drop in biofuels consumption, to be linked to the European legislative context. In 2014 the consumption resumed its growth with a 9.5 % increase and the provisional estimations for 2015 show that this is likely to continue slightly. The main consumers of biodiesel are France, Germany and Italy with over 1 Mtoe consumed each since 2009 already.

The bioethanol / ETBE share of all biofuels consumption was stable between 2010 and 2012, when it represented 20 % of all biofuels and then started to decrease in 2013 to reach 15 % in 2014. In absolute terms, consumption of bioethanol has increased from 2010 to 2012 with total biofuels consumption and then decreased in 2013 and 2014. Main consumers in 2015 were Germany, the UK and France, followed by Spain, Sweden, Poland and the Netherlands.

The consumption decreased in 2014 for solid biomass, its production decreased even more sharply, which means the rate of imports increased. These imports were mostly based on pellets even though the European Union remains the largest pellet producer and consumer in the world, Italy being its largest consumer followed by Germany. It is expected that EU wood pellet production is not able to keep up with the demand from both the residential heating market and for power generation. Therefore, the future consumption of the EU will significantly depend on a range of market factors and in particular on Member States' incentives and conditions. The growing demand of EU wood pellets consumption is supported by increased investments in medium-sized combined heat and power plants. Due to this fact, wood pellets will be traded more internationally.

The consumption of wood residues increased from 52 million tonnes in 2011 to 64.9 million tonnes in 2015. However, from 2014 to 2015 the consumption increased only by about 0.7 % (2013/2014:

0.5 %; 2012/2013: 8.6 %).

The EU has been a prime market for energy related biomass trade over the past decade. The consumption and trade of biomass energy in the form of wood pellets has increased significantly since 2008. Approximately half of the global trade of wood pellets takes place within and among EU Member States. Major external exporters to the EU include the United States, Canada, and Russia. In contrast to wood pellets, roundwood and wood chips for energy purposes are currently transported over shorter distances. Therefore, third countries of origin play a smaller role.

The development of the biogas industry in individual European countries is in direct correlation with the governments' support policies in the given country. The gross final energy consumption of gaseous biomass used in the HC sector in EU in 2015 increased by about 13 % compared to the previous year. The main consumers within the EU are Germany, the UK and Italy. The sector confirmed the loss of impetus sparked by the biogas policy changes of the European Union's two main producer countries, Germany and Italy.

The consumption of biofuels in the transport sector increased by about 2 % in 2015 compared to the previous year. The consumption of bioethanol in the EU stagnated in recent years. Biodiesel consumption has increased since 2013 and has since then returned to the same level as in 2012.

Biofuel production had eperienced an exponential growth in the last decade, both at European and global level. The difference between the biodiesel and the bioethanol markets is driven by agricultural and biofuel policies and the different interests of market players.

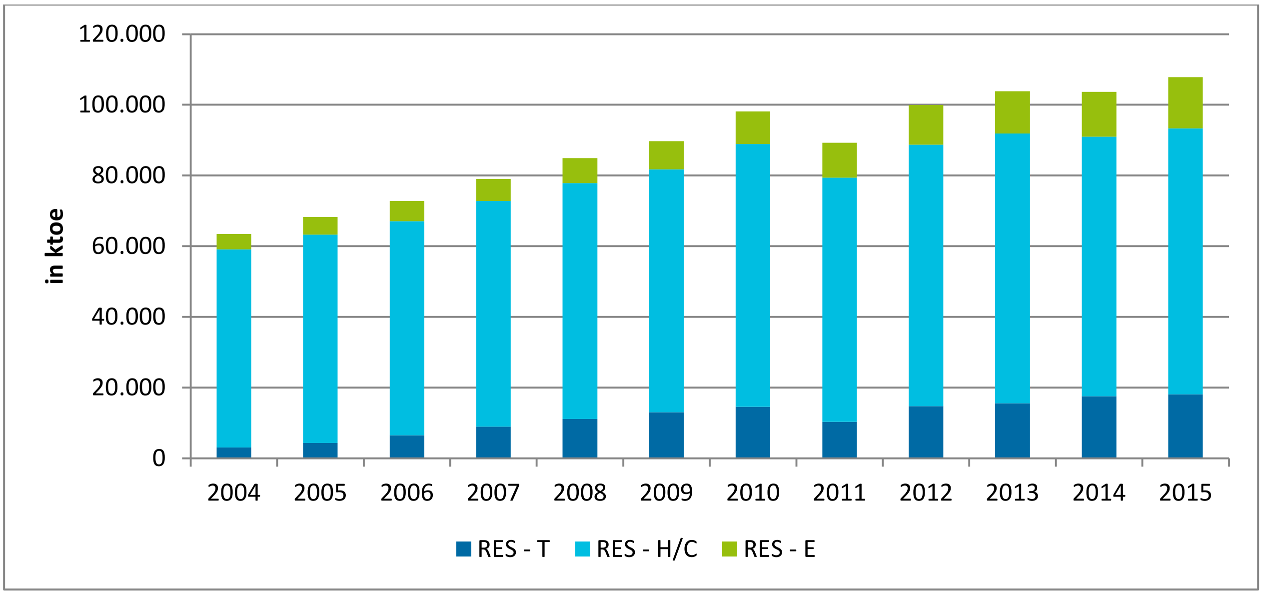
Trade balances vary across the individual Member States regarding international and intra-EU trade. The main importers of biodiesel are Spain, Germany, Italy and United Kingdom, for bioethanol it is Germany and United Kingdom. The EU is a net importer of bioethanol. In 2014 EU countries imported 1.3 Mtoe bioethanol of which 30 % originated from EU Member States, while 70 % originated from countries of the rest of the world. Also regarding biodiesel EU is a net importer. In 2014 5.8 Mtoe biodiesel were imported of which 51 % originated from EU Member States and 49 % from outside EU.

1.1.1. EU Bioenergy gross final energy consumption

The section presents a detailed database of EU bioenergy consumption at EU Member State level covering quantities, types and origin of biofuels and bioliquids, solid biomass and biogas consumed as well as data on the types and origin of their feedstocks. The progress includes the years 2013-2015 as far as data were available. The progress in availability of bioenergy made from waste, residues, non-food cellulosic and ligno-cellulosic material is also assessed.

Biomass energy use in EU Member States has been growing steadily, followed by a short decline in 2011 (Figure 1-2). Since 2011 the growth rate is considerably lower and biomass use stabilized. The main user of biomass for energy is the heating and cooling sector (70 %) (RES-H/C). 17 % of the biomass is used in the renewable transport sector (RES-T) and 13 % in renewable electricity sector (RES-E) in 2015.

Figure 1-2: Biomass – gross final energy consumption (in ktoe)



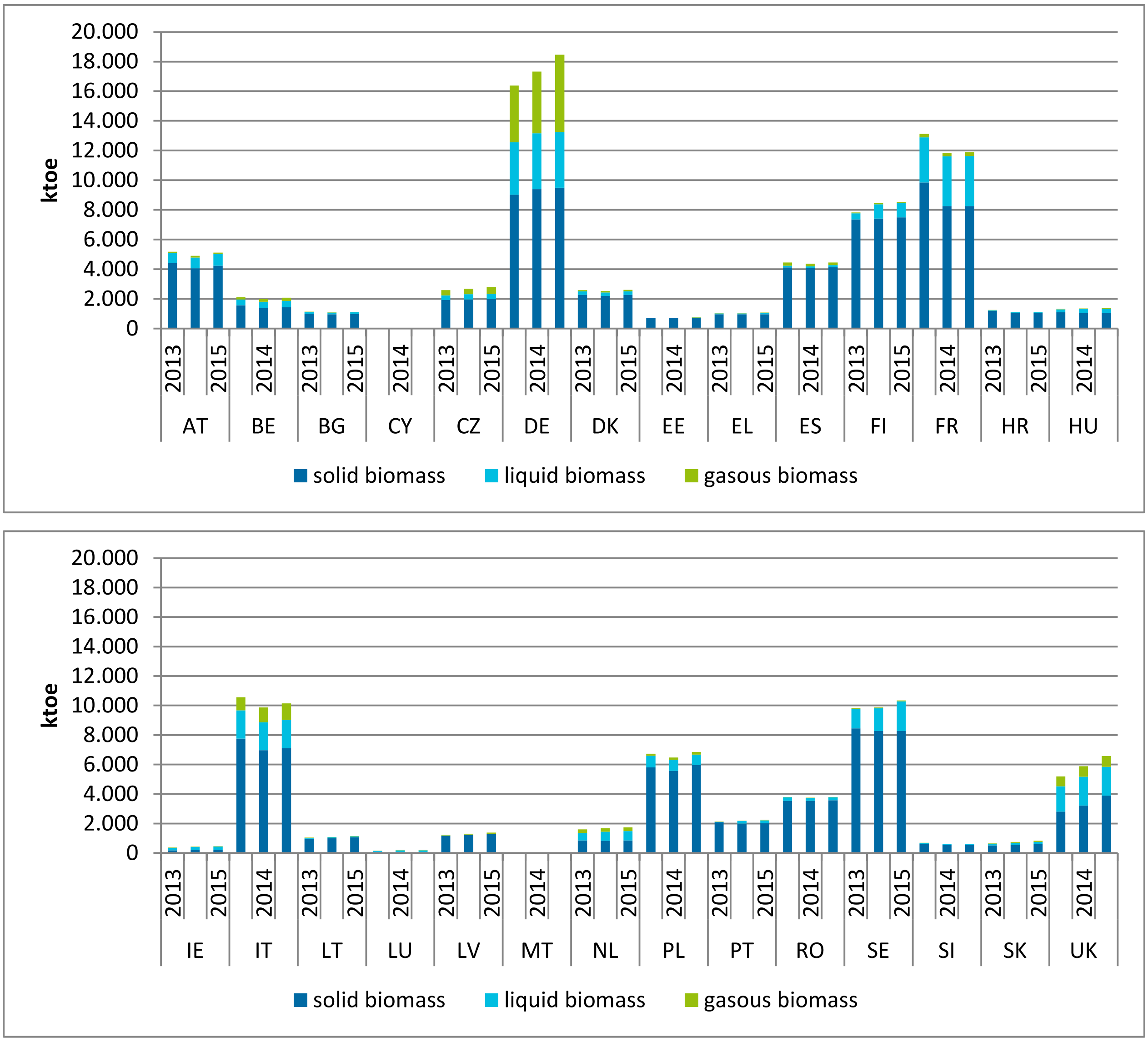
Source: [1]

Biomass energy includes three subcategories:

- solid biomass that includes all solid organic components like wood, wood waste, chips and particles, wood pellets, residues etc.;
- biogas that is produced through anaerobic fermentation from residues, waste or sewage sludge;
- biofuels or bioliquids like bioethanol or biodiesel that are produced from different types of biomass.

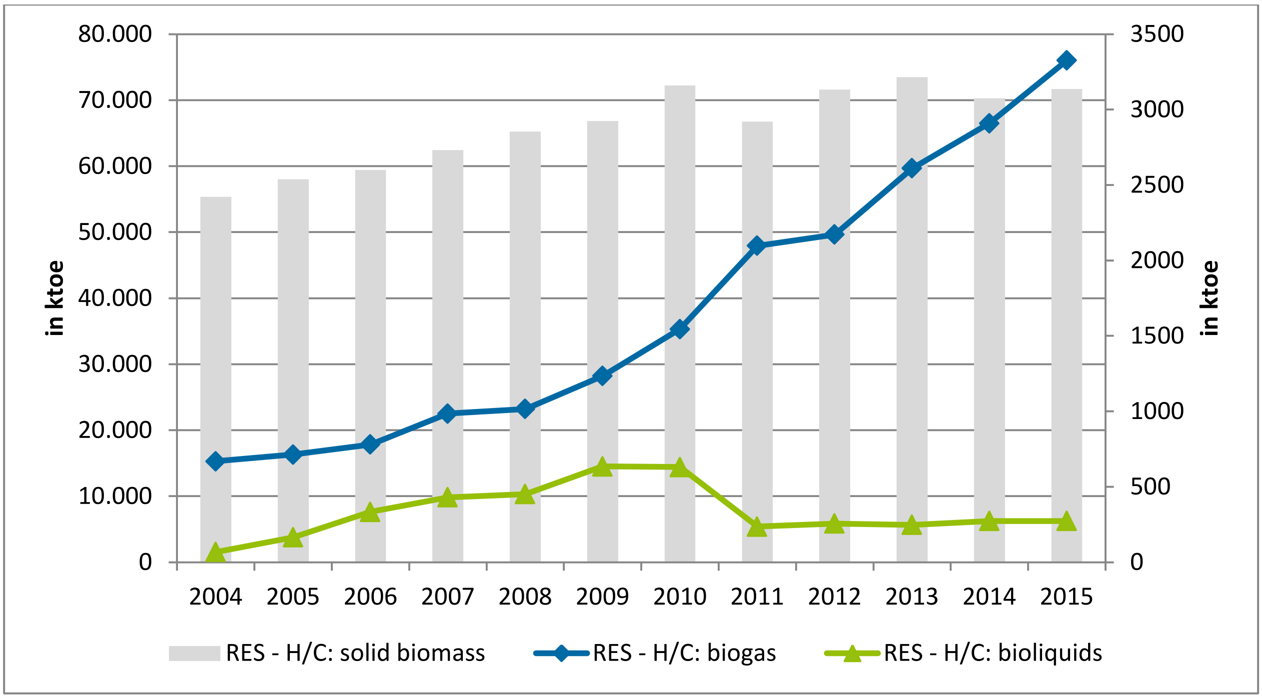
Within RES-H/C solid biomass still plays the most important role. The growth in bioenergy consumption in this sector, however, is mainly due to biogas rather than solid biomass (Figure 1-3) Germany is the Member State leading in biogas consumption within RES-H/C with a strong increase since 2008. 55% of the EU-28 biogas is produced in Germany. In Italy consumption peaked in 2011 and decreased sharply in 2012. Since then biogas consumption in Italy remains at a constant level. High biogas consumption can be found predominantly in those countries that have developed an industrial biogas sector (primarily Germany, Italy, Austria, and the Czech Republic) [30].

Figure 1-3: Biomass – gross final energy consumption by Member State and biomass type for 2013, 2014 and 2015 (in ktoe)



Source: [1]

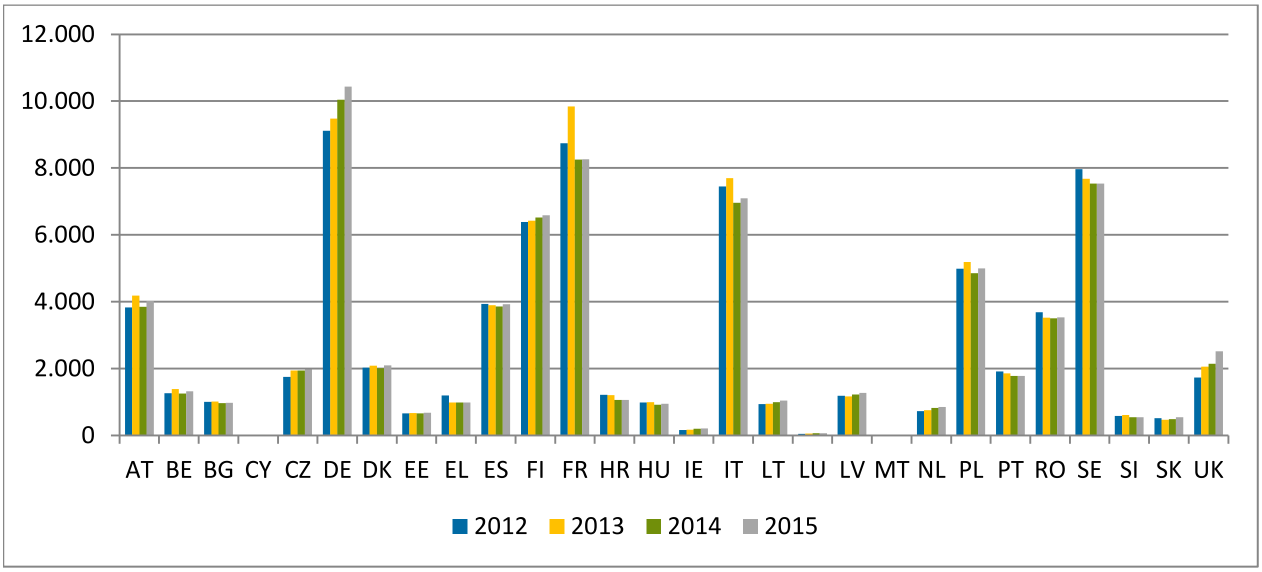
Figure 1-4: RES-H/C – final energy consumption



Source: [1]

The gross final energy consumption of all biomass categories in RES-H/C in EU increased by about 2% - from 73,485 ktoe in 2014 to 75,303 ktoe in 2015. The current share of liquid biomass amounts to 0.4%, gaseous biomass forms 4.4% and solid biomass 95.2%. The largest consumers of biomass among EU Member States are Germany, France, Italy, Finland and Sweden, closely followed by Austria, Spain and Poland (Figure 1-5).

Figure 1-5: RES H/C - gross final energy consumption of biomass (in ktoe)

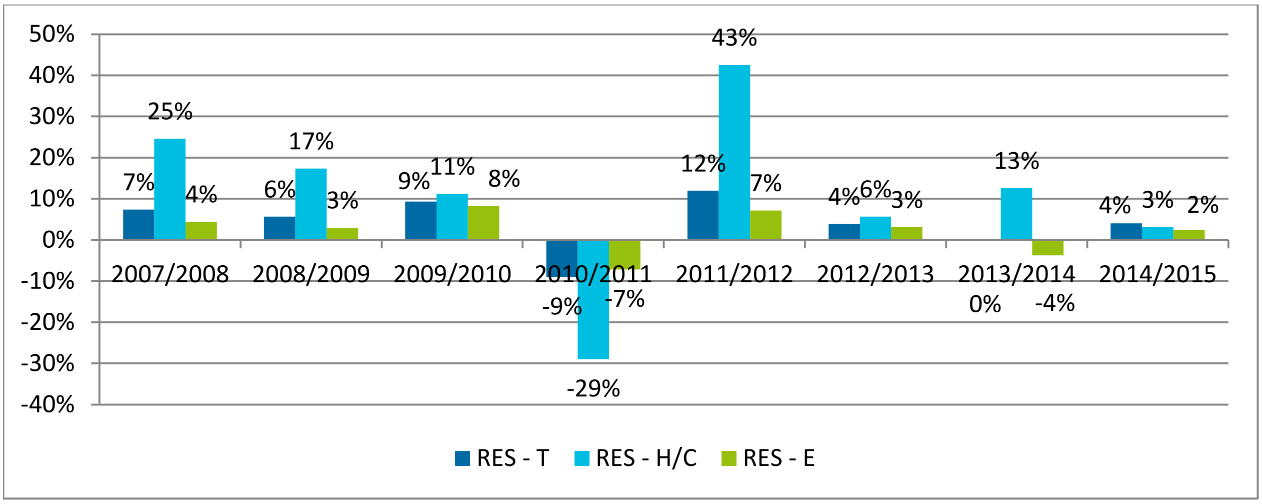


Source: [1]

The progress of biomass gross final energy consumption compared to the respective previous year is presented in the following figure (1-5) for RES H/C, RES T und RES E. Biomass is supposed to be the main contributor to renewable heating and cooling policies.

In 2010, this rise has slowed down and seems to stabilise since 2012, mostly because of the solid biomass market. The phenomenon is explained by mild winters and by efforts made in energy efficiency. The decrease mostly comes from the market of the heat directly consumed by end-users while the figures of biomass consumption for district heating did not plummet. Moreover, some countries such as France still have to establish their national strategy regarding forest management, prior to set the path of a strong policy regarding biomass consumption in H&C.

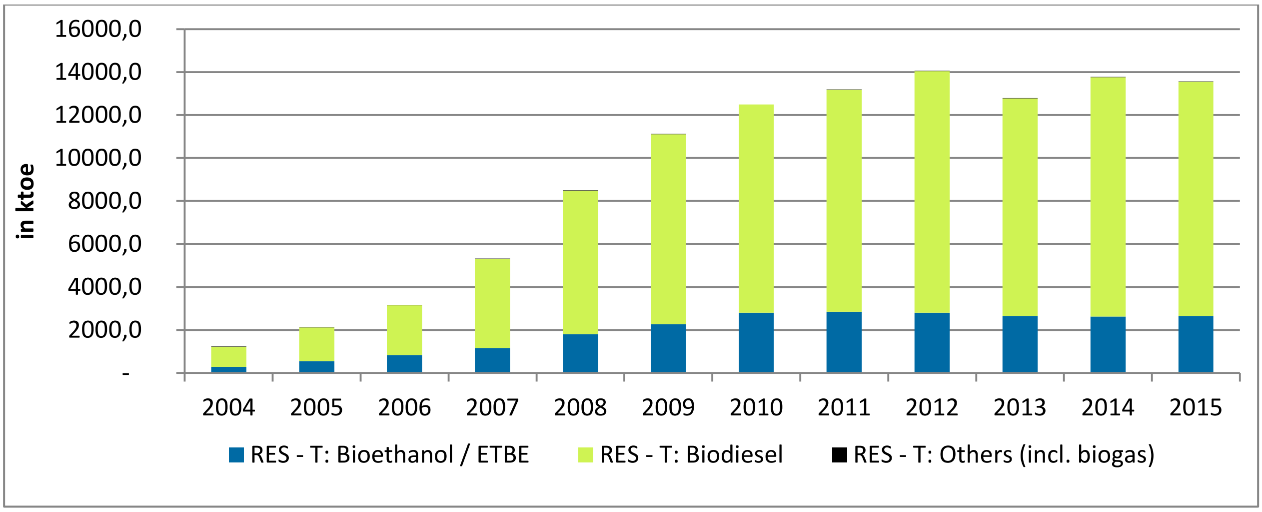
Figure 1-6: EU-28 biomass gross final energy consumption: progress compared to the respective previous year (in %)



Source: Authors' own calculation based on [1]

The following figure (Figure 1-7) presents the consumption in RES-T for the main categories of liquid biomass: biodiesel, bioethanol. Renewable electricity used in transport and hydrogen are presented in chapter 1.1.7.

Figure 1-7: RES T - gross final energy consumption (in ktoe)



Source: [1]

The transport sector is dominated by the use of biodiesel. Biodiesel is the main biofuel used for transport in the EU representing 79 % of total use of all biofuels in transport in 2015. 2013 shows a drop in biofuels consumption that can be linked to the European legislative context. In 2014 the consumption resumed its growth with a 9.5 % increase and the provisional estimations for 2015 show that this is likely to continue. The main consumers of biodiesel are France, Germany and Italy with over 1 Mtoe consumed each since 2009.

The bioethanol / ETBE share of all biofuels consumption was stable between 2010 and 2012, when it represented 20 % of all biofuels and then started to decrease in 2013 to reach 15 % in 2014. In absolute terms consumption of bioethanol has increased from 2010 to 2012 with total biofuels consumption and then decreased in 2013 and 2014. Main consumers in 2015 were Germany, the UK and France, followed by Spain, Sweden, Poland and the Netherlands.

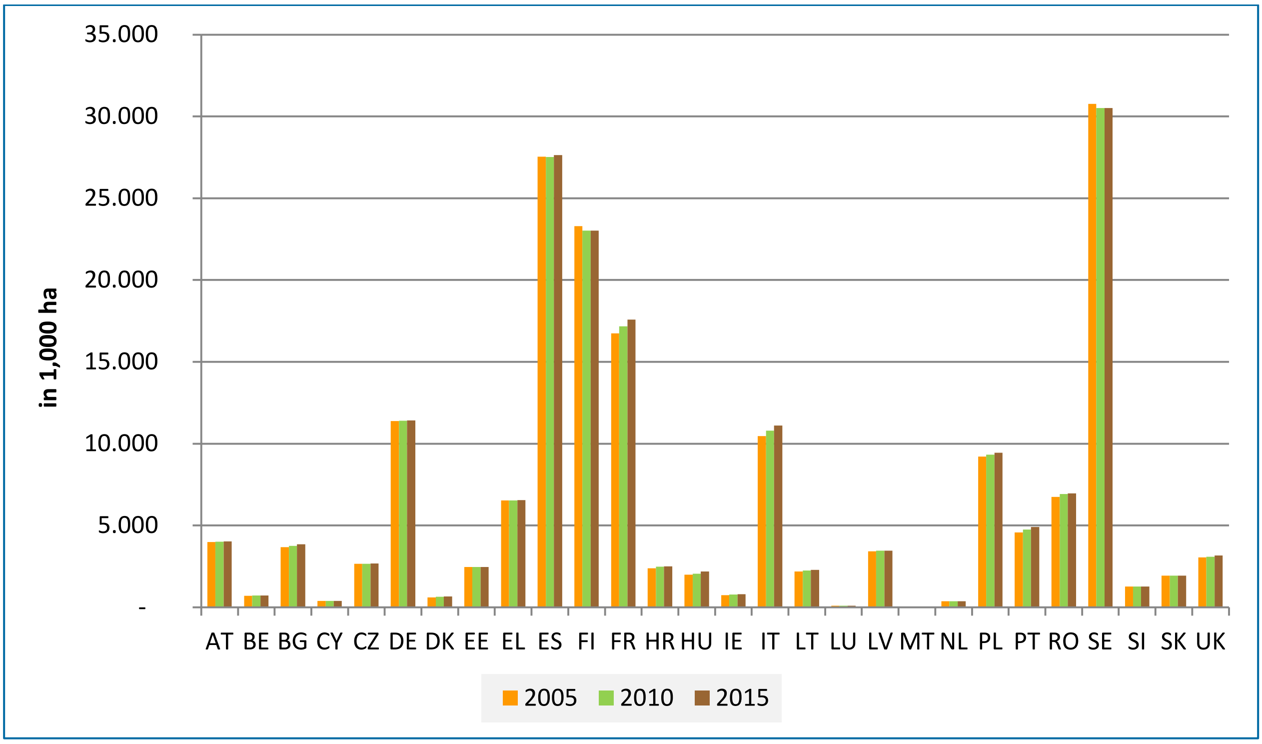
Both, biodiesel and bioethanol show distinctive increases for a specific time window (2005-2009), with a considerable reduction of growth rates after that period that reflects the tight legislative context, i.e. the revision of the EU RED.

1.1.2. Solid biomass

1.1.2.1. Production and consuption of solid biomass

The EU had approximately 181 million hectares of forests and other wooded land. This corresponds to 45 % of its land area [31]. The area covered by forest and other wooded land has increased by about 5 % since 1990 within EU-28.

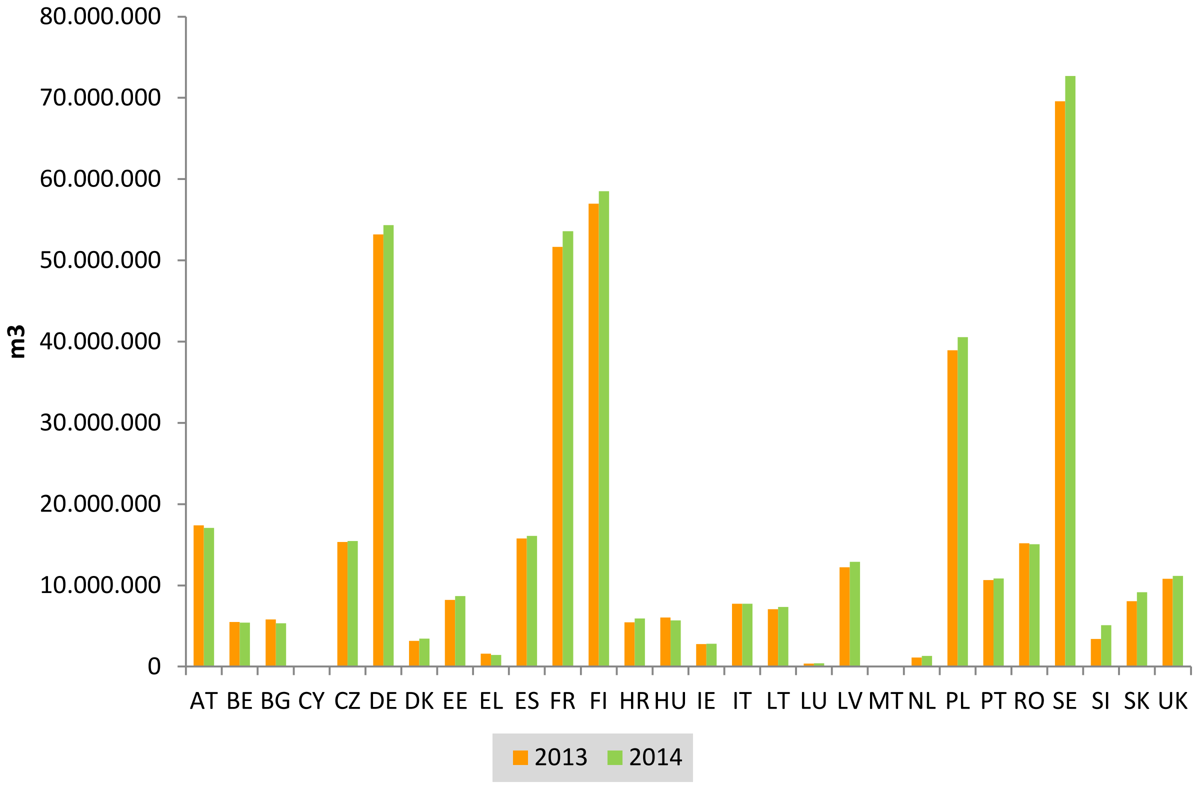
Figure 1-8: Total area of forests and other wooded land (in 1,000 ha)



Source: [127]

The EU in total produced 448 million m³ of wood in 2014. Around 23% was used as wood fuel, 42% as sawlogs and veneer logs, 31% as pulpwood and the rest as other industrial roundwood. Sweden produced the most roundwood in 2014 among all Member States. Between 2014 and 2015 roundwood production increased in almost all Member States (except for Austria, Bulgaria, Hungary, and Romania) (Figure 1-9) – of this a not further defined part is used as wood fuel.

Figure 1-9: Roundwood production (in m³)



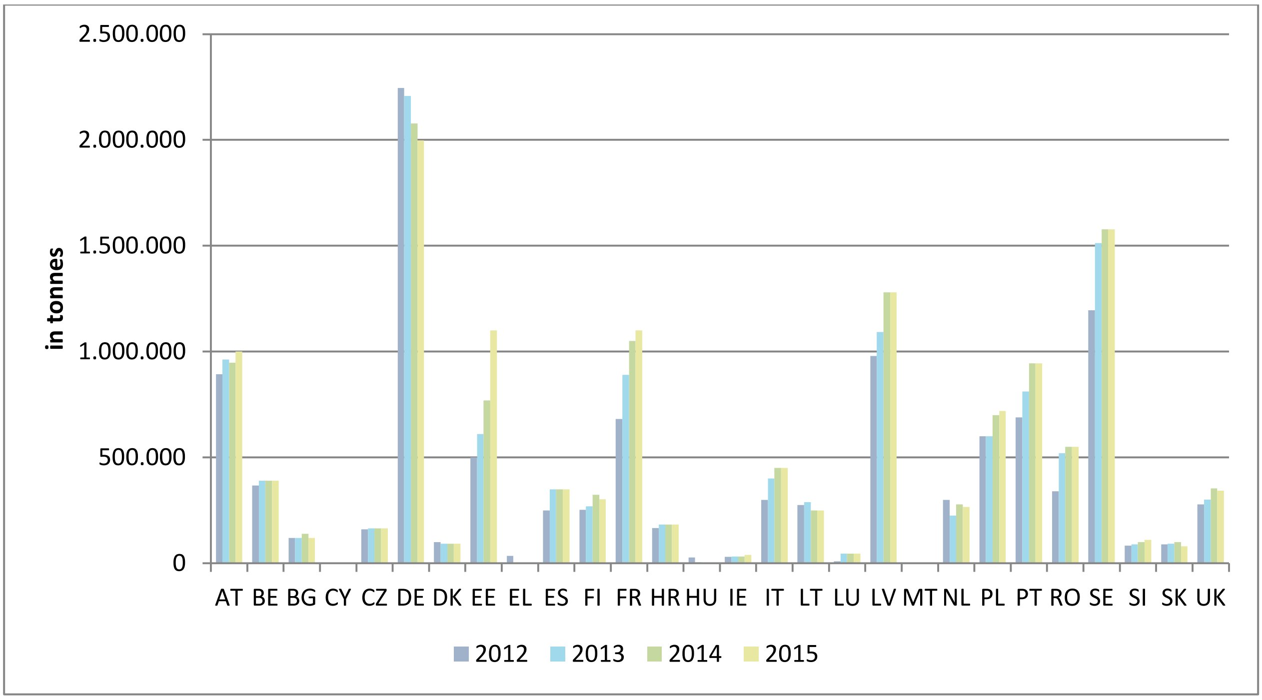
Source: [24]

About half of Europe's renewable energy consumption is wood [1, 2]. In some Member States such as Poland and Finland it is even more than half. Although consumption decreased in 2014 for solid biomass, its production decreased even more sharply, which means the rate of imports increased. These imports are mostly based on pellets even though the European Union remains the first pellet producer and consumer in the world, Italy being its largest consumer followed by Germany.

Germany is the largest wood pellet producer in the EU, followed by Sweden, Latvia and France. The production in Germany decreased between 2013 and 2014. In most other Member States, the production either increased or stagnated (Figure 1-10). On the production side the increase is lower (from 11 million tonnes in 2012 to 13,4 million tonnes in 2015) and stays since 2014 on the same level. But again, the EU is the worlds biggest producer of wood pellets, though compared to the production plants in North America, plants in the EU are mainly small or medium-sized [26]. Germany is the largest producer wood pellet producer followed by Sweden, Latvia and France (Figure 1-10). Depending on domestic use, Swedish self-sufficiency fluctuates between 70 and 90 percent. Sweden imports from Russia and the Baltic states in years of high demand [26]. France and Estonia expanded significantly their production since 2012. In case of France the growth is driven by an increase in the demand for collective residential heating and industrial power production [126].

The USDA [26] expect that EU wood pellet production will very likely not be able to keep up with the demand from both, the residential heating market and power generation.

Figure 1-10: Wood pellet production (in tonnes)



Source: [24]

The EU consumption of wood pellets has increased from 14 million tonnes in 2012 to 19.8 million tonnes in 2015. The EU is the world largest wood pellet market. About 65 % was used for heating and 35 % for power. Residential use for heating is relatively stable compared to industrial use for power generation. About 60 % of the pellet demand is for household use. Due to mild winters over the last three years and therefore the low prices for fossil fuel inputs, the use of pellets for residential heating has tempered [26]. The main wood pellet consumers in 2015 in the EU-28 are Germany, Denmark, Italy, Sweden, and UK (Figure 1-11). The energy content of the total consumption of wood pellets[1] within the EU-28 (19.8 million tonnes in 2015) is equivalent to approximately 15% of direct and indirect supply of wood biomass for heating and electricity (see Table 1-2).

The European pellet market is characterised by large heterogeneity. In addition, the consumption structure varies largely. While in some countries (e.g. Austria, Italy, France and Germany) wood pellets are used in small scale residential heating, they are mainly used for electricity production in other countries (e.g. the Netherlands). The use in residential heating is driven by subsidies and tax deductions. In Sweden and other countries, both uses developed simultanously. Also in France will the industrial use of pellets is expected to increase.

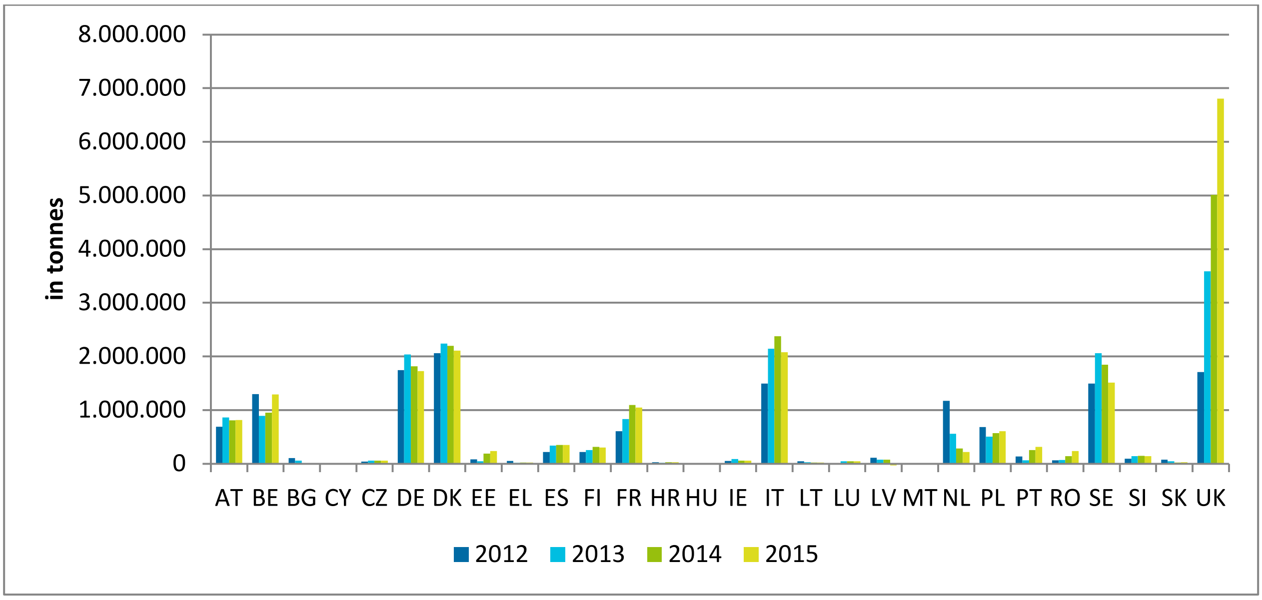
Instead, pellet demand in Member States like the United Kingdom, Belgium and the Netherlands are dominated by large scale power plants. As these countries lack a sufficient domestic production of wood pellets they largely dependent on imports [26].

[1] Lower heating value of wood pellets: 18 GJ/t = 0,406 toe/t

The availability of raw materials is largely depending on the competition with other industries. Wood pellets are traded internationally in significant amounts. With a further growing demand in EU dependence on sources outside EU will gain importance.

The USDA [26] expect that the future consumption of wood pellets in the EU will additionally depend on a range of market factors and in particular on Member States' incentives and conditions. The growing demand of EU wood pellets consumption is supported by increased investments in medium-sized combined heat and power plants. Also due to this fact, wood pellets will be traded more internationally.

Figure 1-11: Wood pellet consumption (in tonnes)



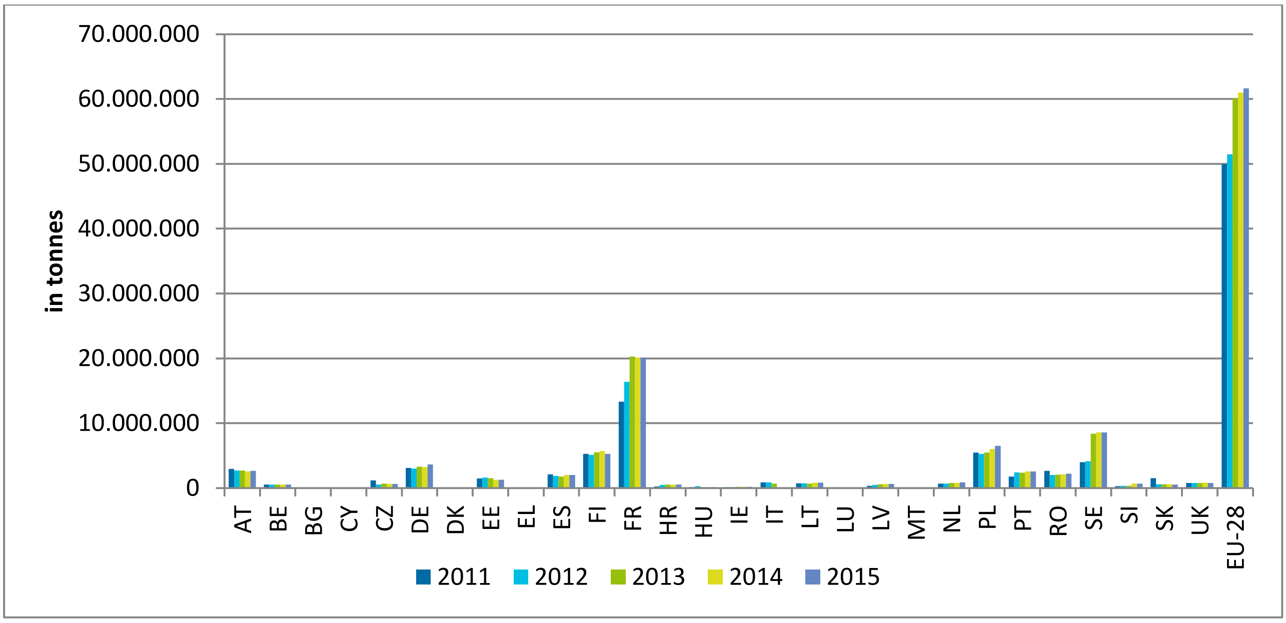
Source: [24]

The consumption of wood residues increased from 52 million tonnes in 2011 to 64.9 million tonnes in 2015. However, from 2014 to 2015 the consumption increased only by about 0.7 % (2013/2014: 0.5 %; 2012/2013: 8.6 %).

France is by far the largest producer of wood residues followed by Sweden, Poland and Finland (Figure 1-12). Especially France expanded its production significantly since 2011. Also the EU production increased steadily since 2011, with a large increase between 2012 and 2013, mainly due to production increases in France and Sweden.

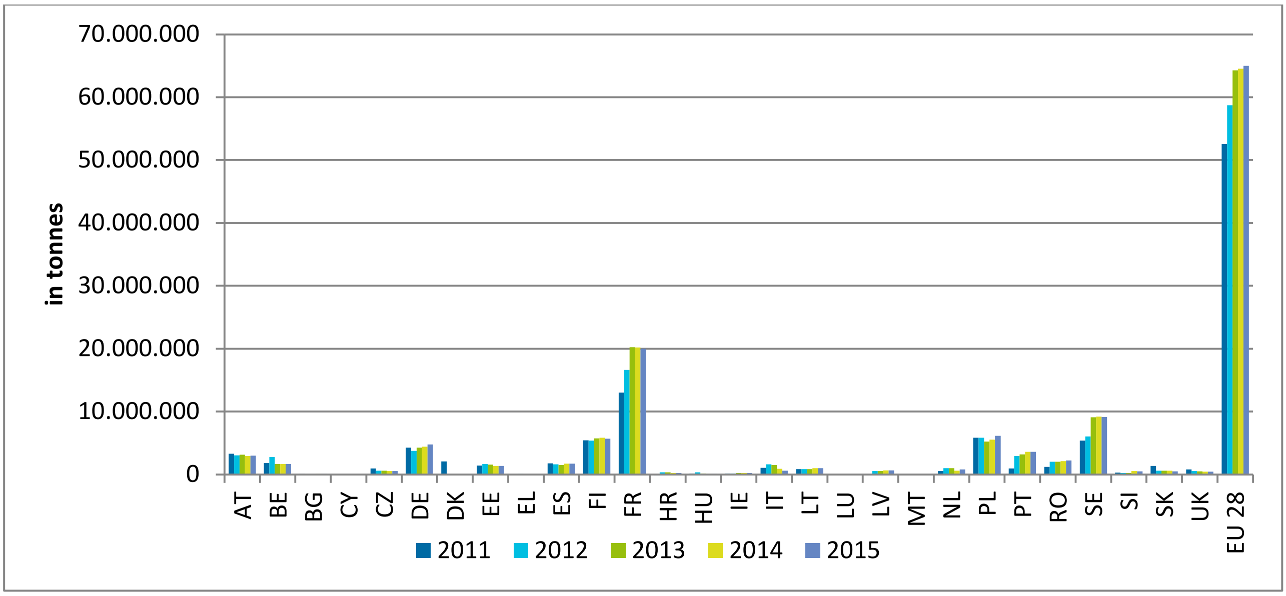
The amount of wood residues consumption is relatively similar to their production figure (Figure 1-13) indicating that wood residues are not traded between Member States. France, Sweden, Poland and Finland are the leading consumers and producers with an increasing trend since 2011, followed by Germany, Spain and Austria. In Sweden and France wood residues consumption and production slightly decreased between 2014 and 2015. Austria shows a decreasing trend since 2011.

Figure 1-12: Wood residues production (in tonnes)



Source: [32]

Figure 1-13: Wood residues consumption (in tonnes)



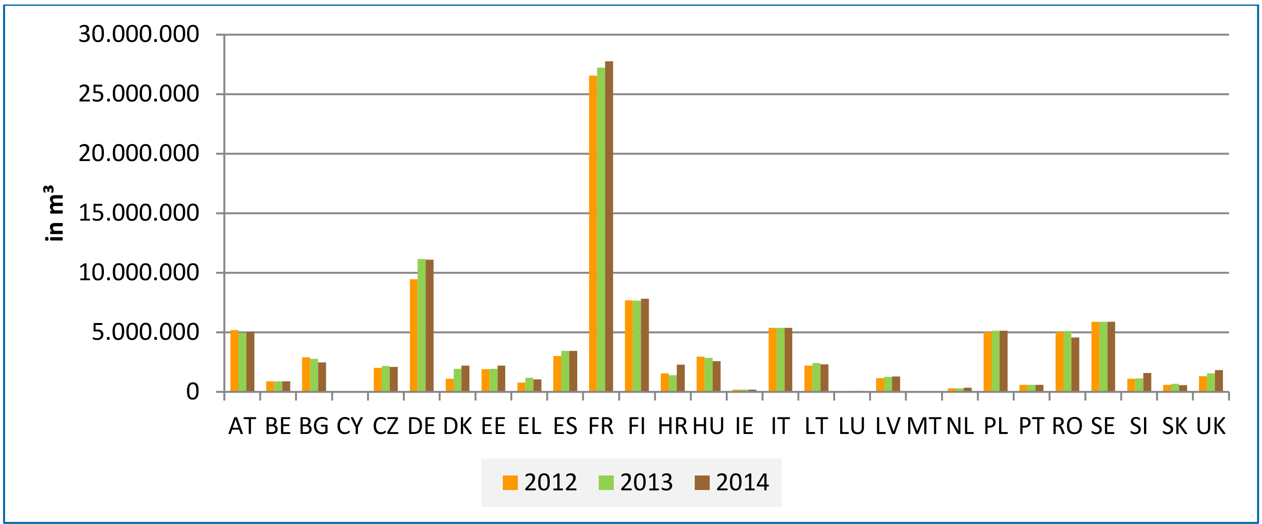
Source: [32]

Wood fuel production within EU-28 is steadily increasing. Wood fuel is defined as roundwood that is directly used as fuel for purposes such as cooking, heating or power production. The leading production countries within the EU-28 are France, Germany, Finland, Sweden, Italy and Austria.

The consumption of wood residues increased from 52 million tonnes in 2011 to 64.9 million tonnes in 2015. The largest producer are France, Sweden and Poland. According to BASIS 2015 project the overall wood chips consumption for Bioenergy production at the European level in 2013 ranged around 51 million of tonnes a year. As it could be expected regarding the installed number of appliances per Member State, the five main wood chips bioenergy producers are representing around 70% of the general consumption (BASIS 2015).

A summary of the Member States' Progress Reports biomass supply for heating and electricity of woody biomass (direct and indirect supply) development is presented in Table 1-2.

Figure 1-14: Wood fuel production (in m³)



Source: [32]

Table 1-2: Use of biomass resources for energy purposes (in ktoe)

	Primary energy in domestic raw material (ktoe)		Primary energy in amount of imported raw material from EU (ktoe)		Primary energy in amount of imported raw material from non-EU countries (ktoe)	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**
Biomass supply for heating and electricity						
Direct supply of wood biomass from forests and other wooded land energy generation (fellings, etc.)	26,443	24,304	1,235	1,182	92	185
Indirect supply of wood biomass (residues and co-products from wood industry, etc.)	28,803	26,801	2,492	2,273	1,498	1,534
Energy crops (grasses etc.) and short rotation trees (please specify)	863	861	0	1	3	3
Agricultural byproducts / processed residues and fishery by-products 1)	4,818	4,387	1,253	6,309	30	658
Biomass from waste (municipal, industrial, etc.)	30,384	34,890	57	94	71	123
Others, please specify	785	859	53	56	1	2
Sum	92,096	92,102	5,090	9,915	1,695	2,505
Supply of wood biomass	91%	91%	6%	6%	3%	3%

Source: [2]

Due to inconsistencies, a comparison between Member States is only possible at the primary energy level and not on the level of domestic materials. The reporting quality differs with respect to specification of sources and crops. Only a few Member States report in detail on biomass crops. Within the category “Others” Member States report biogas from very different sources such as animal and urban waste (Cyprus) and used cooking oil (Hungary).

In EU the direct supply of biomass from forests and other wooded land for energy generation decreased by about 8 %. The share of imported material was about 5 % from EU and 1 % from non-EU countries. In contrast to the imports of wood biomass from EU, the share of imports from outside EU increased from 92 ktoe to 185 ktoe. Member States with the highest supply of wood biomass in 2014 were Poland, France and Spain.

The indirect supply of wood biomass (residues and co-products from wood industry) decreased between 2013 and 2014 by about 7 %. The share of imported material was about 9 % from EU and 6 % from non-EU countries. Member States with the highest supply of wood biomass in 2014 were Sweden, France and Romania.

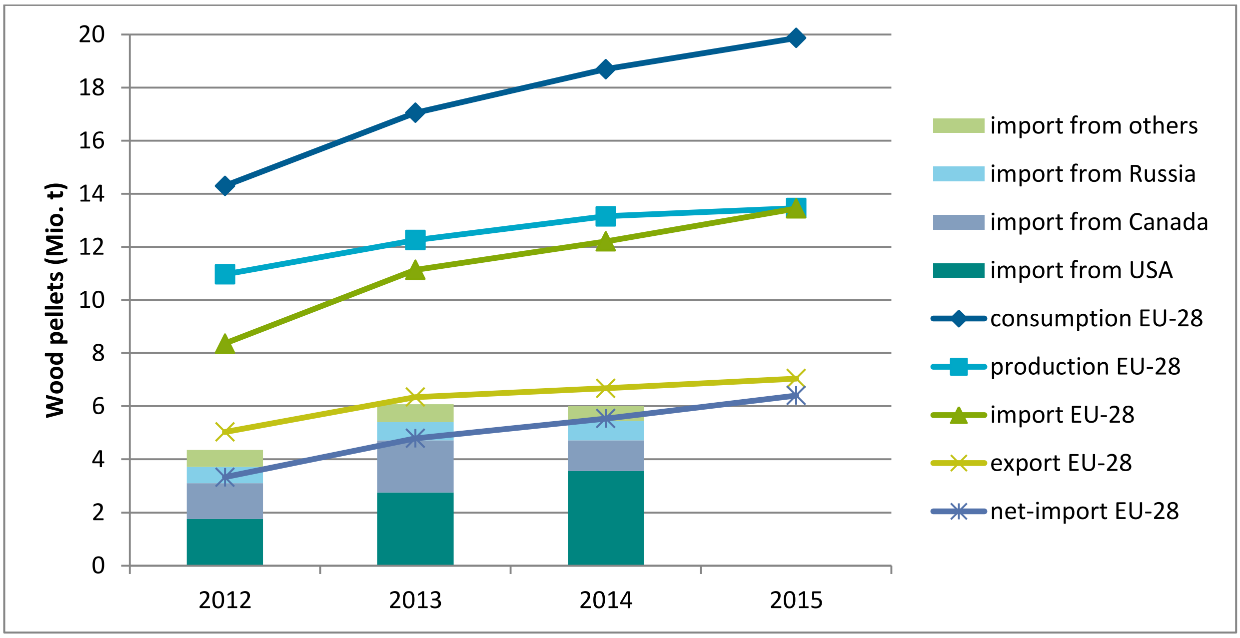
Regarding information on biomass to generate heat and electricity Germany has no up-to-date data for this reporting period. The last record available covers the reporting period 2011-2012. This also applies for the use of indirectly available wood biomass. Furthermore, Germany reported common arable crops for heat and electricity from farmland: biomass from farmland as use for biogas came predominantly from maize (52 % in 2014) and 48 % manure and other residues. The energy related contribution in 2013 and 2014 were 72 % maize silage, 11 % grass silage, 14% grain and whole cereal plant silage and 3 % beets. In the reporting period 2014/2015 85 %-90 % of the vegetable oil used as biomass for energy came from refined palm oil and the rest from rapeseed oil. Around 6.000 ha of fast growing wood were used as solid fuels in 2014/2015.

1.1.2.2. Trade of solid biomass

Wood pellets

The consumption and trade of biomass energy in the form of wood pellets has increased significantly since 2008. Wood pellets are increasingly being utilized at an industrial scale for electric power generation, combined heat and power in industrial and commercial applications (CHP), and in other medium and large -scale thermal uses. The increase in demand has been primarily driven by policies in the European Union (EU) to increase the use of renewable energy, for which wood pellets qualify. Because local sourcing of wood pellets is insufficient to meet demand in many countries, wood pellets have become an increasingly traded commodity. Approximately half the global trade of wood pellets takes place within and among EU members. Major external exporters to the EU include the United States, Canada, and Russia. Prospective markets for wood pellets are emerging as well in parts of Asia, most notably in Japan and South Korea [33].

Figure 1-15: Import and export of wood pellets, including main third countries, in relation to consumption and production in EU-28



Source: [32] and [33] for exporting countries

Most of the pellets have been combusted in residential heating (dominated by Italy, Germany and Austria), followed by district heating (Sweden and Denmark) and large scale power production (Belgium, Netherlands, UK) [29]. Latvia and Portugal produce mainly for export and use in large scale power plants abroad [26].

Countries where the pellet production is significantly higher than the domestic consumption (e.g. Estonia and Latvia) became pellet exporters to countries with a net pellet demand such as the UK or Denmark. A common characteristic of all pellet markets in Europe is the ongoing growth on the demand side.

The intra-EU trade is mainly from the Baltic States (Estonia, Latvia, Lithuania) and Finland to Denmark, Sweden and the UK.

The EU imports are mainly dominated by Russia, Canada and the USA (Table 1-3). North American trade is primarily destined for markets in the Netherlands, the UK and Belgium. The majority of Russian exports enter Sweden or Denmark [29].

The main countries for wood pellets within EU 28 are France (1.2 Mt), Germany (2 Mt), Latvia (1.2 Mt), Portugal (948.000 t) and Sweden (1.5 Mt). The main third countries of origin are Canada (1.9 Mt) and USA (6.9 Mt).

The UN Comtrade database reports as main trading partners for wood pellets the following countries: Belarus (9 %), Canada (9 %), Russian Federation (19 %), Ukraine (8 %), USA (28 %).

Table 1-3: Wood pellet export countries to the EU – main countries of origin (in Mio. Tonnes)

	2011	2012	2013	2014
USA	1	1.75	2.75	3.56
Canada	1.14	1.35	1.97	1.16
Russia	0.46	0.62	0.68	0.72
Bosnia	0.08	0.08	0.2	0.16
Ukraine	0.12	0.2	0.16	0.12
Belarus	0.1	0.12	0.1	0.12
Serbia	0.06	0.02	0.08	0
Others	0.14	0.21	0.14	0.16

Source: [33]

Roundwood and woodchips

Roundwood and wood chip trade is interlinked, since both end up in similar conversion facilities. [29] indicates that Germany, Denmark and Sweden are the leading importers of lower prices/quality roundwood for energy purposes, sourcing largely from the Baltic States. Wood chip trade is important to Sweden and Denmark from Russia and the Baltic States and to Italy from the Balkan. Sweden is the largest EU consumer of roundwood and wood chips for energy purposes.

In case of roundwood imports for energy purposes no extra-EU imports are known. In contrast, wood chips have been imported from Brazil and Africa (e.g. Liberia).

[29] summarizes that in contrast to wood pellets, roundwood and wood chips for energy purposes are transported only for shorter distances. Therefore, possible main third countries of origin do not play such an important role.

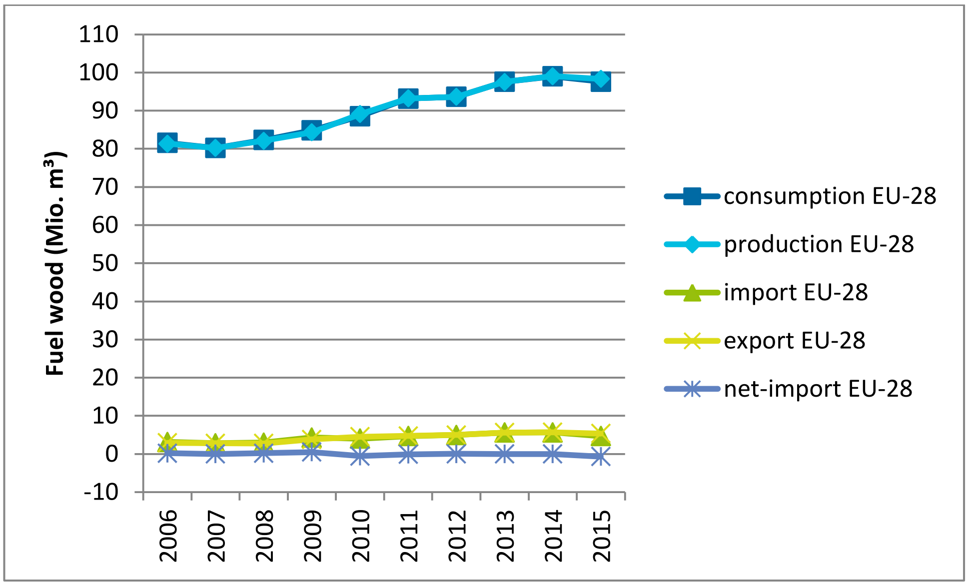
Fuelwood

Imports of fuelwood have increased since 2006 with a small decline from 2014 to 2015. The increase can partly be attributed to the EU enlargement during these years. Exports and imports have stagnated in the same period. Fuelwood imports are dominated by Italy in 2015 (1,078,073 m^3). This is similar to the past decade. Further main importers within EU-28 are Austria, Germany and Romania.

Italy is the Member State with the highest import quantities of fuelwood in the last decade, largely sourcing from the Balkan and its border states. Other Member States like Germany or Sweden import mostly from Latvia or neighbouring countries. Belgium imports mostly from France.

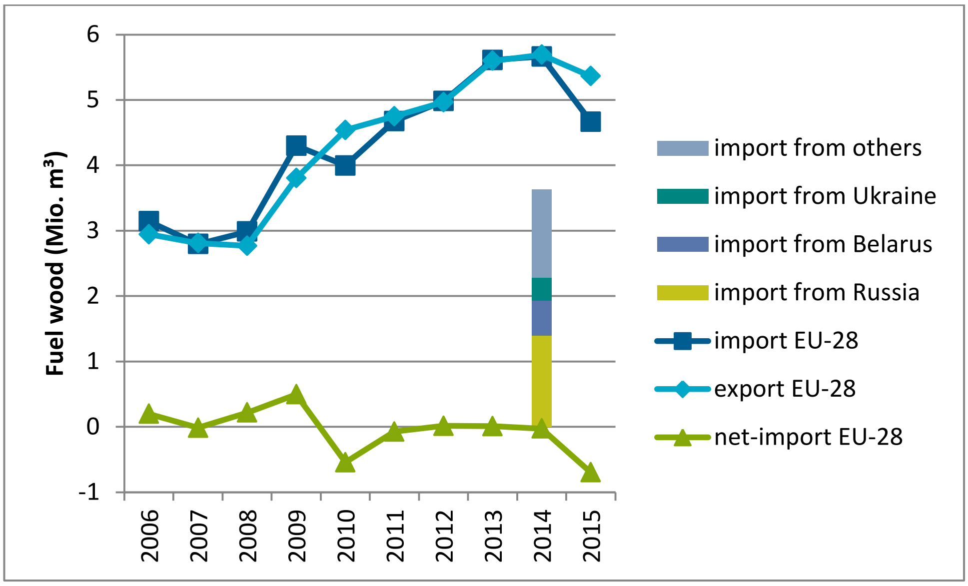
[29] describes that the EU fuelwood trade shows signs of re-exports and/or a switch of local fuelwood with cheaper imports allowing exports to higher price markets, e.g. Hungary and Slovenia. The majority of EU fuelwood trade is for residential heating. Wood industry sources have also been imported from Russia. Further import countries to the EU-28 are Ukraine and Belarus.

Figure 1-16: Import and export of fuel wood in relation to consumption and production in EU-28



Source: [32]

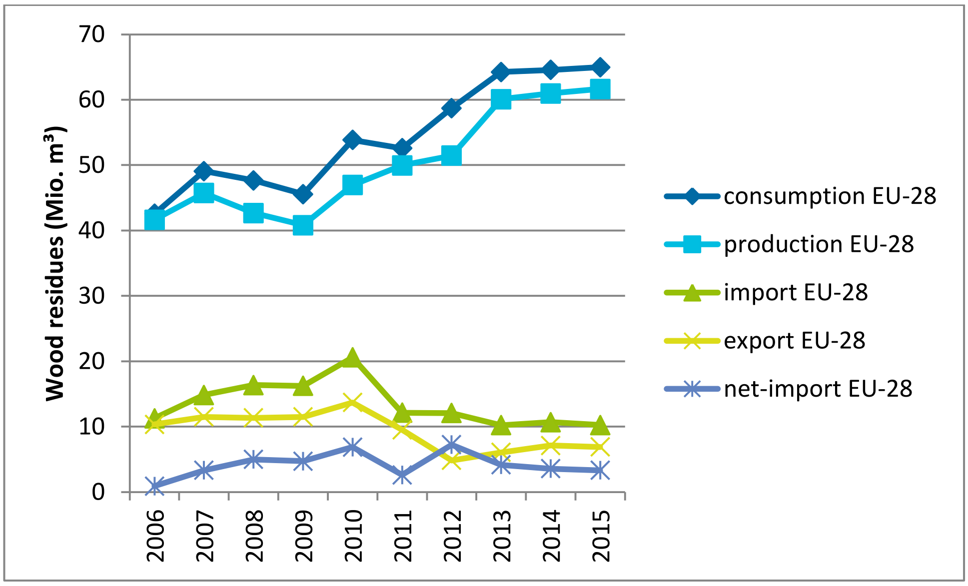
Figure 1-17: Import and export of fuel wood, including main third countries



Source: [32]

Within EU-28, France (27 Mm³) and Sweden (27 Mm³) are the main countries of origin for wood residues. Brazil (17 Mm³), Canada (8.7 Mm³), China (83 Mm³), Japan (6.9 Mm³), Russian Federation (7 Mm³) and USA (7 Mm³).

Figure 1-18: Import and export of wood residues in relation to consumption and production in EU-28



Source: [32]

1.1.3. Gaseous biomass

The development of the biogas industry in individual European countries is in direct correlation with the government's support policies in the given country. The biogas technology is relatively mature, safe and in most cases relatively efficient, but the precondition for a successful biogas investment is the professional approach to engineering, construction and operation. The main challenges for the biogas industry are the competitiveness with other renewable energy sources due to high unit costs for electricity generation, a limited raw material base and the monetization of the digestate [34]. It is expected that biogas will lose some of its impetus in those countries where policies controlling the sector expansion have changed and the future use of energy crops will be regulated [30].

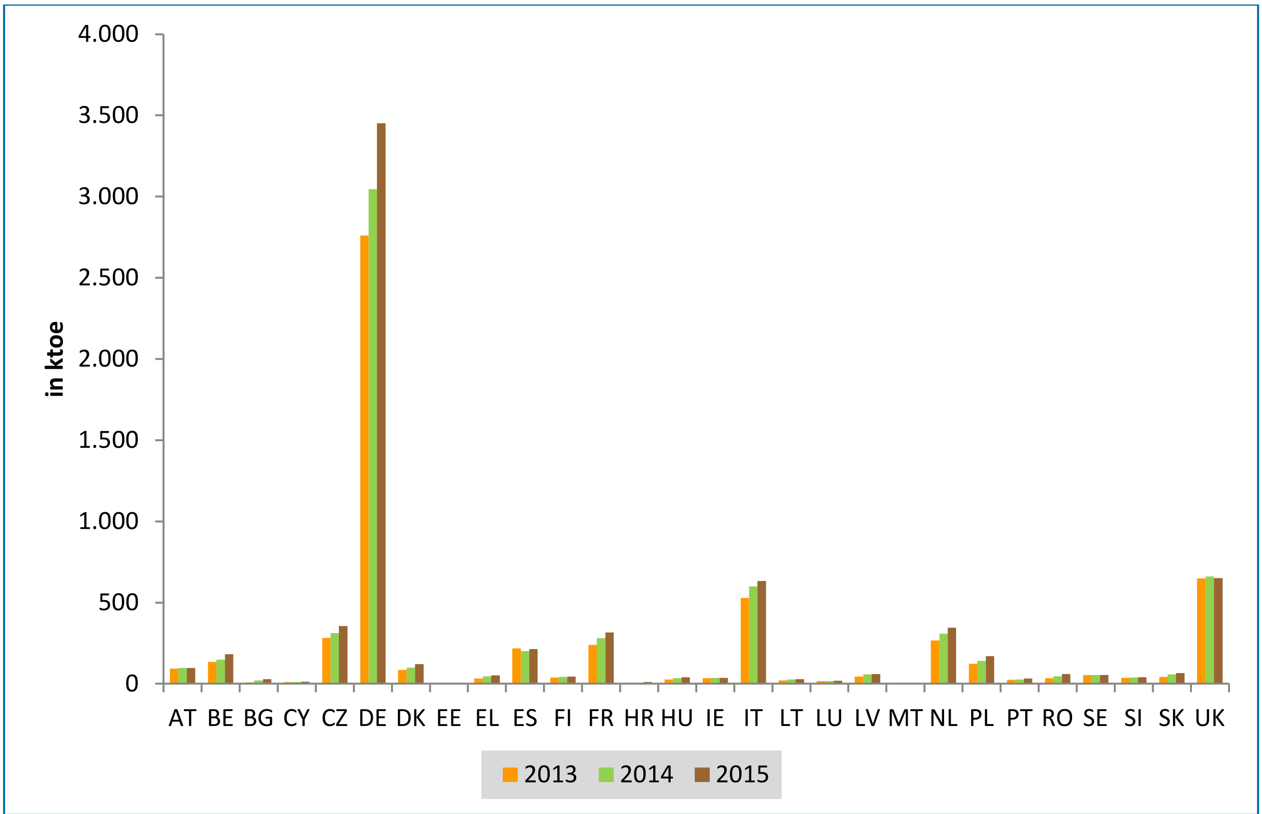
In [34] the authors describe the key future roles for the biogas industry in Europe as follows:

- A contribution to and marketing as a need-based electricity production to provide:
  - balancing power (combined power plants)
  - system services: frequency stability, voltage maintenance, supply restoration, bottleneck management, etc.
- An important role for achieving GHG emission reduction potentials in agriculture through
  - the treatment of manure, waste and by-products;
  - nutrient recycling and local energy supplies.
- A means for efficient management of industrial and municipal organic wastes
- An option for the utilization of set-aside land and landscape maintenance residues
- The production of biomethane for grid injection and transport use

In order to realize the growth potential, the biogas industry needs to respond by intensifying its efforts aimed at further increasing efficiency and flexibility, reducing investment and operational costs, establishing cooperation/partnership with the natural gas industry and improving public acceptance [34].

While the share of biogas in heating and cooling was negligible in 2004 (0.7 Mtoe or 0.1 %), in 2014, 2.9 Mtoe (0.6 %) of heat was produced from biogas. For electricity the share rose from 0.7 Mtoe (0.4%) in 2014 to 5.0 Mtoe (1.8%) in 2014. In contrast, until today biogas does not play a prominent role in the transport sector on EU-28 level (0.1 Mtoe or 0.04% in 2014 – with others. The gross final energy consumption of gaseous biomass used in the HC-sector in EU-28 increased by about 13 % compared to the previous year. The main consumers within the EU-28 are Germany, the UK and Italy. Especially Germany shows a high increase in 2015 compared to the previous year that is of a similar order of magnitude as from 2013 to 2014 (Figure 1-19).

Figure 1-19: Gross final energy consumption gaseous biomass – HC (in ktoe)



Source: [127]

According to 2015 Germany and the United Kingdom represent the two largest biogas producer in the EU. Germany generates the predominant share of its biogas from fermentation of agricultural crops and crop residues (79 % in 2014) while the United Kingdom, Greece, Estonia, Ireland and Portugal rely almost entirely on landfill and sewage sludge gas. All other Member States use a variety of feedstock combinations [26].

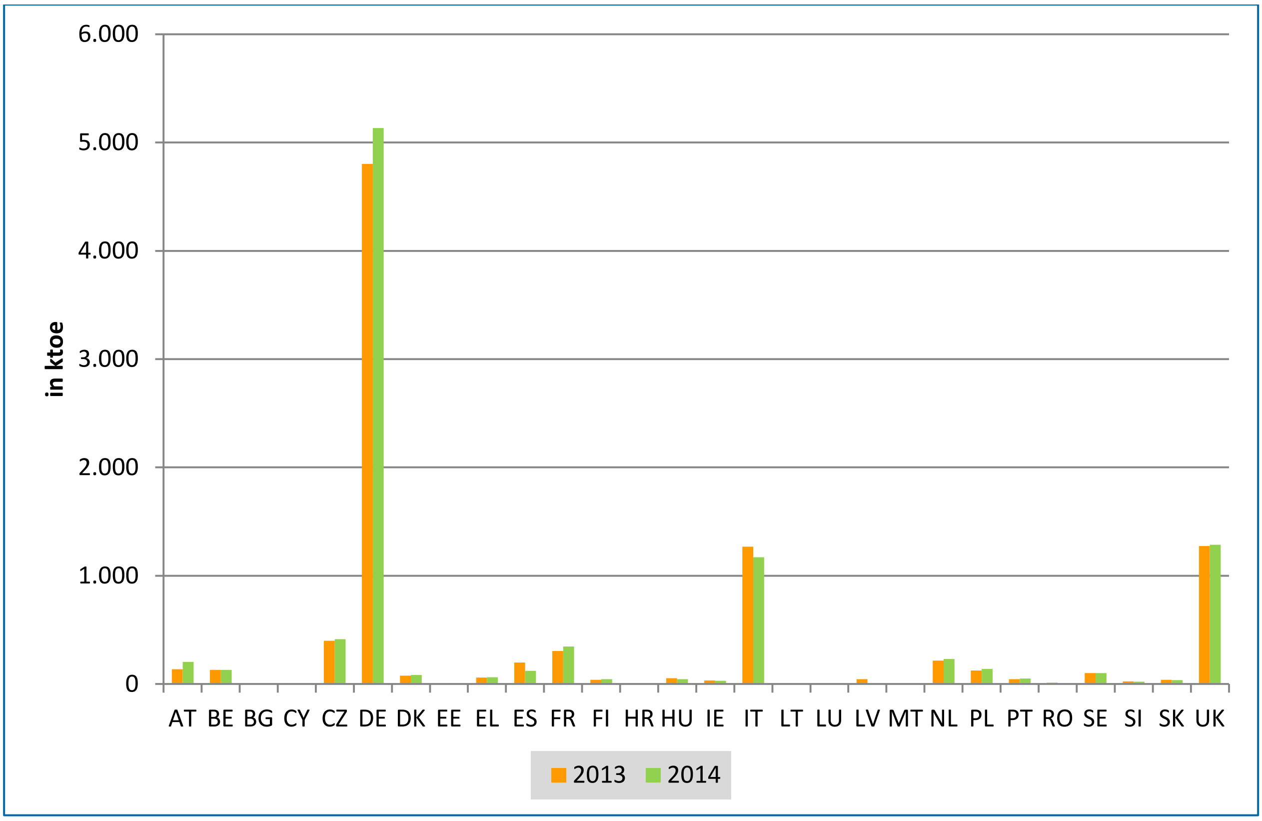
Germany uses as common renewable raw material for fermentation 52 % maize, 48 % manure and other residues. The energy related contribution consists of 72 % maize silage, 11 % grass silage, 14 % grain and whole cereal plant silage and 3 % beets. Germany is the only Member State that reported this detail on crop use for biogas. The high use rate of biogas is due to the fact that farmers in Germany get a guaranteed feed-in price for the generated electricity, which is considerably higher than that of electricity generated from fossil fuels, natural gas or other sources. Nevertheless, changes in the German Renewable Energy Law reduced the attractiveness of investing into biogas production in 2012 and 2014. This results in a reduced increase of biogas plants. The focus switches to investments into expansion or renovation of existing plants [26].

A few Member States, like Czech Republic, Denmark, France, Italy and Netherlands have an increasing biogas production. In Czech Republic the increase is driven by feed-in tariffs. In Denmark the increase is driven by the goal to use 50 % of livestock manure for biogas production by 2020. In France public aid mechanisms comprise the heat fund, feed-in tariffs and regulations, and the creation of a feed-in tariff for biomethane injection into natural gas grids [30].

However, the sector confirmed the loss of impetus sparked by the biogas policy changes of the European Union's two main producer countries, Germany and Italy [30]. For many years, “other biogas” has dominated the distribution of the EU's primary biogas energy output. EurObserv'ER estimates its share at 69 % of EU output in 2013, a long way ahead of landfill biogas at 21.6 %, and wastewater treatment biogas at 9.4 %. Yet, this “other biogas” category does not universally hold the largest share across Member States. It tends to predominate in those countries that have developed an industrial methanisation sector, primarily Germany, Italy, Austria, and the Czech Republic. Landfill biogas can also play a role (as in UK, France, Spain, Portugal, and Ireland) while wastewater treatment biogas seldom prevails (Sweden and Poland) [30].

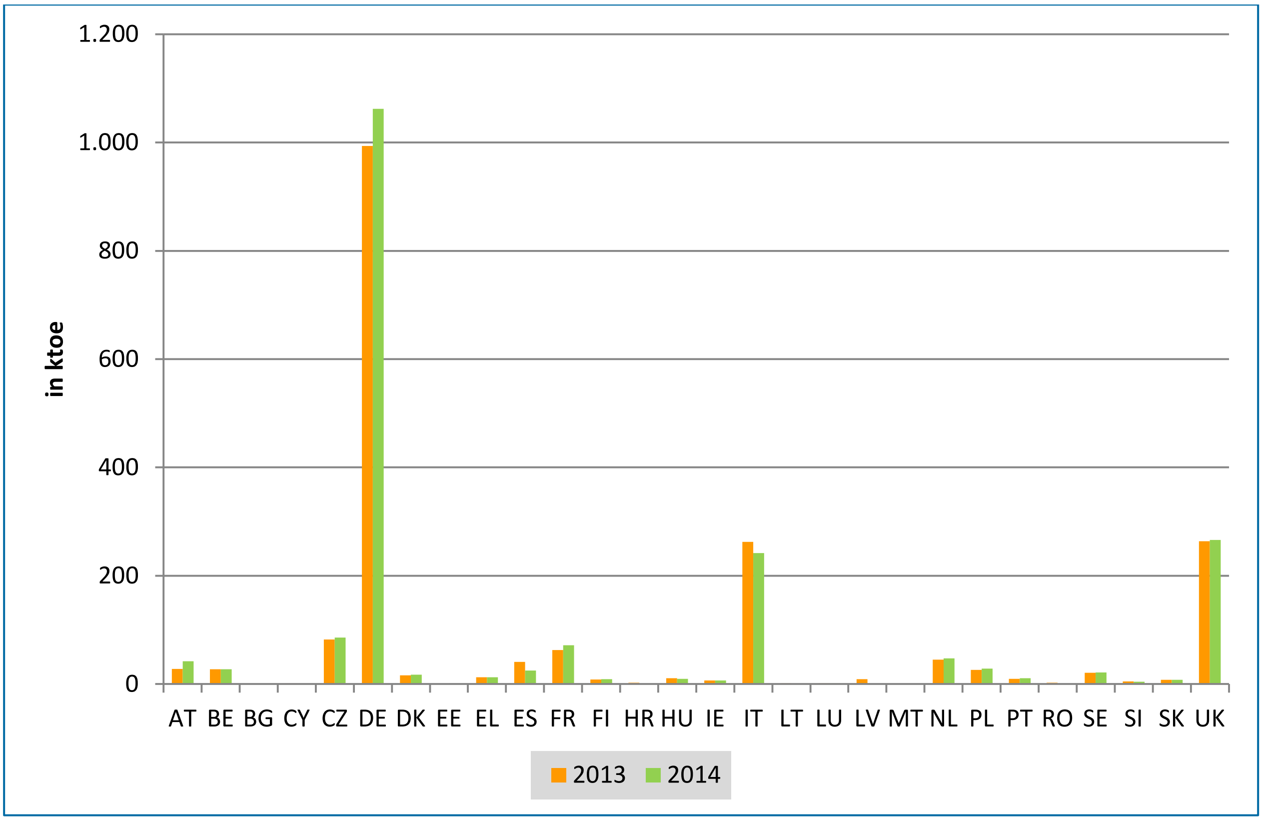
The majority of biogas is used to generate electricity and/or heat. A future trend is co-generation, e.g. in Germany, Netherlands, Austria, Czech Republic, and Poland.

Figure 1-20: Biogas production - anaerobic fermentation of biomass (in ktoe)



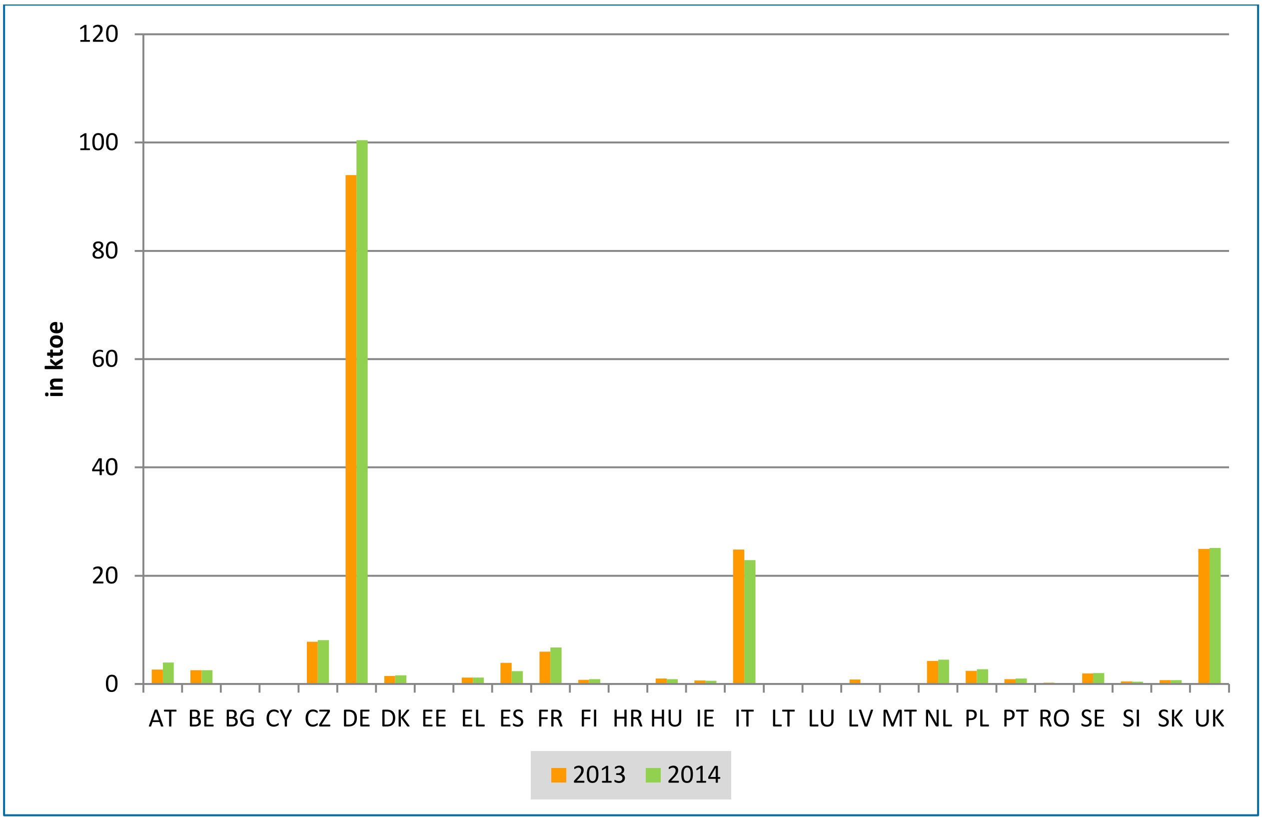
Source: [28] with authors' own calculation based on [35]

Figure 1-21: Biogas production - landfill (in ktoe)



Source: [28] with authors' own calculation based on [35]

Figure 1-22: Biogas production – sewage sludge (in ktoe)



Source: [28] with authors' own calculation based on [35]

Biomethane production is primarily gaining popularity in EU Member States, because it enables them to reduce their reliance on natural gas imports. The countries most involved in biomethane production are Germany (151 plants), Sweden (53 plants), the Netherlands (23 plants), Austria (10 plants), Finland (6 plants) and the small country Luxembourg (3 plants). More recently the UK (4 plants), France (3 plants), Italy (2 plants), Denmark (1 plant), Hungary (1 plant) and Croatia (1 plant) have become involved and offer considerable development potential [30].

EURObservER [30] summarizes that in order to recover, the biogas sector requires fast decisions about the environmental requirement levels for biogas and biomethane production with regard to GHG emissions, so that they can be included in the European renewable energy target calculations. Thus the future development of the biogas sector is essentially a political issue.

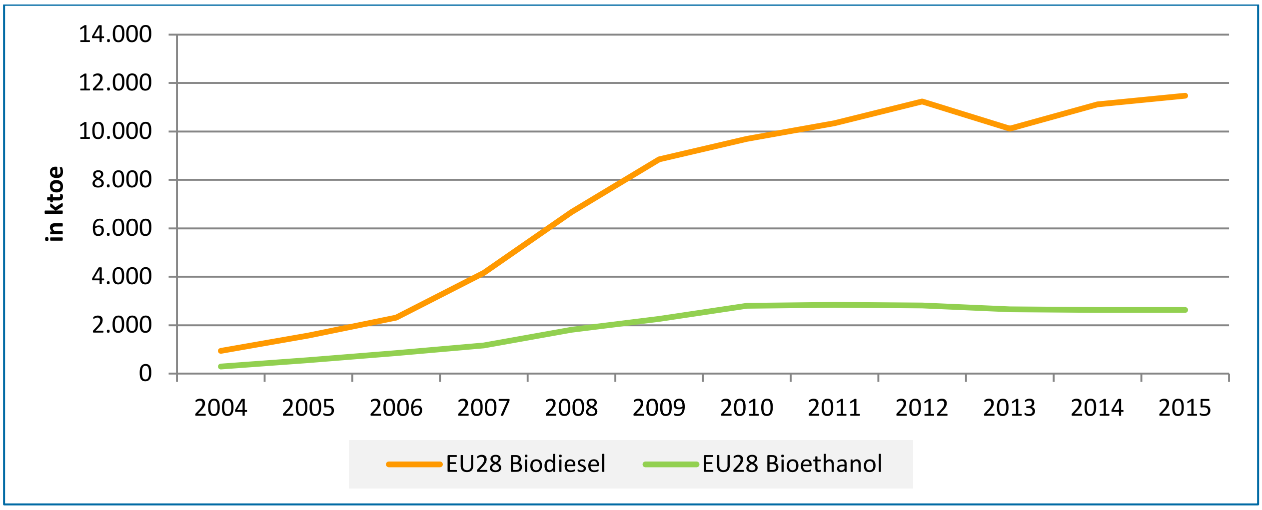
1.1.4. Biofuels and bioliquids

The consumption of liquid biomass within the EU-28 HC sector amounted to 273 ktoe in 2015. Only a few Member States (Austria, Belgium, Germany, Denmark, Finland, Italy Netherlands, Portugal and Sweden) consume liquid biomass in the HC sector.

The consumption of biofuels in the transport sector increased by about 2 % in 2015 compared to the previous year. The consumption of bioethanol in the EU stagnated in recent years. Biodiesel consumption has increased since 2013 and has since returned to the same level as in 2012. (Figure 1-23) shows the consumption of biodiesel within the Member States. France, Germany, Italy and Sweden were the largest consumers in 2015. Except Sweden, the consumption of biodiesel stagnated within the Member States. Sweden shows a relative difference to 2014 of about 36 %.

The leading Member States in terms of bioethanol consumption are Germany, France and the UK. The consumption stagnated in 2014/2015 in all of these countries.

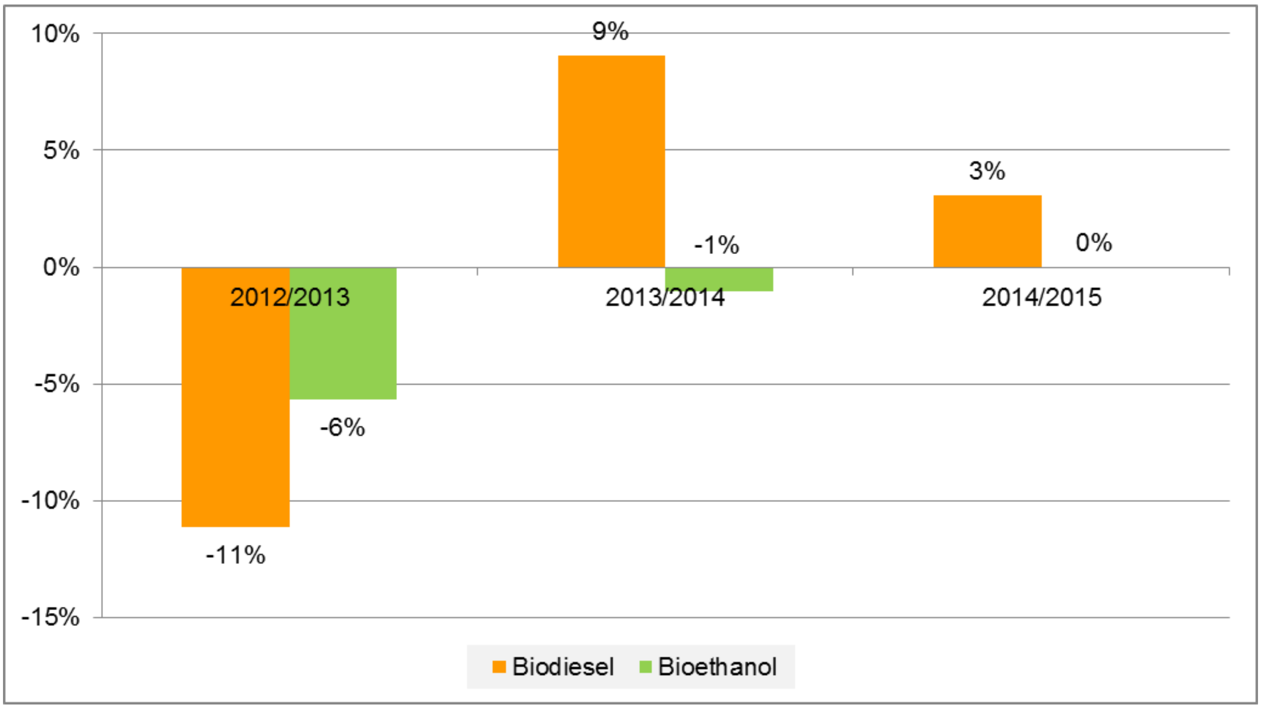
Figure 1-23: EU 28 gross final energy consumption of biodiesel and bioethanol (in ktoe)



Source: [127]

Compared to the previous year biodiesel consumption increased in the reporting period about 3 %. The consumption of bioethanol decreases since 2012 and stayed in the reporting period on the same level as last year (Figure 1-24).

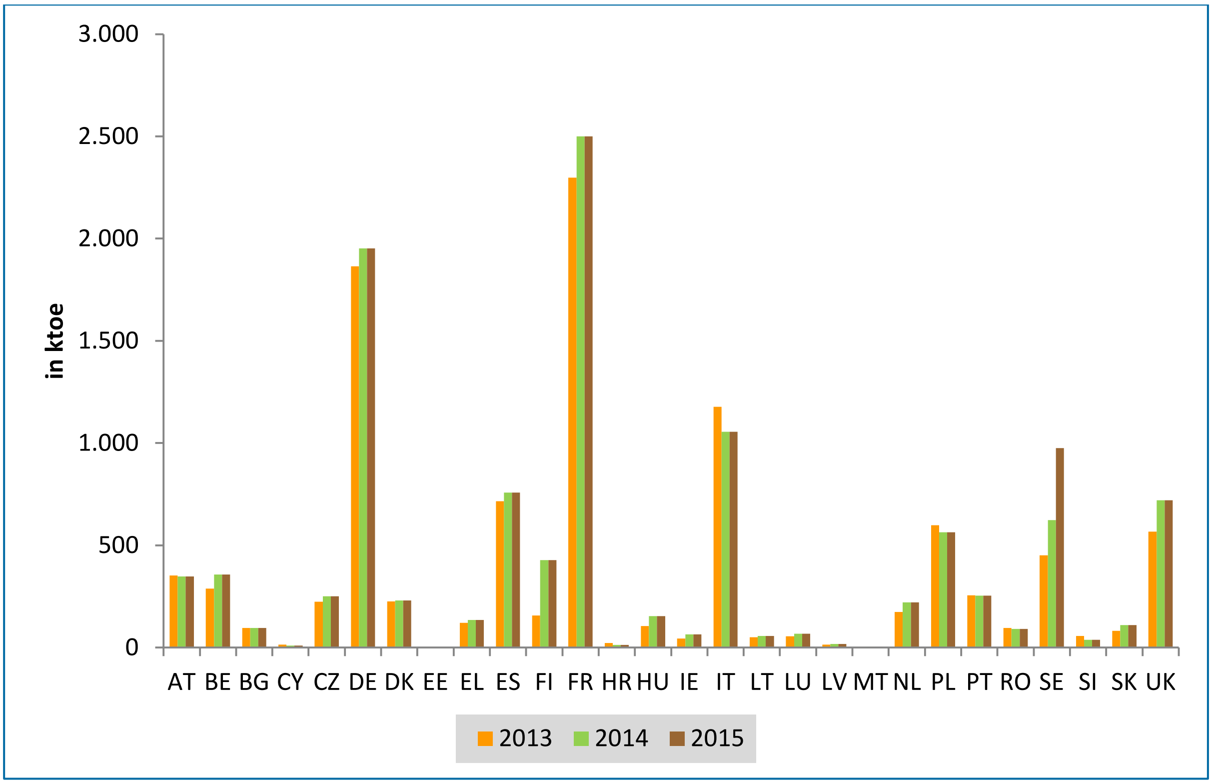
Figure 1-24: Bioethanol/biodiesel: progress compared to the previous year (EU 28)



Source: own calculation based on [127]

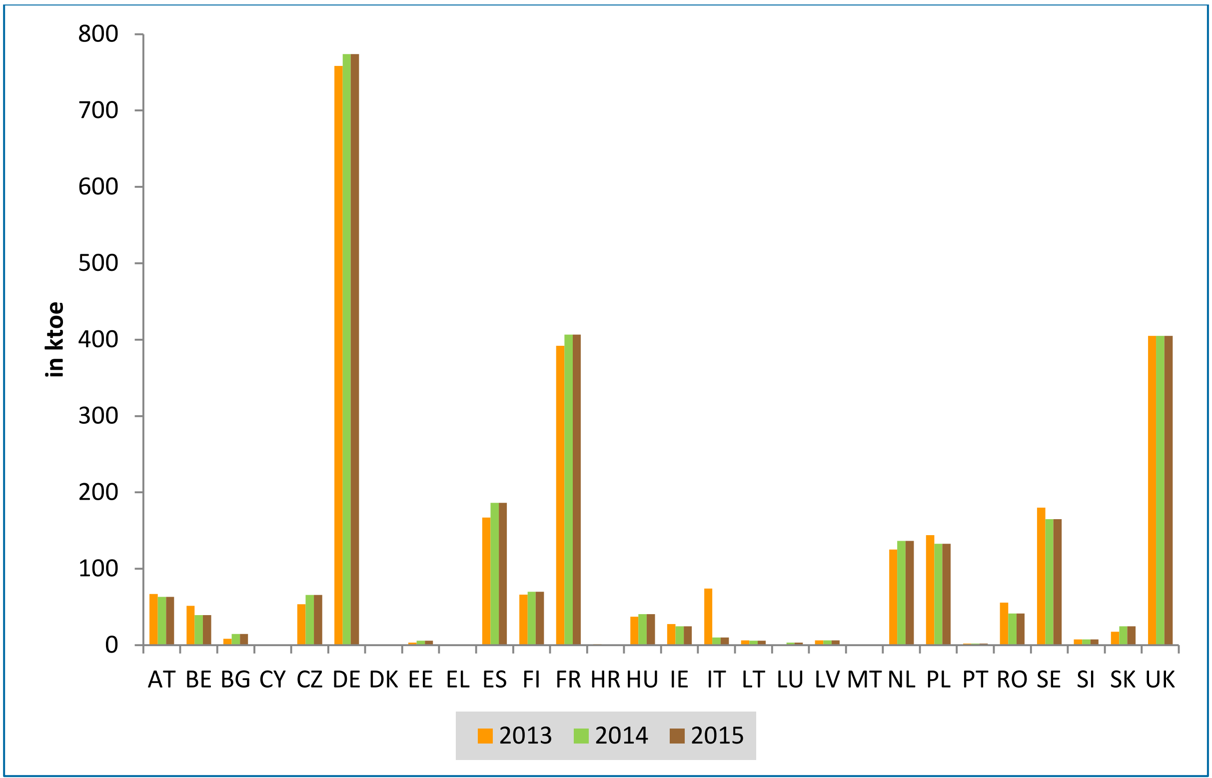
The biodiesel consumption is dominated by France and Germany, followed by Italy, Sweden, United Kingdom and Spain. The main reasons in case of France and Germany are biodiesel blends, early investment support, existing know-how and infrastructure regarding rapeseed oil production and processing [29].

Figure 1-25: Gross final energy consumption of biodiesel (in ktoe)



Source: [127]

Figure 1-26: Gross final energy consumption of bioethanol (in ktoe)

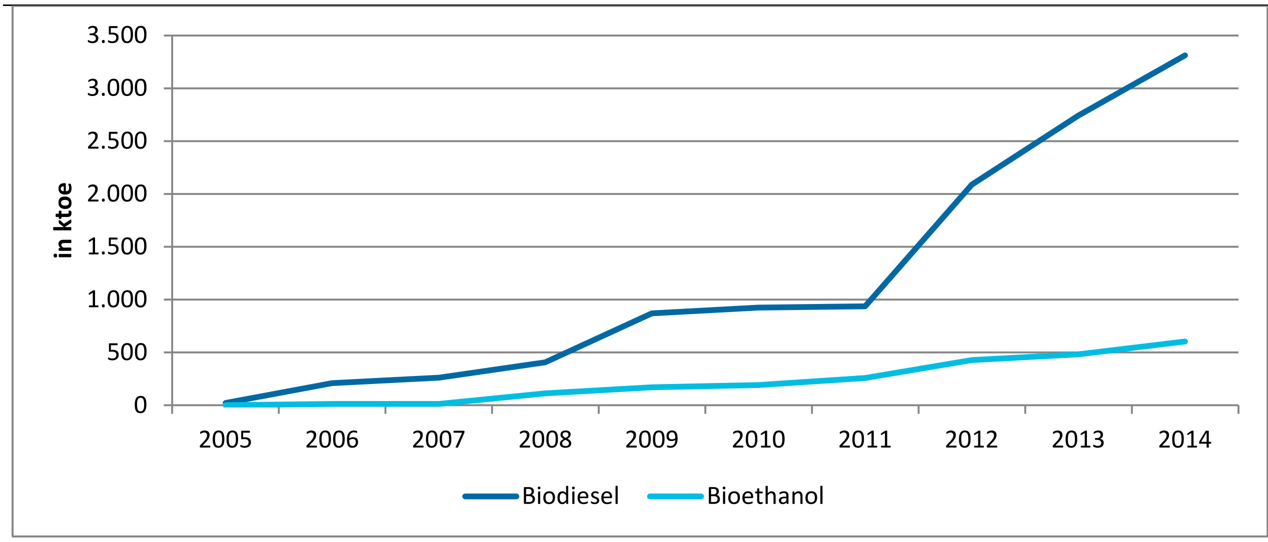


Source: [127]

1.1.4.1. Liquid biofuel trade

The biofuel production has experienced an exponential growth in the past years, both at EU and global level (Figure 1-27). The difference between the biodiesel and the bioethanol market is driven by agricultural and biofuel policies and the different interests of the market players. Due to policies blending into fuels for road transport (e.g. by the introduction of the EU biofuel quota or tax exemptions) biofuel production in EU has focused on biodiesel,.

Figure 1-27: Imports of biodiesel and bioethanol in the EU-28



Source: [127] nrg 126a

The trade patterns vary across individual Member States regarding international and intra-EU trade. The main importers of biodiesel are Spain, Germany, Italy and United Kingdom, for bioethanol it is Germany and United Kingdom. The reporting on imports, feedstocks and countries of origin is very low (see chapter 1.1.4.2 - 1.1.4.5).

In general the portfolio of imports in the EU is influenced by EU tariff regimes.

In 2013, the European Commission imposed an anti-dumping duty on the bioethanol imports from the United States. This rate significantly cut US exports of bioethanol to the EU. Other less competitive suppliers that received preferential duties were able to gain access to the EU. In 2013 and 2014 about 450 and 375 million liter of ethanol have been supplied through zero duty quotas, mainly used by Guatemala, Peru, Pakistan and Bolivia. During 2015, however, these EU bioethanol imports dropped further. The rising price of sugar is expected to reduce the sugar cane ethanol production in Brazil as well as other South and Central American countries during 2016 and through 2017. Currently, about 125 million liters of the 215 million liters of bioethanol are imported from the United States, and about 90 million liters are imported as ETBE. Similar to the sugar cane ethanol from South and Central America, EU imports of corn ethanol from the United States are not expected to increase during 2016. In 2016, corn ethanol production in the United States is expected to stagnate, with limited volumes available for export. Currently EU domestic ethanol prices are too low to even attract significant volumes of duty-free ethanol from foreign markets. Continuous plant outages could, however, cause a local shortage situation, and support a price increase sufficient to induce imports [26].

In 2013, the EC introduced anti-dumping duties on biodiesel imports Argentina and Indonesia. As a result, imports from both countries have dropped considerably in 2013 and almost ceased in 2014. The void was partially filled with domestic EU production and partially with higher imports from countries not covered by anti-dumping duties. Here the biggest beneficiaries were Malaysia, South Korea, India, and Brazil. In 2015 most biodiesel, about 527 million liters, was imported containing at least 96.5 % biodiesel. The majority of biodiesel imports occur through the Netherlands, Spain, and Bulgaria. Biodiesel imports are constrained by the sustainability requirements laid down in the Renewable Energy Directive (RED) [26].

EU biodiesel exports to destinations outside the bloc are marginal and normally only amount to around one percent of production. The exceptional increase of exports in 2013 was due to higher exports to the United States. EU exports to the United States and thus total exports dropped sharply in 2014. In 2015 the top three export destinations were Norway, Switzerland and the United States [26].

There is an increasing share of international imports in the EU biodiesel trade balance in the last years. This is due to diverse reasons. Biodiesel prices differ across the MS mainly due to different tax levels and biofuel policies. Some Member States do not produce sufficient domestic feedstock and rather import oilseeds, vegetable oil or biodiesel [29].

Figure 1-28 shows the EU imports of biodiesel arose between 2008 and 2009 and from 2011 to 2014 strongly. The main destinations were Sweden, France and the United Kingdom. Biofuel producer located in ports benefit from lower import tariffs for feedstock in comparison to the biofuel product.

Excursion

No dataset combines detailed information on the country of origin of feedstock imports and which share of the imported feedstock is used for biofuel production within the EU-28.

Eurostat data does not reflect the whole biodiesel import into the EU. Firstly there are additional categories for which data is not reported publicly and the EU customs codes for biodiesel and mixtures containting more than 30% non-petroleum products, only covers blends of 20% biodiesel content and higher. Fossil fuel blends with biodiesel content up to 30% is covered by custom's codes of petroleum products, incl. diesel, petrol, kerosine.

Trade data vary across different sources.

MS Progress Reports submitted under the RED in 2015 and the literature review did not yield sufficient information to close this gap. The gathering of primary data by a consultation of all EU-recognised certification systems was unsuccessful. All 18 EU-recognized Certification Systems were contacted about detailed information on imported feedstocks and their countries of origin. 6 Certification System (Bon-sucro, RTS, RTB, Abengoa Bioenergy, Ensus, RSPO) indicated that data on biofuel quantities were available, but without further subdivision of feedstocks. 8 Certification Systems had no data available according to written or oral statements. 4 Certification System did not react at all.

However, based on the publicly available data sources above the following information can be derived:

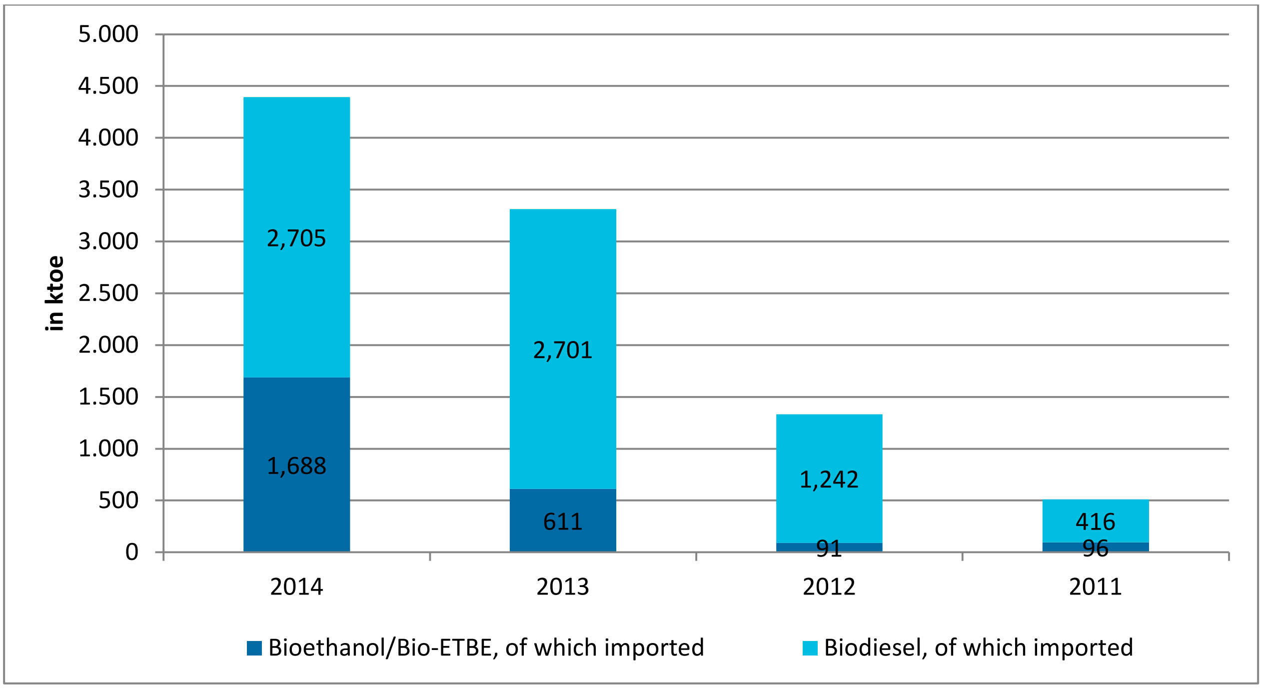
- Production, consumption, imports and exports of biofuels within the EU-28

- Imports of biofuels (final product) into EU-28 distinguished by country of origin for fuels in the transport sector
- Imports of agricultural commodities that can be used for production of biofuels (i.e. feedstocks) into the EU-28 by country of origin (i.e. for biogasoline: corn, wheat, rye, sugar beet)

Currently, no data source provides feedstock quantities in sufficient detail organised according to countries of origin, with exception of individual reports by a few Member States (e.g. DE, IE and UK).

According to Member States' Progress Report Table 1d the Member States report the contribution to the 2020 renewable targets for transport by renewable technology. The data quality differs, e.g. Germany does not report imported quantities in the table but describe in detail feedstock use and countries of origin for their biofuels. Despite data uncertainty, the analysis showed a rising trend on imported biofuels for the EU-28.

Figure 1-28: Import of bioethanol and biodiesel as reported by the Member States, including imports from other Member States (in ktoe) – Table 1d of the Member States' reports

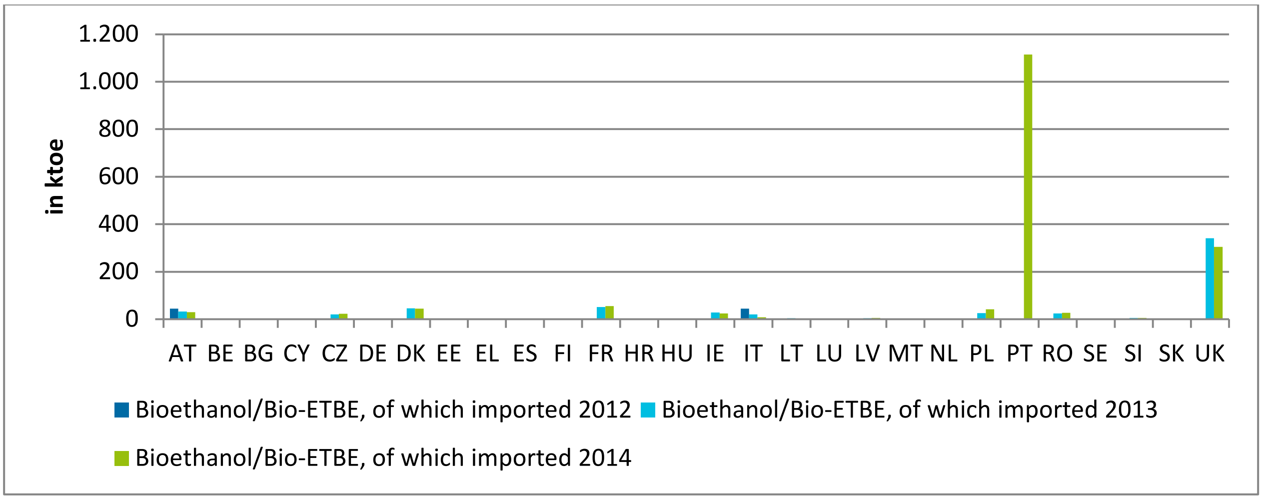


Source: [2]

Between 2011 and 2014 the import numbers of biodiesel (including from other Member States and third countries) increased from 416 ktoe to 2,705 ktoe. Bioethanol imports increased from 96 ktoe to 1,688 ktoe. Nevertheless, it is unclear whether the increases are due to real import increases or improved and more complete data compared to previous years. The increase can thus be a reporting effect.

The following figures (Figure 1-29, Figure 1-30) show the imports at Member State level between 2012 and 2014. Portugal has reported a very high import value in 2014. This value is equal to the whole bioethanol use. They do not report other data for earlier years. Therefore, it is not comparable. Germany, Finland, Hungary, Netherlands and Sweden have no information according to their reporting. Other Member States like Belgium, Cyprus, Estonia, Greece, Spain, Croatia, Malta and Slovakia report zero imports on bioethanol. The United Kingdom reduced imports on bioethanol from 341 ktoe in 2013 to 305 in 2014. For 2012 they reported zero imports. Italy reduced their imports on bioethanol from 45 ktoe in 2012 to 8 ktoe in 2014 and Austria's imports decreased from 45 ktoe in 2012 to 30 in 2014.

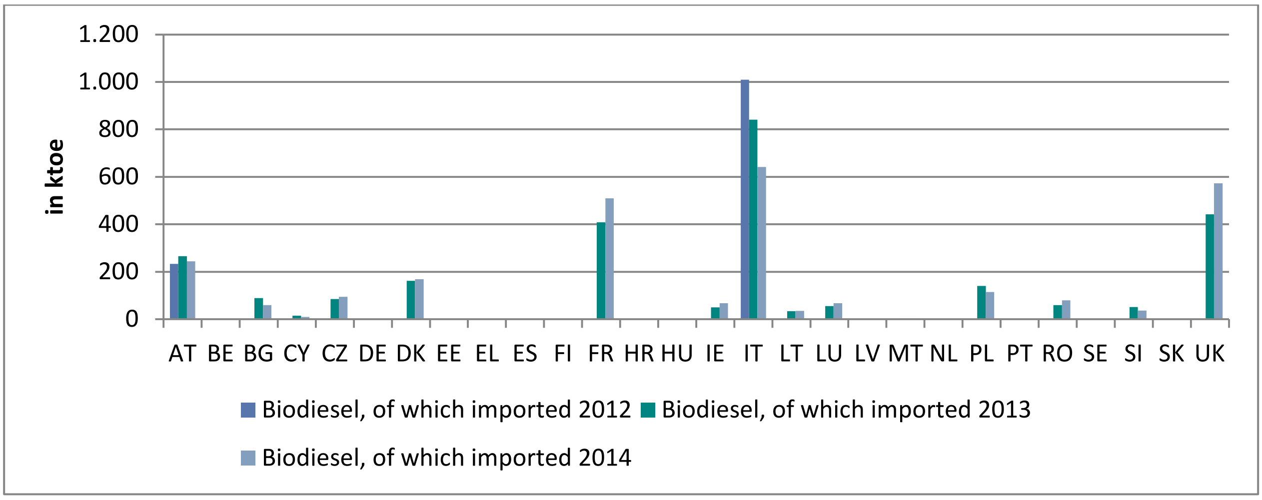
Figure 1-29: Imports of bioethanol - as reported by the Member States, including imports from other Member States - between 2012-2014, Table 1d (in ktoe)



Source: [2]

The biodiesel import at Member State level shows the following figure. The information on quantities has improved compared to 2012 where only two Member States reported data (Austria and Italy). In 2014 Germany, Finland, Hungary, the Netherlands and Sweden presented no information in Table 1d of their Progress Report. Belgium, Estonia, Greece, Spain, Croatia, Latvia, Portugal and Slovakia reported zero imports of biodiesel. The United Kingdom shows an increase from 442 ktoe in 2013 to 573 ktoe in 2014. They reported zero imports on biodiesel in 2012. They are together with Italy and France the biggest importer in EU-28. In Italy imports of biodiesel decreased from 1,009 ktoe in 2012 to 642 ktoe in 2014. France shows an increase from 408 in 2013 to 509 ktoe in 2014. They reported zero imports on biodiesel in 2012. Austrias imports decrease to 244 ktoe in 2014. Austria reported an increase from 233 ktoe in 2012 to 266 ktoe in 2013.

Figure 1-30: Imports of biodiesel - as reported by the Member States, including imports from other Member States between 2012-2014, Table 1d of the Member States' reports (in ktoe)



Source: [2]

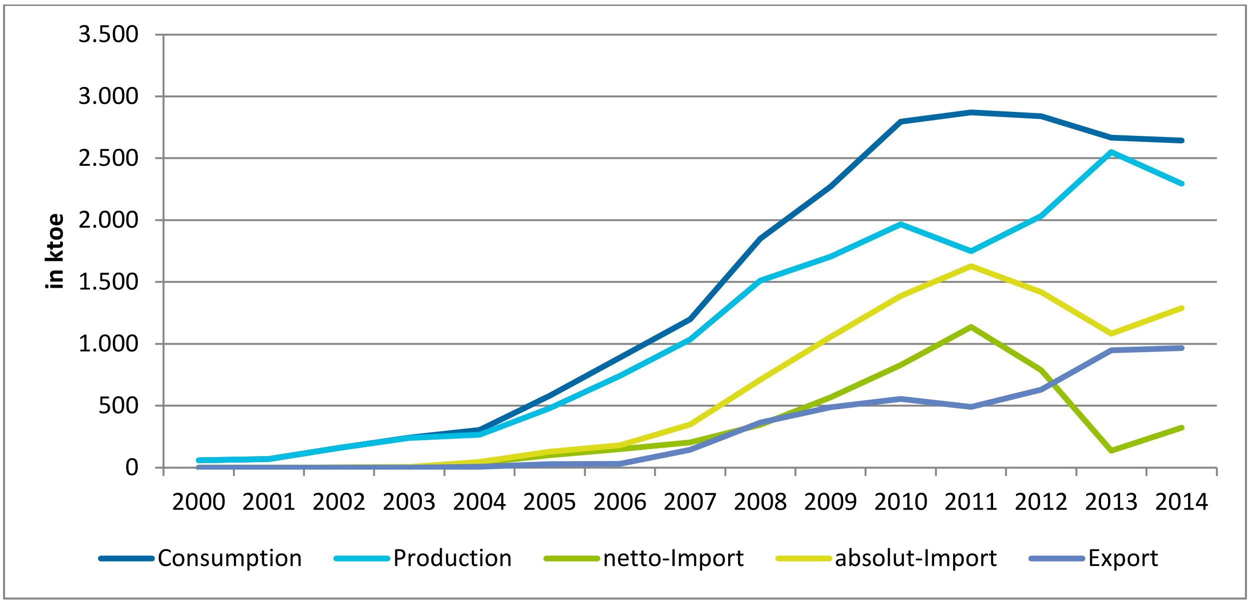
1.1.4.2. Main countries of origin – bioethanol production

The EU-28 is importer (and net importer) of bioethanol. In 2014 it imported 1.3 Mtoe bioethanol of which 30 % originated from European Member States, while 70 % originated from countries of the rest of the world.

Of the imports originating from outside the EU in 2014, according to [127] nrg_126a:

- 98.6 % were of non-specified origin;
- the remaining 1.4 % originated from Russia (0.5%), Gabon (0.4%); Peru (0.3%), Saudi Arabia (0.1%), Turkey (0.1%).

Figure 1-31: EU-28 bioethanol production, consumption (gross inland), imports and exports



Source: [127] (nrg_107a)

Table 1-4: Comparison of Eurostat Progress Report Table 1d on final energy consumption of biogasoline in the transport sector for EU-28, reporting year 2014; EU-28

Source	Unit	Consumption of biogasoline (Eurostat) resp. Bioethanol/ETBE (MSPR)	Biogasoline production	Imported biogasoline (Eurostat) resp. Bioethanol/ETBE (MSPR)	Domestically produced and domestically consumed biogasoline**	Domestically produced and exported biogasoline**
		(1)	(2)	(3)	(4) = (2)-(3)	(5) = (2)-(4)
Eurostat	Mtoe	2.65	2.3	1.30	1.37	0.93
Member States Progress Reports 2015	Mtoe	3,6	NA	1,7*	NA	NA

Source: [2] 2015 Table 1d; [127] nrg_107a

* an aggregation to EU-28 is not possible, as several Member States (Belgium, Germany, Greece, Finland, Hungary, Malta, the Netherlands, Sweden) did not report on imported biogasoline.

** Production based on imported & domestic feedstock

In the USDA FAS EU biofuels annuals there is no further analysis of import countries, quantities or feedstocks are given. But there is a short list with countries given from which EU-28 is importing bioethanol. For 2014 USA, Guatemala, Peru, Pakistan and Bolivia are mentioned [128].

1.1.4.3. Feedstock use bioethanol

The evaluation of different data sources has shown that [128] reported the most detailed data on used feedstocks for biofuel consumption. The re-check of data of [9] has shown less feedstocks reported than [128]. Other sources like EurObserv'ER biofuel monitoring or actual studies on biofuel trade report on consumption on production are on a very aggregated level on information on feedstocks, which is not usable for further calculation. Some studies base their analysis also on USDA FAS (earlier report versions than 2016) or [8], which are also based on [26].

Therefore the report based on the use of [128] data due to the contribution of feedstocks to EU28 bioethanol consumption from countries of origin:

The following table shows the structure of bioethanol feedstocks in 2015, based on report on biofuels [128].

Table 1-5: Feedstock base of Bioethanol production in the EU-28

Bioethanol production, domestic and imported feedstock (in 2014)	*Mass (1,000 Mt)*	*Input (%)*
Wheat	2,798	15%
Corn	5,174	27%
Barley	541	3%
Sugar Beet	9,364	49%
Rye	846	4%
Cellulosic Biomass	270	1%
Total	18,993	100%

Source: [128]

The main third countries named by [128]for the import of corn are the US and Ukraine. But Ukraine is preferred by the producers of ethanol since the DDG can be sold as non-GM feed to the domestic market.

The countries of origin for the use of feedstocks within the EU-28 are not available via the identified data sources.

However, it is possible to identify via UN Comtrade[2] which agricultural products are imported into the EU-28 and where these originate from; i.e. it is possible to identify the main trading partners of the EU-28.

Bioethanol is being produced based on the feedstocks named above: sugar beet, corn, wheat, rye and barley. UN Comtrade data on these agricultural products is available for the years 2013 and 2014, but not for 2015 yet. The illustration below is based on data for the year 2014.

All trading partners outside the EU-28 for the commodities mentioned above are provided as percent of total imports for the year 2014.

The main trading partners[3] according to UN Comtrade are

- for barley Republic of Moldova (29 %); Russia (25 %); Serbia (8 %); Ukraine (37 %);
- for corn Brazil (5 %); Canada (10 %); Russia (7 %); Serbia (6 %); Ukraine (59 %); USA (7 %);
- for sugar beet Serbia (100 %);
- for rye Russia (43 %); Ukraine (56 %);

[2] http://comtrade.un.org/

[3] The list includes all trading partners with shares of 5 % or above of the overall imported amount. The complete list is provided in the Annex.

- for wheat Canada (49 %); Russia (7 %); Ukraine (20 %); USA (13 %).

However, similar to FAO trade data[4], this data lacks further information on which shares of these imports are used for the production of biogasoline within the EU-28.

1.1.4.4. Main countries of origin – biodiesel production

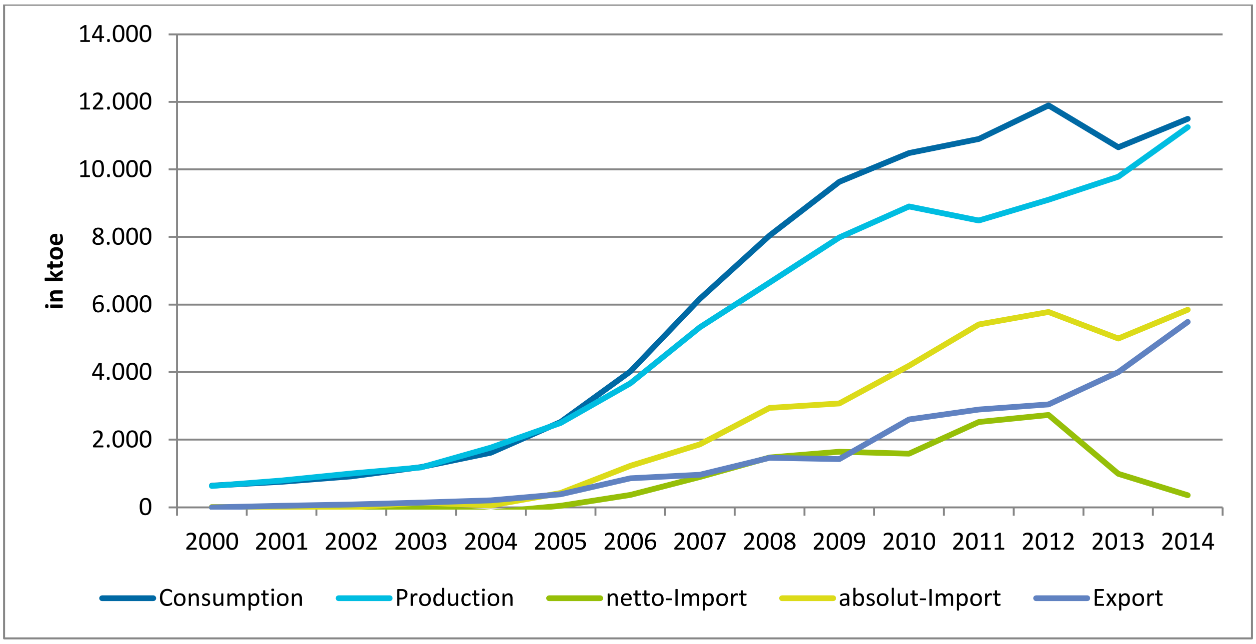
The EU-28 is importer (and net importer) of biodiesel. In 2014 it imported 5.8 Mtoe biodiesel of which 51 % originated from European Member States, while 49 % originated from countries of the rest of the world. USDA FAS 2016 mentioned that the majority of biodiesel imports occur through the Netherlands, Spain and Bulgaria. Within the Progress Reports the picture is different: Denmark, Luxemburg and Slovenia import 100% of their biodiesel consumption for transport sector ([2] 2015, Table 1d).

Of the imports originating from outside the EU in 2014, according to Eurostat nrg_126a:

- 66.5 % were of non-specified origin;
- the remaining 33.5 % originated from Argentina (19.6 %), Indonesia (3.2 %); Switzerland (2.4 %), Malaysia (2.5 %), Ukraine (2.5 %), Singapure (1.6 %), USA (1,4 %), India (1 %) Brazil (0.3 %), China (0.2 %), Israel (0.2 %), Australia (0.1 %).

In the USDA FAS EU biofuels annuals there is no further analysis of import countries, quantities or feedstocks are given. But there is a short list with countries given from which EU-28 is importing biodiesel. For 2014 USA, Argentina, Indonesia, Malaysia, South Korea, India, and Brazil were mentioned [128].

Figure 1-32: EU-28 biodiesel production, consumption (gross inland), imports and exports



Source: [127] (nrg_107a)

[4] http://faostat.fao.org/site/291/default.aspx

Table 1-6: Comparison of Eurostat Progress Report Table 1d on final energy consumption of biodiesel in the transport sector for EU-28, reporting year 2014; EU-28

Source	Unit	Consumption of biodiesel (Eurostat) resp. biodiesel (MSPR)	Biodiesel production	Imported biodiesel (Eurostat) resp. biodiesel (MSPR)	Domestically produced and domestically consumed biodisel**	Domestically produced and exported biodiesel**
		(1)	(2)	(3)	(4) = (2)-(3)	(5) = (2)-(4)
Eurostat	Mtoe	11.3	11.2	5.8	5.4	5.8
Member States Progress Reports 2015	Mtoe	10,3	NA	2,7*	NA	NA

Source: [2] 2015 Table 1d; [127] nrg_107a

* an aggregation to EU-28 is not possible, as several Member States (Finland, Hungary, Netherlands, Sweden) did not report on imported biodiesel.

** Production based on imported & domestic feedstock

1.1.4.5. Feedstock use biodiesel

The consumption and production of vegetable oils increased constantly over the past years. The largest share is taken by rapeseed oil and palm oil. The last segment is fast growing due to its low pricing.

The evaluation of different data sources has shown that [128] reported the most detailed data on used feedstocks for biofuel consumption. Other sources like EurObserv'ER biofuel monitoring or actual studies on biofuel trade report on consumption on production are on a very aggregated level on information on feedstocks, which is not usable for further calculation. Some studies base their analysis also on USDA FAS (earlier report versions than 2016) or [8] which are also based on USDA FAS.

Therefore the report based on the use of [128] data due to the contribution of feedstocks to EU28 bioethanol consumption from countries of origin:

The following table shows the structure of biodiesel feedstocks in 2015, based on UDA FAS report on biofuels [128].

Table 1-7: Feedstock base of biodiesel production in the EU-28

Biodiesel production, domestic and imported feedstock (in 2014)	*Mass (1,000 Mt)*	*Input (%)*
Rapeseed oil	6,100	52%
UCO	1,800	15%
Palm oil	1,580	13%
Soybean oil	890	8%
Animal fats	920	8%
Sunflower oil	320	3%
Other (pine oil, fatty acids)	170	1%
Total	11,780	100%

Source: [128]

The countries of origin for the use of feedstocks within the EU-28 were not available via the identified data sources.

However, it is possible to identify via UN Comtrade[5] which agricultural products are imported into the EU-28 and where these originate from; i.e. it is possible to identify the main trading partners of the EU-28.

Biodiesel is being produced based on the feedstocks named above: rapeseed oil, palm oil, soybean oil sunflower oil, animal fats. UN Comtrade data on these agricultural products is available for the years 2013 and 2014, but not for 2015 yet. The illustration below is based on data for the year 2014.

All trading partners outside the EU-28 for the commodities mentioned above are provided as percent of total imports for the year 2014.

[5] http://comtrade.un.org/

The main trading partners[6] according to UN Comtrade are

- for rapeseed oil Russian Federation (39 %) Belarus (27 %); United Arab Emirates (23 %), Canada (6 %), Serbia (4 %),
- for sunflower oil Ukraine (73 %), Republic of Moldova (9 %), Argentina (8 %), Serbia (5 %), Russian Federation (3 %)
- for palmoil Indonesia (54 %), Malaysia (27 %), Papua New Guinea (8 %), Guatemala (2 %), Honduras (2 %), Colombia (2 %), Togo (1 %)
- for soy bean oil Ukraine (24 %), Paragua (21 %), Russian Federation (20 %), Norway (20 %), Serbia (10 %)

However, similar to FAO trade data[7], this data lacks further information on which shares of these imports are used for the production of biodiesel within the EU-28.

1.1.4.6. Cellulosic Energy Crops for biofuels

Information on biomass supply for transport from the progress report are summarized in Table 1-8. In contrast to the previous year decrease the amount of primary energy in domestic raw material from 3,062 ktoe to 2,093 ktoe. Most of the material is imported from EU and only a small share comes from non EU countries.

The reporting information from the Member States are low. Only Austria, Belgium, France, Croatia, Hungary, Ireland, Latvia, Lithuania, Romania and Slovakia reported within the table 4 scheme. Germany and UK used own reporting structures. However, this is not comparable with the table structure of the Progress Reports.

Additional information on the use of energy crops comes from [31]. The use of energy crops is small [31] compared to other feedstocks for biofuels.Table 1-8.

Table 1-8: Biomass supply for transport (Table 4 Progress Report)

	Primary energy in domestic raw material (ktoe)		Primary energy in amount of imported raw material from EU (ktoe)		Primary energy in amount of imported raw material from non-EU countries (ktoe)	
	2013	2014	2013	2014	2013	2014
Biomass supply for transport						
Common arable crops for biofuels (please specify main types)	3,062	2,093	1,102	2,054	251	283

Source: [2] 2015

[6] The list includes all trading partners with shares of 5 % or above of the overall imported amount. The complete list is provided in the Annex.

[7] http://faostat.fao.org/site/291/default.aspx

Table 1-9: Cellulosic energy crops (in ha)

	Switchgrass	Reed Canary grass	Willow	Poplar	Miscanthus	Energy crops total (Eurostat 2014)
	ha	ha	ha	ha	ha	ha
AT	200	20	280	1,069	1,014	1,200
BE			70		120	
BG						1,400 (2013)
CY						
CZ						2,300
DE			4,000	5,000	15,000	3,100
DK		19	5,697	2,807	64	
EE						
EL						1.000 (2012)
ES						
FI		18,700	<100			6,600
FR			2,300		3,500	
HR						100 (2010)
HU						6,100
IE			930		2,200	1,600
IT			670	5,490	50-100	
LT			550			300
LU						200
LV						1,100 (2012)
MT						
NL					90	
PL			5,000-9,000	300		2,300
PT						
RO	50,000					500
SE		780	11,000	550	450	600
SI						
SK						
UK			1,500-2,300		17,000	7,000
EU28	**50,200**	**19,519**	**31,097-36,897**	**15,216**	**39,488-39,538**	**35,400**

Source: [31], [6]

1.1.4.7. Double Counting: biofuels pursuent to Art. 21. (2)

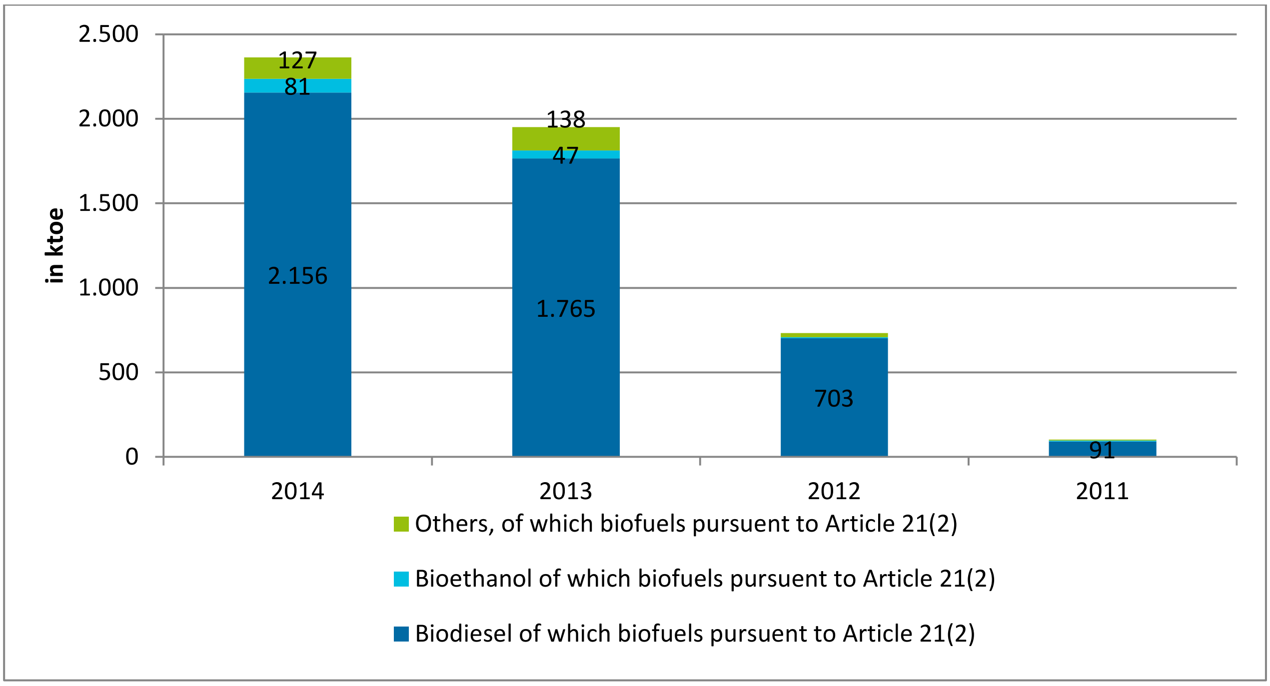
The majority of double counted biofuels in the EU are produced from biodiesel (Figure 1-33). The highest consumption was reported in United Kingdom, Germany and Sweden. In 2014, the highest consumption of “other biofuels” (mainly vegetable oils used pure), was reported in Sweden and Germany. Only the United Kingdom reported on double counting of “other biofuels”. For other Member States no data exist or they do not have double counting on this kind of biofuels (Figure 1-34).

The 2015 adopted legislation revising the RED (Directive (EU) 2015/1513 states that biofuels produced from feedstocks listed in the Annex IX should be considered twice their energy content for the purpose of complying with the target. This means that biofuels made out of ligno-cellulosic, nonfood cellulosic, waste, and residue materials will count double towards the 10 percent target of RED. However, it does not allow multiple counting of advanced biofuels and renewable electricity in transport sector towards the 20 percent general renewable energy target.

The key issue with double counting of biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material has not been implemented in several MS and the definition of waste differs between MS despite the definition of waste provided in the EU Waste Framework Directive.

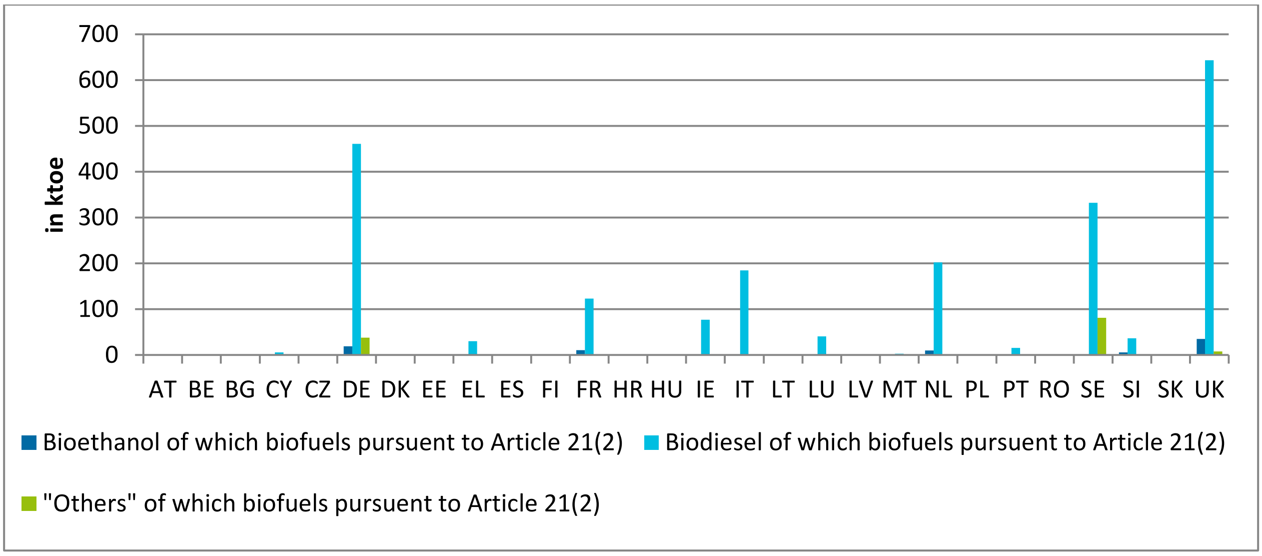
Overall, the use of these feedstock types that can be counted twice (double counting) in the monitoring of the renewable energy in transport target, stimulate the production of advanced biofuels. However, the measure also results in lower greenhouse gas emission reductions because double counted biofuels do not have a double impact on CO_2 emissions.

Figure 1-33: Amount of biofuels pursuant to RED Article 21 (2)



Source: [2]

Figure 1-34: Amount of biofuels pursuant to Art. 21 (2) in 2014 by Member State



Source: [2]

1.1.5. Land use associated with the EU bioenergy consumption – land use allocation tool

Current land use in EU

In 2013 in EU 28 there were about 174 million ha of utilised agricultural area. These include about 60 % arable land, 34 % permanent grassland, 6 % permanent crops and 0.2 % other land [129].

Table 1-10: Agricultural land use in 2013

MS	Utilised agricultural area (UAA) (ha)	Wooded area	Arable land	Permanent grassland and meadow	Permanent crops	Other
	ha	*ha*	*ha*	*ha*	*ha*	*ha*
AT	2,726,890	2,264,830	136,386,000	107,662,252	1,969,288	3
BE	1,307,900	1,020	79,962,047	37,940	68,789	-
BG	4,650,940	915,470	327,939,000	25,024,088	86,944	8
CY	1,571,200	93,430	87,843,000	3,675,298	294,648	6
CZ	109,330	630	8,012,000	1,066	345,842	3
DE	3,491,470	1,520,460	249,211,000	41,809,417	72,213	0
DK	2,619,340	175,750	239,722,000	1,311,613	129,269	0
EE	957,510	211,450	62,831,000	7,167,362	21,851	8
EL	2,282,400	2,807,340	224,762,257	3,813,783	118,900	-
ES	27,739,430	1,046,530	1,846,620,000	31,095,633	1,766,970	2
FI	16,699,580	1,303,200	1,187,589,000	36,061,153	361,821	1
FR	4,856,780	38,990	181,680,000	1,687,781	3,189,469	7
HR	4,656,520	1,583,180	380,082,000	23,891,925	2,408,318	25
HU	4,959,450	147,940	104,197,000	11,680,711	5,469	0
IE	12,098,890	2,680,220	672,836,000	73,467,583	19,395,895	10
IT	1,877,720	792,510	120,414,000	27,613,680	136,985	43
LT	2,861,250	162,450	227,783,000	3,180,017	82,864	-
LU	131,040	5,900	6,260,000	301,213	992	0
LV	10,880	0	857,000	-	12,739	760
MT	1,847,570	12,230	103,786,000	511,747	295,385	0
NL	14,409,870	1,033,130	1,075,957,000	22,987,959	2,987,414	16
PL	3,641,590	807,640	110,086,000	40,288,519	3,434,623	13
PT	13,055,850	1,214,180	819,759,000	40,904,182	906,679	76
RO	1,901,610	1,108,700	136,342,000	30,220,895	56,483	4
SE	485,760	375,500	17,269,000	22,013,935	229,692	7
SI	23,300,220	4,696,770	1,129,462,000	160,495,783	35,482,391	0
SK	3,035,920	3,382,410	258,229,000	49,985,449	989	0
UK	17,326,990	786,840	635,340,635	49,667,262	111,061	0
EU-28	**174,613,900**	**29,168,700**	**10,435,608,056**	**996,495,493**	**58,948,535**	**10**

Source: [129], Table ef_kvaareg, demo_r_d3area and ef_oluft)

The EU had approximately 181 million hectares of forests and other wooded land. This corresponds with 45 % of its land area [124]. The area covered by forest and other wooded land has increased by about 5 % since 1990 within EU28.

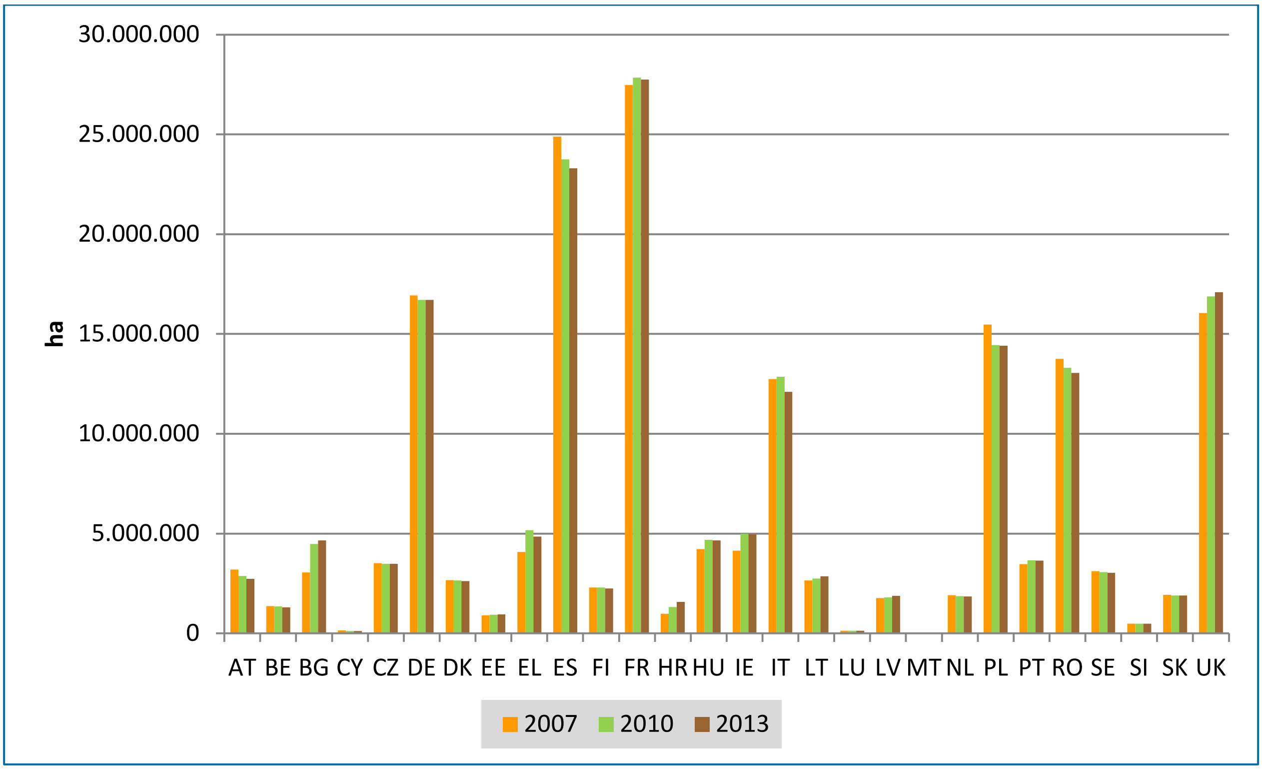
The utilized agricultural area is distributed across the Member States as presented in Figure 1-35.

In comparison: at the global level the land use distribution between agricultural land, forest land and infrastructure is roughly one third (Figure 1-37). Two third of the agricultural land is used as pasture land and the other third is dedicated to cropland. However, the vast majority of the cropland is used for food and feed production. At the global level 5 % of the land is dedicated to bioenergy use.

72 % of the agricultural land (compared to the total agricultural land) is subject to one green direct payment obligation. This shows a great potential of environmental and climate benefits on a large share of EU farmland. This is uneven within the Member States, where the highests percentages have Belgium, Lithuania, Hungary and Sweden [130].

Arable land under the crop diversification obligation amounts to 75% ot the total EU arable land. The situation within the Member States varies strongly from less than 10% to more than 90 % of arable land. Approximately 25 % of total EU arable land is not subject to crop diversification, 13 % is subject to two-crop requirement and 62 % to the tree-crop requirement [130].

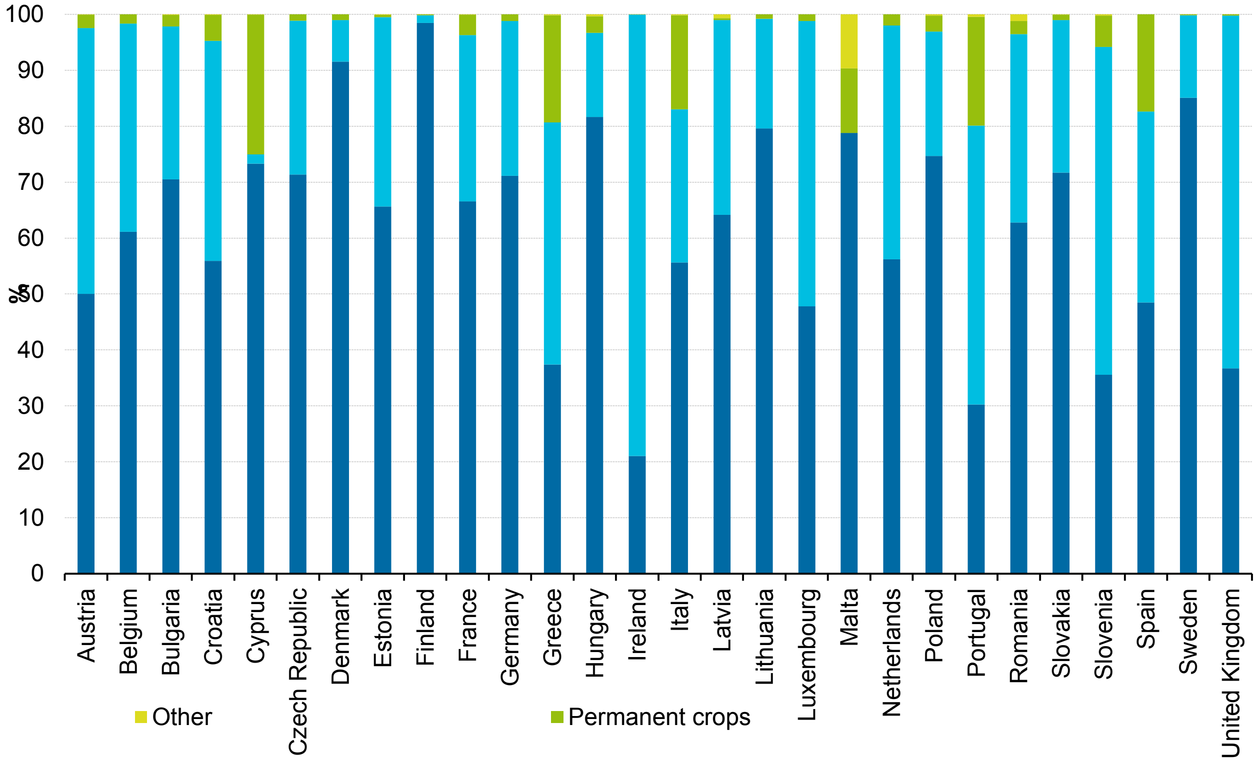
Figure 1-35: Utilised agricultural area (ha)



Source: [127]

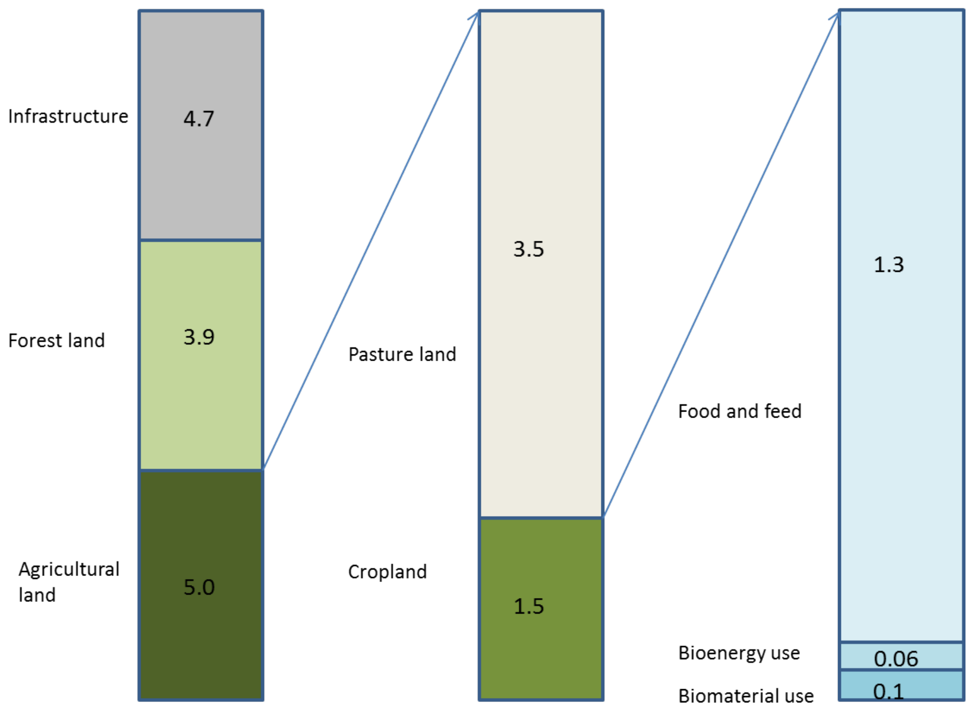
More than a third of EU farmland is permanent grassland, a fifth of this grassland is classified as environmentally sensitive due to protecting biodiversity and carbon storage. Within the Member Stares the variation is shown in Figure 1-36.

Figure 1-36: Permanent Grassland



Source: [129] Table ef_oluft

Figure 1-37: Land use on a global level



Quelle: [86] data from 2006/2007.

Regarding land use within EU 28, the European Comission reported in SWD 2016/218 in their review on greening as a new policy instrument in the first pillar that a significant reinforcement in the environmental ambition of the CAP can be shown. The practice of crop diversification was already applied on most arable land. Controlling the ratio of permanent grassland in relation to the total agricultural areas contributes to the sequestration of carbon: Furthermore, the greening reuqirements contributes to avoiding further deterioration [130].

Land use for biofuels production within EU Member States (Article 23(1))

The Member States monitor their land use changes for the production of crops dedicated to energy production (Table 4a in [2]).

The monitoring has improved in terms of completeness in contrast to the previous years. But there are still improvements needed, particularly regarding common methods of data collection. This concerns Estonia, which provides no information on crops dedicated to energy production, Spain, Lithuania and Luxemburg, which has no statistics to land use for short rotation trees. The specification for the different crops use is also improvable. Cyprus and Croatia reported that agricultural land was not used for dedicated energy production in 2013 and 2014 and there is no future expectation in this direction. Lithuania and Malta have not reported any land use information.

Table 1-11: Current domestic agricultural land use for production of crops dedicated to energy production (ha)

	Landused for common arable crops and oilseeds				Land used for short rotation trees				Land used for other energy crops			
	2011	**2012**	**2013**	**2014**	**2011**	**2012**	**2013**	**2014**	**2011**	**2012**	**2013**	**2014**
AT	67,500	67,300	77,500	71,500	1,300	1,500	1,500	1,500	1,137	1,214	1,179	1,173
BE	14,818	16,674	23,453	20,634	145	165	100	91	190	138	43	47
BG	-	-	-	-	-	-	1,584	1,595	n/a	n/a	-	-
CY	-	-	-	-	-	-	-	-	-	-	-	-
CZ	189,620	172,426	159,745	164,463	771	1,292	1,589	2,086	n/a	n/a	not monitored	not monitored
DE	2,051,000	2,147,400	1,979,700	2,211,300	4,000	4,900	6,000	6,000	3,000	2,000	3,200	4,900
DK	70,000	70,000	130,000	125,000	4,000	4,000	9,014	9,518	50	50	85	80
EE	-	-	-	-	-	-	-	-	-	-	-	-
EL	88,975	67,389	78,460	80,491	-	-	-	-	-	-	-	-
ES	50,291	n/a	-	-	n/a	n/a	-	-	n/a	n/a	-	-
FI	n/a	n/a	n/a	n/a	40	36	42	24	10,444	14,949	8,549	7,501
FR	1,107,199	1,230,073	-	1,162,799	4,466	4,508	4,062	5,539	n/a	n/a	-	-
HR	-	-	-	-	-	-	-	-	-	-	-	-
HU	162,000	197,000	300,000	300,000	3,000	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IE	297,000	315,000	320,599	318,042	689	839	914	1,033	2,413	2,349	2,055	1,612
IT	-	-	-	-	6,000	6,000	5,000	5,000	n/a	n/a	-	-
LT	146,860	177,320	-	-	1,500	2,000	-	-	n/a	n/a	-	-
LU	569	581	531	591	n/a	n/a	no specific statistics	no specific statistics	145	84	187	92
LV	650,874	693,424	549,500	556,600	209	321	6,628	-	1,155	884	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-
NL	4,000	4,000	800	800	13	6	7	20	91	124	191	190
PL	n/a	n/a	601,370	553,975	7,619	10,344	11,486	13,499	n/a	n/a	-	-
PT	426	4,357	-	-	n/a	n/a	-	-	n/a	n/a	-	-
RO	6,167	6,125	6,176	6,248	n/a	n/a	n/a	n/a	0	0	0	0
SE	n/a	n/a	n/a	n/a	12,064	11,861	11,825	11,637	828	912	906	646
SI	4,770	5,141	6,131	5,563	n/a	n/a	-	-	n/a	n/a	-	-
SK	152,000	153,000	220,683	187,914	n/a	n/a	590	650	n/a	n/a	-	-
UK	32,617	14,942	42,000	112,000	2,720	2,551	3,000	3,000	7,517	8,075	7,000	7,000
EU - 28	5,096,686	5,342,152	4,496,648	5,877,920	48,536	50,323	63,341	61,192	26,970	30,779	23,395	23,241

Source: [2]

The total amount of land used for the production of energy crops in 2014 was about 5.8 million hectares. The hectar amount in 2013 was about 4.7 million hectares. But, France and Lithuania did not report in 2013. Thus, approximately one million ha are missing. When interpolating, the agricultural land use for energy production increase in the last three years about 5 % per year (own estimation).

The largest part of land is used for the production of common arable crops and oilseeds (97 %). The land used for short rotation trees decreased in the reporting period 2013 to 2014 by about 4 %

and for “other energy crops” about 1 %. Finland for instance, reduced the land use on other energy crops nearly by half.

The largest amount of land use dedicated to biofuel production in the reporting period are reported from Germany (37 %) and France (19 %). These two Member States represent 57 % of the acreage used for biofuel production. This share has decreased in contrast to the previous years .

The following issues were reported by Member States regarding land use impacts:

Czech Republic stated a significant change in land use for cultivating raw materials for the production of biofuels. This materials are canola, sugar beet and maize in 2013, in 2014 additionally wheat.

In Germany the land for the production of regenerative energy is mainly used to cultivate biomass. The land use shows an additional area of approximately 280.000 ha in 2013/2014.

Estonia notes a reduction of agricultural land use area due to difficulties in the agricultural sector.

Due to the limited use of raw materials in Spain, the impact on land use is irrelevant.

Netherlands stated no significant changes in land use as a result of increased biomass use.

A large part of agricultural area in Poland is used for livestock production than solely for biofuel production.

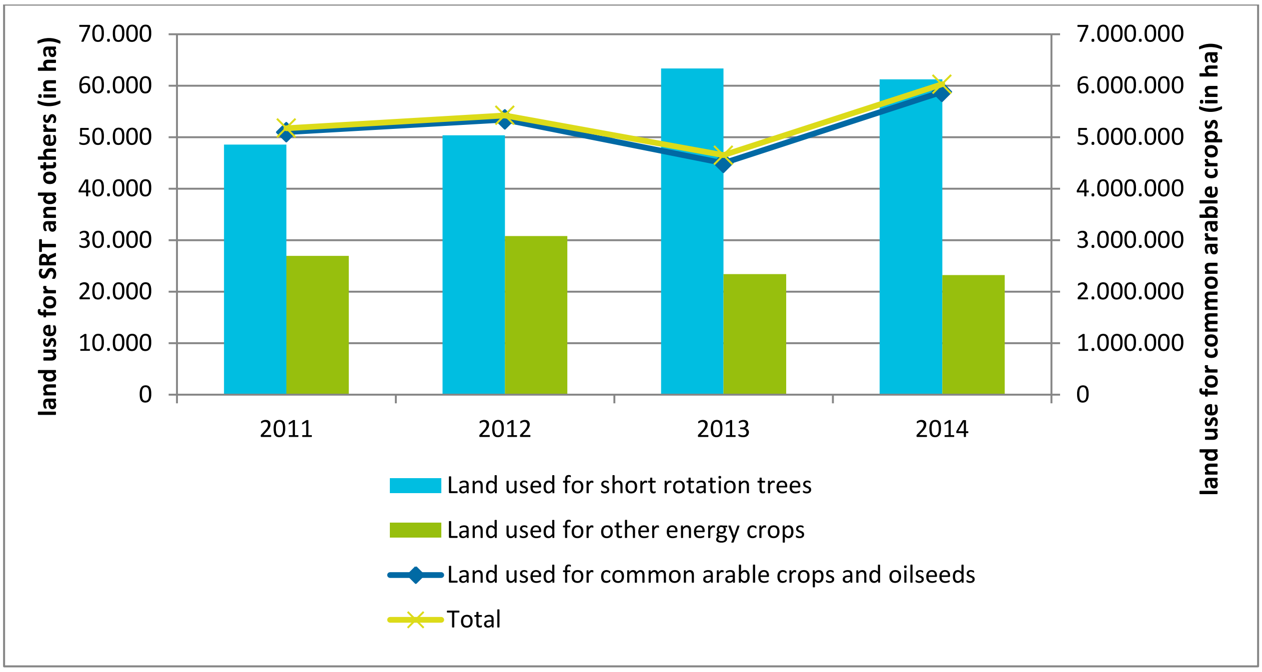
In Romania the surface cultivated with rapeseed eventually meant for biodiesel production increased by 2010, after which it decreased. In 2013 and 2014 this surface stabilized. Limitations on food products introduced by promoting energy crops are not reported.

Sweden has no current causing on land use. The current use of domestic crops for biofuels is limited and it is not considered to be causing any changes to land use in Sweden.

Slovakia stated an increase in interest in energy wood from non-forest land. This is because the costs of producing fuel chips are lower than they would be on forest land. The planting of energy crops has not increased significantly. The energy wood production potential for forest land continues to be under-exploited.

Further explanations of the Member States according to the data availability or other issues, see Annex.

Figure 1-38: Land use dedicated to energy crops



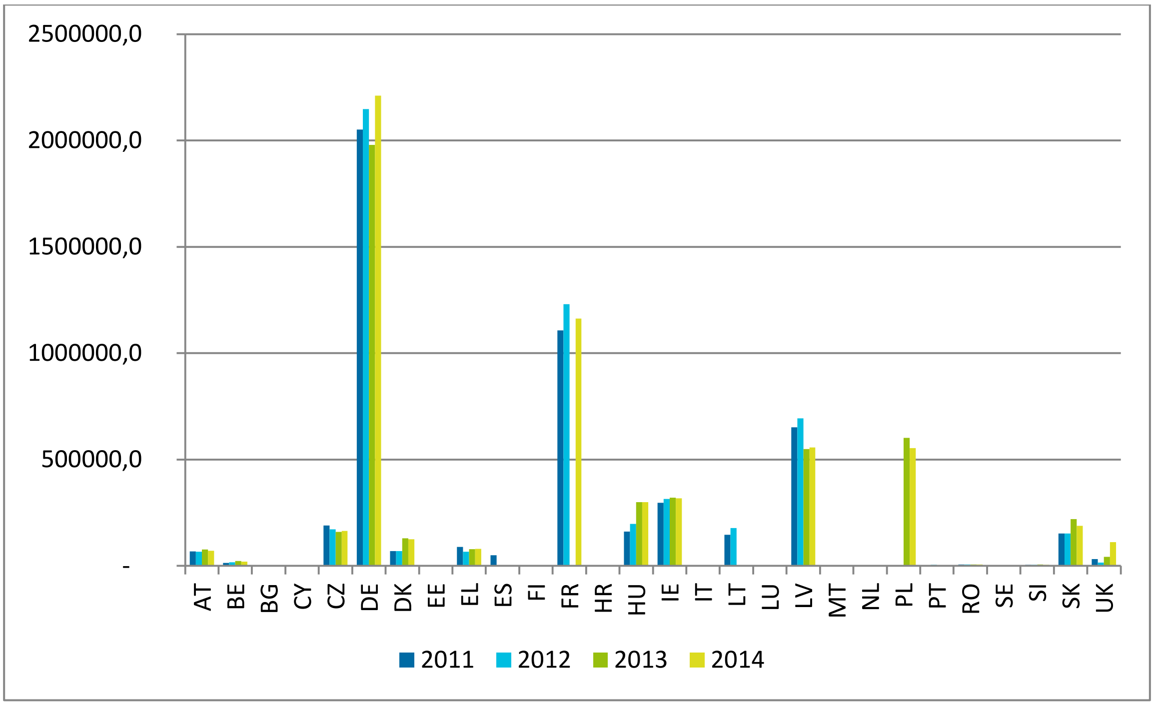
Source: [2]

Bulgaria, Germany, France and Italy reported the highest amount of land use for common arable crops and oilseeds in 2014. This is similar to the previous years.

In total, the land used for short rotation trees increased until 2013 and has a small decline to 2014. Germany, Denmark, Poland and Sweden reported the largest areas. Latvia had a strong increase in area for short rotation trees in 2013, but did not report numbers for 2014.

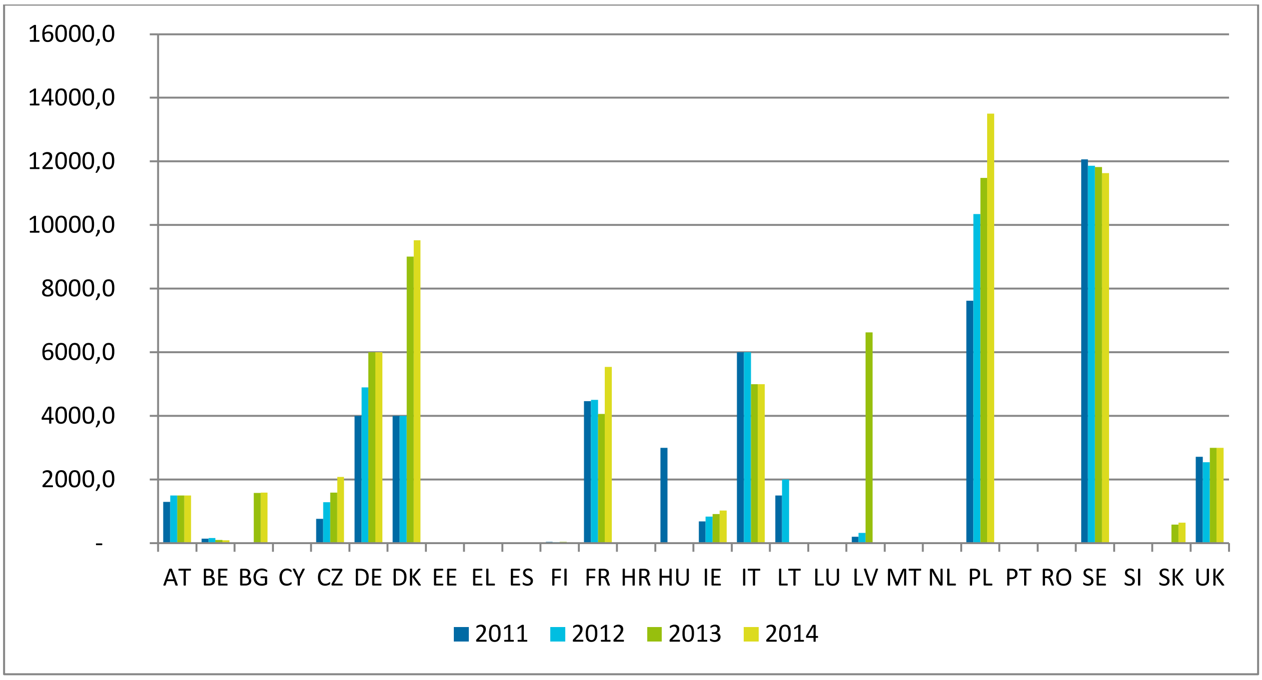
For the cultivation of other energy crops are Finland and UK the Member States with the largest reported amounts in 2014, similar to the previous years. Germany reported a high increase in 2014.

Figure 1-39: Land use for common arable crops and oilseeds



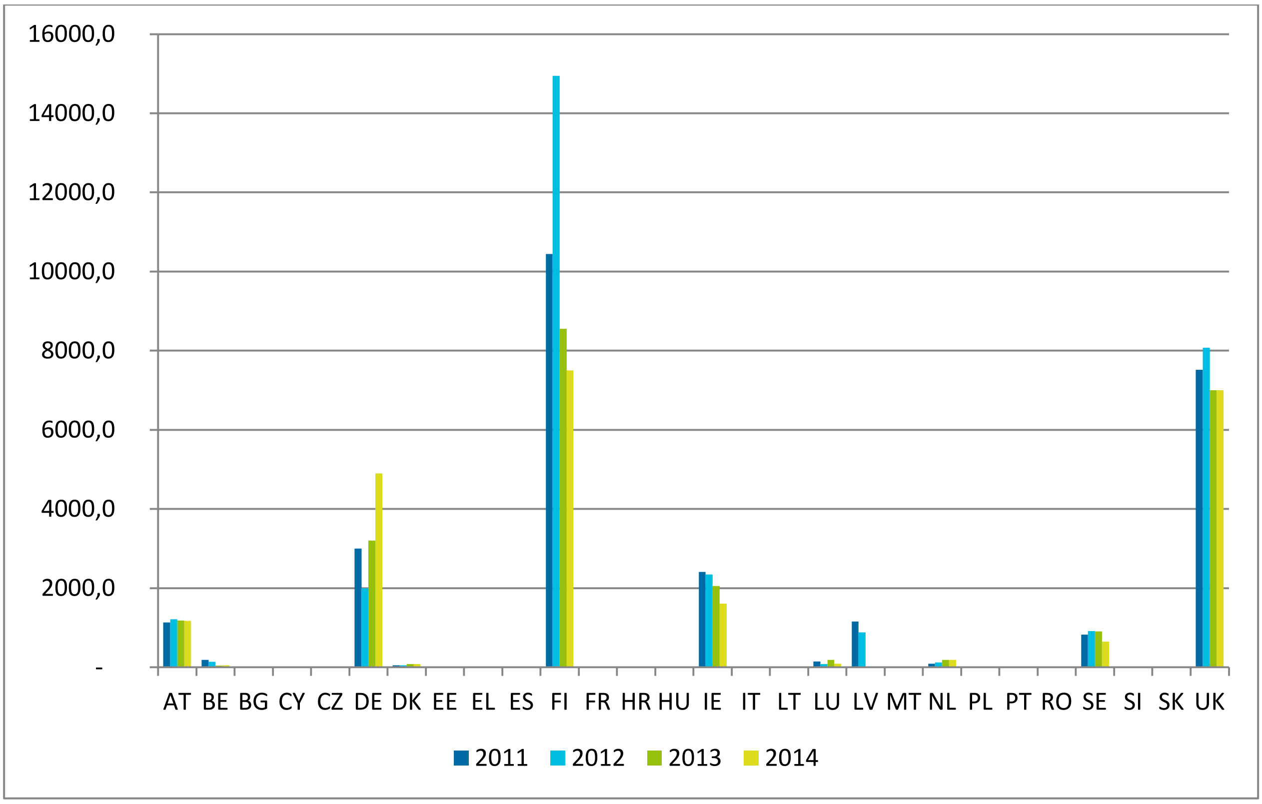
Source: [2]

Figure 1-40: Land use for short rotation trees



Source: [2]

Figure 1-41: Land use for other energy crops



Source: [2]

The reported amounts on land use for biofuels production differ widely between the Member States. Data gaps and inconsistencies seem to be an issue as especially large Member States like UK or Spain. They have reported a very small or even nor area used for biofuel production despite significant production levels. It has to be concluded that a detailed comparison or evaluation of the land use for biofuel production is therefore not possible in a consistent manner. The reasons for the observed inconsistencies may be due to the fact that survey methods differ or national statistics have been changed (deleted or amended). It can be recommended to imply a validation process to improve the data availability and the significance of the data.

1.1.6. Progress in availability of bioenergy made from waste, residues, non-food cellulosic and ligno-cellulosic material

The chapter shows the progress in the availability of biofuels, biomass and biogas made from waste, residues, non-food cellulosic and ligno-cellulosic material based. We used latest available Eurostat data (2012) for the categories of biodegradable waste for all sectors in each country. These categories include municipal solid waste in addition to a variety of other waste products. Agricultural and forestry residues are not included in this data, but animal manure is included.

The Eurostat waste data is categorized by treatment. Waste can be recovered for any useful purpose. Useful recovery includes recycling, composting, backfilling (defined as material used in landscaping or engineering), and incineration with energy recovery. Waste that is landfilled, released into water bodies, or incinerated without energy recovery is considered sustainably available for biofuel production.

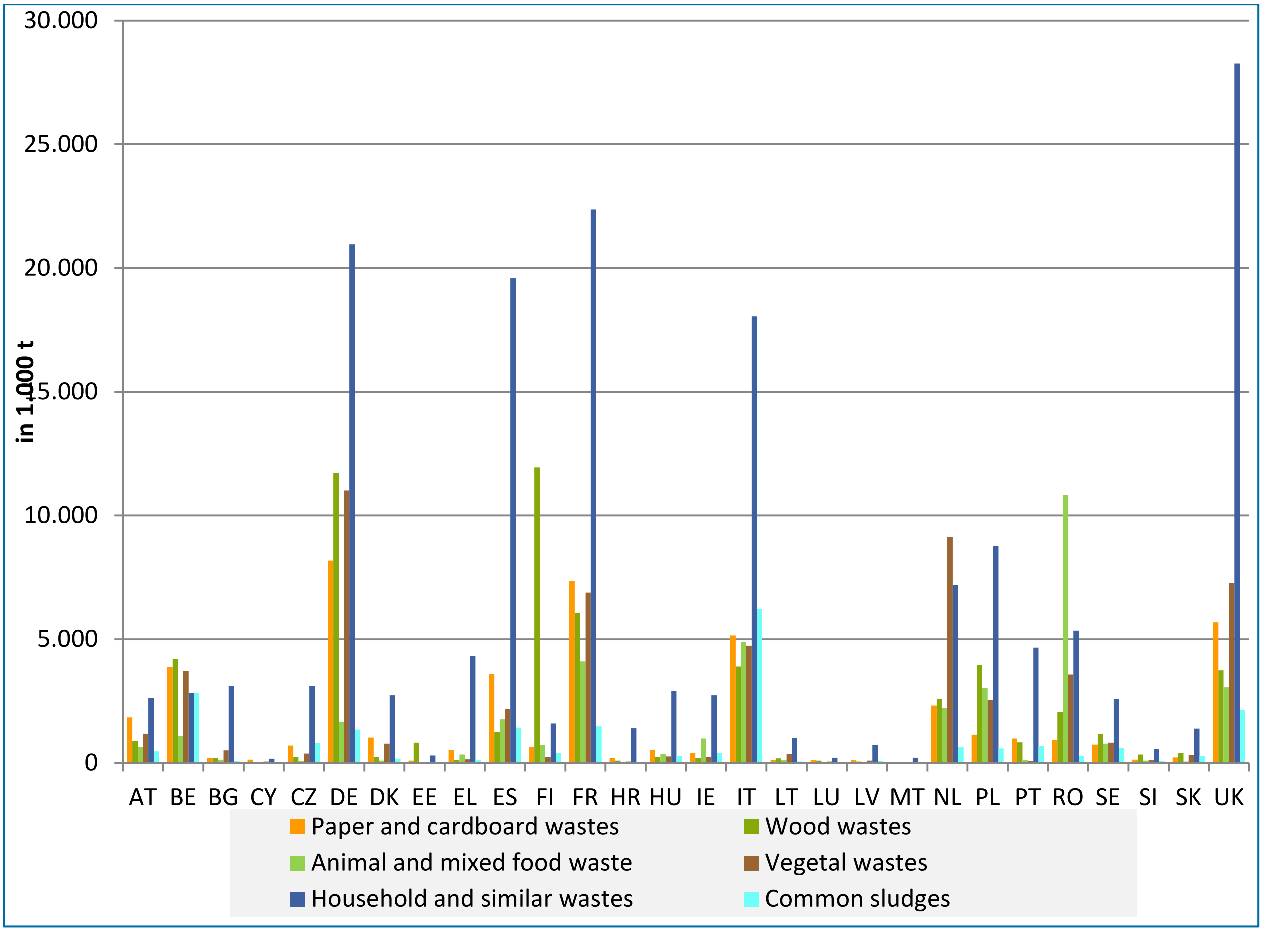
It is expected that waste generation and landfilling will decrease in the EU from the present to 2030 due to policies including the EU Waste Framework Directive (2008/98/EC) [11], the Landfill Directive (1999/31/EC), and the Packaging and Packaging Waste Directive (94/62/EC). Additional waste reduction measures may be expected both on the EU and national level. Due to the strong political interest in reducing waste generation and landfilling, [40] assume aggressive reductions in biogenic waste landfilling of 20 % in 2020 and a further 50 % reduction to 2030. They assume a constant overall quantity of biogenic waste that is incinerated, but that energy recovery will be practiced on a growing fraction of this. Furthermore they assume a 20 % reduction in incineration without energy recovery to 2020 and a further 50 % reduction to 2030 [40].

In 2012 EU-28 generated 2.514 million tons of waste. The total amount of treated waste amounts to 2302 million tonnes (92 %). 46 % were subject to recovery other than energy recovery. 42 % was subject to deposit onto or into land.

The EU average of energy recovery from waste is about 4%. The recovery is higher in DK (23 %), PT (17 %), BE (11 %) and Finland (11 %) (Figure 1-45).

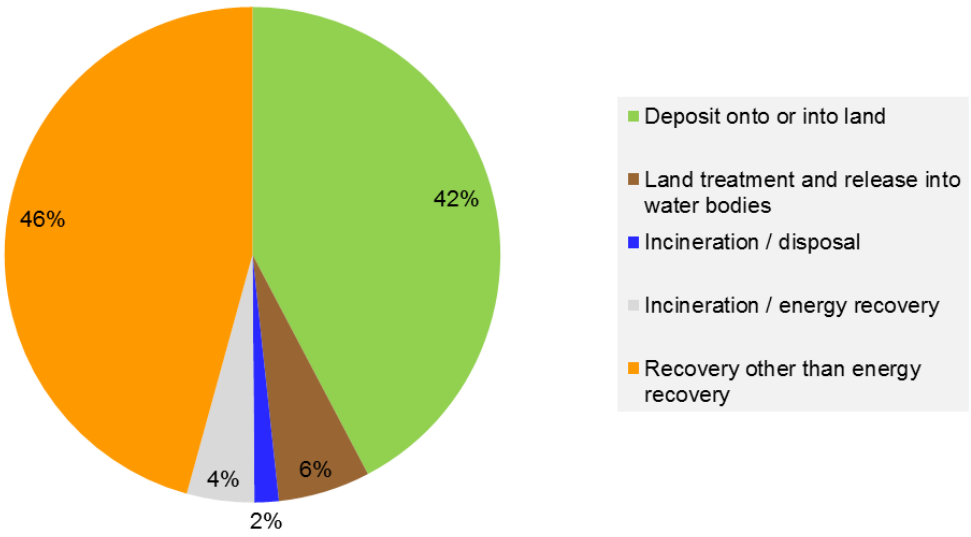
In the last decade, all Member States have increased their energy production from municipal waste treatment. It increased from 24% in 2012 to 27% in 2014 for EU-28 (Figure 1-47).

Figure 1-42: Biodegradable waste generated in EU 28 in 2012 (in 1000 t)



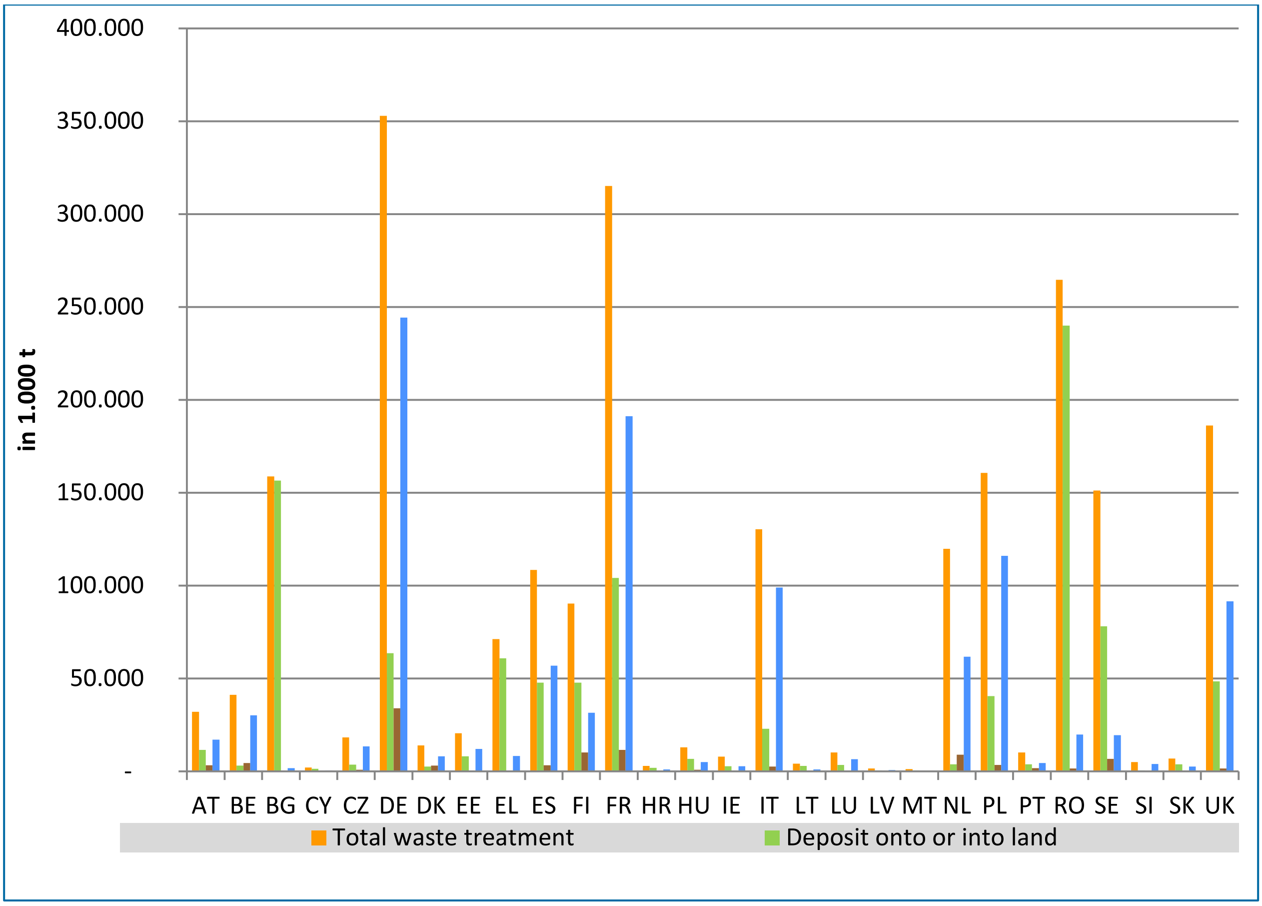
Source: [127]

Figure 1-43: Share of waste treatment in 2012 (in percent)



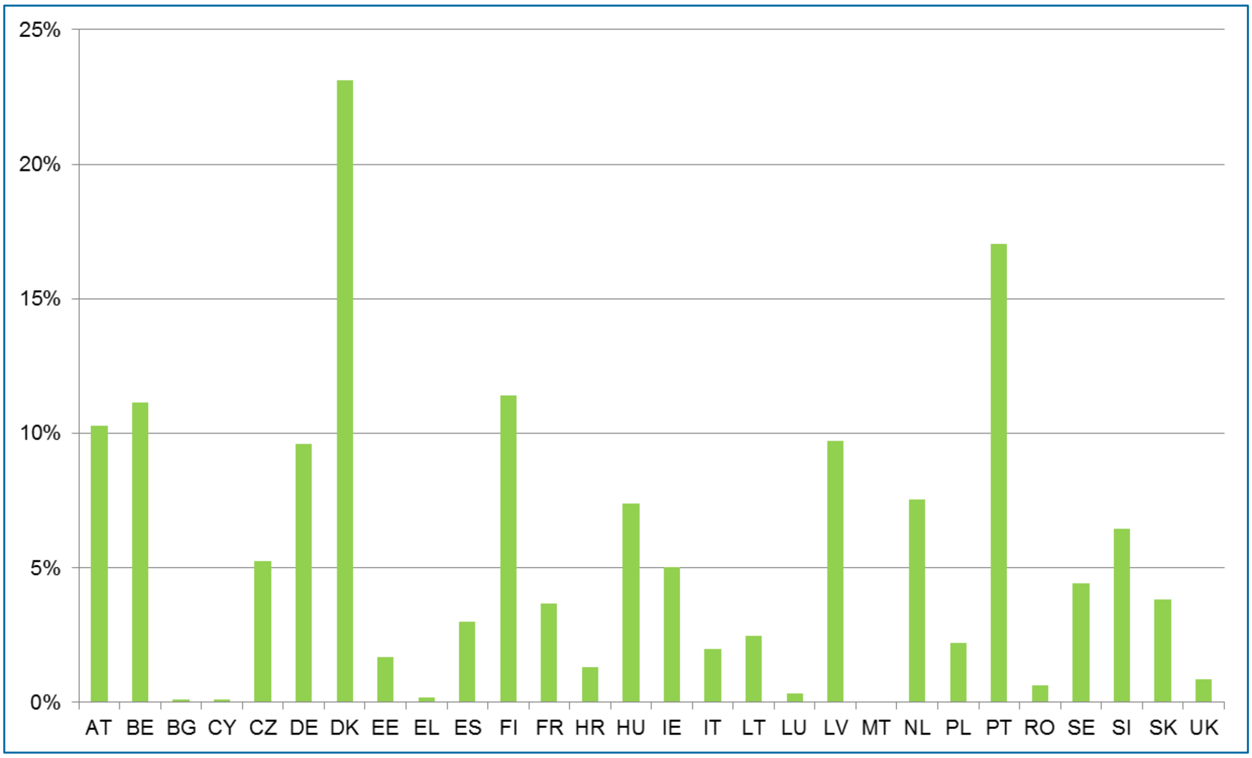
Source: [127]

Figure 1-44: Waste treatment in 2012 (in 1000 t)



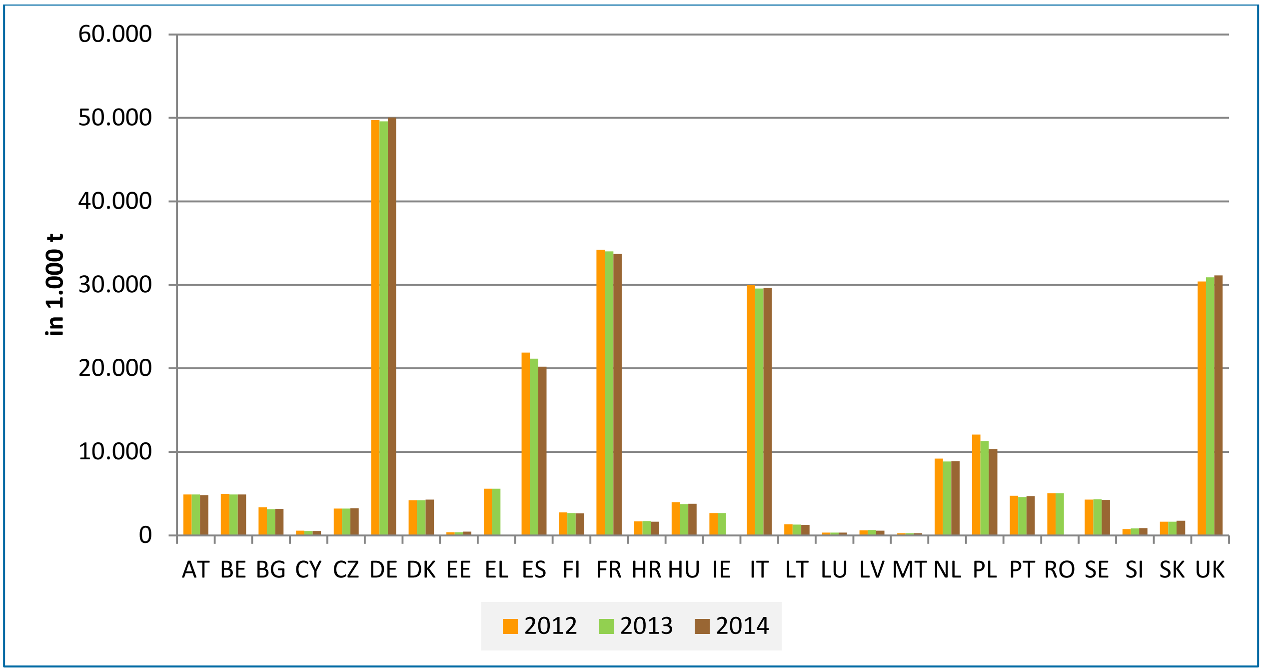
Source: [127]

Figure 1-45: Share of energy recovery from waste in 2012 (in percent)



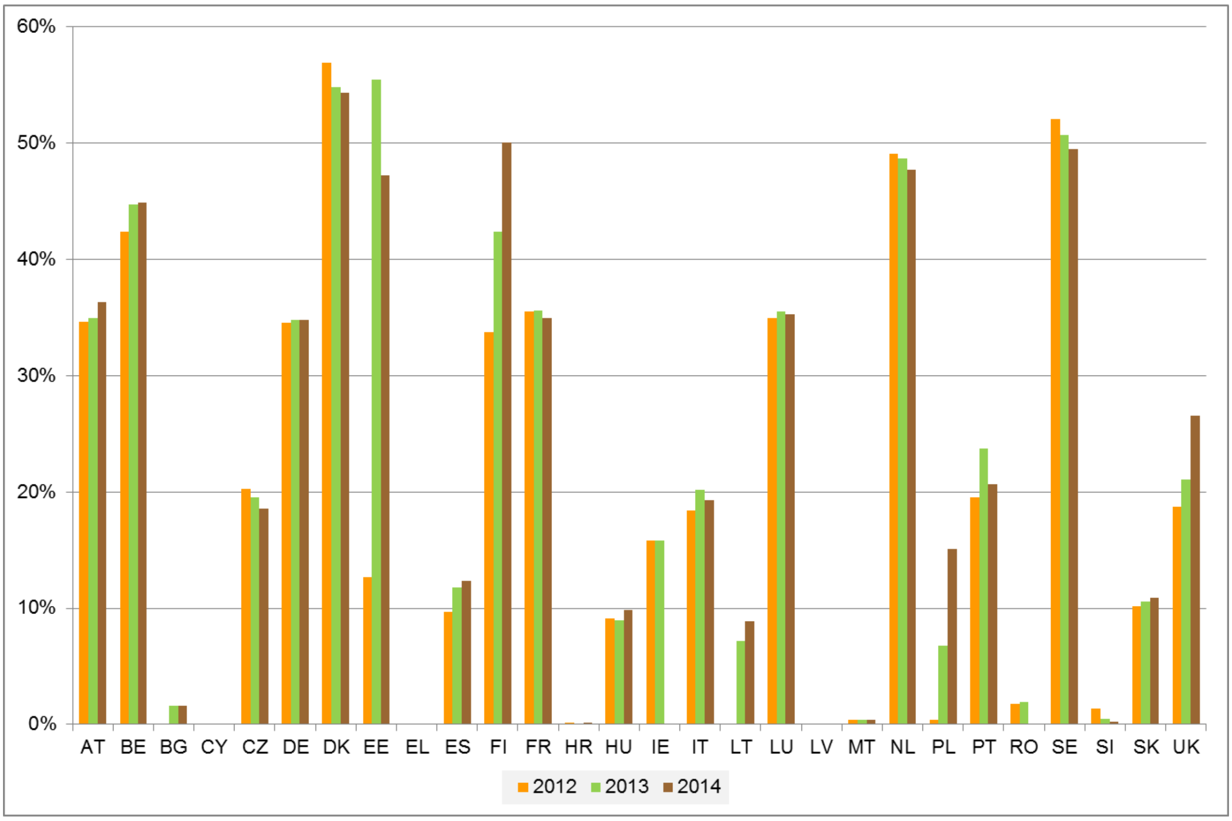
Source: Authors' own calculation based on [127]

Figure 1-46: Municipal waste (in 1000 t)



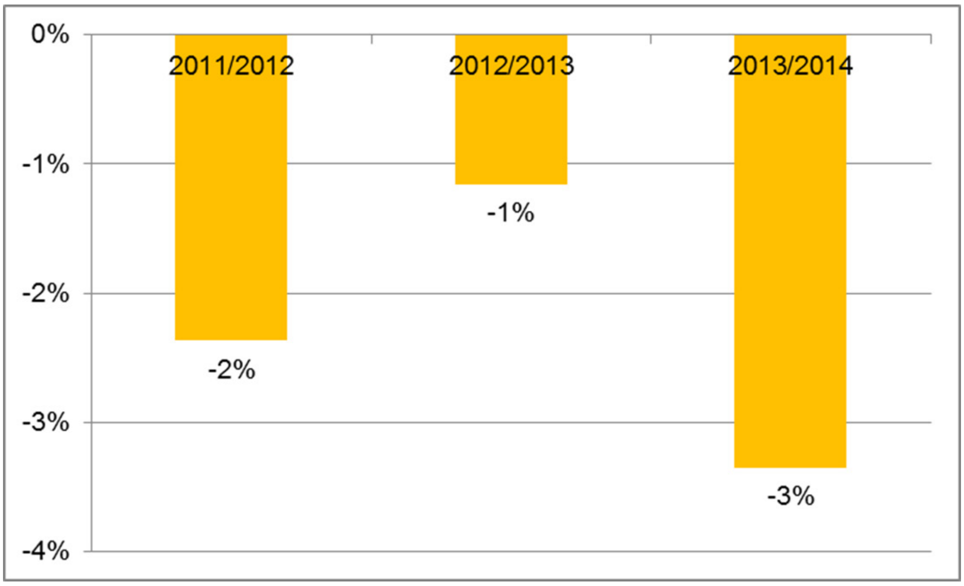
Source: [127]

Figure 1-47: Energy production from municipal waste treatment EU 28 - Incineration incl. energy recovery



Source: [127]

Figure 1-48: Energy production from municipal waste treatment: progress compared to the previous year in EU-28



Source: Authors' own calculation based on [127]

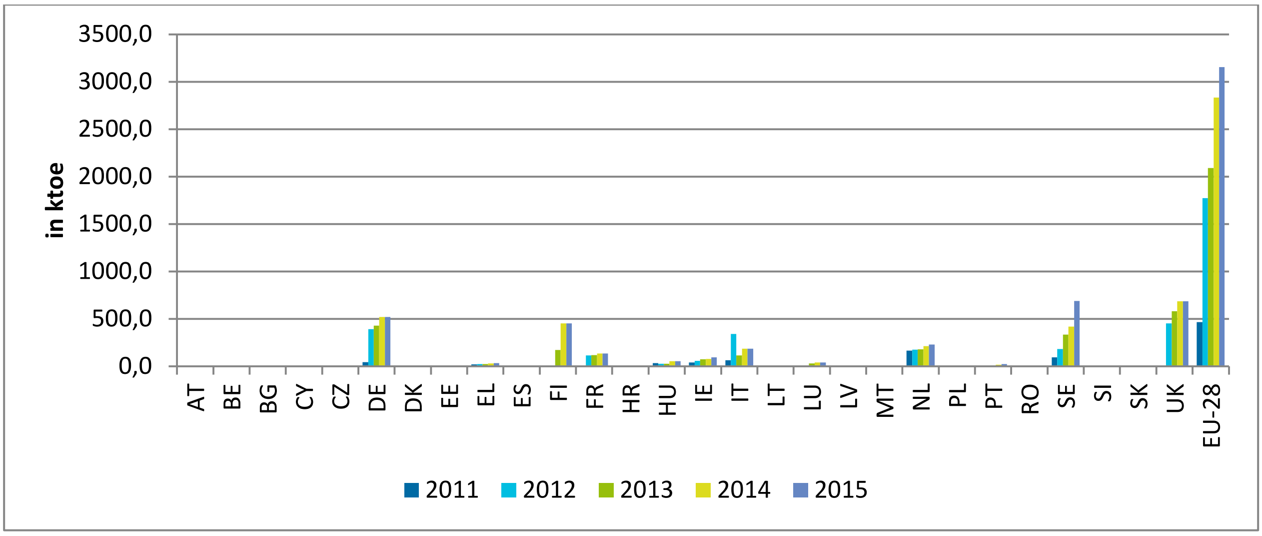
The split between different waste types in EU-28 is as follows: Municipal waste is the largest waste stream: 33 % household and similar waste (including plastics, own assumption: 50 % renewable), 27 % wood waste (renewable), 17 % sorting residues (own assumption: 50 % renewable), 10 % mixed (own assumption: no renewable share) and undifferentiated materials and 13 % others (own assumption: no renewable share).

It can be summarized that most of the available resource comes from agricultural residues (France, Germany, Denmark). It will be increase over time in this Member States, and so total availability in these countries is projected to increase as well. In Finland and Sweden, forestry residue availability is prominent. In the UK, which has high per capita waste generation, biogenic wastes represent the greatest available resource. Overall, larger countries tend to have a higher absolute quantity of wastes and residues available. Agricultural residue availability is generally expected to increase as total production of agricultural commodities increases across the EU. Some countries, such as Poland and Austria, are expected to significantly increase consumption of agricultural residues in heat, power, and biogas, and this effect overwhelms the expected increase in agricultural residue production so that overall availability decreases over time. Waste availability is projected to decrease in all countries as the EU prioritizes lower generation and higher recycling of waste. In Spain and the UK, where biogenic waste is the dominant available resource, total availability is expected to decline [40].

[40] estimate that at present 157 million tonnes of agricultural and forestry residues and wastes could be sustainably available for biofuel production without negative impacts on the environment or other uses. They estimate that 85 million tonnes of sustainably available agricultural residues for the EU is conservative, likely because their analysis implements strong assumptions of residue requirements for soil protection and assumes very strong residue yield growth.

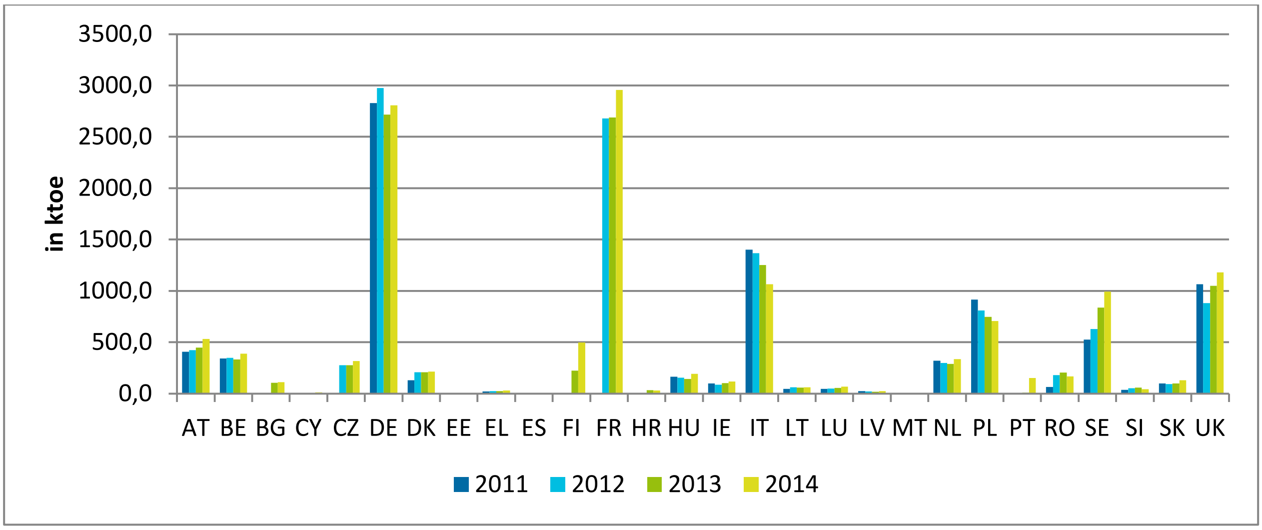
The Member States describe the development and share of biofuels in accordance with (Article 22 (1) (i) as follows: The share of biofuels has increased significantly since 2010. Between 2014 and 2015 the progress was 10.1 %. Especially between 2011 and 2012 the share of biofuels increased from 467 ktoe to 1,771 ktoe.

Figure 1-49: Development and share of biofuels in accordance with (Article 22 (1) (RES-T)



Source: [2] 2015

Figure 1-50: RES-T: Compliance



Source: [2] 2015

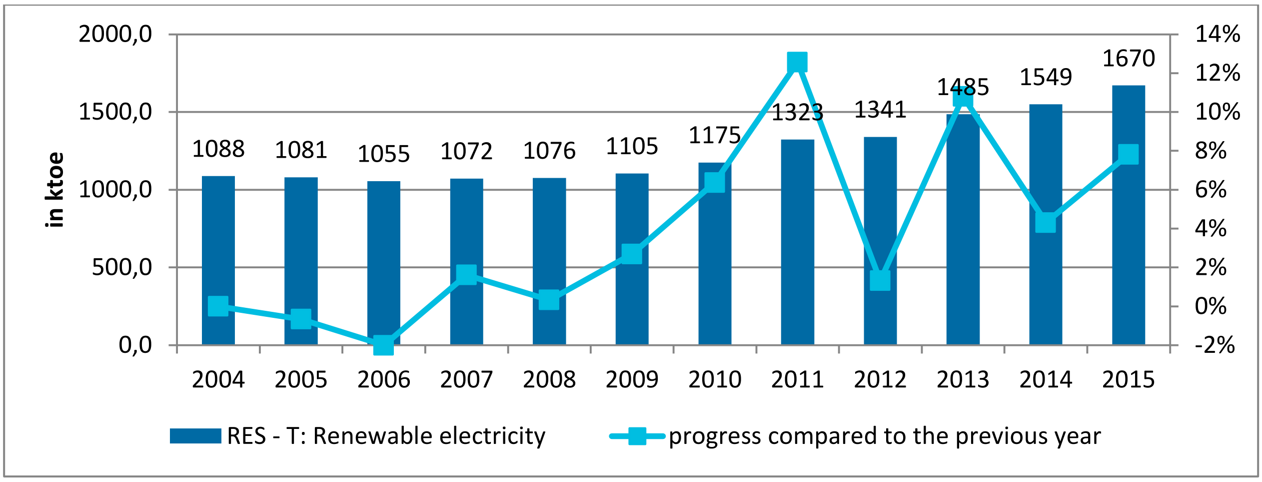
Biofuels can be produced from products, co-products, residues or wastes. Furthermore, the double counting mechanism is applied to residues and wastes, and in some Member States there is also a direct link to eligibility for state aid for instance in the form of tax benefits. In other words, from the fuel producer's perspective, feedstocks classified as residues or wastes are of great interest [41].

Several member states have chosen to define the terms in accordance with the Waste Framework Directive, while others have created definitions believed to be suitable for RED purposes. This has resulted in feedstocks being classified differently in different member states, i.e. a feedstock which in one member state is seen as a co-product can very well be labelled as a residue in another [41].

1.1.7. Progress in the use of renewable electricity and hydrogen in transport

The use of renewable electricity has increased steadily to 1,670 ktoe in 2015. This is a progress compared to the previous year at around 8 %.

Figure 1-51: RES-T: Renewable electricity incl. progress



Source: [127]

Hydrogen produced from renewables for the use in transport has not been reported in the Progress Reports.

An overview of hydrogen filling stations worldwide and in Europe can be found at http://www.netinform.net/h2/H2Stations/Default.aspx.

1.2. Assessment of biofuel sustainability

The RED requires the EC to report bi-annually on the measures taken by Member States and main third countries of feedstock production to safeguard sustainability of biomass feedstock production. Within the following section we provide information on voluntary schemes recognised by the EC, national systems of the Member States and possible bilateral agreements with main third countries.

1.2.1. Measures taken to respect the sustainability criteria for biofuels consumed in the EU (Article 17 (7)(1))

According to the national Progress Reports for 2015, 26 of the EU-28 Member States have transposed the RED sustainability criteria into national legislation. Croatia and Slovenia did not explicitly mention it within their Progress Reports for 2015. Croatia described "activities that have been undertaken to fulfil the obligation to comply with sustainability requirements in the production and use of biofuels". Slovenia has a Decree on Sustainability Criteria for Biofuels and on Greenhouse Gas Emissions within the Lifecycle of Transport Fuels ULRS, No 38/2012. It was stated in another document from 2014 that this decree is in preparation[8]. Unfortunately no further detailed information was found within the latest Progress Report. An overview of all Member States is presented in Table 1-12.

Table 1-12: Assessment of the transposition of the RED sustainability criteria into national legislation

Member State	National implementation of RED sustainability criteria	Comments
AT	yes	Information on amendment, Update of Kraftstoffverordnung was implemented in December 2012 due to sustainability criteria and in 2014 due to new annexes and calculation methods
BE	yes	In 2011 new regional provisions were adopted, transposing the requirements of Directive 2009/28/EC regarding the sustainability of biofuels.
BG	yes	The Renewable Energy Act (ZEVI), which transposes the sustainability provisions of Directive 2009/28/EC on the promotion of the use of energy from renewable sources, entered into force on 3 May 2011.
CY	yes	Since September 2013 all biofuels are accompanied by sustainability certificates based on voluntary schemes recognised by the EC. Economic accounting bodies do not use the national system to verify sustainability criteria, since domestic production of biofuels is negligible and raw materials used are domestic waste cooking oil.
CZ	yes	Act No. 201/2012 on air protection and No. 351/2012 on biofuel sustainability criteria

8 http://www.locsee.eu/uploads/documents/plans/Implementation_Plan_SLOVENIA.pdf

DE	yes	The German Federal Government transposed the Renewable Energy Directive and Fuel Quality Directive sustainability requirements (Article 17) into national legislation through the Biofuels Sustainability Ordinance (Biokraft-NachV). The Biokraft-NachV entered into force on 2 November 2009 for all provisions except provisions §24 (partial proof of sustainability) and §34 (2) (about the procedures to recognise VS) which came into effect on 1 January 2010.
DK	yes	The sustainability criteria in the Renewable Energy Directive for biofuels in the transport sector have been implemented in Danish legislation since 1 January 2010.
EE	yes	Regulation of the Ministry of the Environment on environmental requirements for liquid fuels, the sustainability criteria for biofuels and the procedure for certifying compliance was issued on 22 December 2010.
EL	yes	Law 4062/2012 fully transposed Directive 2009/28/EC into the Greek legislative framework setting the regulatory sustainability criteria for biofuels and bioliquids and verification of compliance, calculation of the biofuels and bioliquids impact on GHG
ES	yes	Royal Decree 1597/2011 of 4 November, which came into force in 2013, governs the sustainability criteria for biofuels and bioliquids, the National Sustainability Verification System and the double value of some biofuels for calculation purposes
FI	yes	Sustainability criteria for biofuels and bioliquids were implemented through Government Bill for an Act on Sustainability Criteria for Biofuels and Bioliquids, 393/2013 on 1 July 2013. Draft act amending the act on Excise Duty on Liquid fuels has presented in January 2016. By law, liquefied petroleum gas is tax -exempt, but nevertheless, it is mandatory to use the EMCS system when moving these products between EU countries (see section “Moving products under suspension of excise duty” below). From the beginning of 2016, however, liquefied petroleum gas will no longer be tax-exempt.
FR	yes	The sustainability requirements were implemented in France in November 2011. A transition period was in place until April 2012 during which economic operators had to provide evidence that they intend to join a voluntary scheme or to use the services of independent auditors. They were granted time until 31 December 2012 to provide a posteriori evidence of independent certification of sustainability.
HR	unknown	No explicit mention of the Act, activities have been undertaken to fulfil the obligation to comply with sustainability requirements in the production and use of biofuels
HU	yes	Hungarian regulations establish sustainability criteria for biofuels in line with the provisions of the Renewable Energy Directive
IE	yes	The Biofuels Obligation Scheme was initiated in July 2010 in line with the EU Renewable Energy Directive 2009/28/EC
IT	yes	Legislative Decree No 55/2011, which transposed Directive 2009/30/EC, and Legislative Decree No 28/2011 require adoption of EU sustainability criteria. Ministerial Decree from 23 January 2012, as amended and supplemented, put in place the national biofuel and bioliquid certification system, which establishes the methods for checking compliance with sustainability criteria.

LT	yes	Order No D1 - 2 of the Ministry for the Environment from 3 January 2011 (Official Gazette 2011, No 2 - 83) approved the Rules for calculating Greenhouse gas requirements. All biofuel production is recognised under ISCC System (97%). The remaining 3% cannot be verified, as they are produced from third countries.
LU	yes	A Grand Duchy Regulation entered into force in March 2011. The Grand Duchy Regulation from 27 February 2011 lays down the sustainability criteria for biofuels and bioliquids
LV	yes	The Latvian Government Regulations regarding Sustainability Criteria for Biofuels and Bioliquids were adopted on 5 July 2011. A transitional arrangement was in place during 2011, according to which there were no strict compliance requirements during 2011 for biofuels consumed in Latvia, but requiring economic operators to do an independent (ex-post) audit by 1 April 2012 to demonstrate compliance with the sustainability criteria. The implementation of the Renewable Energy Directive and Fuel Quality Directive sustainability criteria is integrated in Latvia.
MT	yes	Already implemented in 2010, Biofuels Regulations (S.L. 545.28), Biofuels and Bioliquids Market Regulations (S.L. 545.15) compliance verification
NL	yes	The Netherlands have implemented the Renewable Energy Directive and Fuel Quality Directive sustainability criteria in a single Government Decree and Ministerial Order which entered into force on 1 January 2011 and which also contains the RED target for renewable energy in transport. The regulations relating to double-counting of renewable energy for transport were amended on 1 January 2013.
PL	yes	21 March 2014, act amending the Act on Biofuel Components and Liquid Biofuels and certain other acts was adopted, followed by the act amending the Act on biofuel components and liquid biofuels and certain other acts on 15 January 2015; fully transpose the provisions of Directive 2009/28/EC into the Polish legal system
PT	yes	In 2010 the Renewable Energy Directive was transposed and applied in Portugal, implementing the sustainability criteria and high quality standards.
RO	yes	The compliance with sustainability criteria was mandated in Government Decision No 935/2011 on the promotion of the use of biofuels and bioliquids, published in the Official Gazette No 716/11 October 2011, which came into effect in December 2011
SE	yes	Implementation of the sustainability criteria of the Renewables Directive Act on sustainability criteria for biofuels and bioliquids occurred in November 2011. (Act 2010:598)
SI	unknown	Decree on Sustainability Criteria for Biofuels and on Greenhouse Gas Emissions within the Lifecycle of Transport Fuels ULRS, No 38/2012, but no information if it has been implemented
SK	yes	A sustainability criterion has been introduced in Slovakian law for biofuels as of 2011.
UK	yes	The RTFO was amended to implement the transport elements of the EU Renewable Energy Directive (RED), which include mandatory sustainability criteria for biofuels, on 15 December 2011. In 2015 the UK decided on mandatory sustainability criteria for biomass and biogas. The criteria are based on EC recommendations and include a minimum 60% lifecycle GHG savings requirement and a land criterion. For woody biomass the Timber Standard is used.

Source: [8], [2] 2015

In contrast to the last reporting period, five Member States had not mentioned the sustainability criteria in national legislation. During this period the status of implementation for two Member States (HR and SI) remains unknown. Slovenia published a Decree on Sustainability Criteria for Biofuels and on Greenhouse Gas Emissions within the Lifecycle of Transport Fuels in 2012. Nevertheless, there is no information on whether it has been implemented or not. In the case of Croatia there is no explicit mention of implementation. Several activities have been undertaken to fulfil the obligation to comply with sustainability requirements in the production and use of biofuels.

The progress reports discuss more or less possible impacts of the consumption of biofuels/biomass. They indicate economical, legislative and regulatory measures to reduce or mitigate the impact of biofuels feedstock cultivation on GHG-emissions (Article 17(2) and Article 23(4)), biodiversity (Article 17(3)) and Article 23(5)(c)), land with high carbon stock (Article 17(4)), peatlands (Article 17(5)), soil, water and air protection (Article 17(7)(1)). These issues are included in the sustainability legislation. Additionally some research has been or will be done, to build upon the knowledge about possible negative impacts of biofuels/biomass use. Most of the newly implemented measures are technical regulations e.g. for allocation methods. Spain implemented and designed a sustainability control scheme for the entire biofuel value chain. Another large set of new measures refers to financial support e.g. for biofuel producers.

Ecofys (2014) have already noted that national regulations typically exist for agricultural production, which also includes the cultivation of biofuel feedstock.

The complete list of measures can be found in Table 2-1 at the end of this report.

EurObserv'ER, in its latest biofuel market update (July 2016), estimated European Union biofuel requirements for transport to amount 14 Mtoe in 2015 (1.7 % less than in 2014). An EurObserv'ER survey also covers the consumption of biofuel certified as sustainable (set by the European Renewable Energy Directive as the only biofuel to be considered in national targets). Preliminary estimates suggest that certified consumption was about 12.9 Mtoe, or 92.1 % of EU biofuel consumption. This discrepancy is explained by Spain's failure to implement the legal framework in 2015 that would have officially certified its biofuel consumption. This anomaly should be removed in 2016, as a Royal Decree has been passed to bring Spain's biofuel consumption in line with the Renewable Energy Directive's sustainability requirements.9

The same considerations apply for measures for soil, water and air protection: national regulations exist for agricultural production, which also include the cultivation of biofuel feedstock (Ecofys 2014).

The complete list of the reported Member States measures can be found in Table 2-1 at the end of this report.

Further analysis on environmental impacts see chapter 1.2.3.1

Member State *estimate impacts of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality* in their Member State Reports (see reported text in Table 1-13). About 57% of the Member States (16) state that no negative effects from the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality are known, and 43% of the Member States provide no information or give no clear statement on this topic (compare Table 1-13).

[9] EurObserv'ER 2016: Biofuel Barometer, page 5

The only Member State reporting negative impacts on biodiversity, water and soil is Germany (Table 1-13). More intensive cultivation of agricultural land in Germany generally entails risks to biodiversity, water resources, water quality and soil quality. Rape, for example, which accounts for most of the land used for biofuel production, is frequently less beneficial if compared directly with other crops such as sunflowers and winter wheat (e.g. water quality).

Also Sweden admits that the loss of biodiversity in agriculture is well documented, and much of it is due to rationalisation and new agricultural methods. Also acidification from crop production and from running biogas plants can occur. However, the land used for biofuel production in Sweden is marginal and negative are marginal, too.

Table 1-13: Summary of reported estimated impacts of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality impacts

	Number of EU Member States	Proportion
No negative effects known on biodiversity, water resources, water quality and soil quality	16	57.1 %
Negative effects on biodiversity, water resources, water quality and soil quality possible due more intensive cultivation of agricultural land	1	3.6 %
No clear statement	6	21.4 %
No information / no assessment	6	21.4 %

Source: Own analysis of [2]

Arguments given by Member States to justify that no or low negative impacts on biodiversity, water and soil occur are manifold (see Table 1-14). Twelve Member States state that no or only a small scale biofuel crop production takes place in their country, and thus, no or only marginal negative impacts can be expected. Six Member States argue that fulfilling the binding RED criteria is sufficient to make sure that these negative impacts do not occur. Furthermore, several Member States give reference to the assessment effects from renewable energy sources or from agriculture production as well as to the compliance with Cross Compliance rules or other European and national laws and strategies (compare Table 1-14 and Table 1-15).

It can be summarized that most EU Member States expect low or no impacts of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality. Nevertheless, the arguments given by Germany and Sweden may also apply for other countries with high amounts of domestic biofuel crop production like France, and a more critical analysis on this topic in Member State reports would be helpful.

Table 1-14: Summary of arguments for no / low impacts of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality impacts

	Number of EU Member States	Proportion
Arguments for no / low impacts on biodiversity, water resources, water quality and soil quality		
Only wastes / no domestic biofuel crop production	3	10.7 %
Only limited / only small scale biofuel crop production	9	32.1 %
Fulfilling RED criteria (certification/national implementation)	6	21.4 %
Assessment of effects from RES, including biofuels	2	7.1 %
Assessment of impact of agriculture production	1	3.6 %
Reference to the implementation of EU legislation / EU strategies	2	7.1 %
Reference to Cross Compliance rules	4	14.3 %
Reference to national law / national strategies (protected areas, water management plans, biodiversity strategy, etc.)	3	10.7 %

Source: Own analysis of [2]; multiple mentioning possible.

Table 1-15: Impacts of the production of biofuels on biodiversity, water resources, water quality and soil quality

AT	Austria has undertaken to protect the sustainable use and restoration of biodiversity and proper distribution of the advantages from the use of genetic resources [Convention on Biological Diversity (CBD, BGBl. 213/1995), EU Biodiversity Strategy 2020]. The Habitats Directive and the Birds Directive require Austria to class certain areas as protected sites and to maintain a favourable conservation status for the flora and fauna in question. In the Alpine Convention, Austria pledged to protect species and nature in the Alps. Conservation and promotion of biological diversity in forest ecosystems is a core concern of the Ministerial Conference on the Protection of Forests in Europe (MCPFE). Long-standing efforts have already been made under the support programme for rural development, in cooperation with open-minded agricultural and forestry farmers, in a bid to reconcile a varied, multi-purpose agricultural landscape with support for biological diversity in agricultural landscapes. Austria adopted its 'Biodiversity Strategy 2020+' in 2014. The BMLFUW Regulation on agricultural raw materials for biofuels and liquid biomass fuels, BGBl. II No 250/2010, ensures that Austrian agricultural raw materials produced in accordance with cross compliance (CC) and conservation law can be declared sustainable. The ultimate objective of Directive 2000/60/EC [Water Framework Directive (WFD)] is to 'prevent further deterioration and protect and enhance the status of aquatic ecosystems. In order to attain the objectives and implement the principles of the WFD, the Federal Minister for Agriculture and Forestry, Environment and Water Management has compiled a National Water Management Plan 2009 (NGP 2009), in cooperation with the provincial water management planning departments, and published it on the Ministry website.
BE	The production of biofuels is not known to have had any adverse effects on biodiversity, water and soil quality.

BG	In accordance with Article 85(1) of the Environment Protection Act (ZOOS), Article 31(4) of the Biological Diversity Act (ZBR) and Decision No 1 EO-1/2009 of the Minister for Environment and Water, the draft NPDEVI an Opinion on Environmental Assessment (OEA) was issued by the Minister for Environment and Water. The Report considers possible environmental impacts following the installation of current RES technologies, including biofuels in transport, bioethanol and biodiesel. Controlling the environmental impact of the generation of energy from RS, including the production of biofuels, is implemented by the MOSV structures through their powers pursuant to ZOS and its subordinate legislation. According to the annual control plans, the regional environmental and water inspectorates will carry out checks on compliance with the requirements of the environmental legislation, on the conditions related to any environmental impact assessments which have been issued and the integrated permits of these sites. Monitoring and control of the environmental impact once the NPDEVI is implemented are carried out based on measures and indicators set out in the OEA,
CY	No biofuels or bioliquids were produced in Cyprus in 2013-2014 from domestic biomass and, therefore, no impact on biodiversity, water resources, water quality and soil quality has been identified. Production depended exclusively on imported raw materials processed in Cyprus with a small quantity of domestic waste vegetable oils.
CZ	The impact of agricultural production on biodiversity, water, soil, air, and other aspects of the environment are routinely monitored in the Czech Republic and are evaluated using a set of relevant indicators. The values of selected indicators are presented to the government and made public through the annual Report on the State of Agriculture, Report on the State of the Environment, and the Sustainable Development Report for the Czech Republic. In the 2013 – 2014 monitoring period, the value of most of the agricultural environmental impact indicators remained at approximately the same level. This indicates that the impact of biomass production for energy use on agricultural land was neutral during the monitoring period.
DE	The development of agricultural production is influenced by various factors. The culti-vation and marketing of raw materials for the production of biofuels is only one of these factors. It is difficult to empirically verify the direct effects of biofuel production on the overall agricultural production system or demonstrate a monocausal link between the two. This is particularly true given that the German agricultural market is closely tied to the global markets. It is generally the case that pressure on agricultural land is increasing. There are various reasons for this (including population growth, increasing material use, reserved areas, rising prices for agricultural goods and land, etc.). More intensive cultivation of agricultural land in Germany generally entails risks to biodiversity, water resources, water quality and soil quality.
DK	Production has been so limited that, in the opinion of the Danish Energy Agency, there has not been a significant impact.
EE	no environmental impact assessments regarding production of biofuels and their raw materials have been conducted in Estonia. No biofuels are produced in Estonia, and other agricultural activities are not known to have become more environment-intensive than usual. In connection with the increase in the amount of solid biomass used and the increase in its export potential, the Estonian government plans to further analyse the possible negative environmental impacts of the production of energy products.
EL	No specific study has been performed to gauge the impact of the production of biofuels and bioliquids on biodiversity, water resources, water and soil quality within Greece so far. no significant impact is expected due to the small scale energy crops cultivated in the country and the appropriate legislation issued and applied
ES	in the case of Spain the impacts referred to under point nine are bound to be irrelevant due to the limited use of domestic raw material for biofuel production.
FI	For the time being, the production of biofuels and bioliquids in Finland is based on material from domestic waste and residues and, to some extent, on imported raw materials. Monitoring is carried out within the framework of the national sustainability scheme to ensure that biofuels and bioliquids are produced sustainably and that they do not have a harmful impact on biodiversity, for example.

	The production of biofuels therefore cannot be assessed to have had an impact on any of these factors in Finland.
FR	There has been no assessment of the impact of the production of biofuels on these natural resources in the preceding two years. France is concentrating first and foremost on implementing the sustainability criteria for biofuels set out in Directive 2009/28/EC.
HR	Up to 2014 no system had as yet been established in Croatia for assessing the impacts of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality. However, activities have been undertaken to prepare the ground for Croatia to fulfil the obligation to comply with sustainability requirements in the production and use of biofuels as a prerequisite for counting biofuel energy towards meeting the national biofuel market placement targets and the obligation to place biofuels on the market – a condition to be met by Croatia so that it can avail of incentive payments for biofuel production.
HU	Data supply in progress.
IE	The most significant feedstocks for domestic biofuel production over the two years have been waste and residues - i.e. used cooking oil and tallow. A small amount (62,509 litres) of bioftiel from rape seed oil which was produced in Ireland was placed on the market in 2013. In 2014 all biofuels produced in Ireland and placed on the market were made from used cooking oil or category 1 tallow. With this mix of feedstocks, domestic production of bioftiels has produced no detectable impacts in terms of biodiversity, water resources, water quality or soil quality in Ireland in 2013 or 2014.
IT	Italy energy crops have had limited spread and have taken up just a small share of the overall Utilised Agricultural Area. There are a number of reasons for this: some purely agricultural (certain crops have a relatively small yield hence low profitability) others linked to the market trends in commodity crops, which make it more cost-effective, for some crops (especially oilseeds partly used to produce biofuels) to import them from abroad and then processed in Italy. Italy ranks among the top countries in Europe in terms of biodiesel production capacity, but it is also one of the main importers of the raw materials for making biodiesel, (e.g. palm oil from Indonesia and other energy crops grown in various European countries). In all likelihood, therefore, the countries from which Italy imports those crops are those which should most address impacts on biodiversity (e.g. the case of the rainforest in south-east Asia); impacts typically linked to ordinary agricultural practices, on the other hand, might be recorded in the European countries where energy crops have spread the most (impact on fallow land, simplification of the agricultural landscape, intensification of agricultural practices designed to maximise yield per unit area of land). In Italy, the main energy crops grown to make biofuels and bioliquids are oilseeds (especially rapeseed, sunflower and soy); however, their allocation between energy and non-energy uses is not precisely recorded in the national statistics. In any case, since the total land area devoted to these crops for energy purposes is of a few thousand hectares, these energy crop uses have no significant impact on the rural ecosystem.
LT	the impact of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality was not assessed.
LU	Compared to the second progress report, there has been no change to information on the estimated impacts of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality.
LV	In Latvia, no research has been conducted during the reporting period to assess the impact of the production of biofuels and bioliquids on biodiversity, water resources, water quality and soil quality.
MT	Local biofuel production derives mainly from waste cooking oil waste streams. Thus, there is minimal, if any, negative impact on biodiversity, water resources, water quality and soil quality. The local manufacturer of biofuels has to abide to Integrated Pollution Prevention and Control regulations. This local production is considered as having a positive impact on environment as it reuses waste.

NL	Hardly any raw materials for biofuels are grown in the Netherlands. In addition, practically no new agricultural land has been brought into use. For this reason, the impact on biodiversity, water resources, water quality and soil quality as a result of growing crops for biofuels is irrelevant in the Netherlands.
PL	Given the short time frame for the performance of the task in question arising from the entry into force of the Act on RES and the lack of data to perform the task, the Polish authorities will provide the information in the next reporting period.
PT	Given the low levels of endogenous agricultural material used in the production of biofuels, it does not appear that at national level, there is any impact on biodiversity, water resources or soil quality.
RO	Government Decision No 935/2011 on promoting the use of biofuels and bioliquids and by Government Decision No 928/2012 establishing the conditions for putting petrol and diesel oil on the market and introducing a mechanism for monitoring and reducing greenhouse gas emissions. These government decisions were amended and supplemented by GD No 1121/2013, which entered into force on 6 January 2014. Biofuels and bioliquids may not be produced from raw materials produced on land rich in biodiversity, in particular land that, starting with 1 January 2008, belonged to one of the following categories, regardless of whether this classification is still valid or not: primary forests and other woodland of native species, areas designated by law or by the environmental authority, pastures rich in biodiversity. Biofuels and bioliquids cannot be produced from raw materials that come from land with high carbon stock, in particular land that used to hold one of the following statuses, starting with 1 January 2008, and that no longer holds said status, as follows: wetlands, high-density forests, land larger than one hectare, covered with trees more than 5 meter high. Biofuels and bioliquids cannot be produced from raw materials that come from lands which, on 1 January 2008, were peat bogs, except for the case in which there is proof that the planting and harvesting of that raw material does not involve the drainage of the soil that had not been drained previously.
SE	Only a small proportion of this agricultural area is used to grow crops for biofuels. The total cultivated area is not currently controlled to any great extent by demand for raw materials for biofuels. The loss of biodiversity in agriculture is well documented, and much of it is due to rationalisation and new agricultural methods. As it is so marginal, it is hardly possible to quantify the effects on biodiversity of Sweden production of biofuels from wheat and rape. 'Water resources' refers to activities that affect the quantity of water, i.e. irrigation, etc. Access to water is not a problem in Sweden, other than in the occasional year when some parts of the country may be hit by drought. However, cereals and other crops that are used to produce biofuels are not irrigated, not even in years when there is a drought. Since no new agricultural land is deemed to have been given over to the current production of crops for biofuels, the assumption is that these crops do not contribute to any direct changes in stored carbon in the soil that need to be taken into account in this context. With the assumptions described above, the cultivation of cereals for ethanol contributed just over 280 tonnes of eutrophying substances (PO43 equivalents) in 2013, and 197 tonnes in 2014, and approximately 126 tonnes of acidifying substances (SO2 equivalents) in 2013, and 88 tonnes in 2014. Rape for biodiesel contributed approximately 139 tonnes of eutrophying substances (PO43 equivalents) in 2013, and 246 tonnes in 2014, and approximately 45 tonnes of acidifying agents (SO2 equivalents) in 2013, and 79 tonnes in 2014; In 2013, the production of biogas for biofuels amounted to approximately 85 million m3 (equivalent of 0.73 TWh), contributing to emissions of approximately 27 tonnes of eutrophying substances (PO43 equivalents) and approximately 147 tonnes of acidifying substances (SO2 equivalents) if the value for the biogas substrate from household waste is used for the entire amount produced. In 2014, the production of biogas for biofuels amounted to approximately 97 million m3 (0.82 TWh), contributing to approximately 31 tonnes of eutrophying substances (PO43 equivalents) and approximately 168 tonnes of acidifying substances (SO2 equivalents), with the same assumptions as for 2013.
SI	nothing reported

SK	Biofuels and bioliquids in Slovakia meeting sustainability criteria are produced from agricultural raw materials which are grown and produced in accordance with requirements and standards for good agricultural and environmental condition pursuant to Council Regulation (EC) No 73/2009. This is guaranteed by a declaration by the farmer or supplier of biomass stating that the requirement for good agricultural and environmental condition has been met. At the moment there is no relevant data on the adverse impact of producing biofuels on biodiversity, water resources, water quality or soil quality. It is assumed that these impacts are negligible, since the area of crops cultivated for biofuels in 2009 to 2014 did not increase significantly compared with the previous period.
UK	The Joint Nature Conservation Committee (JNCC), the UK Government's statutory advisor on UK and international nature conservation, commissioned a report in 2013 to look at the impacts on UK biodiversity from the production of biofuels and bioliquids from domestic feedstocks. The report looked at the potential of using bird population data as a proxy for broader biodiversity: http://jncc.defra.gov.uk/default.aspx?page=4229

The *Cartagena Protocol on Biosafety to the Convention on Biological Diversity* is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health. The Cartagena Protocol was adopted on 29 January 2000 and entered into force on 11 September 2003. All Member States have ratified or accepted the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (see Table 1-16).

Table 1-16: Implementation of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity on Member States level

	Date	Accession Mode	Signature
Austria	2003-09-11	Ratification	2000-05-24
Belgium	2004-07-14	Ratification	2000-05-24
Bulgaria	2003-09-11	Ratification	2000-05-24
Cyprus	2004-03-04	Accession	
Czech Republic	2003-09-11	Ratification	2000-05-24
Germany	2004-02-1B	Ratification	2000-05-24
Denmark	2003-09-11	Ratification	2000-05-24
Estonia	2004-06-22	Ratification	2000-09-06
Greece	2004-0B-19	Ratification	2000-05-24
Spain	2003-09-11	Ratification	2000-05-24
Finland	2004-10-07	Ratification	2000-05-24
France	2003-09-11	Approval	2000-05-24
Croatia	2003-09-11	Ratification	2000-09-0B
Hungary	2004-04-12	Ratification	2000-05-24
Ireland	2004-02-12	Ratification	2000-05-24
Italy	2004-06-22	Ratification	2000-05-24
Lithuania	2004-02-05	Ratification	2000-05-24
Luxembourg	2003-09-11	Ratification	2000-07-11
Latvia	2004-05-13	Accession	
Malta	2007-04-05	Accession	

Netherlands	2003-09-11	Acceptance	2000-05-24
Poland	2004-03-09	Ratification	2000-05-24
Portugal	2004-12-29	Acceptance	2000-05-24
Romania	2003-09-2B	Ratification	2000-10-11
Sweden	2003-09-11	Ratification	2000-05-24
Slovenia	2003-09-11	Ratification	2000-05-24
Slovakia	2004-02-22	Ratification	2000-05-24
United Kingdom	2004-02-17	Ratification	2000-05-24

Source: [42]

Also almost all identified main third countries have ratified or accepted the Cartagena Protocol (see Table 1-17). However, according to [135], Argentina, Russia and USA do not participate in the Cartagena Protocol.

Table 1-17: Main third countries: Implementation of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity

	Date	Accession Mode	Signature
Argentina	--	--	--
Bolivia	2003-09-11	Ratification	2000-05-24
Brazil	2004-02-22	Accession	0
Canada	--	--	--
China	2005-09-06	Approval	2000-0B-0B
Guatemala	2005-01-26	Accession	0
India	2003-09-11	Ratification	2001-01-23
Indonesia	2005-03-03	Ratification	2000-05-24
Malaysia	2003-12-02	Ratification	2000-05-24
Pakistan	2009-05-31	Ratification	2001-06-04
Peru	2004-07-13	Ratification	2000-05-24
Russia	--	--	--
Serbia	2006-05-09	Accession	0
South Korea	200B-01-01	Ratification	2000-09-06
Thailand	2006-02-0B	Accession	0
Ukraine	2003-09-11	Accession	0
USA	--	--	--

Source: [42]

The *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES has been implemented by all of the EU Member States (Table 1-18). Also all identified main third countries participate in CITES (Table 1-19).

Table 1-18: Implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora

Member State	Type	date of joining	entry in force
Austria	Accession	27.01.1982	27.04.1982
Belgium	Ratification	03.10.1983	01.01.1984
Bulgaria	Accession	16.01.1991	16.04.1991
Cyprus	Ratification	18.10.1974	01.07.1975
Czech Republic	Succession	14.04.1993	01.01.1993
Germany	Ratification	22.03.1976	20.06.1976
Denmark	Ratification	26.07.1977	24.10.1977
Estonia	Accession	22.07.1992	20.10.1992
Greece	Accession	08.10.1992	06.01.1993
Spain	Accession	30.05.1986	28.08.1986
Finland	Accession	10.05.1976	08.08.1976
France	Approval	11.05.1978	09.08.1978
Croatia	Accession	14.03.2000	12.06.2000
Hungary	Accession	29.05.1985	27.08.1985
Ireland	Ratification	08.01.2002	08.04.2002
Italy	Ratification	02.10.1979	31.12.1979
Lithuania	Accession	10.12.2001	09.03.2002
Luxembourg	Ratification	13.12.1983	12.03.1984
Latvia	Accession	11.02.1997	12.05.1997
Malta	Accession	17.04.1989	16.07.1989
Netherlands	Ratification	19.04.1984	18.07.1984
Poland	Ratification	12.12.1989	12.03.1990
Portugal	Ratification	11.12.1980	11.03.1981
Romania	Accession	18.08.1994	16.11.1994
Sweden	Ratification	20.08.1974	01.07.1975
Slovenia	Accession	24.01.2000	23.04.2000
Slovakia	Succession	02.03.1993	01.01.1993
United Kingdom	Ratification	02.08.1976	31.10.1976

Source: https://cites.org/eng/disc/parties/chronolo.php

Table 1-19: Main third countries: Implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora

Main Third Countries	Type	date of joining	entry in force
Argentina	Ratification	08-01-1981	08-04-1981
Bolivia	Ratification	06-07-1979	04-10-1979
Brazil	Ratification	06-08-1975	04-11-1975
Canada	Ratification	10-04-1975	09-07-1975
China	Accession	08-01-1981	08-04-1981
Guatemala	Ratification	07-11-1979	05-02-1980
India	Ratification	20-07-1976	18-10-1976
Indonesia	Accession	28-12-1978	28-03-1979
Malaysia	Accession	20-10-1977	18-01-1978
Pakistan	Accession	20-04-1976	19-07-1976
Peru	Ratification	27-06-1975	25-09-1975
Russia	Continuation	13-01-1992	01-01-1992
Serbia	Continuation	06-06-2006	03-06-2006
South Korea	Accession	09-07-1993	07-10-1993
Thailand	Ratification	21-01-1983	21-04-1983
Ukraine	Accession	30-12-1999	29-03-2000
USA	Ratification	14-01-1974	01-07-1975

Source: https://cites.org/eng/disc/parties/chronolo.php

1.2.2. Ratification and implementation of Labour Convention (Article 17(7)(2))

Ratifying conventions adopted by the International Labour Organization create legal obligations to improve labour standards in the domestic economy.

The following Conventions have been ratified and implemented in many countries:

- Forced Labour Convention, 1930 (No. 29)
- Protocol of 2014 to the Forced Labour Convention, 1930 (P029)
- Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)
- Right to Organise and Collective Bargaining Convention, 1949 (No. 98)
- Equal Remuneration Convention, 1951 (No. 100)
- Abolition of Forced Labour Convention, 1957 (No. 105)
- Discrimination (Employment and Occupation) Convention, 1958 (No. 111)
- Minimum Age Convention, 1973 (No. 138)
- Worst Forms of Child Labour Convention, 1999 (No. 182)

The Member States have implemented and enforced the conventions, except P 029. The Convention will enter into force for Czech Republic on 09 Jun 2017 and for United Kingdom on 22 Jan 2017.

The ILO commented on the implementation or enforcement of ILO conventions. In some Member States the ILO requested additional information in 2015, e.g. Austria has to provide information on the application in practice of the National Action Plan (2012–14), indicating whether the objectives set out have been achieved and whether an evaluation has been undertaken in order to assess the impact of the measures (C029) adopted. Cyprus was requested in 2015 to reduce the gender pay gap (due to C100) and to include in its equality legislation provisions specifically prohibiting discrimination in employment and occupation on the grounds of social origin (C111). Croatia was requested to provide details on measures envisaged or taken with a view to accelerating judicial proceedings in cases of anti-union discrimination (C098). The requests for information are not always relevant to biofuel production.

In most Member States the ILO comments, observations or requests concern Convention 98, distantly followed by 100, 138 and 87. The discrimination of anti-union or the participation of union activities are the most specific concerns, but are not especially focused on the biofuels sector.

For the main third countries of origin the following picture emerges:

Table 1-20: ILO-Convention Ratification

	Conventions							
Country	**29**	**87**	**98**	**100**	**105**	**111**	**138**	**182**
Argentina								
Belarus								
Bolivia								
Brazil		■						
Canada			■					
China	■	■	■		■			
Guatemala								
India		■	■				■	■
Indonesia								
Korea, Republic of	■	■	■		■			
Malaysia		■				■		
Norway								
Pakistan								
Peru								
Russian Federation								
Serbia								
Thailand		■	■			■		
Ukraine								
United States	■	■	■	■		■	■	
Uruguay								

Source: [131]

Filled boxes depict conventions that have not been ratified.

Some main countries of origin have not ratified the conventions. This includes the following countries: Brazil, Canada, China, India, Republic of Korea, Malaysia, Thailand, and USA.

Most of the countries have ratified most of the conventions. In the case of US it is argued that the remaining five conventions have been found to directly conflict with US law and practice and thus have not been considered for ratification since ratification would require extensive revisions of US state and federal labour laws.

Canada has officially ratified an international treaty that seeks to eliminate child labour and ensure children do not leave school to join the workforce full time in June 2016 and it will come into force in June 2017.

Other relevant ratifications by countries for EU biofuel production have not been achieved. In contrast to this, most voluntary standards address social criteria through the adoption of the ILO criteria.

In theory, national laws on land tenure, resource rights, environmental protection and labour are in a stronger position to influence practice than voluntary measures specific to biofuels. Schutet al. (2013) contend that if such policies are effectively designed and implemented, additional instruments aimed at governing biofuel production become unnecessary [43].

Nevertheless, there are critical voices regarding a full ratification:

Guatemala, who ratified all of the conventions [44], dicussed that national laws, for instance on labour practices, are better placed to influence practice than voluntary measures specific to biofuels. While the legal framework ostensibly safeguards the social and environmental sustainability of the sugar sector, in practice the lack of institutional capacity means that law enforcement is inadequate. As a result, it is the EU market that sets the sustainability requirements with which biofuels produced in Guatemala should comply. Under such circumstances, certification schemes are likely to assume additional importance yet, may be blind to the political economic realities within which biofuels are produced. Finally, the EU's governance framework for biofuels fails to capture many of the issues that matter to local people and their communities, namely land access, trade unions, and compliance with the law. This is problematic, as it raises questions about the ability of the EU's governance framework to drive more sustainable practices in producer countries. While sustainability standards had driven some positive changes in Guatemala, they had also endorsed highly questionable practices. To conclude, by negating the concerns of those affected by agricultural production, the EU's governance system runs the risk that it will strengthen the position of more powerful actors, while further marginalizing already vulnerable people and their communities [44].

[43] recommend according to the given diversity of pre-existing economic, social and political arrangements where biofuel crops are grown, it is not necessarily desirable to treat each of these considerations the same way in all times and places. Locally relevant criteria are therefore important. Measures that focus on anticipating and avoiding problems are more likely to protect sustainability than those focused on monitoring outcomes and ensuring redress (e.g. EU reporting requirements). This could be a way to make biofuel governance both more proactive and flexible.

Due to this fact ILO conventions seem to have only limited influence on good governance practices and social sustainability of biofuel production, all over the world.

1.2.3. Impacts of sustainability of biofuels consumed in the EU

1.2.3.1. Environmental, including on biodiversity (Article 23(5)(b))

Summary

With regard to environmental aspects, under the Renewable Energy Directive (RED) the European Commission is required to report according to Article 23.5 (b) on the impact of increased demand for biofuel on sustainability in the Community and in third countries, considering environmental impacts, including impacts on biodiversity.

The binding sustainability requirements include minimum GHG saving requirements for biofuels compared to fossil fuels and the exclusion or sustainable use of areas of high biodiversity, areas of high carbon stock and peatlands globally as well as agricultural management in the EU. Direct negative effects from bioenergy crop production are addressed through certification (coverage of 92% in 2014), but displacement effects in main third countries are possible.

Member State Reports: Except for Germany, the reporting Member States indicated only negligible impacts of biofuel production on the environment. This is due to the fact that the production quantities are relatively small but also because statistical data and research results often do not exist.

Land use change in EU Member States reported under UNFCCC: While at national level only small land use changes regarding forests and wetlands were observed in 2013 and 2014 in EU Member States, the loss of grassland was evident in many Member States. A direct causal relationship between the loss of grassland area and an increase in the area of cropland used for the production of bioenergy, however, appears to be unlikely in EU Member States for that period, with the exception of Lithuania. The loss of grassland area is more likely a result of an increase in settlements, forest areas and cropland areas for non-energy crops. However, subnational effects and possible displacement cascades (grassland to cropland and cropland to settlements elsewhere) cannot be analyzed with the data available.

Biodiversity: Many areas relevant for biodiversity are excluded from the cultivation of biodiesel and bioethanol feedstocks under the RED. Nevertheless, there is a risk that the production of biodiesel and bioethanol feedstocks in third countries – main biofuel and biofuel feedstock supliers to the EU can take place on areas relevant for biodiversity impacts. Based on modelling results high risks are expected especially for Indonesia, Malaysia, Guatemala and Peru, and medium risks in Argentina and Brazil. Modelled biodiversity risks are low or absent for other main third countries. Risks of direct effects can be excluded for 92% of the biofuels consumed in the EU, but displacement effects may be driven by EU consumption.

Soil: The protection of soils is only addressed in the RED for agricultural land within the EU. The analysis for main third countries showed that biofuel feedstocks are often cultivated on soils with low suitability for agriculture, which can be used as an indicator for soil degradation risks. This is the case for both, already existing and newly established cropland. Model results show that soil suitability was in general lower in cases of bioethanol feedstocks compared to biodiesel feedstocks. However, this analysis gives no information on whether existing risks are adequately addressed, but emphasizes the need for risk reducing measures.

Water: Water related sustainability requirements, e.g. related to water stress, water scarcity or water quality, are absent from the RED. High water stress appears to be an issue in single main third countries rather than for biodiesel or bioethanol feedstocks in general. For example, a proportion of more than 60% of cropland with a high water stress can be found in Pakistan and Peru, and for sugar

cane also in USA and EU. Similar to the protection of soils, this analysis gives no information on whether existing water risks are adequately managed, but emphasizes their need.

Greenhouse gas emissions: GHG emissions are well covered by the RED (sound GHG calculation, exclusion of areas with high carbon stock). The analysis of main third countries shows that land newly converted to cropland is associated to high GHG emissions, except bioethanol produced from the perennial crop sugar cane.

Excurse on solid biomass: EU demand for wood pellets is a main driver for wood pellet production in Russia, Canada and USA. Negative impacts through biomass extraction on sensitive areas (biodiverse forests, peatlands and wetlands) seem likely in a number of main third countries. There is the risk for negative impacts through wood energy extraction, but impacts of other wood uses like industrial roundwood appear more relevant in those countries, regarding the total volume.

Background

The Renewable Energy Directive (RED) has set up several binding environmental requirements:

- Biofuels and bioliquids shall achieve a greenhouse gas reduction compared to fossil fuels of at least 35% until 31 December 2017 and at least 50 % from 1 January 2018. (Article 17.2) Biofuels and bioliquids, produced in installations starting operation after 5 October 2015 shall achieve at least 60 % GHG emissioin savings compared to fossil fuels.
- Land with high biodiversity value shall be excluded from or not negatively affected by biofuel feedstock production (Article 17.3). Land with high biodiversity value and associated requirements are defined in Article 17.3 a (primary forests), in Article 17.3 a (protection areas), and in Article 17.3 a (highly biodiverse grasslands).
- Land with high carbon stock shall be excluded from biofuel feedstock production (Article 17.4), namely wetlands (Article 17.4 a) and forests (Article 17.4 a and b). In case of forests with a tree cover of 10-30 %, cultivation can be allowed when the GHG-reduction goal can be achieved (Article 17.4 c).
- Peatland shall be excluded from cultivation unless the cultivation and harvesting of biofuel feedstocks does not involve drainage of previously undrained soil (Article 17.5).
- Cultivation of biofuel feedstocks within the EU has to fulfil the Cross Compliance rules (Article 17.6).

New developments like the ILUC-Directive in 2015 (Directive (EU) 2015/1513[10]) and the decision on highly biodiverse grasslands in 2014 (Commission Regulation (EU) 1307/2014[11]) did not affect the biofuel production in the reporting period covered in this report.

[10] EP (European Parliament) (2015): Directive (EU) 2015/1513 of the European Parliament and the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Official Journal of the European Union (15.9.2015, EN): L 239/1 - L 239/29.

[11] EC (European Commission) (2014): Commission Regulation (EU) No 1307/2014 of 8 December 2014 on defining the criteria and geographic ranges of highly biodiverse grassland for the purposes of Article 7b(3)(c) of Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels and Article

It needs to be recognized that the RED covers only biofuels for transport and bioliquids (all sectors). The sustainability of solid and gaseous biomass used for power generation and heat and cooling is not covered by harmonised and mandatory sustainability criteria under the RED, though the Commission recommended Member States to adopt sustainability requirements covered in the RED on a national scale [132].

Biofuels to be accounted towards the EU renewable energy targets and to be eligible for public support have to comply with the above mentioned binding environmental sustainability criteria of the RED and the compliance has to be verified by a national or EU-wide sustainability certification schemes. For example, in 2014, 92% of the biofuels consumed in the EU Member States were certified as sustainable in accordance with the requirements of the RED [45]. Theoretically, no direct negative impacts e.g. on primary forests, protected areas, highly biodiverse grassland, forests, wetlands and peatland should occur from these biofuels. Nevertheless, a smaller proportion (i.e. 7.1% of biofuels consumed in the EU in 2014) were not certfified (mainly in Spain where the legal framework for certification was not introduced yet [45]). Furthermore, measures in EU Member States and main third countries that are a significant source of biofuels consumed within the EU may be weak, and negative impacts may occur in other production sectors than biofuels due to displacement effects.

Consequently, we assessed potential impacts of agricultural production on the environment by means of three approaches:

1. Analysis of environmental impacts reported in Member State reports
2. Analysis of land use change data reported by EU Member States under UNFCCC
3. Modelling of impacts from land use change in EU Member States and main third countries, focusing on the environmental impact categories biodiversity loss, soil quality, water stress, and carbon loss.

Finally, we analyse potential negative impacts that may occur from EU solid biomass consumption in EU Member States and main third countries.

Member State reports

In summary, except for Germany, the reporting Member States indicated only negligible impacts of biofuel production on the environment. This is due to the fact that the production quantities are relatively small but also because no statistical data or research exists. Environmental impacts reported by EU Member States are the following:

In Cyprus there is no impact on biodiversity, water resources, water quality and soil quality to be expected, because no biofuels from domestic biomass were produced.

Czech Republic expects no negative impacts on the environment due to risk of financial penalty in the case of lacking compliance with good agricultural and environmental conditions. The impacts on biodiversity, water, soil, air and other aspects are routinely monitored, utilising a set of indicators. The last report said that the influence of biomass cultivation on agricultural land is neutral.

17(3)(c) of Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. Official Journal of the European Union (9.12.2014, EN): L 351/3 - L 351/5.

Germany has high livestock numbers, coinciding with high incidence of biogas. A high proportion of maize is often associated with high levels of ammonia in the air and nitrates in the groundwater, a negative humus balance, increased risk of attack by pests (corn borer and corn rootworm), impoverishment of agricultural biodiversity, and adverse effects on the look of the landscape. Furthermore, an increasing demand for biomass for energy use has made grassland an important supplier of biomass. An intensification of grassland use typically leads to reduced biodiversity. For 2014 it is assumed, that there was no further ploughing up of permanent grassland in Germany. Other negative effects on biodiversity can result from the loss of agricultural micro-structures such as hedges, uncultivated field edges and other border areas. There is no indication for impacts on the availability of water. Nevertheless, due to nitrate und phosphate use and changes in hydro morphology the water quality is likely to meet the targets. The effects on soil quality may arise, but conditions like change in the level of organic soil content, increased risk of erosion by wind and water and increased risk of compaction remain constant. Currently there is no nationwide study of changes in the environmental state of agricultural soils in Germany.

The cultivation of rapeseed for biofuel production has potential effects on regional diversity of species and water quality: impact on regional species inventory, excess of nitrogen on land due to susceptibility to insect damage and fungal infections. An empirical verification of effects does not exist.

In Denmark no significant impacts were observed, due to the limited production of biofuels.

In Estonia no negative impacts on the environment have been reported, due to rather low levels of production. We also do not know whether other agricultural activities are becoming more environmentally intensive than without bioenergy production. Estonia plans to analyse in the future possible negative environmental impacts following a potential increase of solid biomass production.

Greece has no data or information available on this issue.

In Finland the production of biofuels and bio liquids is largely based on domestic waste and residues, so there is no harmful impact on biodiversity or any other environmental aspects expected.

France does not carry out any assessments of impacts, but concentrates on implementing the sustainability criteria for biofuels.

In Ireland only a small amount of feedstocks (rapeseed) was used for biofuel production. Biofuels are mostly produced from used cooking oil. Therefore Ireland reported no detectable impacts on biodiversity, water or soil.

In Italy energy crops have had limited spread and have taken up just a small share of the overall utilised agricultural area. This is due to low profitability and market trends to import crops from abroad for processing in Italy. The impacts on biodiversity are therefore expected to be addressed by the producing countries. Impacts within Italy due to growing feedstocks like rapeseed and sunflower are not recorded in national statistics.

Lithuania and Latvia have no data to assess possible impacts on the environment.

Malta says that if there are any negative impacts on biodiversity, water and soil, the effects are minimal. This is due to the fact that the local production of biofuels is largely based on wastes.

The Netherlands reports that no land use changes have occurred due to biofuel production. Therefore, no significant impact on biodiversity is expected.

Poland will provide information on this issue in the next reporting period.

Energy crops in Portugal are only used for experimental purposes. Therefore the country expects no negative impacts on the environment.

In Sweden impacts on biodiversity through agriculture are well documented and much of it is due to rationalisation and new agricultural methods. It is difficult to quantify the explicit impacts of production of biofuels. Cereals and other crops are not irrigated; therefore there is no impact on water quality. Furthermore there are no direct changes in stored carbon in the soil .

Slovakia has no relevant data on the adverse impact of producing biofuels on biodiversity, water and soil.

The remaining Member States (Austria, Belgium, Bulgaria, Croatia, Luxemburg, Romania, Spain, Slovenia, UK) did not report any effects.

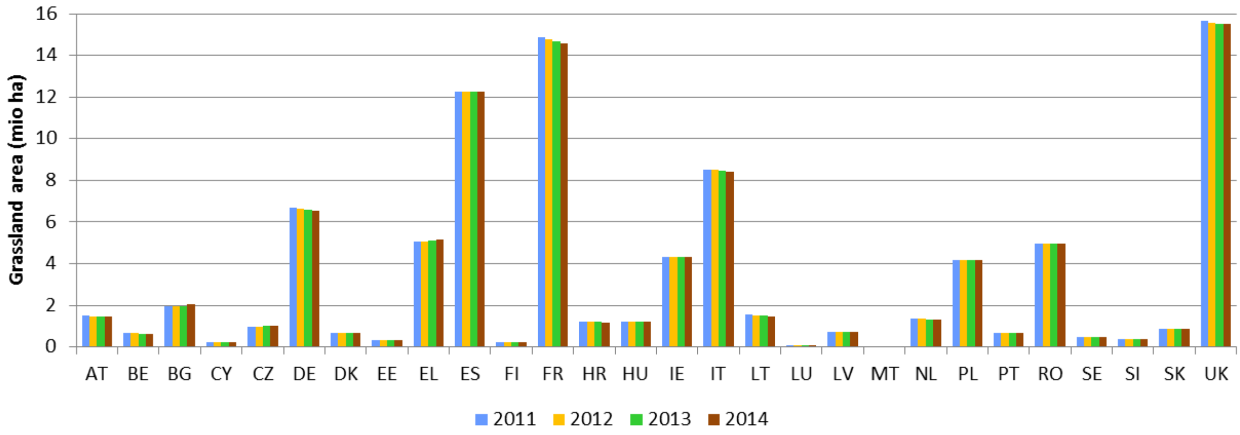
Land use change in EU Member States reported under UNFCCC

Under the United Nations Framework Convention on Climate Change (UNFCCC) all parties included in Annex I are required to submit annual inventories to the Convention. The reporting follows standardized guidelines and is summarised in a common reporting format [133]. Under the sector Land Use, Land Use Change and Forestry (LULUCF) land use data are reported, including the land categories forests, cropland, grasslands and wetlands. These annual data (1990 to 2014) are available for all EU Member States, but not for most main third countries identified in Chapter 3.1.6. Thus, only EU-28 Member States were analysed on the basis of this database.

The analysis of the reported LULUCF data for 2013 and 2014 revealed that the forest area stayed almost constant or increased for most EU Member States. Minor decreases of the forest area occurred only in Spain (2013: -0.06 %; 2014: -0.10 %), Finland (2013: -0.06 %; 2014: -0.05 %) and Latvia (2013 and 2014: -0.04 %). Also the dynamics of wetland areas were found to be low, but for some Member States decreases of wetlands of up to -0.31 % were slightly larger than for forest area changes.

In contrast to forests and wetlands, much stronger decreases were apparent for grassland areas. The highest grassland losses occurred in Lithuania with 1.6 % in 2013 and 2.4 % in 2014. Significant decreases of grasslands were also visible in countries characterized by large amounts of grassland areas (e.g. Germany, France, Italy and UK).

Figure 1-52: Development of grassland area in EU-28 Member States (2011-2014)



Source: [133]

The loss of grassland might be driven by an increase of bioenergy production and the resulting conversion of grasslands to cropland. However, no data are available that allow for a direct analysis of such a relationship. Nevertheless, plotting land categories for member states characterised by large losses of grassland in relation to changes of area used for the production of bioenergy (compare Figure 1-52) allow some interesting insights:

In Germany the cropland area stayed stable in 2013 and 2014, though the area used for bioenergy production decreased in 2013 and then increased strongly in 2014. The loss of grasslands occurred mainly due to an increase in settlements and also forests in both years. A causal chain between grassland loss and an increase of the production area for bioenergy appears unlikely from the national perspective. However, subnational conclusions are not possible by means of the used data.

In France the decline of grassland was high in 2013 and 2014, mainly coming along with an increase of cropland, settlements and forests. However, the production area for bioenergy decreased in these two years and is, thus, unlikely to be responsible for the increase of cropland and loss of grasslands.

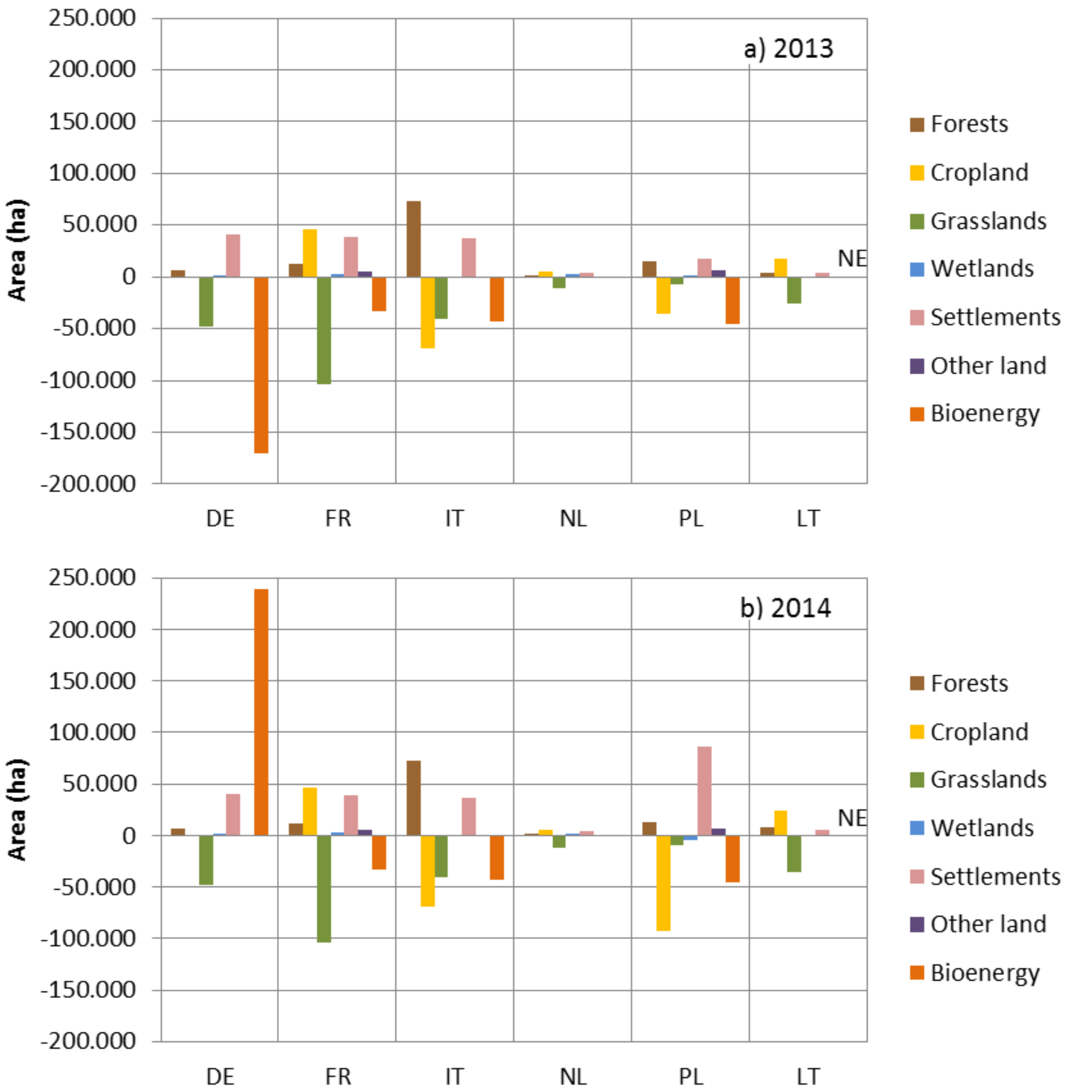
In Italy a decrease of cropland occurred along with a decrease of bioenergy production. However, the grassland area still decreased due to a strong increase of forests and settlements.

The situation in Poland was similar to the one in Italy, though the loss of grasslands was relatively low compared to the land use changes for cropland and settlements.

In the Netherlands grasslands declined in favour of cropland, wetlands, settlements and forests, but the production area for bioenergy declined slightly (about – 400 ha/a).

The Lithuanian loss of grassland was mainly accompanied by an increase of the cropland area. Unfortunately, no data on the area used for bioenergy production was reported by Lithuania for 2013 and 2014. In 2012 the bioenergy production area increased by 30,000 ha in parallel to a 23,000 ha increase of cropland and a grassland loss of 35,000 ha.

Figure 1-53: Area of land categories in relation to changes in bioenergy production areas for EU Member States with high decreases of grasslands (top six in 2013 and 2014)



Source: [133] reported under UNFCCC (Land categories); area used for bioenergy production origins from Member State reports (France 2013: interpolation of 2012 and 2014 values)

From a national perspective, a causal relationship between the loss of grasslands and an increase of the area used for the production of bioenergy appears to be unlikely in EU Member States in 2013 and 2014, with the probable exception of Lithuania. The loss of grasslands is more likely a result of an increase of settlements, forest areas and cropland areas due to other crops. However, subnational effects and possible displacement cascades (grassland to cropland and cropland to settlements elsewhere) cannot be analysed by the presented data.

Modelling impacts from land use and land use change in Member States and main third countries (LandSHIFT)

Spatial data on land use reported at the global scale are absent. Global land use patterns are commonly computed on the basis of existing land cover maps in combination with reported production values and yield changes. Here, land use changes related to EU-28 agriculture commodities ' production, including the potential biofuel feedstocks are analysed by using the land use model LandSHIFT (**Land S**imulation to **H**armonize and **I**ntegrate **F**reshwater Availability and the **T**errestrial Environment).

It must be stated clearly that this assessment is partly based on reported data and partly on model algorithms. Furthermore, no direct relation between biofuel consumption within the EU-28 and land use pattern in main third countries and EU Member States can be drawn. Only impacts from the production of crops that can potentially be used as bioenergy feedstocks can be analysed. The covered crops are soy bean, oil palm and other oil seeds applicable for biodiesel production and wheat, other cereals, maize and sugar cane for bioethanol production.

Modelling land allocation

The land use model LandSHIFT is applied to generate land use maps for the years 2007 and 2014 coving the territories of the EU member states and the main third countries identified in Section 0. A detailed description of the model can be found in Schaldach et al. (2011) and Alcamo et al. (2011). LandSHIFT operates on a global spatial grid with a cell size of 5 arc-minutes (~9x9 km at the equator). Each cell is assigned to a country or world region (macro level). In this study the macro level comprises the aforementioned EU member states and the most important biomass export countries/regions. Model input (drivers) on the macro-level includes information on crop production in metric tons, livestock numbers, population numbers and technological improvements. Cell-level information comprises a land use type, human population density, and a set of parameters that describe landscape characteristics (e.g. terrain slope, potential crop yields, road infrastructure) and land use restrictions (e.g. protected areas).

The model is initialized with a global land-cover map for the year 2001. Additional information on the spatial location of specific crop types and pasture is introduced by merging this map with census data of cropland and grazing land area provided on the macro level. Land-cover is based on the MODIS MCD12Q1 dataset [46], while census data are obtained from the FAO Statistical Division [32]. The provided census data contain crop-specific areas only as harvested areas. As the model requires physical area, this data is recalculated as the relative share total harvested area of each crop in relation to total physical area as a 5-year average. All model area results are based on these conversion factors.

In each simulation step LandSHIFT translates the macro-level model drivers into spatial land use patterns. First the suitability of each raster cell for the different land use types is determined based on the cell-level information, using a multi-criteria analysis. Thereafter the model allocates the amount of land needed for achieving the specified crop production and pasture in the most suitable raster cells. To give a simplified example: if in country “A” 1.000 t of soybean is produced, the model first identifies the most suitable raster cells for soybean production. Then, based on their respective crop productivity it allocates the production to the required number of cells by changing their land use type accordingly.

In the analysis we perform two simulation time steps for the years 2009 and 2014. The map in year 2009 represents the situation after adoption and entering into force of the RED and the map in year 2014 corresponds with the timeframe of the reporting requirements. Model results are raster maps that depict the land use patterns in the EU Member States and in the main third countries. According to model initialization, calculations are performed with 5-year means.

With regard to the conservation of protected areas, primary forests and forests we assume that countries with a corruption index (CI; [47] above 25 (for protected areas) and above 50 (for primary forests and forests) ensure the protection of these sensible areas, and the respective cells are excluded from a conversion to new cropland in model runs. For countries with a corruption index below or equal to the corresponding corruption threshold no efficient protection of these sensible areas is assumed and they can be converted to new cropland.

Sustainability analysis - environmental impacts (GIS analysis)

LandSHIFT provides spatial pattern on land use and land use change for the EU Member States and main third countries. Potential risk of agricultural production can be assessed in respect to the environmental impact on biodiversity loss, soil quality, water stress and carbon loss (in the following addressed as environmental impact categories) by comparing spatial land use pattern with pattern of these environmental impact categories. The latter analysis is conducted with a Geographic Information System (GIS) for the calculated land use maps in 2009 and 2014 (static analysis) as well as for the land use change (change analysis) between the two time steps.

In the first step of the static-analysis the raster cells of the crop types used as feedstock for bioenergy production are extracted from the land use maps. In the second step we overlay these cells with maps related to different environmental impact categories (e.g. water stress). The fraction of the respective cropland cells within areas, e.g. on high, medium and low environmental risk, are identified. In contrast the change-analysis focuses on cells with natural and semi-natural land-cover that are converted to agriculture between 2009 and 2014. Similar to the static analysis first the relevant cells are extracted and then overlaid with the respective maps for the environmental impact categories.

Third countries (main biofuel and biofuel feedstock suppliers to the EU-28)

The analysis in section 1.1.4.2 to 1.1.4.5 revealed, that available data source are not sufficient to derive a full list of main third countries of origin. Reflecting available information and in accordance with the Commission we focus the land use modelling on the following third countries as main biofuel and biofuel feedstock suppliers to the EU-28:

- Soybean: Argentina and Brazil
- Palm oil: Indonesia and Malaysia
- Rapeseed: Ukraine
- Sugar cane: Brazil, Bolivia, Guatemala, Peru and Pakistan
- Maize: USA
- Cereals: Ukraine

Figure 1-54: Used maps related to environmental impact categories

Impact category	Sub-categories	Product / Tool	Specifications
Biodiversity [12]	Protected areas	World Database on Protected Areas (WDPA) [141]	IUCN Protected Areas Categories I-VI; cropland and used grassland already existing in 2008 can still be used.
	Primary forests	Intact Forests Landscape (IFL) [142]	All IFL-areas that coincides with LUT Forest from MODIS
	Highly biodiverse areas	Global: maps on vertebrate species diversity [143]	If all Bird, Mammals and Amphibians are threatened or geographic range size smaller than the global median
		EU: maps on high nature value farmland (HNVF) [144]	All HNVF areas
	Peatlands	Harmonized World Soil Database (HWSD) [145]	Class 14 (Histosole)
	Wetlands	Global Lakes and Wetlands Database (GLWD) [146]	Categories (4-8 and 10)
	Unused grasslands	MODIS (Friedl et al. 2010)	LUT Categories 6,7,9
	Used grasslands	LandSHIFT (own calculation)	Pastures
	Forests	MODIS [139]	LUT Categories 1-5 and 8
Soil	Soil suitability for cultivation	soil suitability map from the International Institute for Applied Systems Analysis (IIASA; soil-constrained-combined (Plate 27))	IIASA categories grouped as: - 1 to 3: high suitability - 4 to 5: medium suitability - 6 to 7: low suitability
Water	Water stress	Global hydrology model WaterGAP (Index between 0 and 1) [147]	- high water stress: >0.4 - medium water stress: 0.2 – 0.4 - low water stress: <0.2
Carbon	Emission / Fixation of greenhouse gases	LCA approach of the EU Renewable Energy Directive (RED)	Calculated as described in [148]

Source: Own compilation.

[12] To avoid double-counting of areas, the following allocation hierarchy is applied: protected area > primary forest > highly biodiverse area > peatland > wetland > unused grassland > used grassland > forest. E.g. a primary forest located in a protected area is counted as protected area and not as primary forest or forest. A highly biodiverse grassland is counted as highly biodiverse area and not as grassland.

Biodiversity. Habitat loss as a result of land use changes is the major threat to biodiversity, with over 80% of globally threatened birds, mammals, and amphibians affected wholly or in part by habitat loss [56. As conversion of land with high biodiversity value (primary forests, protection areas and highly biodiverse grassland), land with high carbon stock (wetlands and forests) and peatland is forbidden under the RED, the applied biodiversity risk assessment focuses on potential indirect impacts, such on habitat loss due to indirect land use change in biodiverse-relevant land categories associated to additional land expansion for other uses than biofuels. In the static-analysis and change-analysis the selected cropland is overlaid with different maps indicating biodiversity-relevant areas (figure 1-54) covering time period from 2007 to 2014. Conversion of protected areas, primary forests and highly biodiverse areas, peatland, wetlands, unused grasslands and forests is associated with a “medium” to “high risk”. The risks associated with the use of already-used grassland (pasture) are discussed for each country individually. The conversion of fallow land to cropland is classified as being of “low risk” to biodiversity.

Soils. To assess the impact of crop cultivation on soil, we used the soil suitability map from the International Institute for Applied Systems Analysis (IIASA; soil-constrained-combined (Plate 27)). IIASA categories 1 to 3 are defined as soils that are well-suited for agricultural use. IIASA categories 4 to 5 are defined as being less well-suited, and IIASA categories 6 and 7 are only poorly suited for agricultural use (category 8 is unsuitable for agriculture). The assessment assumes that poor suitability is usually accompanied by a high risk to soil quality.

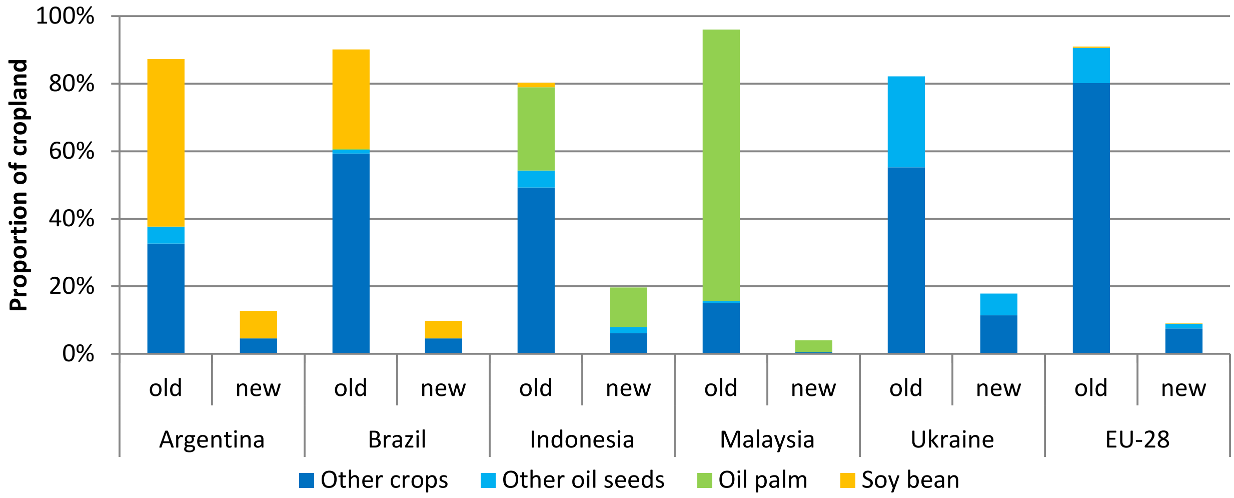
Water stress. In the scientific literature water stress is often defined as the ratio between water withdrawals by different sectors (e.g. households, agriculture and industry) and water availability. In our analysis we use maps of water stress calculated by the global hydrology model WaterGAP [54] and determine the share of cropland selected in the static-analysis within regions with different levels of water stress.

Carbon loss. Greenhouse gas emissions from land use change result from diminishing carbon stocks in soil and vegetation when carbon rich ecosystems are converted to agriculture. These carbon losses are derived from a land use change analysis between 2007 and 2014 that is in line with the GHG-calculation rules of the RED. The procedure is documented in detail by [55]. Based on crop yields in the covered countries from FAOSTAT, conversion factors from [57] and allocation factors applied in [58] greenhouse gas emissions per energy unit of produced biofuels are calculated.

New cropland

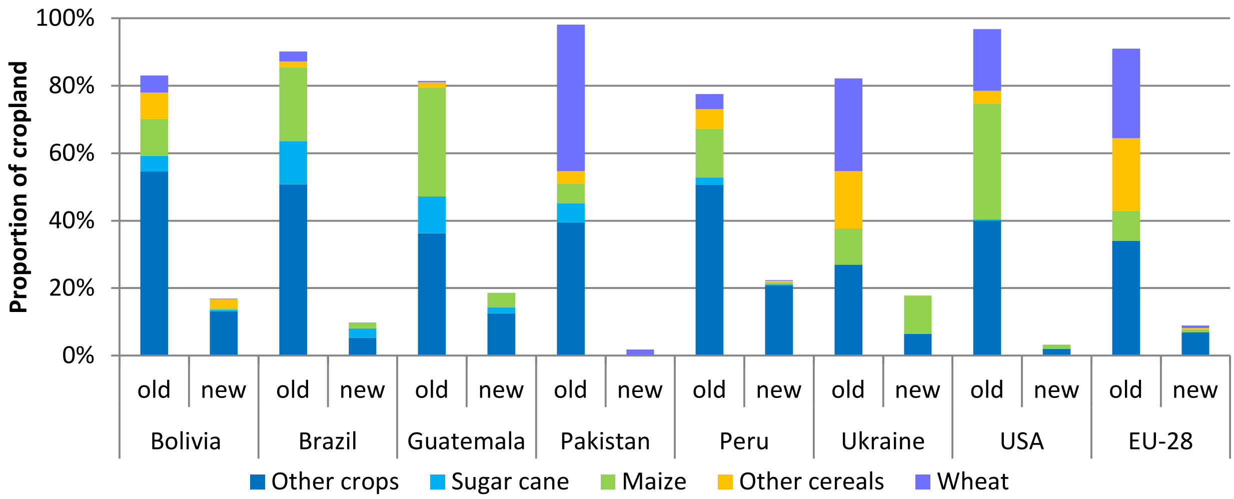
For all identified main third countries and in EU-28 the modelled land use change reveal, that other land categories are converted to new cropland in between 2007 and 2014 (compare Figure 1-55 and Figure 1-56). The amount of modelled new cropland ranges from low rates of a few present points (e.g. Pakistan, USA and Malaysia) up to more than 20 % (e.g. Indonesia and Peru). The new cropland area in many of the analysed countries is used with a significant share for the production of soy bean in Argentina and Brazil, oil palm in Indonesia and Malaysia and for the production of cereals and sugar cane (e.g. maize in Ukraine and sugar cane in Brazil. However, in several main third countries the model results show that new croplands are rarely used for the production of crops that can be used for biodiesel and bioethanol production (e.g. Peru, USA and EU-28).

Figure 1-55: Proportion of already existent and new cropland in 2014 (compared to 2007) used for the production of oil crops in third countries - main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT

Figure 1-56: Proportion of already existent and new cropland in 2014 (compared to 2007) used for the production cereals and sugar cane in third countries – main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT

Biodiversity

The amount of new cropland that is located on former biodiversity relevant areas and that it is used for the production of possible bioethanol and biodiesel feedstocks is utilized as an indicator to assess the risk of the loss of biodiversity. The interpretation of this indicator must be differentiated according to area types:

- Areas excluded from conversion by the RED (protected areas, primary forests, forests, wetlands and peatlands). These areas shall not be affected directly by the production of bioenergy feedstocks, due to displacement effects still may exist.
- Areas that are only partly protected by the RED (highly biodiverse areas outside of protected areas[13], highly biodiverse grassland[14]).
- Areas not excluded from conversion (unused and used grasslands that are not highly biodiverse)

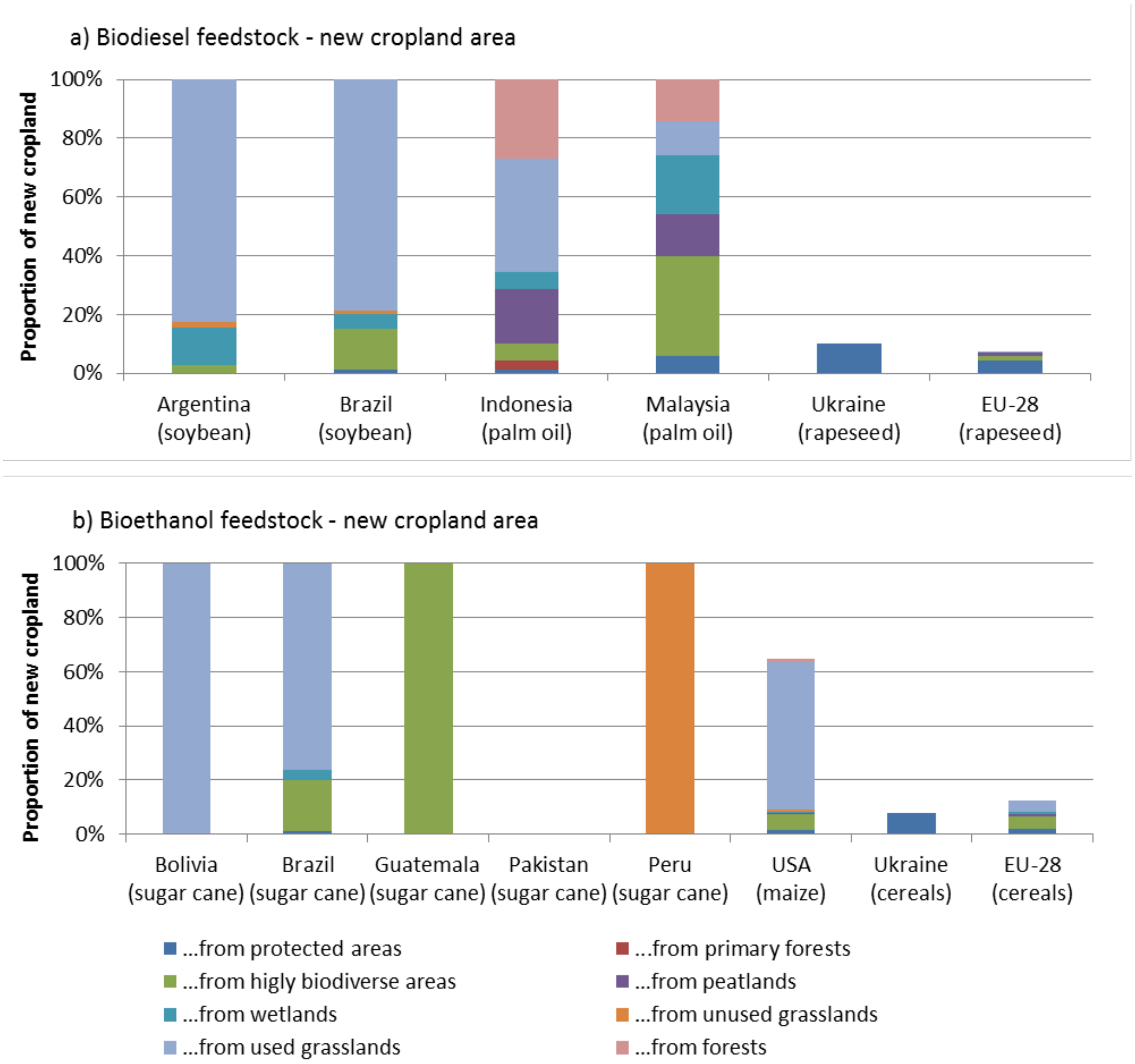
New cropland used for total production of different agriculture commodities that are mainly used for food/feed, but also can be used for production of biodiesel and bioethanol is often located on former used grasslands (e.g. Argentina, Bolivia, Brazil and USA), followed by highly biodiverse areas (e.g. Malaysia, Guatemala and Brazil) and unused grasslands (Peru). Significant use of new cropland for biofuel crops on peatland, wetlands and forests was mainly modelled for Malaysia and Indonesia. In Pakistan, production of sugar cane was modelled only on uncritical areas.

In total, the production of agriculture commodities that can be used for production of biodiesel and bioethanol in third countries (main biofuel suppliers to the EU) can take place also on former biodiversity relevant areas (before 2008). High risks can be expected especially in Indonesia, Malaysia, Guatemala and Peru, and medium risks in Argentina and Brazil.

[13] Art. 17.3 (a) (ii): “areas designated for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature, subject to their recognition in accordance with the second subparagraph of Article 18(4)” – a comprehensive list of these areas is not available.

[14] Art. 17.3: “The Commission shall establish the criteria and geographic ranges to determine which grassland shall be covered by point (c) [highly biodiverse grassland] of the first subparagraph.” – This task was fulfilled by the Commission in December 2014 (Commission Regulation 1307/2014). These specifications did not apply in 2014 and before.

Figure 1-57: Proportion of biodiversity relevant areas converted to new cropland (2007-2014) in third countries – main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT

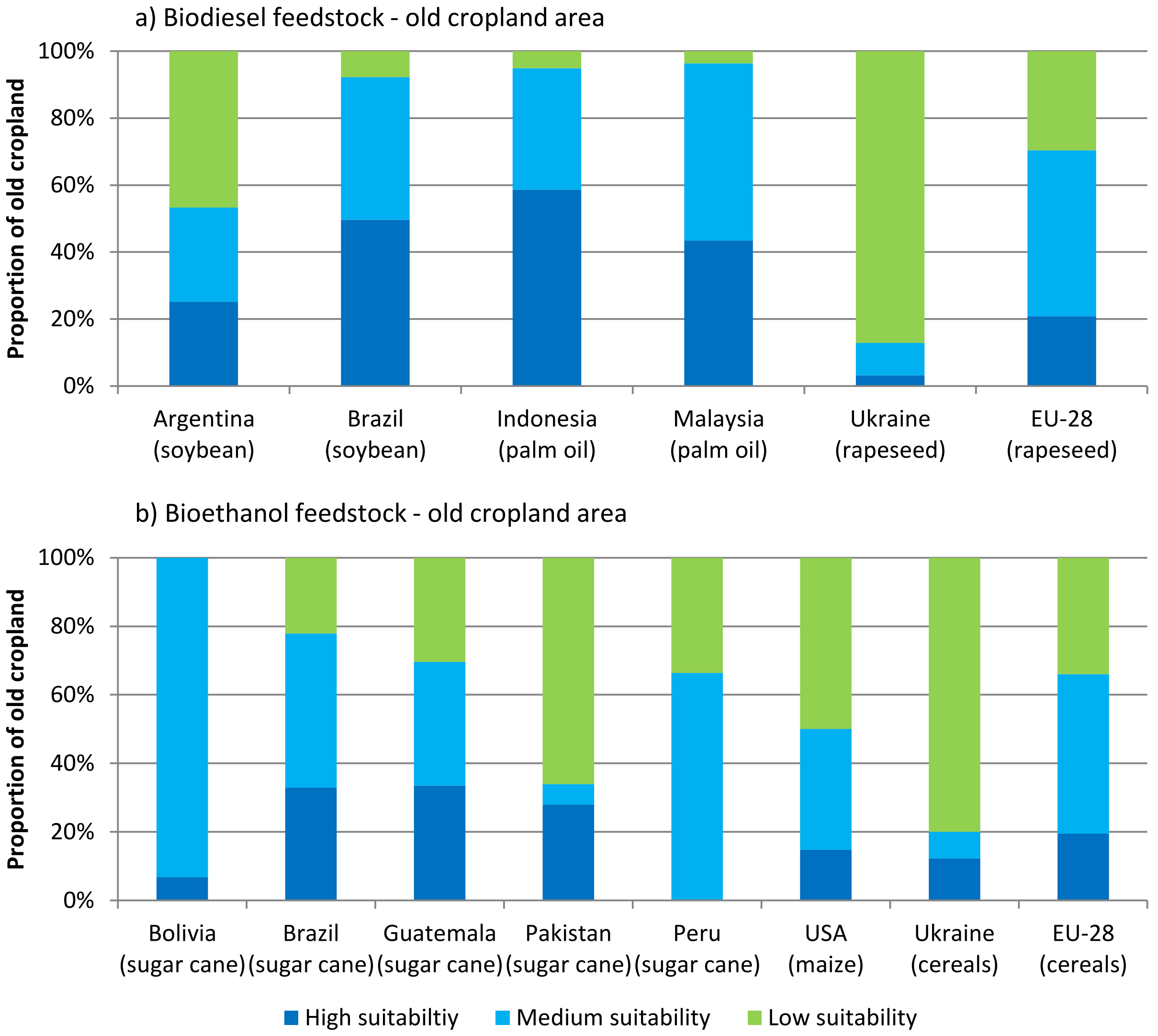
Soils

In the RED the protection of soils is only addressed for agricultural land within the EU-28 (Article 17.6). In case of the cultivation of biofuel feedstocks on cropland outside the EU, no sustainability requirements exist in the RED.

Distribution pattern of soil suitability for agriculture land used as an indicator for soil risks are presented in Figure 1-58 for cropland already existing in and before 2007 and in Figure 1-58 for cropland converted since 2007. Soil suitability was in general lower in cases of bioethanol feedstocks compared to biodiesel feedstocks. High amounts of old cropland (already existing before 2008) characterised by a low suitability for cropping were used for the production of these feedstocks, e.g., in Ukraine, Pakistan, USA and Argentina. In case of new cropland with low suitability (in use since 2008), countries like Argentina, Ukraine, Guatemala, Peru and USA show high proportions.

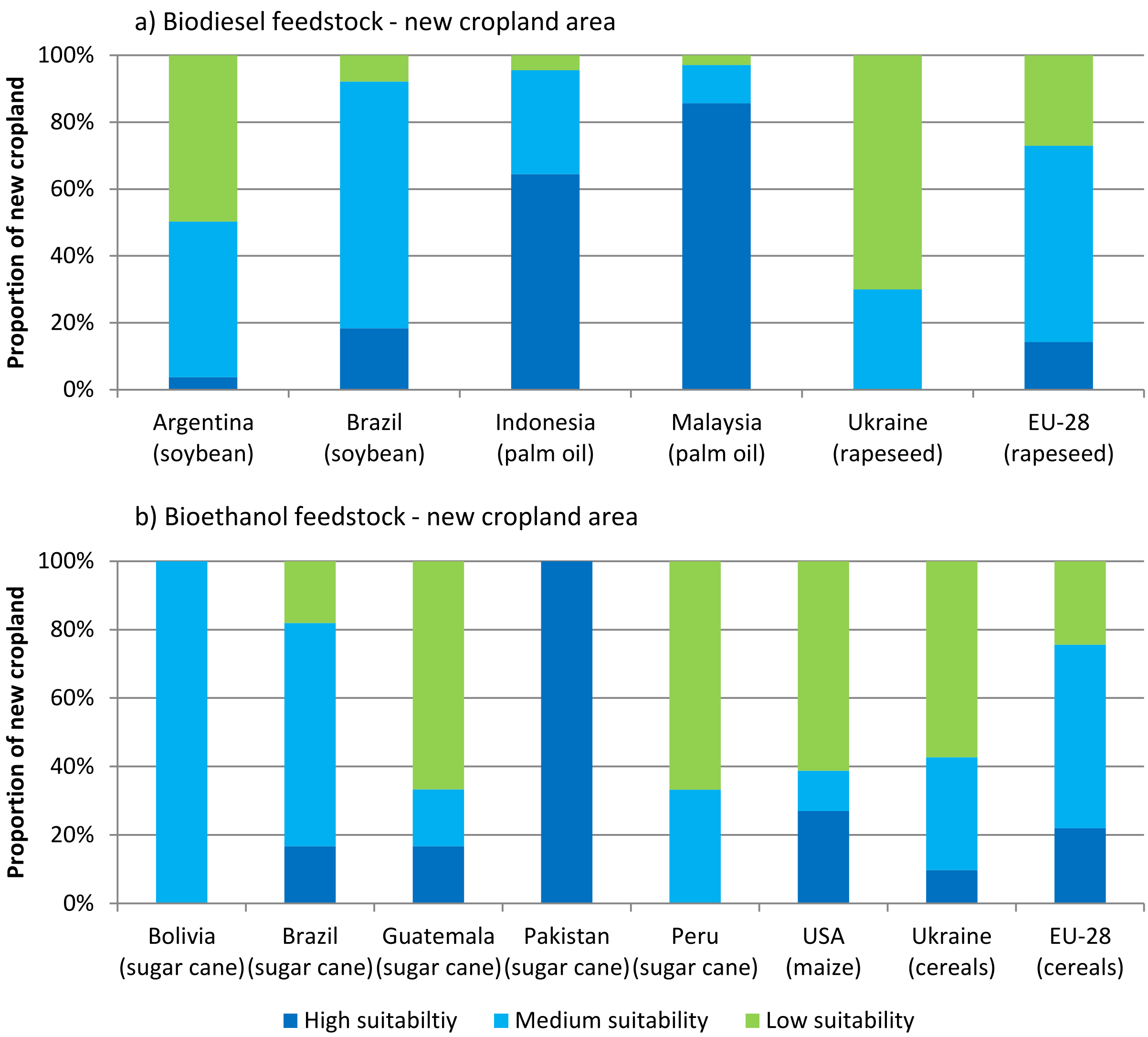
The analysis on soil suitability modelled for third countries (main biofuel and biofuel feedstock suppliers to the EU) and the EU-28 gives no information on whether existing risks are adequately managed, but it shows the need to make it sure.

Figure 1-58: Proportion of already existent cropland area (before 2008) according to soil suitability in third countries - main biofuel and biofuel feedstock suppliers to the suppliers to the EU-28



Source: data computed by LandSHIFT

Figure 1-59: Proportion of newly converted cropland area (2007-2014) according to soil suitability in third countries - main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT

Water

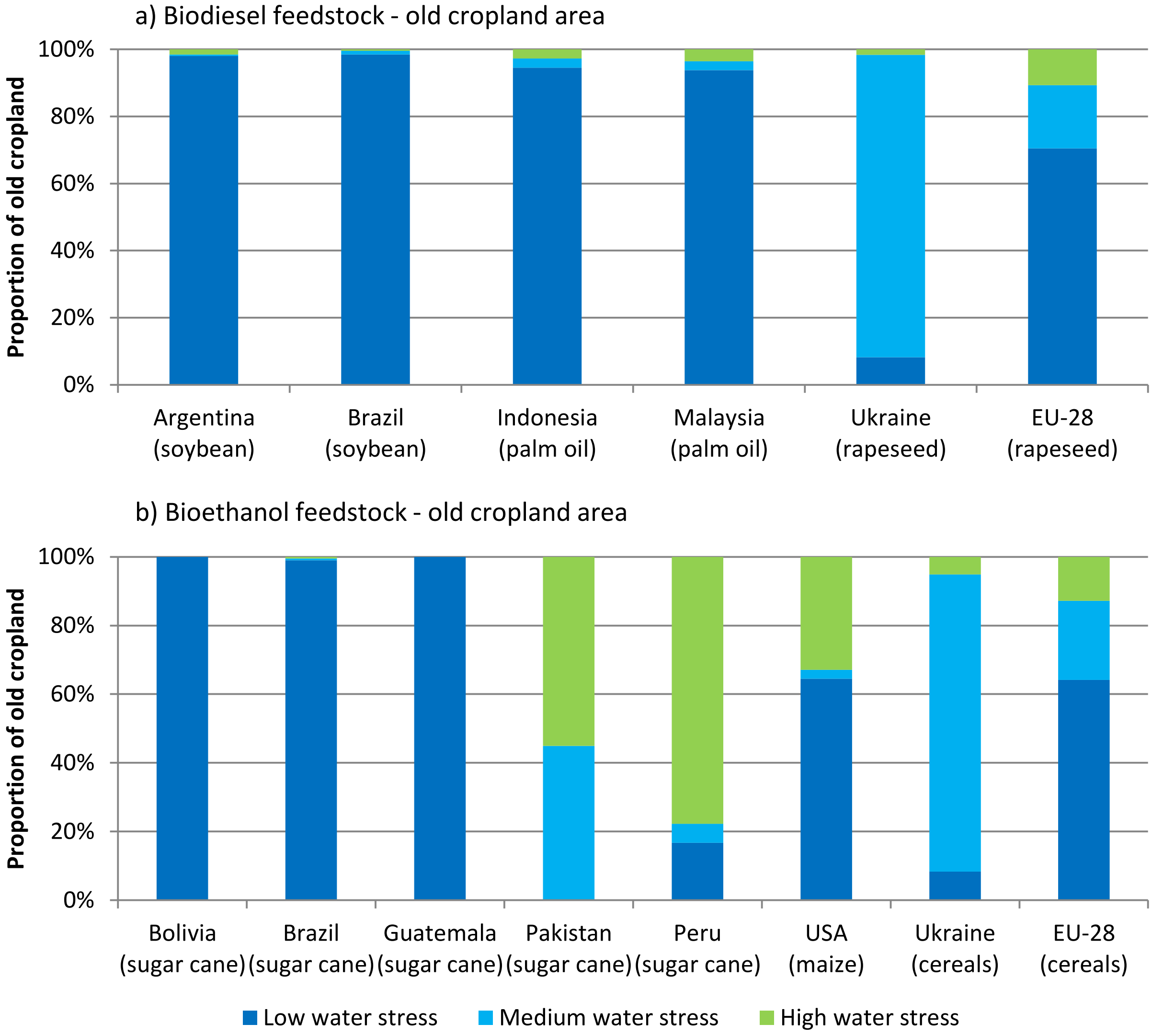
Water related sustainability requirements, e.g. related to water stress, water scarcity or water quality, are absent from the RED. Only newly converted wetlands are excluded as cultivation areas (Article 17.4 a), but this requirement aims at a protection of carbon stocks and not water issues.

The modelled location of potential cropland areas used for the cultivation of biodiesel and bioethanol feedstocks in regions characterised by a high water stress is shown in Figure 1-60 (already existing cropland) and Figure 1-61 (newly converted cropland).

High water stress appears to be much more related to single main third countries rather than to biodiesel or bioethanol feedstocks. For example, a high proportion of cropland with a high water stress can be found in Peru and Pakistan, and the USA in case of new cropland areas. In contrast, other main third countries like Argentina, Brazil, Indonesia, Malaysia, Bolivia and Guatemala show very high proportions of croplands located in regions of low water stress.

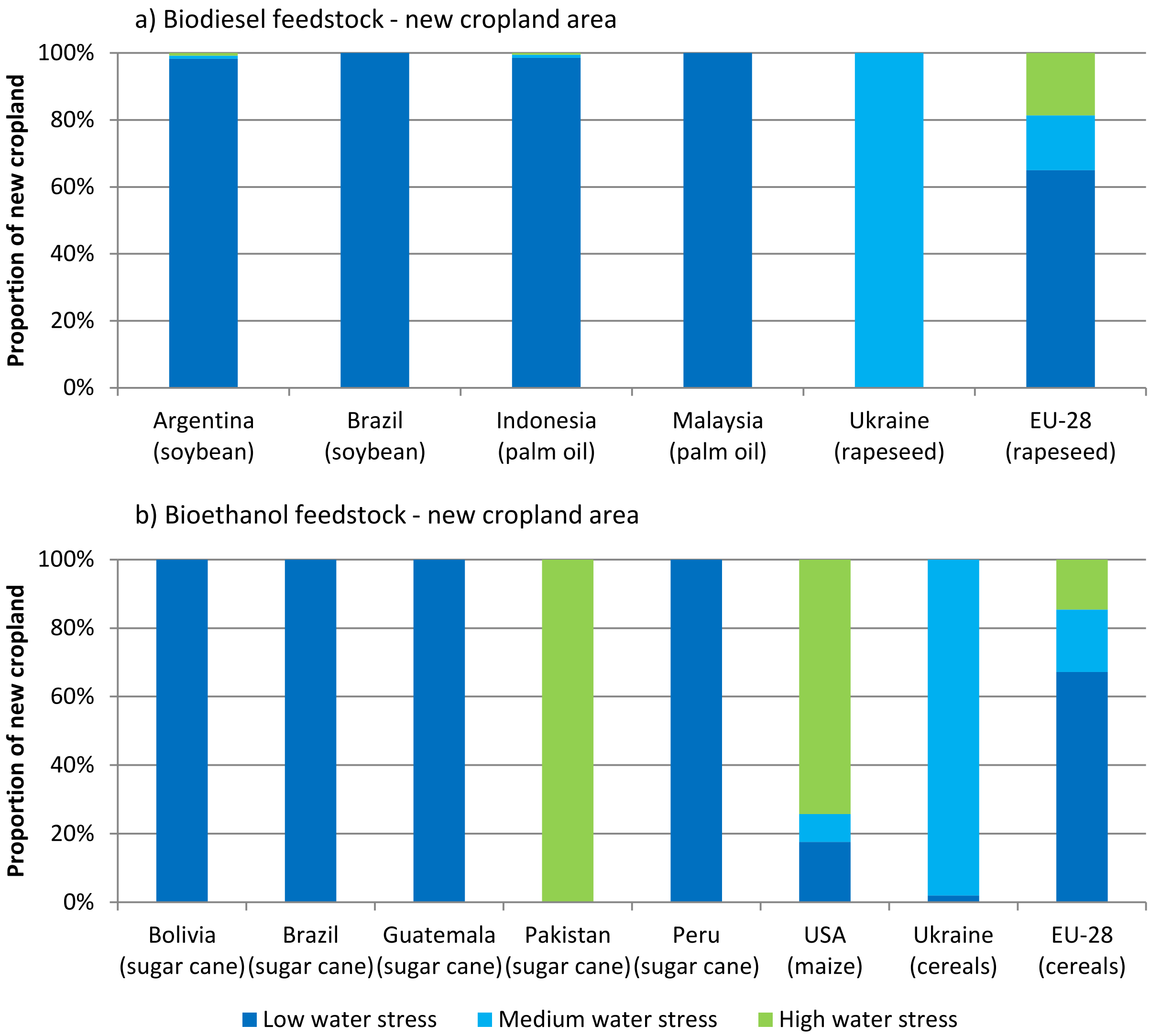
The analysis gives no information on whether existing water risks are adequately managed in main third countries and EU-28, but it shows the need to ensure it.

Figure 1-60: Proportion of already existent cropland area (before 2008) according to water stress in third countries - main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT

Figure 1-61: Proportion of newly converted cropland area (2007-2014) according to water stress in third countries - main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT

Greenhouse gases emissions

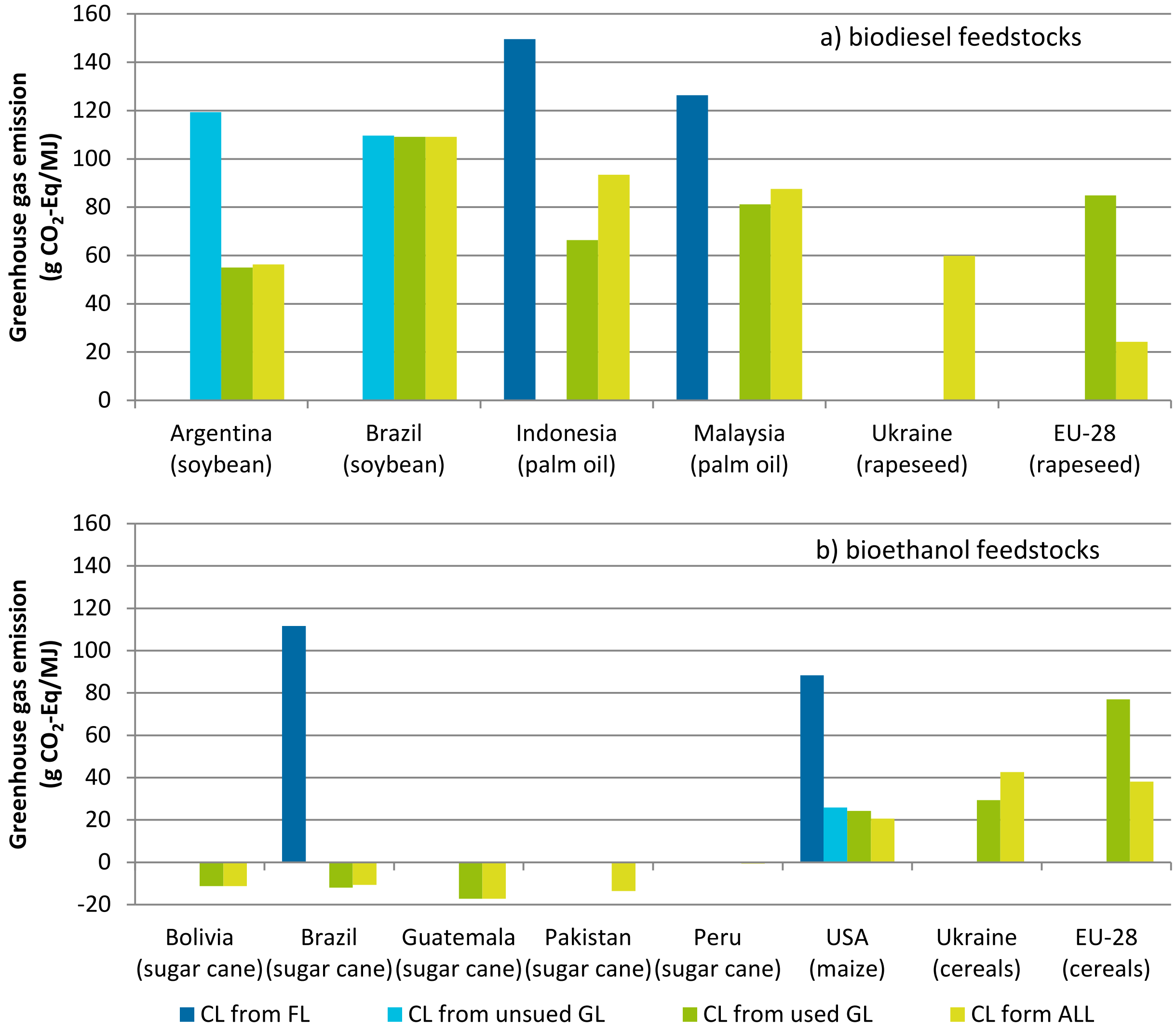
The reduction of greenhouse gases emission is one of the goals of the RED. It is well known that land use change can reduce GHG-savings, and GHG-emissions from direct land use change are included in the GHG-calculation of the RED. Furthermore, the conversion of areas with high carbon stock, i.e. wetlands and forests, is not allowed under the RED. As about 90% of the biofuels utilized in EU-28 comply with the RED (see above), only about 10% of these biofuels are associated with a risk of high GHG-emissions due to direct land use change.

The modelling in this report for GHG-emissions associated with land conversion towards cropland in between 2007 and 2014 is presented for third countries (main biofuel and biofuel feedstock suppliers to the EU-28) in Figure 1-62. Greenhouse gas emissions are calculated in relation to the energy content of biodiesel and bioethanol to be able to compare these emissions against the default value of 83.8 g CO_2-Eq/MJ of fossil fuels and against the 35% GHG-reduction requirement for biofuels allowing 54.5 g CO_2-Eq/MJ for biofuels (compare RED, Article 17.2).

Land conversion towards cropland potentially used for the production of agriculture commodities - that can be used for production of biodiesel in third countries (main biofuel and biofuel feedstock suppliers to the EU-28) - is modelled to take place mainly on used and unused grasslands, e.g. in Argentina, Brazil, Malaysia, Indonesia and EU-28. Respective conversion of forest land, however, was only modelled in Malaysia and Indonesia (Figure 1-62 a).

Greenhouse gas emissions related to the additional land conversion for cultivation of agriculture commodities that can be used also for production of bioethanol mostly showed values above 50 g CO_2-Eq/MJ and reached values up to 250 g CO_2-Eq/MJ (Figure 1-62 b). GHG-emissions associated to land conversion from production of cereals were generally lower compared to oil crops and values above 50 g CO_2-Eq/MJ have been modelled for more often for oil crops. In case of sugar cane CO_2 was stored after land use change as sugar cane is a perennial crop with a high productivity.

Figure 1-62: Greenhouse gas emissions related to newly converted cropland area (2007-2014) in third countries – main biofuel and biofuel feedstock suppliers to the EU-28



Source: data computed by LandSHIFT . CL = cropland; GL = grassland; FL = forest land; ALL = all land categories.

Excursion: Solid Biomass

According to the RED, a reporting on solid biomass is only required, when it is use as biofuels for transport. Due to the fact that solid biomass is a major renewable energy resource in Europe, the sustainability of the energetic use of wood is assessed in this excursion.

In Section 3.1.3.1 Belarus, Canada, Russia, Ukraine and USA have been identified as major third countries of origin of fuel wood and wood pellets. The following analysis for these countries is based on

Reported data: land cover change including cover of forests reported by FAOSTAT.

GIS-analysis: overlay of maps listed in

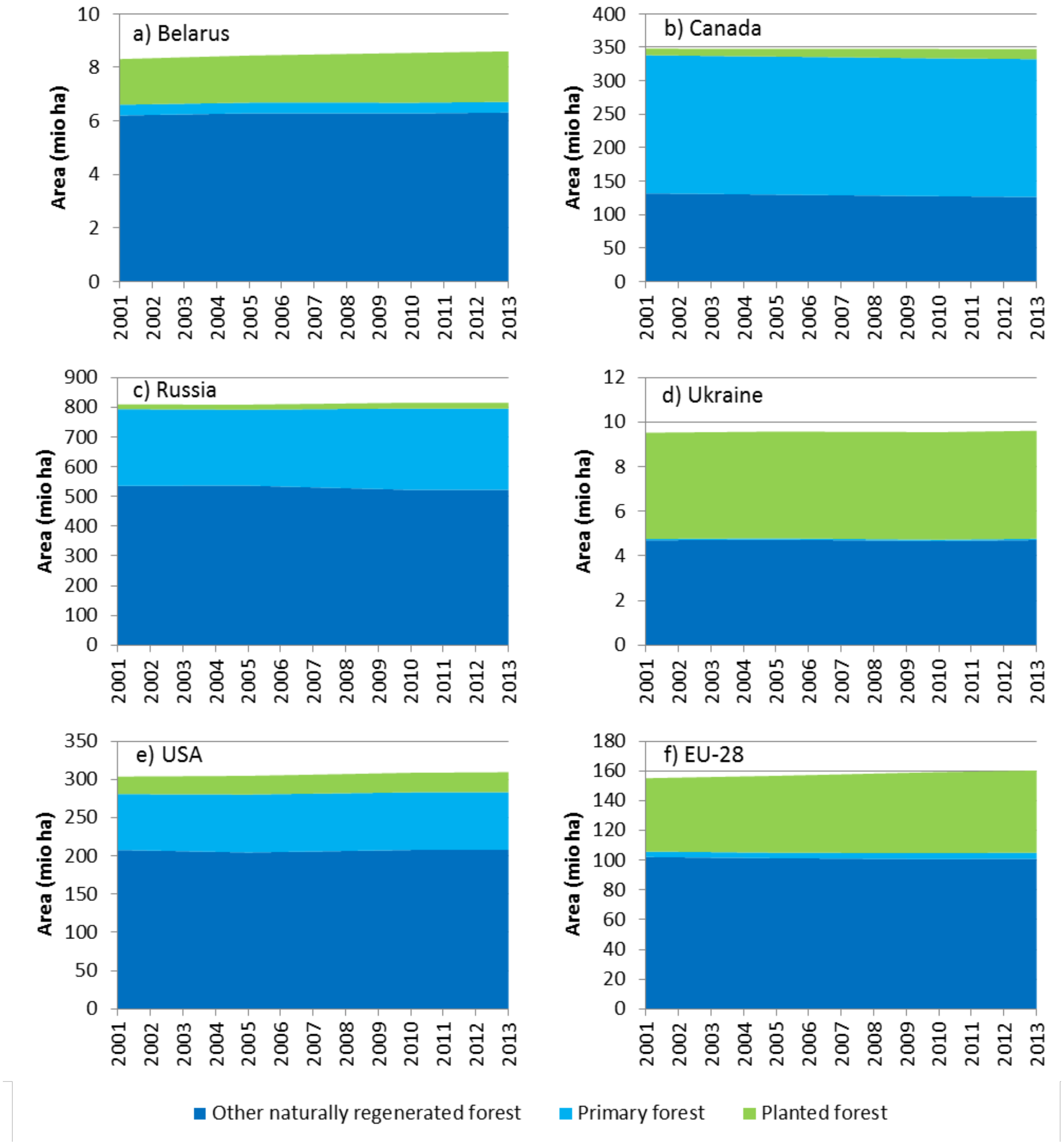
with forest area in 2013 (MODIS 2013) and deforested areas since 2007 (MODIS 2007 and 2013 [59, 46]).

Land cover change (FAOSTAT)

According to FAOSTAT data, the main third countries and EU-28 show rather different patterns with regard to primary forests, natural regenerated forests and planted forests. Countries like Canada, Russia and USA are covered by large areas of primary forests and low once for planted forests. Oppositely, in Ukraine, Belarus and EU Member States planted forests are common and primary forests are low or absent (Figure 1-63).

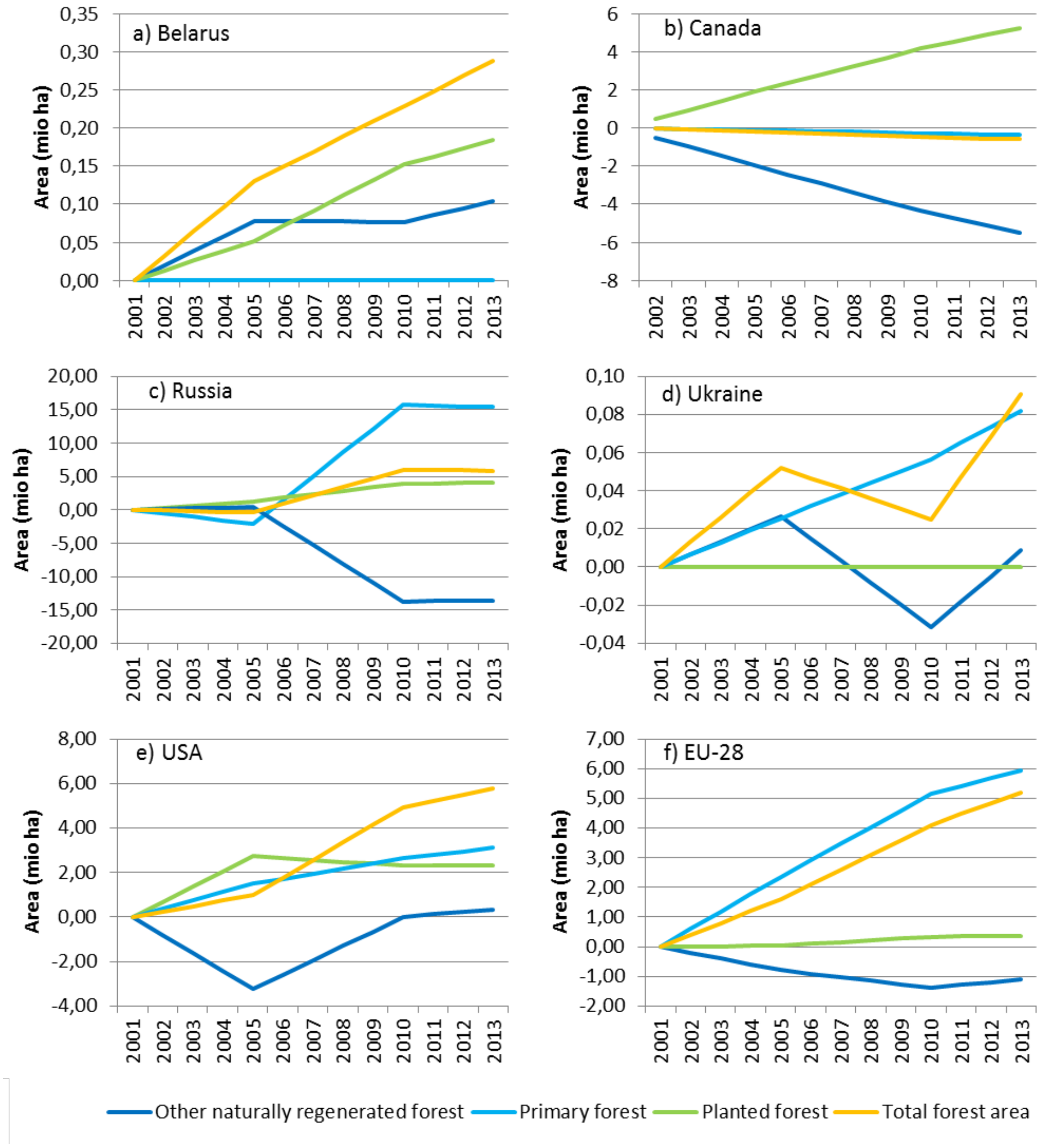
Increases and decreases of the three forest area types since 2001 are presented in Figure 1-65. In all countries the total forest area increased, except in Canada where the total forest area stayed almost constant over time. Also the area of primary forests stayed constant or increased in all main third countries. In some countries like Canada, Russia and EU-28, the area of other natural regenerated forests decreased, but this was compensated by an increase of primary forests and / or planted forests.

Figure 1-63: Area of primary forests, other natural regenerated forest and planted forest in main third countries of origin of fuel wood and wood pellets and EU-28



Source: [32]

Figure 1-64: Change of primary forests, other natural regenerated forest and planted forest compared to 2001 in main third countries of origin of fuel wood and wood pellets and EU-28

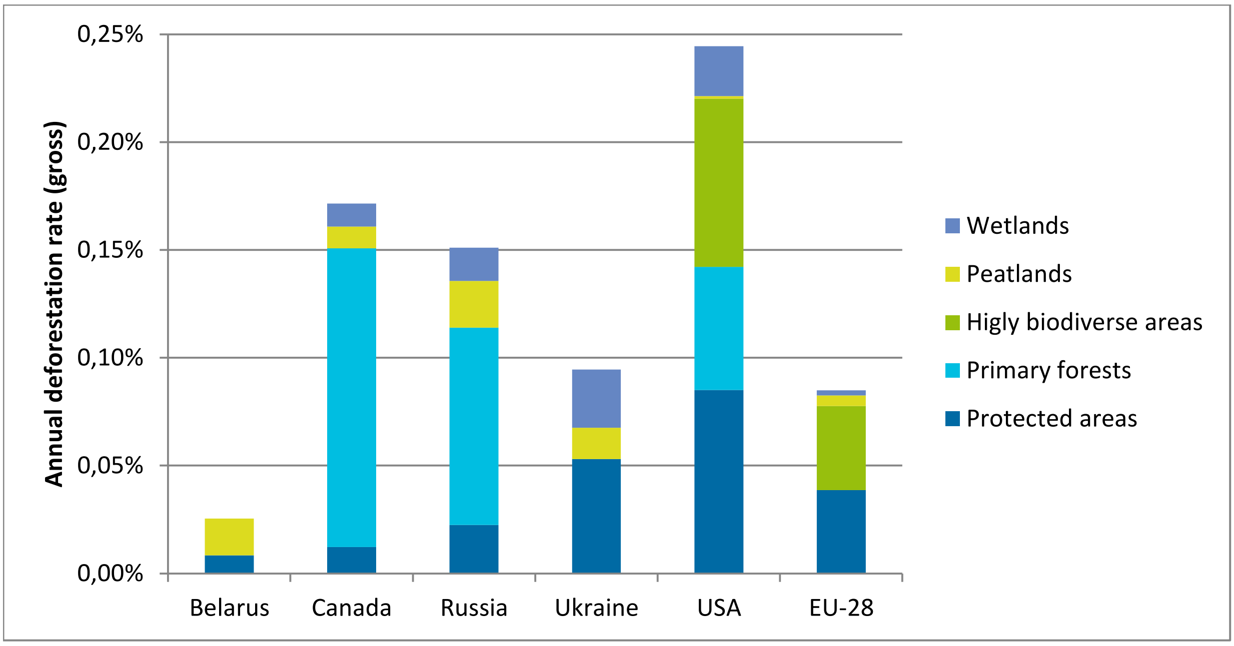


Source: [32]

The amount of forest with high biodiversity value or being located on peatland or wetland ranges for the main third countries and the EU-28 from 18 % in Ukraine to 58 % in Canada (Figure 1-65). Especially Canada and Russia show a high proportion of primary forest of 42 % and 23 %, respectively. Forest on peatland is most common in Belarus (10 %), followed by Canada, EU-28, Russia and Ukraine. Highly biodiverse forest areas outside of protected areas emerge only in USA and EU-28.

These sensitive forest areas are often not protected in the analysed countries. In Canada only 4 % of the forest area lays in protected areas and 54 % points of the forested area identified as sensitive is not protected. In Russia 7 % of protected forest areas accompany with 30 % of sensitive forest areas. Also in the other countries only 38 % to 50 % of the sensitive areas are protected.

Figure 1-65: Annual deforestation rate (gross) of forest area of high biodiversity value, peatland and wetland (2007-2013) for main third countries of origin of fuel wood and wood pellets and EU-28



Source: data computed by LandSHIFT based on MODIS 2007 and MODIS 20013

Table 1-21: Production of fuel wood and wood pellets in 2014 for main third countries of origin and EU-28 as well as imports to EU-28

	Belarus	Canada	Russia	Ukraine	USA	EU-28
Domestic production						
Total industrial roundwood (mio m^3)	11.32	148.83	188.30	8.16	356.81	345.66
Fuel wood (mio m^3)	8.24	4.64	14.70	10.17	41.88	99.02
Wood pellets (mio t)	0.30	1.90	0.91	0.21	6.90	13.15
Import to EU-28						
Fuel wood (mio m^3)	0.53	0.02	1.40	0.36	0.33	
% of production of fuel wood	*6.4%*	*0.4%*	*9.5%*	*3.5%*	*0.8%*	
Wood pellets (mio t)		1.16	0.72		3.56	
% of production of wood pellets		*61.1%*	*78.8%*		*51.6%*	

Source: [32]

The loss of biodiverse forests result in a higher negative effects on biodiversity than positive effects may arise from the creation of new forest areas. Thus, from a biodiversity perspective, the net development of forest areas as reported by FAOSTAT is less meaningful than the gross loss of biodiverse forest areas, including peatland and wetlands. From 2007 until 2013, large gross deforestation of biodiverse forests took place in Russia (6.7 Mio. ha), Canada (4.3 Mio. ha) and USA (4.1 Mio. ha).

The gross deforestation rate of biodiverse forest areas in this time period ranged from less than 0.03% per year in Belarus up to almost 0.25% in USA. The proportion of area types being affected by deforestation was rather similar to the total distribution patterns of these area types. Surprisingly, protected areas were not significantly excluded from deforestation even in USA and EU-28.

As shown above, deforestation can significantly affect biodiversity relevant forest area in main third countries and the EU-28. However, no data are available to verify the linkage between the use of fuel wood and pellets and the loss of sensitive forests. However, production values of wood products can give insights of the relevance of European wood energy demands on negative effects in main third countries and the EU-28. The industrial Roundwood production is much more dominant compared to the wood energy production in Canada, Russia and USA and to a smaller extent also in EU-28 (Table 1-21). In Belarus and Ukraine both sectors show a similar magnitude. However, the deforestation rate of sensible areas is relatively low in the latter two countries compared to those with a lower proportion of wood energy production. The relevance of wood pellets appears low due to its low magnitude compared to industrial round wood and fuel wood in all covered countries (Table 1-21). From this analysis it appears that negative impacts from the production of industrial roundwood may be higher compared from those from wood energy.

The wood energy production in main third countries is partly driven by the EU-28 demand. Fuel wood imports to the EU-28 in relation to fuel wood production in main third countries ranges from almost 10 % in Russia to values below 1 % in Canada and USA. Oppositely, the EU-28 demand for wood pellets covers 52 % to 79 % of the wood pellet production in Canada, Russia and USA, but the total amount of the wood pellet production compared to the production of industrial round wood in these countries is low (Table 1-21).

In summary, negative impacts on sensitive areas (biodiverse forests, peatlands and wetlands) from deforestation seem likely in all main third countries expect Belarus. Wood energy may play a role for negative impacts, but other wood segments like industrial roundwood appear more relevant. Nevertheless, EU-28 demand for wood pellets is a main driver for wood pellet production in Russia, Canada and USA.

1.2.3.2. Effects of community import policies (Article 23 (5) a)

A range of policies have been used to support the development of the liquid biofuels sector in the EU, including use mandates, budgetary support and trade policies. This contains [60]:

Use and blending mandates: these require liquid biofuel suppliers (refiners and/or retailers) to supply a certain amount of liquid biofuels or a certain percentage of liquid biofuels in total transport fuel use.

Budgetary support: includes price support via tax credits to liquid biofuel producers and/or processors (refiners).

Trade policies: import tariffs are used to protect domestic liquid biofuels producers; imports are increasingly influenced by the sustainability requirements under the RED, which results in the differentiation of biofuels on the basis of their feedstocks and production methods

While the use and blending mandates and budgetary support policies are implemented at the Member State level, tariffs on imports are implemented for the EU bloc as a whole.

Tax credits were initially widely used in EU Member States to stimulate growth in the biofuels sector, allowing producers to invest in biofuel production. From 2007 tax credits for pure biofuels have been progressively reduced. In Italy, biodiesel was exempt from tax for a given quota up to 2007. Taxes were applied from 2008 but at a reduced rate compared to diesel and quotas were cut significantly in 2010 [60].

Blending and Use Mandates unlike tax credits - they do not lead to budgetary costs for the government. Rather, mandates may lead to higher fuel prices for consumers since biofuels are more expensive to produce than fossil fuels and thus the obligation to supply a certain percentage of biofuels leads to additional costs. Most Member States have moved towards a mandatory system. For example, within Germany the 2006 Biofuel Quota Act laid down a mandate for fuel suppliers to include a specific percentage of biofuels from 2007. High penalties were imposed for non-compliance. From 2009, the quota for total fuel consumption from biofuels was set at 6.25 percent based on energy content. This increases progressively, reaching 8 percent in 2015. A different system is applied in France (the second largest consumer of biofuels), wherein fuel suppliers are required to pay a supplementary tax if they supply fuels with a biofuel content less than a specified amount. Starting from 2005 the French government gradually increased the quota to reach a 7 percent target in 2010. In contrast, a few Member States, such as Sweden, continue to use tax credits rather than mandates to promote the use of biofuels [60].

[60] that according to EU biofuel policies, the biofuel use has plateaued as Member States have become reluctant to implement further increases in mandated biofuel incorporation. Further growth could happen, if current sentiments towards biofuels change, technologies are developed that are more palatable to EU citizens, or fossil fuel energy prices increase significantly.

EU import tariffs vary depending on the types of biofuel. These tariff rates are harmonised within the EU. The difference in the import tariffs indicates the different positions of the EU in the world market. For biodiesel, the EU is more of a price maker as it produces over half of the world's production and consumes almost 70 percent. For bioethanol, the EU is a much smaller player and its products have not been cost-competitive. If the import tariff were lowered or eliminated, it is expected that significant ethanol imports would enter the EU market. To close this loophole, the EU specified that from 3 April 2012 onwards all imported ethanol/petrol blends that contain 70 per cent ethanol blended with 30 per cent petrol must be classified by EU customs authorities as denatured ethanol. The biofuel duties are much higher than the former chemical duties [60].

New non-tariff barriers, such as sustainability criteria, are emerging and their potential to limit trade in biofuels is significant. These measures must be enacted in a transparent way and respect international trade laws. Otherwise, they run the risk of being challenged at the World Trade Organization[15].

[15] http://sugarcane.org/global-policies/policies-in-the-european-union/policy-overview-ethanol-in-europe

1.2.3.3. Economic ((Article 23(5)(b))

Summary

Although biofuel investment was more or less stable on a global level in the past two years, it shows brisk ups and downs on a regional level. This must be evaluated as an effect particularly of biodiesel and ethanol markets, and of their vulnerability to policy and regulatory changes as well as shifting patterns in international trade. The biofuel sector is worldwide the second biggest employer in the renewable energy industry, right after photovoltaics. Biofuel employment in Europe increased slightly in the period 2012 – 2014. France, Germany, Spain and Belgium are the top employers in Europe. On a global level, market ups and downs are reflected by the employment rate which decreased by 6% from 2013 to 2014.

Investments

Economic impacts can be framed in terms of investment in new installations of RES technologies. The annually updated market report by Bloomberg New Energy Finance (BNEF) estimates global new investment in renewable energy in 2015 for biomass (including waste-to-energy (WtE) plants) at $ 6 billion plus another $ 3 billion for biofuels. These $ 9 billion represent only a tiny 3 % share of global new investments of $ 286 billion for all renewable energy, however, the used methodology “only” monitors venture capital and private equity (VC/PE), asset finance, public finance and mergers and acquisitions (M&A). Smaller biomass or biogas installations (such as agricultural AD plants) are not covered. A notable trend according to the BNEF authors is that for the first time investment in renewables (excluding large hydro) in developing countries outweighed that in developed economies. China, India and Brazil committed a total of $156 billion, while developed countries invested $130 billion [134]. Also the REN21 report provides some investment figures for biofuels, related to ethanol and biodiesel production. Global ethanol production increased from 94.5 billion liters in 2014 to 98.3 billion liters in 2015. United States, Brazil, China, Canada and Thailand were the top five producing countries, providing the highest net capacity additions. Global biodiesel production slightly decreased from 30.4 billion liters in 2014 to 30.1 billion liters in 2015, with United States, Brazil, Germany, Argentina and France providing the highest net capacity additions. Particularly striking regional trends in global development in the course of the last year were the decline of 20 % in Argentinian biofuel production due to constrained export markets, and an increase of 12 % in the Colombian ethanol production, while Brazil continued again both ethanol and biodiesel production. In the Asian market China increased its biodiesel production, while Indonesia saw a heavy production decrease of 60 %. According the report, in many countries liquid biofuels markets were sheltered thanks to blending mandates. Still, investment in large-scale new capacity in the main producer countries was limited, according to the report, due to regulatory and market uncertainty. In 2015 it fell by 35 % to USD 3.1 billion.

Job creation and employment

The literature on global and European employment and job creation induced by renewable energy use and application is diverse and inconclusive. Often, renewable energy employment is enmeshed in a wider scope of a green economy or low carbon economy approaches that sum up estimations including job effects by energy efficiency measures, or a wider environmental scope of environmental-related jobs such as pollution abatement, sustainable forestry and so on. These definitions clearly go beyond the narrower definition of renewable energy use. The best available estimations on renewable energy employment on a global scale are the regularly updated editions of the REN21 Renewables 2016. Global Status Report estimates a total global employment level of 8,05 million direct and indirect jobs in renewable energy worldwide [135]. Globally, the REN 21 network counts 822,000 jobs in solid biomass and 382,000 jobs in the global biogas industry. Combined with jobs in liquid biofuels (1,687,000 jobs), bioenergy accounts for roughly 36 % of total renewable energy-induced employment worldwide. In total, bioenergy employment thus amounts to nearly 2.9 million persons worldwide.

For the European Union, there are a number of reports, studies with a different scope and methodologies on assessing renewable energy-induced employment impacts. The most ambitious and comprehensive modelling exercise was presented by the Employ-RES project that has presented projections under different policy scenarios for 2020 and 2030 [136]. The report found that RE employment increased from 1.2 million jobs in 2005 to 2 million in 2011, equal to 0.9 % of total employment in the EU.

Besides such meta-studies, national statistical bodies, energy ministries or research institutions publish national job counts. For 2015, annual national job counts are available for Germany (BMWi/AGEE-Stat, forthcoming October 2016) [137], Austria [138, 139] and the United Kingdom [140]. A report on socioeconomic impacts and job creation for the Netherlands was published by Statistic Netherlands for 2014 [141]. These reports also include job creation in solid biomass, biogas (AD) and biofuels.

Beyond single European and national renewable energy data, industry associations publish their own job and (partially) turnover estimations on their sector. This is the case for PV and solar thermal in Germany [142], ePure for ethanol [143], EWEA for Wind [144], Estif for solar thermal [145], AEBIOM for solid biomass [6], and CEWEP for waste to energy [146]. Socioeconomic impacts for PV in the European Union are also regularly updated for some larger PV markets by the IEA-PVPS (photovoltaic power systems) national status reports, with the latter not fully covering all member states [147].

In 2013 IEA-RETD published a methodology to estimate employment impacts of renewables including biomass and CHP [148]. The project has published sample data (direct and indirect employment effects of the installation and operation of facilities as well as of fuel supply in the agricultural and forestry sectors of the bioenergy value chain. Data were not published for all EU Member States but only for Denmark, France, Germany, Ireland, Netherlands, and the United Kingdom. Data comprised biogas (incl. CHP), Biomass small scale (incl. CHP), Biomass large scale (incl. CHP), Biomass co-firing (incl. CHP), Biowaste (incl. CHP).

The advantage of this study is that it presents a coherent set of job calculations, with the disadvantages of not covering the biofuel sector and somewhat outdated input indicators (installation figures, investment data and specific cost indicators dating from 2010).

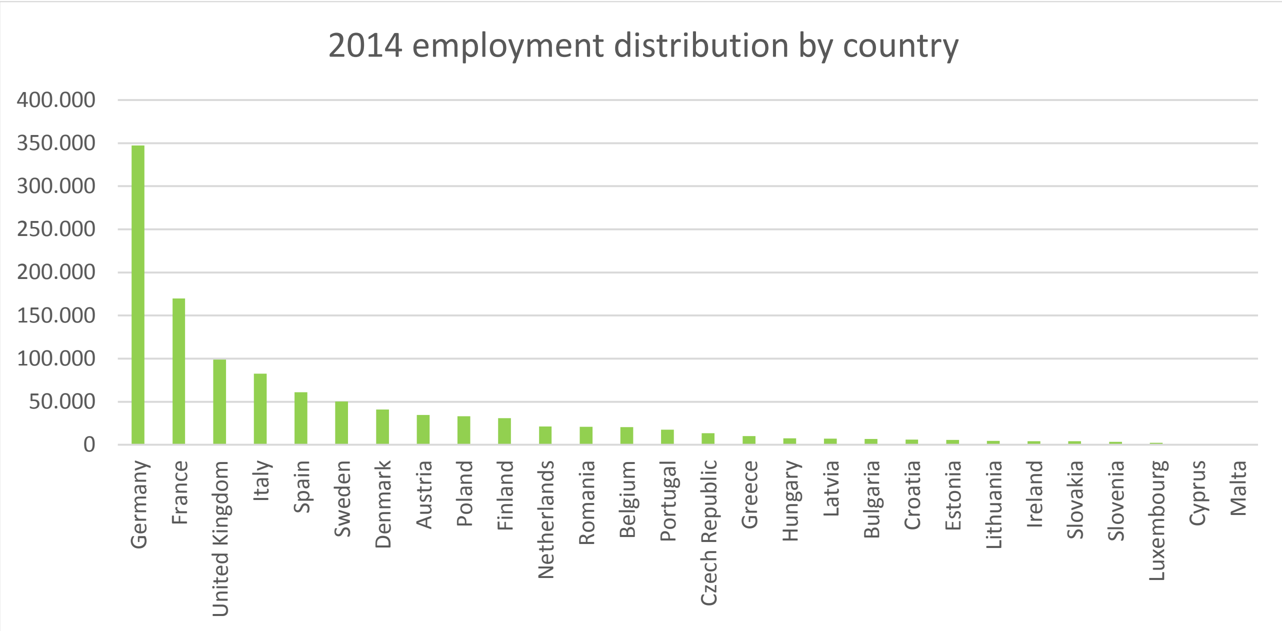
EurObserv'ER in its annual meta survey estimates a total employment level for all EU-28 Member States of nearly 1.1 million for 2014 [149]. Broken down to all 28 EU Member States, Germany has the largest renewable energy job market with 347,400 persons employed in the renewable energy sector (not taking into account over 8,000 jobs in publicly funded research and administration as published by AGEE-Stat for 2014) followed by France, the UK, Italy, Spain and Sweden (Table 1-22).

Table 1-22: Biomass employment in 2014

Total Employment	Denmark	France	Germany	Ireland	Netherlands	UK
Biogas (incl. CHP)	223	545	34,059	44	690	4.337
Biomass small scale (incl. CHP)	2,023	818	24,211	78	3,600	4.776
Biomass large scale (incl. CHP)	1,116	65	2,915	0	256	1.261
Biomass co-firing (incl. CHP)	95	32	178	15	118	1.003
Biowaste (incl. CHP)	75	57	1,165	0	358	283
Total employment	**3,533**	**1,518**	**62,526**	**138**	**5,022**	**1,1661**

Source: [150]

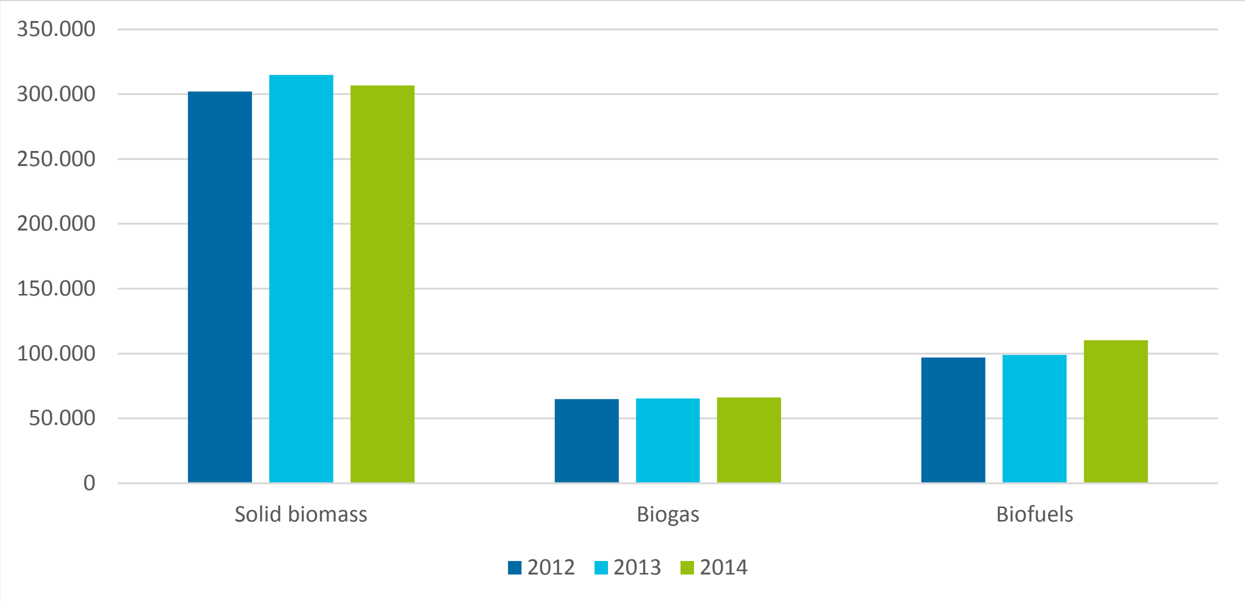
Figure 1-66: 2014 employment distribution by Member State



Source: [150, 143]

Solid biomass accounts for 306,800 jobs, biogas for over 66,200 and the entire EU biofuel industry for over 110,350 jobs. Analyzing employment development for the different bioenergy sectors in the course of the last three years, biofuels and solid biomass show a slight increase, biogas a slight decrease.

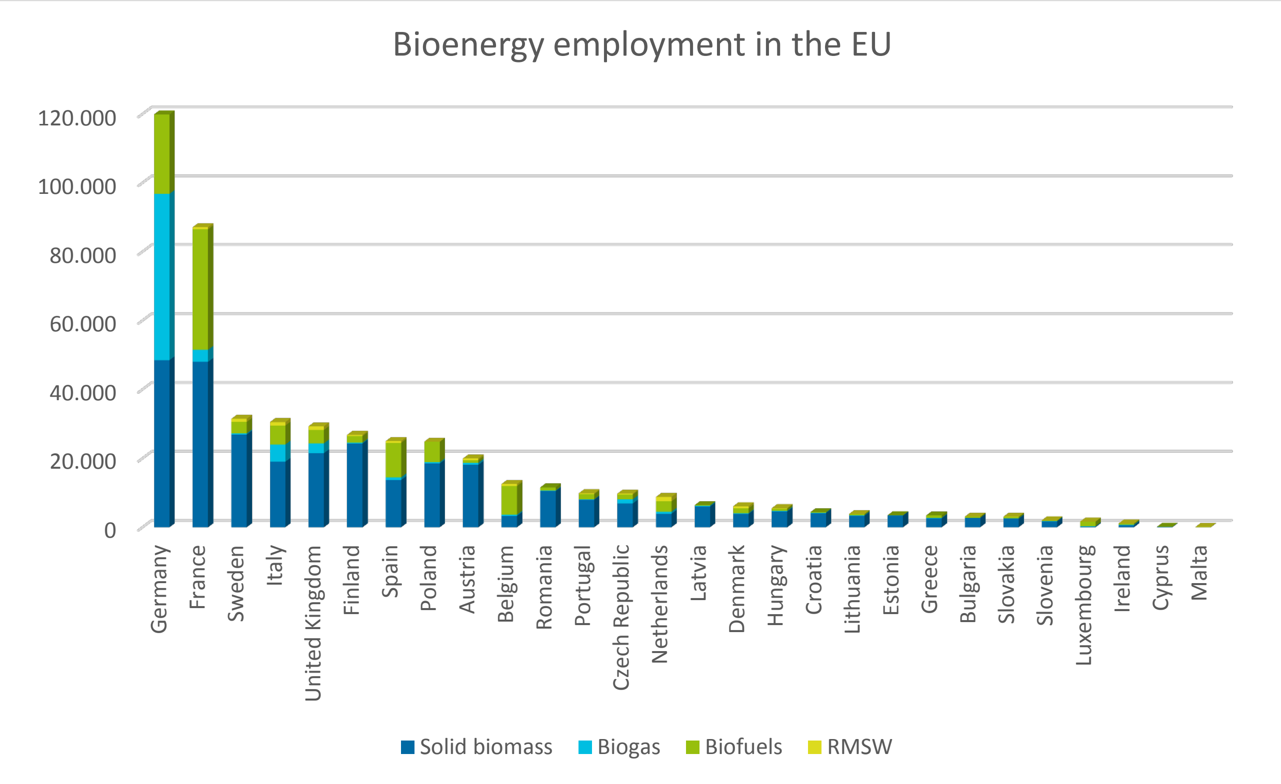
Figure 1-67: EU employment in the bioenergy sector (direct and indirect jobs)



Source: [150, 143]

Bioenergy-induced gross employment in the EU is roughly 491,000 persons, with Germany (120,000) France (87,000) and Sweden (31,500 jobs) as the largest bioenergy job markets in solid biomass, biofuel production and biogas.

Figure 1-68: EU employment in the bioenergy sector by Member State



Source: [150, 143]

Biofuel employment in third countries

According to the IRENA report on Renewable Energy and Jobs [151], global liquid biofuel employment declined by 6 % in 2015 to 1.7 million jobs. IRENA evaluates this as an effect of the ongoing mechanization (e.g. in United States and Brazil) on the one hand, as result of declining production in countries like Indonesia on the other hand. Even though Brazil's ethanol industry had to experience a reduction of about 45,000 jobs (due to continued mechanization of sugarcane harvesting, even as production rose), with 821,000 jobs it continues to have the largest liquid biofuel workforce. This corresponds to a slight decrease (845,000 jobs in 2014). In Indonesia, the work force in the biofuel sector declined from 223,000 jobs in 2014 to 94,800 in 2015. Indonesia's palm oil-based biofuel industry grew dramatically since 2006, until exports collapsed in 2015. Biodiesel production dropped by more than half and the utilization rate of bio refinery capacity fell to 24 % [26]. Jobs increased in Malaysia and Thailand and reached 76,900 and 31,800 respectively.

1.2.3.4. Feedstock availability and food prices (Article 17(7)(2))

Summary

Most of the countries do not record a connection between agricultural commodity prices and the usage of biomass for biofuels, but rather observe price fluctuations for corresponding biomass following world market prices. The influence of biofuels on agricultural commodities on the world market is not only widely, but also inconclusively discussed. Different studies are based on different assumptions and methodologies, and therefore come to disputed conclusions. For future investigations it is not only crucial to find a consensus on the scientific approach, but also to consider wider implications of the usage of biomass for biofuels on food security, such as yield increases because of mechanization or the transition of low-level subsistence farming households towards more stable sources of income.

Member States progress reports

Austria reported that the effects of the energy use of biomass on agriculture are very minor. Possible fluctuations in commodity prices could be triggered by weather, export restrictions and speculation.

Belgium ordered a scientific study. Therefore there is no data available at the moment. For the Flemish region there have been no known price changes from the use of biomass.

The Czech Republic has no evidence of an increase of agricultural commodity prices due to biofuels. The country has sufficient arable land available to secure 100% food self-sufficiency and to meet the 10% RES target in transport. All of this is possible without being in competition for land.

According to the European Commission – Germany stated that the demand for biofuel in the EU had a global price effect of 1-2% for cereals in the period 2010/2011 and 4% for rapeseed, soya and palm oil in the years 2008 and 2010.

In Estonia the prices of biomass used to produce energy did not increase in the reporting period.

Spain notes, that the prices for agricultural raw material follows the international markets and so the price changes for biofuels.

In France, prices for raw material of biofuels are extremely volatile. There is no indicator to link these trends to an increased use of biomass. They discuss the difficulty of isolating the net effect of the development of biofuels on agricultural prices, owing to interactions with numerous other factors and feedback loops. Another factor is the difference in methods used. The reality of the direct and indirect interactions between biofuels and agricultural prices are highly complex.

The range of biomass feedstocks in Ireland has had no material influence on commodity prices or land use.

Lithuania stated no significant changes in commodity prices and land use through increased use of biomass. The price for rapeseed used for producing biodiesel is very similar to the previous years. Fluctuation is influenced by global trends on rapeseed markets rather than by the use for fuel production. Mostly farmers sell rapeseed both for fuel and food production. Therefore it is difficult to assess their choice to contribute to biodiesel production.

Latvia noted also no significant impact between cereal prices and biomass uses. The country has no future expectation that the production of biofuels will compete with the production of agricultural products.

Malta stated no influence on commodity prices because of the support given to PV systems and solar water heater. Biodiesel is mostly produced from waste cooking oil and animal fats as feedstocks. Therefore no fuel crops are planted locally.

In Poland the input for biogas is mostly based on agricultural by-products and residues, which do not compete with the food markets, although a close link between the domestic market prices and the world market prices for agricultural raw materials exists. Only a small share of raw materials is produced in Poland and this had only a small impact on market prices for the feedstocks. Another reason: The prices for agricultural products decreased, as did the area of agricultural land, while the area of forests and wooded land increased.

In Portugal price fluctuation caused by consumption for energy purposes is not recorded.

Sweden stated that the prices for biofuels are affected by prices on international markets and so they are in line with international price quotations.

The UK noted no evidence exists for linking commodity prices with land use changes.

Food prices, food security and bioenergy on a global level

The relation of fluctuations in food prices and bioenergy on a global level are currently widely discussed. A main reason for this controversy is the application of different methodologies. For example Kline et al illustrate that changes in global commodity prices are distinct from changes in consumer food price indices [152]. Taking into consideration the variety of different factors highlighted in the annual SOFI reports, malnutrition can be associated with many factors other than food intake. Therefore, the effect of biofuels on food security could be determined less by food price indices, and more by other project-specific factors such as the physical infrastructure, institutional capacity, training, ecosystem stability and others. The authors of the study demonstrate that reports assessing that biofuels harm food security rely on assumed relationships between biofuels, rising global food commodity prices and food insecurity over short time spans. Papers which show that biofuels do not raise food prices often cite the same FAO commodity data. They criticize that the assumptions underlying both parties are questionable and do not include long-term trends. According to them, the world's most severe famines would occur during extended periods of depressed global food prices. Furthermore, they assert that "biofuel projects could address food security concerns by applying best practices that reduce exposure to risks of food insecurity." [152] Those bioenergy projects can improve resilience by helping to transfer low-level subsistence farming households towards more stable sources of income.

Furthermore, effects of bioenergy on an improved resource management and accompanying productivity increases are discussed. In a report published in 2015, the Scientific Committee on Problems of the Environment, Souza et al is quoted on the increase of productivity: "Over the last 22 years, the total harvested area increased from 45.9 Mha in 1990 to 63 Mha in 2012. Sugarcane increased from 4.3 Mha in 1990 to 9.7 Mha in 2012. In the same period, soy's harvested area grew from 11.5 Mha to 24.9 Mha, increasing by 117% whilst productivity rose by 50%. Sugarcane's planted area increased by 130%, productivity increased by 20%. Over the last 22 years, Brazil has seen both an increase in total harvested area and in the share of land devoted to soybean, corn and sugarcane. Thus, the expansion in sugarcane and soybean production in Brazil results from a combination of cropland expansion and productivity increases." [61].

German environmental NGO Heinrich Böll Foundation in its 2016 Soil Atlas provides a different argumentation, claiming that Europe is the continent that is most dependent in terms of soil outside of its borders. The ecological soil footprint of the EU (based on estimations by the Vienna-based Sustainable Europe Research Institute (SERI)) is estimated at around 640 million ha per year and thus one and a half times the land area size of the EU [153] It is acknowledged that such calculations are questionable, but these figures do not even take into account important resources such as cotton, minerals or metals which would additionally add up to a negative EU footprint in terms of land. Beyond this, six of the top 10 land-importing countries (Germany, the United Kingdom, Italy, France, the Netherlands and Spain) are located in Europe and each "…"importing almost 80 million hectares a year". [153]

Whereas the concept of an ecological footprint does not say anything about the availability of food or price increases, there are certainly considerable impacts from European demand for third country economies. Research conducted by the Vienna University of Economics and Business calculated in 2014, that to meet the bioenergy requirements of its 2030 Framework for Climate and Energy, the EU will need an extra 70 million hectares of land, an area larger than France with the virtual area imported more than doubling since 2000, from 1 to 2 million hectares – and through the virtual area for oilseed rape, and other vegetable oils tripling to nearly 3 million hectares during the same period. The report states that European biofuel policy might have particularly damaging environmental and social effects in Indonesia and Malaysia, the biggest palm oil producers. "These countries are biodiversity hotspots and have insecure land rights. Establishing new plantations often means clearing forests and displacing farmers and indigenous people." [153]

1.2.3.5. Wider development issues (Article 17(7)(2))

Summary

Only few European countries report about particular measures on rural development. This raises the question of how far the inherent chance of the biofuel sector to foster rural development is put into practice. Incentives should be provided to exploit this positive side effect which the biofuel market could present. The monitoring of impacts of the biofuel sector on rural development in third countries is still problematic, because of the lack of a binding arrangement on which factors should be explored. Recent results of voluntary schemes show a trend towards a decline of certified production regarding biofuel feedstock. The trend of global continuing land acquisition is still a big issue and provides a particular problem for undocumented land holders with insecure tenure rights. Capacity building measures in the biofuel sector are underrepresented compared to other renewable energy technologies and should be enforced. Particularly more women need qualified training in order to enable them to get into higher qualified jobs and decision-making positions.

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The wider development issues can be classified as follows:

- Rural and social development
- Land tenure
- Capacity development and technology transfer
- Gender issues

Rural and social development

Little information has been provided in member states progress reports on rural and social development, gender issues or capacity development in third countries. In some cases national rural development programmes are mentioned (Austria, Bulgaria, Croatia, Czech Republic, Finland, Lithuania, Poland, Romania, Sweden and the UK).

Austria reported that funds from the European Agricultural Fund for Rural Development (EAFRD) have been provided via klimaaktiv mobil for the Austrian Programme for Rural Development 2014–2020. Croatia stated that the production of raw agricultural materials used for biofuel production in the Republic of Croatia should comply with the sustainability criteria, as demonstrated by examining the records of the Paying Agency for Agriculture, Fisheries and Rural Development.

Czech Republic reported investment support by the European Agricultural Fund for Rural Development within the Rural Development Programme RDP (Ministry of Agriculture).

Finland reports that development projects relating to renewable energy can be supported through the Rural Development Programme for Mainland Finland. Making the use of biogas from agricultural residue more widespread in Finland requires development work to improve its price competitiveness.

Lithuania had set up the Rural Development Programme, at first for the time span 2007-2013. The programme included measures to promote the use of renewable energy sources, such as Measure 6 “Modernisation of agricultural holdings” under which the production of biogas and the cultivation of short rotation coppice can be supported; or Measure 2 “Support for business start-up and development”. Aid intensity varies from 40% to 65% of eligible project costs. The maximum amount of support for a project depends on the measure and ranges from EUR 40 000 to EUR 2.8 million. The programme will continue until 2020.

Poland implemented measures related to RES under the Rural Development Programmes (RDPs) in 2007-2013 (as of 31 December 2014) Under RDP 2007-2013, support to RES was provided as part of the following measures:

- diversification into non-agricultural activities;
- creation and development of micro-enterprises;
- basic services for the economy and rural population.

During the implementation of Measure 311 diversification into non-agricultural activities, one agreement was signed in 2013 for the performance of an operation in the area of 'production of energetic materials from biomass'. The operation has been completed. Total payments amounted to approx. PLN 53 000, and the payments from the European Agricultural Fund for Rural Development (EAFRD) amounted to PLN 39 600.

In Slovakia, in the 2014-2020 programming period, the rural development programme is supporting the acquisition of technologies for the extraction and processing of woody biomass fuel. There is also support for improving the accessibility of forest stands, building and improving land for the production of fuel chips. The objective of the measure is to step up the production of woody feedstock on forest land with suitable conditions, in particular through the use of fast-growing trees and procedures for their management.

Sweden gives investment aid under the Rural Development Programme 2014–2020. Farmers and other entrepreneurs in rural areas who wish to invest in the production or processing of biogas will be able to apply for aid as of autumn 2015. The compensation may be up to 40 % in investment aid, and in northern Sweden this aid may be as much as 50 % in some cases. The investment aid forms part of the Rural Development Programme for 2014-2020. The aid will be available for enterprises in the garden and reindeer-farming sectors, and there will be more agricultural investment opportunities. When the investment aid commences in its entirety, there will also be an opportunity for garden and agriculture enterprises to apply for investment aid in order to make their energy consumption more efficient, and to reduce emissions of greenhouse gases and ammonia. The previous Rural Development Programme for 2007-2013 highlighted areas such as climate initiatives and renewable energy, which the new programme does not contain.

The UK reported a Rural Community Energy Fund under the category "other funding and grants to encourage deployment and innovation".

Global perspective on rural and social development

By the end of September 2016, 19 approved national voluntary schemes were listed with approval dating from 19 July 2011 until 9 August 2016. 4 out of the 19 schemes have expired as of 09/08/2016, after 5 years.[16] As mentioned in [8] some voluntary schemes cover wider development issues, due to socioeconomic development in rural areas and indigenous people and communities (e.g. RSB, principle 5). RSB, Bonsucro and RSPO can be considered as relevant for biofuel sustainability.

RSB mentioned in its last evaluation report from 2015,[17] 17 companies certified (for comparison: 3 certified companies in 2012, 10 in 2013), which represent 23 operation sites and are located in 14 countries. The total surface covered by RSB certified feedstock production represents about 20 750 ha. Over the period covered by the report, the certified operators produced about 390.500 tonnes of biofuels – according the report under safe and fair conditions for the workers. Furthermore, the report mentions additional measures of operators located in poor countries to reduce local poverty, e.g. the establishing of community rice fields and the training of smallholder farmers.

Bonsucro reports that in 2014 land under certified cane reached over 800.000 ha, which correspond to an increase of 8 % compared to 2013. However this growth rate is much lower than

[16] See https://ec.europa.eu/energy/sites/ener/files/documents/voluntary%20schemes%20overview%20table%20to%20publish_0.pdf, last accessed 26 September 2016.

[17] See http://rsb.org/pdfs/M&E/15-03-11%20RSB%20Outcome%20Evaluation%20Report.pdf

previous years (about 50 % from 2011 to 2012). Also the market for certified ethanol production had a decrease in uptake in the period 2013 – 2014 (about 5 %) compared to 2012-2013 (about 40 %), and is still low (19 % in 2014) [154].

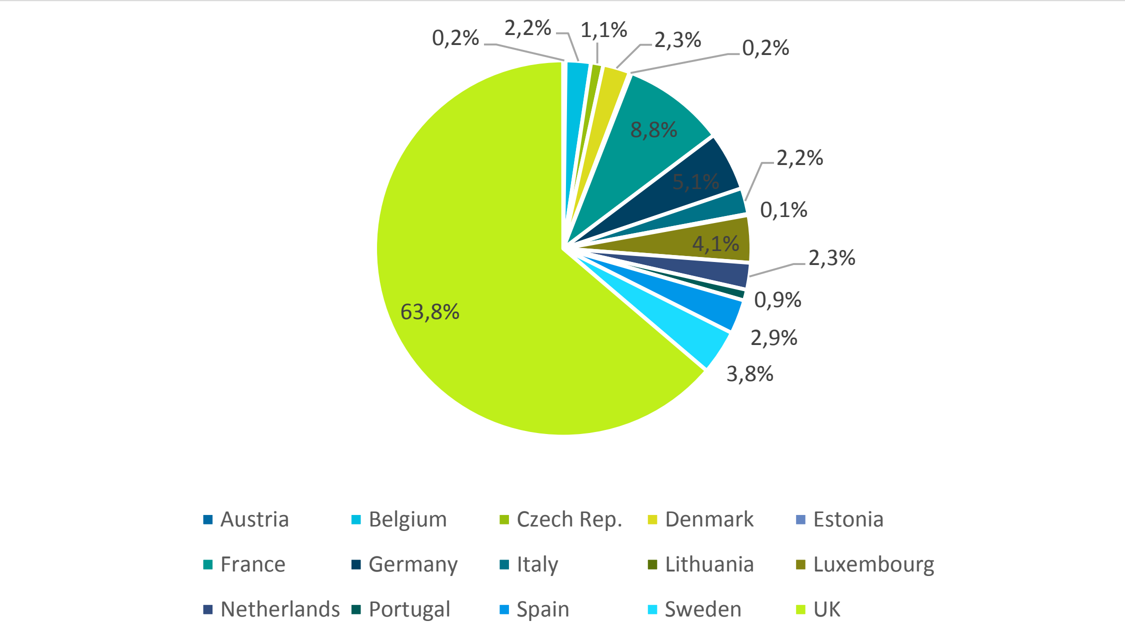
According to the Round Table on Sustainable Palm Oil (RSPO) 2.90 million hectares of land by 3045 members were RSPO principles and criteria certification. Broken down to figures these included 281 certified palm oil mills, 68 growers, 2,050 companies with supply chain certificates and 3,539 facilities with supply chain certificates. Overall 11.37 million tonnes or 17% of global palm oil production were thus certified [155]. A remarkable trend though is that for the first time, RSPO monitored a decline in the certified Sustainable Palm Oil production area (in ha), down from 2.773.999 ha in 2015 to 2.278.587 ha in 2016.

Besides the voluntary schemes, cross-national initiatives such as the Global Bioenergy Partnership (GBEP) have been accessed to observe trends in the rural and social development. GBEP, originally established to implement the commitments made at the G8 in 2005, has developed a set of 24 sustainability indicators for bioenergy, including some indicators concerning rural and social development. Under "social pillar" they list indicators such as (9.) allocation and tenure of land for new bioenergy production, (10.) price and supply of a national food basket, (11.) change in income, (12.) jobs in the bioenergy sector, (13.) change in unpaid time spent by women and children collecting biomass, (14.) bioenergy used to expand access to modern energy services, (15.) change in mortality and (16.) burden of disease attribute to indoor smoke and incidence of occupational injury. According to an overview on their website, measuring of these indicators is currently undertaken in Brazil, China, Egypt, Ethiopia, Ghana, Italy, Kenya and Paraguay. Former measuring results can be reviewed from Argentina, Columbia and Indonesia. The Argentinian report mentions a general problem caused by a lack of data in order to evaluate the indicators according the GBEP methodology. Columbia reports about exploration of positive effects regarding the quality of jobs associated with biofuel feedstock production or processing. These are a higher level of formalization of employment, better wages and benefits and better protection against occupational risks for sugarcane and oil palm workers compared to the average agricultural worker. Furthermore the report mentions a transformation in the supply chain of palm oil: small-scale producers form strategic business partnerships (Alianzas) in order to improve their access to credit, strengthen their bargaining power with the mills and to ensure a secure market for their products. Also the Indonesian report states a better job quality in the oil palm sector compared to other agricultural sectors, mentioning a higher level of formalization of employment, better wages and a better protection against occupational risks. As negative impacts, some cases of land conflicts are mentioned, caused by a lack of adequate legal recognition of customary rights to land.

Respect of land use-rights (Article 17(7)(2)) - Land tenure / land grabbing

The international non-profit organization GRAIN has documented land grabbing in an updated dataset, with 491 land deals covering over 30 million hectares and spanning 78 countries [156]. Investors based in EU member states hold a 35 % share or contract sized area of 10.4 million ha. Within the European Union, investors based in the United Kingdom by far hold the largest shares of land deals (nearly two thirds) followed by France, Germany and Luxembourg-based investors .

Figure 1-69: Share of EU based investors in global land deals



Source: [156]

Research conducted by [63] pointed out in 2014 to the fact that, although foreign governments and commercial farming companies that invest and acquire land may maintain underutilized agricultural area, and that their investments may promote productivity and enhance local employment, often the surplus food produced in the acquired land is typically exported to other regions, while the target countries exhibit high levels of malnourishment.

[64] confirm in 2016 in their updated analysis of international land deals the ongoing trend of continuing land acquisitions all over the world. Agricultural land acquisitions covered by the Land Matrix dataset are increasingly becoming operational. Overall, the Land Matrix has captured 1,204 concluded deals, which cover over 42.2 million hectares of land, larger than the size of Germany. Although the large part of the covered large-scale agricultural land deals are for farming purposes and food crops (26.7 million hectares), followed by unspecified agricultural intentions – mostly involving oil palm (263 deals on 5.6 million hectares), agrofuels (221 deals on 5.1 million hectares) for energetic purposes (most often are oil seeds, including oil palm and jatropha, cereals such as corn and wheat, and sugar crops) have a significant impact. This growing share includes the dominance of oil palm and rubber in Asian investments and the relative dominance of fuel crops in the case of UK and Indian investors.

A new report by [65] indicates that there are no comprehensive data on the extent of land grabbing. However, the report confirms that it is mainly land on the African continent that is most vulnerable, as 90 % of Africa’s rural land is undocumented making it vulnerable to land grabbing activities and expropriation with adverse impacts on local communities and indigenous population. In effect, the impact of land grabbing may be deteriorating the role of those with less secure tenure rights, especially women.

Insecure land rights according to the use of biofuels is a concern. Several studies discuss the impact of importing countries (like the EU). For example, a World Bank study published in 2011 identified “demand for biofuel feedstocks as a reflection of policies and mandates in key consuming countries” as one of the main drivers of the global expansion of cultivated area. The study drew on multiple sources, including systematic national inventories of land deals. A separate report, also published in 2011, found that biofuels accounted for 63 % of land acquired in Africa since 2005 [66, 63].

Germany indicates, that it is hard to identify if land grabbing or the risk of famine and poverty increase through the consumption of biofuels. No other Member State reported further issues on respect of land use rights.

Capacity development and technology transfer

Capacity development and technology transfer are necessary requirements to enhance a firm development of bioenergy technology, though numerical data are rarely collected. Besides of Sweden, no other country reported on the issue. Sweden referred to local and regional capacity development for climate and energy adaptation as a regional measure. The appropriation of SEK 25 million per annum over the 2016-2019 period may be used to finance the work done by the county administrative boards on coordinating local authorities, enterprises and other stakeholders in their respective counties and running the development, implementation, follow-up and evaluation of regional energy and climate strategies, aid for regional networks, and collaboration projects.

Current examples of international capacity development can be found by investigating individual activities of renewable energy agencies and initiatives. IRENA strongly focuses on the relevance of capacity building activities and published already in 2012 its “Capacity Building Strategic Framework”. The paper underlines the importance of cooperation between educational institutions, providing the necessary technical know-how, and universities or academia having the experience to develop structured curricula and providing a necessary framework. Furthermore, it mentions a lack of visibility and accessibility of renewable energy education and training. By means of the IRELP platform IRENA implemented a tool to improve access to education and training as well as the visibility of other training opportunities. It is striking to note the lower number of bioenergy training offers compared to other renewable energy technologies listed in the IRELP database, what might be an indicator that there is still a lack of qualified training opportunities in this sector. This evidence is even strengthened by monitoring capacity building activities of other initiatives. GBEP implemented a working group on capacity building for sustainable bioenergy in 2011, aiming to raise awareness on bioenergy technology. However, besides the annually-conducted Bioenergy Week and the implementation of a study tour on capacity building and training (2013) led by Brazil, no other current activities are published on their website.

Gender issues

Gender issues are not specifically mentioned in the member state progress reports. But as indicated in [67], gender is a vital aspect in energy provision in many developing economies. Nearly half of the world’s farmers are women. According to the UN Food and Agriculture Organization (FAO), in 2010 women accounted for 43 % of the agricultural labour force worldwide, with wide regional variations. Concrete and recent studies on gender issues in the context of bioenergy are scarcely available. Conclusions can be drawn only from facts about women’s tenure of land, their situation in agriculture, involvement into decision making processes and education levels.

The FAO’s gender and land rights database analyses the distribution of agricultural holders by sex, in which the agricultural holder is “the civil or juridical person who makes the major decisions regarding resource use and exercises management control over the agricultural holding operation." [68]. The data shows quite evident gender inequalities, with an overall global share of female agricultural holders of just 12.8 %. At the same time, a FAO study on Gender inequality in agrifood systems in Latin America and the Caribbean of 2016 quotes that particularly in rural areas women's contribution would be mostly invisible, even though they perform a large part of the activities plus additional domestic work and homecare. Women mainly participate in activities that involve time and physical effort. On the other hand, they are less represented in those links of the value chain associated with increased revenue generation.

The United Nation's The World's Women 2015 Report states for technical and vocational education and training programmes still a lower enrolment of girls than boys in 140 of 163 monitored countries (period 2005 – 2012). Participation in tertiary education showed strong progress between 1990 and 2012, in which participation of women rose from 14 to 31 %, for men from 13 to 33 %. However, women are still underrepresented in tertiary fields of studies related to science (7 %) and engineering (5 %).

These data might give an indication that employment opportunities and working conditions for women in the bioenergy sector have not really improved since the last FAO report on this topic (2008). However, detailed case studies are necessary to analyse this mere assumption. Zähringer reports in a gender analysis of the Serbian bioenergy sector in 2012 about largely varying participation of women in different decision-making levels: while some women active in political decision making position on a national level, communal and local level is dominated by male representative. In the economy, far more males than females are engaged in business activities, while women are responsible to a high degree for the organisation of the household and the provisioning of firewood.

1.2.3.6. Security of supply ((Article 23(5)(a))

No information is reported from the Member States according to security of supply.

The EU Energy Security Strategy from May 2014 contains the following key actions:

- Immediate actions aimed at increasing the EU's capacity to overcome a major disruption during the winter 2014/2015
- Strengthening emergency/solidarity mechanisms including coordination of risk assessments and contingency plans; and protecting strategic infrastructure
- Moderating energy demand
- Building a well-functioning and fully integrated internal market
- Increasing energy production in the European Union (incl. renewable energy)
- Further developing energy technologies
- Diversifying external supplies and related infrastructure
- Improving coordination of national energy policies and speaking with one voice in external energy policy

The improvement of EU energy security needs a change course and increase in its production of alternative energy. This includes biofuels: Biofuel technology replaces imported oil with home-grown energy and as such it is one of the most important and far-reaching resource. Locally-produced biofuels offer the opportunity to increase Europe's energy security and it diversifies away from the main energy countries like Russia and the Gulf countries, towards major biofuel exporters such as the US and Brazil. Nevertheless, the availability of biomass is an important issue. As discussed above, the EU is a importer of biofuels. Further investment and innovation in the European agricultural sector are necessary to create more productivity, and these higher yields lead to less land needed for livestock. This will not only release land for biomass production and other uses, but can also lead to lower direct GHG emissions from food production[18].

Another aspect is the influence of EU biofuel policy on other countries. [69] stated that almost half of the world's population relies on wood-biomass energy for cooking and heating. Most of this population lives in developing countries, where four out of five people live without electricity, mainly in rural sub-Saharan Africa and South Asia. If more wood and other biomass is imported from those countries to be used for the production of biofuels, this might lead to competition with local biomass used for energy production, either directly when biomass that currently feeds local energy needs is redirected to export and hence no longer available for the local population or indirectly, when designated sites for the production of biomass for export displace land uses that have a significant role in feeding local energy needs or in ensuring local income. Otherwise, biofuels can also have a positive impact on energy supply in rural areas, if programs are run for a decentralized application of biofuels. For example, different projects in the developing world are promoting ethanol as a clean, more efficient, affordable, and easily accessible household fuel.

Biofuels can improve energy security through diversification of energy sources. Furthermore it can recycles waste, reduces greenhouse-gas emissions, and produces jobs (often in rural areas). That is why replacing imported oil with home-grown energy is one of the most important and far-reaching legacies today.

1.2.4. Impacts of biomass consumed in the EU

1.2.4.1. Commodity price changes (Article 23(1))

Summary

Price effects reported by Member States are limited due to the fact that bioenergy use makes up only a small share of the total agricultural activity in the Member State.

Price shocks are less influenced by tax exemptions or biofuel mandates but more through import duties or climate anomalies.

The Organization for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO) concluded that the recent period of high agricultural commodity prices is most likely over. The outlook stated that the increased demand for food and feed for a growing and more affluent population is projected to be mostly met through productivity gains, with yield improvements expected to account for about 80% of the increase in crop output [70].

Member States reports

In the following the Member States reported the impact of the biofuel policy on commodity prices in their progress reports.

[18] http://www.biofuelsforeurope.eu/energy-security/

The market of forestry biomass in Austria had a moderate price increase due to different reasons, e.g. a large increase in processing capacity in the Austrian wood processing industry. This resulted in increased demand for timber stocks and durable wood products. Nevertheless, an oversupply of wood has been observed and the wood prices have fallen. It will be expected, that the prices do not reverse. Future rising prices will be expected due to the development of the sawmill industry (price rise for indirectly available wood biomass).

In Belgium no prices changes and land use changes are known from the use of biomass and other renewable energy sources.

In Bulgaria the prices for commodities increased between 2013 and 2014 annually on average around 5.9 % and 5.4 %, respectively. The arable products were sold for lower prices than in the previous year, except for rice and oats. Bulgaria has an increase in harvested areas for main cereal crops compared to 2012 (triticale and rye). On the other hand crops like wheat, barley and oats decreased between 3 % and 11 %, maize 8 %. This resulted in an increased overall production of cereal crops by around 31 %. The production of sunflower increased by around 12% and rape by around 24 % due to more harvested area and a higher average yield. The report says that due to favourable weather conditions the average yield of most cereal crops was higher and so the overall production. According to higher prices for main agricultural products the production value of arable and livestock farming were negatively influenced and decreased, as a consequence of a lower volume of production.

Cyprus has no information on any changes, because no crops were exclusively destined for energy use. This is due to the fact, that the agricultural sector cannot support exploitation of substantial volumes of products or by-products from agriculture and forestry for energy generation purposes. The reason for this is primarily the water supply problem in Cyprus.

In Germany the price of wood has increased while corresponding with an increasing demand for wood. The price of wood chips has doubled since 2003, but during the reporting period the price stayed at a nearly constant high level with minor fluctuations. According to the increase in wood-fired heating systems, the overall prices have seen an upward trend. The prices of wood pellets have increased because of higher raw material costs. The same is relevant for the prices of wood briquettes produced from sawdust and sawmill by-products. The rise is linked to the downturn in construction activity, the rise in plywood, the price level of waste and mild winters in the reporting period. The prices for vegetable oils are determined by the world market. The prices have fallen since 2011. Prices for biogas substrates are scarcely dependent from the world market. This is due to the fact that they are only transported short distances. The price level of agricultural products was higher compared to 2010 but mainly due to animal products.

Denmark has just a small change in demand for biomass for energy and therefore no measurable effect on raw material prices and land use.

The price of firewood in Estonia shows a downward trend, due to warmer winters than average and therefore lower demand. The trend has been seen for a several years. In the same manner the prices for chips and sawdust decreased.

The main commodities in Greece are saw dust and chips, fire wood, rice husks, exhausted olive cakes, fruit kernels, pellets and sunflower and rapeseed seeds. The prices for forest residues show a slight decrease. Firewood and exhausted olive cakes are recorded a relative increase of prices between 2011 and 2014. In any cases the firewood prices depend on the countries of origin. According to legal frameworks for bioenergy production, imports of firewood are expected while exhausted olive cakes may be exploited locally.

The price of woodchips in Finland rose by 1.9% in 2014. Due to the fact that field biomass is little used in Finland, the use has not affected the prices of food and feed crops. Timber became more expensive, particularly when the prices for de-branched tree trunk and treetop mass increased. Prices trends are unknown due to the fact that statistics on prices and quantities of wood in the form of wood chips from forestry as a raw material started at the beginning of 2014. There was great regional price fluctuation in the prices of energy wood in 2014 for each energy wood species. The use of wood pellets increased but not their price. The increasing uses of wind power and bioenergy have affected the price of woodland and forests. They have risen rapidly. Nevertheless, Finland has no detailed statistics on that issue.

France shows an upward price trend for energy wood.

Average commodity prices in Hungary of rape and corn decreased in the period 2013/2014.

In Luxemburg there is no robust data on commodity prices because there is essentially no real market. In general production costs for silage maize, green fodders etc. have increased in recent years and thus the cost of operating biogas plants. This adjusts to the feed-in tariff for biogas plants.

Due to wood pellets, wood chippings and wood-based fuel products, there is no change in commodity prices in the Netherlands. Driving factors of wood pellets are dry bulk shipping rates, demand in other countries and supply. The Netherlands produces only a fraction for its own supply. Price developments of wood-based fuel products are handled confidentially and therefore not reported.

Poland observes a close link between domestic and world market prices for agricultural raw materials, but only a little impact on price levels caused by the use of agricultural material for energy purposes. In the period 2013/2014 average buying-prices for wheat, rye, barley, maize, and oilseed rape decreased.

In Portugal no price fluctuations caused by the consumption of forestry wastes for energy purposes were recorded.

In Sweden the price of wood pellets and wood chips has fallen. The downward trend started after the cold winter in 2009/10. Also the price for processed wood fuels (pellets, etc.) has fallen. This is due to the fact that imports of household waste are increasing. Sweden has expanded its waste incineration capacity in the last years. This means the demand for wood fuels has fallen and prices are kept low. Due to warmer winters over the last 3 years the demand for waste and recycled wood is also fallen.

Slovenia's reference price for wood biomass was slightly lower in 2014 and the price for corn silage substrate was rising.

Slovakia has low prices of energy chips due to the growth in their production from wood harvested on non-forest land, the disposal of wood from recurrent disaster and feedstock derived from mechanical processing of timber in the wood-processing industry. Because of the stagnation of fibre wood prices, more wood can be used for energy purposes. The prices of wood fuel increased and the prices are influenced by the trend in natural gas prices for households. Interest in wood fuel is rising steadily, especially in the countryside. The price of wood pellets is increasing slowly, in view of high level gas use.

Spain is importing most of its raw material, therefore no relevant impact on commodity prices was observed.

The United Kingdom has no evidence on a linkage of commodity prices on land use change.

1.2.4.2. Food security (Article 23(1))

Summary

Food security is expected to be largely unaffected by the use of crop residues and perennial crops grown on marginal land.

The EU has to pay attention on food security with a target on the rate of food loss and waste, low carbon agriculture, and water efficient food production. Furthermore a reduction of animal stocks would be useful for creating more agriculture land for food production.

With the CAP reform in 2013 the EU has tried to contribute more to a sustainable agriculture. Viable food production is one of the policy objectives.

In accordance with 2013 analysis of [73] high food prices increase the cost of food for consumers. But they also increase income for farmers, who represent mostly a poorer part of the global population. Furthermore high food prices stimulate local investments in agriculture, necessary for future food security. Whether the net effects are positive or negative depends on whether poor households or countries buy or import, or sell or export food [73].

Costs and impacts of international food prices can be limited by reducing applied tariffs, avoiding export restrictions, creating buffer stock and domestic food assistance, regional market integration and investing in food production and resilience [73]

To reduce volatility on the agricultural markets especially according to negative impacts on poorer regions or countries the dimensions of food security has to be considered [73]:

- Availability of food is determined by domestic production, import capacity, existence of food stocks and food aid;
- Access to food depends on levels of poverty, purchasing power of households, prices and the existence of transport and market infrastructure as well as food distribution and storage systems;
- Stability of supply and access may be affected by weather, price fluctuations, human-induced disasters and a variety of political and economic factors;
- Safe and healthy food utilization depends on care and feeding, food safety and quality, access to clean water, health and sanitation.

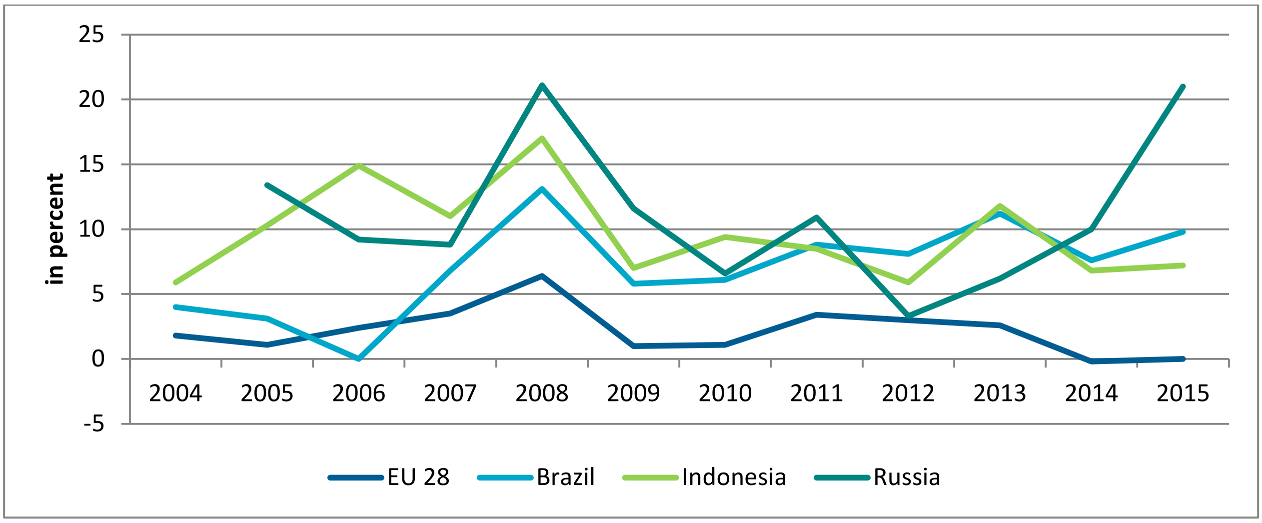
Changes in feedstock prices

According to the United Nations Food and Agriculture Organization (FAO), "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." the Committee on World Food Security identified four main dimensions: availability, access, utilization and the stability of the previous three dimensions. The World Resource Institute amended sustainability as a fifth dimension [74].

The food price is one of the most significant indicators in determining the state of food security. The prices for most types of biomass are formed on global agricultural markets. The food price index is derived by averaging all food/crop commodities in the World Bank monitor on commodity prices.

In summary, EU Member States reported limited or no impact on prices due to their domestic biofuel production (see Chapter 3.2.2.4.). However, globally food prices have increased 142 % in developing countries and 38 % in the OECD in total over the last decade (Figure 1-70). And food prices are expected to remain high through the next decade [75].

Figure 1-70: Annual growth rate of the food price index for different wold regions/countries (in %)



Source: [70]

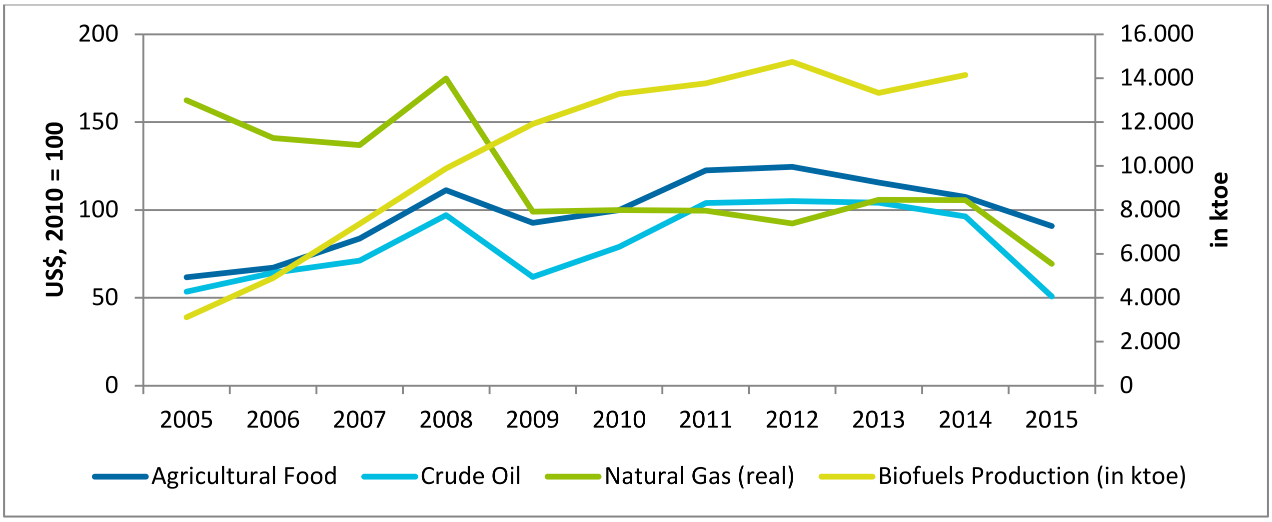
The following factors to cause food price inflation were reported in 2013 [75]:

- Growing demand from developing countries
- Changing structure of demand
- Energy prices
- Biofuels
- Weather-related production shortfalls
- Stock levels
- Operations on the financial market
- Short-term trade policy choices
- Exchange rate swings
- Growing scarcity of viable agricultural land
- Under-investment

It has to be noted that these factors vary widely in their importance for different regions of the world and different commodities. Energy and agricultural prices have become increasingly intertwined as stronger linkages between energy and agricultural markets have developed. Elevated prices for crude oil and natural gas, in particular, have pronounced negative impacts on the supply of world food crops [168]. Oil is an energy source that is tightly integrated with food production, processing and transportation systems. The increasingly faster price surge up to the 2008 climax coincides with increasing growth in global biofuels production. Over the years, biofuel production continues to increase while crop production decreases. Biofuels production slows down between 2010 and 2012. After 2012 the global biofuel volumes increased significantly (around 30 %). In 2013, a further growth was expected until 2025 [70].

There is a strong relationship between energy and non-energy prices. This has been established long before the price boom (2004-2008) [79]. They say that the effect of energy prices on food is four to five times higher than manufacturing sectors. The policy-driven expansion of biofuels has not those strong negative impacts on food prices. [169] states in 2016, that the price link between energy and food commodities is not as strong as some would have expected. They discuss that under a mandate prices for maize will decline. This leads to a negative relationship between food and oil prices. High oil prices increase the cost of food production but also cause a leftward shift to the demand of food. He results that the strength of the relationship among food, biofuel and energy prices should not be used as evidence for or against the impact of biofuels on food prices. [169] describes another issue in addition to the policy-driven effect and this is the level at which energy prices provide a floor to agricultural prices. The issue is complex due to the involvement of elements like values of by-products, subsidies, mandates, trade interventions or sunk costs of the biofuel industry. Behind this background the food/fuel relationship is non-linear. Nevertheless energy prices interact with food markets by increasing the costs of production of food commodities and by inducing policies that divert food crops to the production of biofuels [79].

Figure 1-71: Global agricultural food price index, biofuels production, energy price index



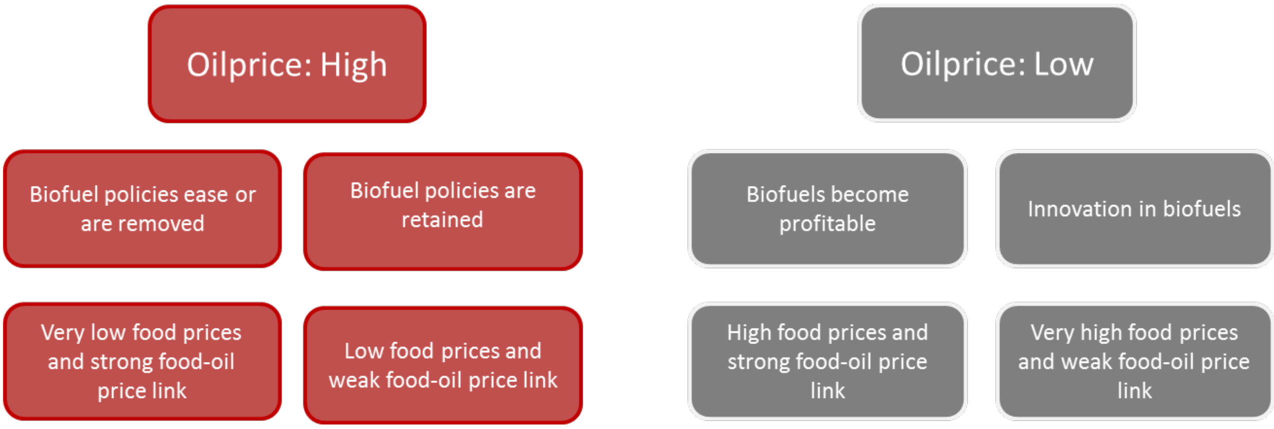
Source: [157, 158] [127] nrg 107a

The figure above shows that a correlation between crop prices and biofuels volume is absent after 2008, while crop prices correlate strongly with the prices of all commodities, suggesting that the underlying issue is not only biofuels, but other influences [73].

[73] argue based on a literature review that any agricultural demand shock from biofuels in a market that is already restricted in options (low in stocks, nervous and speculative) leads to a quick increase in prices.

In the long term the development of the oil price is expected to play a pivotal role in determining food prices that goes far beyond the costs of production [76].

Figure 1-72: Food vs. biofuel prices influenced by biofuel policies and innovation



Source: [76]

[77] analysed in 2013 the impact of biofuel policies of grains and oilseed prices. While feed grain and oilseed prices were in lockstep with each other and with oil prices in 2008, both economic and developing country policy responses to the feed grain/oilseed price shock had a cascading effect on wheat and rice prices. They noted that mandates and tax credits (categories of biofuel policies), do not discriminate against international trade, e.g. Brazilian ethanol foreclosure of US markets. Leading into the biofuel era, developing countries were concerned by low prices due to rich country agricultural policies. But because the increase in prices was so sudden, developing countries were unable to take advantage of it as expansion in sugarcane production. [77] shows the link between biofuel policies in European or other “rich” countries exists and is distorted by European agricultural policy.

In 2014 only 2 %, of Europe’s cereals supply was used to produce ethanol – not enough to reduce cereals supply to food markets. Europe’s ethanol consumption has only been responsible for 1-2% of any increase in global cereals prices since 2006. It is projected that further increases to European biofuels consumption to meet Europe’s biofuels targets in 2020 will have a very small impact on food commodity prices. Rising oil prices have been found in 2013 and 2015 to be responsible for almost 66 % of all food price increases [78, 79].

[80] described in 2013 that the United States has been a dominant player in the implementation of biofuel policies. There is a strong interaction of biofuel policies instituted by the European Union. Moreover, the temporary agreement between the United States and five EU countries that allowed the US tax credit on ethanol exports to the European Union to take the form of a production subsidy for US ethanol producers had both short- and long-term effects, including some that failed to increase energy efficiency or to decrease global inequalities.

A 2014 study by the University of Utrecht found that it is possible to sustainably increase biofuels production in Europe, with no negative impacts on food availability, when biofuels are produced from agricultural yield increases and when unused land is used to grow crops for biofuels production. European ethanol production utilised only 2 % of EU grain supply and only 8 % of EU sugar substrate in 2014. Under EU sugar rules, only surplus sugar that cannot be used for food production can be used to produce ethanol. The amount of cereals used to produce ethanol in Europe in 2014 was more than offset by EU cereals production increases, meaning there was no competition between ethanol and food production. Europe is the world's largest food exporter, which means it produces enough food and biofuels for its own use and still helps feed the world [35].

[81] discussed in 2015 in their study the role of EU biofuel policy on the economics of biodiesel. The EU is a net-importer of biodiesel with rapeseed as the main crop. The EU has a comparative advantage in domestic biodiesel production. All crops are affected by biodiesel policies through the law of one relative international price of grains and oilseeds. Changes in the world price of biodiesel effects not only the EU biodiesel demand but also the EU biodiesel industry and therefore the profitability of the sector. They also point out that EU import tariffs on US biodiesel did not help the profitability of the sector, because of imports from other countries and because mandate premiums were minimal leading. EU policy according to anti-dumping duties and therefore reduced imports, increase the price in the EU for biodiesel. The price link between biodiesel/bioethanol and their feedstocks is tiered: in case of biodiesel an exogenous shock first affects the price of oil (e.g. soybean oil) and then the price of the feedstock (e.g. soybean). In the case of ethanol and corn prices there is no grading. Ultimately this results in the finding that the same shock in the price of biofuels has a greater effect on the price of corn for ethanol than on the price of biodiesel feedstocks. A higher biodiesel price results in more feedstock production and this leads to more feedstock product production (e.g. soybean meals). Oppositely, a higher ethanol price attracts more corn to ethanol production, reducing the amount of corn for food and feed use.

[81] summarize the influence of alternative biofuels policies as follows: the market prices respond much more under a binding tax exemption than under a mandate. This is due to the fact that the demand for diesel fuel is very inelastic. Therefore the consumption of diesel fuel changes minimally due to higher diesel prices. A diesel price shock has opposing effects on market prices: the prices of feedstocks and oils increase, the prices of meal products decreases under the tax credit, whereas the opposite happens with the mandate.

Influence of dietary habits on food stability and access

A number of studies (e.g. [82], [83] in 2011 and 2012) have discussed the influence of dietary habits on biomass potentials and food security. All studies came to the conclusion that the influence of dietary habits is highly relevant.

Table 1-23: Land requirements

	m² / 1.000 kcal
beef	31.2
pork	7.3
milk	5.0
oil fruits	3.2
corn	1.1

Source: [159]

Table 1-23 shows that the share of animal products varies considerably on a global level. North America consumes around six times more animal proteins than Africa. Furthermore, the share of highly processed food and sugar is in western countries significantly higher. It became clear that hunger and malnutrition are primarily distribution problems. Therefore, land use (on the EU level) for bioenergy is just one influencing factor. The other important factor is the land use for our diet habits and from our import partners.

If the global trend (including the trend within EU-28) is an increase of animal products, it means increasing pressure on available land (in- and outside of the EU).

[84] noted in 2015 that an evidence-based policy formulation is key to ensuring integrated food and energy systems are developed when viable. They further recommend that the impacts on costs and yields (on the Member State level) of feedstocks would need investigation. This is due to the fact that, if the selling price of feedstocks were to change, the competitiveness at the farmer level might change. Therefore it would also be useful to investigate the change over time. Yield changes, in combination with feedstock price changes and further work on the definition of the fossil fuel comparison price, might alter the competitiveness position of feedstocks with respect to fossil fuel-based electricity production.

1.2.4.3. Biomass using sectors (Article 23(5)(d))

In the following the focus will be on material use of biomass in contrast to the energy use in EU biofuel sector. The use of food and feed will be not considered. For this issues see chapter 1.2.3.4.

Sectors included in the use of renewable raw materials are sawmill and wood-based industry, pulp and paper industry, chemical industry, oleochemistry, textile industry and pharmaceuticals and cosmetics.

According to the impacts of biomass use on different sectors, some Member States reported the following (mostly on wood sector):

Due to Rural Development Programmes financed by the EU, wood use in a sustainable manner will be expected in Austria. In total, Austria expects a decline of wood use.

Cyprus has little agricultural land and forestry. Therefore there are limits to an increasing agriculture and forestry sector. Cyprus thus promotes animal, urban and industrial waste as raw material for biomass energy production.

Germany has an increased demand for land and this affects the rents or agricultural land, especially in areas with high density of biogas. High rents are in some regions mainly attributable to the combination of a high live-stocking density and biogas plants which trigger regional competition over land use, which triggers rising land prices.

Several new pellet factories were opened in Estonia, one of which with the largest production of 250.000 tonnes per year.

Latvia is a net exporter of cereals and energy crops. An increase in the production of energy crops may lead to a corresponding decrease in the production of other cereals.

In Poland, the production of by-products from biofuel production resulted in an increased use of animal feed production. So Poland produces more valuable protein components.

Due to the economic benefits, there has been an increase in imports of wood for the production of wood chips in Slovenia.

An analysis by [41] elaborated on the current competition between the petrochemicals sector, the bioenergy & fuels sector and the sector of industrial materials made from biomass. The bio-energy and -fuels sector is able to compete with petrochemicals thanks to all the subsidies and support mechanisms. Petrochemicals can easily compete with both other sectors as well, again because of many tax breaks. Yet, the biomaterials cannot compete with either of the other sectors because there is no support mechanism in any form. The consequences are a very low growth of the sector and an increase of the prices for biomass. Furthermore the battle for biomass is lost for the materials sector and raw materials are almost solely used by the bioenergy/biofuels sector. This means hundreds of potential biomass applications in the materials sector are not being materialised. They show that the RED is one of the main causes of the longstanding and systematic discrimination between material and energy uses. The RED hinders the development of material use by providing comprehensive support to energetic uses of biomass that is not balanced by comparable incentives for the material use. [41] describe the reasons in unfavourable framework conditions combined with high biomass prices and uncertain biomass supplies.

The EU bioeconomy concept focuses on sustainable production and conversion of biomass into a broad range of industrial products, materials, energy, as well as food and health products. Management and controlling of this transition needs appropriate measurement, indicators and assessment tools to cover not only the bioeconomy as a whole, but also the different dimensions of bioeconomy development. As a consequence, a monitoring system for the bioeconomy has been heavily debated on national and international levels, but has not yet been established.

Over recent years technological progress and political promotion led to a significant expansion and intensification of the use of bio-based resources both in the EU and worldwide. Conflicting and problematic effects and interactions have become apparent, with both desired and undesired impacts occurring. At least partially, these impacts have thwarted the promising solutions of the bioeconomy. Expansion and intensification of the use of bio-based resources impacts life-sustaining functions from the local to the global level as regards fertile land, climate effects, biodiversity, water and household as well as economic viability, income chances and food security. Similar to economies as a whole, also bio-based value chains are becoming more globalised. National strategies to promote the use of bio-based resources may have pronounced impacts on land use, environment and income in other countries.

[85] analyse the European bioeconomy. Excluding the sectors food, beverages and tobacco products the turnover was about 1 trillion Euro. 43 % are from agriculture and forestry, 1 % biofuels and 7 % bioenergy.

[41] summarizes the conflicts about biomass use in different sectors as follows:

Table 1-24: RED and conflicts about biomass use

Product	Competition for	Competition to
Surfactants, other chemicals (Oleochemistry)	Animal fats, vegetable oils	Biodiesel
Epichlorohydrin, acrylic acid and acrolein	Glycerol	Glycerol-based fuels (e.g. biomethanol in gasoline blends) and fuel additives (e.g. GTBE)
Bio-ethanol for chemicals	Sugar, starch, cellulose	Biofuel sector, fossil-based ethanol for chemicals
Bio-based chemicals/building blocks	All kinds of biomass, especially residues from forest and agro industries	Biofuel & bioenergy sector
Natural Fibre Composites, insulation material, technical textiles, speciality pulp & paper	Agricultural areas	Biofuel & bioenergy sector; especially biogas
Pulp & Paper and cellulose fibres for textiles, nano-cellulose	Wood	Bioenergy (heat & electricity) from burning wood (and 2nd generation biofuels in the future?)
Pine chemicals (e.g. rosin, etc.)	Tall oil (by-product from pulp & paper)	Biodiesel
Furniture, panel and other construction materials (woodworking industry)	Wood	Bioenergy (heat & electricity) from burning wood (and 2nd generation biofuels in the future?)
Potting soil, growing media	Bark (wood), green waste for compost	Bioenergy (heat & electricity) from burning wood (and 2nd generation biofuels in the future?), biogas

Source: [41]

Other biomass sectors (for material use) compete with bioenergy for biomass that is not used for food or feed. As a result of the comprehensive support system for bioenergy and biofuels, which was ultimately created by the EU RED, the prices for biomass and land have greatly increased. This makes access to biomass for material use much harder and more expensive, but this is not compensated for by support measures. This market distortion hinders the competitiveness of producers of materials from biomass [86].

The bio-based chemistry and plastics industries are exposed to full competition from chemical industry products. Without any accompanying measures, new, bio-based industries must be developed that can prove their viability in the face of the well-established and long -optimized mass production of the chemical industry. Then there are high biomass prices resulting from the promotion of energy use, which are not counteracted by taxes on fossil carbon sources as a raw material for the chemical industry. All of this creates an extremely tough competitive environment [86].

There is an interlinkage between EU biofuel sector and other bioeconomy sectors related to policies and support. They propose to reform measures to amend the RED in order to reduce market distortion between material and energy use and to prevent future misallocations of biomass (due to economic and ecological criteria). As stated in [160] it is still questionable if the feedstock use for biofuels in the EU is a bigger barrier for the development of a bio-based economy. [41] indicates that market distortion is becoming particularly visible in the case of supposedly unused residues.

[87] stated that more knowledge is needed on how to sustainably produce and use biomass. Marine biomass should also be considered in the debate. Many of the new technologies (e.g. electric cars) will not be available before 2030-40, while conventional biomass is now available. It was argued that the current discussion focuses too much on agriculture, and that there is a need to include forestry in the discussion, as it holds potential to play a major role in the transition to a bio-based economy (potential to increase forest productivity: tree species, breeding). The construction sector was pointed out as a sector that could contribute effectively to energy reduction, e.g. by substituting steel and concrete with bio-based materials.

Overall, it can be stated that emerging bioeconomy sectors are hindered by EU biofuel policies. An increasing use of biomass in bio-based chemicals and materials would be very well in line with strengthening the industrial production in the European Union. With the right incentives, a transformation of existing structures of bioenergy and biofuels production towards the industrial material use of biomass should be initiated, e.g. by including industrial material use of biomass in the RED overall quotas and also in the fuel quota. Furthermore, all kinds of biomass use should be certified for their sustainable production. [41] summarize that the creation of new, one-sided hurdles should be prevented. In this context, it is desirable to expand the criteria for all sectors – biofuels, bioenergy and bio-based chemicals and materials – to cover more aspects than the five criteria obligatory for biofuels today.

1.2.5. Analysis of advanced biofuels

Summary

Measures to promote biofuels should focus on advanced biofuels, with low ILUC impacts and high overall GHG emission savings [88].

[40] demonstrated in their study that most EU Member States are likely to have more than enough feedstock in 2020 to meet the 0.5% advanced biofuel blending subtarget in the ILUC Directive. This level of biofuel production can be met using sustainably available agricultural and forestry residues and biogenic wastes without negative environmental impacts and without diverting feedstock from other uses.

Nevertheless policy support for advanced biofuels needs to be sustained by promoting biomass availability and technological deployment [88].

Regardless of the long-term priorities of biomass use for energy, the stimulation of lignocellulosic biomass production by development of near term and cost-effective markets is judged to be a no-regrets strategy for Europe. Strategies that induce a relevant development and exploit existing energy infrastructures in order to reduce risk and reach lower costs, are proposed as an attractive complement for the present and prospective biofuel policies [89].

There is a need for economic support for market competition of second generation, e.g. evaluation of alternative taxation or subsidy schemes. Further research or reporting is needed on sensitivity analysis of feedstock prices to estimate the associated impact of suppliers on the economic performance, or subsidies to increase the competitiveness of biofuels [89].

However, in the case of using waste and waste residues the waste hierarchy should be guaranteed. This means that the material use always has priority. Furthermore, it should be considered that the additional extraction of agricultural residues from agricultural land affects the soil carbon content. This should be part of the reporting obligations of the Member States.

A restriction of energy crops on lower quality land could also be useful to avoid land use competition.

Introduction

Advanced biofuels or second generation biofuels are fuels produced from biomass feedstocks that do not directly compete with food production (mainly lignocellulosic biomass, wastes and residues). As the production of first generation biofuels is facing severe criticism due to the perceived competition with food production and indirect land use change, second generation biofuels made from non-food biomass are being developed to avoid such adverse impacts.

To support the advanced biofuels the EC started a number of programs and support schemes:

- EC strategy 2012 “Innovating for Sustainable Growth: a Bioeconomy in Europe”
- Bio-Based Industries Joint Undertaking Public-Private Partnership, July 2014
- European Bioeconomy Alliance, February 2015
- 4th BioEconomy Stakeholders Conference, April 2016
- ILUC directive (2015/1513), 9 September 2015 which consists of the following support schemes
- RED caps first generation biofuels at the maximum level of 7 %.

Double-counting of advanced biofuels has been confirmed and applicable feedstocks for double-counting has been clarified (part A and B of Annex IX).

A 0.5 percent national sub target for advanced biofuels (part A of Annex IX) has to be set until 6 April 2017. The new cap on first-generation biofuels also restricts the European market for producers outside the European Union and creates opportunities for external producers who want to supply the advanced ethanol market in Europe, for which trade can play a major role in the future.

After adoption and entering into force of the RED by the European Union in 2009, the double counting system has been introduced in a number of member states. This should stimulate the market, but actually the market is in saturation. The majority of double counted biofuels in the EU are produced from used cooking oil or animal fat. Hungary and Finland reported in 2013 the highest consumption of "other biofuels".

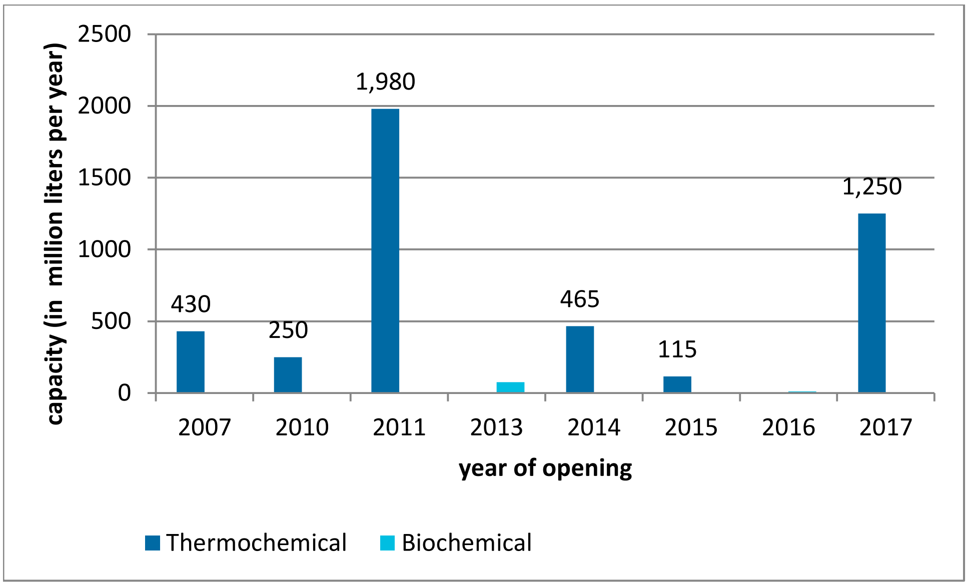
Production

The share of the EU market for second generation biofuels amounts to 9 % of total global installed capacity in 2015 [88].

The production of advanced biofuels has taken off. From 2007 to 2015 3.2 billion litres of thermo-chemically produced advanced biofuels and 0.075 billion litres of bio-chemically produced advanced biofuels were reported in total (accumulated values). Production is expected to expand until 2017 with a further 1.3 billion litres.

In 2015, hydrotreated vegetable oils (HVO) production was estimated at 2.3 billion litres, and is expected to increase to about 2.9 billion litres in 2017 (USDA FAS 2016). With new plants in Italy and France, production could further expand to about 4 billion litres in 2020. The commercialization of cellulosic ethanol is lagging behind compared to the development of HVO. The current capacity is about 85 million litres in the EU. Expansion of capacity has been announced in Finland (200 million litres) and France (315 million litres). But given the limited support, the capacity for cellulosic ethanol production could possibly increase to a maximum of about 0.3 billion litres [128].

Figure 1-73: Advanced biofuel plants in the EU (in litres per year)



Source: [35]

Italy was the first EU Member State to mandate the use of advanced biofuel. The decree requires that gasoline and diesel contain at least 1.2 % advanced biofuel as of January 2018 and 2019, rising to 1.6 % in 2020 and 2021, and 2 % by 2022. Reportedly also Denmark, the Netherlands and France are considering implementing a specific target of 0.5 % or higher.

Table 1-25: Advanced Biofuel Plants in the EU

Country	Process	Biofuel	Feedstock	Capacity (million litres per year)	Year of opening
Thermochemical					
Finland	H	HVO	Oils and fats	430 (2 lines)	2007
The Netherlands	P/FT	Methanol	Glycerin	250	2010
Spain	H	HVO	Oils and fats	700 (7 plants)	2011
The Netherlands	H	HVO	Oils and fats	1,280	2011
Italy	H	HVO	Palm Oil	465	2014
Finland	H	HVO	Tall Oil	115	2015
Italy	H	HVO	Oils and fats	680	2017
France	H	HVO	Oils and fats	570	2017
Biochemical					
Italy	HL/F	Ethanol	Wheat straw	75	2013
Finland	HL/F	Ethanol	Saw dust	10	2016

Source: [35]

Use of cellulosic ethanol

Advanced ethanol, such as cellulosic ethanol, is a renewable fuel that further optimises resource efficiency by using waste and residue material, such as straw. In Europe, cellulosic ethanol can also be produced from dedicated energy crops such as miscanthus and switch grass. Processing the feedstocks to extract sugars requires high-tech facilities, pioneering enzyme and yeast extraction technologies, as well as highly-skilled people. Europe support the development through traditional financing in the first stages of R&D up to the point of pilot and demonstration plants [91].

Italy opened the world's largest advanced biofuels refinery of 75 million litres of cellulosic ethanol annually in 2013. Slovakia started in 2014 the construction of a 55,0000 metric ton facility to produce cellulosic ethanol from non-food biomass. The Ministry of Employment and Economy in Finland granted 30 million EUR to support the development of a 90 MMly commercial cellulosic ethanol plant. Denmark announced in 2014 the commercial production of second generation ethanol. The plant will produce 64.4 million liters of ethanol, 77,000 t of lignin pellets, 1.51 MNm^3 of methane and 75,000 t of liquid waste annually, which will be transformed into biogas and injected into the national gas grid after its upgrade into methane. The process will use 250,000 t/year of locally sourced straw.

Developing countries like Thailand and India have not had much progress in cellulosic ethanol due to the fact that they focus on first generation biofuel sector development [88].

The US is hardly working on the development of cellulosic ethanol plants and technologies.

To improve the economics of cellulosic ethanol production in biorefineries, researchers are looking for ways to add value to lignin by conversion to other products (e.g. bio-oils containing aromatic compounds). Conversion technologies include use of solvents, hydrothermal depolymerisation, and super critical depolymerisation[19].

Cellulosic ethanol makes less than 0.1 % of the European transport fuel market. Commercial production of cellulosic ethanol is limited in the EU. The main factors, e.g. in France, are high research and production costs and regulatory uncertainty. It is estimated that a commercial scale will be reached the earliest before 2020 [128]. The first commercial cellulosic ethanol facility in Europe opened in Northern Italy in 2013, but while other pilot and demonstration facilities are currently in operation, there are minimal prospects for commercial-scale cellulosic ethanol in Europe at present. In contrast, several commercial plants are operational in the USA and Brazil, and a second wave of plants is also under construction in these markets. The current use of multiple-counting as a policy too in measuring contributions towards the EU's renewable transport target has not incentivised truly advanced biofuel technologies or supported innovation in the renewable energy sector. The EU needs to change its focus in order to help innovation ventures and projects move from R&D to commercial deployment in the short to medium term in order to avoid 'innovation leakage' [91]. [91] recommend that the Member States should introduce a dedicated but realistic sub-target for advanced biofuels, together with clear definitions of eligible feedstocks. Furthermore it should be established binding targets in stimulating commercial-scale investment in advanced biofuels before and after 2020. Such binding targets, combined with a longer-term perspective of the EU's climate policy, and meaningful financial support for upfront investments, would provide investors and innovators with clarity and a predictable market.

[19] European Biofuels technology platform: http://www.biofuelstp.eu/cellulosic-ethanol.html

Use in the aviation sector

Airbus launched the Advanced Biofuels Flightpath in 2011. They will achieve the sustainable biofuels used in the EU civil aviation sector by 2020 [128]. A few production pathways have been certified and sustainable feedstock sourcing in addition to final product prices remain major barriers. A significant number of test and demonstration flights have taken place on all of the continents, but few countries actively promote aviation biofuels. In order to lower GHG emissions from aviation, several options seem more cost-effective than biofuels, yet those have been used as marketing tools by airlines [92].

The slowly developments of advanced biofuels are a result of high R&D investment, high costs of production and high initial investment costs in the production capacity. The double counting option stimulates the use of these feedstocks. In case of a removal of double counting would be accepted that more conventional biofuels achieve the RED targets. That could be lead to increased negative impacts on global and local scale (see ILUC chapter).

Analysis of availability and sustainability of biofuels from waste, residues, ligno (cellulosic) non-food material (Article 23(5)(e))

The European Biofuels Technology Platform reports according to the availability of advanced biofuels in Europe, that the future use of advanced biofuels depends on cultivation of energy crops and mobilisation of waste streams.

The International Institute for Applied Systems Analysis (IIASA) reports on biomass potentials on a Member States level. The potentially available land area for the cultivation of energy crops in the EU is estimated to reach 47.8 Mha in 2030, and when combined with second-generation technology, the European Union can potentially produce up to 13.5 EJ of biofuels. Additionally, feedstocks sourced from forestry and agricultural residues are estimated to provide between 11 EJ and 13 EJ, and surplus forest growth could provide approximately 35 EJ of biofuel. IRENA estimated the potential in Renewable Energy Roadmap countries to amount to 48 EJ from energy crops and 13 EJ from forestry residues in countries that could potentially trade biomass for advanced biofuels production [41, 43, 44].

[93] state that if all waste and residues were converted only to biofuels in the EU, 16 % of road transport fuel could be provided in 2030 (technical potential of sustainably available feedstock from waste). If advanced biofuels from wastes and residues are sourced sustainably, they can deliver GHG savings well in excess of 60 per cent, even when taking a full lifecycle approach.

Advanced biofuels offer a potentially higher reduction in greenhouse gases (GHG) compared to conventional biofuels. However, there remain issues regarding competition for land and feedstock between liquid biofuels and the rapidly expanding use for heat and power generation through combustion.

The sustainability of biofuels is covered by the Biofuels Certification Scheme, while projects such as BioGrace[20] and Global-Bio-Pact[21] aim to harmonise the way sustainability of bioenergy and biofuels is calculated and certified. However, the same rules need to be applied to all use of biomass for food and other products. There is limited value in creating sustainable biofuels if

[20] http://www.biograce.net/

[21] http://www.globalbiopact.eu/publications.html

unregulated and unsustainable biomass production is allowed for other uses. At the moment there is a vigorous debate about indirect Land Use Change (ILUC) (see chapter chapter 1.2.7 on ILUC issues).

Energy security is one of the main drivers behind alternative fuels developments, which leads to biofuels promotion in some regions and side-tracking in others. In spite of several units operating successfully, such as HVO/renewable diesel plants in Europe or Asia and new cellulosic ethanol plants in Europe and North America, these projects are not followed by investments in new plants. Sustainable feedstock sourcing, financing and economics/product prices are still major hurdles that advanced biofuels producers struggle to overcome [89].

A case study from [89] on the design of second generation biomass discusses environmental and social sustainability impacts. In all scenarios the total costs outweigh the benefits. Identical results are obtained also for unit production costs. However, refined oil economically performs better against its fossil-based counterpart than upgraded oil and blended oil. This implies that the technological improvements with respect to upgraded oil are able to reduce the production costs, but prices are still not competitive. Economic sustainability of conventional refinery processing is strongly influenced by the low yield of hydrocracking and high transportation costs. Therefore, technological improvements might play a role in reducing the production costs. Biomass areas in the proximity of a conventional refinery are the preferred option for increasing the economic sustainability of bio-oil from pyrolysis. They further describe the environmental performance as low. In terms of environmental issues, the mobile plant is worse than the fixed plant while economically, the results are vice-versa [89].

Data are necessary to narrow down the questions and to specify more clearly the risks and opportunities in technological development. The combination of the rather robust life cycle description of technology routes with market oriented modelling that also takes policy measures into consideration offers meaningful indicators and more insight into today's complex supply systems [94].

[37] discuss the availability of agricultural residues, forestry residues, and biogenic wastes that could potentially be used for advanced biofuel production in EU Member States at the present and projected to 2020 and 2030. They find that most EU Member States are likely to have more than enough sustainably available feedstock to meet the advanced biofuel requirement, and a majority may have more than 10 times the necessary amount. The target appears to them to be achievable in most Member States. Nevertheless, some countries, including Austria, Cyprus, Denmark, Estonia, Ireland, Luxembourg, Malta, and Slovenia, need to import either feedstock or advanced biofuel from neighboring countries to meet the target. This is largely because these are small countries with low absolute rates of waste and residue production. Some of these countries also have relatively high existing uses of these feedstocks; for example, Ireland produces a fair amount of agricultural residues but is understood to consume a high proportion of them in livestock and mushroom cultivation [37].

Impacts on replacement of food and feed products (Article 23(5)(e))

Biofuels that use non-food biomass such as lignocellulose are being promoted to ease the conflict between fuels and food. The competition with ligno-ethanol will crowd out food-based ethanol. The success of ligno-ethanol depends on the crude oil price. Ligno-ethanol is less sensitive to the crude oil price than food-based ethanol with the exception of sugar cane-based ethanol. Lignin, a residual of hydrolysis, is dried and burned to generate process heat, reducing the demand for external energy carriers. However, the additional demand for external energy carriers differs depending on the share of lignin in the feedstock, ranging from 3 % (e.g., sorghum bicolor subsp. drummondii) to 23 % (e.g., straw) [94].

In the medium run ligno-ethanol could enter the gasoline market. Market success is determined in part by the quota system. Yet other factors also play a role, such as low costs of feedstock, high ethanol yields, and the low sensitivity to the price of crude oil [94].

[95] analysed the potential impacts of a globally distributed lignocellulosic biofuel production system on the resource food.

Table 1-26: Potential impacts of a globally distributed lignocellulosic biofuel production system on the resource food

Perennial Crops	Crop residues	Forestry residues	Processing and conversion	Distribution of impacts
Replace current use of food crops; Crops were grown on land of value for food	No direct competition with food, replace current use of food crops	No direct competition, indirect impacts not assessed	No direct impact	Impacts globally distributed, disproportionately affecting lower-income population relying on the market for accessing food; Local or regional impacts were biomass is sourced by displacing people from common land

Quelle: [95]

Expectations of benefits from lignocellulosic biofuels for food security are based on the assumption that lignocellulose can replace current use of food crops for biofuels without itself clashing with food priorities, and reduce use of petroleum where demand is forecast to increase due to population growth and development. However, these positive expectations are tempered by concerns about land availability if energy crops were to encroach on land for food production. Concerns about potentially negative impacts are informed by the assumption that lignocellulosic biofuel development in a global economy can clash with food security with incentives favouring sourcing of feedstocks from poorer Southern countries for use in the richer North. Monitoring sustainability impacts is difficult due to the fact that lignocellulose is too bulky to transport and and that countries are more likely to import the finished product, i.e., liquid fuel. [95] discuss that in the case of imports of finished products, poorer regions will experience only negative impacts (e.g., location-specific environmental risks) and none of the positive ones (improved energy security).

In the case of technological improvements which can fix negative impacts, [95] warn that improving crop traits or the efficiency of lignocellulosic conversion processes will be accompanied by a rebound effect where overall energy demand is driven up rather than down. This does not mean that poorer regions benefit from energy security due to increasing production of biofuels [95].

To avoiding negative impacts, [95] recommend the following approaches:

- Source lignocellulose domestically (e.g., a UK biofuel production system relying on UK-grown feedstocks)
- Improve crop traits so as to reduce some negative impacts and increase positive ones (for example, higher yield, less water usage, improved water quality)
- Develop a biorefinery model that would yield high value added by-products as well as fuel and hence make the process more efficient in energy and economic terms

1.2.6. Analysis of non-food crops (Article 23(5)(g))

Summary

[88] stated that an investment tax would be a positive signal for the cellulosic industry because this is more attractive at this stage of cellulosic technology development. Support should be given to further improve crop yields in a sustainable manner, for example through genomics and biotechnology combined with agronomic improvement. Considerable advances have been made in the improvement of crop yields and in the understanding of the key criteria that need to be met for more sustainable production, as well as which crops best meet these criteria and the changes needed to further improve sustainability. The challenges of meeting feedstock supply through yield improvement and the expansion of feedstocks in more sustainable ways can be met, but only with secure and prolonged support and sensible, easily adoptable policies that recognize the environmental as well as economic objectives. However, these policies are needed now (2014 study) along with strategies for increasing feedstock production in sustainable ways that can be implemented immediately [41].

Policies and measures which enhance skills and incentives to collect residues for bioenergy can be: best practices on logistics for cost-effective, sustainable residue collection; promotion of investment in cogeneration plants, with agricultural residues as feedstock, through standardized feed-in tariffs and power purchase agreements [97].

In rural areas of developing countries, where much of the residue potential is located, revenue sharing schemes can help ensure that farmers and villagers receive a portion of the revenue from electricity and heat sales to encourage their collection efforts. Capacity building efforts can also play an important role by providing skills to carry out feasibility studies for finance and engineering studies to design the plants, as well as skills to build, operate and maintain the steam turbines, boilers and gasifiers. National bioenergy policies, with clearly defined and realistic targets for producing electricity or biofuel from residues, as well as financial incentives to collect residues for energy purposes, can help ensure that cogeneration plants and bio refineries are well supplied with a steady, reliable flow of residue feedstock [97].

Bio-based materials are in competition not only on the product side, but also for their feedstocks which can be used for bioenergy instead. High subsidies for energy crops lead to high biomass and land prices that make industrial material use less attractive. The potential long term growth for bio-based products will depend on their capacity to substitute fossil-based products and to satisfy various end-used requirements at a competitive cost, to create product cycles that are low in terms of GHG emissions and have lower environmental impacts.

Forest biomass is currently the most important source of renewable energy. Many studies have estimated the potential supply from forest for bioenergy. The estimated minimum and maximum values are approximately 5,000 PJ and 7,600 PJ for 2020 and 3,300 PJ and 7,500 PJ for 2030 [96].

Approximately 5.5 million ha of agricultural land are used for bioenergy cropping in the EU. This amounts to 3.2 % of the total cropping area. Non-food lignocellulosic crops today play a minor role (1 %), accounting for only about 50,000 – 60,000 ha of land (Khawaja und Janssen 2014[22]).The lack of information and the lack of specificity of certain data sources present a significant challenge to the accurate identification of land areas with potential for non-food lignocellulosic crop cultivation. Nevertheless, some studies of 2008 have estimated the potential of abandoned non-arable land. In addition, estimations were made on the possibility of growing non-food lignocellulosic crops on a part of the arable land. If the potential from the two categories are summed up, the total minimum potential is presented an approximately 2,200 PJ and the maximum 6,400 PJ. For 2020, the potential is between 3,450 and 9,100 PJ and for 2030, between 3,600 and 8,700 PJ [49].

Currently, there is no specific data on the share from agricultural residues for bioenergy production. The estimated minimum and maximum values are approximately 2,650 PJ and 3,100 PJ for 2020 and 5,200 PJ and 5,400 PJ for 2030. Another source is the biodegradable fraction of municipal solid waste, common sludges and kitchen oils and fats. The estimated minimum and maximum values for the total categories are approximately 900 PJ and 1,850 PJ for 2020 and 850 PJ and 1,850 PJ for 2030 [96].

Second-generation crops still need technology development efforts to be made. Indeed, there is as yet still no cellulose-based ethanol production technology on an industrial scale. The main problem is not the fermentation process itself, but rather obtaining sugar from cellulose more efficiently. Here the celluloses, which are enzymes that cut the cellulose polymer chains to release sugar, play a crucial role. Obtaining these enzymes is very expensive, however, meaning that they have to be ten times more efficient at breaking down lignocellulose biomass than starch. From the point of view of the crops, improvements in plant biotechnology may contribute to solving the problem by means of the identification of species and molecular tools enabling crops to be generated in which the cellulose is more readily accessible to the enzymes, yielding a lignocellulose that is more amenable to saccharification so as to allow sugar to be obtained more efficiently. This technological effort is crucial to consolidating biofuels, as it will enable agricultural wastes to be used sustainably without competing with food production [50].

[97] says, that with 40 % efficiency in a lignocellulosic conversion process, this residue would yield 18 EJ to 38 EJ of biofuel. That is roughly 20 % to 40 % of all the liquid fuel used for transport in 2012, potentially nearly twice the fuel used for marine shipping and aviation. It also represents 10 % to 30 % of projected transport energy demand in 2050. At 80 % efficiency in a combined heat and power plant, the same residue could generate 36-76 EJ of usable energy.

[88] reported that the Advanced Biofuels & Chemicals Project Database monitored the capacity of advanced biofuels and renewable chemicals for the 2011-2016 period in 27 countries.

Exploitation of emerging feedstock crops will require investment in breeding and agronomy to further enhance yields and adapt varieties to a wider range of environments, including future climates.

[22] Sustainable supply of non-food biomass for a resource efficient bioeconomy. Review Paper.

Research and development issues are summarized in Table 1-27.

Table 1-27: Key R&D issues concerning advanced biofuels

Technology	R&D Issues
Cellulosic-ethanol	Improvement of micro-organisms and enzymes.
	Use of C5 sugars, either for fermentation or upgrading to valuable co-products.
	Use of lignin as value-adding energy carrier or material feedstock.
	Feedstock handling and processing in cellulosic plants
HVO	Feedstock flexibility.
	Use of renewable hydrogen to improve GHG balance.
Other biomass-based diesel/kerosene fuel	Reliable and robust conversion process in pilot and demonstration plants.
Algae-biofuels	Energy- and cost-efficient cultivation, harvesting and oil extraction.
	Nutrient and water recycling.
	Value-adding co-product streams.

Source: [88]

1.2.7. ILUC assessment (Art. 23 (5) (f))

Summary

The long list of model parameters of recent studies can be "standardized" but often there is no data available that describe the input parameters chosen. This reflects the most important uncertainties.

- In general, recent studies show higher ILUC emissions than former studies. The highest risk is still associated by biofuels based on agricultural products.
- ILUC emissions are still in a wide range by feedstock, especially for sugar cane, palm oil and soybean oil. This is mainly based on variability uncertainty[23].
- Advanced biofuels show significantly lower ILUC risk.
- Highest ILUC risk results from peatland oxidation and deforestation in well-known regions. Here ILUC mitigations strategies (project based volumes) seem to be more promising.
- Policy implications
- Differentiation of ILUC factors by crop would lead to more robust results than differentiation by the three feedstock groups starch, sugar and vegetable oil. However, this would mean for most biodiesel options not to be able to comply with the 35% minimum reduction requirement.
- Streamlining of RES-D, land use and climate mitigation policies could lead to a positive momentum of standards for all type of biomass use in the field of land management and conversion.
- Post 2020: Remaining time should be used to elaborate concepts that are based on a mix of instruments and analysis of their effect and integrity.

1.2.7.1. Reporting obligations

Indirect land use change (ILUC) is currently not part of the binding sustainability requirements in the Renewable Energy Directive (RED).

Directive EU-2015/1513 (ILUC Directive) requires entirely extended reporting obligations by the Commission concerning ILUC in its Report on Renewable Energy.

Fuel suppliers are to report on emissions deriving from ILUC, but these are not included in the sustainability criteria for the biofuels or the GHG calculation methodology (in the MSPR the Member States shall ensure that fuel suppliers report annually on the necessary data).

The Directive was published on 9 September 2015 and Member States are obliged to transpose the Directive into national legislation by 10 September 2017. Hence, in the actual MSPR information on ILUC is not yet reported compliant with the ILUC Directive.

If appropriate, the Commission should develop a concrete methodology to minimise greenhouse gas emissions caused by indirect land use changes for the period after 2020. Therefore the Commission shall submit legislative proposals by 31 December 2017 for introducing adjusted estimated ILUC emissions factors into the appropriate sustainability criteria of Directive 2009/28/EC. This involves

[23] This means that variability of parameters lead to broad range of results: In the mentioned fuel options the variation results e.g. from large range of soil carbon content, of previous land use and efficiency of production.

information on, and analysis of, the available scientific research results regarding indirect land use change in relation to all production pathways

an assessment of whether the range of uncertainty identified in the analysis underlying the estimations of indirect land use change emissions can be narrowed

and the possible impact of Union policies, such as environment, climate and agricultural policies, can be factored in.

1.2.7.2. Available scientific research results regarding ILUC

Up to now, there has been no standardized methodology for quantifying greenhouse gas emissions caused by indirect land use changes concerning the energy content of biofuels (THG/mtoe). ILUC can only be assessed with quantitative models that typically require a large number of input parameters and assumptions. The following different approaches of ILUC models exist [98], [99]:

1. Economic Equilibrium Models which deliver prospective information of additional feedstock demand as a reaction to a marginal shock in the biofuel markets (conceivable as the result of a supply curve of different types and origins of biofuels).
   Examples are first ILUC modelling studies for the Commission (using IFPRI MIRAGE, CAPRI, GTAP-AEZ, AG-LINK COSIMO), further refining of IFPRI MIRAGE - [100], [100] - and GLOBIOM[24] [102].
2. Causal Descriptive Model (CD Model), the objective of which was to demonstrate the validity of the approach and to provide additional evidence, [103], [104]. This approach is based on statistical analysis, expert input and literature review of historical trends to quantify the market responses to the additional feedstock demand and product substitutions, and the necessary parameters for this.
3. Deterministic Models (also called Normative or Simplified Models) are based on assumptions based on statistical metadata (ex-post analysis) where an increase of biofuel crops has taken place 105], [106], [107].

Results of recent studies

The debate on ILUC came up with the publication of two papers in 2008, [108] and [109], which estimated carbon emissions from LUC. In 2010 the Commission presented several studies to evaluate the scale of ILUC linked with the EU biofuels targets (“first generation of studies”). After these studies several meta-analyses were carried out – focusing on comparisons of models and parameter, e.g. [111], [112] - as well as improvement of input data and assumptions, e.g. [112], [113], [106]. But little effort has been spent on developing new methods or modeling tools. Therefore the results of only a few studies will be presented in this report[25] and will be compared with the findings of the overview study of Ahlgren and di Lucia [98]. Considered will be:

1. Studies based on economic modelling:
   a) GLOBIOM (2015) - The Global Biosphere Management Model (GLOBIOM) is a partial equilibrium (PE) model developed by IIASA. The GLOBIOM study was commissioned 2013 - 2015.

[24] http://www.globiom-ILUC.eu/

[25] Peer reviewed articles or studies presented by environmental agencies of the member states

b) Laborde (2014) presents the results of work carried out in 2012-2013 by the JRC and IFPRI. Focus was the correction of some assumptions/parameters – the yield increase, fixed food consumption (instead of effects of reduction in food consumption) and displacement by crops.

c) Laborde (2011) - The European Commission commissioned IFPRI to improve the MIRAGE-Biof model in order to support the scientific foundation for legislative proposal on ILUC.

2. Studies based on causal descriptive modelling:

a) Baral and Malins (2016) – objective of their paper was to provide additional evidence of the ILUC emissions of rape seed oil biodiesel using another approach other than economic modelling (analysis is based on the E4Tech model from the year 2010 with refined key parameters).

b) E4Tech (2010) [103]– is one of the “first generation” studies. It is again presented in order to have comparison for Baral and Malins (2016).

The focus is on the results of the three studies based on economic modelling that provide an ILUC factor by crop and a range of uncertainties. The results of the descriptive modelling are displayed in order to contrast the figures with results of an alternative approach. These give the ILUC emissions with a range.

Table 1-29: Range of results (by feed stock and fuel type) of recent ILUC studies using different methods.

	Type of Modelling		economic	economic	economic	causal descriptive	causal descriptive
	Unit	g CO_2-eq/MJ	g CO_2-eq/MJ	g CO_2-eq/MJ	g CO_2-eq/MJ	g CO_2-eq/MJ	g CO_2-eq/MJ
	Source	*ILUC from directive*	*GLOBIOM 2015*	*Laborde et al. 2014*	*Laborde et al. 2011*	*Baral & Malins 2016*	*E4Tech 2010*
			with high uncertainty ranges	lower yields, fixed food consumption and changed displacement rules	*presented in Laborde et al. (2014) but based on 2011 assumptions		
BioEtOH from	wheat		22-34	23	13.1-14.4		
	maize		9-14	13	10.0-10.3		
	barley		27-38	-	-		
	group of Starch	**12**	**19-29**	**-**	**(11)***		
BioEtOH from	sugar beet		11-15	7	4.1-6.6		
	sugar cane		17	16	13.4-17.2		8-27
	sugar	**13**	**8-11**	**-**	**(12)***		
Biogas from	maize silage		15-21	-	-		
Biodiesel from	sunflower oil		56-63	62	51.8-52.7		
	palm oil		231	63	54.3-55.1		
	rape oil		50-65	56	53.8-54.6		
	soybean oil		149	72	55.8-56.7	57 (18-101)	15-35
	vegetable oil	**55**	**89-101**	**-**	(52)*		**9-66**
BioEtOH	cereal straw		11-16	-			

from							
	perennials		-12 to -20				
	SRC		-29 to -35				
	forest residues		17				

Source: [102], [101], [100], [104], [103] ; Dark colored cells = higher ILUC emissions, light colored cells = lower ILUC emissions

The results of ILUC emissions in the different studies lead to the following conclusions:

- The GLOBIOM and IFPRI MIRAGE show similar order of magnitudes of ILUC emissions for the main feedstocks (wheat, maize, sugar beet, sugar cane, sunflower oil and rapeseed oil).
- The causal descriptive model approach leads to ILUC emissions in the same order of magnitude for rapeseed biodiesel like the economic models.
- Both studies show that the ILUC emissions of bioethanol from sugar and starch plants are lower than those of biodiesel from oil plants.
- There are significant differences concerning soybean oil and palm oil. The GLOBIOM results are notably above the results of IFPRI. The reason for this is lower elasticity of substitution in the GLOBIOM model and therefore more import of these oil types. Furthermore the model uses a higher emission factor for peat oxidation.
- The recent modeling results confirm the better performance of advanced biofuels concerning ILUC emissions with residues or high yielding perennials as feedstocks (only modeled by GLOBIOM). The use of residues leads to lower ILUC emissions whereas perennials and short rotation coppice even sequester carbon compared to the former land use (usually arable land or underutilized land).
- It must be recognized, that the modeled ILUC emissions of the recent studies are in most cases above those modeled by earlier studies (see increasing intensity of grey colored cells in the table). However, the figures point to the risk of ILUC effects caused by biofuels based on agricultural products.
- The variability of ILUC emissions is still large for specific feedstocks.
  This must be noted for both, between the different studies (inter-study perspective) as well as within each study (intra-study perspective, e.g. results from GLOBIOM, picture below). This range is mainly due to variability of input parameters that will be analyzed in more detail in the next chapter.
- Currently, extrapolation often delivers the best data – especially in case of behavioral decisions and/or economic terms. E.g. there is relatively few literature-based based data of elasticities with relatively little emphasis on their uncertainties [114].
- Extrapolation of the, relatively few, literature-based elasticities to other regions or into the future is frequently practiced, because it is the best available data. However, often there is relatively little emphasis on the uncertainties involved.

These conclusions are widely in line with main findings of the overview study of 2014 [98]: There it is stated that in spite of some convergence of results over time, variability of ILUC factors was still high. Those for biodiesel showed wider ranges than those for ethanol. No first-generation biodiesel would be able to comply with the EU GHG saving requirements after introducing an ILUC factor. Up to 2013, only few studies analyzed advanced biofuels (from switchgrass and miscanthus and maize stover). The results for energy grass options were not evident, but maize stover, a by-product from maize production, showed in both studies comparatively low ILUC effects.

Figure 1-74: Overview of modelling results of the GLOBIOM study for LUC emissions for different scenarios with uncertainty ranges.

Source: GLOBIOM report 2016

1.2.7.3. The range of uncertainty identified in the analyses – can it be narrowed?

The range of model results for ILUC emissions is often found to be in a same order of magnitude as the average value. Sources of uncertainty in ILUC estimation have been discussed often in the recent literature [112, 114 [113], [116]. Decision making requires scientific robustness; therefore, this chapter gives some insights into sources of uncertainty of ILUC estimates.

In general, model results are influenced by many input data and assumptions. These concern market (behavioral)[26] parameters as well as biophysical parameters. All parameters have to be set for a baseline scenario as well as for a bioenergy scenario; many of them differ by region but also have often large additional uncertainties due to lack of knowledge.

An important category of parameters is that of elasticities that express changes in the demand for goods due to price changes: The impacts of biofuel production can vary from intensification of

[26] There is large recognition of the sensitivity of LUC impacts to behavioural parameters in economic models. (GLOBIOM)

agriculture to change of consumption patterns to land conversion. The ratio between those effects is barely known, not constant towards the future or in the context of other circumstances [114].

Below there is a list of most important parameters and policy assumptions that is derived from several papers and studies - [101], [102, 107], [114].

Parameters:

- Yield, yield increase and harvest level (baseline assumptions and market induced yield increase[27]) on a regional level;
- Substitution (options) of products and elasticity in trade and demand – these effects can lead to changes in diets and food consumption[28] (elasticity factors);
- Use of co-products and their substitution rate;
- Water supply (costs of irrigation vice versa yield increase);
- Carbon stock of the land assumed to be affected by LUC (spatially differentiated):
- soil: released (or fixed) carbon, foregone sequestration (e.g. du to due to crops and residue use);
- Vegetation: released (or fixed) carbon due to changes in land use patterns – grassland, cropland, forest, marginal land etc.
- Policy assumptions
- Land availability (assumptions about the category of land available, used area of degraded and/or abandoned land and its productivity and price);
- Policy instruments with the aim to reduce the demand for other land intensive products (demand elasticity);
- Allocation of LUC emissions (e.g. 20 to 30 years).

The lack of data and understanding must be noted as the major source of parameter uncertainty, e.g. for a lot of regional characteristics (e.g. actual substitution rate, costs, carbon stocks). Uncertainty due to assumptions is largely driven by policy and behavioral dependencies (e.g. future diets, policy instruments and their impact). Not always is the differentiation between parameter uncertainty and the influence of policy assumption obvious. Yield projections depend similarly on future policies and also costs could be considered rather as policy assumptions. However, a differentiation makes sense to identify options for mitigating uncertainties in ILUC estimation that can be attributed to parameters. In principle, parameter uncertainty can potentially be reduced further in the future, e.g. through the availability of more accurate maps, better cost data, model improvements etc. Solely the vast size of data makes estimation difficult to which extent better data could lead to more robust results.

[27] Market induced yield increase could be investments in the agricultural system and intensification or a change in management in order to yield a second crop – e.g. double cropping or a second harvest period in the same year or changes in crop rotation.
In economic models, the values available are often extrapolated or adapted to other regions in the world because they are the best available. However, this dynamic is highly uncertain, especially with respect to a changing policy context or new technologies (PBL 2014)

[28] Sensitivity analysis of food consumption levels has shown a significant influence of this parameter on the ILUC emissions (Laborde et al., 2014): constant total food consumption (same level as in the baseline scenario) and a simultaneous increased biofuel use resulted in significant higher ILUC emissions.

The further harmonization of modelling approaches can be another way to bring ranges closer to each other. The GLOBIOM study and Laborde 2014 showed that higher consistency of results can be achieved by data harmonization and adjustment of assumptions; nevertheless harmonization has not led to a major reduction of the range of results in this case. Furthermore there are limits to model harmonization as the different models were developed for different purposes; consequently they differ in geographical resolution and commodity level, complexity and feedback loops.

1.2.7.4. Findings

One major reason for supporting the use of biofuels in EU is to reduce GHG emissions. But by now, research concerning ILUC is still not able to give a clear signal that ILUC emissions are not likely to be substantial. As long there are no considerable market volumes of advanced biofuels with low ILUC risk a regulation addressing ILUC is reasonable.

Option - Implementation of an ILUC factor on the current state of knowledge

- The results of the ILUC values presented above leads to the conclusion of the necessity of a crop differentiated approach, instead of solely a differentiation in the three feedstock groups of starch, sugar and vegetable oil plants as currently given in the annex of the ILUC directive (EU-COM 2015/1513).
- Advanced biofuels are significant with a low ILUC risk.
- The introduction of ILUC factors would lead to a drop out of most biodiesel options because they would not reach the GHG reduction. This would lead to a conflict with the aim of protection of investments (ILUC Directive, reasoning No. 3 & 4).

Alternative Options

A main point of criticism with ILUC modeling approaches is the inability to include the full range of LUC related impacts of previous approaches, e.g. biodiversity impacts, eutrophication, water use, land grabbing, food competition, see [110], [112], [117]. Other authors state that the ILUC factor detached ILUC impacts from their space specific contexts [118]. In order to involve social and environmental effects, an alternative concept should consider the spatial context. E.g. it can be seen that deforestation and peatland drainage in Malaysia and Indonesia are problems that trigger ILUC on all vegetable oil plants. These concerns could be avoided by introducing appropriate environmental safeguard system, [102], [107].

A number of authors point out that **mitigation of ILUC** could be a proper way of tackling ILUC. In the ILUC Directive the option for project based volumes is already implemented (No. 23).

ILUC mitigation projects could address measures that lead to e.g.:

in the agricultural sector (improved efficiency)

yield increases through optimized production (e.g. from technical measures), by double cropping or an additional yield (2nd harvest, introduction of agroforestry systems) etc.

the use of more underutilized land (abandoned land or set aside) or marginal (degraded).

in the industrial sector to chain integration, through improved resource efficiency e.g. by use of by-products (lignin, CO_2) or increased food chain efficiency.

Examples have been published by Utrecht University [112], [119] and Ecofys (in cooperation with other organizations – e.g. [121,122]). Important tasks will the verification of the “additionality of the produced biomass" of those projects since only increased land-efficiency of production will lead to ILUC mitigation. Even though some examples of such measures have been tested in case studies already, the methodology is still in its infancy stage, whereas a broad implementation of ILUC mitigation projects would need reliable certification criteria and the introduction of certification systems. Experience from the introduction and operationalization of sustainability criteria of the RED (Articles 17 to 19) can give a hint to single steps and time demand which is necessary to reach an effective execution.

Another option would be the **introduction of a sub-target for advanced biofuels** [122, 123]. But currently low investments into this industry will lead to only a very small share of advanced fuels in the short term. Especially as this technology is still in R&D phase, no relevant capacities are expected until 2020.

Another approach would be to **adopt a national target for land use patterns and pursue international agreements** to limit adverse land- use change outside the EU. One option would be to strengthen programs under the REDD+ since both processes, REDD+ and ILUC regulation under RED, encounter the issue of displacement of land use and the related emissions (carbon leakage) [122], [124]. An example for a possible compensation mechanism this is given in [125][29]. Whereas the current ILUC approach in the RED underlays a consumer responsibility, the carbon leakage concept takes perspective of producer responsibility. This is reflected on the great interest and level of lobby activities about ILUC [124].

Accordingly, streamlining of RED, land use and climate mitigation policies (such as REDD+) could lead to a positive momentum of standards for all type of biomass use in the field of land conversion, highly concerned are e.g. the reporting obligations under the UNFCCC and REDD+ /FLECT. In the long term this would lead to a dissipation of ILUC, since all land use changes would be addressed directly [126]

For the preparation of a new **RED for the period after 2020** there are currently no alternative concepts for introducing an ILUC factor, despite remaining uncertainties. Apart from the lack of knowledge, alternative options show more or less high transaction efforts and there is only little experience. Therefore, remaining time should be used to elaborate concepts that are based on a mix of instruments and for analysis of their effects and its integrity. In parallel alternative mid- and long-term opportunities should be figured out, esp. streamlining of RED, land use and climate mitigation policies.

For the preparation of a new RED for the period after 2020 there is no well analyzed option except from introducing an ILUC factor – which is an option with extended uncertainties. Apart from the lack of knowledge, all options show more or less high transaction effort and there is only little experience. Therefore, remaining time should be used to elaborate concepts which base on a mix of instruments and analyzation of its effect and its integrity. In parallel mid- and long-term opportunities should be figured out.

[29] In the cited report the mechanism is described as followed: "The indirect GHG emissions resulting from land conversion for biofuel production could directly be addressed through imposing an obligation on fuel suppliers to compensate for the indirect emissions that they report (and which would be adequately verified) with REDD+ and/or peatland related credits. This would allow in the short term that all indirect emissions are fully redressed. It would also allow in the mid- and long term – through the stimulation of enhanced REDD+ and peatland related intervention – that indirect emissions and damages to tropical forests and peat swamps be brought down to a halt."

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2. Annex

Table 2-1: Measures on Biofuels, Biomass from Progress Report 2015

MS	Name and reference of the measure	Expected results
AT	Amendment of the Fuel Regulation	Use of sustainable biofuels to contribute towards the 10% target
AT	Support for biomass heating systems	Construction of biomass heating systems
AT	Upper Austrian Energy Conservation Regulation 2008. Support for connections to biogenic district and local heating	Higher proportion of biogenic district and local heating
AT	Energy Support Guidelines	Construction of biomass systems, district heating connections and thermal solar systems
AT	Energy Support Guidelines	Construction of biomass district heating systems
AT	Biodiversity Strategy 2020	energy supply by preservation of biodiversity with sub-targets and specific measures
AT	Alpine convention	protection of species and nature of the Alps
AT	2. BMLFUW Regulation on agricultural raw materials for biofuels and liquid biomass fuels	agricultural raw material production in accordance with cross compliance0
AT	Water Managment Plan 2015	prevention of further deterioration and enhancing aquatic ecosystems
AT	Certification System (elNa) or AMA (Agrarmarkt Austria)	demonstation of biofuels sustainability
BE	Mandatory blending of sustainable biofuels	KTOE
BE	Biomass boiler grant	MC/MW
BE	Biometh platform	MC
BE	Biometh/biogas study	MC
BE	Biomass sustainability criterion	MC
BG	Obligation of the persons placing on the market petroleum-derived liquid fuels for transport purposes to offer fuels for diesel and petrol engines blended with biofuels in the percentage terms laid down in the ZVAEIB and, currently, in the ZEVI	Production and use of biofuel (ktoe)
BG	Replacement of liquid fuels and electricity used for heating public buildings with biofuels and energy from RS	ktoe
BG	Elaboration of assessment procedures, requiring mandatory marking of equipment used for the incineration of biomass	ktoe
BG	Gradual increase in the share of fuels from biomass in the Energy Aid Programme	ktoe
BG	Development of a Programme for Accelerated Switch of Public Transport Vehicles to Biofuels	ktoe

BG	Biofuels quality control system	ktoe
BG	Elaboration of a legal framework for regulating the management of bio-waste in the country	Storage and rational use of natural resources through an increase in the volume of recycled and utilised bio-waste.
CY	Obligation to replace conventional transport fuels with biofuels at a level of 2.4% per energy content of all transport fuels20	Increase in the proportion of biofuel in transport
CZ	Act No. 201/2012 Coll., on air protection, as amended	Use of biofuel in transport Biofuel certification for sustainability criteria
DE	Biofuel quota in the Federal Immission Control Act [BImSchG])	Minimum share of biofuels in the total quantity of fuel brought into circulation; from 2015, minimum saving in greenhouse gases from road transport
DE	Biomass Electricity Sustain-ability Regulation [Biomassestrom Nachhal-tigkeitsver-ordnung — BioSt-NachV]	Implementation of the sustaina-bility requirements for bioliq-uids under Directive 2009/28/EC
DE	Biofuel Sus- tainability Regulation [Biokraft- NachV]	Implementation of the sustaina-bility requirements for biofuels under Directive 2009/28/EC
DE	Gas Network Access Regulation [GasNZV]	Promotion of biogas fed into the natural gas network
DK	New and increased premiums for use of biogas for electricity generation and upgrading	Promoting biogas production
DK	New premiums for transport, processing and other use of biogas	Promoting biogas production and consumption
EE	Investment support for bioenergy generation	Increased generation of energy from renewable sources
EE	Biomethane filling stations	Number of installed biomethane filling stations
EE	Regular bus services using biomethane fuel	Changed behaviour, consumed energy production
EE	Bringing biomethane to the market	Energy production
EE	Obligation to mix liquid biofuels	Energy production
EL	Invitation for the participation in 2016 biodiesel allocation one 184157/30.11.2015, OG B 2601/2015)	
EL	Allocation of biodiesel for the year 2015 in accordance with the provisions of art. 15 A of law 3054/2002 oik. 176374/18.5.2015 (OG 911/2015)	
EL	Requirements for providing information at the sales point for biofuel blends (MD 1/2012, OG B 1288/11.4.2012 as amended by MD 33749, OG B 623/2015)	
EL	Invitation for the participation in 2015 biodiesel allocation oik. 23327/19.12.2014, OG B 3549/2015)	
EL	Law 4296/2014, Art. 8 concerning priority of licencing of specific RES and Biomass, Biogas or Biofuel installations (OG A	

	214/02.10.2014)	
EL	Invitation for the participation in 2014 biodiesel allocation (MD ΔΙ/Α/οικ.6769/14.04.2014, OG B 937/2014)	
EL	Specification of criteria and methodology for the allocation of biodiesel (JMD ΔΙ/Α/οικ 2497, OGB 253/8.2.2013 and its modification Δ1/Α/οικ. 4075/5.3.2014 (OG B 586/2014))	
EL	Solid biomass fuels for non-industrial use - Requirements and testing methods (MD 198, OG B 2499/04.10.2013)	
EL	Technical regulation for storage and transport of biofuels at oil refineries and oil products facilities (Δ3/Α/οικ. 15225, OG B 2055/23.8.2013)	
EL	Allocation of 92,000 kiloliters of biodiesel for the year 2013 in accordance with the provisions of art. 15A of law 3054/2002 (JMDA1/A/oik. 11750/14.6.2013, OGB 1452/14.6.2013)	
EL	Law4146/2013 "Establishment of a friendly developmental environment for strategic and private investment and other provisions" (OG A 90/18.04.2013), as amended by Art 68 of Law 4155/2013 (OG A 120/29.05.2013): Provisions for tax incentives for all RES technologies and investment subsidies for hydro, pumped hydro, hybrid, biomass and biogas stations	
EL	Invitation for the participation in 2013 biodiesel allocation (MD Δ1/Α/οικ.3008/18.2.2013, OG B 335/2013 as amended by ΔΙ/Α/οικ. 5206/14.3.2013, OG B 626/2013)	
EL	Additional obligations for the environmental licensing of electricity and thermal energy production units using biogas from anaerobic digestion of biomass (MD oik. 166640, OG B 554/08.03.2013)	
EL	Licensing for the production and trade of biofuels or bioliquids (MDA2/A/22285/9.11.2012, OGB 2998/12.11.2012)	
EL	Specification of raw materials for biofuels whose contribution is double counted towards RES targets (JMD ΔΙ/Α/οικ. 10839, OGB 1667/16.5.2012)	
EL	Bureau for the Monitoring of Sustainability of Biofuels and Bioliquids (JMD ΔΙ/Α/οικ. 10838, OGB 1661/15.5.2012)	
EL	Supreme Chemical Council decision 316/2010 transposing directive 2009/30/EC and setting specifications for gasoline-bioethanol blends (OG B 501/29.02.2012)	
EL	Invitation for the participation in 2011 biodiesel allocation (MD Δ1/Α/13972/16.6.2011, OG B 1307/16.6.2011)	
ES	Development of biomass fuel regulation and standardisation.	Standardisation of different types of biomass for domestic use including specific regulations and standards for pellets, etc.
ES	Monitoring of international biomass markets	Surveillance, control and reaction to fluctuations in international markets
ES	Establishment of multiannual plans for exploiting forestry or agriculture for energy.	3 000 000 t/year

ES	Design and implementation of a sustainability control scheme for biofuels and bioliquids. Law 11 /2013 of 26 July 2013 on measures to support entrepreneurs and encourage employment growth and creation.	This introduced a grace period for the biofuel sustainability requirement, ending 1 January 2016
ES	Harmonious development of the Spanish biofuel market. State Secretariat for Energy Decision of 24 January 2014 publishing a final list of plants or production units of biodiesel with quantity allocated towards the mandatory targets for biofuels.	The intention is to develop a mechanism allowing the Spanish market to undertake the harmonious development of biofuel production and consumption capacity variables. This helps to increase energy independence and increase security of supply.
ES	Law 11/2013 of 26 July 2013 on measures to support entrepreneurs and encourage employment growth and creation.	Establishment of biofuel sale or consumption obligations for 2013 and beyond. The aim of this measure is to promote the use of biofuels.
ES	Circular 1/2013 of 9 May 2013 issued by the National Energy Commission regulating management of the mechanism promoting the use of biofuels and other renewable fuels used for transport.	Regulates management of the mechanism promoting the use of biofuels within the framework of the obligation to use such fuels in the transport sector, including aspects relating to verification of sustainability.
ES	State Secretariat for Energy Decision of 8 July 2013 updating for 2013 values of equations for calculating compensatory payments related to compliance with the biofuel obligation, set out in Order ITC/2877/2008 of 9 October 2008.	Guarantee compliance with biofuel sale or consumption obligations.
ES	State Secretariat for Energy Decision of 2 April 2014 approving a list of raw materials for the manufacture of biofuels, counted twice for the purposes of compliance with obligations relating to the consumption and sale of biofuels for transport purposes, obligations imposed on entities bound by renewable energy requirements and the target set for the use of energy from renewable sources in all forms of transport.	Promote the use of biofuels that provide additional benefits while also promoting investment in research into and development of related technologies that take time to become competitive.
FI	Must-carry status for biofuel (Act on Promoting the Use of Biofuels in Transport;	Share of biofuels corresponding to the requirement
FI	446/2007) Sustainability criteria for biofuels and bioliquids (Act on Biofuels and Bioliquids; 393/2013)	There have been indications that the sustainability criteria for biofuels and bioliquids have been met
FI	Production aid for biogas (Act on Production Aid for Electricity Produced from Renewable Energy Sources; 1396/2010)	19 MVA and 0.7 TWh in 2020
FI	Production aid for small CHP plants (Act on Production Aid for Electricity Produced from Renewable Energy Sources; 1396/2010)	160-210 MVA and 1-1.5 TWh in 2020
FI	Production aid for wood chips from forestry (Act on Production Aid for Electricity Produced from Renewable Energy Sources; 1396/2010)	5.3 TWh in 2020

FI	Investment aid for biogas plants (Council of State Decree on Aid for Bioenergy Production; 607/2008)	Promoting the construction of biogas plants in agricultural areas with many animals
FI	Regional wood-energy advisers	Increasing the use of wood energy among heat entrepreneurs
FI	Act on Excise Duty on Liquid Fuels; increasing carbon-dioxide tax on petrol and diesel oil by 10 %	Encouraging the use of biofuels
FI	Act on Excise Duty on Liquid Fuels; increasing carbon-dioxide tax on heating and machinery fuels from EUR 30 to EUR 35 per tonne of carbon dioxide	Encouraging the use of biofuels
FR	General Tax on Polluting Activities (TGAP)	Achievement of biofuel incorporation targets
FR	Partial exemption from domestic consumption tax (TIC)	Reduction in the additional costs of biofuel production
HR	Obligation to place biofuels on the Croatian market	Increase in biofuel consumption Contribution to achieving the 10% target for the share of RES in energy generation for transport by 2020.
HR	Obligation to purchase or lease vehicles that can use biofuels in public transport and the public sector	Increased biofuel consumption Contribution to achieving the target of a 10% RES share in overall energy generation in the transport sector by 2020
HR	Promotion of biofuel production	Increase in biofuel production
IE	REFIT 3	310MW of biomass technologies (anaerobic digestion, high efficiency CHP and biomass combustion and co-tiring)
IE	Bioenergy scheme for the production of non-food crops	Grant support for the planting of perennial biomass crops (willow and miscanthus)- contributes to biomass needs of renewable energy sector
IE	Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010, SI33/2012and S.I No. 562/2012	Facilitated the introduction of the Biofuel Obligation Scheme to promote increased production and use of Biofuels on Irish transport fuels market The obligation rate was increased to 6% with effect from 1 January 2013 by S.I. No. 562/2012
IE	S.I. 158 of 2011 and 2010 Biofuel Obligation Act, S.I. No. 482 of 2014 and SI 483 of2014	Legal Provisions that transpose Renewable Energy Directive 2009/28/EC in Ireland

IE	Draft Bioenergy Plan published October 2014	The draft Plan was published subject to the completion of SEA and AA. It sets out the broader context for the development of Ireland's bioenergy sector, and the current status with regard to the range of policy areas that must be coordinated in order to create the conditions necessary to support the development of this sector.
IT	Obligation to release biofuels for consumption (Law No 81 of 11 March 2006; Article 33 of Legislative Decree No 28/2011 as amended; Ministerial Decree of 10 October 2014)	Spread of sustainable biofuels (EU target by 2020: 10% of transport consumption covered from renewable sources)
IT	Conditions for connecting biomethane systems to the natural gas network. (Article 20 of Legislative Decree No 28/2011; Decision 46/2015/R/gas of 12 February 2015)	Feeding of biomethane into the natural gas network
IT	Incentives for biomethane injected into the natural gas network (Article 21 of Legislative Decree No 28/2011, Ministerial Decree of 5 December 2013)	Feeding of biomethane into the natural gas network
IT	Provisions on sustainable bioliquids/biofuels (Legislative Decrees No 55/2011 and No 28/2011, Ministerial Decree of 23 January 2012)	Promotion of sustainable biofuels and bioliquids (EU binding target for Italy by 2020: share of 10% RES in transport and share of 17% RES in total energy consumption)
LT	The prices of buying-in of electricity from renewable energy sources (A) National Control Commission for Prices and Energy, Resolution No O3-282 of 28 September 2012 on the setting of tariffs for electricity and biogas from renewable energy sources for 2013. National Control Commission for Prices and Energy, Resolution No O3-58 of 28 February 2013 on the setting of tariffs for electricity from renewable energy sources for Q2 2013. National Control Commission for Prices and Energy, Resolution No O3-197 of 30 May 2013 on the setting of tariffs for electricity from renewable energy sources for Q3 2013. National Control Commission for Prices and Energy, Resolution No O3-335 of 27 August 2013 on the setting of tariffs for electricity from renewable energy sources for Q4 2013. (B) National Control Commission for Prices and Energy, Resolution No O3-714 of 28 November 2013 on the setting of tariffs for electricity from renewable energy sources for Q1 2014. National Control Commission for Prices and Energy, Resolution No O3-66 of 3 March 2014 on the setting of tariffs for electricity from renewable energy sources for Q2 2014. National Control Commission for Prices and Energy, Resolution No O3-152 of 30 May 2014 on the setting of tariffs for electricity from renewable energy sources for Q3 2014. National Control Commission for Prices and Energy, Resolution No O3-333 of 28 July 2014 on the setting of tariffs for electricity from renewable energy sources for	Increase in electricity generation from renewable energy sources/ Increase in electricity generation from renewable energy sources (B)

	Q4 2014.	
LT	Compulsory blending of biofuels into mineral fuels (A) Order No I-346 of the Minister for Energy of the Republic of Lithuania of 14 December 2010 approving the Rules for trade in petroleum products, biofuels, bio-oils and other combustible liquid products in the Republic of Lithuania. (B) Order No I-348/D1-1014/3-742 of the Minister for Energy, the Minister for the Environment and the Minister for Transport and Communications of the Republic of Lithuania of 22 December 2010 approving the Mandatory Quality Parameters for petroleum products, biofuels and liquid fuel consumed in the Republic of Lithuania. Fuels sold on the domestic market must meet the following requirements with regard to their content and quality (in force until 27 June 2014): 95 RON motor spirit must be produced using the additive bio-ethyl tertiary butyl ether ('bio-ETBE'), the proportion of which in the blend with petrol must be at least 10 % and no more than 22 % by volume; 95 RON motor spirit produced without bio-ETBE must have a bioethanol content of between 5 % and 10 % by volume. The mandatory proportion of bioethanol in 95 RON motor spirit is 5 % (with a permitted tolerance of ±0.5 %) by volume. The permitted tolerance for bioethanol in ethanol automotive fuel (E85) is ±0.5 % by volume; 98 RON motor spirit need not be directly blended with bioethanol; Diesel must contain 7 % biofuels by volume (with a permitted tolerance of minus 1 % until 31 December 2012 and minus 0.5 % from 1 January 2013). In winter, Class 1 and 2 Arctic diesel need not contain biofuels; The proportion of biofuels in class 1 or 2 arctic diesel between 10 and 30 November and between 1 and 20 March may be lower than the mandatory percentage, and the cold filter plugging point and cloud point may be higher than specified for that class of diesel; The maximum permitted petrol	Growth in use of renewable energy sources in the transport sector (AB)

	vapour pressure for petrol between 1 and 20 May and between 10 and 30 September may lie between the maximum permitted vapour pressures laid down for classes of petrol blends for the summer season and for the cold season.' Fuels sold on the domestic market must meet the following requirements with regard to their content and quality (in force as of 28 June 2014): 95 RON motor spirit must be produced using the additive bio-ethyl tertiary butyl ether ('bio-ETBE'), the proportion of which in the blend with petrol must be at least 10 % and no more than 22 % by volume; 95 RON motor spirit produced without bio-ETBE must have a bioethanol content of between 5 % and 10 % by volume. The mandatory proportion of bioethanol in 95 RON motor spirit is 5 % (with a permitted tolerance of ±0.5 %) by volume. The permitted tolerance for bioethanol in ethanol automotive fuel (E85) is ±0.5 % by volume; 98 RON motor spirit need not be directly blended with bioethanol; Diesel fuel must contain 7% (the permissible error may be minus 0.5%) by volume of biofuel. In winter, Class 1 and 2 Arctic diesel need not contain biofuels; The proportion of biofuels in diesel fuel between 10 and 30 November and between 1 March and 10 April may be lower than the mandatory percentage, and the cold filter plugging point and cloud point may be higher than specified for that class of diesel; The maximum permitted petrol vapour pressure for petrol between 1 and 20 May and between 10 and 30 September may lie between the maximum permitted vapour pressures laid down for classes of petrol blends for the warm season and for the cold season.	
LT	Excise duty relief on biofuels Excise duty relief for energy products produced from or with the addition of biomaterials, as laid down by the Law of the Republic of Lithuania on excise duties: • For energy products that exceed the mandatory percentage of additives of biological origin laid down by law for petroleum products supplied to the country's domestic market, the rate of excise duty is reduced by a proportion corresponding to the percentage of additives of biological origin in excess of the mandatory percentage laid down by law. • for energy products in which the proportion of additives of biological origin is 30 % or higher, the rate of excise duty is reduced in proportion to the percentage of additives of biological origin in the product; where products are manufactured only from biomaterials, they are exempt from excise duties.	Increase in production of energy products containing materials of biological origin

LT	Funding of biofuel production Pursuant to the Rules on the funding of biofuel production development approved by Order No 3D-417 of the Minister for Agriculture of the Republic of Lithuania of 25 July 2008 approving the Rules on the funding of biofuel production development, a portion of the price of rapeseed oil intended for the production of rapeseed methyl(ethyl)ester (RME) and a portion of the price of rapeseed and cereal grain ('raw material') purchased for the production of dehydrated ethanol is offset from State budget funds ('aid'). Aid beneficiaries receive compensatory payments towards the raw material acquisition (cultivation) costs incurred between 1 January and 15 November of the current year: EUR 46.34/t for rapeseed and EUR 33.02/t for cereal grain.	Increase in agricultural produce used in the production of biofuel
LT	Funding of the planting of short rotation coppice Lithuanian Rural Development Programme for 2007-2013. Lithuanian Rural Development Programme for 2007-2013, Measure "Modernisation of agricultural holdings", Activity Areas 2 and 3, Implementing Rules approved by Order No 3D-480 of the Minister for Agriculture of the Republic of Lithuania of 31 October 2007 approving the implementing rules for Activity Areas 2 and 3 of Measure "Modernisation of agricultural holdings" of the Lithuanian Rural Development Programme for 2007-2013. One of the activities supported under Measure "Modernisation of agricultural holdings" of the Lithuanian Rural Development Programme for 2007-2013 is the planting of short rotation coppice. Aid to the planting of short rotation coppice may not exceed EUR 434/ha. The aid intensity is up to 50 %. Aid for the activity area "Planting of short rotation coppice" may be applied for by natural and legal persons lawfully managing agricultural land.	Increased surface areas of short rotation coppice

LT	Pollution tax concessions Pursuant to Articles 5(3) and (4) of the Law of the Republic of Lithuania on environmental pollution tax (paragraph 4 in force until 31 May 2013): paragraph 3(4): taxpayers polluting the environment from transport are exempt from the environmental pollution tax from mobile pollution sources if they use eligible biofuels in their operations and produce supporting documentary evidence paragraph 4: natural and legal persons who have produced documents confirming the use of biofuel are exempt from tax on environmental pollution from stationary pollution sources in respect of emissions resulting from the use of biofuel. As of 1 June 2013, Article 5 (4): paragraph 4: natural and legal persons who have produced documents confirming the use of biofuel are exempt from tax on environmental pollution within the limits indicated in the integrated pollution prevention and control permit or the pollution permit from stationary pollution sources in respect of emissions resulting from the use of biofuel. paragraph 4: natural and legal persons who have produced documents confirming the use of biofuel are exempt from tax on environmental pollution from stationary pollution sources in respect of emissions resulting from the use of biofuel. As of 1 June 2013, Article 5 (4): paragraph 4: natural and legal persons who have produced documents confirming the use of biofuel are exempt from tax on environmental pollution within the limits indicated in the integrated pollution prevention and control permit or the pollution permit from stationary pollution sources in respect of emissions resulting from the use of biofuel.	Increase in consumption of biofuel/ Increase in consumption of biofuel (paragraph 4)
LT	National Forestry Sector Development Programme 2012-2020 Drawn up in view of the fact that forests are becoming increasingly significant owing to their multiple benefits for the state, society, the country's economy and people. Forests help ensure landscape stability and environmental quality, and safeguard biodiversity. They provide timber and other forest products satisfy society's ecological, economic and social needs. Moreover, forests constitute an essential factor in maintaining ecological balance and provide habitats for many species of fauna and flora, halt soil erosion, absorb carbon dioxide and cleanse the air, accumulate carbon in biomass thereby reducing the amount of greenhouse gases in the atmosphere, protect ground and surface waters and provide people with opportunities for recreation.	Increased annual amount of felling waste and unsellable small timber used as biofuel: 2015 - 300 000 m3; 2020 - 500 000 m3

LT	Calculating the amount of greenhouse gas emissions resulting from the production and use of biofuels and bioliquids (A) Rules for calculating the effect of greenhouse gas emissions resulting from the production and use of biofuels, liquid bio-products and comparative fossil fuel approved by Order No D1-2 of the Minister for the Environment of the Republic of Lithuania of 3 January 2011 approving the Rules for calculating the effect of greenhouse gas emissions resulting from the production and use of biofuels, liquid bio-products and comparative fossil fuel setting the conditions and methods for the calculation of the comparative effect (the amount of atmospheric emissions of CO2) of the burning of fossil fuel or of biofuels or liquid bio-products emitting the same amount of energy. (B) Methodology for estimating the energy and environmental impacts during the service period of vehicles presented in the Procedure for setting the energy efficiency and environmental requirements applicable when purchasing vehicles and specifying the cases when they must be applied approved by Order No 3-100 of the Minister for Transport and Communications of the Republic of Lithuania of 21 February 2011 approving the Procedure for setting the energy efficiency and environmental requirements applicable when purchasing vehicles and specifying the cases when they must be applied, which lays down energy efficiency and environmental requirements and cases where they are to apply to road vehicles of Categories M1, N1, N2, N3, M2 and M3 and which is applicable when estimating the energy and environmental impacts during the service period of vehicles	Production of biofuel and liquid bio-products meeting the sustainability criteria/ Wider procurement and use of less polluting and more energy-efficient road vehicles (B)

LT	Separation of the biodegradable fraction of municipal and economic waste (A) Procedure for determining the composition of mixed municipal wastes intended for disposal in regional non-hazardous waste landfills and assessing the amounts of biodegradable municipal wastes disposed of therein approved by Order No D1-661 of the Minister for the Environment of the Republic of Lithuania of 31 August 2011 approving the Procedure for determining the composition of mixed municipal wastes intended for disposal in regional non-hazardous waste landfills and assessing the amounts of biodegradable municipal wastes disposed of therein which lays down the procedure specifying the arrangements for assessing the composition of mixed municipal wastes being sent for disposal in regional non-hazardous waste landfills and the amounts of biodegradable municipal wastes disposed of therein so as to determine the extent to which targets for reducing the amount of biodegradable municipal wastes sent to landfill have been met; for submitting reports on the composition of the mixed wastes sent for disposal in regional non-hazardous waste landfills and the amounts of biodegradable municipal wastes disposed of therein. Works to determine the composition of mixed municipal waste disposed of at regional landfills for non-hazardous waste are performed four times a year in 2012, 2013, 2016, 2018 and 2020. The determination of the composition of mixed municipal waste disposed of at regional landfills for non-hazardous waste is organised by the operator of the relevant regional landfill for non-hazardous waste (B) Methodology for the separation of the biodegradable fraction of industrial and municipal waste having regard to the renewable portion of the energy produced from industrial and municipal waste approved by Order No D1-810 of the Minister for the Environment of the Republic of Lithuania of 4 October 2012 approving the Methodology for the separation of the biodegradable fraction of industrial and municipal waste having regard to the renewable portion of the energy produced from industrial and municipal waste which regulates the procedure for establishing the biodegradable fraction of municipal and/or industrial waste used to produce energy from renewable sources. The methodology lays down the requirements for economic operators which produce biogas from municipal and/or production and other economic waste and solid recovered fuel from municipal and/or production and other economic waste, use biogas, solid recovered fuel, municipal and/or production and other economic waste for energy production and operate regional landfills for non-hazardous waste and/or supervise closed landfills for non-hazardous waste accumulating landfill biogases as well as economic operators using landfill biogas for energy production	Development of municipal waste use in energy production/ Development of the use of municipal and/or economic waste to produce energy (AB)

LT	Support measures promoting the use of vehicles powered by electricity or purer fuels (biofuels, gases) Measure "Integrated development of environment-friendly public transport" (VP3-3.3-SM-01-V) in the Annex to the Operational Programme for the Promotion of Cohesion approved by Resolution No 787 of the Government of the Republic of Lithuania of 23 July 2008 approving the Annex to the Operational Programme for the Promotion of Cohesion which is intended for improving air quality by comprehensively upgrading the system of public transport services with a view to reducing air pollution, ensuring more efficient transport for the urban population, promoting the mobility of the workforce, reducing traffic congestion, improving traffic safety and ensuring high quality of public transport services provided. The implementation of this measure supports the procurement of environment-friendly public transport (trolleybuses and buses powered by gas, electricity and hybrid engines) and an increased share of purer fuels (biofuels, gases) and electricity in the total quantity of fuels consumed by public transport	Increased use of purer fuels (biofuels, gases) and electricity for public transport needs
LT	To promote the use of biofuel in transport by financial and legal measures Plan of measures for implementing the National Development Strategy for Renewable Energy Sources for 2010-2015 approved by Order No 1-180 of the Minister for Energy of the Republic of Lithuania of 23 June 2010	Increased use of biofuel in transport
LT	To draw up financial support measures promoting the upgrading of heat production facilities supplying heat to public buildings in rural areas (schools, kindergartens, healthcare establishments, buildings of local authorities, etc.) and to adapt such facilities for biofuel (wood, straw) combustion including grass biomass (grass pellets) Plan of measures for implementing the National Development Strategy for Renewable Energy Sources for 2010-2015 approved by Order No 1-180 of the Minister for Energy of the Republic of Lithuania of 23 June 2010	Increased use of biofuel
LT	National Forestry Sector Development Programme 2012-2020 National Forestry Sector Development Programme for 2012-2020 approved by Resolution No 569 of the Government of the Republic of Lithuania. The purpose of the Programme is to implement the long-term policy of Lithuania concerning the forestry sector compatible with other policies supported by national traditions, legislative arrangements of the European Union, international conventions, resolutions, agreements and programme requirements and to set out the development goals and objectives of the forestry sector up to 2020	To increase annual quantities of felling waste and small unsellable wood to be used for the production of biofuel: in 2015 - 300 000 m3; in 2020 - 500 000 m3
LT	Support for biofuel producers Order No 3D-679 of the Minister for Agriculture of the Republic of Lithuania of 9 September 2015 approving the maximum quantity of compensated rapeseed and cereals purchased (cultivated) in 2015	140 000 t biofuels

LT	Support for short rotation coppice Lithuanian Rural Development Programme for 2014-2020 Order No 3D-302 of the Minister for Agriculture of the Republic of Lithuania of 21 April 2015 approving the implementing rules applicable as of 2015 for Activity Area "Support for investments in agricultural holdings" of Measure "Investments in tangible assets" of the Lithuanian Rural Development Programme for 2014-2020. No result is reported as the funds are allocated to the entire measure without breaking it down into individual activities	Number of ha planted, updated on an annual basis
LT	Support to biogas producers Lithuanian Rural Development Programme for 2014-2020 Order No 3D-632 of the Minister for Agriculture of the Republic of Lithuania of 11 August 2015 approving the implementing rules applicable as of 2015 for Activity Area "Support for biogas production from agricultural and other waste" of Measure "Economic and business development" of the Lithuanian Rural Development Programme for 2014-2020	Installed electric capacity 20 MW
LT	Support for biogas producers Lithuanian Rural Development Programme for 2014-2020 Order No 3D-302 of the Minister for Agriculture of the Republic of Lithuania of 21 April 2015 approving the implementing rules applicable as of 2015 for Activity Area "Support for investments in agricultural holdings" of Measure "Investments in tangible assets" of the Lithuanian Rural Development Programme for 2014-2020. No result is reported as the funds are allocated to the entire measure without breaking it down into individual activities	Installed electric capacity MW, to be updated
LT	Support for the production of biopellets According to the Ministry of Agriculture of the Republic of Lithuania, activity rules have not yet been approved. No result is reported as the funds are allocated to the entire activity without separating the production of biopellets	Installed capacity in thousands of tonnes, updated on an annual basis
LT	By constructing new cogeneration capacities, to ensure that the district heating systems of other cities are additionally equipped with 43 MW electric power cogeneration facilities powered by biofuels and/or biogas National Heating Sector Development Programme for 2015 -2021 approved by Resolution No 284 of the Government of the Republic of Lithuania of 18 March 2015 approving the National Heating Sector Development Programme	District heating systems of other cities to be additionally equipped with 43 MW electric power cogeneration facilities powered by biofuels and/or biogas
LV	Reduced rate of excise duty (Law on Excise Duties)	Promotion of the use of biofuels
LV	Mandatory blending of biofuels in fossil fuels at 4.5-5 % by volume of the total amount of the end-product (Cabinet Regulation No 332 of 26 September 2000 "Requirements for Conformity Assessment of Petrol and Diesel Fuel"	Promotion of the production and consumption of biofuels in order to achieve the target of 5.75 % of the total amount of transport fuels in the economy by 31 December 2010 according to the Biofuel Law
LV	Plan for the deployment of alternative fuels infrastructure (pursuant to the conditions of Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure)	Development of alternative fuels infrastructure by thus promoting the utilisation and distribution of vehicles powered

		by alternative fuels
LV	Latvian Rural Development Programme for 20072013, Measure "Energy generation from biomass of agricultural and forestry origin", Cabinet Regulation No 268 of 16 March 2010 "Procedure for the granting of State and European Union aid to the "Energy generation from biomass of agricultural and forestry origin" Sub-measure of the "Aid to the establishment and development of undertakings" Measure (including diversification of non-farming activities)	Electricity generation up to 40 MW
MT	Educational campaign on better waste segregation of biodiagradable waste	Biodegradable waste for WtE seneiahon
MT	Set biofuel content level in imported fuels to gradually reach 10% by 2020, and monitor compliance	Framework to reach target of 10% renewable energy in transport
NL	Proeftuinen duurzame mobiliteit (sustainable mobility pilot areas) subsidy programme: vehicles using biogas and higher blends of biofuels	Energy innovation
NL	Proeftuinen duurzame mobiliteit (sustainable mobility pilot areas) subsidy programme: hybrid and electric vehicles	Energy innovation
NL	Energy tax on electricity and gas (offsetting for electricity, biomass heating)	Generated energy
PL	Providing financial support schemes in order to implement the measures related to the production of biofuel components, liquid biofuels or other renewable fuels and their use in transport.	Increased use of biofuel components, liquid biofuels or other renewable fuels in the transport sector.
PT	Creation of a decentralised network of biomass plants	Creation of a decentralised network of new biomass plants following the invitation to tender for the attribution of capacity which was launched in 2006.
PT	Allocation of incentives to be applied to plants using forestry biomass subject to certain conditions, through voluntary agreements with the plant promoters.	Create a framework for commitment with the promoters of biomass plants thus enabling projects to be carried out and committing promoters to supporting the implementation of forestry policy measures, organising the logistical chain, enhancing the local economy, being socially responsible and complying with deadlines for the construction and implementation of projects.

PT	Promote the use of endogenous resources and waste for the production of biofuels and solutions related to second-generation raw material (non-food cellulosic material, and ligno-cellulosic material).	Significant increase in the use of endogenous resources in biofuel production. The measure has been implemente d but without results. There is interest in residual material but no interest on the part of producers in endogenous raw materials.
PT	Transposition and application in Portugal of directives and best practice in the area of biofuels and in particular the setting of sustainability criteria and high quality standards.	Ensure sustainable production of biofuels
PT	Drawing up the Hydrogen Roadmap	Identifying the capacity for hydrogen and defining the roadmap for its respective developmen t and use.
RO	Establishing the share of bio-fuels in petrol and diesel placed on the market in 20132014 (Government Decision No 935/2011)	Increasing biofuel consumption
RO	Placing on the market only bio-fuels and bio-liquids obtained from raw material meeting the sustainability criteria defined and the obligation to check the compliance with such criteria (Government Decision No 935/2011)	Implementation of sustainable development principles
RO	Establishing the share of bio-fuels in petrol and diesel placed on the market in 20132014 (Government Decision No 1121/2013 amending and supplementing GD No 935/2011 and GD No 928/2012)	Increasing biofuel consumption
RO	Certifying biofuels and bio-liquids with regard to meeting the sustainability criteria - voluntary schemes recognised by the European Commission for proving the compliance with sustainability criteria pursuant to Directive 2009/28/EC (Order No 136/2012 of the Ministry of Economy and Business Environment)	Transposition of EU law
SE	Investment aid for biogas and other renewable gases Ordinance (2009:938) on State aid for measures relating to the production, distribution and consumption of biogas and other renewable gases	Greater production, distribution and consumption of renewable gases.
SE	Coordination of energy adaptation in the transport sector Bill 2015/16:1	Promote adaptation in the transport sector
SE	Implementatio n of the sustainability criteria laid down in the Renewables Directive. Act (2010:598) on sustainability criteria for biofuels and bioliquids	Greater use of sustainable biofuels and bioliquids
SE	Fuel Act (2011:319)	Reduced greenhouse gas emissions
SE	Pump Act Act (2005:1248) on the requirement to provide renewable fuels	Greater availability of renewable fuels
SK	Mandatory blending of biocomponents — introduction of sustainability criteria	increasing use of RES in transport
SK	Facilitation of access to gas network for biomethane	production of biomethane
SK	Feed-in price guarantee for electricity from biomethane	production of biomethane
SK	Support for cultivation of fast-growing trees	increase supply of biomass

SK	Support for household use of renewable energy	installation of biomass boilers, solar panels, PV and heat pumps
SK	Growth in timber production — support for establishing energy crops	increase supply of biomass
UK	Renewable Transport Fuel Obligation (RTFO)	Increase proportion of renewable fuel in road fuel and reduce emissions from GHG by regulating for the use of sustainable biofuel.
UK	Anaerobic Digestion Loan Fund	£10m loan fund to support the development of new AD capacity in England. The fund can provide asset backed loans for plant, machinery and/or groundworks. Minimum investment size of £50,000 / maximum of £1,000,000
UK	UKH2 Mobility	Evaluate hydrogen as an Ultra-Low Emission Vehicle (ULEV) fuel in the UK by sharing data on trends and consumer habits and attitudes to ULEVs. The UK government funded phase one of this project (£11 million); Jan 2012 to March 2013, the next three phases are funded from private investment.
UK	Low carbon Trucks	Evaluate potential for low carbon HGVs by working with industry on prototype vehicles and funding further R&D The UK government has provided £11.3m of funding.
UK	Advanced biofuels demo	Promote advanced biofuels and address the risks and barriers associated with it. The scheme aims to bring together those in the R&D field (e.g. universities) with industry to share ideas and test fuels. The UK government has provided £25m of funding in December 2014 for three years to 2018.

UK	Biomass sustainability.	Ensure all biomass in receipt of subsidy under Renewables Obligation (RO), Renewable Heat Incentive (RHI) and Contracts For Difference (CfD) is sustainable by introducing minimum sustainability requirement: a greenhouse gas saving (at least 60% saving compared to the EU grid average) and a land criteria
UK	Anaerobic Digestion (AD) Strategy and Action Plan	Increase deployment of energy from waste by AD. Sets out a range of actions, for HMG working with industry, to overcome regulatory, financial and other barriers.
UK	Northern Ireland Biomass Processing Challenge Fund (DARD)	Installation on-farm of an increased number of biomass-fuelled renewable energy technologies. To provide farmers with a secure supply of clean energy for use in support of their agricultural activities.

2.1. Trade Partners on agricultural commodities/feedstocks relevant for biogasoline production

Table 2-2 2014 imports of agricultural commodities into the EU-28 as percent of total, distinguished by trading partner

Commodity	Barley	Corn	Rye	Sugar Beets	Wheat
			% of total EU-28 imports		
Trade partner					
Albania	0%	0%	0%	0%	0%
Algeria	0%	0%	0%	0%	0%
Antigua and Barbuda	0%	0%	0%	0%	0%
Areas, nes	0%	0%	0%	0%	0%
Argentina	0%	2%	0%	0%	0%
Armenia	0%	0%	0%	0%	0%
Australia	0%	0%	0%	0%	2%
Belarus	0%	0%	0%	0%	0%
Bolivia (Plurinational State of)	0%	0%	0%	0%	0%
Bosnia Herzegovina	0%	0%	0%	0%	0%
Brazil	0%	5%	0%	0%	0%
Cambodia	0%	0%	0%	0%	0%
Cameroon	0%	0%	0%	0%	0%
Canada	0%	10%	0%	0%	49%
Chile	0%	0%	0%	0%	0%
China	0%	0%	0%	0%	0%
China, Hong Kong SAR	0%	0%	0%	0%	0%
Colombia	0%	0%	0%	0%	0%
Costa Rica	0%	0%	0%	0%	0%
Côte d'Ivoire	0%	0%	0%	0%	0%
Dominican Rep.	0%	0%	0%	0%	0%
Ecuador	0%	0%	0%	0%	0%
Egypt	0%	0%	0%	0%	0%
Eritrea	0%	0%	0%	0%	0%
Ethiopia	0%	0%	0%	0%	0%
Gambia	0%	0%	0%	0%	0%
Ghana	0%	0%	0%	0%	0%
Guatemala	0%	0%	0%	0%	0%
Guinea-Bissau	0%	0%	0%	0%	0%
Iceland	0%	0%	0%	0%	0%
India	0%	0%	0%	0%	0%
Indonesia	0%	0%	0%	0%	0%
Iran	0%	0%	0%	0%	0%
Israel	0%	0%	0%	0%	0%
Japan	0%	0%	0%	0%	0%

Jordan	0%	0%	0%	0%	0%
Kazakhstan	0%	0%	0%	0%	1%
Kenya	0%	0%	0%	0%	0%
Kuwait	0%	0%	0%	0%	0%
Kyrgyzstan	0%	0%	0%	0%	0%
Lebanon	0%	0%	0%	0%	0%
Madagascar	0%	0%	0%	0%	0%
Malaysia	0%	0%	0%	0%	0%
Mexico	0%	0%	0%	0%	3%
Montenegro	0%	0%	0%	0%	0%
Morocco	0%	0%	0%	0%	0%
Nepal	0%	0%	0%	0%	0%
New Zealand	0%	0%	0%	0%	0%
Nigeria	0%	0%	0%	0%	0%
Norway	0%	0%	0%	0%	0%
Other Asia, nes	0%	0%	0%	0%	0%
Other Europe, nes	0%	0%	0%	0%	0%
Paraguay	0%	0%	0%	0%	0%
Peru	0%	0%	0%	0%	0%
Philippines	0%	0%	0%	0%	0%
Rep. of Korea	0%	0%	0%	0%	0%
Rep. of Moldova	29%	2%	1%	0%	2%
Russian Federation	25%	7%	43%	0%	7%
Rwanda	0%	0%	0%	0%	0%
Saudi Arabia	0%	0%	0%	0%	0%
Senegal	0%	0%	0%	0%	0%
Serbia	8%	6%	0%	99%	2%
South Africa	0%	1%	0%	0%	0%
State of Palestine	0%	0%	0%	0%	0%
Sudan	0%	0%	0%	0%	0%
Switzerland	1%	0%	0%	0%	0%
Syria	0%	0%	0%	0%	0%
TFYR of Macedonia	0%	0%	0%	0%	0%
Thailand	0%	0%	0%	0%	0%
Togo	0%	0%	0%	0%	0%
Tokelau	0%	0%	0%	0%	0%
Turkey	0%	0%	0%	0%	0%
Turkmenistan	0%	0%	0%	0%	0%
Uganda	0%	0%	0%	0%	0%
Ukraine	37%	59%	55%	0%	20%
United Arab Emirates	0%	0%	0%	0%	0%
Uruguay	0%	0%	0%	0%	0%
USA	0%	7%	0%	0%	13%
Uzbekistan	0%	0%	0%	0%	0%
Viet Nam	0%	0%	0%	0%	0%

Zambia	0%	0%	0%	0%	0%
Zimbabwe	0%	0%	0%	0%	0%
Gibraltar	0%	0%	0%	0%	0%
Tunisia	0%	0%	0%	0%	0%
Singapore	0%	0%	0%	0%	0%
El Salvador	0%	0%	0%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Quelle: UN Comtrade; downloaded 2016-09-21

Table 2-3: Additional Information on Table 4a - current domestic agricultural land use for production of crops dedicated to energy production (ha)

MS	2013	2014
AT	net area including area factoring for combined production of protein feed (DDGS, rape cake). During biofuel production, only part of the yield is used for ethanol production (starch) or vegetable oil production (oil); a large part of the raw material is retained as valuable protein feed for farm animals and can replace imports of protein feed (e.g. soya imports from soya farms in South Africa).	net area including area factoring for combined production of protein feed (DDGS, rape cake). During biofuel production, only part of the yield is used for ethanol production (starch) or vegetable oil production (oil); a large part of the raw material is retained as valuable protein feed for farm animals and can replace imports of protein feed (e.g. soya imports from soya farms in South Africa).
BE		
BG		
CY	Agricultural land was not used for decicated energy production in 2013 and 2014	
CZ	This is not land used, but a reverse estimate of land area needed to produce biofuels. Note: for short rotation trees is information on the areas included in the LPIS system as an SRT culture. The are for other cultivated energy crops is not monitored as a separete culture.	
DE		
DK	land use for common arable crops are own calculations on the basis of the biogas census and Statistics Denmark (yield per ha)	
EE	there is no information regarding domestic agricultural land use for production of crops dedicated to energy production	
EL		
ES	in case of biofuels no information available	
FI		
FR	Until 2009, a survey was carried out in respect of industrial set-aside land and energy crop areas benefiting from assistance. Using those data, it was possible to assess the areas used for energy crops. Following the abolition of obligatory set-aside in 2009, only the energy crop areas were known for that year. As of 2010, these data are no longer compiled. There are no data available for subsequent years, therefore, for row 3 of Table 4a above. The data given in row 1 of the above table are obtained from competitive intelligence relating to biofuels. These are gross area figures that do not take account of co-products.	The data in 2014 are taken from farmers declarations. they do not include areas planted by industrial or forestry concernes
HR	no agricultural land is used for growing energy	

	crops	
HU		
IE		
IT		
LT		
LU	it is only possible to draw conclusions about land use in connection with grasses used for energy purposes. The land used for energy purposes decreased slightly in 2014 compared to 2013. However, this is probably does not represent a general trend. As a 4-year average, it has remained relatively constant at approximately 730 ha	Most plant types used for energy purposes are also used for basic fodder production in farms that keep livestock.
LV		
MT	no significant domestic land is being used for the production of fuel/energy related crops, rotation trees and grasses.	
NL	Domestic agricultural land use for the cultivation of crops dedicated to energy production is minimal compared with the total area used for arable crops of 520 000 hectares and the total area used for green fodder (including forage maize) of 240 000 hectares in 2012.	
PL		
PT	The data on the use of agricultural soils contained in Table 4a relates to the production of wheat, sugar beet and sunflower. The wheat crop is most widespread, followed by sunflower. At national level, these crops are not used for the production of energy.	
RO		estimation
SE	there is no information, about what the crops are used for. Table 4 a contains information on land where cereals and other crops and energy forests. Hemp is not used for energy to any great extent.	
SI		
SK		
UK		includes maize used on anaerobic digestion, which was not captured / recorded in 2013 figures

Source: Member States Reports 2015