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IEA BIOENERGY – TASK 40

Sustainable International Bioenergy Trade: Securing supply and demand

Country Report: Austria 2014

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1 Introduction

Austria is a small country located in Central Europe with a population of 8.5 million which accounts for 1.7% of the EU28 population (EUROSTAT, 2015a). It borders both Germany and the Czech Republic to the north, Slovakia and Hungary to the east, Slovenia and Italy to the south, and Switzerland and Liechtenstein to the west. Austria's terrain is mostly mountainous and the weather conditions are characterized by a temperate and alpine climate.

The territory of Austria covers 84,000 km² (8.4 million ha). According to the latest forest inventory (BFW, 2011), 4 million ha (47.6% of Austria) are covered with forest. The total agricultural area is about 3.2 million ha; arable land accounts for 1.375 million ha and 1.8 million ha are grass land (approximately half of it is used extensively).

Austria's gross domestic product was € 323 bn in 2013 which accounted for about 2.4% of the EU28. GDP per inhabitant amounted to about € 38.000. (EUROSTAT, 2015a)

This Country Report is built upon the Austrian Country Report 2011 (Kalt et al., 2012) from which parts of texts are directly transferred in several chapters with updated values for the year 2013.

1.1 Energy supply and demand

To provide an overview on the country's energy balance and its historical development data representing the time frame 2000-2013 was extracted from national statistics data base (Statistik Austria, 2015a) further referred to as National Energy Balance.

Austria is a net importer of (primary) energy. Its primary energy production accounted for about 1/3 of its gross inland consumption in the considered time period. Figure 1 illustrates the share of all primary energy sources which have been produced in Austria on an annual basis. While about 84 PJ crude oil and natural gas have been exploited in 2013 in four production sites in Lower and Upper Austria (WKO, 2013), coal mining does not appear in the energy balance since 2005. At the same time the share of renewable energy production increased from about 69% in 2000 to about 78% in 2013 of which primary energy production from renewables other than biomass and from biomass and biogenic waste are distributed nearly equally (179 PJ renewables other than biomass and 223 PJ from biomass and biogenic waste in 2013). Together with about 27 PJ from non-biogenic waste Austrian primary energy production accounted for about 513 PJ in 2013.

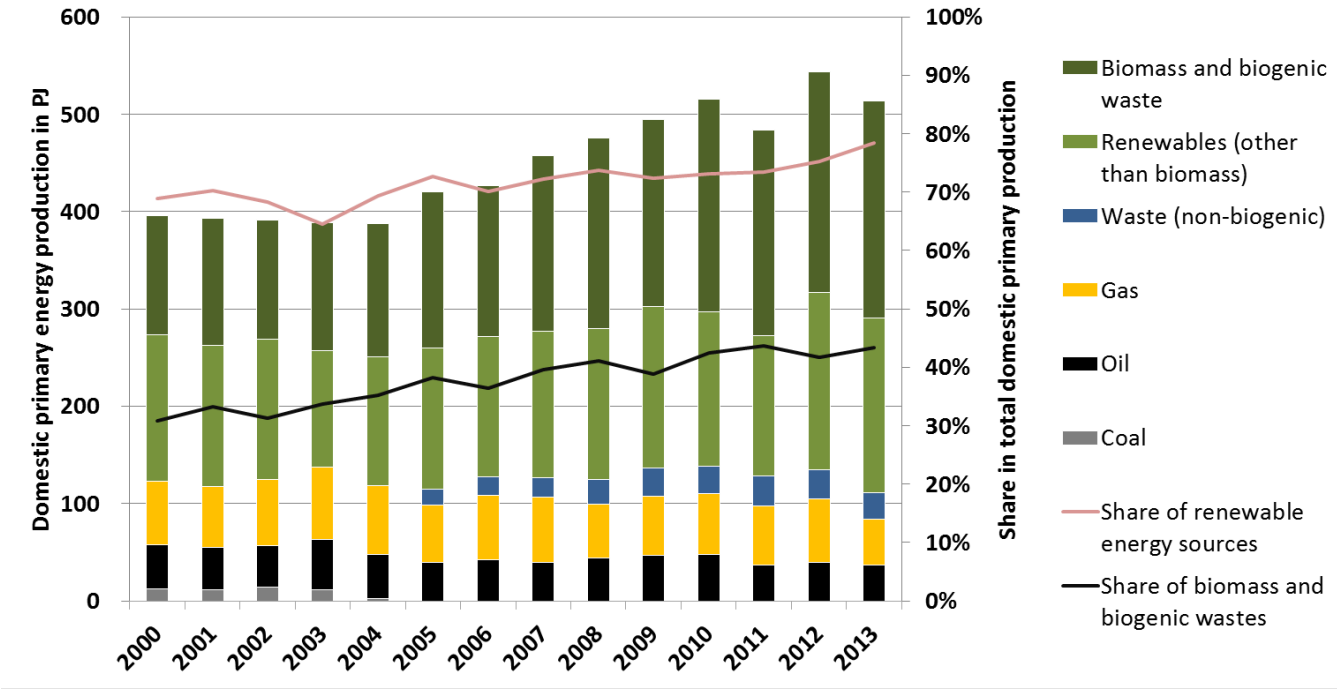

Figure 1: Domestic primary energy production by source. Own illustration based on: (Statistik Austria, 2015a)

Figure 2 gives the share of primary energy sources for electricity production. The main share is contributed from renewable energy other than biomass. Next to small contributions from photovoltaic with 0.6 TWh and wind power with 3.2 TWh, the lions share is hydro power with an electricity output of 42.0 TWh in 2013. Interestingly a similar electricity output (41.8 TWh) can also be noted already for the year 2000. About 4.6 TWh of electricity output were based on biomass and biogenic waste incineration in power plants and CHP plants in 2013.

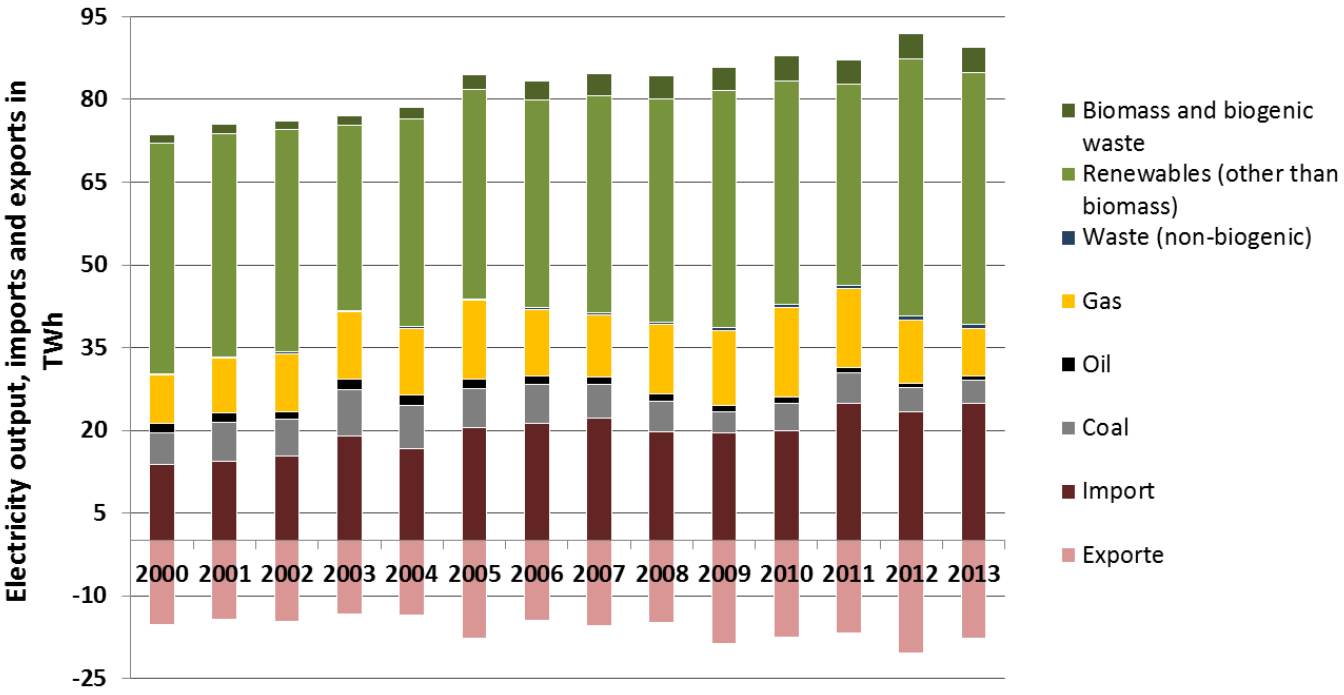

Figure 2: Austrian electricity output, imports and exports by source. Own illustration based on: (Statistik Austria, 2015a)

In contrary to electricity, district heat is produced in Austria mainly based on biomass and biogenic waste (37 PJ_{2013}) and natural gas (36 PJ_{2013}). From Figure 3 a fourfold (400%) increase of biomass and biogenic waste for district heating between 2000 and 2013 can be derived. In the same time frame the utilisation of non-biogenic waste, renewables other than biomass and gas for heating increased by 160%, 57% and 48% while heating oil recorded a decrease by 55%.

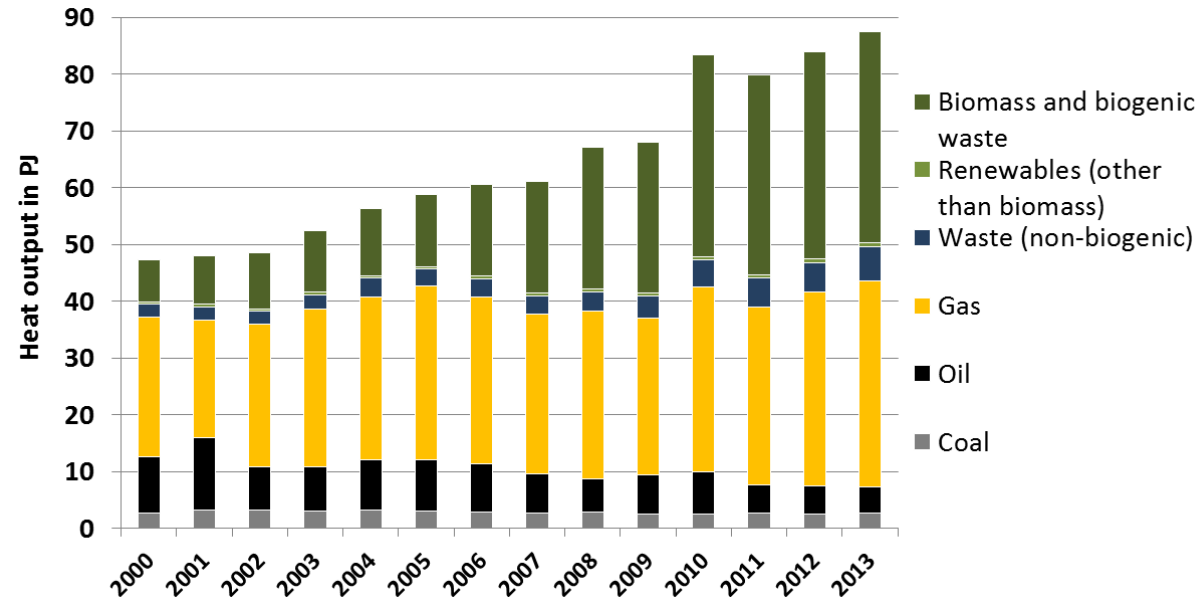

Figure 3: Austrian district heat production by source. Own illustration based on: (Statistik Austria, 2015a)

During the last decade, transport fuel consumption in Austria reached its peak in 2004 at about 355 PJ. Figure 4 illustrates production and net-imports of fossil- and bio-fuels for transportation. While the ratio of diesel to gasoline consumption increased in the discussed period from about 2.2 to 4, Austria reduced the imports of gasoline while diesel net imports increased by about 74%. Since 2005 biodiesel appears in the national energy statistics and since 2007 also bioethanol. Chapter 3 will explain drivers behind the increased biodiesel and bioethanol consumption for transportation.

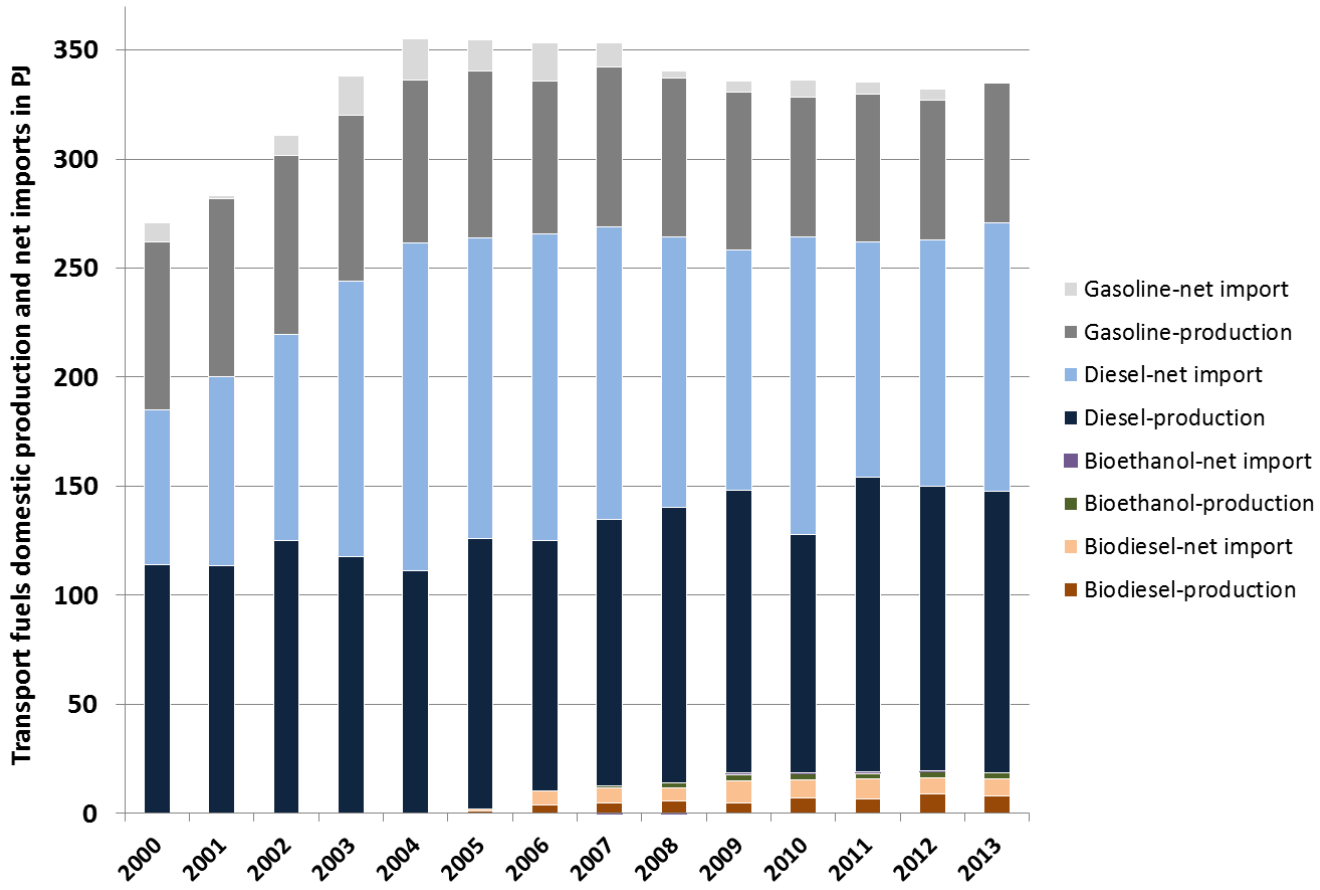

Figure 4: Transport fuels refinery output and net-imports (negative net-imports of gasoline 2013 (-27 TJ) and bioethanol in 2008-2009 (<100 TJ) are not shown). Own illustration based on: (Statistik Austria, 2015a)

In Figure 5, the gross inland consumption of the country is illustrated for the discussed time frame. According to its definition it can be computed either by 1) the sum of primary energy production, net-imports and stock changes or 2) as illustrated in Figure 5 by the sum of final energy consumption, energy consumption in the energy sector, non-energy utilisation of energy carriers (e.g. for chemicals etc.) and various losses including losses through transportation but also the difference of input and output of the transformation processes. Gross inland consumption increased from about 1200 PJ in 2000 to about 1400 PJ in only four years at which level it can also be found in the beginning of the current decade (2010 - 2013). Strongest drivers are final energy consumption of the industry (≈ +32%), for transportation (≈ +26%), and in the energy sector (≈ +13%). All other sectors also increased

energy consumption by 5 - 8 % excluding the service sector which decreased by 2% since the beginning of this century.

Largest industrial energy consumers in 2013 have been paper and print, steel and iron, chemicals and petrochemicals and non-ferrous minerals industries with 21%, 15%, 13% and 11% respectively. The strongest increase from 2000 onwards is recorded by the wood processing industry, production of machinery and construction with +121%, +68% and +66%.

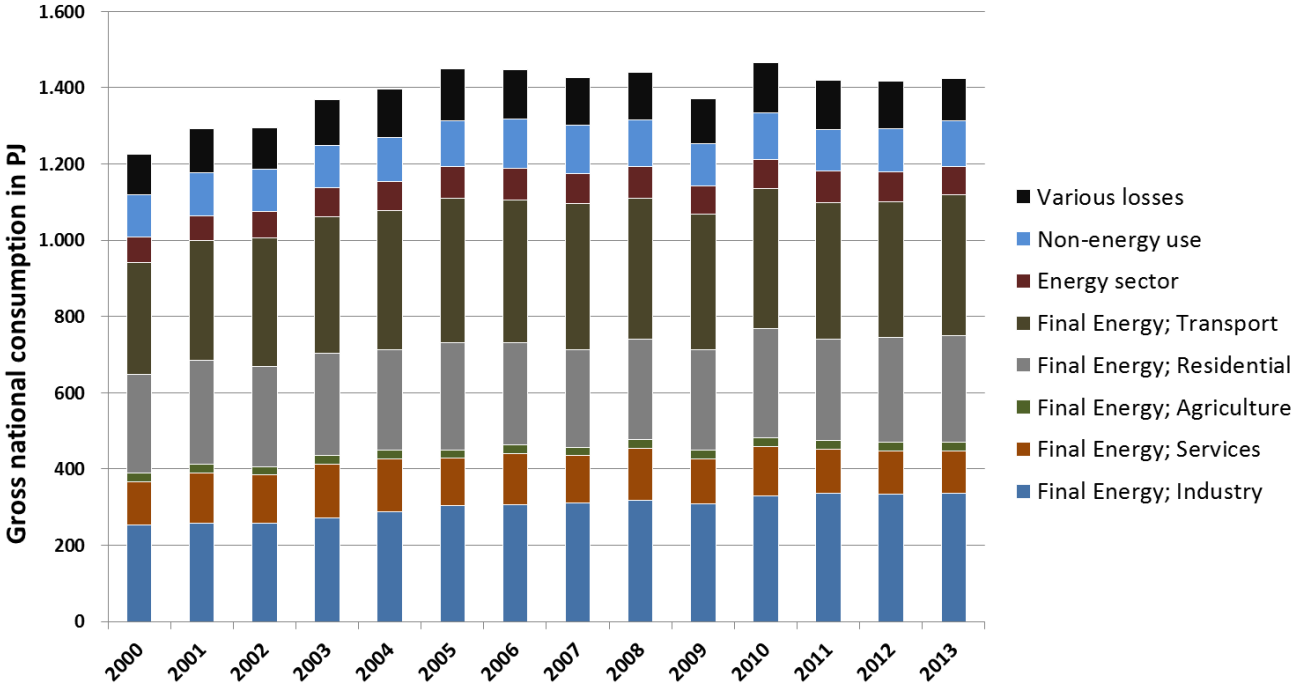

Figure 5: Gross inland consumption by sector. Own illustration based on: (Statistik Austria, 2015a)

1.2 GHG-Emissions

According to the latest National Inventory (Pazdernik et al., 2014) submitted under the Kyoto Protocol Austria's target for the period 2008 – 2012 to reduce emissions by 13% compared to base year (1990) emissions was not met (see Figure 6). The largest share of emissions is sourced by the energy category with nearly 60 $Mt_{CO2\text{-}eq}$ in 2012. By definition of the inventory it summarises transportation, manufacturing industries and construction, energy industries, other sectors and other emission sources with a 2012 share of 36%, 26%, 21%, 16% and 1% respectively. The "Other sectors"- category and therefore 12% of total emissions accounted mainly for burning fossil fuels for space and water heating in the commercial, agricultural and household sector. Furthermore 3,8 Mt CO2 equivalents could be removed in 2012 mainly by afforestation/reforestation in Austria (LULUCF-category) (Pazdernik et al., 2014).

Table 1: Greenhouse gas source and sink categories and total (net emissions) in 2012. Source: (Pazdernik et al., 2014, p.A-239)

GHG Source and sink categories	Total emissions CO2-eq (kt)	Share of energy category	Total share
Energy	59692	100%	78,3%
Energy-industries	12447	21%	16,3%
Manufactoring	15581	26%	20,4%
Transport	21636	36%	28,4%
Other sectors	9498	16%	12,5%
Other emmiters	530	1%	0,7%
Industrial processe	10877		14,3%
Solvents	335		0,4%
Agriculture	7499		9,8%
LULUCF	-3839		-5,0%
Waste	1657		2,2%

About one third (~28 Mt CO2 in 2012) of total Austrian GHG emissions resulted from installations under the EU emission trading scheme. (Pazdernik et al., 2014)

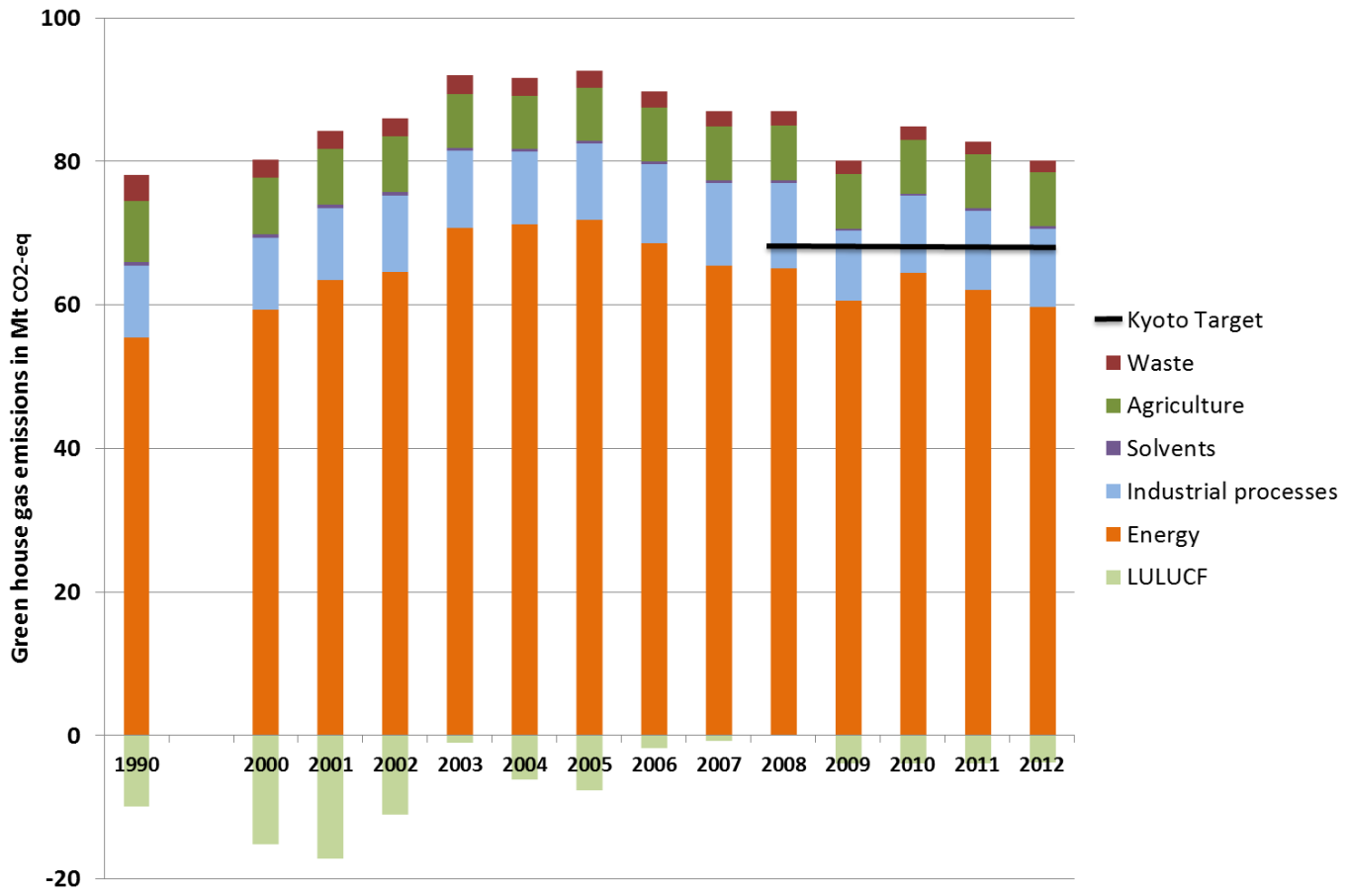

Figure 6: GHG-emissions by source and sink categories. Own illustration based on: (Pazdernik et al., 2014, p.A-239)

2 Domestic biomass resources, current use, trends and main users

About 245 PJ biogenic energy carriers where consumed (gross domestic consumption) in Austria in 2013. The distribution between solid, liquid and gaseous bioenergy accounted for 74%, 22% and 3% respectively. For this report, they are clustered according to the National Energy Balance as shown in Table 2.

Table 2: Bioenergy carrier types according to national energy balance. Source: (Statistik Austria, 2015a)

Solid bioenergy carriers	Liquid bioenergy carriers	Gaseous bioenergy carriers
Fuel wood	Biodiesel	Biogas
Biogenic waste (from households)	Bioethanol	Landfill gas
Pellets and briquettes	Black liquor	Sewage gas
Waste wood	Other liquid biogenic	
Wood char		
Other solid biogenic		

Main consumers are conversion processes, residential final energy consumption (mainly solid), and final energy consumption in industries. About 72 PJ of solid bioenergy carriers are consumed by households in 2013 illustrated in Figure 7. Therefore mainly wood logs (57 PJ) followed by pellets and briquettes (8 PJ) and waste wood (7 PJ) were used. Also comparable negligible amounts of wood char and biogas have been used in this sector. Conversion processes and final energy use in industry exhibit a higher diversity of bioenergy carriers and are explained in more detail in the following figures.

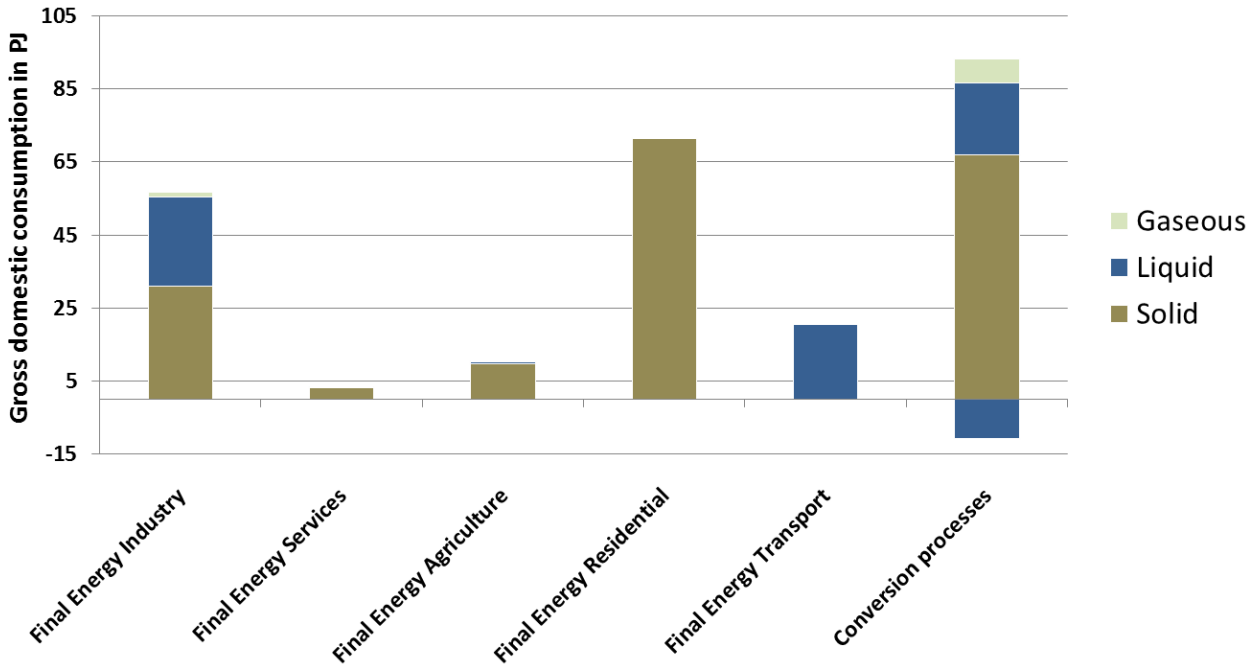

Figure 7: Gross domestic consumption of bioenergy in 2013. Own illustration based on: (Statistik Austria, 2015a)

About 94 PJ of biomass have been consumed in the conversion processes in 2013 in Austria (see Figure 8). The main share, solid bioenergy was converted into heat and power in CHP, heat and power plants with about 27 PJ, 23 PJ and 16 PJ respectively. A very small proportion was converted into charcoal. Liquid bioenergy consumption took either place for CHP and pure power production or for biofuels production (namely for blending with fossil fuels). CHP and power production accounted for about 9 PJ and was only based on black liquor. About 11 PJ of the category other liquid biogenic have been converted into biofuels (see Chapter 5.2). Another 7 PJ gaseous bioenergy, mainly biogas was transformed into power and partly into heat in 2013.

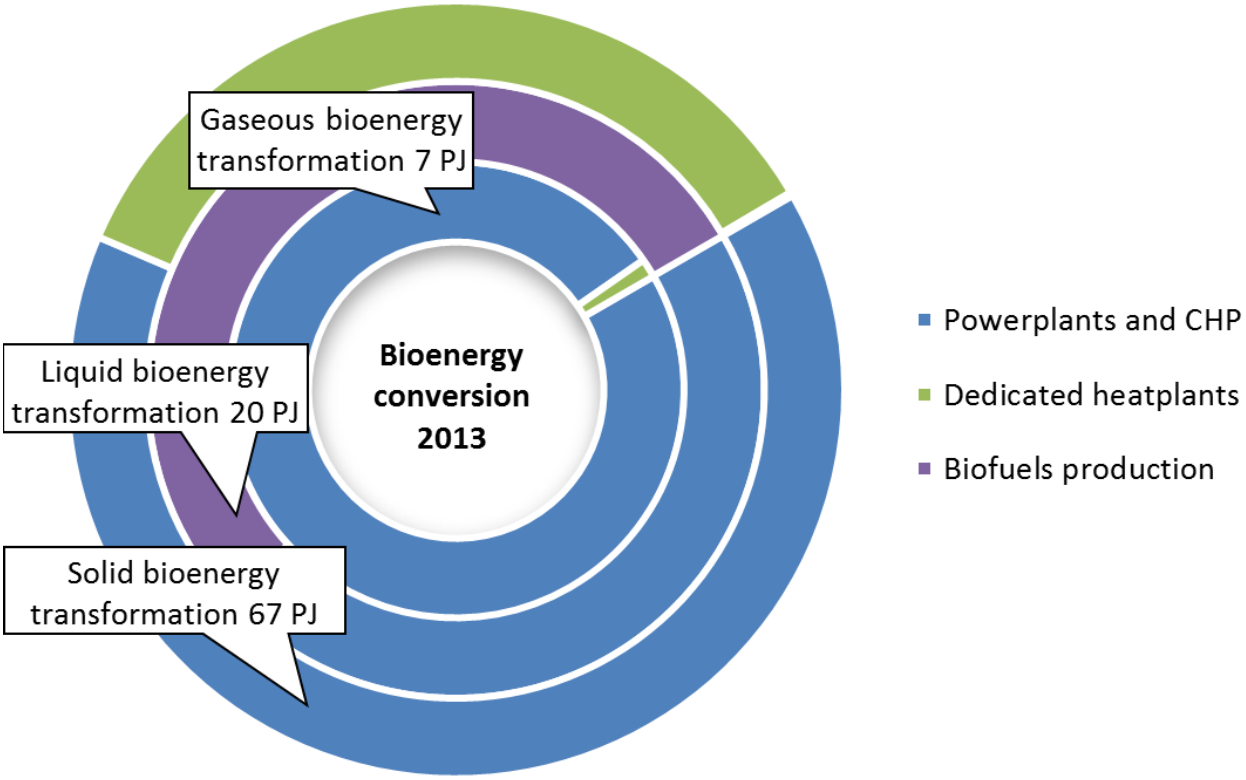

Figure 8: Bioenergy use in the conversion sector (94 PJ) 2013. Own illustration based on: (Statistik Austria, 2015a)

On the final energy consumption of bioenergy in Austrian industries (excluding dedicated power and/ or heat producers) in 2013 two main consumers can be spotted automatically on the basis of Figure 9: 1) Solid bioenergy is mainly consumed by wood and wood processing industries followed by non-ferrous metals, paper, pulp and print and chemicals and petrochemicals production. 2) Liquid bioenergy is mainly consumed by the paper, pulp and print industry (black liquor) and partly used in the construction sector. 3) And a small amount of gaseous bioenergy is used as well in the pulp, paper and print industry followed by food and chemicals industries.

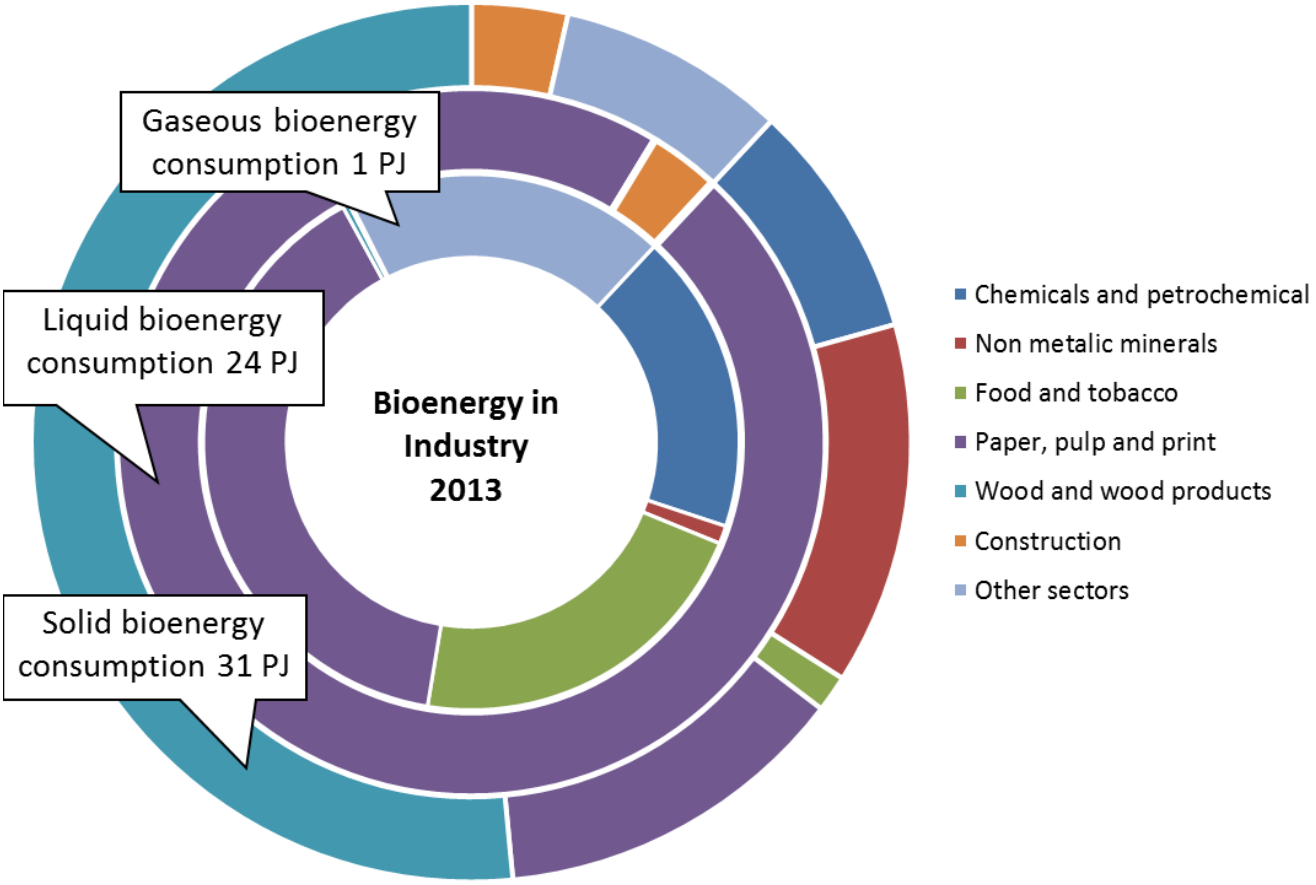

Figure 9: Bioenergy consumption in Industry (56 PJ) in 2013. The category "other sectors" includes Iron and Steel, non-ferrous metals, transport equipment, machinery, mining and querying, textile and leather and non-specified sectors. Own illustration based on: (Statistik Austria, 2015a)

3 Policy support and expected biomass use in 2020 (and beyond)

As part of the European Union the country is compelled to make its contribution to reach the targets of the climate and energy package also known as the "20-20-20" targets. The European objectives for the year 2020 are as follows:

- 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable sources to 20%;
- And a 20% improvement of energy efficiency.

Four measures are put in place to support these targets:

1. The EU Emission Trading Directive is the basis for the, since 2013, third trading period of the EU ETS (Emission Trading Scheme) including a single EU-wide cap on emission allowances to reach a 21% reduction of emissions in the involved sectors below the 2005 level.

2. The Effort Sharing Decision sets binding annual targets for the Member States covering the period 2013 – 2020. Targets are set individually according to the MS relative wealth.
3. The Renewable Energy Directive again outlines individual targets to raise their shares of renewable energy in their energy consumption by 2020 and National Renewable Energy Action Plans (NREAPs) have been submitted in 2009 to the Commission.
4. And a directive to create a legal framework for the environmental safe use of carbon capture and storage technologies.

The package does not include measurements on energy efficiency directly. However the Energy Efficiency Directive (2012/27/EU) requires the EU-28 Countries to "use energy more efficiently at all stages of the energy chain". A certain amount of final energy savings in the period 2014 – 2020 is obligatory for every MS and indicative national energy efficiency targets have been submitted in 2014 in the form of National Energy Efficiency Action Plans (NEEAPs) to the Commission.

3.1 Targets for Austria

Austria's contributions to the discussed targets are as follows:

- According to the Effort Sharing Decision (406/2009/EG) the reduction of GHG-emissions for sectors not part of the ETS have to account for 16% compared to the 2005 levels.
- According to the Renewable Energy Directive (2009/28/EG) the country is obliged to increase its share of renewables in the total gross final energy consumption until 2020 to 34%.
- The Energy Strategy Austria (BMWFJ and BMLFUW, 2010) discusses the decision to stabilise the countries final energy consumption at 1.100 PJ until 2020.

In 2013 a position paper was presented addressing qualitative targets regarding a bioeconomy (ÖVAF and BIOS, 2013). The position paper was followed by a strategy paper for biobased industries in Austria (Ganglberger and Sturm, 2014) including basic definitions and descriptions of biobased products including biobased insulation materials, polymers, chemicals, biofuels, fertilizer and others.

3.2 Legal implementation with regard to bioenergy

3.2.1 Heating and cooling

The Environmental Measures Support Act (Umweltförderungsgesetz) defines measures and support for environmental protection. The main topics focus on areas of support, financing, responsibility and procedural regulations. Various general areas of support are covered; the promotion of renewable energies is laid down in detail in the guidelines for domestic environmental support (Umweltförderung im Inland; UFI). Generally up to 30% of investment costs can be covered for biomass based systems for the following technologies and sizes:

- individual biomass units up to 400 kW_{th},
- individual biomass units from 400 kW_{th},
- biomass CHP,
- biomass microgrids,
- local biomass heating.

While renewable energy measures are promoted in industrial and commercial buildings mainly at federal level through the UFG (environmental measures support act), the development of the legislation and RE measures for residential buildings is largely within the competence of the "Länder" (provinces). Both from a financial and efficiency perspective, the "Länder-specific" investment incentives for private households represent the main support instrument for RE heating and cooling projects in Austria.

The implementation of measures relating to buildings mainly lies in the competence of the nine regions, however the conclusion of the agreement between federal and state government was able to introduce an essential step to the harmonisation and reinforcement of RE measures in the building sector. The federal state governments have for the most part already implemented the obligations agreed on in the Article 15a B-VG Agreement[1] in the respective state-specific housing support laws. A detailed overview of the housing support laws of all federal states can be found in Annex 1 of the National Renewable Energy Action Plan -NREAP (Karner et al., 2010)

The housing support (Wohnbauförderung; WBF) is the promotional tool with which both the construction of housing as well as the remediation of residential buildings is supported. Since the implementation of building-related measures lies in local competence, the conditions of eligibility in the respective federal states are regulated just as differently as the type and level of housing support.

Furthermore a subsidy scheme for wood heating form the Climate & Energy Fund for private households applies to the substitution of fossil fuel based heating systems with pellet and wood-chip central heating systems and pellet stoves.

3.2.2 Biofuels directive and the law on the taxation of mineral oils

The Fuel Order Amendment (Kraftstoffverordnung) changed in 2012 (KVO, 2012) lays down the Biofuels Directive (2003/30/EG), the Renewables Directive (2009/28/EG) and the Fuel Quality Directive (2009/30/EG) in Austrian law. It regulates a biofuel substitution of 5.75%, measured by the energy content of total fossil petrol or diesel introduced or used in the federal territory (KVO, 2012). By 2020 the substitution target of 8.45% (with regard to energy content) has to be fulfilled with ensuring GHG-mitigation of at least 35% until 2017 and 50% (to 60% for new installations) later (KVO, 2012). Starting with July 2014, only biofuels meeting the mitigation requirements are allowed to be used for a tax relief determined by the Mineral Oil Duty Act (Mineralölsteuergesetz). The substitution of fossil fuels (with regard to energy content) in the year 2013 accounted for 6.19% (Winter, 2014).

The Mineral Oil Duty Act (MöStG, 1995) was amended in 2007 and contains the currently valid rates of duty listed in Table 3.

[1] Agreement under Article 15a B-VG (2009) between the federal government and states on measures in the building sector for the purpose of reducing the emission of greenhouse gases.

Table 3: Rates of duty for fossil fuels and biofuels for Austria since 2010.

Fuel type	Specification	rate of duty per 1,000 litres
Petrol	**containing at least 44 l of biogenic substances and with a sulphur content of no more than 10 mg/kg**	**482€**
	Other	**515€**
Diesel	**containing at least 44 l of biogenic substances and with a sulphur content of no more than 10 mg/kg**	**397€**
	Other	**425€**
Pure biofuels	**completely exempt from mineral oil duty**	**0€**

Since 2013 the verification of sustainability requirements are mandatory for all Austrian producers using an electronic monitoring system called elNa[2]. The tool was created by the Austrian Environmental Agency to minimize the administrative burden and to facilitate the data transfer with other monitoring systems (Winter and bmlfuw, 2014). Other than the German NABISY-system[3] only transport relevant certificates are covered.

3.2.3 Green electricity act

The support policy for energy from renewable sources in the electricity sector is provided by the Green Electricity Act (Ökostromgesetz) which was updated in 2012 (ÖSG, 2012).

Under the Green Electricity Act, a technology-specific support of plants producing electric energy on the basis of renewable energy sources (solid, liquid, gaseous biomass, wind power, photovoltaics, landfill and sewage gas, geothermics and small hydropower) is provided by means of fixed feed-in tariffs. Furthermore investment grants are awarded in place of feed-in tariffs for plants based on waste liquor of the paper and pulp industry as well as small and medium hydro power plants.

Support takes place according to the specific technology and is processed via the processing and administration centre called OeMAG. The electricity delivered to the grid is paid at a tariff determined by ordinance of the Ministry of economics for a guaranteed period of 15 years for bioenergy and 13 years for all other renewable power producers. Since 2006, a cap of the available support contract volume for new eco-electricity plants has been in place. The award of supplier contracts between eco-electricity producers and OeMAG takes place on a “first come, first served” basis. Therefore producers have to be registered in a database for the proof of origin (Herkunftsnachweisdatenbank or HKN-DB). According to this database about 11.470 GWh of green electricity was fed into the grid in 2013. On the contrary 7.140 GWh have been remunerated from OeMAG (see Table 4). This accounted to 12.5% of total electricity consumed from the end users. Remunerations of about 747 M€ have been paid to the producers in 2013. The remunerations include furthermore the market value of the purchased electricity which accounted for 277 M€ in 2013. Therefore the support volume for green electricity was about 470 M€.

[2] http://www.umweltbundesamt.at/en/services/services_climate/services_climate_references/en_elna/
[3] https://nabisy.ble.de/app/start

Table 4: Remuneration 2013 (solid biomass includes waste with high biogenic share; gaseous biomass includes also remuneration for operating costs; All green electricity producers include: Bioenergy, Wind, Solar, Geothermal and Hydropower) Source: (E-Control, 2014)

Energy carrier	Installed capacity in MW	Feed in quantities in GWh	Number of Units	Remuneration in M€	Share of delivery quantity	Specific remuneration in Cent/kWh
Solid biomass	322	2013	129	272,8	3,50%	13,55
Gaseous biomass	83	544,3	293	96,8	1%	17,79
Liquid biomass	5	0,19	32	0,02	0,0003%	11,83
Landfill and sewage gas	15,8	26	44	1,4	0,05%	5,42
All green electricity producers	2648	7140,5	18482	747,1	12,50%	10,46

While about 50% of the total remuneration for green electricity was dedicated to solid, liquid and gaseous biomass, only 36% of the feed in quantity was based on biomass. This is due to generally higher feed in tariffs for solid and gaseous biomass than for other main green electricity producers (hydropower and wind). Specific remunerations are calculated for the year 2013 in Table 4. In comparison specific remunerations for hydropower and wind have been 4.9 and 8.3 Cent/kWh, only for photovoltaic remunerations have been higher (28.7 Cent/kWh).

To handle the decentralised conversion into electricity through the injection of biomethane into the gas grid the Biomethane Registry Austria[4] was put into operation in 2012 according to (ÖSG, 2012). Furthermore additional 2 Cent/kWh are granted if biomethane is converted decentralised into electricity (elsewhere than at the methane production site).

Targets for 2015 and 2020 are defined as well by (ÖSG, 2012): To achieve the indicative target of 15% supported green electricity in 2015 among others an additional investment of 100 MW biomass and biogas for 2015 and 200 MW until 2020 are planned. The achievement of this target is estimated as unlikely considering the actual development. (E-Control, 2014, p.40)

According to (E-Control, 2014) fixed feed in tariffs should be substituted in the near future with a combination of a premium additional to the market prices or a certification system. Furthermore promotion schemes might be gradually tendered starting with 2015 and 2016 following a recommendation from the commission (2014 Environmental and Energy State Aid Guidelines - EEAG[5]).

[4] http://www.biomethanregister.at/de
[5] http://europa.eu/rapid/press-release_MEMO-14-276_en.htm

3.2.4 Other implementations with regard to bioenergy

The following policy actions regarding the biomass value chain are gathered from (Pelkmans et al., 2014):

- Austrian agrienvironmental Programme 2007 (Österreichsiches Agrar-Umweltprogramm ÖPUL)
- Variety Protection Act 2001 (Sortenschutzgesetz 2001)
- BIO Austria Reugulations for Organic Farming in (BIO AUSTRIA – Produktionsrichtlinien)
- National nitrates action programme 2012 (Aktionsprogramm Nitrat 2012)
- Forest Act 1975 (Forstgesetz 1975)
- Waste Management Act 2002 (Abfallwirtschaftsgesetz AWG)
- Federal Waste Management Plan 2011 (Bundes-Abfallwirtschaftsplan BAWP 2011)
- Animal material directive (Tiermaterialiengesetz TMG)
- Regulation on recycling of waste wood (RecyclingholzV)
- Nature Protection laws of the federal states (Naturschutzgesetze der Bundesländer)
- Air Pollution Control Act (Immissionsschutzgesetz - Luft)
- Environmental Aid Act (Umweltförderungsgesetz UFG)
- Environmental Management Law (Umweltmanagementgesetz UMG)
- Environmental Impact Assessment Act (Umweltverträglichkeitsprüfungsgesetz UVP-G)
- Emission Certificate Law 2011 (Emissionszertifikategesetz – EZG)
- Climate & Energy Fund Act (Klima- und Energiefondsgesetz KLI.EN-FondsG)
- Green electricity feed-in tariff regulation (Ökostrom-Einspeisetarifverordnung)
- Combined Heat and Power Law (Kraft-Wärme-Kopplungsgesetz KWKG)
- Natural Gas Act 2011 (Gaswirtschaftsgesetz GWG 2011)
- Climate Protection Act (Klimaschutzgesetz KSG 2011) with Climate Action Plan for 2012 and 2013, and Progress Report (Pazdernik et al., 2014).

3.3 Scenarios

Estimates about the impact of the discussed policies on domestic bioenergy production and consumption can be found in the National Renewable Energy Action Plan *(Karner et al., 2010)* and based on the NREAP in a synthesis report used as the basis for the monitoring mechanism 2013 *(Krutzler et al., 2013)*. While the NREAP calculations are based on statistical data and information from 2009, the second report is based on data of the National Energy Balance until the year 2010 and on policy information until 2012 including estimations on most likely developments thereafter (in the "with additional measures" (WAM) - scenario). Final bioenergy consumption according to the discussed WAM-scenario is shown in *Figure 10*. No significant increase of the final bioenergy consumption is expected, mainly through a decrease of residential final energy consumption due to better insulation. In other sectors, a slight increase in final bioenergy consumption until 2020 is outlined mainly due to an expected economic growth of 1.5% and the discussed biofuel targets.

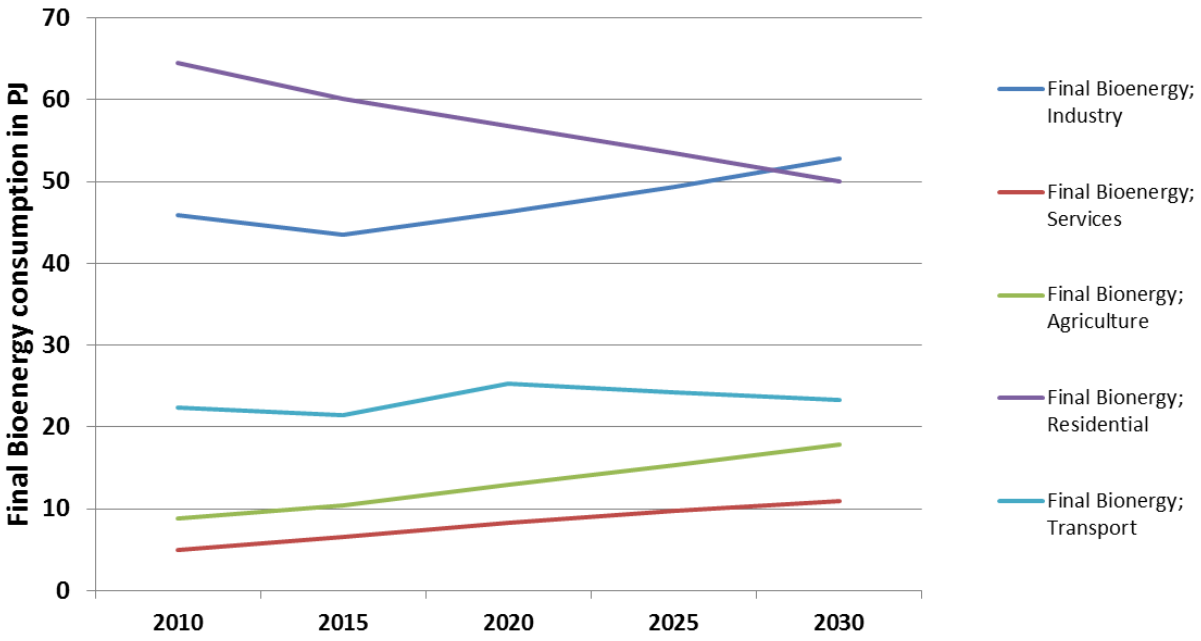

Figure 10: Final energy consumption of biomass in WAM-scenario. Own illustration based on: (Krutzler et al., 2013)

4 Biomass prices

In Figure 11, average fuel prices for Austria in 2013 are illustrated for 1) energy carriers used for heating and process energy, for 2) energy carriers used for transportation and for 3) electricity. Prices for fossil fuels and electricity are derived from (OECD, 2015) and include average excise taxes (VAT and special taxes considering refunds for commercial and industrial consumption). The price for biodiesel is an average price acquired from about 20 gas stations and four days throughout 2013 (Treibstoffpreisanalyse 2013, Arbeiterkammer[6]). For pellets and fuel wood prices we use data from Propellets and Statistik Austria cited in (Bürger, unpublished). Pellets are delivered with pellets trucks, thus an extra rate for the

[6] Personal communication 27.01.2015; AK Wien, Pezenka Dominik & Thoman Josef

delivery has to be considered. This rate ("Einblaspauschale") was taken into consideration with 37.47 €/Delivery[7] for January 2015.

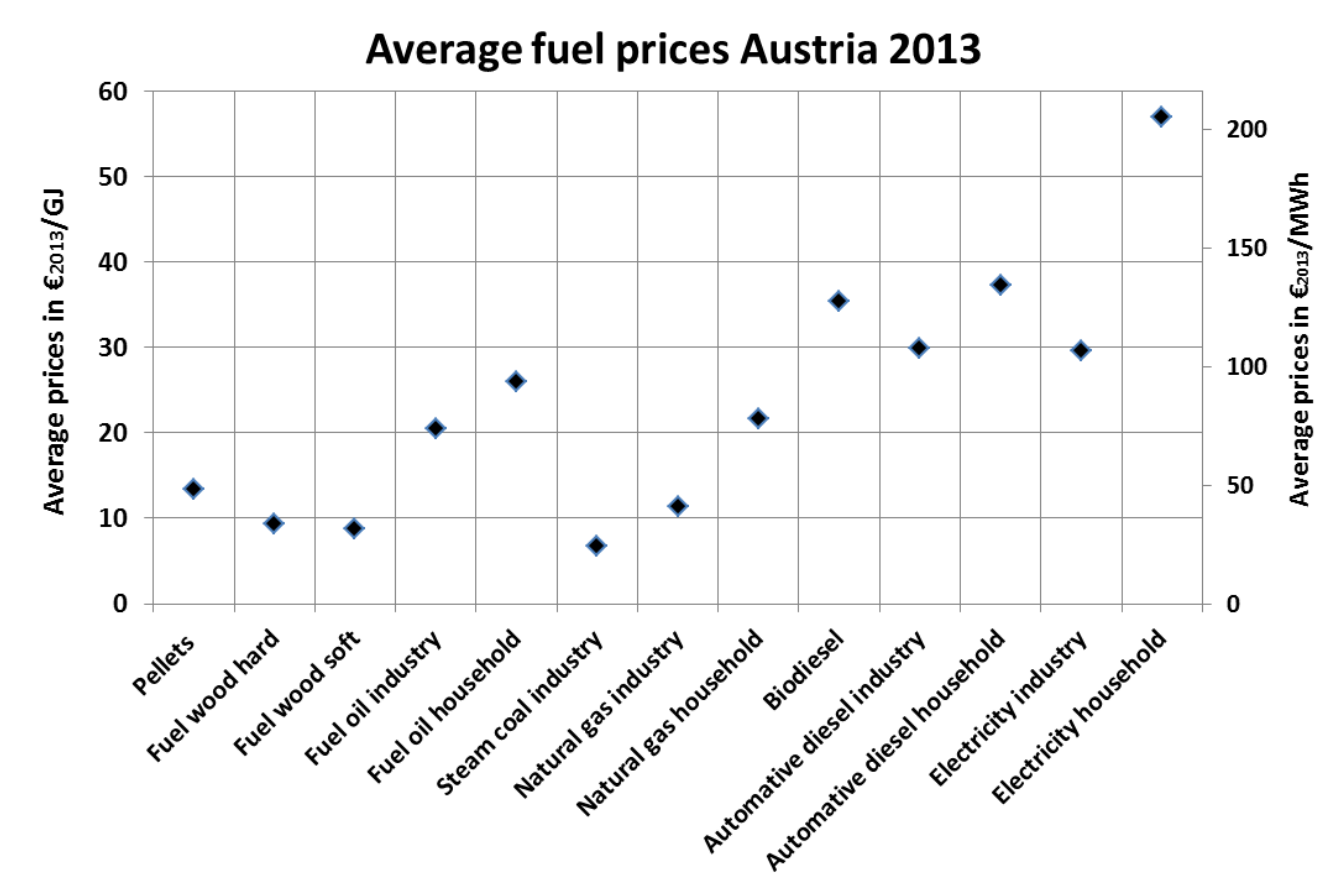

Figure 11: End user prices including excise tax for fossil fuels and biodiesel and VAT for solid bioenergy carriers. Own illustration based on: (Bürger, 2015) and (OECD, 2015)

Highest fluctuations could be found for electricity household prices with 2 €/GJ difference between maximum and minimum averages (for quarterly periods) in 2013. The fluctuations for biodiesel costs could not be used for this comparison since price surveys only exist for eight specific days in the year 2013. Monthly average pellets prices fluctuated in total by 1.29 and 1.34 €/GJ (for industrial and household use) and fuel wood by 21 and 25 cent/GJ (for hardwood and softwood respectively).

For the heating of residential buildings, important fuels and their cost developments from 2000 onwards are shown in Figure 12. While fuel oil and natural gas show an increase of 65% and 61% respectively, fuel wood and pellets exhibit an increase of 12% and 6% in the period 2000 - 2013. All prices are expressed in $€_{2013}$ based on the consumers´ price index of Austria (Statistik Austria, 2015b).

[7] Personal communication 26.01.2015; Propellets.at, Christian Schlagitweit

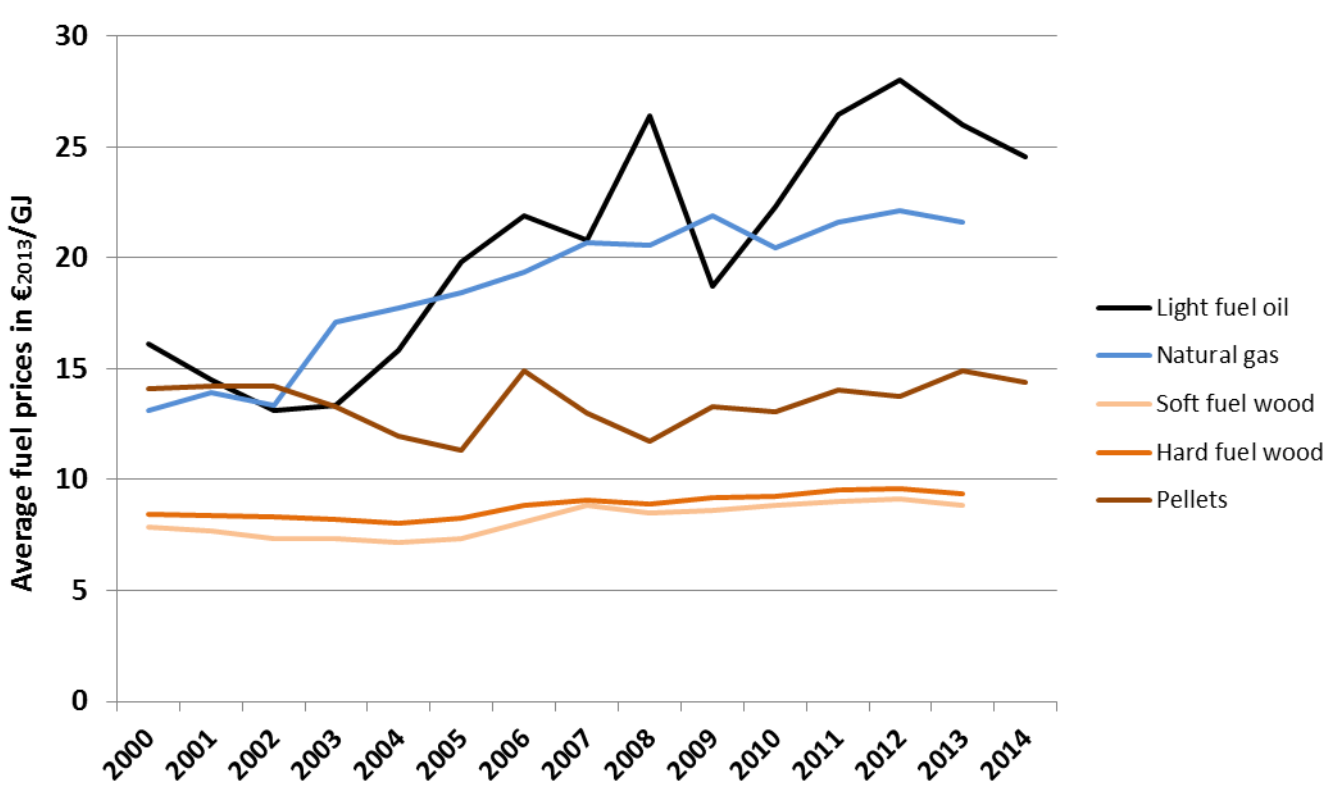

Figure 12: Household prices (including taxes and supply costs) for fuels used for heating in Austria. Own illustration based on: (Bürger, 2015) and (OECD, 2015)

5 International bioenergy trade

According to Austria's Energy Balance (Statistik Austria, 2015a) the country was a net importer of bioenergy carriers since 2006, reaching a maximum of 28 PJ of net imports in 2013. In Figure 13 imports and exports of the respective bioenergy carriers are illustrated for 2005 to 2013. Highest trade streams (imports and exports) can be recorded for wood pellets & briquettes in the current decade, while net imports are highest for fuel wood and biodiesel in 2013. While biodiesel and bioethanol indicate biogenic quantities which are blended with fossil transport fuels, other biogenic liquids indicate the sum of the pure liquid biofuels prior blending[8]. In total, about 4 PJ other biogenic liquids are net-imported and used together with domestic primary production mainly for the "transformation sector" (namely blending) in refineries to produce gasoline and diesel blended with bioethanol and biodiesel (11 PJ liquid biofuel content) as discussed in Chapter 5.2.

Following paragraphs discuss import and export quantities for the year 2013:

[8] Personal communication: Dr. Bittermann, Statistik Austria, 18.02.2015

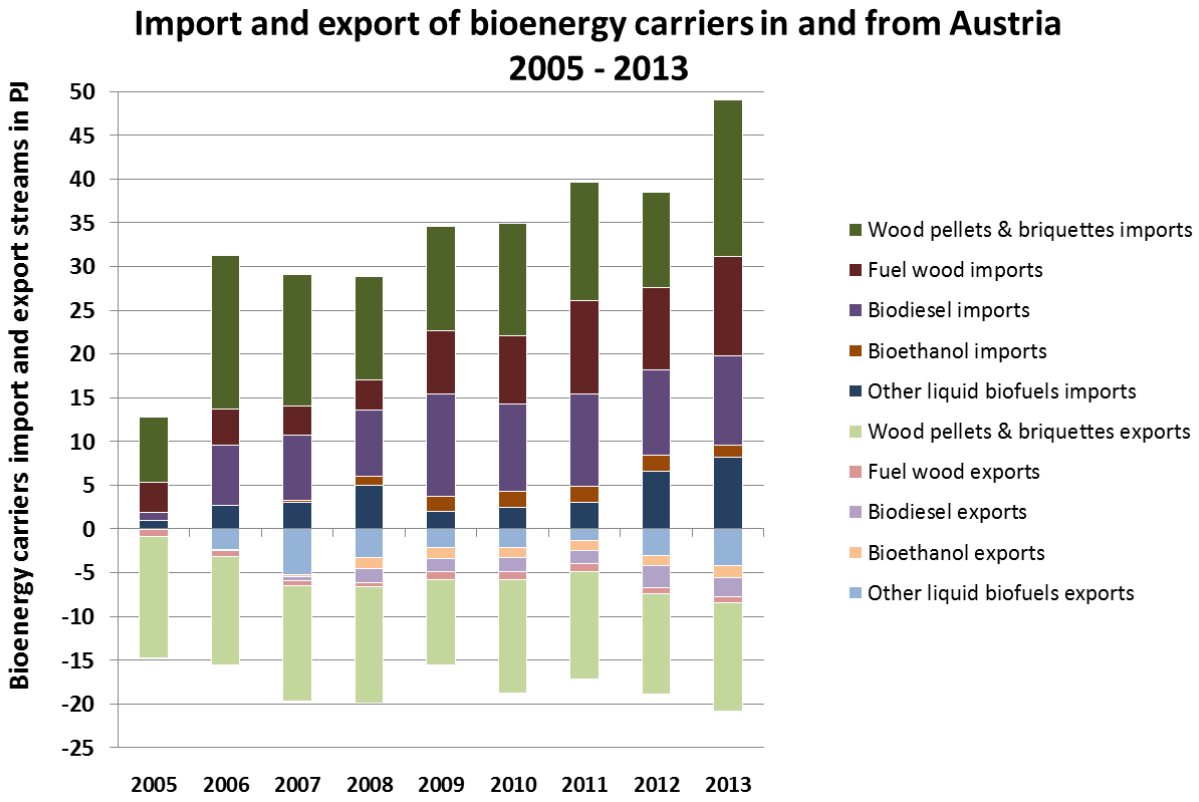

Figure 13: Import and export of bioenergy carriers in and from Austria in the time frame 2005 - 2013. Own illustration based on: (Statistik Austria, 2015a)

5.1 Solid bioenergy trade

The Austrian Energy Balance includes balances for bioenergy carriers, both in TJ and in tonnes. Conversion takes place with heating values of 14.3 GJ/t for fuel wood and 17.3 GJ/t for pellets & briquettes respectively. For the year 2013, net-imports of about 741 kt and 320 kt are shown for fuel wood and pellets & briquettes. In (EUROSTAT, 2015b) trade of these commodities are listed under the CN/HS code 440110 for fuel wood logs and HS 440131 for pellets and HS 440139 for other agglomeration of sawdust, waste and scrap (e.g. briquettes). Based on the physical values of this database, net-imports of about 786 kt and 373 kt can be computed for fuel wood and pellets & briquettes for which both values are in the same magnitude than in the National Energy Balance mentioned above. Furthermore the International Trade database includes trade streams from reporter (in this case Austria) to partners (within the EU and beyond).

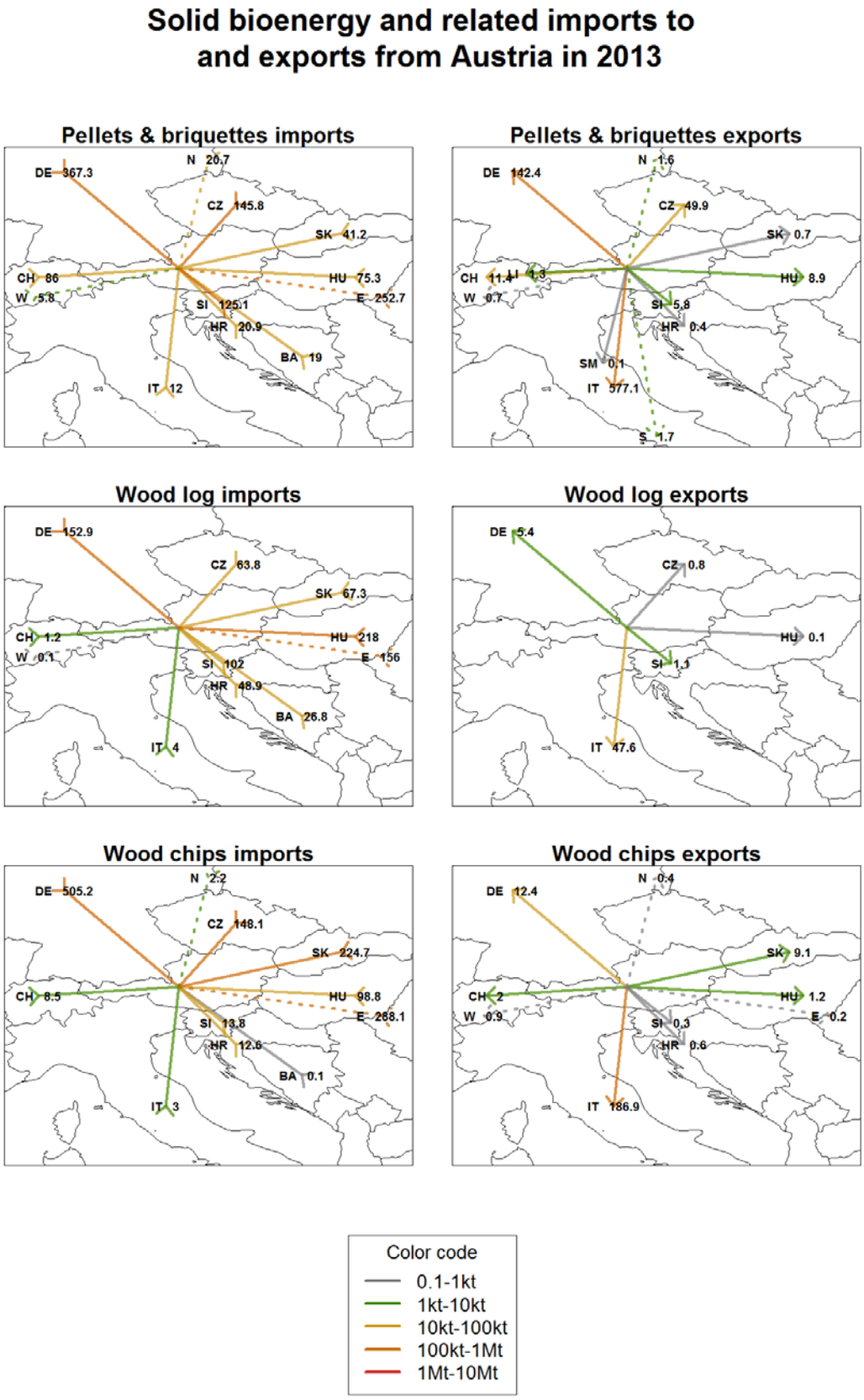

Figure 14: Import and export flows in 2013 to neighbouring countries according to ISO 3166 abbreviation. Summed-up streams to non-neighbouring countries are shown as dashed arrows pointing North (N), East (E), South (S) and West (W). Only trade streams bigger than 99 tonnes are shown. Own illustration based on: (EUROSTAT, 2015b)

Under the codes HS 440121 and HS 440122 the commodity wood chips is listed (coniferous and other "WOOD IN CHIPS OR PARTICLES (EXCL. THOSE OF A KIND USED PRINCIPALLY FOR DYING OR TANNING PURPOSES")) in (EUROSTAT, 2015b). Even though products traded under the discussed codes "mainly refer to high quality chips for pulp and paper production" (Lamers et al., 2012) we assume that an unknown share is used for energy purposes. Net imports of this commodity accounted for about 1100 kt in 2013 which is in the same order of magnitude as fuel wood logs and pellets & briquettes together with the mere difference that no trade is outlined for it in the Austrian Energy Balance (where its part used for energy purposes is listed under wood wastes). On the other hand the comparably vanishing small net imports of 11 kt wood charcoal (HS 440200) are indicated for 2013 in the Austrian Energy Balance while no trade is indicated in (EUROSTAT, 2015b). Trade flows derived from the latter are illustrated in Figure 14.

Highest pellets & briquettes import streams can be found from Germany (367 kt) and from non-direct neighbour countries in the east (253 kt), mainly from Romania (248 kt). Fuel wood log imports on the other hand are mainly directed from Hungary (218 kt) and Germany (153 kt) and from Romania, Ukraine and Bulgaria (together 156 kt). Export of pellets and briquettes go mostly to Italy (577 kt) and back to Germany (142 kt) while a vanishing small amount of fuel wood log is exported to Italy. As already discussed, also wood chips are considered for the assessment of solid bioenergy commodities in this report. However, the authors assume that same trade streams are interesting for energy purposes as well. Highest import streams are directed from Germany (505 kt), Romania and other eastern European Countries (268 kt) and Slovakia (225 kt). The only important destination for Austrian exports is Italy (189 kt).

All in all, Germany was the most important trade partners (with regard to the biomass types considered here) in 2013, followed by Romania, Hungary and the Czech Republic (with 1025 kt, 572 kt, 392 kt and 358 kt). Most important export flows where directed towards Italy (812 kt) and Germany (160 kt). In total, 3.3 Mt imports where facing 1.1 Mt exports in 2013 (including wood chips for material use).

5.2 Liquid and gaseous bioenergy trade

Assessing import and export streams of liquid biofuels for transportation as well as feedstocks in relation to liquid biofuels production is less straightforward than for solid bioenergy carriers due to two main reasons: 1) Liquid biofuels can be either traded mixed with fossil fuels or pure and 2) there is no HS classification by end-users for ethanol and ethanol blends neither for their dedicated feedstocks (e.g. cereals, sugar beet, sugar cane …) and biodiesel feedstocks (e.g. vegetable oils like rapeseed oil, soybean oil, palm oil …).

Biodiesel imports and exports accounted for about 280 kt and 61 kt according to (Statistik Austria, 2015a). In European trade statistics, data is available for 2012 and 2013 for biodiesel (HS 3826). Here imports and exports accounted for about 245 kt and 152 kt with the specific definition "BIODIESEL AND MIXTURES THEREOF, NOT CONTAINING OR CONTAINING < 70% BY WEIGHT OF PETROLEUM OILS OR OILS OBTAINED FROM BITUMINOUS MINERALS". Biggest import streams are directed from Germany (119 kt) followed by Poland with 58 kt. Exporting countries are Slovenia with 46 kt, Italy with 38 kt and back to Germany with 29 kt.

Bioethanol imports and exports are given by the Energy Balance with 44 kt and 42 kt respectively. In European Trade Statistics imports and exports from ethanol in general (HS 2909) is listed with 29 kt and 21 kt respectively. According to its full definition[9] also products not used for energy purposes are listed under HS 2909. Main importer countries are Germany (18 kt) and Denmark with 8 kt. Largest exporting streams are directed towards Germany and Romania with 16 kt and 3 kt.

Other liquid biofuels are imported and exported according to the Energy Balance with 225 kt and 118 kt. They refer to, as already mentioned, biodiesel and bioethanol prior blending.

The National Biofuels Report (Winter, 2014) gives a list of fuels consumed in transportation in 2013 in Austria. The report gives consumed blended biodiesel and bioethanol quantities of about 445 kt and 89 kt respectively which are in line with the sum of net-imports and refinery outputs of biodiesel and bioethanol in the National Energy Balance. Furthermore the report lists 63 kt of pure biodiesel (B100) consumption and 18 kt of vegetable oil fuels.

Under HS 15 all "ANIMAL OR VEGETABLE FATS AND OILS AND THEIR CLEAVAGE PRODUCTS; PREPARED EDIBLE FATS; ANIMAL OR VEGETABLE WAXES" are listed and 410 kt and 278 kt for imports and exports have been reported in European Trade Statistics. Imports are mainly directed from Germany (118 kt) and the Netherlands with 66 kt. Exports are going mainly to Germany (91 kt) and Italy with 38 kt.

For vegetable fats and oils (as well as for animal fats) Supply Balance Sheets exist from national statistics authorities (Statistik Austria, 2015c). Imports and exports according to this statistics are 322 kt and 110 kt respectively for vegetable fats and oils. Furthermore the share of industrial use and other consumptions (food, feed and losses) can be computed based on numbers of the named statistics. Industrial use for vegetable fats and oils accounted for around 51% while self-sufficiency rates of vegetable fats and oils are about 30% since 2008 (for animal fats >100%). According to (Winter, 2014) nine production sites produced biodiesel in Austria mainly based on rape seed (72%), waste cooking oil (17%) and animal fats (11%).

Cereal imports and exports are about 1.9 Mt and 1.1 Mt in 2013 according to European Trade Statistics (HS 10) with main importer countries Hungary (557 kt), Slovakia (399 kt) and Germany (390 kt) and main exporter countries Italy (730 kt) and Germany (177 kt). Supply balance sheets indicate imports and exports of about 2 Mt and 1.8 Mt in 2013. Industrial use for cereals[10] increased from 16% in 2007/08 to 31% in 2012/13 with a total self-sufficiency rate decrease from 109% to 94%. According to (Winter, 2014) one production site produced bioethanol mainly based on maize and corn (55% and 45% respectively)

[9] "ETHERS, ETHER-ALCOHOLS, ETHER-PHENOLS, ETHER-ALCOHOL-PHENOLS, ALCOHOL PEROXIDES, ETHER PEROXIDE, KETONE PEROXIDES, WHETHER OR NOT CHEMICALLY DEFINED, AND THEIR HALOGENATED, SULPHONATED, NITRATED OR NITROSATED DERIVATIVES"

[10] Common wheat, Durum wheat, Rye, Barley, Oats, Grain maize, Triticale, Meslin, Other cereals

Table 5: Liquid biofuel trade for Austria 2013 in kt from National Energy Balance, European trade statistics and National Supply Balance statistics. Based on: (Statistik Austria, 2015a), (EUROSTAT, 2015b), (Statistik Austria, 2015c)[11] and (Winter, 2014)

Austria, 2013, kt	Biodiesel	Bioethanol	Other liquid biofuels	Vegetable oil fuels	Vegetable fats & oils	Rapeseeds	Cereals	Comments
National Energy Balance								
Domestic raw energy production	0	0	278					
Imports	280	44	225					before transesterification?
Exports	61	41	118					mainly pure ethanol
Refinery Input	0	0	301					blended !
Refinery Output	220	82	0					
Gross domestic consumption	224	8	382					= direct+blending
Final energy consumption	443	89	80					"other liquid"
National Biofuels Report								
Consumption, blended	445	89						
Consumption, pure	63			18				~ 80kt "other liquid"
Production, pure	217	176						
International Trade Statistics								
Imports	245	29			410			
Exports	152	21			278			
National Supply Balance *(see 11)*								
Feedstock Imports					341	209	2002	
Feedstock Exports					147	57	1760	
Feedstock domestic Use					529	321	5163	
Feedstock Industrial Use (%)					49	-	31	
Feedstock Net Imports and industrial use thereof					95	-	-	

In Table 5 the previously discussed values for liquid biofuel trade from different statistics are summarised one more time.

Under the category “vegetable fats and oils” for European trade statistics, vegetable oils and animal fats are outlined which are used for energy as well as food and feed purposes. Net-imports calculated based on the National Supply Balance (listed in Table 5 under feedstock for biodiesel) accounted for about 194 kt in 2013. Taking into account the share of industrial use, this results in about 95 kt imported vegetable oil as the upper threshold (if other industrial uses, e.g. for lubricants are not considered) for biodiesel production in 2013 based on this feedstock net-imports. According to (Winter, 2014) about 61 kt biodiesel are produced based on oils and fats and the rest and major part (156 kt) based on rape seed. For rape seed no data for the share of industrial use is indicated in the National Supply Balance Sheets but net-imports of 152 kt and domestic use of 321 kt for all purposes. Weighted average self-sufficiency of the discussed feedstock types (for all purposes) is 50% based on self-sufficiency degree from (Statistik Austria, 2015c) and feedstock utilisation shares for biodiesel production from (Winter, 2014). In contrast for cereals (Statistik Austria, 2015c) indicates a self-sufficiency degree of 94% (for all purposes).

[11] National Supply Balance sheets are used to represent supply and use of agricultural production in general (especially for food and feed but also material and energy use).

In summary, a similar picture can be drawn for import and export streams of liquid biofuels and feedstocks thereof as for solid biofuels: The most important exporting countries to Austria for biodiesel, ethanol and vegetable oils (according to International Trade Statistics) are Germany followed by the Czech Republic with 256 kt and 95 kt respectively in 2013. Most important export destinations are as well Germany, followed by Italy with 135 kt and 77 kt respectively in 2013. In the same year, 684 kt imports faced about 451 kt exports according to International Trade Statistics. In National Energy Balance total imports of 549 kt and exports of 220 kt are indicated. As already discussed, the latter indicates pure liquid biofuel quantities (even though partially traded in blended conditions).

Furthermore, no biomethane trade has been reported by the Austrian certification systems elNa (for transportation) and the biomethane register[12] (for electricity generation).

In (Kalt, 2015) a complete set of biomass streams in Austria is discussed (for feed, material and energy purposes). The following sinks for biomass and sources for bioenergy as secondary product were identified:

Since Austria has a strong wood processing industry, most indirect trade streams are based on waste liquor, bark and cut-offs and other wood processing residues (also processed to wood pellets). According to its definition, also bioenergy from landfills, sewage plants and anaerobic digestion as well as animal rendering, and miscellaneous industry sectors have to be considered as indirect trade of bioenergy based on a high variety of biomass primary used for non-energy purposes. These streams play a minor role compared to the discussed indirect trade streams based on the wood processing industry.

5.3 Transport modes

Freight transport statistics for the year 2012 and the most important bioenergy trade partners for Austria are listed in Table 6 for the year 2012. Next to trucks used for transportation of cargo (in general), also rail transport has a significant role for transportation within Austria and with a low share of 4.6 % the utilisation of inland waterways, mainly the Danube.

Table 6: Freight transport 2012, modal shares. Source : (EUROSTAT, 2015c)

2012 modal shares of total cargo transport km in %	Czech Republic	Germany	Italy	Austria	Romania
Railways	21,8	23,1	14	40,8	24,2
Roads	78,2	64,6	85,9	54,6	53,3
Inland waterways	0,1	12,3	0,1	4,6	22,5

Most important industries with regard to transported tonne km are “not identified goods”, “stones and minerals” followed by “agricultural and forestry products” as well as “wood products, paper and data carriers”. The modal shares for Austria are listed in Table 7.

[12] http://www.biomethanregister.at/de

Table 7: Freight transport in Austria 2013, modal shares by selected economic sector. Source : (EUROSTAT, 2015c)

based on quantities given in t*km	Share of total cargo transport	Share of truck transport	Share of rail transport	Share of waterway transport
Agricultural and forestry products	11%	38%	45%	17%
Wood products, paper and data carriers	9%	54%	46%	0%
Stones and minerals	15%	51%	35%	14%
Not identified goods	15%	9%	90%	1%

It can be assumed, that especially solid bioenergy carriers are imported to a significant extent via rail from Germany and Romania but also partly via the Danube transport route (Matzner, 2013). The same holds for exports to Germany, bioenergy exports to Italy are most likely handled via truck transport.

6 Drivers, barriers & opportunities for international bioenergy trade

Regarding the rapid increase in bioenergy use in recent years, it is apparent that biomass imports played a crucial role in covering the additional demand. According to the National Energy Balance, biomass trade for energy has increased significantly: Imports have surged from about 13 PJ in 2005 to 49 PJ in 2013, and exports from 15 to 21 PJ during the same period. Wood chip trade accounted for additional imports and exports of 31 PJ and 11 PJ respectively in 2013 [13], its split between material use (see Chapter 5.1) and energy use is unknown.

In the National Energy Balance the ratio of domestic production to gross domestic consumption accounts for about 94% in 2013. Net-import of wood chips from the International Trade Data Base was about 11% of the gross domestic production in the same year. Assessments in previous studies (e.g. (Kalt & Kranzl, 2011),(Kalt, 2015)) have shown that indirect wood imports are even more significant than direct net imports of wood recorded in energy statistics. However, it needs to be stressed that while Austria is importing large amounts of raw wood, it is a net exporter of the following wood products: sawnwood, panelboard and paper products (see Kalt & Kranzl, 2011).

Biomass imports are definitely crucial for achieving Austria's energy policy target in the field of biofuels for transport. Considering the 10%-target for renewable energy in the transport sector in 2020 it is expected that imports will continue to be of crucial importance for the achievement of Austria's energy policy targets. Especially biodiesel import streams and vegetable oil imports from Germany and the Netherlands increased lately. As Austria is land-locked it is assumed that these trade streams are originating at international ports in North Europe and therefore contain inter-continentally traded products to. How the decision to cap the liquid biofuels production from food crops to 7% is going to influence these trade streams cannot be estimated yet.

[13] Assumed conversion factor 9.4 GJ/t. Source: (Junginger et al., 2011)

With regard to woody biomass, Austria's neighbouring countries Germany, Italy, Czech Republic, Slovakia and Hungary have been by far the most important trade partners in the recent years (see also Kalt & Kranzl, 2011). However, for 2013, Germany was followed directly by Romania as trade partner for exports to Austria. Still, it is concluded that despite a rapid growth of biomass cross-border trade in recent years, the largest part of imported and exported fuelwood, wood chips, other wood fuels and also wood pellets is still traded over relatively short transport distances, longer transport distances are expected to be managed via inland waterway freight transportation.

Next to domestic consumption for transportation, bioenergy consumption for heating in the industry and services sector and bioenergy production and consumption in the agricultural sector is expected to grow during the current decade. However, with an already relatively high level of bioenergy in gross domestic consumption in Austria (13% in 2013 (Statistik Austria, 2015a)) and an expected decrease of biomass heating in the household sector due to better insulation, no significant growth of solid bioenergy consumption is expected by the authors in the near future. Rather moderate extension plans for bioelectricity production (see Chapter 3.2.3) support this assumption.

Even though Austria is in favour of applying sustainability criteria for forest biomass, national decision makers see existing certification schemes (PEFC, FSC) as sufficient to guarantee the sustainability of woody bioenergy carriers. This is due to concerns about higher bureaucratic and financial burdens for the forest owner of a large amount small and privately owned forests (OECD/IEA, 2014). However, the relatively strong pulp and paper industry asks for e.g. cascaded use of woody biomass[14].

Furthermore, the impact of the additional acquisition of carbon certificates due to non-compliance of the Kyoto targets in the period 2008 – 2012 (see Chapter 1.2) on current discussions about the climate action plan (from 2015 onwards) is unknown at the time of publication of this report.

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8.3 International trade data

International wood trade, imports and exports to and from Austria according to (EUROSTAT, 2015b).

Country name	Used abbreviation	Fuel wood import	Pellets &briquettes imports	Fuel wood exports	Pellets & Briquettes exports	Wood chips import	Stemwood imports	Wood chips export	Stem wood export
BOSNIA AND HERZEGOVINA	BA	267834	190483	0	0	1151	264675	7	0
SWITZERLAND (incl. LI->1994)	CH	11999	860028	0	113573	85481	2063159	20307	57100
CZECH REPUBLIC (CS->1992)	CZ	638259	1458355	8283	499432	1481491	23561297	6	136112
GERMANY (incl DD from 1991)	DE	1529378	3672941	53923	1424161	5052336	15204706	124334	2596765
ARMENIA	E	0	0	0	0	0	0	45	0
AUSTRALIA	E	0	0	0	0	0	0	0	16
AZERBAIJAN	E	0	0	0	0	0	0	0	0
BULGARIA	E	142937	7318	0	37	445734	6905	0	0
CHINA (PEOPLE'S REPUBLIC OF)	E	0	0	0	0	0	6	0	10690
GEORGIA	E	0	0	0	0	0	0	618	0
HONG KONG	E	0	0	0	0	0	0	0	3628
INDONESIA (ID+TP from 77,excl. TP -> 2001)	E	0	0	0	0	0	0	0	904
INDIA	E	0	0	0	0	0	0	0	240
JAPAN	E	0	0	0	3	0	0	0	0
KAZAKHSTAN	E	0	0	0	0	0	0	67	0
LEBANON	E	0	0	0	0	0	0	0	0
MOLDOVA, REPUBLIC OF	E	0	0	0	0	0	0	1	0
FORMER YUGOSLAV REPUBLIC OF MACEDONIA	E	0	0	0	0	0	0	237	0
QATAR	E	0	0	0	3	0	0	676	0
ROMANIA	E	804988	2476598	405	493	2434628	503364	175	420
RUSSIAN FEDERATION (RUSSIA)	E	209	11311	0	6	0	4680	0	0
THAILAND	E	0	2	0	2	0	0	0	0
TURKEY	E	0	0	0	0	0	334	188	0
UKRAINE	E	594832	31165	0	0	215	3149185	114	213
BELARUS (BELORUSSIA)	E	17455	846	0	0	0	25780	0	0
CYPRUS	E	0	0	0	0	0	22728	0	0
CROATIA	HR	488869	208979	0	3566	126418	563839	5898	586
HUNGARY	HU	2180467	753429	1363	88856	988174	6580673	12174	128474
ITALY	IT	39796	120213	476245	5770571	29974	1563679	1869445	2611928
KOSOVO (EU data from 01/06/05 ex CS)	KO	0	0	0	0	0	234	124	0
LIECHTENSTEIN	LI	0	464	0	12550	230	6630	0	800
MONTENEGRO	ME	0	0	15	18	0	0	0	0
DENMARK	N	0	0	0	0	0	379	0	4365
UNITED KINGDOM	N	0	83	0	73	0	279	1584	0
LATVIA	N	0	4563	1	0	21628	2354	1	0
NETHERLANDS	N	96	124418	0	15212	391	1187	2660	457
NORWAY (incl.SJ excl.1995,1996)	N	0	0	0	245	0	0	0	0
POLAND	N	0	40339	3	11	0	1923329	225	6369
SWEDEN	N	348	1121	0	0	0	0	0	4727
ESTONIA	N	0	1461	0	0	0	14097	0	0
FINLAND	N	0	0	0	0	0	3125	0	0
LITHUANIA	N	0	35367	0	0	0	502	0	0
SERBIA (EU data from 01/06/05 ex CS)	RS	3691	31958	0	0	0	21157	224	400
GREECE	S	0	0	0	17455	0	0	8	37077
MALTA	S	0	0	0	0	0	0	0	1111
SOUTH AFRICA (incl. NA ->1989)	S	0	0	0	0	0	0	37	0
SLOVENIA	SI	1020488	1250848	11171	58118	137740	5795685	3009	905962
SLOVAKIA	SK	672515	412301	31	6777	2246577	7898027	90763	659
SAN MARINO	SM	0	0	0	1490	0	0	0	0
BELGIUM (and LUXBG -> 1998)	W	0	5218	698	2430	0	3745	570	1208
CANADA	W	0	4	0	0	4	4152	0	0
SPAIN	W	662	0	0	10	0	7415	0	0
FRANCE	W	418	443	0	4696	34	872543	8247	13642
IRELAND	W	0	410	0	0	0	613	0	342
CAYMAN ISLANDS	W	0	0	179	0	0	0	0	0
MEXICO	W	1	0	0	0	0	0	0	337
UNITED STATES	W	0	51736	0	0	186	1842	0	240
LUXEMBOURG	W	0	0	0	0	0	4740	0	0
PANAMA (excl. CANAL ->1980)	W	0	0	0	0	0	218	0	0
PORTUGAL	W	0	0	0	0	0	0	0	0