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Sustainable energy in the Danube region as an integral part of the EU 2020 strategy

Analysis of NREAPs, NEEAPs and renewable energy progress reports of Danube region countries

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Abstract

Title: Sustainable energy in Danube region an integral part of EU 2020 strategy

This report contributes to the Bioenergy Nexus cluster of Joint Research Centre (JRC) initiative "Scientific Support to the Danube Strategy" in the framework of European Union Strategy for the Danube region (EUSDR). In line with Article 4 and Article 22 of the Renewable Energy Directive Danube region countries have submitted to the European Commission and to the Energy Community their national renewable energy action plans (NREAPs) and biennial progress reports. Danube region countries have submitted also to European Commission and to the Energy Community their national energy efficiency action plans (NEEAPs) as required by the Energy Efficiency Directives.

This report presents a detailed view of the energy mix of the Danube region countries for the period 1990-2013 as well as energy efficiency and renewable energy indicators as reported for year 2013 together with the expected progress up to 2020. In particular, the report focuses on the current and projected development of bioenergy in Danube region countries providing a deep analysis of its deployment in the three main sectors of Electricity, Heating/Cooling and Transport.

'Bioenergy has significant potential to mitigate GHGs if resources are sustainably developed and efficient technologies are applied'

IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, 2011

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Manjola BANJA designed, coordinated and authored the report with principal contributors Fabio MONFORTI-FERRARIO (Energy Efficiency and Renewables Unit) that contributed to the section of energy policy in Danube region and reviewing the report; Katalin BÓDIS (Energy Efficiency and Renewables Unit) that performed GIS mapping of energy indicators in the region; Marina ECONOMIDOU (Energy Efficiency and Renewables Unit) that contributed in the section of energy efficiency.

This report was co-authored with other colleagues: Jean-François DALLEMAND (Energy Efficiency and Renewables Unit), Nicolae SCARLAT (Energy Efficiency and Renewables Unit) and Hrvoje MEDARAC (Knowledge for Energy Union Unit), have all provided valuable inputs; and Albana KONA (Energy Efficiency and Renewables Unit) has contributed to the Covenant of Mayors in Danube region section.

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Executive Summary

Policy context: Encouraging sustainable energy through the development of renewable energy and implementation of energy efficiency measures, the European Union Strategy for the Danube Region (EUSDR) [1] is an integral part of the EU 2020 energy and climate strategy and it is associated with targets by 2020: 20% of gross final energy consumption (GFEC) from renewable energy sources; 20% reduction of greenhouse gases compared with 1990 level; and driving up energy efficiency by 20 %. Presenting the history of the EU 2020 strategy, this report brings together and assesses the data reported by the Danube region countries (both EU and non EU)[1] in their main policy documents submitted respectively to the European Commission (EC) and Energy Community (EnC) as required by the Directive on Renewable Energy (RED) [2] and the Directive on Energy Efficiency (EED) [3].

Key conclusion: Harmonisation of renewable energy and energy efficiency policy framework in the Danube macro region countries is pushing towards an integrated and low carbon energy market broadly used one-third of the EU[2] energy market. Both primary energy production and gross inland consumption have decreased in many Danube region countries in the 23-year time period since 1990. The drop of GHG emissions in the Danube region by 38% during these 23 years is driven by the decrease of the energy intensity of the economy and change in the energy mix landscape. Despite these changes, solid fuels still remain the main primary energy source in Danube region, holding the highest share in both primary energy production and gross inland consumption. Even if net imports of primary energy sources have decreased by a factor of three since 1990, the Danube region countries are still dependent on imports on Russia, which plays a main role in gas and oil markets. The use of energy in the Danube region has become more efficient in almost all sectors, except in the transport and services sectors. The avoided final energy consumption over these 23 years together with final energy consumption of renewables is increasingly competing with other sources in the Danube region, overcoming altogether in 2013 the final energy consumption of any other single primary energy source in the Danube region. The renewable energy share in the gross final energy consumption in the Danube region increased to 13.9% in 2013: 5.7% of renewable electricity, 7.1% of renewable heat/cold and 1.1% of biofuels. Renewable electricity offered a substantial contribution to the reduction of GHG emissions, accounting for almost two-third of the total net GHG emissions saved due to renewable energy use in the region in 2013. In this context, bioenergy is already a major source of renewable energy in the Danube region, and will continue playing an important role in the shift towards sustainable energy, although the shall be accompanied with a change in the renewable energy portfolio putting emphasis on new technologies such as wind, solar PV and heat pumps.

Quick guide: In the ***First Part***, this report presents an overview of the renewables and energy efficiency policy framework in the countries of the Danube region as well as a short description of local sustainable energy policies. The ***Second Part*** shows energy trends in the Danube region in terms of Primary Energy Production (PEP), Gross Inland Consumption (GIC) of Energy, Gross Final Energy

[1] The division of Danube region countries in the EU and non EU refers to the status that these countries had in the time this report was written. Hereafter the expression "EU Danube countries" will refer to nine EU Member States (Germany, Austria, Bulgaria, Croatia, the Czech Republic, Hungary, Slovakia, Slovenia and Romania) whereas "EnC Danube countries" will refer to five Energy Community Contracting Parties (Serbia, Montenegro, Moldova, Ukraine and Bosnia & Herzegovina).
[2] EU refers to EU28.

Consumption (GFEC), imports, energy dependence and energy intensity of the economy over the period 1990-2013. An overview of current energy savings in terms of Final and Primary Energy Consumption (FEC and PEC), energy efficiency 2020 targets and measures as well as renewable energy development in the Danube region countries and the projections up to 2020 are presented in the ***Third Part***. The energy efficiency analysis covers four main end user sectors: industry, residential, services and transport and six primary energy sources: solid fuels, total petroleum, gas, electrical energy, heat and renewables. An analysis of the 2020 energy efficiency targets and measures in each Danube region country is also presented in this part. The renewable analysis includes three sectors (electricity, heating/cooling and transport), together with all renewable energy technologies and sources. The graphs and maps in this part of the report are based on national energy efficiency action plans [17] [23], national renewable energy action plans [15] [18] and renewable energy progress reports [16] [19] submitted to the European Commission in 2011, 2013 and 2015 by the EU countries of the Danube region and those submitted to the Energy Community in 2015 and 2016 by its Contracting Parties[3]. The ***Fourth Part*** of this report describes the current level of bioenergy development in the Danube region as well as projections up to 2020. The relevant graphs and maps are based on national renewable energy action plans and renewable energy progress reports submitted to the European Commission in 2011, 2013 and 2015 by the EU countries concerned and those submitted to the Energy Community in 2015 by EnC countries. The ***Fifth Part*** provides an overview of the GHG emissions in Danube region countries between 1990 and 2012 and GHG emission savings in these countries between 2012 and 2013. This includes energy and transport-related GHG emissions in the Danube region as well as the GHG emissions of the public power and heating sectors. To explore the raw data used in this report, an ***Electronic Annex*** in excel format available for download[4] is prepared.

Related and future work: This report provides an update of a JRC report on bioenergy development in the Danube region [4], being part of a set of reports on renewable energy development in the EU ([5], [6], [7], [8], [9], [10], [11] and [12]). Future updates will be based on progress reports on sustainable energy development in the Danube region in line with the requirements of the Directive on Renewable Energy and Energy Efficiency Directive.

[3] The analysis presented in this report includes the contribution of Bosnia and Herzegovina that has submitted to Energy Community Secretariat in May 2016 its national renewable energy action plan.

[4] http://iet.jrc.ec.europa.eu/remea/sustainable-energy-danube-region

Main findings

The demand for energy in the Danube region has been shaped by political changes and the restructuring of the economy that has taken place in some countries of the region since 1990. Between 1990 and 2013 half of the Danube region countries reduced apace both their primary energy consumption and gross inland consumption.

The energy demand of the Danube region declined immediately after 1990 due to the political changes that took place in Central Eastern Europe and Western Balkan countries. Five years after 1990, the main energy indicators in Danube region – Primary Energy Production (PEP) and Gross Inland Consumption of Energy (GIC) – were lower by 25% and 36%, respectively and fell further up to 2000. Over these 23 years, half of the Danube region countries decreased apace both their primary and gross inland energy consumption.

All Danube region countries decreased the energy intensity of their economy between 1990 and 2013. Nevertheless, in the Danube region the energy intensity of the economy of EnC countries is still higher compared with the energy intensity of the economy of EU countries.

Energy intensity of the Danube region's economy[5] has dropped from 1990 level in both the EU and EnC countries. The EnC countries of the region experienced a steeper decline in absolute Gross Inland Consumption over these 23 years, along with a decrease in Gross Domestic Product in Purchasing Power Parity (GDP in PPP). In 2013, the energy intensity in the Danube EnC countries was still almost three times higher compared with the EU Danube countries and more than double of the average energy intensity of the Danube region as a whole. During the same period, GIC per capita dropped steeper in the Danube EnC countries compared with the decrease in EU countries of the region.

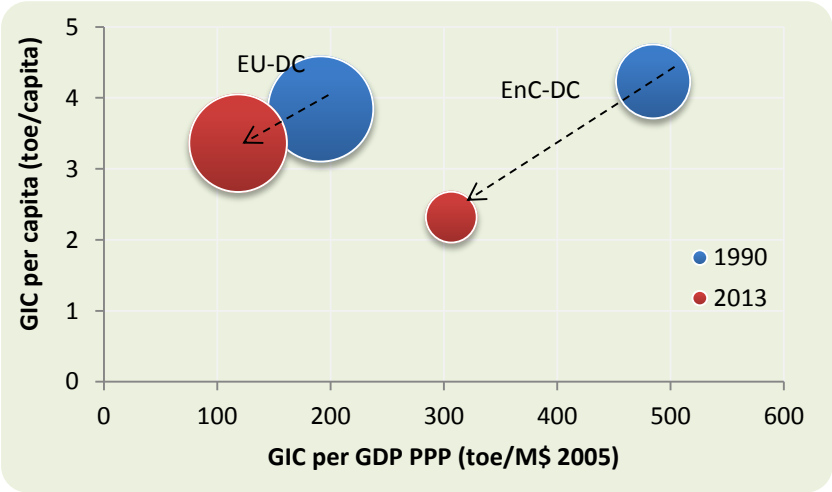


Figure 1. Gross Inland Consumption per capita and energy intensity in Danube region, 1990-2013[6,7]

[5] See Glossary for the definition
[6] Raw data can be found at the Tables A.1, A 2, A.5 and A 6 in the Electronic Annex of this report.
[7] The size of bubbles indicates Gross Inland Consumption in EU and EnC countries of Danube region respectively for 1990 and 2013.

All Danube region countries are dependent on the import of primary energy sources. Russia is the main provider of gas and oil in the Danube region. Solid fuels and nuclear accounted for 60% of primary energy production in Danube region in 2013. In the same year together with oil & oil products, solid fuels held the biggest share (more than 54%) in gross inland consumption.

Energy dependence[8] in the Danube region in 2013 was 49.3%, lower than the EU average of 53%, but still higher than in 1990 (46.5%). Imports from Russia were dominating the scene, counting for a share of more than 60% of the overall gas imports, and for 35% of oil-related imports.

The overall final energy consumption in the Danube region decreased during these 23 years but consumption evolved along different patterns in end-user sectors , in particular in the transport sector where indeed a small increase has been evidenced. It is expected that the main impact of the 2020 energy efficiency targets in the Danube countries will consist in the change of final energy consumption relative contributions within the building sector, arising from the decrease in residential energy consumption and increase in services.

Final energy consumption in the Danube region decreased by 25% over these 23 years, mainly due to the restructuring of the industry sector whose relative contribution dropped to 30% from 44% in 1990. Within five years after 1990, the building sector (services and residential) became the largest consumer of energy in the Danube region, a contribution that reached almost 42% in 2013. Absolute energy comsumption in the transport sector has been on a rising trend, albeit very moderate, over this 23 years period. Since 2000, the services sector has started to follow the pace of the transport sector, while the residential sector continued its falling trend, showing that the relative contribution of these two sectors within building sector is changing, increasing in services and decreasing in residential, a change that is expected to be supported by the 2020 energy efficiency targets in the Danube region countries.

The breakdown of the final energy consumption at the energy primary source level in the Danube region has changed mainly for industry and buildings, while almost no changes took place in the portfolio of the transport sector. The industry sector contributed the most in the decrease of GHG emissions in the region, whereas the transport sector's contribution remained almost unchanged since 1990.

Fossil fuels (solid fuels, oil & oil products and gas) are dominant in the end-use sectors in the Danube region, but their contribution changed over the 23 year time period; in 1990 the share of fossil fuels in the final energy consumption within the building sector was above 60% whereas in 2013 this share had decreased up to 51%. In 1990, the industry sector saw a contribution of more than 71% from fossil fuels, which in 2013 was just above 58%. Gas provided 22.1% of the final energy consumed in the Danube region in 1990, a contribution that increased to 38.2% in 2013. In the transport sector, petroleum products kept their dominant role all along this period, decreasing their relative contribution from 96.3% in 1990 to 90% in 2013. Due to structural changes, the industry sector emitted in 2013 almost 35% less GHG whereas the transport sector only 1.5% less.

[8] See Glossary for the definition

Between 1990 and 2013, the avoided final consumption of energy together with renewables is increasingly competing with the final energy consumption of any other single primary energy source in the Danube region.

Over the 23 years of this analysis, the Danube region avoided 142.5 Mtoe in terms of final energy consumption; a reduction equivalent to almost 34% of final energy consumption in the Danube region in 2013. The avoided final energy consumption over these 23 years together with the final energy consumption of renewables overcomes in 2013 the final energy consumption of any other single primary energy source in the Danube region.

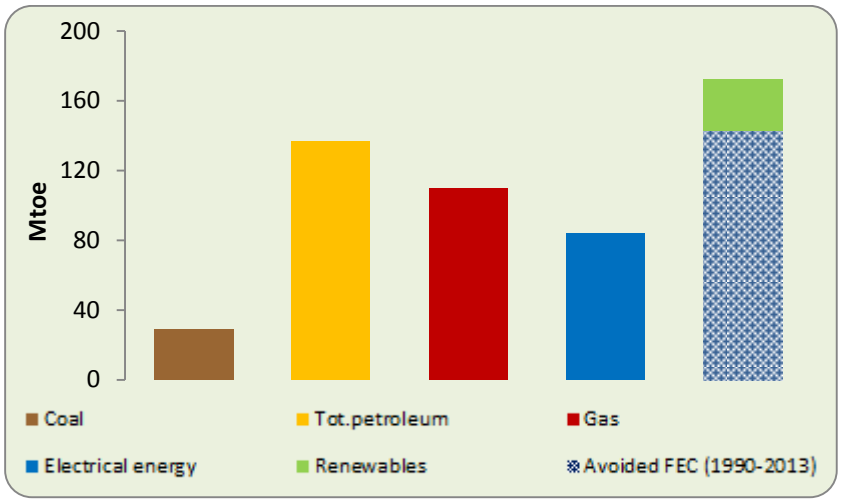


Figure 2. Final energy consumption (FEC) of each primary source in 2013 and the avoided FEC (1990-2013)[9]

During the period 1990-2013, greenhouse gases (GHG) emissions[10] decreased in the Danube region due to the decrease of energy intensity of the economy and the change in the energy mix portfolio. The energy sector remained the main source of GHG in the Danube region.

Over a 23 year period, GHG emissions in the Danube region decreased by more than 42%, reaching 1848 Mt CO_2 eq from 3209 Mt CO_2 eq. The main factors behind this drop are the decrease of the energy intensity of the economy and change in the energy mix composition towards a larger renewable energy share. This is reflected in the decreasing trend of energy-related GHG emissions intensity. Nevertheless, energy remains the main source of GHG emissions in the Danube region with a contribution of almost 80% in relative terms.

Renewable energy in gross final energy consumption in the Danube region stood at 13.9% in 2013. This included 5.7% renewable electricity, 7.1% renewable heat/cold and 1.1% biofuels in transport sector. When excluding electricity consumption, renewable energy in the Danube region amounted to 3.5% in the industry sector, 18.5% in the building sector and 3.9% in the transport sector.

[9] The avoided Final Energy Consumption in Danube region over period 1990-2013.

[10] The analysis of Danube region GHG emissions and GHG emission savings due to renewable energy covers period 1990-2013 because the detailed data for year 2013 are not yet available. For year 2013 only a short description of the total GHG emissions and GHG emission savings due to renewable energy for each Danube region country is provided.

The final renewable energy in the Danube region totalled 58.5 Mtoe and was mainly used for heating purposes, with this sector accounting for half of final renewable energy consumption in 2013. Almost 10 % of renewable heat in the region was consumed in the EnC countries. The contribution of the final renewable energy to the Gross Final Energy Consumption (GFEC) was found to be 13.4% in 2013, projected to increase to 18.7 % in 2020. The EnC countries of the region are expected to double their absolute contribution to the final renewable energy by 2020.

Renewable electricity was the main source of GHG emission savings in all Danube region countries, accounting in 2013 for almost two-thirds of the total net GHG emissions saved due to renewable energy use in the region.

The development of renewable energy in the Danube region resulted in an absolute figure of 276.7 Mt CO_2 eq emission savings in 2013, equal to 36% of the EU's net GHG emission savings arising from renewables in the same year. Meanwhile the greenhouse gas emission savings due to renewable energy use increased by 7.4% (+19 Mt CO2 eq). During the same period greenhouse gas emissions in Danube region decreased by 6.8% (-134 Mt CO2 eq) in which the savings of emissions due to renewable energy counted for 14.2%. The role of renewable energy in the final reduction of greenhouse gas emissions in the region since 1990 accounted for 11.5% in 2012 and 13% in 2013. The composition of final renewable energy determines not only the absolute GHG savings but also how much GHG is saved from one unit of renewable energy. The shift towards new renewable energy technologies brought a higher average GHG savings intensity in the EU countries of the region, at 5.1 t CO_2 eq/ toe, compared to 2.6 t CO_2 eq/toe the GHG savings intensity in the EnC countries.

Bioenergy is a major source of renewable energy in Danube region mainly in the form of solid biomass mostly used for heating/cooling purposes. By 2020 bioenergy could account for 59% of final renewable energy consumption in the Danube region.

Bioenergy was the main component of the overall renewable energy portfolio in Danube region in year 2013 with a contribution of almost 63%. Although bioelectricity was the bioenergy type that developed faster with an average annual growth rate of 10.5%, three-quarters of the total bioenergy fed the heating sector. The contribution of the EnC countries in the region accounted for 11% on the final bioenergy.

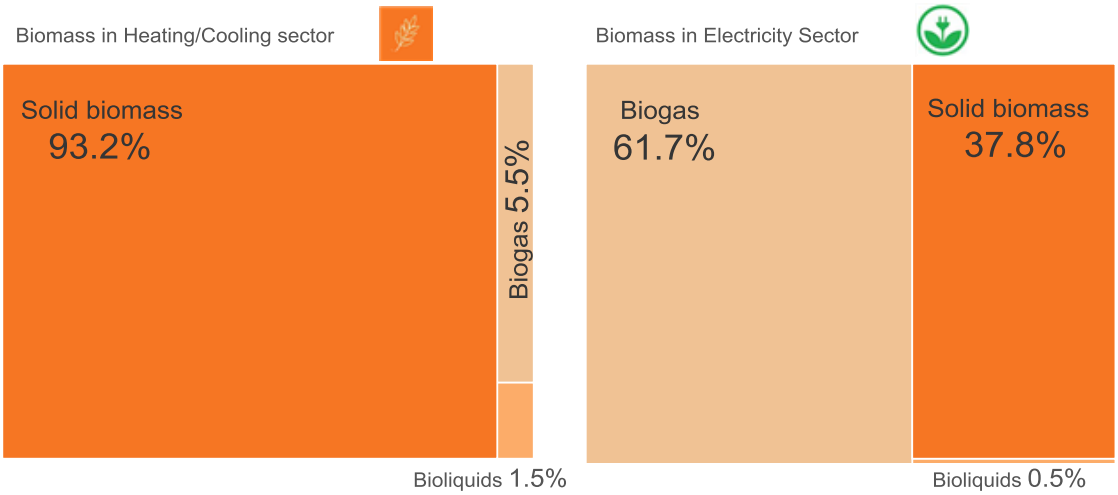


Figure 3. Shares of biomass sources in Danube region Bioheat (left) and Bioelectricity (right), 2013

More than 85% of renewable heat in Danube region was in the form of solid biomass. Solid biomass was the main resource used in bioheat, with more than 93% in contribution, and together with the contribution of the same biomass category in electricity sector, covers more than three-quarters of the bioenergy needs in the area . Biogas in the electricity sector developed so fast that in 2013 it already exceeded the expected 2020 plan by +4%.

In 2020, bioenergy is expected to increase its absolute contribution to 48.6 Mtoe, with its relative share in final renewable energy decreasing being just below 60%. The development of bioenergy use in the transport sector is expected to have the fastest increase up to 2020 (average 11.9% annually) covering almost one-fifth of the final bioenergy expected use. Solid biomass will still remain the main source of bioenergy in the Danube region in 2020 but its contribution will decrease in relative terms, covering just over two-thirds of the final bioenergy expected consumption. The EnC countries are expected to increase their contribution to the Danube region final bioenergy in year 2020 by 18%.

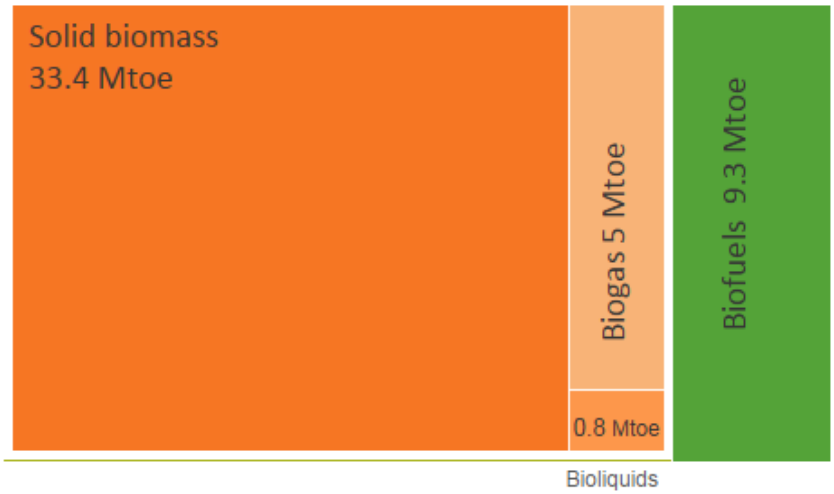


Figure 4. Expected breakdown of bioenergy by sub category, 2020

Forest biomass is the main source of biomass supply for energy purposes in Danube region. Danube region will continue to import biomass to fulfil the demand for energy. Almost one-fifth of biomass supply in 2020 is expected to be used in cogeneration.

In 2013 Danube region supplied[11] for its electricity and heating/cooling needs 36.3 Mtoe (1519 PJ) of biomass when it consumes[12] in these two sectors 32.4 Mtoe (1358 PJ). The main form of biomass supply in Danube region was forestry (almost 70%). Domestic agriculture by-products contributed with just over one-fifth of domestic biomass used for electricity and heating/cooling whereas waste and other (including energy crops) remained respectively at 6.7% and 2% of contribution. To fulfil the needs of the electricity and heating/cooling sectors, Danube region imported in 2013 almost 5% (1694 ktoe) of total biomass supplied in these two sectors. In 2020 the available domestic supply of biomass for energy in Danube region is expected to increase by nearly 38% from 2013 level reaching 47.6 Mtoe whereas the expected energy consumption originated from biomass in these sectors will be 39.2 Mtoe increasing by nearly 21%.

[11] "Biomass supply" refers to primary energy in raw biomass material. The primary energy of biomass is defined as the energy content of the primary input fuels to the energy conversion process.
[12] "Biomass consumption" refers to total biomass consumed for energy production including domestic and imported biomass.

Introduction

The current European Union (EU) policy framework related to renewables and energy efficiency stems from the 2020 energy and climate strategy [13], associated with a reduction in energy consumption and a gradual shift from fossil fuels to renewable energy sources.

The European Council endorsed the European Union Strategy for the Danube Region (EUSDR) in June 2011. The overarching goal of achieving a 'low-carbon economy' is integral to the European Union (EU) 2020 energy and climate strategy. The policy framework covering the Danube region is evolving and up to now includes the Renewable Energy Directive and Energy Efficiency Directive. Within this framework, binding targets are set for developing renewable energies and reducing greenhouse gas (GHG) emissions, and the latest legislation incorporates the promotion of energy efficiency.

The area covered by the EUSDR extends from the Black Forest (Germany) to the Black Sea (Romania-Ukraine-Moldova). The 14 countries concerned [14] cover 99.8 % of the physical Danube basin and include nine EU Member States (Germany, Austria, Bulgaria, Croatia, the Czech Republic, Hungary, Slovakia, Slovenia and Romania), three accession countries (Serbia, Bosnia & Herzegovina, and Montenegro) and two neighborhood countries (Moldova and Ukraine). Energy developments in Hungary, Austria, Romania, Serbia and Slovakia have major effects on the region since more than 90 % of their territory is part of the Danube area while countries like Germany and Ukraine are less involved because just 16.8 % and 5.4 % of their territory respectively is part of the Danube region.

Since 2010, the EU Countries of Danube region have submitted their national renewable energy action plans (NREAPs) to the European Commission as part of the requirements of the Renewable Energy Directive and starting from 2011 [15] they have submitted every two years their progress reports on renewable energy development, so far covering the periods 2009-10 and 2011-12 [16] .

In regards to Energy Efficiency Directive, the EU countries of the Danube region must draw up their national energy efficiency action plans (NEEAPs) every three-year and report on the progress achieved towards their national energy efficiency targets on an annual basis. The latest NEEAPs of the EU countries in the Danube region were due in April 2014 [17].

Several countries in South East Europe (SEE) are Contracting Parties to the Energy Community: the Western Balkan countries (Albania, Bosnia and Herzegovina, Kosovo, Former Republic of Macedonia, Montenegro and Serbia) as well as Moldova and Ukraine. The Energy Community Treaty (EnCT) has adopted the relevant Acquis Communautaire in the energy field to create a regional market compatible with the internal market of the EU to set up regulatory structures and liberalize the energy markets in Contracting Parties.

The Ministerial Council of the Energy Community adopted in October 2012 the EU's Renewable Energy Directive 2009/28/EC and the Contracting Parties committed to binding renewable energy targets by 2020 and to prepare NREAPs outlining the scenarios and policies they intend to pursue to meet these binding targets.

In consequence, following the adoption of the Renewable Energy Directive (2009/28/EC) by Ministerial Council Decision 2012/04/MC, the Energy Community's Contracting Parties submitted their NREAPs during 2013-2014 [18]. In accordance with Article 15 of the Ministerial Council Decision, the Contracting Parties have submitted their first progress reports covering the period 2012-2013 [19].

Based on three Ministerial Council decisions in 2009, 2010 and 2011, three directives [20], [21], [22] in energy efficiency became also part of Energy Community acquis. The Article 14 of Directive 2006/32/EU require the Energy Community's Contract Parties to prepare their NEEAPs [23] and submit them to the Energy Community Secretariat every three year up to 2016.

Box 1. The European Union Strategy for Danube Region (EUSDR) - history

The European Union Strategy for Danube Region (EUSDR) dates back in time of the political and diplomatic initiative named "Danube Cooperation Process (DCP)". The DCP, in which all Danube countries and some European Union candidate countries participated, was established based on an initiative launched by Austria, Romania, European Commission and the Stability Pact in June 2001. The DCP aimed to "give a new political impetus to the strengthening and development of multilateral relations among Danube countries". Within the framework of DCP in June 2008 it was launched an initiative (originally by Austria and Romania) recommending to the European Commission to prepare a macro-regional Strategy for the Danube Region. The European Union Council mandated the European Commission on 18 June 2009 to devise a Common Comprehensive Strategy for the Danube Region. In January 2010, the European Commission started a public consultation on the European Union Strategy for the Danube Region. The Bucharest Summit on 8 November 2010 provided the opportunity for the final debate on the future Danube Strategy adopting the final text of the European Union Strategy for the Danube Region as well as the accompanying Action Plan. On 3 February 2011 Commissioner Johannes Hahn designates the Priority Area Coordinators and on 13 April 2011 the adoption of the Council Conclusions by the European Union Council for General Affairs took place. The European Council formally endorsed the Strategy under the Hungarian EU Presidency on 24 June 2011.

Summarized from different European Commission documents.

Danube region as integral part of EU 2020 policy framework

Pushing towards a low-carbon economy the EU 2020 energy and climate strategy is involving both national and regional energy markets. In Danube macro region this impact is shaped through the European Union's support strategy and is becoming more concrete by the implementation of Directive 2009/28/EC and Energy Efficiency Directives. Implementation of energy policies in regional level is country-specific and the overall harmonisation of these policies is bringing new opportunities in the region for practical and effective contributions to the EU energy and climate strategy.

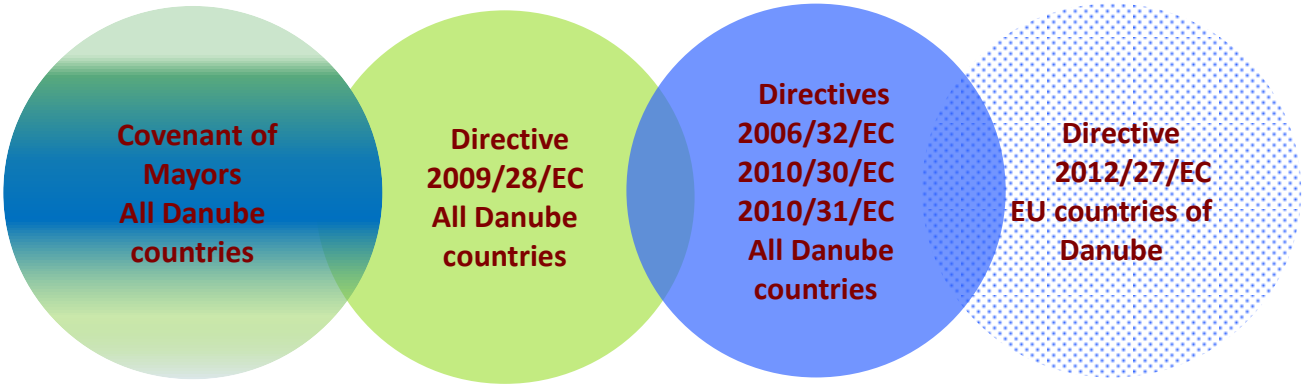


Figure 1 . Energy Policy Framework in place in Danube region[13]

Renewable energy policy framework

The Renewable Energy Directive (2009/28/EC) sets a general binding target for the European Union to derive 20% of its final energy from renewable sources by 2020, promoting the development of renewable energy technologies/sources in support of the objective to reduce greenhouse gas emissions in the EU by 2020 compared with 1990 levels. These targets reflect an equal level of ambition for EU Member States and Energy Community Contracting Parties, taking account of their starting points.

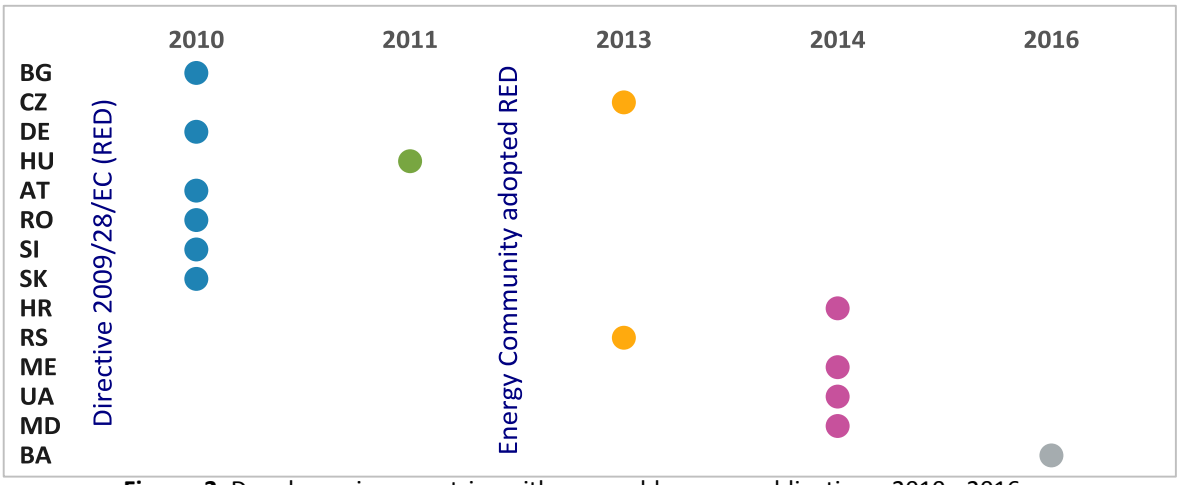


Figure 2. Danube region countries with renewable energy obligations, 2010 - 2016

[13] Ranking of different types of energy policy framework in this figure is done only for schematic purpose. It is not linked with the time these policies are launched or implemented.

The Directive requires each Danube region country to adopt a national renewable energy action plan (NREAP) establishing the pathways for developing renewable energy sources including bioenergy. Progress towards reaching the goals set in each EU country's NREAP has to be reported every two years starting from 2011 and from 2014 for EnC countries of the region. Article 22(1) (a) of Directive 2009/28/EC requires the countries concerned to report on the progress made in taking measures to support the growth or development of renewable energy in their territory, taking into account the indicative trajectory for achieving the 2020 overall RES share target as planned in their NREAPs.

Danube region countries' progress reports refer to support schemes (Article 22(1)(b)) that they are using to promote renewable energy, administrative procedures (Article 22(1)(e)) to remove regulatory and non-regulatory barriers to the development of renewable energy, and measures taken to ensure the transmission and distribution of electricity produced from renewable energy sources and to improve the framework or rules for bearing and sharing costs (Article (22)(1)(f)) related to grid connection and reinforcement. The renewable energy policy support in Danube region is mainly focussed on the production of renewable energy through different types of instruments.

Table 1. Renewable energy support schemes in Danube region countries

Danube region country	RES - E	RES - HC	RES – T
BG	FIT	Subsidy	Quota
CZ	FIT and FIP	Subsidy	Quota + tax exempt
DE	FIT	Loans	Quota
HR	FIT and loans	In progress	Quota
HU	FIT	Subsidy	Quota
AT	FIT (Tariff subsidies)	Flat rate Subsidy	Quota
RO	Green certificates	Grants	Capital grants
SI	Grant incentive	Subsidies	Quota + tax exempt
SK	FIT	In progress	Quota + reduced excise
RS	FIT	In progress	Quota
ME	FIT	Interest-free loans	-
UA	Green tariff & tax granting	Tax exempt	Tax exempt
MD	FIT	Planned	Planned
BA	FIT and FIP	-	Blending Obligations

More than 170 support measures (economic, financial, regulatory, administrative, support) for the development of renewable energy are in place in Danube region, equal to more than 30% of existing measures in the EU. One- fifth of these measures are in force in EnC countries of Danube region. In Germany more than half of support measures are targeted at electricity production [24].

Feed-in tariff support schemes for renewable electricity are in place in seven countries of Danube region (BG, DE, HU, SK, RS, ME and MD)[14]. This type of support guarantees access to the grid and long-term prices at which power producers can sell energy generated from renewable sources into the grid or thermal system. In Bulgaria feed-in tariffs are combined with a preferential price in long terms agreement.

[14] See Abbreviation section to get the full country names.

Box 2. Eligibility period in renewable electricity support schemes in EU countries of Danube region

AT	Biomass and biogas technologies A given operator of a plant fuelled by solid or liquid biomass or biogas is entitled to the purchase of all electricity he exports to the grid and to the payment of the tariff applicable on the date on which the contract is concluded, for 15 years starting on the date on which the plant is put into operation (§ 16 par. 1 no. 1 ÖSG 2012). Other plants A given operator of any other renewable energy plant is entitled the purchase of electricity exported and to the payment of the tariff applicable on the date on which the contract is concluded, for 13 years starting on the date on which the plant is put into operation (§ 16 par. 1 no. 2 ÖSG 2012).
BG	The period of the obligation to purchase and dispatch electricity depends on the subsidy agreement between the plant operator and the grid operator. The term of such an agreement is 20 years for plants using geothermal energy, biomass and solar energy, 15 years for plants using biogas and hydropower and 12 years for wind power plants (art. 31 par. 2 ERSA).
HR	The contracts have duration of 14 years (Art. 18 § 1 Tariff system for RES-E).
CZ	The tariff for all eligible technologies is statutorily guaranteed for 20 years. Hydro-energy plants are exempt from this rule, as their tariff will be paid for 30 years (Regulation No. 347/2012).
DE	The tariff payment period is usually 20 years plus the year in which the system or plant was put into operation (§ 22 EEG 2014).
HU	The eligibility period is set out by the Hungarian Energy and Public Utility Regulatory Authority according to provisions in the implementing decrees and shall not exceed the pay-off period of the plant (§§ 11 3) and 4) Act No. LXXXVI of 2007).
SK	The obligation period for all eligible technologies is limited to 15 years and starts in the year in which a plant is put into operation or in the year of reconstruction or upgrade. Operators of plants whose total installed capacity does not exceed 500 kW are entitled to the payment of the price of electricity to cover grid losses during the entire lifetime of the plant (§ 3 par. 6 RES Act).
SI	The uniform annual price is guaranteed for the period agreed on by both contracting parties and laid down in the contract. The price is based on the reference price applicable on the day on which the contract is concluded and will be paid for no more than 15 years (§ 9 RS 37/2009).

Extracted from www.res-legal.eu , May 2016 [25]

Czech Republic's feed-in tariffs support schemes go together with green bonuses which depend on the type of renewable energy source used to produce electricity. Romania applies the system of green certificates through long-term contracts (15 years). In Croatia the production of electricity from renewable energy sources is promoted through a combination of feed-in tariff and loans.

Direct support to renewable energy is the dominant type of support in Austria in which tariff subsidies are used to support the development of renewables.

Green tariffs are the main support scheme for renewables in Ukraine with a green tariff index (GTI) of 2.3 for biogas and biomass power plants, whereas grant incentives reflecting the market situation are in place in Slovenia. In Slovenia tariff subsidies are used to support the development of renewables. Serbia use investment subsidies (capital grants or loans (for biogas power plants) and feed-in tariffs for biomass power plants whereas in Moldova biogas and biomass are eligible for feed-in tariffs support schemes.

Renewable energy in heating/cooling sector is supported through different schemes in Danube region countries. In Bulgaria the scheme for promoting renewable heat is the subsidy exemption from property tax for building owners. Subsidy is also used as a support scheme for renewable energy in heating/cooling in Czech Republic but a subsidy cohesion programme for 2014-2020 has not yet been adopted there.

In Germany the Renewable Energies Heat Act, the Market Incentive Programme and low-interest loans support renewable heating/cooling and numerous support schemes are available for renewable heat at Land level. In Croatia a support scheme for renewable heating from biomass is in progress.

In Austria under the Environmental Assistance special investment incentives are in place for biomass heating plants. At the federal level, the support differs according to technology: usually, a flat rate of support is carefully calculated. Another option being a standard reimbursement rate amounting to 25 % of the environment-related investment costs possibly to be increased through awards to a maximum of 30 %. Several regional schemes complement in different ways the federal framework.

Hungary provides subsidies in the form of non-refundable aid to entities willing to act for satisfying local heat and cooling demand from renewable energy sources Eligible applicants include businesses, bodies funded from the governmental budget, not-for profit organizations and other economic entities.

In Romania the support scheme implies the granting of a non-refundable financing from structural funds for the performance of investments. In the case of application of State aid rules, financial support shall be exclusively granted to economic operators for the performance of initial investments in order to use RES for the production of electricity and thermal energy. Without State aid rules applied, co-financing shall be granted to local authorities and intercommunity development associations. Since 2010 incentives have been updated and extended under the “Green House” Programme to natural persons and legal persons without economic activity.

Slovenia supports the renewable energy sources for heating/cooling through soft loans and subsidies. Financial support for RES used in heating and cooling is provided within different streams targeting specific technologies: solar collectors and wood biomass boilers in households, wood biomass and geothermal district heating systems, wood biomass boiler equipment and, since 2010, heat pumps for the preparation of sanitary hot water and heating in households. Moreover, an Energy advice network – EnSVet (Energetsko Svetovanje) – has been organized.

In Slovakia, financial measures are planned for supporting the use of RES in households, including the installation of biomass boilers and heat pumps. Specific programs are also planned to support the development of RES based heating and cooling in public building and in all new or deeply renovated buildings.

In Republic of Serbia incentives to renewable H&C are generally available inside more general programs, such as the Fund Green for Growth or the Fund for Development of the Republic of Serbia and take the form of both credit lines, loans or subsides. Serbia has also planned to issue a specific Decree/Recommendation on Incentives for the production of heat from RES.

In Montenegro interest-free credit lines have been opened for installation of solar-thermal systems and heating systems fuelled by pellets or briquettes for households.

In Ukraine, the Tax and Customs Codes contain provisions that envisage tax exemption of company profits earned from combined electricity and heat production and/or production of heat using biological fuel types

Box 3. Renewable electricity legislation and policy in Bosnia and Herzegovina

Bosnia & Herzegovina is committed to an ambitious national binding target of 40 percent share of renewable energy sources in the gross final energy consumption by 2020. Bosnia & Herzegovina consists of two separate political entities, each with different energy laws and regulations. In the state level the implementation concerns the directives are coordinated by the Ministry of Foreign Trade and Economic Relations (MOFTER). Since 2012, Bosnia & Herzegovina is using Feed-in fixed tariffs, which is under entity jurisdiction. The Federation of Bosnia & Herzegovina (FBiH) adopted in 2013 the Law on Electricity of the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of BiH, issue no. 66/13) and the Law on the Use of Renewable Energy Sources and Efficient Cogeneration (Official Gazette of the FBiH, issues no. 70/13 and 05/14). Pursuant to Article 22 of this law the Federal Government enacted a Regulation on Incentives to Production of Electricity from Renewable Sources and Efficient Cogeneration and Determining of Incentives, which serves as a basis for implementation of incentives for the use of RES electric power in the FBiH. In Republika Srpska (RS), this scheme is based on the Law on Renewable Energy Sources and Efficient Cogeneration (Official Gazette of RS, issues no. 39/13, 108/13 and 79/15), and the Renewable Energy Action Plan. Until the incentives system Operator is established, administrative, financial, and other operations of the system of incentives for production of energy using RES and efficient cogeneration will be the responsibility of Elektroprivreda RS. Both entities, RS and the FBiH promote electricity generated from renewable sources through feed-in tariffs or feed-in premiums. Support is granted for 15 years in RS and 12 years in FBiH. Feed-in premium is offered in case of production for personal use or free market trade (RS). The support includes also the advantages in connecting to the grid, priority in the dispatching system, guaranteed takeover of produced electric power by the grid. In RS incentive may be given to any electric power producer who produces energy in a new efficient cogeneration plant of 10 MWe max. In addition, premium may be given to a producer with a plant with installed power between 10 MW and 30 MW. Currently, there is no state level incentives programme for the use of RES energy in transport. In the FBiH and RS Regulation on Types, Contents, and Quality of Biofuel in Motor Vehicle Fuels is in force (Official Gazette of the FBiH, issue no. 26/08 and Official Gazette of RS, issue no. 82/07) are in force. Nevertheless at the moment, both FBiH and RS do not have any incentive schemes for biofuels that meet the criteria from Article 21(2) of Directive 2009/28/EC. At the moment, Bosnia & Herzegovina does not have any incentive programmes for the use of energy generated from biomass, except feed-in tariffs on entity level for stimulating use of biomass in production of electric power.

Summarized from: Bosnia & Herzegovina NREAP, June 2016 [18]

The main support scheme for renewable energy in transport sector in the Danube region is a quota system which is a non-financial measure linked to a specific target. For biofuels, the quota represents the obligatory minimum share of these fuels in petrol and diesel.

In Czech Republic the main incentive for renewable energy use in transport is a quota system and biofuels are exempt from consumption tax. In Croatia the main promotion scheme in the field of renewable energy in transport is a biofuel quota obligation. Additionally, the state provides a subsidy for producers of biofuels as well as a tax regulation mechanism to encourage the usage of biofuels.

Renewable fuels in Germany are mainly supported by a quota system and through fiscal regulation. In Slovakia the biofuels sustainability criteria have been in place since 2011. The main incentive for renewable energy use in transport in Slovenia is a quota system and certain tax exemptions.

In Romania the program "Stimulation of regional development by investing in agricultural and forestry product processing in order to obtain nonagricultural products" aims at stimulating Romanian economic operators to initiate and/or extend biofuels production, thus contributing to fulfilling the national obligations regarding biofuels promotion. At the same time, the scheme shall lead to the creation of jobs and the identification of new markets for the agricultural production. The scheme offers non-refundable support (capital grants) for investments to enterprises of ant size which perform initial investments in tangible and/or intangible assets in the food industry for primary processing of forestry products and production of biofuels.

In Slovakia, fuel producers and the seller are required to offer, in petrol and diesel fuel for transport purposes, a minimum quantity of biofuels (or other renewable fuels) increasing with time (3.9% in 2012) and complying with sustainability criterion (as of 2011). Reduced excise duty is granted to all companies releasing biofuels for consumption in the tax territory.

In Ukraine, the Tax and Customs Codes of Ukraine contain provisions that envisage the tax exemption of biofuel producers' profits earned from biofuel sales.

Box 4. Serbia's new Energy Law – in line with EU's Third Energy Package

Serbia's new Energy Law enacted on 29 December 2014 seeks to boost investments in the renewable energy sector making thus a step forward in harmonizing Serbian law with the relevant EU framework in the energy sector. The new Energy Law prepared in collaboration with Energy Community implements further the EU's Third Energy Package removing a number of obstacles present in the previous energy law improving the Serbian energy sector's regulatory framework. Certain provisions of the new Energy Law also aim at ensuring a better functioning of the process for issuing construction permits for energy assets, with a view to bring the Serbian energy law framework in line with important changes introduced by the recent amendments to the Serbian Law on Planning and Construction. The new Energy Law defines an one-year from the day of its entry into force for the adoption of the necessary secondary legislation. In the meantime, the existing bylaws and regulations will continue to apply. New entries in renewables legal framework include:

- ✓ Grid connection – state owned grid operators are obliged to o issue a power-of-attorney to investors to finance and construct the grid connection infrastructure in their name and on their behalf;
- ✓ Improved bankability of power purchase agreements (PPA) for wind farms and other renewables;
- ✓ Sets the framework for "acceptable contracts" and "guarantees that entire output from renewable sources will be bought;
- ✓ Off-taker - Improved rules regarding the status of a preliminary privileged power producer of electricity;

Summarized from "Official Gazette of the RS", No. 145/2014 [28]

Energy efficiency policy framework

The European Union policy framework forms a key driver for the implementation of a wide range of energy efficiency policies at national level. In 2006, the Directive 2006/32/EC on energy end-use efficiency and energy services (ESD) was adopted with the aim to enhance energy end-use efficiency across the EU and establish the right conditions for the development of energy services at national level. The ESD, inter-alia, required Member States to set energy savings targets of 9% for the year 2016 and remove existing market barriers by providing improved frameworks and incentives. Under the Directive, the EU countries of the Danube region submitted information on their targets, progress and efforts made in the so-called national energy efficiency action plans (NEEAPs), which were due in 2007, 2011 and 2014.

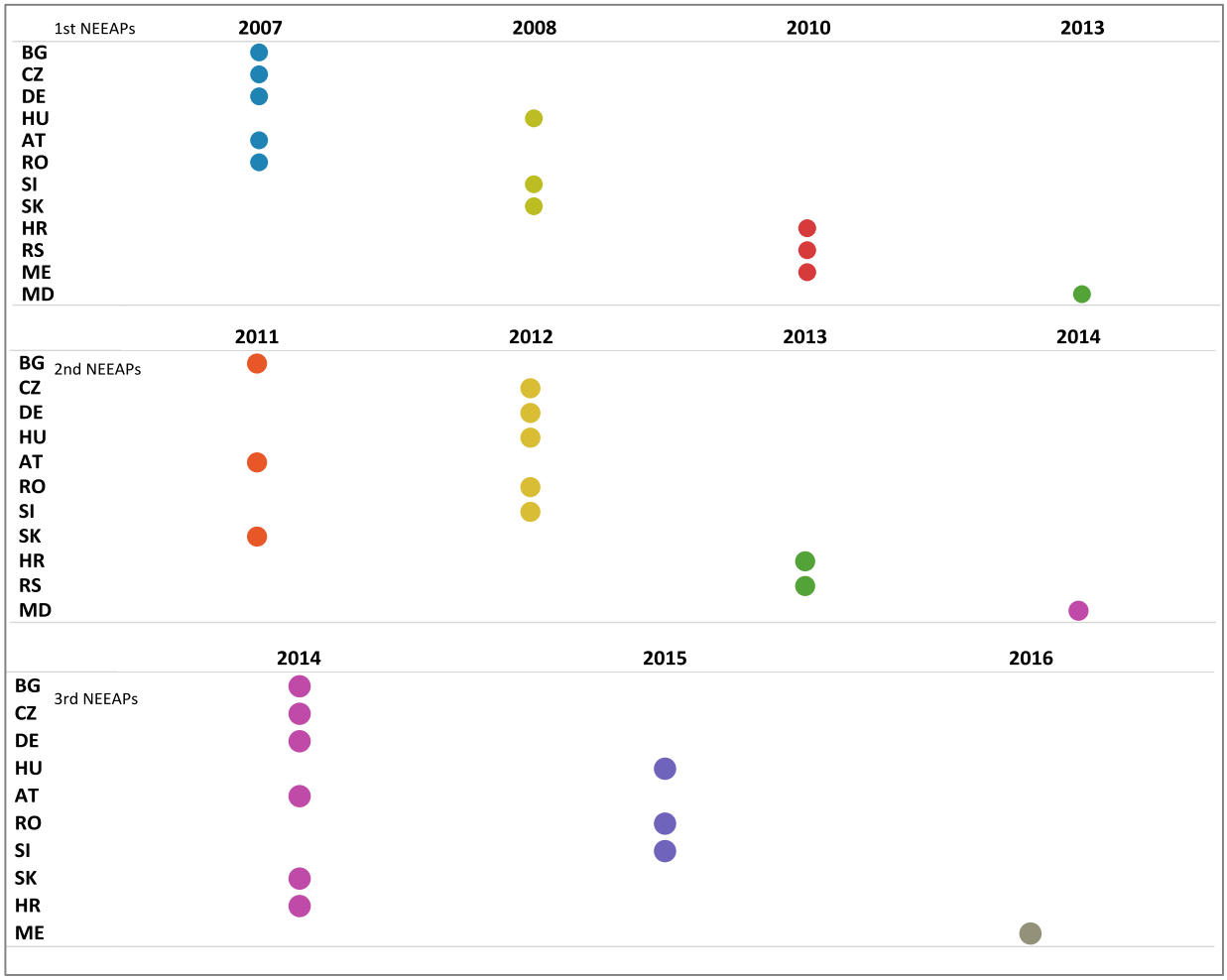


Figure 3. Danube region countries with energy efficiency obligations, 2007 - 2016

The ESD, together with the Cogeneration Directive (2004/8/EC), was repealed in 2012 with the introduction of the Directive 2012/27/EU on energy efficiency (EED). The EED, which is a key part of the EU's overall climate and energy legislative package, requires EU Member States to set indicative national energy efficiency targets for the year 2020 and legally binding measures that improve energy efficiency at all stages of the energy chain from production to final consumption. As part of the implementation of the EED, Member States are required to implement energy efficiency obligation schemes, renovate 3% of their central government building stock, establish building renovation

strategies etc. With proper implementation of the EED requirements, the EU can reach its 20% energy efficiency target by 2020, which equates to a reduction of 370 Mtoe compared to the baseline consumption for 2020 and leads to EU primary energy consumption of 1483 Mtoe in 2020.

In compliance with the Directive's requirements, the EU countries of the Danube region submitted their first NEEAPs under the EED in 2014, replacing the final NEEAP reporting requirements of the ESD due to the overlapping timeframe[15]. The next NEEAPs under the EED are due in 2017 and 2020.

With regards to the building sector, the Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) has been the main policy driver for reducing energy use for heating, cooling, ventilation, hot water and lighting associated with buildings. The EPBD required the application of a methodological framework for calculating the energy performance of buildings. It has allowed the EU countries of the Danube region to set minimum energy performance requirements for both new and existing buildings and establish energy performance certification schemes with the aim to inform the potential buyer or tenant about the energy class of their building. Following a revision in 2010, the recast Directive (2010/31/EU) introduced a calculation methodology to increase the stringency of minimum energy performance requirements and push them towards cost-optimal levels. With the recast EPBD, a gradual convergence to nearly zero energy buildings is also expected as a result of the obligation for new buildings to be of nearly zero energy levels by 2020[16].

[15] The first NEEAPs under the EED submitted in 2014 requested information on the progress of the ESD targets.
[16] For public sector and buildings, this requirement is set for 2018.

Box 5. Renewable heat policy in buildings in EU countries of Danube region

AT	The implementation of building related measures mainly lies in local competence. However, the conclusion of the Article 15a B-VG Agreement between the Austrian federal and state governments introduced 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 according to Article 15a B-VG Agreement in their respective housing support laws. While RE measures are promoted in industrial and commercial buildings mainly at federal level through the Umweltförderungsgesetz (UFG – Environmental Aid Act), the development of the legislation and RE measures for residential buildings falls largely within the sphere of competence of the federal states. The support of RE measures in the building sector is provided as part of the 'Environmental Assistance in Austria' (UFI) field of action (§ 24 par. 1 UFG). The promotion under UFI is directed primarily towards Austrian companies and is in the form of financial support for investments. The amount of support is set according to the applied technology and shall not exceed 50 % of environment related investment costs. (§ 27 UFG) The applications are to be assessed by a commission on matters of environmental assistance in Austria. (§ 28 UFG). Since the implementation of measures in the residential building sector lies in local competence, the conditions of eligibility and the amount of support in the respective federal states are regulated differently. The promotion of measures takes place exclusively in the form of financial support for investments (most of them one-off, outright investment subsidies).
BG	Obligations related to the use of renewable sources to produce energy in buildings are defined in Article 15 par. 2 no. 1 of the Energy Efficiency Act. According to this regulation, any investment project for a new building with total floor coverage of over 1000 m² must comply with the possibilities of using decentralized systems for the use of renewable energy. This requirement is also part of the new ERSA, stating that in the construction of new or reconstruction, major renovation, overhaul or refurbishing of existing buildings, installations will become operational for production of energy from renewable sources where this is technically feasible and economically viable (art. 20 par. 1 ERSA). In these buildings, at least 15 percent of the total heating and cooling needed for the building shall have to be produced from renewable sources (art. 20 par. 2 ERSA). In the preparation of investment projects for new buildings or reconstruction, major renovation, overhaul or refurbishing of existing buildings, the possibilities of using renewable energy to demonstrate the technical feasibility and economic viability shall be mandatorily analysed. The analysis of the possibilities for using energy from renewable sources is part of the evaluation indicators of annual energy consumption in the building (art. 20 par. 3 ERSA). In case of implementation of projects for modernization of production processes in small and medium enterprises, the energy efficiency measures shall be combined with the commissioning into operation of plants for production of heating and cooling from renewable sources for meeting the technological needs of the enterprise (art. 20 par. 4 ERSA). Concerning public buildings, these obligations came into effect on 1 January 2012; for all other buildings they will become effective from 31 December 2014.
CZ	Act No. 406/2000 Coll., on energy management and Regulation No. 148/2007 Coll., on energy performance of buildings stipulate that each new building and any building over 1,000 m² undergoing a major refurbishment has to undergo a renewable energy use assessment. The amendment of Act No. 406/2000 Coll. envisages that if renewable energy sources are technically, economically and environmentally feasible, they will have to be incorporated in all new or refurbished buildings - starting from 2015 this will apply to all other buildings.
HU	For new building projects Decree No. 7/2006 and its amending Decree No. 24/2014 recommend the consideration of using renewable energy sources for decentralised energy supply in the planning process (§ 5 par. (1) Decree No. 7/2006). Nevertheless, this is a recommendation rather than obligation. Furthermore, in case of energy renovation of existing buildings, the buildings need to fulfil energy efficiency requirements after the renovation as outlined in annex 1 part I. and V.of Decree No. 7/2006 (§§ 6 par. (1) (2) Decree No. 7/2006). Further, the NREAP envisages obligations for minimum levels of renewable energy in new and newly refurbished buildings. However, according to the Hungarian Energy and Public Utility Regulatory Authority such obligations have not been in place so far.

DE	Owners of new buildings and buildings under renovation are obliged to use a particular share of heat and cooling produced from renewable energy. Public buildings are bound by this obligation as well and moreover, are required in terms of profound renovation to fulfil the quota (also buildings of the public hand constructed and run abroad). The quota applies to buildings with a floor space > 50m² that is heated or cooled with the exceptions of e.g. buildings for animal breeding, underground buildings, religious buildings etc. The quota for heat and cooling produced from renewable energy varies according to renewable energy source and whether it is a new building or a renovation of an existing building. Moreover, the quota can be fulfilled if more buildings belong together by ownership meeting the obligation in sum or certain compensation measures apply. The obligations for new buildings and renovation are fulfilled if the heat and cooling demand is covered by 50% from installations using waste heat or CHP as well as via energy savings or district heating/cooling. Currently, no regulations exist for the mandatory use of renewable energy in existing buildings on the federal level, but federal states can adopt such regulations, e.g. Baden-Württemberg. Exemption from the obligation is granted on grounds of technical barriers, contradiction with other tasks and obligations, indebtedness or preservation order (Erneuerbare-Energien-Wärmegesetz- EEWärmeG).
RO	Building obligations for RES-H are neither specified nor announced for the future. However, for new building projects with a surface of more than 1000 m² Law No. 372/2005 recommends the consideration of using renewable energy sources for decentralised energy supply in the planning process (art. 10 Law No. 372/2005). Nevertheless, this is a recommendation rather than obligation.
SK	The law on energy performance of buildings (Act No. 555/2005) is the main instrument to reduce GHG emissions from buildings. The amending Act No. 300/2012 provided a regulation on Energy Performance Certificates (EPC) for buildings. The legislative changes took effect as of January 2013, and they set standards for the compilation of EPCs in order to improve their quality. Energy certification is required for buildings or separate parts of a building that are sold or rented to a new tenant, as well as all newly constructed buildings or all buildings that have undergone major renovation (§ 5 par. 2 a Act No. 555/2005).
SI	The terms set in RS 52/2010 are used when constructing new buildings or when reconstructing buildings or one of its elements if this reconstruction affects at least 25 percent of the thermal envelope, and the change is technically possible. (§ 2 of RS 52/2010). Exceptions are listed in § 3 of RS 52/2010. These rules govern, when it comes to RES-H, that hot water is normally provided using solar panels or alternative installations using RES (§ 13 RS 52/2010). Furthermore it sets out (§ 16 RS 52/2010) that the energy efficiency of buildings is achieved if, in addition to the requirements of § 7 RS 52/2010 (which sets the energy efficiency technical parameters that buildings need to meet): Either at least 25 % of total energy consumption for the operation of facilities in a building is provided with the use of renewable energy in the building itself or that the proportion of final energy consumption for heating and cooling and hot water production in one of the following ways: (i) at least 25 % of solar radiation; (ii) at least 30 % of gaseous biomass; (iii) at least 50 % of solid biomass; (iv) at least 70 % from geothermal energy; (v) at least 50 % of the heat of the environment; (vi) at least 50 % of CHP plants with high efficiency. The heating and cooling of the building is supplied to at least 50 % from energy-efficient installations. Irrespective of the requirements stated above, single-family houses meet the criteria when using at least 6 m2 (bright areas) of solar collectors with an annual yield of 500 kWh.

Extracted from www.res-legal.eu [25]

In December 2009 and subsequently in September 2010 and October 2011 the Energy Community Ministerial Council decided to adopt and include selected key energy efficiency legislation as part of the Energy Community *acquis*:

- ✓ Directive 2006/32/EC on energy end-use efficiency and energy services;
- ✓ Directive 2010/31/EU on the energy performance of buildings;
- ✓ Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products

The Energy Community is presently preparing for the adoption of Directive 2012/27/EU that once adopted it will have a significant impact on energy efficiency compared to status quo. Montenegro and Serbia have submitted already their 1st and 2nd NEEAPs. Following their later accession to the Treaty, Moldova adopted its 1st NEEAP in 2013, and Ukraine developed final draft of its 1st NEEAP in 2013.

Box 6. Montenegro new Law on the Efficient Use of Energy

Montenegro as a candidate for EU accession and a member of the Energy Community is committed to the implementation of the EU *acquis communautaire* in energy field. Due to these commitments the Parliament of Montenegro adopted on 16 December 2014 the new Law on Efficient Use of Energy, which was published in the "*Official Gazette of Montenegro*" 57/2014 on 26 December 2014 and on 21 January 2015 (correction). The new Law regulates relations in the field of efficient use of energy at final consumption side, obligations related to the adoption and implementation of programs and plans for energy efficiency improvement at national and local level and at the level of energy entities and consumers, implementation of plans, public authorizations and responsibilities for development and implementation of the energy efficiency policy as well as all other energy efficiency measures and stakeholders responsible for their implementation. The Law does not regulate energy efficiency in facilities for energy production, transformation, transmission and distribution. The Energy Law regulates energy efficiency on supply side. The adoption of the new Law will enable a more efficient implementation and further development of by-laws in the field of energy efficiency, particularly regulations in the area of energy efficiency in buildings. The new Law is harmonized with the European legal framework, as follows:

- ✓ Energy efficiency in buildings - Directive 2010/31/EC on the energy performance of buildings;
- ✓ Energy labelling of energy related products - Directive 2010/30/EU on energy labelling of energy related products and the implementing regulations for different groups of products;
- ✓ Eco-design of products that affect energy consumption - Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy-related products and the implementing measures for different groups of products.

In June 2016 Montenegro submitted to EnC Secretariat its 3rd Energy Efficiency Action Plan.

Source: Energy Community

Local sustainable energy policy framework (Covenant of Mayors)[17]

To endorse and support the efforts of local authorities in the implementation of sustainable energy policies a unique bottom-up movement, the Covenant of Mayors (CoM) [29], that is in line with the EU climate and energy package was launched after the EU 2020 strategy. The CoM offers a new model of multi-level governance where the common objectives set at the national level are enacted at the local level allowing the signatories to develop actions adapted to their particular settings. The CoM signatories commit to meet and even exceed by 2020 the EU 20% CO_2 reduction objective through the increase of energy efficiency and the development of renewable energy sources.

The Energy Efficiency Directive specifically acknowledges the CoM initiative and the role of local governments in achieving significant energy savings. In middle of October 2015 the new integrated CoM for climate and energy was launched by the European Commission in order to help cities develop synergies between mitigation and adaptation. The initiative is part of the EU's Energy Union priority of reducing emissions while moderating energy demand and investing in renewable energies and energy efficiency. The new initiative will also contribute to make Europe more climate-resilient, in line with the EU Strategy on adaptation to climate change.

This movement has an increasing number of signatories, almost six thousands, for a total of ca. 208 million of inhabitants. More than 4500 local authorities have submitted an Sustainable Energy Action Plan (SEAP) for a total of ca. 166 million inhabitants. Out of these, 122 signatories, representing 3% of the signatories with SEAP, have submitted a monitoring report including a monitoring emission inventory for a total ca. 11 million inhabitants.

Although the minimum commitment was to reduce the current emissions by 20% by 2020, CoM signatories who have already submitted the progress report, i.e. a monitoring inventory reached an overall reduction of 23% between baseline and monitoring emission inventories. Compared to the baseline inventories, final energy consumptions have dropped by 14% in absolute value mainly due to energy efficiency improvements in buildings for heating and cooling (26% of decrease) and more efficient transportation (energy consumption in transport sector decrease by 9% from baseline to monitoring years).

In CoM signatories the final energy consumption using renewable sources has increased around 2.5 times from baseline to monitoring emission inventories, while the share of renewables on final energy consumption increased from 3% to 14% through the increase of electricity production from renewables (79% in absolute values), increase of renewable sources in district heating using (around five times), doubling of local decentralized heat production from renewables (solar, geothermal, biomass) and increase of biomass in transport [30].

In Danube region the number of Covenant of Mayors (CoM) signatories reached 445 as for December 2015 with a population of 46.2 thousand people representing almost 19% of total population of the region. More than 86% of CoM signatories in the Danube region have submitted a Sustainable Energy Action Plan representing a total of 37.5 thousand people.

[17] This report doesn't provide any quantitative analysis of Sustainable Energy Action Plans of Danube region cities.

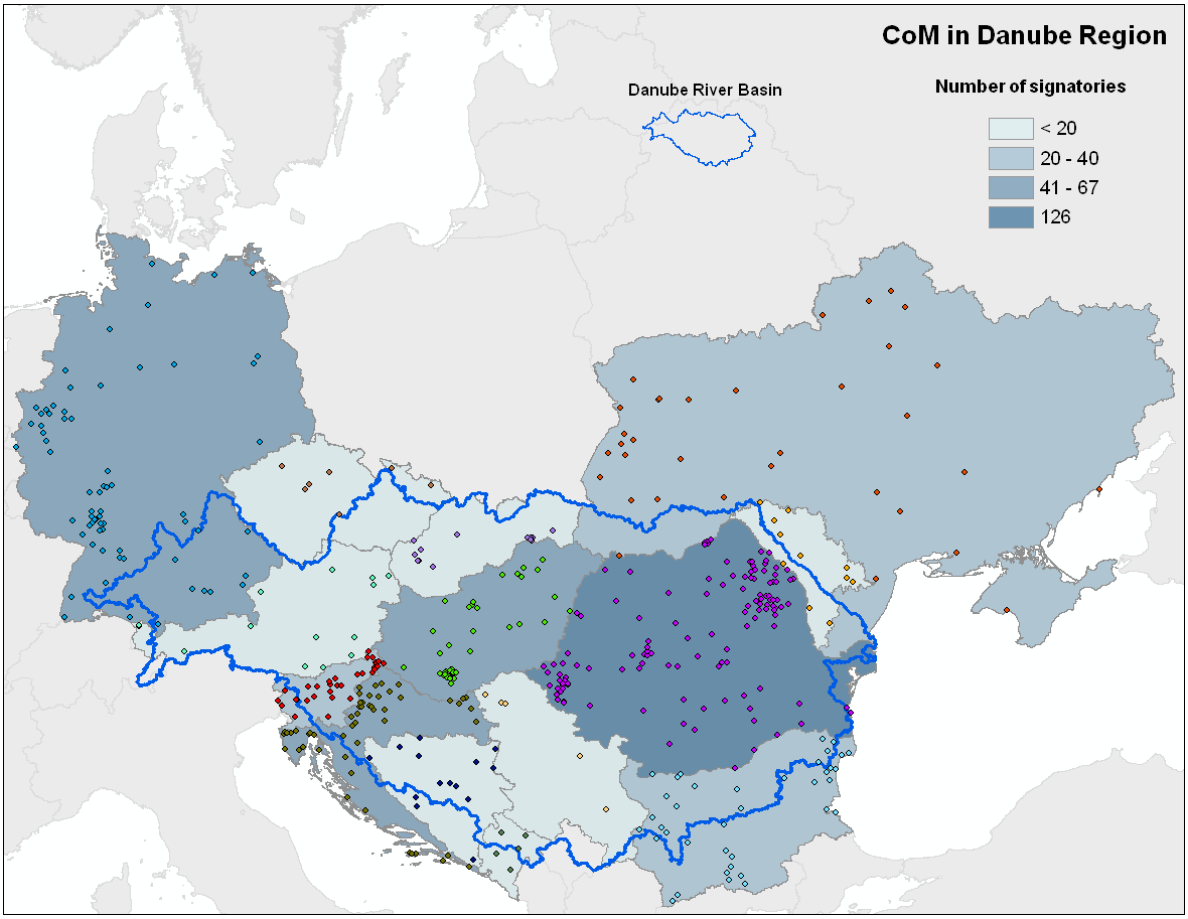


Figure 4. Covenant of Mayors signatories as from January 2016

CoM has reached its full spreading potential in densely population areas in Danube region countries as in Serbia (100%), Slovakia (90%), Ukraine (51%), Bosnia and Herzegovina (79%) and Germany (48%). Intermediate and thinly populated areas signatories with a submitted SEAP represent more than 65% of the total number of signatories in the CoM. Nevertheless, signatories categorized as small - medium towns (population under 50.000 inhabitants) account for a limited share of energy consumption, 7% overall [32].

Box 7. Biomass best practices from Danube region Covenant of Mayors signatories

Saalfelden (AT) - Connection of buildings to the biomass district heating;
Klagenfurt am Wörthersee (AT) - Construction of a new biomass plant, 35 MW heating power to be installed.
Munich (DE) - Use of biomass (conversion into bio-methane and feeding the gas networks);
Stuttgart (DE) - the main share of renewable heating systems is biomass (1.4% of the residential market). Currently, the technical and economic feasibility of building a biomass-fired CHP base load plant is under investigation to be installed in the site of the power plant Stuttgart-Gaisburg;
Burgas (BG) - Building of cogeneration power using biomass;
Varna (BG) - Construction of district plant using biomass;
Berghin Hall (RO) - Upgrade the individual heating systems of houses from stoves to biomass heating systems.
Ighiu (RO)- Upgrade of the individual building heating systems from stoves to biomass heating systems;
Jeseník (CZ)- Utilization of biomass in central heat supply for cogeneration of heat and electricity.

Source: Covenant of Mayors [13]

Box 8. Benchmarks of excellence in some Danube region cities

NIŠ (RS)	**Field of action:** Local heat/cold production (2010 – 2020). **Description:** Shifting from fossil fuels to renewables in district heating system will significantly decrease CO_2 emissions. Total capacity of mazut boiler rooms is around 40 MW, and they produce, during heating season around 32000 MWh of heat. CO2 emission is also reduced by converting heat production to the less polluting fuel. **CO_2 reduction**: 14326.8 t CO2 eq/yr, **Energy savings:** 7680 MWh/yr, **RES produced:** 24320 MWh/yr
ZAGREB (HR)	**Field of action:** Municipal buildings, equipment/facilities, **Implementation timeframe:** 2011 – 2018. **Description:** All buildings in the Health Care Sector (hospitals, health centres, retirement homes) by 2018 should install solar collectors for the preparation of hot water. **CO_2 reduction:** 2077 t CO2 eq/yr, **RES produced:** 9344 MWh/yr.
JUDENBURG (AT)	**Field of action:** Local heat/cold production, **Implementation timeframe:** 2012 – 2014. **Description:** City of Judenburg will build a heat distribution system with a connected load of 14 MW. A pipeline 18 km-long infrastructure will transmit the biomass heat at the pulp mill Pöls. All community and all houses formerly heated with gas have already been connected. The entire project was in 2015 awarded the Austrian Climate Protection Award. The line is about to be extended up to Knittelfeld. **CO_2 reduction:** 4082 t CO2 eq/yr, **RES produced:** 15120 MWh/yr
VOZNESENSK (UA)	**Field of action:** Local electricity production, **Implementation timeframe:** 2010 – 2012. **Responsible body:** education department of Voznesensk City Council **Description:** Implementation at the sites social technology combined heating systems using several different energy sources, such as the use of modern high-efficiency boilers to alternative (renewable) energy sources (fuel of vegetable origin (briquettes, bark, wood waste, sawdust, etc.) by day, electric heating and at night from 23:00 to 6:00 am, when the current rates four times lower than the daytime. **CO2 reduction: 38 t CO2 eq/yr, Energy savings: 211 MWh/a**
GRADIŠKA (BA)	**Field of action:** Local heat/cold production Biomass heating plants, **Implementation timeframe:** 2012 – 2017. **Description:** The first biomass heating plants in the Republic of Serbian and other such in Bosnia & Herzegovina, resulting from public-private partnership of the Municipality of Gradiska and IEE Ltd. Banja Luka. The installed power of 10 kW , energy pieces of bark from mills , wood bio waste from Mount Kozara , local orchards and from the utility company . **CO_2 reduction:** 4630.2 t CO2 eq/yr, **Energy savings:** 877 MWh/yr, **RES produced:** 16661 MWh/yr
HLINSKO (CZ)	**Field of action**: Local heat/cold production (heat from biomass), **Implementation timeframe:** 2010 – 2010. **Description:** Heating company, which supplied the last year of 45 000 GJ of heat, aims to reduce dependence on natural gas and preparing a project for biomass combustion. Just last year, the annual increase in gas prices by 35 %, "assesses the reality of executive Vaclav Pech. Residents of the settlement will save more than CZK 100, while the price of CZK 490 without VAT. Boiler with an output of 2500kW will provide ecological burning wood chips. Composition of heat and 2010 will change from the current 55 % natural gas to 50 % biomass. The residue heat Teplárenská purchases from SAVE already biomass boiler operates. Calculated savings in operating costs for 2010 is 4.5 million saving the fully reflected in the price reduction of heat. **CO2 reduction: 1178 t CO2 eq/yr, RES produced: 11083 MWh/yr**

Source: Covenant of Mayors, [31]

Box 9. Best practices form some Danube region cities SEAPs– short description

BURGAS (BG)	The Municipality of Burgas is the largest municipality located in south-eastern Bulgaria, with an area of 514,362 hectares, representing 0.43% of the country. The city of Burgas is an important industrial, commercial, transport, tourism and administrative centre of the Municipality and South-East region of Bulgaria. The economy has a diverse character, which makes the Municipality the economic leader and an important centre for the development of the region. The main branches of economic activity within the Municipality are: industry (13.4%), services (23.2%), transport (8.3%) and trade (51%). The city of Burgas joined the initiative in 2009, being the first mitigation policy taking place in the city, although it belongs to the Eurocities network. The BEI is calculated based on an IPCC approach, with CO_2 equivalents as emission reporting units. The set target is 25% CO_2 reduction in absolute terms. There are also foreseen targets regarding energy Saving and the use of renewable sources: the reduction of the energy usage in Burgas Municipality at least 27% and at least the 26% of RES share in the energy mix of Burgas Municipality. The Swot analysis developed by sector describing the strengths and weaknesses of the measures implementation established the following priorities: (i) Building sector and sustainable infrastructures - it accounts for 41% of the expected reduction; (ii) Urban mobility; (iii) Use of renewables - The focus is on the use of solar energy (installing PV modules in the municipal and private sector), biogas (from WWTP and waste depots) and biomass for heating in private buildings; (iV) Change energy behaviour.
ZAGREB (HR)	Zagreb is the capital city of Croatia located in the northwest of the country along the Sava river the largest tributary of Danube river. Joining the CoM in 2008 and adopting its SEAP in 2010 the city of Zagreb set its long term objective to reduce the CO2 emissions by 21% in year 2020 comparing with 2008 through the application of energy efficiency measures and the use of renewable energy sources. Without the implementation of energy efficiency measures the CO2 emissions in 2020 will result 7.6% higher comparing with 2008. The most important reduction measures are planned for the residential and for the increased usage of public transport instead of private individual transport. In 2008 CO_2 emissions from building sector shared 63% of the total CO_2 emissions in the city whereas transport sector contributed with 36%. The housing sector has a share of 68% in the entire energy consumption of the building sector, with an average of 179 kWh/m^2. The Zagreb SEAP summarise the measures in terms of main programs for energy efficiency and deployment of renewable energy sources. Firstly, a significant emission reduction are expected to be achieved by energy efficiency measures in public and residential buildings (thermal insulation, renewal of openings, energy savings lamps, etc); incentives scheme for RES usage in existing and new buildings; solar thermal collectors for health and social municipal institution.
MUNICH (DE)	Munich is the third largest city in Germany with more than 1.4 million inhabitants and the highest population density (4530 inh. per km² (December 2013). Munich joined the Covenant of Mayors initiative in 2008 and adopted its "Energy Action Plan" in 2010 with a per-capita reduction target of 47% by 2020 and seven priority areas are identified. Munich is a traffic hub with excellent international and local connections, running a fast and reliable public transport system. However, the city suffers from severe road traffic. Since 2010 Munich calls itself “Bicycle Capital”. In 2008 the City Council established ambitious urban climate protection goals by the Integrated Action Programme for Climate Protection (IHKM, Integriertes Handlungsprogramm Klimaschutz in München). According to the objectives of the Climate Alliance, Munich wants to reduce the per capita CO_2 emissions by 10% every 5 years, resulting in a 50% reduction in 2030 compared to 1990. The Baseline Inventory (BEI) for Munich is reported for year 1990. All the Covenant key sectors are adequately covered: the plan encompasses the total amount of CO_2 emissions resulting from electricity, heat/cold, fossil fuels and renewable energy of all building and industry subsectors. The highest emissions of a Covenant key sector result from residential buildings (24%), in particular from heating oil. The highest impact in terms of CO_2 reduction lies within the strategy of the local energy supplier Stadtwerke München GmbH. SWM operate twelve hydropower plants, several plants that generate electricity from renewable energy and the three thermal power stations that produce about 70 % of its electricity by combined heat and power. A CO2 reduction of 456000 tCO_2/yr is expected from use of renewable energy in electricity and heating (district heating) sectors. The improvement of energy efficiency in municipal buildings and infrastructure between 2010 and 2012 had an impact of 25200 tCO2/yr reduction. In the transport sector the highest CO_2 reduction of 5000 tCO_2/yr is expected by promoting bicycle traffic.

WIEN (AT)	Vienna is the capital of Austria with about 20% of the country's population and the most populous city on the Danube river. Vienna joined the Covenant of Mayors in October 2012 aiming to reduce per capita emissions by 21% of the 1990 levels by 2020. To tackle these challenges focus will be given on several priority tasks: Firstly, and most importantly, the extension of the Vienna district heating network continuing to promote district cooling projects. At the same time, the city will keep up its commitment to thermal building renovation. Furthermore it will continue to promote projects for the use of renewable energy. The city also has to step up its efforts to shift the modal split towards a higher share of public transport planning to extend the Vienna underground network, and make buses and trams both faster and more comfortable. Of course, it is equally important the promotion of ecological mobility by focusing on cycling and pedestrian traffic. The "Spittelau waste incineration plant", one of the core elements of the Vienna district heating system, is a prime example in this context. After the original waste incinerator was destroyed in a major fire in May 1987, the famous Austrian artist Friedensreich Hundertwasser was commissioned to redesign the plant near the city centre. He created a unique masterpiece – a symbiosis of fine art, technology and ecology. The new plant was completed in December 1992. With multi-coloured façade and a chimney featuring a golden sphere, the Spittelau plant has become a new landmark of Vienna. Falcons breed in artificial nests attached to the chimney, adding an element of nature to the high-technology facility. Nowadays the incineration plant attracts thousands of tourists. At the same time, it is equipped with the latest exhaust air treatment technology, thus undercutting official emission limits by 90%. The plant produces green thermal energy, which is fed into the district heating grid and helps cut greenhouse gas emissions from the heating of buildings.
BRATISLAVA (SK)	Bratislava is the capital of Slovakia with a population of 465327 inhabitants (2014) that join the Covenant of Mayors in April 2012. The first SEAP of Bratislava was submitted in January 2015 setting a target of 20% reduction of GHG emissions compared with the baseline year 2005. As energy efficiency and preventing climate change activities are only a part of the City's activities and functions, the preparation of the Action Plan was based on its contribution to the achievement of the overall goal of the City defined in the Programme for Economic and Social Development of the capital City of Bratislava for years 2010 – 2020. Based on the overall strategic plan for the City, a vision of sustainable development for energy industry and for combating climate change was defined as follows: Bratislava, aware of the impact that activities within the city have on the state of climate, will in its development and improvement of quality of residents and visitors' life, actively and responsibly approach the reduction of greenhouse gas emissions within the city's territories in order to contribute to the preservation and improvement of the environment in the City, as well as in surrounding areas. Priorities of Bratislava within the aim to fulfil its vision have been determined on the results of the Baseline Emissions Inventory. It showed that especially sectors of buildings (residential and tertiary) and transport contribute most significantly to the volume of GHG emissions within the city and should be addressed in the first place. While the development of energy efficiency (and thus also GHG emissions) of buildings encountered positive trend in recent years, the emissions from transport grow steadily because of growing intensity of the transport. To tackle and change this development is considered as the main challenge for upcoming years.
BUDAPEST (HU)	The Municipality of Budapest in wide cooperation with its public authority (district, neighboring municipal, county, regional, national governmental and european), residental and private economic partners - in order to satisfy the present and near future social demands - wants to achieve the economically feasible and on a long term sustainable increase of its overall attractiveness so that the evolved state could preserve the natural values of the city as much as possible. Besides the actuation of the much more environment- and energy conscious infrastructure, according to the state in 2005 it can reduce the greenhouse-gas emission of Budapest by 21% or even more significantly by 2020.

Source Covenant of Mayors [31] and JRC, IET report [34]

Energy mix in the Danube region

Political changes after 1990 in Danube region countries are reflected in the immediate downward trend of primary energy production and gross inland consumption until 1995. Subsequent primary energy production has remained fairly stable except for an increase during 2006-2008. In 2013 primary energy production in the region accounted for more than 40% of primary energy produced in the EU that year. More affected during period 1990-95 was the gross inland consumption of Energy Community countries of the Danube region.

Solid fuels and nuclear were in 2013 the main sources of primary energy production in the Danube region with a share of 60%. More than half of gross final inland consumption of energy in 2013 involved *solid fuels* (27.3%) and *oil & oil products* (26.6%). *Energy dependence* in Danube region in 2013 stood at 49.3%, lower than the EU average of 53%, but still higher than in 1990 (46.6%). Imports from Russia were dominant for gas imports with a share of more than 60% and oil & oil products with a share of 34%.

Primary energy production

Primary energy production in Danube countries totalled 465.7 Mtoe (19499 PJ) in 1990, but dropped by -9.7% in the following year. The decrease in primary energy production continued in subsequent years up to 2000 with a Compound Annual Growth Rate (CAGR) of -2.5%, whereas between 2000 and 2006 an increase by a CAGR of 0.7% was recorded. A marked fall in 2009 reflected the primary energy production trend coinciding with the financial and economic crisis. In 2013 primary energy production in the Danube region reached 323.5 Mtoe (13545 PJ).

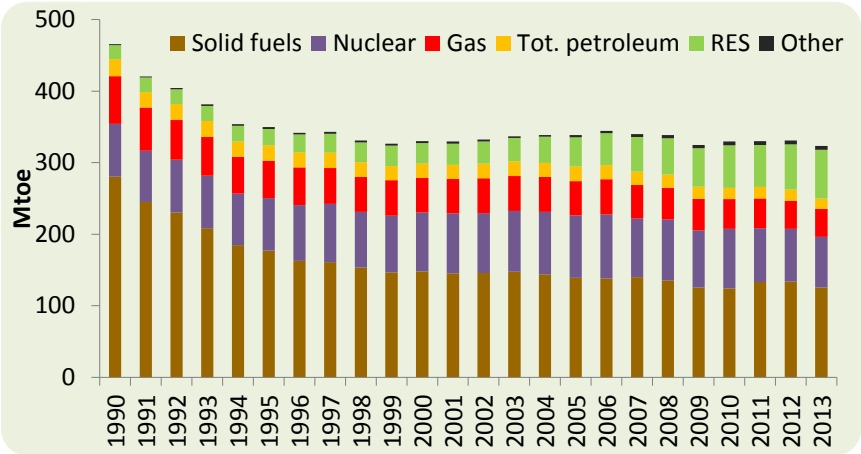


Figure 5. Trend of primary energy production in Danube region, 1990 -2013[18]

[18] Raw data can be found at Table A 3 and A 4 in the Electronic Annex of this report.

Primary energy production of EnC countries of Danube region was affected the most from the changes after year 1990. In 1996 the primary energy production in these countries was 38% less the correspondent figure in 1990.

Primary energy production in Danube region countries in 2013 was equivalent to 41% of the EU's primary energy production of 790 Mtoe (33092 PJ) in the same year. Almost 70% of this energy was produced within EU countries of the Danube region and the rest in EnC countries, among which Ukraine's contribution was the highest, at almost 83% or 82,7 Mtoe (3461 PJ).

Czech Republic and Ukraine had in 1990 the highest primary energy production per capita, respectively 3.9 toe/capita and 2.6 toe/capita, and in 2013 they were still the two countries with highest production of primary energy per capita, respectively 2.8 toe/capita and 1.8 toe/capita

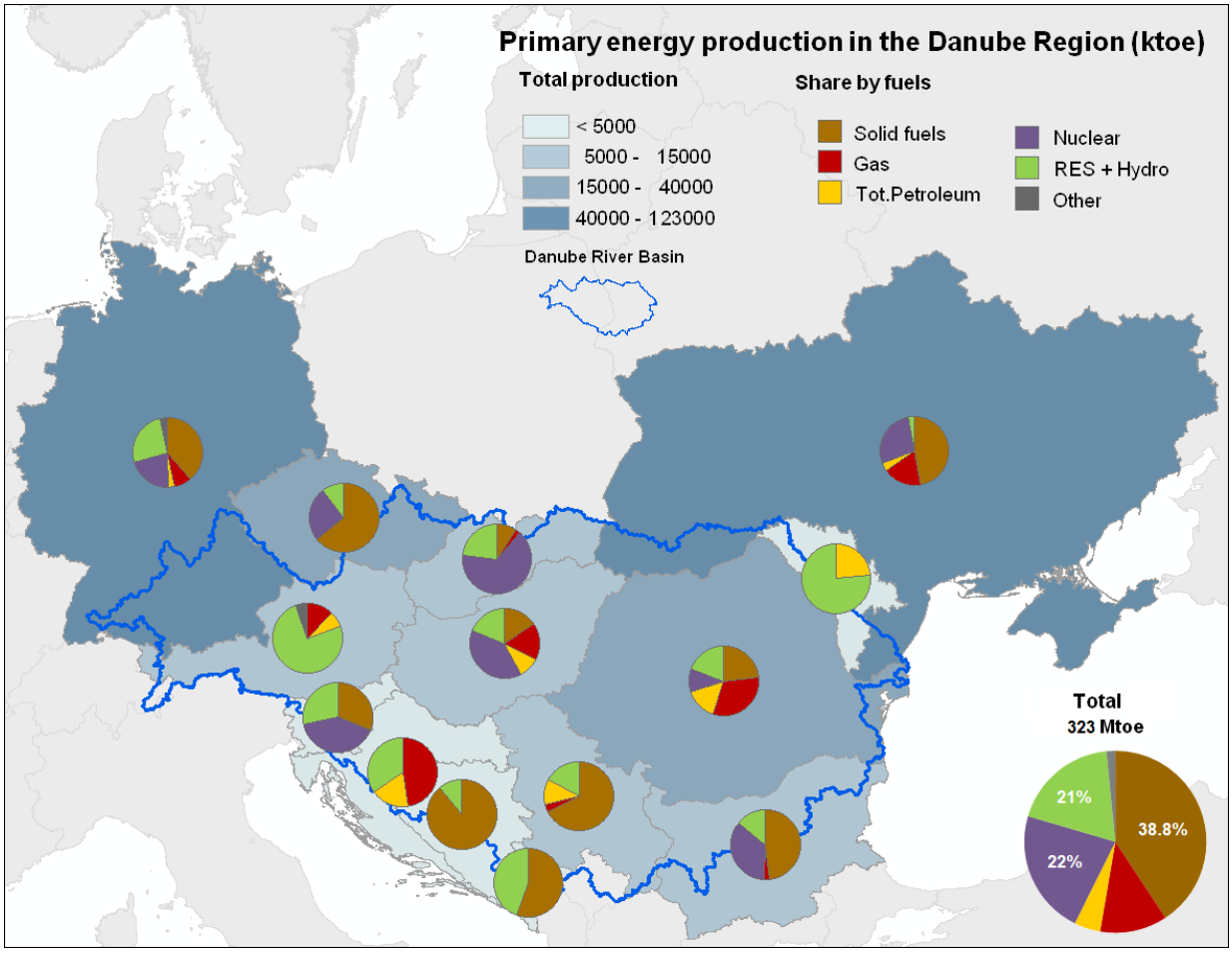


Figure 6. Primary energy production in Danube region countries - breakdown by fuels, 2013[19]

Primary energy production in the Danube region was spread across a range of different energy sources, the most important of which in terms of the size of its contribution in 2013 were solid fuels[20], with just below 39% of the total, followed by nuclear (21.9%), renewables (21.0%), gas (12%), oil (4.7%) and the non-renewable part of waste (1.7%).

[19] Raw data can be found at Table A 4 in the Electronic Annex of this report.
[20] Solid fuels include all coal, both primary (including hard coal and lignite) and derived fuels (including patent fuel, coke oven coke, gas coke, BKB, gas works gas, coke oven gas, blast furnace gas and oxygen steel furnace gas).

In the EU the same year, nuclear had the highest share of primary energy production with 28.6%. Renewables were the next source of primary production of energy with a share of 24.4%. Solid fuels covered 19.7% whereas gas and oil contributed 16.7% and 9.1% respectively.

Primary production of solid fuels in the Danube region countries amounted to 125.6 Mtoe (5259 PJ) in 2013, equivalent to nearly 80.6% of primary production of solid fuels in the EU the same year. With 38.7 Mtoe (1620 PJ) the primary production of gas in Danube region countries was equivalent to 29.4% of EU gas primary production in 2013. The non-renewable part of waste in Danube countries can be considered equivalent to 45.6% (5.5 Mtoe) of the same energy category in the EU for the same year. Solid fuels contribute significantly to primary energy production in some Danube countries such as Bosnia and Herzegovina (82.7%), Serbia (67.7%) and Czech Republic (59%).

Gross inland consumption

Gross inland consumption (GIC) of energy in Danube region stood at 875 Mtoe (36660 PJ) in 1990. Over the 23 years changes that took place in Danube region affected more the GIC of EnC countries. Since 2000 the GIC trend in EnC countries was similar to the corresponding indicator in EU countries of the region, remaining nevertheless all the time at half of the level of the gross inland consumption in the EU countries.

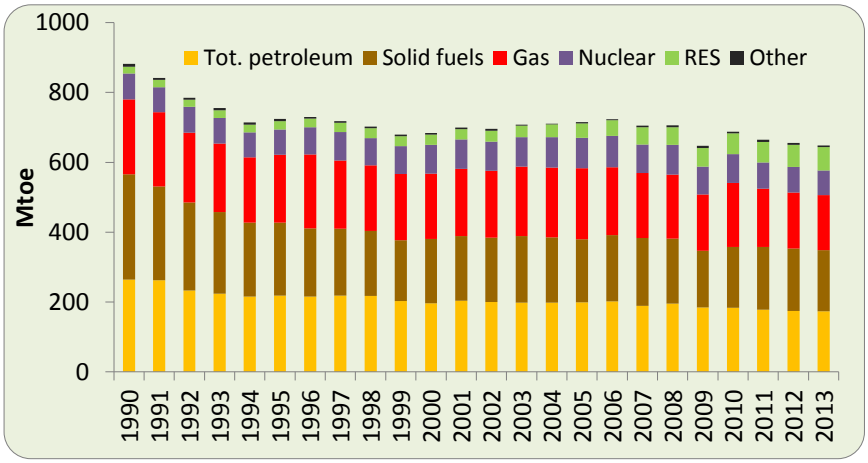


Figure 7. Trend of gross inland consumption in Danube region, 1990 -2013[21]

In year 2000 the EnC countries of Danube region GIC was almost half of their 1990 figure of 292.8 Mtoe (12260 PJ). In 2013 gross inland consumption of energy in Danube countries was almost double their primary energy production, amounting to 645 Mtoe (26998 PJ), equivalent to almost 39% of gross inland consumption of energy in the EU in the same year.

The mixture of fuels and their share in gross inland energy consumption in the Danube region differs from that of the EU. Solid fuels held the biggest share (26.9%) in 2013, followed by petroleum products (26.7%) and gas (24.3%). Nuclear and renewable energy shares were almost equal, respectively 10.9% and 10.3%.

[21] Raw data can be found at Table A 5 and A 6 in the Electronic Annex of this report. Gross inland consumption of renewables is the sum of hydropower and other renewables. For EnC countries the sum is almost totally hydropower.

In terms of EU gross inland consumption, petroleum products had the highest share (33.4%) in 2013, followed by gas (23.3%) and solid fuels (17.2%). Nuclear and renewables respectively accounted for 13.6% and 11.9% of gross inland consumption in the EU. Non-renewable waste had almost the same share (almost0.8%) in Danube region and EU gross inland consumption.

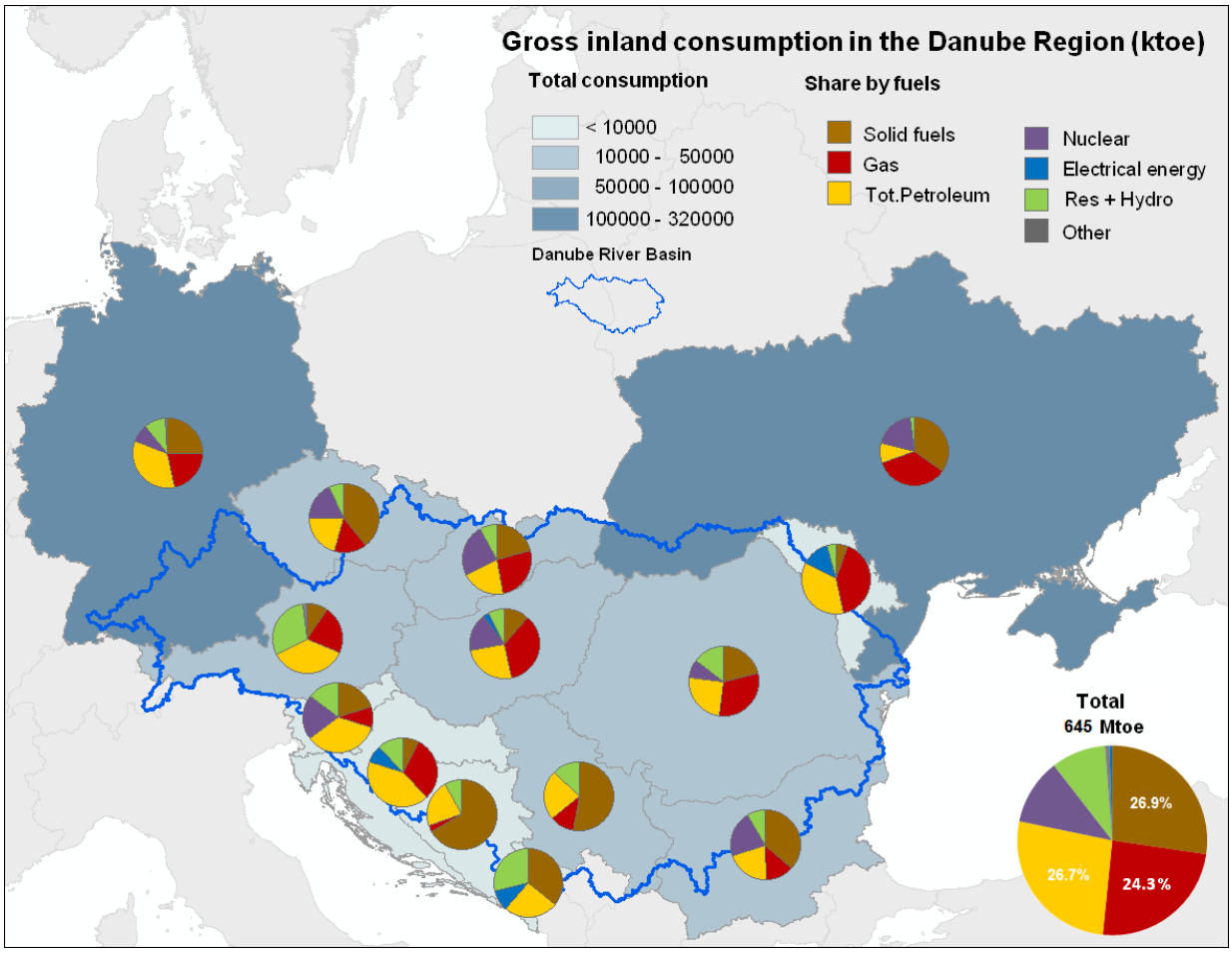


Figure 8. Gross inland consumption in Danube region countries, breakdown by fuels, 2013[22]

Bosnia & Herzegovina and Serbia had the highest share of solid fuels in their gross inland consumption in 2013, respectively 67.7% and 53.1%. The lowest share of solid fuels was seen in Moldova, at 4.7%. The corresponding figures for AT, HU, RO, SI and HR were below 20%.

Eight countries in the Danube region (BG, CZ, DE, HU, RO, SI, SK and UA) have nuclear plants; Slovakia's share in its gross inland consumption is the highest, at 24.2%, followed by Bulgaria with 21.9%. In Moldova gas is the main primary energy source covering more than 56% of gross inland consumption of energy, followed by Hungary with 35.1%. Bosnia and Herzegovina had in 2013 the lowest share of gas in gross inland consumption, at 2.5%. Petroleum products are important in Croatia covering nearly 38% of its gross inland consumption followed by Austria (35.9%) and Germany (33.9%).
Mainly hydro-based Montenegro had the highest share of renewable energy (37%) followed by Austria (30%); whereas in Ukraine the share of renewables was just 2.2%. In Bosnia and Herzegovina the

[22] Raw data can be found at Table A 6 in the Electronic Annex of this report.

share of hydropower in gross inland consumption of renewables was found to be nearly 77%, whereas in Hungary it was only 1%.

Gross inland consumption per capita in Danube region decreased from 4 toe/capita in 1990 to 3.1 toe/capita in 2013. Czech Republic, Austria and Germany had gross inland consumption at 4 toe per capita in 2013 whereas Moldova had only 0.9 toe per capita. Romania, Montenegro and Bosnia & Herzegovina had gross inland consumption below 2 toe per capita.

Gross final energy consumption

Gross final energy consumption (GFEC)[23] in the Danube region in 2013 was found to be 423.6 Mtoe (17735 PJ), equivalent to 37.2% of gross final energy consumption in the EU. More than half of this energy is consumed in the heating/cooling sector and the rest is almost equally divided between electricity (22.8%) and transport (21.5%).

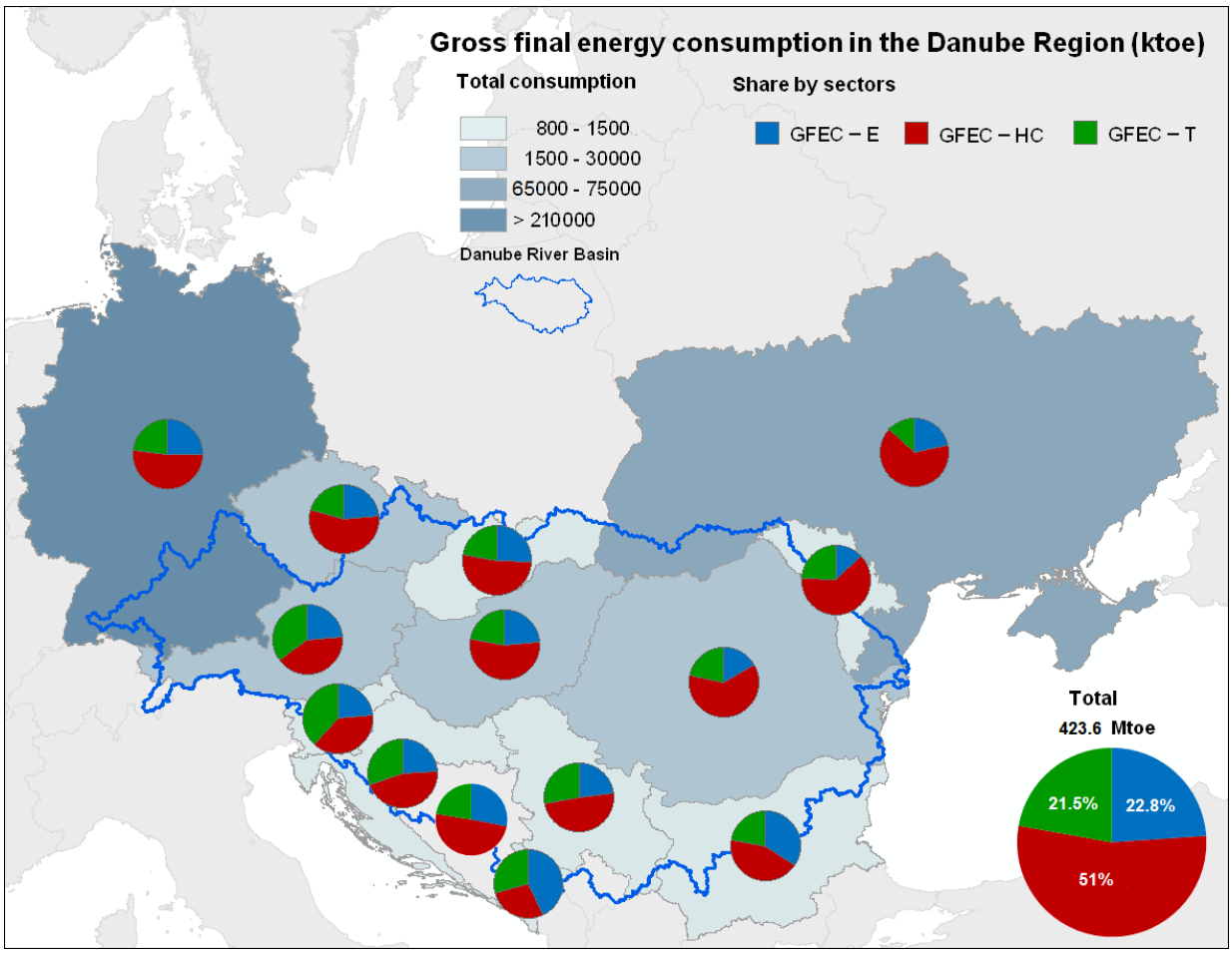


Figure 9. Gross Final Energy Consumption breakdown by sectors in Danube region countries, 2013[24]

[23] GFEC is an indicator defined by Directive 2009/28/EC. It is calculated based on the share of each sector and of overall RES in the GFEC and not as a sum of absolute contribution of each sector.
[24] Raw data can be found at Table A7 in the Electronic Annex of this report.

Gross final energy consumption in the transport sector decreased between 2010 and 2013 with a CAGR of -1.4%, while the electricity sector experienced a positive CAGR of 0.2%.

Heating/cooling was in 2013 the main sector of gross consumption of energy in almost all countries of the Danube region, whereas Montenegro consumed the highest amount of energy in the electricity sector.

Gross final energy consumption per capita in Danube countries in 2013 was 2.0 toe/capita, slightly lower than the EU average figure of 2.24 toe/capita. Austria, Germany, Czech Republic and Slovenia had higher consumption of final energy than the average EU figure for 2013.

Gross final energy consumption in the Danube region is expected to increase with a CAGR of 0.4% to reach 434.2 Mtoe (18180.5 PJ) in 2020. This will equate to 36.3% of expected gross consumption of energy in the EU the same year. The fastest increases in gross final consumption of energy are expected to take place in the electricity and transport sectors, respectively with a CAGR of +1.5% and +1.1%. In the heating/cooling sector, gross final energy consumption is expected to increase with a CAGR of only +0.3%. Between 2013 and 2020 gross final energy consumption is expected to drop only in Germany, Austria, Serbia and Moldova. Romania is expected to have the fastest increase up to 2020 with a CAGR of +3.8%. All EnC countries of the Danube region except Ukraine and Bosnia & Herzegovina will experience a drop in their gross final consumption of energy in the transport sector.

Energy intensity of the economy

Energy intensity of the economy measures the amount of energy a country needs to produce one unit of gross domestic product (GDP). Energy intensity can vary widely among countries, and is strongly correlated with the level of industrialisation and the economy's mix of services and manufacturing. Other key factors include the attention that a country pays to energy efficiency, together with the policies in place.

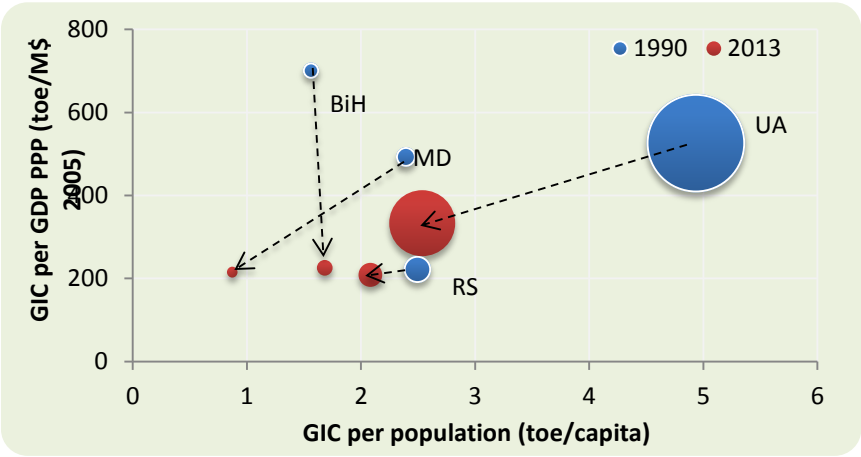


Figure 10. Gross Inland Consumption per capita and Energy Intensity for EnC countries, 1990 and 2013[25]

[25] The size of bubbles indicates the gross inland consumption of energy respectively for 1990 and 2013. Raw data can be found at Tables A 1, A 2, A 5 and A 6 in the Electronic Annex of this report.

Energy intensity of the economy has dropped over the 23 years for all countries of the Danube region. The drop has been greater for Bosnia & Herzegovina, Moldova and Bulgaria, with Austria, Croatia and Serbia least affected. In terms of energy consumption per capita the indicator fell for the majority of countries in the region, except for Austria, Croatia, Slovenia and Bosnia & Herzegovina.

Significant changes have however taken place over the 23 years in EnC countries of the Danube region (Figure 10). Firstly energy intensity dropped in all those countries, particularly in Bosnia and Herzegovina even though it continues to consume slightly more energy per capita. Between 1990 and 2013 Moldova's energy intensity fell significantly and the consumption of energy per capita also decreased. The same trend was observed even in Ukraine, whose energy consumption per capita decreased more than Moldova's. In Serbia there was a drop in both energy intensity and energy consumption per capita but the rate of this change was lower. In 2013 Ukraine was the most intensive economy among Danube region countries, 1506 kg oe/1000 Euro followed by Bosnia & Herzegovina with 718 kg oe/1000 Euro whereas Austria and Germany were the less intensive with respectively 110 kg oe/1000 Euro and 120 kg oe/1000 Euro.

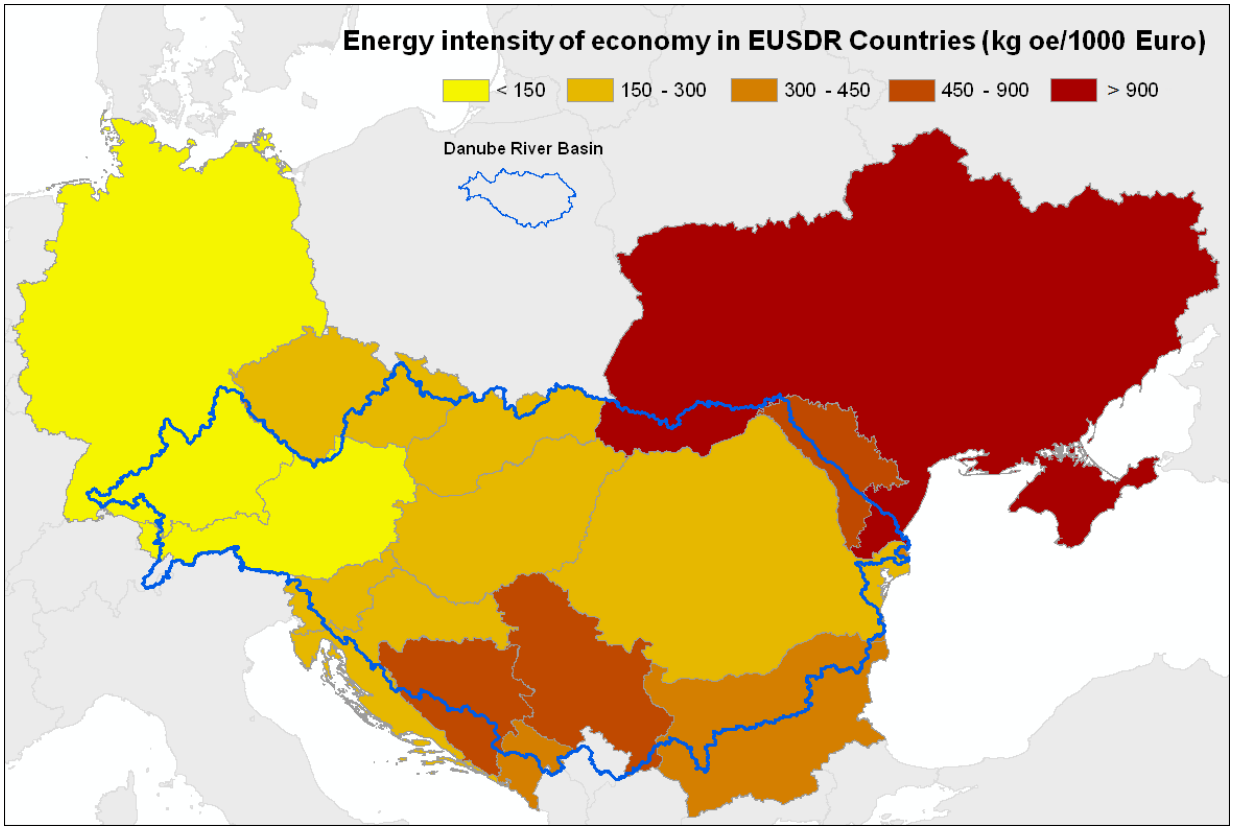


Figure 11. Energy intensity of economy in Danube region countries, 2013[26]

Energy dependence

The Danube region's energy dependence[27] in 2013 was, at 49.3%, 2.1 percentage points higher than in 1990 (46.6%). Moldova was in 1990 the country with the highest energy dependence (99.3 %) whereas

[26] Raw data can be found at Table A 2 in the Electronic Annex of this report.
[27] Energy dependence = Net imports / Σ Gross inland energy consumption + International maritime bunkers

Czech Republic imported in that year only 15.4% of its energy demand. In 2013 Moldova was still the country with the highest energy dependence, importing nearly 90% of its energy demand. The lowest energy dependence in 2013 was found in Romania, at 18.6%.

In 2013 eight countries (BG, AT, RO, SK, RS, UA, MD and BA) were less energy dependent (all products) compared with 1990 whereas five countries (CZ, DE, HU, SI and HR) had increased their energy dependence.

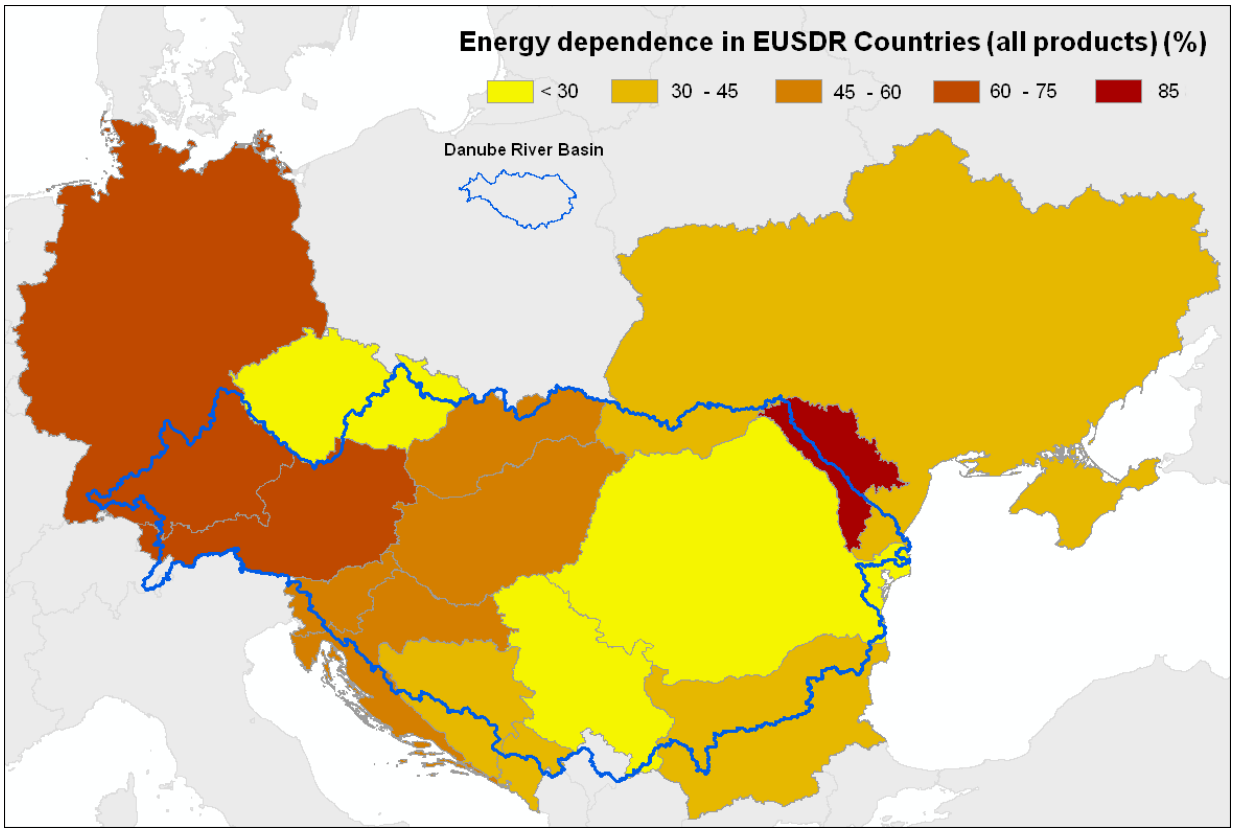


Figure 12. Energy dependence (all products) in Danube region countries, 2013[28]

Net imports[29] of all energy products in Danube region in 1990 were estimated 407.8 Mtoe (17077 PJ), equivalent to 54% of net imports in the EU in the same year. Net imports in the area decreased with a CAGR of -1.12% between 1990 and 2013 whereas in the EU the trend was positive, at +0.9%. The share of net imports in total imports in the region decreased from 81.7% in 1990 to 76.2% in 2013.

More than 36% of imports in the Danube region in 1990 took place in EnC countries, almost equivalent to Germany's imports in the same year. In 2013 the energy imports in EnC countries of the Danube region were 3.5 times less than in 1990, amounting to 12.2% of total imports in the region. Ukraine and Moldova had the steepest drops in energy imports, respectively with a CAGR of -6.2% and -5.98%. More than 60% of all energy products in the area were imported by Germany in 2013, compared with 38% in 1990.

[28] Raw data can be found at Table A 2 in the Electronic Annex of this report.
[29] Net imports are calculated as difference of imports and exports for all products and subcategories. Imports of all products in Danube region in years 1990 and 2013 were respectively 499 Mtoe and 413.6 Mtoe.

Oil & oil products with a share of almost 58% dominated the composition of energy imports in the Danube region in 1990. Gas was the next biggest energy import with a share of 31% whereas solid fuel imports were below 10%. In 2013 the structure of energy imports in the Danube region changed, owing to an increase in imports of solid fuels, gas and other products contributing respectively 14.4%, 33.5% and 3.5% to the total imports for this year. Nevertheless oil & oil products still had the largest import share in 2013, at 48.6%.

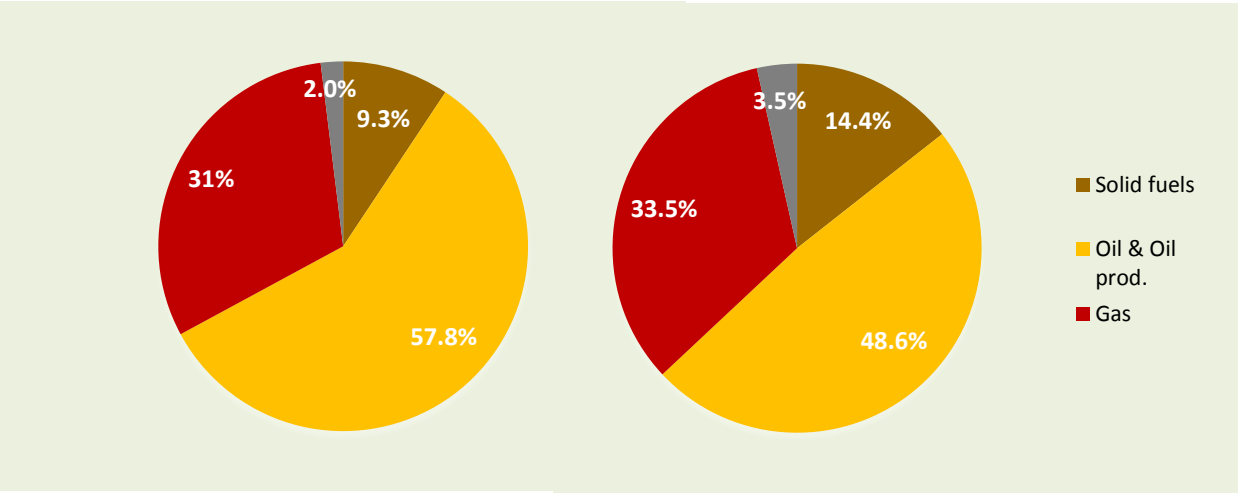


Figure 13. Breakdown of energy imports in Danube region, 1990 (left) – 2013(right)[30]

The Danube region's level of dependence on oil & oil products in 2013 stood at 92%, higher than in 1990 (90.5%). In 2013 the region's imports of oil & oil products were almost 30% less than in 1990 whereas oil & oil imports in the EU during the same period increased by 11.6%. At the same time a significant drop in imports of oil & oil products took place in Ukraine (CAGR of -9.78%) and Moldova (CAGR of -7.8%). In 2013, 34% of oil & oil products in the Danube region originated from Russia while the EU origin was 31%. The rest came from Norway with 5%, Algeria 2%, USA 1% and others 27%.

The Danube region had 27.3% dependence on solid fuels in 2013, more than five times higher comparing to 1990. The share of solid fuels in total imports between 1990 and 2013 increased from 9.3% to 14.4%. In absolute terms the increase entailed a CAGR of 1.2% (+13.5 Mtoe). 16% of solid fuels were imported into EnC countries of the region, almost 60% of the contribution in 1990. Six countries (CZ, DE, SI, RS, ME and BA) imported more solid fuels in 2013 compared with 1990. Among countries whose imports of solid fuels decreased between 1990 and 2013, Moldova experienced the most significant drop with a CAGR of -11.9%. The EU-origin solid fuels imported accounted for 20% of the total imports of these fuels whereas 28% originated from Russia and 17% from USA. Croatia had the highest dependence on solid fuels in 2013, at 110%.

The gas import share increased between 1990 and 2013, from 31% to 33.5% even though in absolute terms it decreased with a CAGR of -0.45%. In 1990 more than half of gas imports took place in EnC countries of Danube region with almost 80 Mtoe. The dependence on gas increased from 71% in 1990 to 74% in 2013. In this year five countries imported more gas compared with 1990, namely Czech Republic (+45.6%), Germany (+92%), Hungary (+30.4%), Austria (+90%) and Croatia (+90%). Romani

[30] Raw data can be found at Tables A 9 and A 10 in the Electronic Annex of this report.

had the highest decrease in gas imports with a CAGR of -7.3% followed by Ukraine (CAGR of -5.2%), Bulgaria and Moldova (CAGR of -3.97% each).

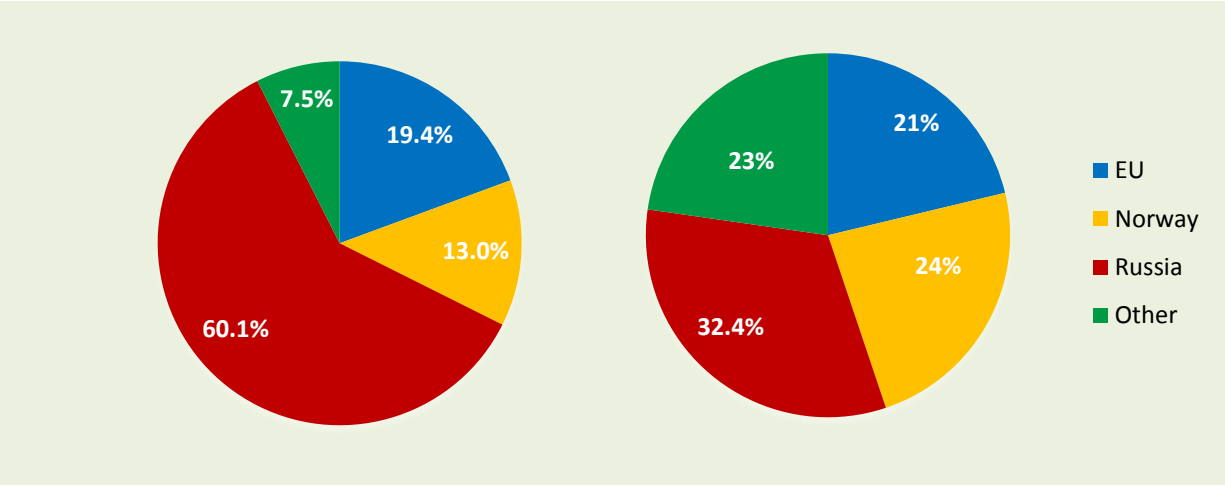


Figure 14. Origin of gas imports in Danube region (left) and EU (right), 2013

Just over 60% of gas imported into the Danube region in 2013 originated from Russia, almost double the corresponding figure for EU imported gas in the same year. Four countries (BG, SK, MD and BA) in 2013 depended fully on gas imports from Russia. EU origin imported gas was present in five countries (DE, RO, SI, HR and UA) with a contribution of more than 19%. Norway gas was imported only from Czech Republic, Germany and Austria. Germany and Ukraine accounted for almost three quarters of total gas imports in the Danube region in 2013. EnC countries took more than 18% of imported gas, with Ukraine having almost 87% of the gas imported in these countries.

Danube region as integral part of EU 2020 energy strategy

Final energy consumed within the Danube region in 2013 accounted for nearly two-thirds of the gross inland consumption in the EU; over period 1990-2013 Danube region saved almost 25% of its final energy mainly in industry sector whereas services and transport sectors consumed more energy; oil & oil products was the main energy carrier of final energy consumption in the Danube region; buildings is the main end use sector in Danube region with a share of 42%;

The quantity of renewable energy mix consumed in the Danube region in 2013 amounted to 58.5 Mtoe, a 13.9 % share in gross energy consumption; more than half of gross renewable energy mix consumed in 2013 was in the form of heat; biomass was the most important source of final renewable energy mix consumed in the Danube region in 2013, accounting for more than 55 %; renewable energy mix is expected to contribute 18.9 % of gross energy consumption in 2020 in the Danube region.

Energy efficiency

Primary and final energy consumption[31]

While in the EU primary energy consumption reached in 2013 the level it had in 1990, in the Danube region reaching 610 Mtoe (25552 PJ) this indicator saw a decrease by 30% (-225 Mtoe) since 1990. More than 34% of primary energy in Danube region in year 1990 was consumed in EnC countries a contribution that decreased to 22.5% in year 2013. Almost 66% (-148 Mtoe) was the contribution of EnC countries to the primary energy consumption savings between 1990 and 2013 in Danube region. In 1990 Germany (333 Mtoe) and Ukraine (249.4 Mtoe) consumed almost 70% of primary energy in Danube region, a contribution that decreases to 67.7% in 2013. Over these 23 years in relative terms Moldova saw the deepest decrease in its primary energy consumption by -103% (-7.3 Mtoe) whereas the highest absolute decrease took place in Ukraine with 139 Mtoe (-64.6%) less. Over this period almost all Danube region countries decreased the consumption of their primary energy except for Austria and Slovenia.

In per capita terms the primary energy consumption in Danube region reached in 2013 to 2.9 toe, (lower as in the EU) compared with 3.8 toe/capita in 1990. Moldova had in 2013 the lowest primary energy consumption per capita (0.9 toe/capita) whereas the highest consumption per capita of primary energy was in Czech Republic and Austria (3.8 toe/capita).

Final energy consumed in Danube region was in 2013 just above two-thirds (65.4%) of gross inland consumption showing that almost 35% of final consumption is found in non-energy consumption, transformation losses, consumption in the energy sector, distribution losses and other exchanges,

[31] Data on PEC were available for period 1992-2013 whereas for FEC data for period 1990-2013 were available.

transfer, returns. Over 23 years Danube region saved more than 25% (-142.5 Mtoe) in final energy consumption reaching 422 Mtoe (17233 PJ)[32], equivalent to 38.2% of final energy consumption in the EU the same year. More than 32% of final energy in year 1990 in Danube region was consumed within EnC countries, a share that in 2013 dropped to nearly 21%. EnC countries of the region consumed energy in 2013 less than half of their final energy consumption in 1990 whereas the EU countries consumed only 13.6% less. In per capita terms final energy consumption in Danube region was 2.0 toe in year 2013 slightly lower than the EU figure of 2.2 toe/capita. Moldova had the lowest final energy consumption per person, only 0.6 toe whereas Austria the highest consumption 3.3 toe/capita. Among non EU countries of the region Ukraine had the highest final energy consumption per capita equal to 1.6 toe followed by Montenegro with 1.2 toe/capita and Serbia with 1.1 toe/capita.

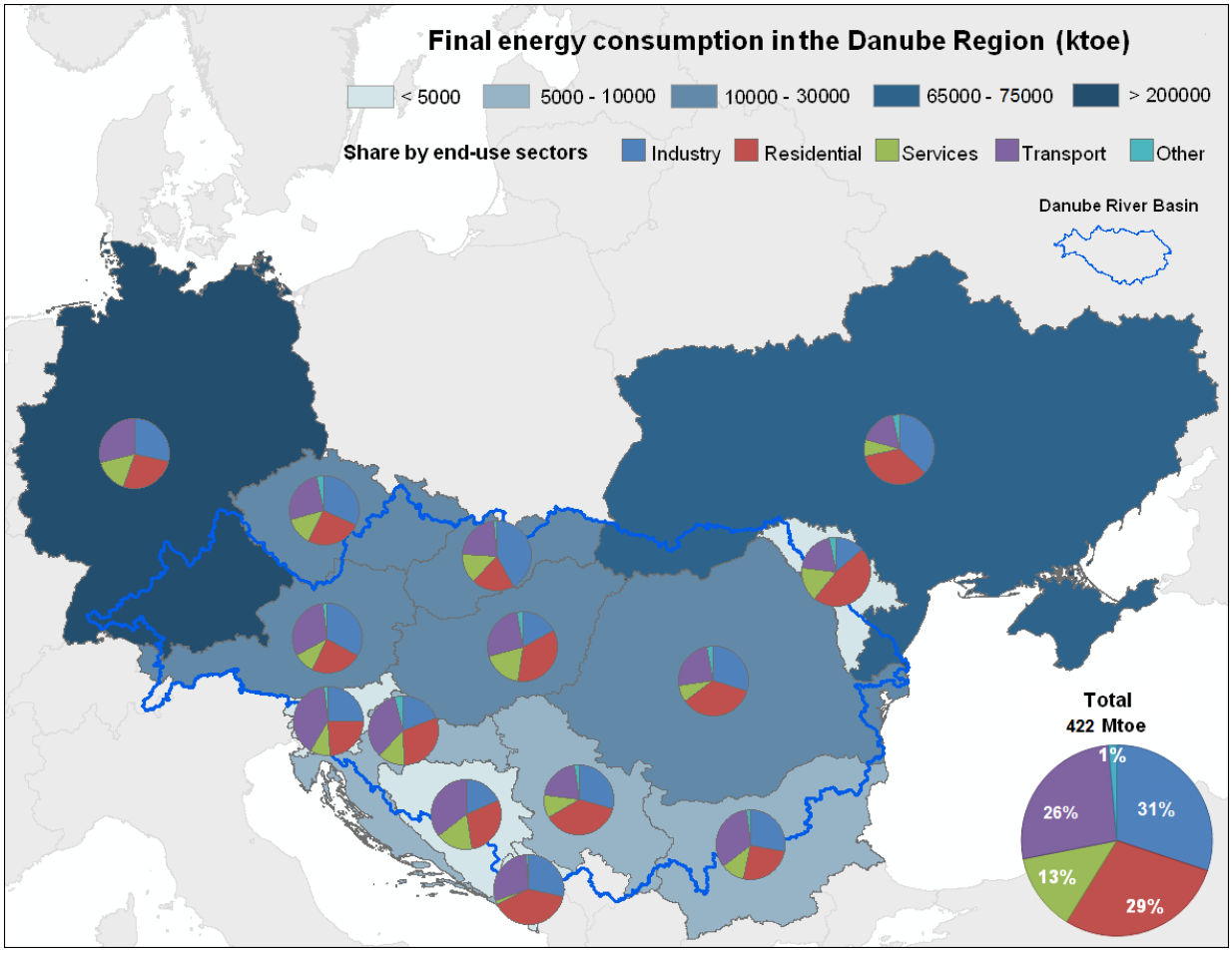


Figure 15. Final energy consumption in Danube region countries, 2013[33]

The impact of up to 2013 of structural changes and energy efficiency measures in Danube region countries is reflected on the share that final energy consumption had in different sectors and how it developed through the years.

[32] To keep the consistency between the EU and EnC Danube region countries total final energy consumption composition reported by three different sources (Eurostat, IEA and Energy Community) the main end users included in the analysis of final energy consumption are: industry, residential services, transport and others (includes the agriculture/forestry together with and others for EU countries and not specified for non EU countries).

[33] Raw data can be found at Table A 12 in the Electronic Annex of this report.

Over period 1990-2013 final energy consumption dropped significantly in almost all countries of Danube region, except for Croatia, Austria and Slovenia that registered a higher consumption in 2013, respectively at + 1.4% (+88.6 ktoe) , +44.5% (+8.9 Mtoe) and +28.5% (+1.1 Mtoe). The largest drop took place in Moldova by 67.7% less (-4.7 Mtoe) whereas the lowest in Germany with 4.9% less.

Germany and Ukraine had the highest levels of final energy consumption in 1990 accounting respectively for 40.5% and 28% share of the Danube region total. In other countries of Danube region the relative shares ranged from 0.7% in Slovenia to 7.2% in Romania. In 1990 Ukraine recorded the highest level of final energy consumption in the Danube region industry sector, at 37%, whereas in Germany services sector consumed the most (69%) of the Danube region services total.

In 1990 the dominant end-user sector in Danube region (as for 44%) was industry with 246.8 Mtoe (10337 PJ), equivalent to 67% of final energy consumed in the same sector in the EU. Residential and transport sectors contributed respectively with 24% (138.4 Mtoe) and 19% (104.5 Mtoe) whereas services accounted for only 7%.

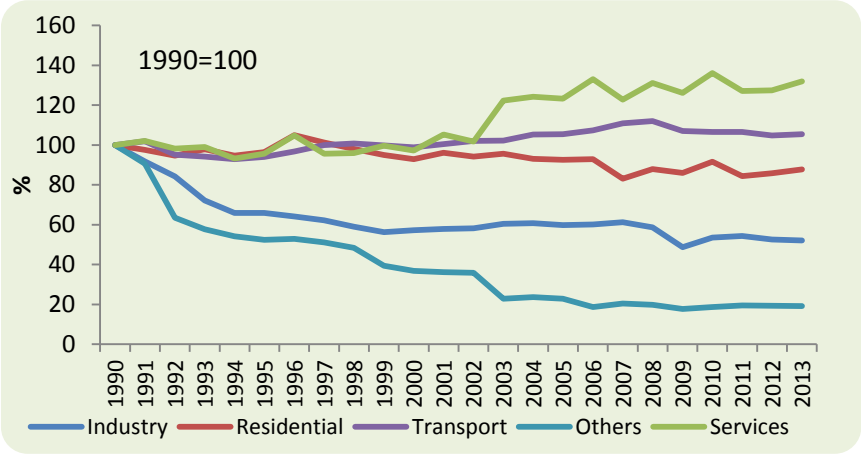


Figure 16. Trend of Final Energy Consumption in end user sectors in Danube region, 1990-2013[34]

Between 1990 and 1993 industry sector in EnC countries consumed more than 40% of final energy in Danube region a share that reached 24.7% in 2013. Buildings (residential and services) sector in EnC countries consumed during the same period more than one-fifth of final energy consumption in Danube region building sector, a share that was kept up to 2013. Final energy consumed in transport sector in EnC countries decrease its contribution in final energy consumed in this sector in Danube region over the 23 years of this analysis, from 23.7% to 14.2%.

Final energy consumption in industry sector trend saw two market drops during period 1990 – 2013; in 1999 being 43.7% (-107.9 Mtoe) below 1990 figure and in 2009 being 51.4% (-126.8 Mtoe) below the 1990 figure. In 2013 final energy consumption in this sector totalled 129 Mtoe (5388 PJ), equivalent to 46.2% of the EU industry final energy consumption the same year whereas its relative contribution in total final energy consumption in the Danube region fell to 30%.

[34] Raw data can be found at Tables A 11 and A 12 in the Electronic Annex of this report.

Building was the second largest energy consumer sector in Danube region in 1990 with 180.4 Mtoe (7552 PJ) accounting for almost one-third of the final energy consumption in this year. It reached the highest absolute final energy consumption in year 1996 (189.3 Mtoe) whereas the highest share in final energy consumption in the region was registered in 2010 (42.4%). In 2013 the final energy consumed in this sector totalled 176.8 Mtoe (7403 PJ) sharing almost 42% of final energy consumption in the region.

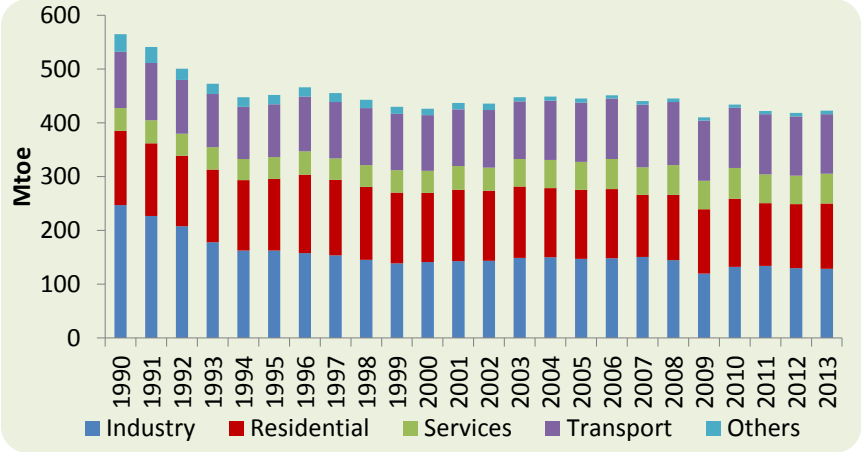


Figure 17. Trend of Final Energy Consumption in Danube region breakdown by end users, 1990 - 2013[35]

In 2013 final energy consumption in residential sector in Danube region reached 121.5 Mtoe (5086 PJ), equivalent to 40.7% of the correspondent indicator in the EU the same year. The decreasing trend (-16.4%) accompanied the development of final energy consumption in residential sector between 1996 and 2013 after increasing by 5% during period 1990-96 from the figure of 138.4 Mtoe (5795 PJ). Despite of this decrease the relative share in final energy consumption increased to 29% in year 2013.

The pace of development of final energy consumption was positive for services sector in the Danube region that consumed 32% (+13.4 Mtoe) more energy in 2013 compared with 1990, doubling its relative share to 13%. In 2013 final energy consumed in services sector was equivalent to 36.7% of the correspondent consumption in the EU.

An increasing trend between 1990 and 2013 with a growth of +5.5% of final energy consumption was also registered in transport sector that amounted to 110.6 Mtoe (4633 PJ) in 2013, equivalent to 31.8% of correspondent consumption in the EU the same year. Energy consumed in transport sector increased to 26% its relative contribution in final energy consumption in the region in 2013.

Among energy sources' oil & oil products had in 2013 the same relative contribution of 32% they had in 1990 final energy consumption in Danube region. Between 1990 and 2013 solid fuels more than halved their share in final energy consumption in Danube region, moving from 18% to 7%, in a time when gas and electrical energy increased respectively with +2 percentage points (from 23%) and +5 percentage points (from 15%).

[35] Raw data can be found at Tables A 11 and A 12 in the Electronic Annex of this report.

Buildings was in 2013 the sector that implies the largest shares of final forms of primary energy sources among which renewables and heat had the highest figures in their respective final consumption, at 66.9% (19.8 Mtoe) and 64.2% (20.4 Mtoe). Gas and electrical energy makes use in this sector respectively 57.3% (62.9 Mtoe) and 53.6% (45.4 Mtoe) of their final consumption. Even that the absolute level of renewables[36] in residential sector between 1990 and 2013 more than double its relative contribution in this sector reached almost 60%, lower than the share of 78% in 1990.

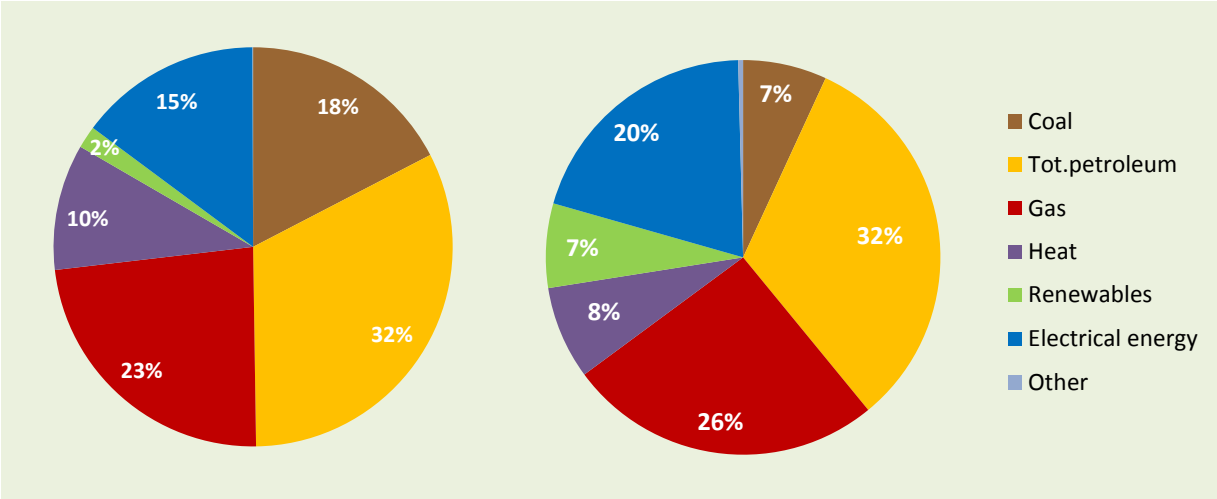


Figure 18. Final Energy Consumption breakdown by primary energy sources, 1990 (left) – 2013 (right)[37]

More than 90% (100.3 Mtoe) was in 2013 the contribution of oil & oil products in the final consumption of transport sector in Danube region, a share slightly lower than 96.4% in 1990. Oil & oil products were in 2013 also important for other end use sector (mainly agriculture) covering almost 57% of final energy consumption in these sectors, higher than the 48% of share in 1990.

Gas was an important primary source for building sector covering more than 35% of final energy consumed in this sector in 2013, higher than 22.3% in 1990. In the residential sector, gas covered in 2013 almost 40% of the final energy consumption, a share that in 1990 was just over 22%. The contribution of gas in final energy consumption in industry sector in Danube region decreased slightly in year 2013 (33.1%) compared with the contribution in year 1990 (35.2%).

In 1990 solid fuels covered more than 17% of the final energy consumed in building sector, a role that moves to the very marginal one in 2013 with a share of only 1.9%. Only in final energy consumption of industry sector solid fuels remained still in 2013 an important primary source with a share of 19.6% compared with 24.3% it had in 1990.

Electrical energy was in 2013 important for service sector covering almost 40% of final energy consumed in this sector, higher than the share of year 1990 (24.4%). It was also an important energy carrier for industry and residential sector with a share respectively equal to 27.4% and 19.7%.

[36] The renewables portfolio in year 1990 was dominated by hydropower technology. This composition changed between 1990 and 2013 moving towards biomass and new renewable technologies.
[37] Raw data can be found at Tables A 13 and A 14 in the Electronic Annex of this report.

Heat was an important energy carrier for residential sector in year 1990 but in 2013 it halved its contribution reaching a share of 11.6% (14.1 Mtoe). In service sector heat increased in 2013 almost 4 times its contribution in final energy consumed in this sector reaching 11.4% (6.3 Mtoe) compared with 3.6% (1.5 Mtoe) on 1990.

Renewables as primary sources increased their contribution in all end use sectors; the relative contribution in final energy consumption in Danube region grew from 2% (10.2 Mtoe) in 1990 to 7% (29.7 Mtoe) in 2013. Renewables had a considerable contribution in building sector covering in 2013 almost 11.2% of final energy consumed in this sector, a share that in 1990 was only 4.5%.

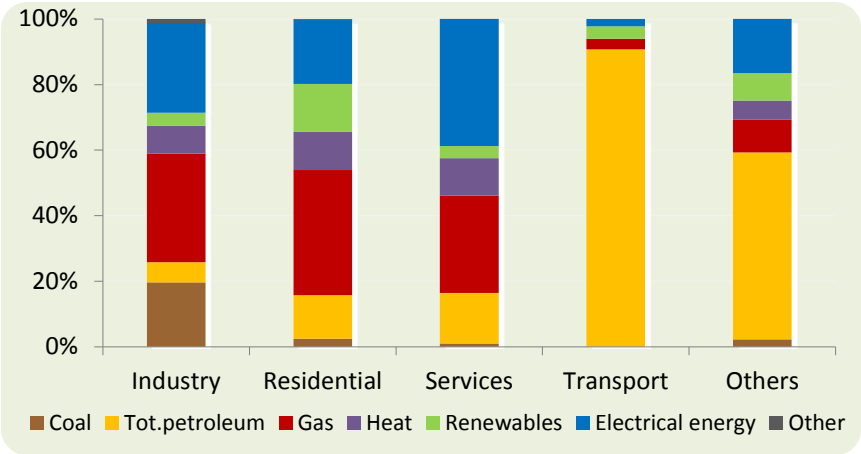


Figure 19. Final Energy Consumption in end users breakdown by primary sources and energy carriers, 2013

Energy efficiency 2020 targets and measures

As mentioned in the section Energy efficiency policy framework, the Energy Efficiency Directive (Directive 2012/27/EU), requires each Member State to set indicative national energy efficiency targets and legally binding measures to help the EU reach its 20% energy efficiency target by 2020. This involves a reduction of 370 Mtoe compared to the baseline consumption for 2020,[38] leading to EU primary energy consumption of 1483 Mtoe in 2020.

Table 2. Energy Efficiency targets in EU countries of Danube region in 2020[39]

EU Country in Danube region	Primary energy consumption (Mtoe)	Final energy consumption (Mtoe)
AT	31.5	26.3
BG	16.9	8.6
CZ	39.6	25.3
DE	276.6	194.3
HR	11.1	7.0
HU	24.1	16.6
RO	43.0	30.3
SI	7.1	5.1
SK	16.4	9.0

[38] The baseline consumption was calculated using PRIMES 2007 projections.

[39] In accordance with Article 3 of the Directive 2012/27/EC (as communicated at NEEAPs 2014). As the translations of the Hungarian and Romanian NEEAPs have not been available at the time of writing of the report, the values provided are based on the information submitted in the Annual Reports 2013 of these countries

In compliance with the Directive's requirements, the EU countries of the Danube region presented their targets, progress and efforts made in their national energy efficiency action plans (NEEAPs), which were due in April 2014 (Table 2).

To compare the efforts proposed by EU countries of the Danube region with the overall 2020 target at EU level, the energy consumption values for 2020 declared in their NEEAPs are compared with Primes 2007 baseline consumption for the same year in a given country.

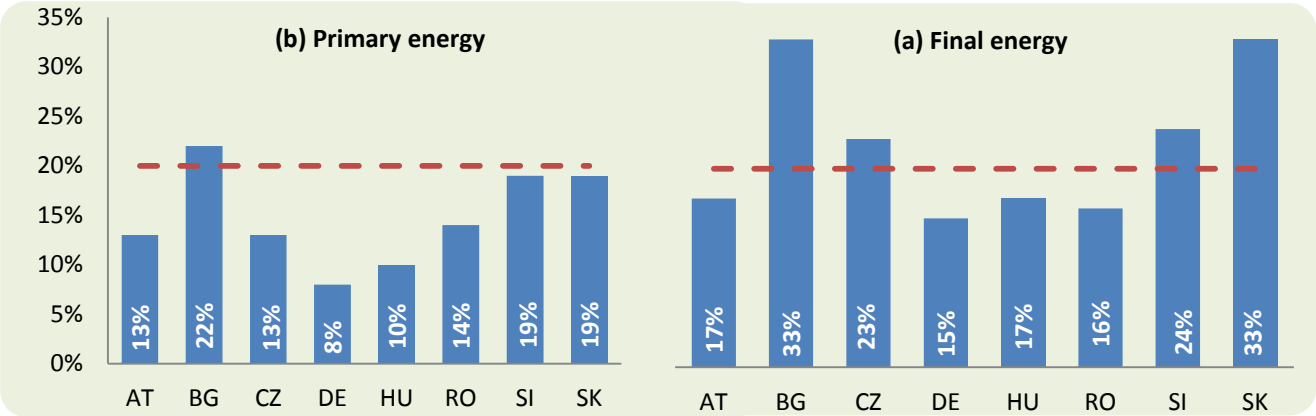


Figure 20. Final and primary energy savings with respect to PRIMES 2007 projections for 2020[40]

This provides an estimation[41] of the percentage energy reduction to be achieved in each EU country of Danube region by 2020. Based on these estimations, it is clear that several of the countries examined have a lower target than the EU-wide 20% target. In terms of savings of final energy consumption BG, CZ, SI and SK are above the EU 20% target whereas in terms of primary energy only Bulgaria has set a higher target than the EU.

The EU countries of the Danube region were also required to evaluate the expected impact of the 2020 targets in different sectors and transformation processes. The likely impact of energy efficiency targets in final energy consumption by sector in 2020 in some EU Danube region countries[42] is shown in Figure 17. The main impact of the energy efficiency targets in the final energy consumption structure is expected in building sector (residential & services).

Germany has adopted in December 2014 an Energy and Climate Package with focus on measures for buildings, in industry and in transport which will help in closing the energy efficiency and CO_2 reduction gaps. Germany's 2020 energy efficiency target is 276.6 Mtoe expressed in primary energy consumption and 194.3 Mtoe expressed in final energy consumption. According to its NEEAP Germany's impact of 2020 energy efficiency targets will affect mainly the building sector in which the final energy consumption is expected to be shifted between residential sector (that is expected to almost halve its relative contribution in the expected final energy consumption) and services sector (that is expected to nearly double its relative contribution in the expected final energy consumption).

[40] Based on the value provided (see Table 2)
[41] Although, some Member States may have used their own baseline calculations, this comparison is made for illustrative purposes
[42] In time of writing of this report (2015) the expected impact of energy efficiency targets in final energy consumption of other EU countries of Danube region was not available.

Bulgaria updated its 2020 energy efficiency target in 2014 that is now 16.9 Mtoe expressed in primary energy consumption and 8.6 Mtoe expressed in final energy consumption. Comparing with year 2013 Bulgaria in terms of primary energy Bulgaria has already consumed 0.6 Mtoe less than the target while in terms of final energy it expect to decrease by only 2%. Bulgaria's 2020 energy efficiency targets will effect mainly the final energy consumption in services sector which is expected to increase its relative contribution in final energy consumption by +3 percentage points compared with year 2013. The relative contribution of the final energy consumption in transport sector of transport is expected to decrease with -2 percentage points and +2 percentage points compared with year 2013.

In 2013 primary energy consumption in Croatia was 8.0 Mtoe whereas the final energy consumption reached 6.6 Mtoe. Croatia's 2020 energy efficiency target is 11.1 Mtoe expressed in primary energy consumption and 7.0 Mtoe expressed in final energy consumption. The impact of energy efficiency 2020 targets in Croatia will be more significant for residential sector which is expected to decrease its relative contribution by a factor larger than 2. Industry and services sector are expected to increase their relative contribution in final energy consumption expected in 2020 by a factor of 1.5 each.

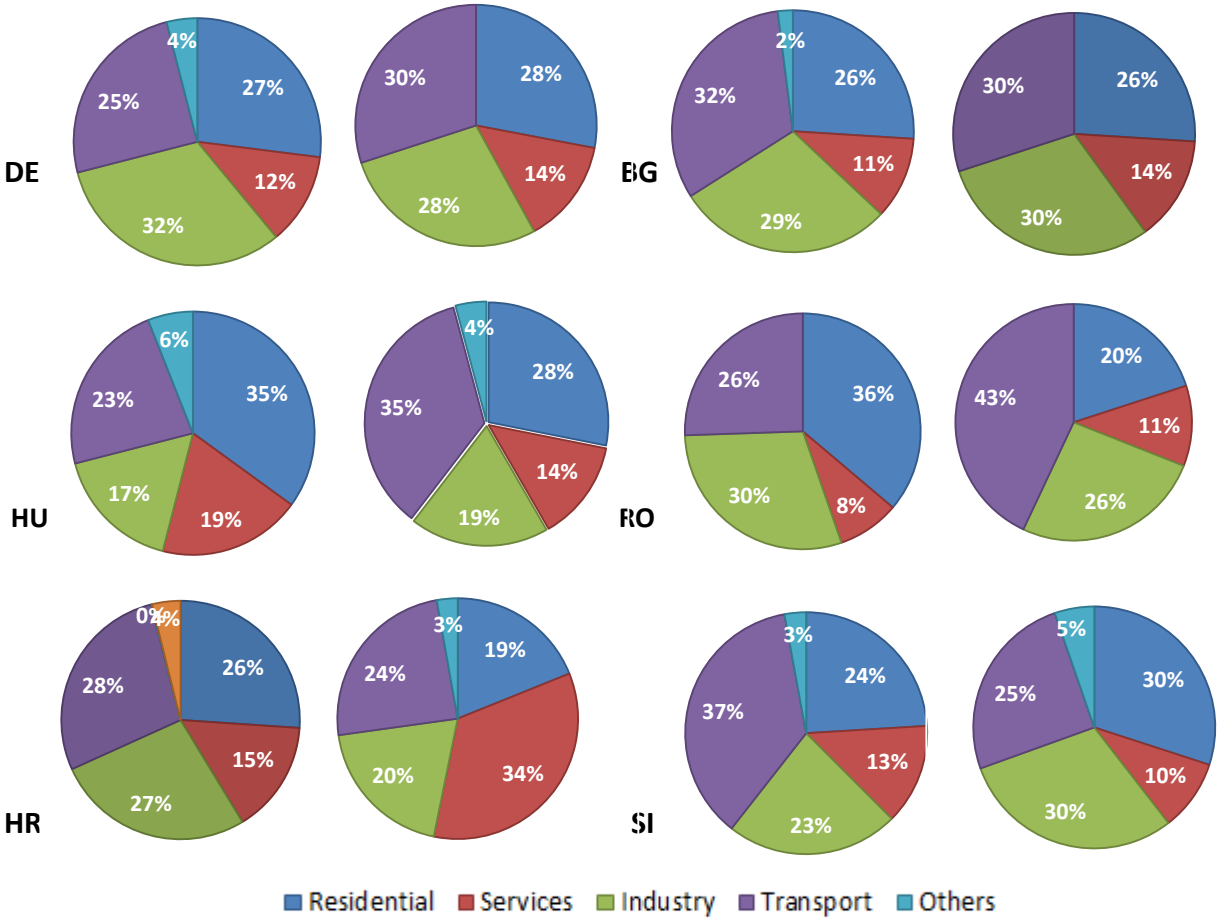


Figure 21. Final Energy Consumption in DE, BG, HR, SI, HU and RO, 2013 (left) – 2020(right) [43]

Slovenia's 2020 energy efficiency target is 7.1 Mtoe expressed in primary energy consumption or 5.1 Mtoe expressed in final energy consumption). The impact of 2020 energy efficiency targets in Slovenia

[43] "Other" – includes even agriculture. For Bulgaria agriculture is included in "services". For Croatia 'other' includes also the construction sector. For Romania services sector reported for 2020 present the "utilities".

will be significant for building sector within which a shift by a factor of 2.4 of relative contribution in final energy consumption from residential sector to services sector is planned. An increase by 5 percentage points of relative contribution of final energy consumption in transport sector is expected to take place in 2020.

Hungary's 2020 energy efficiency target is 24.1 Mtoe expressed in primary energy consumption and 16.6 Mtoe expressed in final energy consumption. The impact of 2020 energy efficiency targets in Hungary is expected to be not so significant keeping almost the same structure of the final energy consumption by end use as in 2013 with a slightly increase of the relative contributions of final energy consumption in transport and services sectors.

Romania's 2020 energy efficiency target is 43 Mtoe expressed in primary energy consumption and 30.3 Mtoe expressed in final energy consumption. The main impact of 2020 energy efficiency targets in the structure of final energy consumption by end use in Romania is expected to take place within building sector in which an increase by 5 percentage points and a decrease by 2 percentage points of relative contributions of residential and services sectors will take place.

With a view to using energy more efficiently and meeting the national targets set in accordance with the Directive's requirements, Member States were requested to implement legally binding measures at all stages of the energy chain from the transformation of energy and its distribution to its final consumption. A number of horizontal measures as well as measures targeting each end-use sector (buildings, public sector, industry, transport) and energy supply have been put forward. Article 7 of the Directive[44] obliges Member States to set a cumulative end-use energy savings target by 2020 and work towards it by setting up an energy efficiency obligation scheme or implementing alternative measures. Table 3 provides an overview of the targets and choices made by the EU Member States.

Table 3. Targets and measures proposed by EU countries of Danube region to meet Article 7 Target[45]

	Declared Article 7 Target	Proposed Measures to meet Article 7 target*	
	Cumulative final energy savings to be achieved by 2020 (ktoe)	Obligation schemes	Alternative measures
AT	5200	√	√
BG	1943	√	
CZ	4564		√
DE	48880		√
HR	1296	√	√
HU	3399		√
RO	5817		√
SI	997	√	√
SK	2284		√

[44] Article 7.1 of the Directive 2012/27/EC obliges Member States to establish an energy efficiency scheme to achieve an annual 1.5% energy savings target within the period from 1 January 2014 to 31 December 2020.
[45] According to information submitted in the NEEAPs 2014 [17]

Table 4. Main measures[46] presented by EU countries of Danube region

	Austria						Bulgaria					
	RES	SER	IND	PU	TRA	SUP	RES	SER	IND	PU	TRA	SUP
Regulatory												
Financial & fiscal												
Information & awareness												
Qualification, training & QA[47]												
Market-based												
Voluntary agreements												
Infrastructure investments												
Other												
	Czech Republic						**Germany**					
	RES	SER	IND	PU	TRA	SUP	RES	SER	IND	PU	TRA	SUP
Regulatory												
Financial & fiscal												
Information & awareness												
Qualification, training & QA												
Market-based												
Voluntary agreements												
Infrastructure investments												
Other												
	Croatia						**Slovakia**					
	RES	SER	IND	PU	TRA	SUP	RES	SER	IND	PU	TRA	SUP
Regulatory												
Financial & fiscal												
Information & awareness												
Qualification, training & QA												
Market-based												
Voluntary agreements												
Infrastructure investments												
Other												

[46] As communicated in NEEAPs 2014 (RES: Residential, SER: Services, IND: Industry, PU: Public, TRA: Transport, SUP: Supply). Shaded areas indicate that there are one or more policy measures identified for the specific sector/policy type.
[47] Quality assurance

Various measures were outlined by Member States in their NEEAPs for 2014, targeting all sectors — residential, services, industry, public, transport and supply sectors — and all policy types (regulatory, financial & fiscal, information & awareness, qualification, training & quality assurance, market-based instruments, voluntary agreements, infrastructure investments and other). A snapshot of the types of measures and targeted sectors is given in Table 4.

In Austria, federal subsidies for energy efficiency in residential (existing or new) buildings are long-running measures that have supported, inter alia, thermal renovation of private dwellings through the provision of one-off grants. The federal subsidies are expected to yield 73 000 TJ of cumulative primary energy savings in the period 2014-2020, representing 32 % of the Article 7 target. Other important measures include taxation of electricity, natural gas and various petroleum products, which together are expected to generate 74 900 TJ of cumulative energy savings in the period 2014-2020 in the residential, service, industry and transport sectors.

Croatia has taken a number of important financial and fiscal measures targeting renovation of the residential and services sectors. These include programmes for energy renovation of existing commercial buildings and family houses as well as a programme dealing specifically with multi-apartment buildings. Altogether these programmes are expected to generate 35 % of the final energy savings target in 2020.

In Germany, energy and electricity taxation is an important cross-sectoral measure that steers consumers towards more resource-efficient use of energy, aiming at primary energy savings of 569 PJ in the period 2014–2020. Some other energy efficiency measures in Germany affect prices (e.g. network usage charges and EEG reallocation) or provide investment support such as the KfW programmes and building codes (energy savings regulation for new and existing buildings).

In Slovakia, the construction, reconstruction and modernisation of heat distribution systems together with construction/upgrade of the transport infrastructure are among the main measures. Mandatory energy audits for industrial enterprises are also important. Bulgaria plans to set up a new obligation scheme — expected to generate final savings of 486ktoe/year. Energy audits of industrial systems consuming 3000MWh/year are expected to generate 151 ktoe.

Table 5. Energy efficiency targets in EnC countries of Danube region

ktoe	ME	RS	MD	UA	BA
ESD scope	654.6	8360	n.a	69258	n.a
Overall energy saving target[48]	**58.9**[49]	**752**	**867**[50]	**6233**[51]	**287**
Intermediate saving target[52]	33 (4%)	397.5 (4.7%)	428 (4.4%)	1385 (2%)	n.a
Achieved energy saving	25 (4%)	102.3 (1.22%)	n.a	n.a	35 (1.1%)
Reference year/period	2002-2006	2008	2009	2009	
NEEAP status	1st ,2nd, 3rd	1st and 2nd	1st	1st (draft)	1st [53]

[48] In 2018 estimated as 9% of the reference final energy consumption in the target year.
[49] Estimated energy savings only from energy efficiency measures in 2012 is 19.05 ktoe.
[50] In 2016
[51] In 2020
[52] In 2015

The Energy Service Directive[54] requires the Contracting Parties of Energy Community to adopt and aim to achieve the target of at least 9% energy savings for the ninth year of application of the Directive and establish, in the first NEEAP, an intermediate national indicative savings target for the third year of application of the Directive.

Energy savings and measures in residential sector and public sector stand out in the majority of the EnC countries of Danube region NEEAPs. In the case of Ukraine, the focus is on Industry that has highest share in final energy consumption. With varying degrees of details, almost all EnC Danube region countries NEEAPs also include measures aimed at Industry and SMEs, Transport, as well as Horizontal measures. Detailed measures in energy supply/transmission/distribution are presented in the NEEAPs of Moldova and Serbia.

Table 6. Main Energy Efficiency measures[55] presented by non EU countries of Danube region

	Montenegro	Serbia	Moldova	Ukraine	Bosnia & Herzegovina
RESIDENTIAL (RES)	3	3		5	5
SERVICES (SER)				4 (incl. PU)	7
BUILDINGS (BLD)	3		2		
ENERGY (ENER)			4		
INDUSTRY (IND)	1	5	3	15	4
PUBLIC (PUB)	4	7 (incl. COM)	3		
TRANSPORT (TR)	5	5	1	15	3
CROSS-SECTORAL (CS)	7		4 (incl. HO)	4 (incl. HO)	
HORIZONTAL (HO)		4			9
COMMERCIAL (COM)	3				

[53] Entity of Srpska Republic adopted the 1st NEEAP in December 2013 while the Entity Federation of Bosnia and Herzegovina still hasn't send its EEAP to Energy Community Secretariat)
[54] In the EU, this Directive was repealed in 2014 and replaced with the Energy Efficiency Directive 2012/27/EU (EED)
[55] As communicated in the 1st and 2nd NEEAPs of Energy Community Contracting Parties [35]

Renewable energy

Renewable energy shares

According to the Danube region countries' progress reports the overall renewable energy share in 2013 was estimated at 13.9%. The share of renewable electricity in gross final energy consumption was 25.0% in 2013. Renewable energy in heating/cooling and transport had a share in gross final energy consumption amounting to 13.9% and 5.5% respectively. In 2020 the overall renewable energy share in the Danube region is expected to reach 18.9%. The shares of renewable energy in electricity, heating/cooling and transport in 2020 in the Danube region are expected to be respectively 30.7%, 17.5% and 12.5%. In 2013 three Danube region countries achieved an overall renewable energy share higher than their 2020 target: Bulgaria, Romania and Croatia[56].

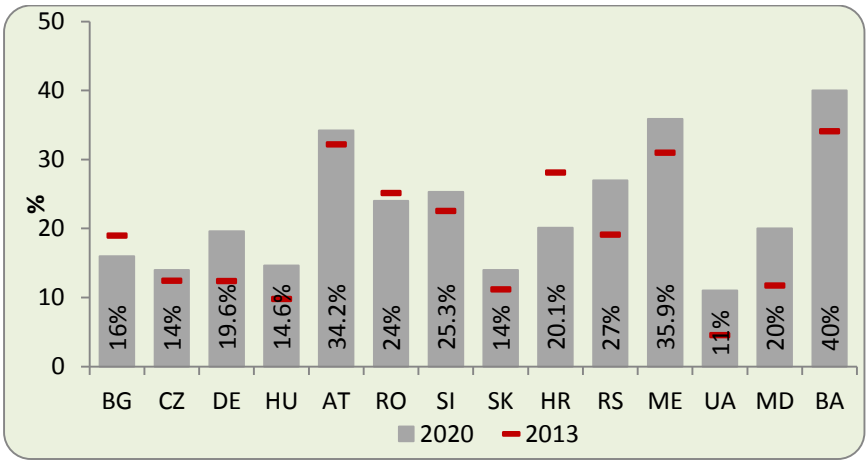


Figure 22. Overall renewable energy shares in Danube region, 2013 and 2020 (targets)[57, 58]

Bosnia & Herzegovina had the highest overall renewable energy share in 2013 (34.1%) and the highest renewable energy shares in heating/cooling sector (48.6%). The highest share in electricity sector was found in Austria with 66.9%. Serbia and Moldova reported no contribution of renewable energy in the transport sector in 2013. Two countries in the region (RS and MD) fell short of the 2013 planned overall shares of renewable energy.

The lowest penetration of renewable energy in gross final energy consumption in 2013 was reported by Ukraine, at only 4.56%. It also had the lowest share of renewable energy in heating/cooling (3.96%) and transport (1.21%).

In the electricity sector Serbia exceeded by the widest margin the 2013 planned share, with respectively +8.8 percentage points. Four countries (HU, AT, SI and MD) missed for this year their plans on renewable shares in electricity sector.

[56] Croatia NREAPs data are set very below the developments of renewable energy reported in its 2015 progress report. Croatia updated the data of 2013 progress reports in May 2016.

[57] Bosnia & Herzegovina NREAP submitted to Energy Community in May 2016. The data referring to year 2013 are considered as an achieved development.

[58] See Tables A 19 and A 20 in the Electronic Annex of this report for the raw data.

In the heating/cooling sector Austria reached the highest positive exceedance from the 2013 planned share with + 12.6 percentage points followed by Slovenia with +8.3 percentage points. Serbia and Moldova stood behind the plans for this year respectively with 4.14 percentage points and 3.35 percentage points less.

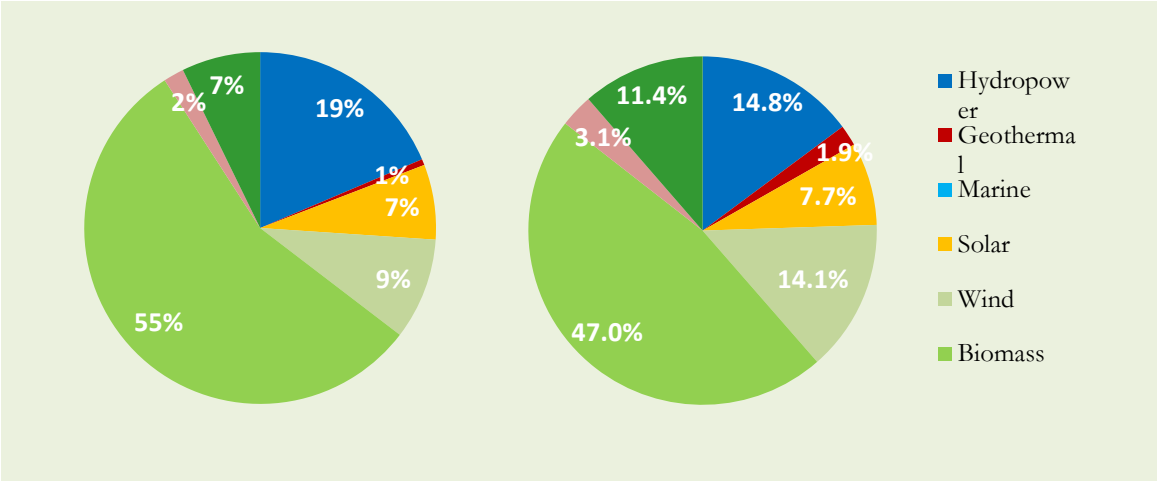
In the transport sector the deviations were negative for four countries Germany, Hungary, Romania and Croatia.

By 2020 Bosnia and Herzegovina is expected to have the highest overall renewable energy share among Danube region countries, with 40%, even though the most significant development of this indicator is expected in Moldova, increasing by +8.3 pp in order to reach the target of 20%. Austria will still have the highest share of renewable energy in the electricity sector with 73.2%, whereas in heating/cooling Bosnia & Herzegovina is expected to have the highest share in 2020 with 52.4%. Czech Republic is expected to achieve the highest share of renewable energy use in the transport sector with 15.5%.

Final renewable energy

Final renewable energy[59] in the Danube region countries increased from 51 Mtoe (2137 PJ) in 2010 to 58.5 Mtoe (2449 PJ) in 2013, equivalent to 34.6% of the same year final renewable energy in the EU, 161 Mtoe (6722.7 PJ). Renewable energy in Danube region developed faster than anticipated in the aggregated NREAPs, almost 8% above the expected figure of 54.5 Mtoe (2280 PJ).

In 2013 the EnC countries contributed with almost 12% (7 Mtoe) to the final renewable energy in the Danube region, with Ukraine providing nearly 45% of the contribution. Among EU countries of the region, Germany was the leader in the region final renewable energy with a contribution of nearly 44.7% (26.2 Mtoe).



[59] Final renewable energy is the sum of renewable energy coming from hydropower, wind, solar, geothermal, biomass, heat pumps, and biofuels. Final renewable energy differs from gross final consumption of renewable energy because the latter includes also the contribution of renewable electricity in the transport sector. Gross consumption of renewable energy in the Danube region in 2013 was 59 Mtoe (2472 PJ).

Figure 23. Breakdown of final renewable energy in Danube region countries, 2013 (left) – 2020(right)[60]

Biomass was the main source of renewable energy mix in Danube countries in 2013 with a share of 53%. The second source of renewable energy mix was hydropower with a share of 20% followed by wind power and biofuels that respectively reached 10% and 8%. Solar share in final renewable mix stood at 7% in 2013. The contributions of heat pumps and geothermal were marginal, remaining respectively at 2% and 1%.

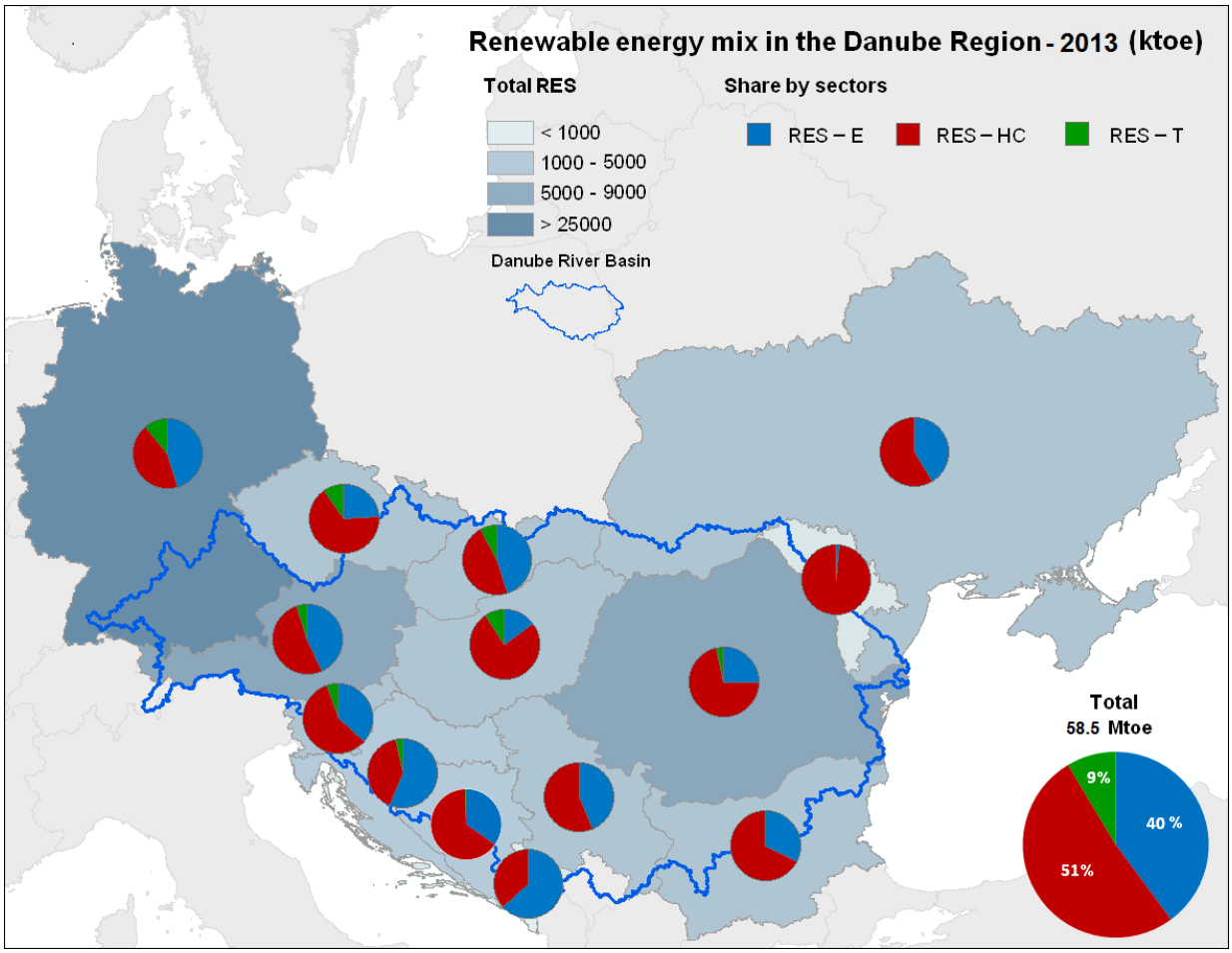


Figure 24. Final renewable energy breakdown by sectors in Danube region countries, 2013[61]

Renewable energy in the heating/cooling sector accounted for more than half of the final renewable energy in the Danube region in 2013 whereas the electricity and transport sectors respectively used 40.9% and 8.1% of the final renewable energy.

Renewable energy in heating/cooling sector in Danube region countries was found to be more than 13% higher than the expected figure of 26.6 Mtoe (1039 PJ) for 2013. The contribution of EnC countries of the area was 9.8% with 3.1 Mtoe (131.6 PJ); more than 55% of which was developed in Ukraine. The highest value of the use of renewable energy in heating/cooling sector was found in Moldova with a share of 98.5% whereas the lowest was found in Montenegro with 38%. In 2013 Austria exceeded by nearly 9% the 2020 plan in the use of renewable energy in its heating/cooling sector.

[60] Raw data can be found at Tables A 25, A 26, A 29, A 30, A 33 and A 34 in the Electronic Annex of this report.
[61] Raw data can be found at Table A 17 in the Electronic Annex of this report.

The planned figure of 23 Mtoe (965.4 PJ) in the electricity sector was exceeded by 4.7%, reaching 24.1 Mtoe (1010.7 PJ). Renewable electricity developed in EnC countries contributed only 2.83 Mtoe (118.3 PJ) to the final figure, equivalent to 11.7%; more than 56% of which was developed in Ukraine.

The use of renewable energy in transport was 12% lower than the 2013 planned figure of 5.5 Mtoe (230 PJ). Only 2.5% of renewable energy was used in the transport sector in EnC countries of the Danube region, with 89% being used in Ukraine mainly in the form of renewable electricity.

By 2020 final renewable energy in the Danube region is expected to have developed with a CAGR of 5.5% to reach 82.4 Mtoe (3448.7 PJ), equivalent to 33.6% of expected renewable energy mix in the EU (245 Mtoe).

Final renewable energy in EnC countries of the region will double to 13.7 Mtoe (575.6 PJ), developing with a CAGR of 10.2% from 2013. Their contribution to the final renewable energy mix will rise to 16.7%. Ukraine is expected to develop the fastest in terms of renewable energy mix up to 2020 with a CAGR of 15.5% and contribution of almost 62% of renewable energy mix in EnC countries of the Danube region.

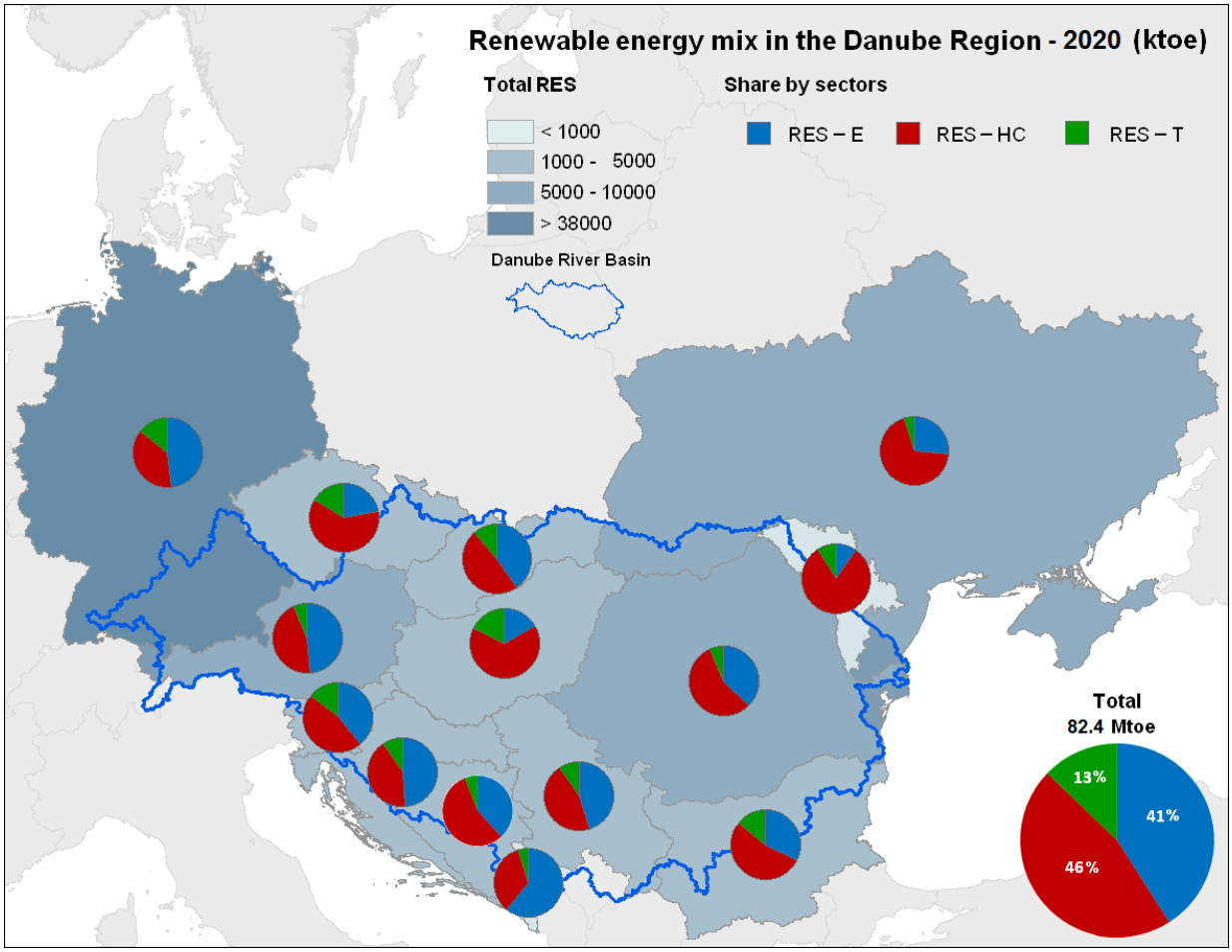


Figure 25. Expected final renewable energy breakdown by sectors in Danube region countries, 2020[62]

[62] See Table A 18 in the Annex of this report for 2020 raw data.

Germany will remain the leading country in terms of final renewable energy in the Danube region with a 46.8% contribution and together with Austria (11.2%) and Ukraine (10.3%) will cover more than two-thirds of the region's expected final renewable energy.

Biomass will still be the main source of final renewable energy in the Danube region in 2020 but its relative contribution will decrease to 47.0% and its development is expected to entail a CAGR of only 3.2%.

Hydropower is also expected to make a relatively smaller contribution in 2020, 14.8%, increasing the absolute figure with a CAGR of 1.5%. Wind power is expected to develop with a CAGR of 11.2% between 2013 and 2020, reaching a contribution of 133 TWh (11.4 Mtoe), equivalent to 14.1% of final renewable energy. Geothermal is expected to have the highest relative increase up to 2020 with a CAGR of 25.5% but with only 1.9% in contribution. Solar's contribution is expected to be 7.7%, developing with a CAGR of 6.5% to reach 6.25 Mtoe (261.7 PJ). Even though in relative terms the contribution of heat pumps will increase by only 1.1 pp, their development is expected to entail a CAGR of 12.3%. The increase in the use of biofuels up to 2020 is expected to entail a CAGR of 11.8%, providing in 2020 a contribution of 11.4% to the region's final renewable energy.

Between 2013 and 2020 the main development among sectors in Danube region is expected in transport with a CAGR of 11.9%, thus reaching the planned 10.6 Mtoe (443 PJ). The fastest developments in this sector are expected to take place in Bosnia & Herzegovina, Ukraine and Croatia with CAGRs of 54.6%, 24.8% and 21.9%. The EnC countries' contribution will increase to 8.8% of final use of renewable energy in the transport sector in the region.

The development of renewable electricity in the Danube region is expected to entail a CAGR of 5.1%, reaching 34.2 Mtoe (1433 PJ). The EnC countries' contribution to renewable electricity in 2020 is expected to be 12.8%. This sector is expected to develop the fastest in Moldova and Hungary with CAGRs of 39.2% and 11.3%.

With a view to reaching the 2020 target of 38.8 Mtoe (1624 PJ), renewable heating/cooling in the Danube region is expected to develop with a CAGR of 3.7%. EnC countries will double their share in the final renewable heat expected by 2020 to more than 22%. Ukraine is expected to have the fastest development with a CAGR of 18.8%, more than three times its absolute figure, and together with Germany (37.2%) and Austria (10.8%) will cover almost two thirds of expected renewable use in the heating/cooling sector of the Danube region.

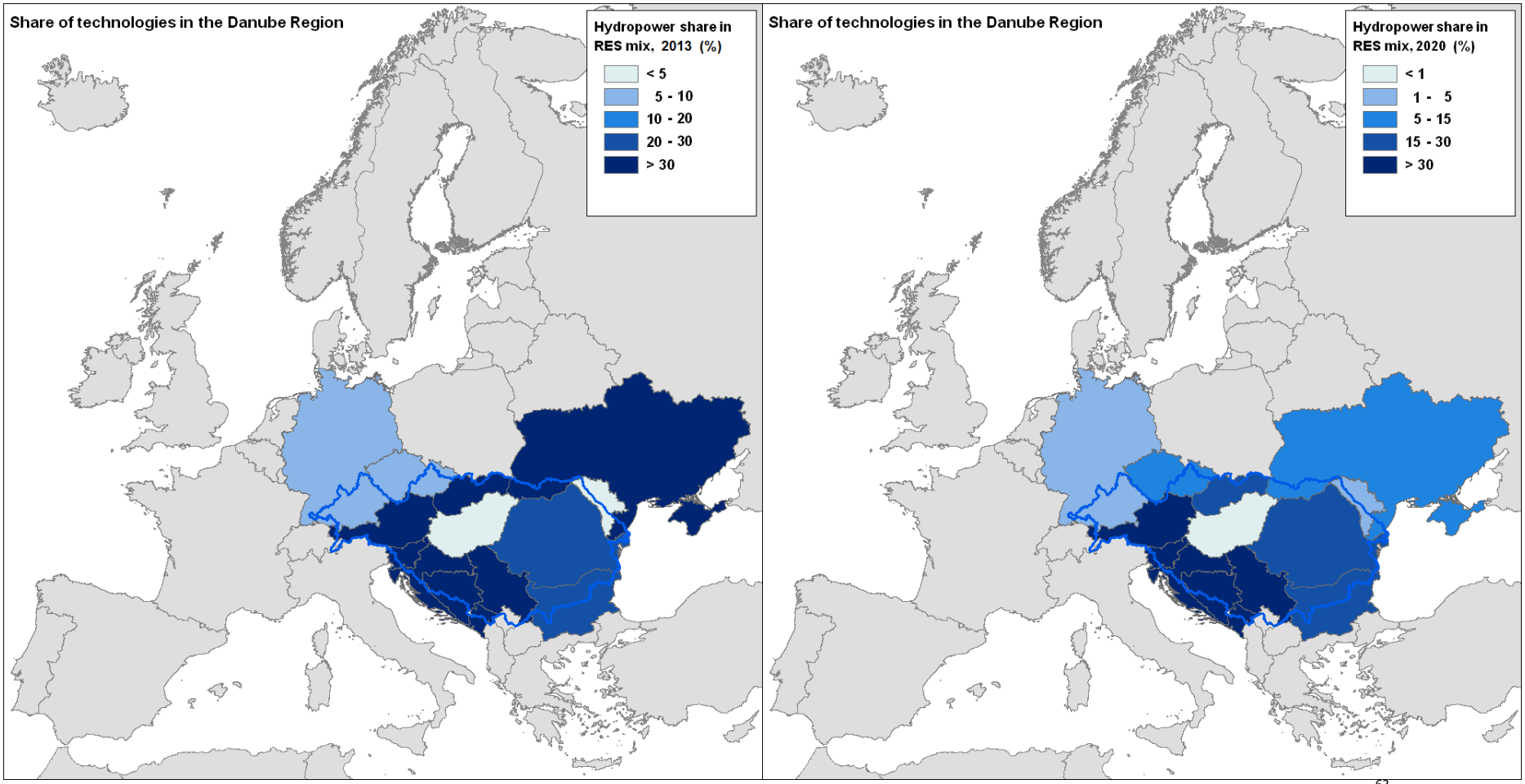


Figure 26. Relative contribution of hydropower technology in each Danube region country final renewable energy, 2013 (left) – 2020(right)[63]

[63] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

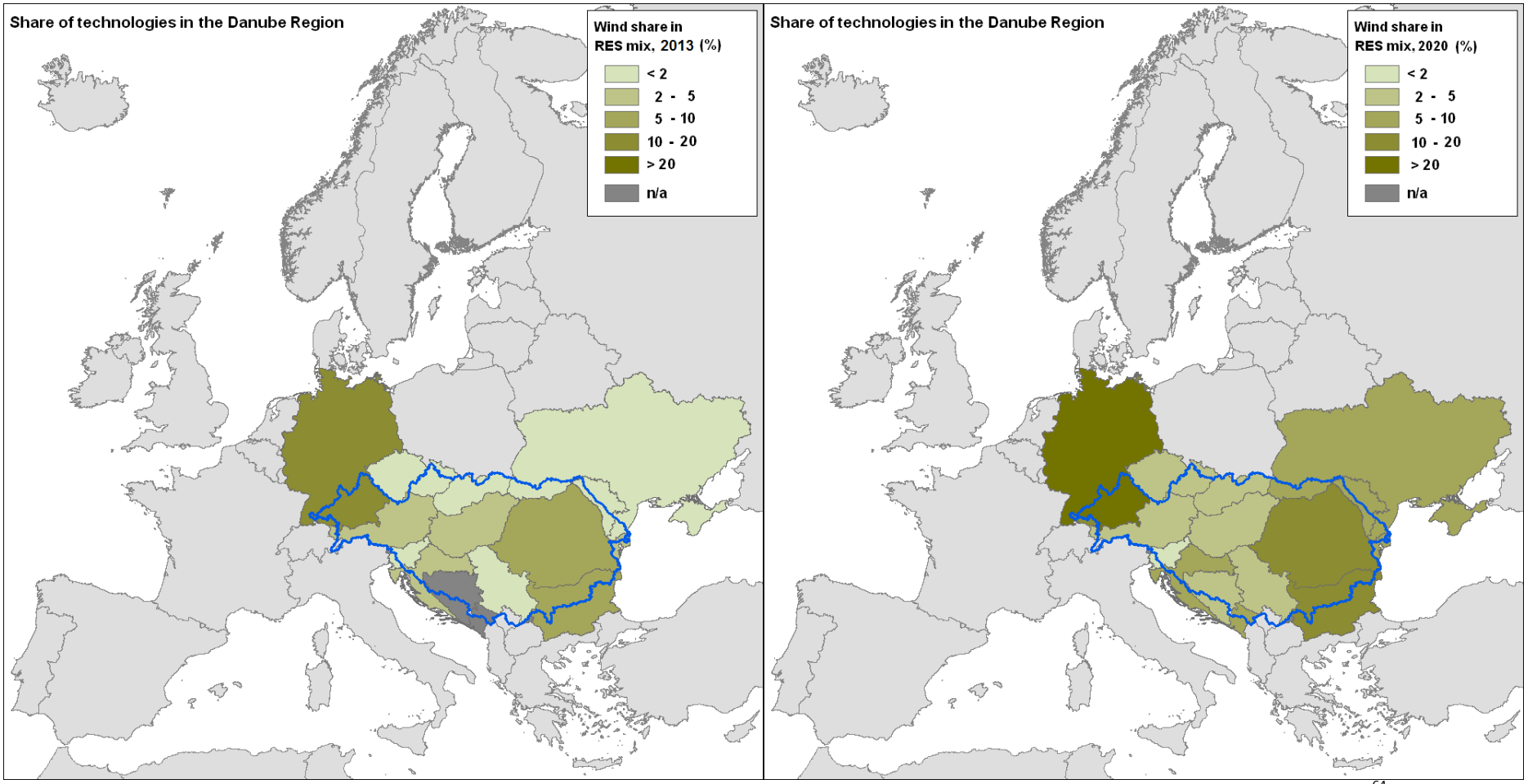


Figure 27. Relative contribution of windpower technology in each Danube region country final renewable energy, 2013 (left) – 2020(right)[64]

[64] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

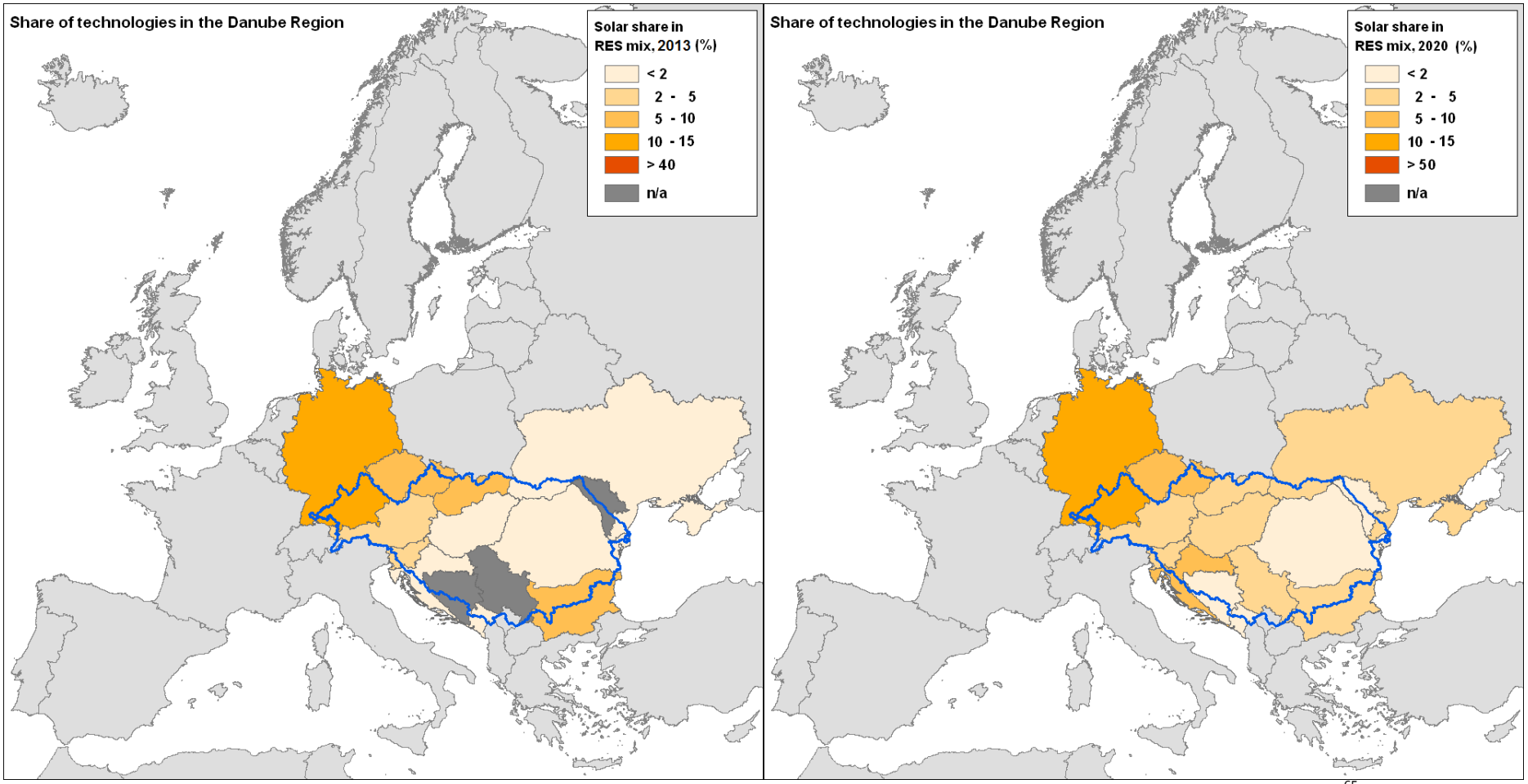


Figure 28. Relative contribution of solar technology in each Danube region country final renewable energy, 2013 (left) – 2020(right)[65]

[65] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

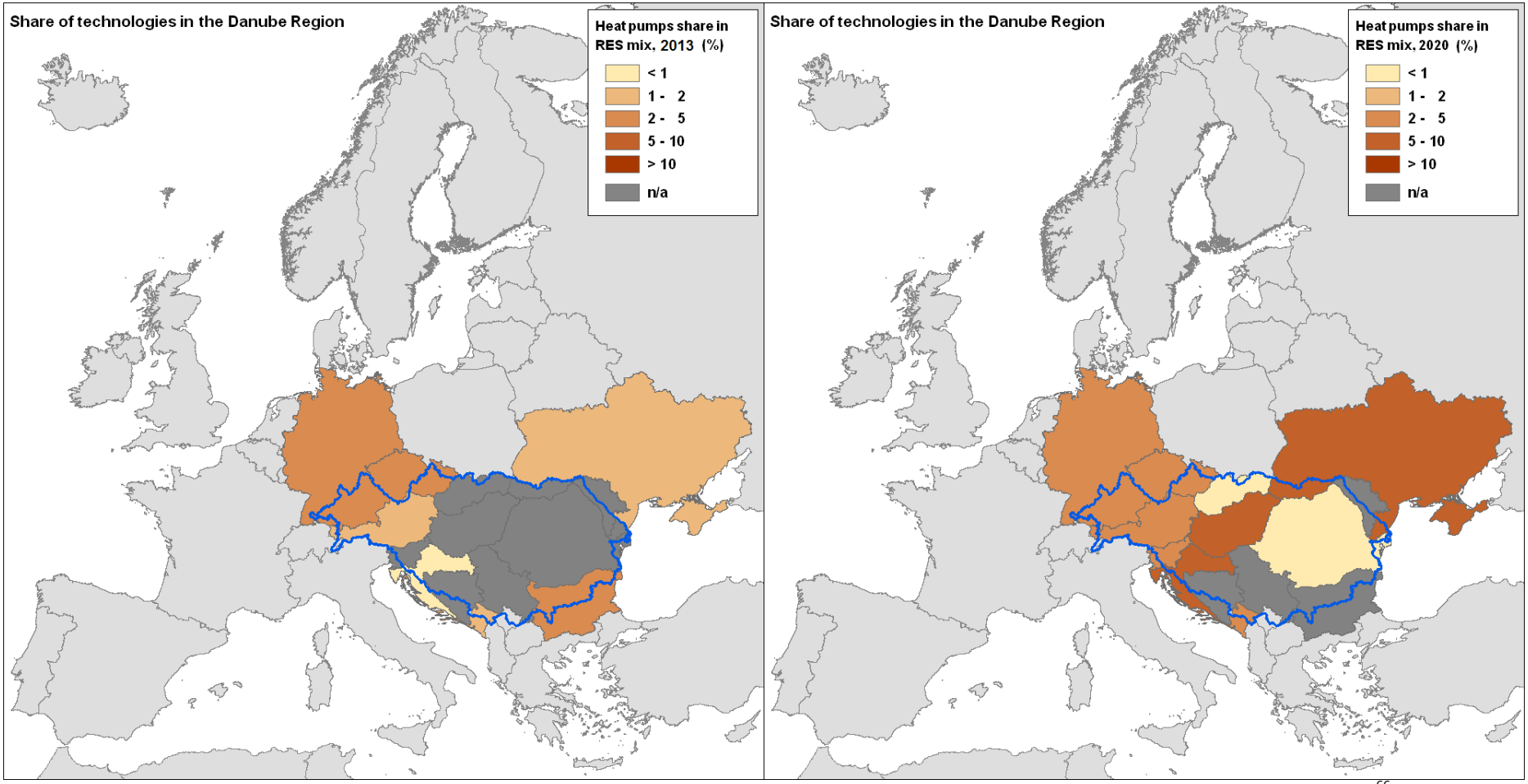


Figure 29. Relative contribution of heat pumps technology in each Danube region country final renewable energy, 2013 (left) – 2020(right)[66]

[66] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

Final renewable energy in electricity sector

Installed capacity

The Danube region's installed electricity capacity of renewable energy was 129.3 GW in 2013, having increased by 38.2% from 93.6 GW in 2010. Almost one-third of renewable energy installed capacity in the region was photovoltaic, followed by wind power (32%), hydropower (28%), biomass (7.0%) and geothermal with only 0.01%. The fastest development between 2010 and 2013 took place in geothermal capacity, +41% yearly in average, while the slowest was in hydropower, at only average annually +2.8% . The EnC countries of the region had 8.4% of renewable energy capacity, down from 10.3% in 2010.

By 2020 the Danube region's renewable energy installed capacity is expected to reach 172.7 GW. Wind power and photovoltaics will be the main renewable technologies in 2020, contributing by 34% each Hydropower technology is expected to increase its absolute capacity by 13.7% but its share in total renewable energy capacity will drop to 24.0%. Geothermal technology capacity is expected to increase the fastest up to 2020, by 48% in average annually, due to the significant effort planned in Germany and Hungary. Nevertheless this technology will remain very marginal with a contribution of 0.23%. The contribution of EnC countries is expected to reach 10.7% in 2020.

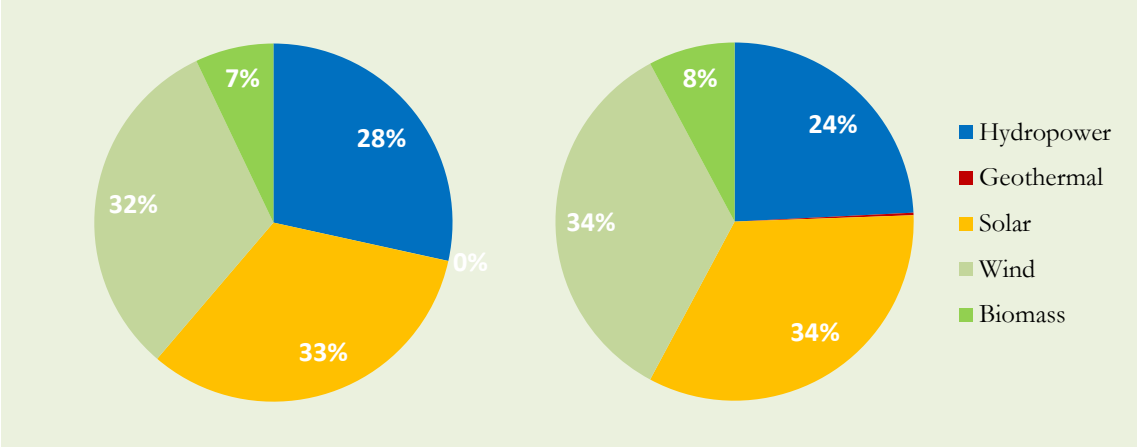


Figure 30. Breakdown of renewable energy capacity in Danube region, 2013 (left) – 2020 (right)[67]

About 21% of hydropower capacity was installed in EnC countries of the Danube region in 2013. Montenegro's renewable energy capacity is totally hydropower and the corresponding share in Serbia and Bosnia & Herzegovina is above 99%. The lowest shares of hydropower capacity in 2013 were reported by Germany (5.4%) and Hungary (7.1%). The highest hydropower capacity in 2013 was found in Austria, at 8038 MW, with the lowest in Moldova (16 MW) and Hungary (58 MW).

In 2013 the EnC countries of the Danube region contributed only 1.8% to total photovoltaic capacity in the area. Photovoltaic installed capacity had the highest penetration in total renewable energy capacity in Czech Republic (54.8%) followed by Germany (44.4%), Bulgaria (26.0%) and Slovakia (23.7%). Germany had in 2013 the highest absolute capacity with 36.3 GW, or almost 86% of total photovoltaic capacity in the region, whereas Bosnia & Herzegovina had the lowest photovoltaic capacity of only 2 MW. Neither Montenegro nor Moldova had any photovoltaic capacity in 2013.

[67] Raw data can be found at Tables A 21 and A 22 in the Electronic Annex of this report.

Wind power in Danube region totalled to 41 GW in 2013, 0.8% of which was situated in the EnC countries in 2013, mainly in Ukraine (334 MW), Moldova 1.1 MW and Serbia 0.5 MW. The highest penetration of wind power in total renewable capacity was found in Germany (42.3%), followed by Hungary (40.5%) and Romania (27.2%). Germany had the highest wind power capacity in 2013, 34.6 GW or almost 85% of total wind power capacity in the Danube region.

In 2013 biomass capacity in the Danube region reached the level of 9.1 GW, to which the EnC countries contributed only 0.4%. More than two thirds of this biomass capacity was installed in Germany whereas Moldova was at the other end of the scale, with only 2.8 MW. The highest penetration of biomass in renewable energy capacity in 2013 was found in Hungary, at 48%, whereas the lowest was in Serbia, at 0.2%. Geothermal technology was used for electricity purposes in only two countries in 2013, namely Germany (24 MW) and Austria (1 MW).

Up to 2020 the EnC countries of the Danube region are expected to make significant changes that will increase their contribution to total renewable energy capacity in the region, moving towards new technologies, wind power and photovoltaics. EnC countries will contribute with 21.2% in the expected 2020 hydropower capacity whereas for other technologies/sources the contributions will be 4.0% in photovoltaics, 5.2% in wind power, 8.4% in biomass and 5.3% in geothermal.

Hydropower will still have the highest penetration in Bosnia & Herzegovina (87.6%), Montenegro (81.3%), Croatia (80.7%), Serbia (80.3%). Wind power is expected to dominate with a share of 85% in renewable energy capacity in Moldova and photovoltaics are expected to cover 51% of renewable energy capacity in Czech Republic. The highest penetration of biomass is expected in Hungary renewable energy capacity (39%) whereas the lowest will be in Bosnia & Herzegovina with only 1.2%.

Final renewable electricity

Final renewable electricity in the Danube region in 2013 amounted to 280.7 TWh (1010.7 PJ), equivalent to 35% of final renewable electricity in the EU. Between 2010 and 2013 renewable electricity in the region developed with a CAGR of 7.8%. Hydropower was the main source of renewable electricity in the Danube region in 2013, with 45%, followed by wind (22.6%), biomass[68] (19%) and solar (13.3%). The biggest expansion among renewable electricity sources occurred in photovoltaics, which increased annually by 44%% over the 2010 level.

The EnC countries contributed significantly to renewable electricity from hydropower (25%) while in other sources their contribution was very marginal. Up to 2020 renewable electricity will develop with a CAGR of 5.1%, to reach 398 TWh (1433 PJ), equal to 33% of expected renewable electricity in the EU. Hydropower and wind power are expected to be the region's main sources of renewable electricity with a respectively contribution of 35.2% and 33.4%. The share of photovoltaics in 2020 will remain at the level of 12% whereas biomass will cover 18.8% of expected renewable electricity. Even though geothermal will have the highest CAGR (+61.6%) between 2013 and 2020, this technology will remain very marginal, contributing only 0.6%.

[68] More on biomass used in the Danube region in 2013 for electricity purposes can be found in bioenergy section of this report.

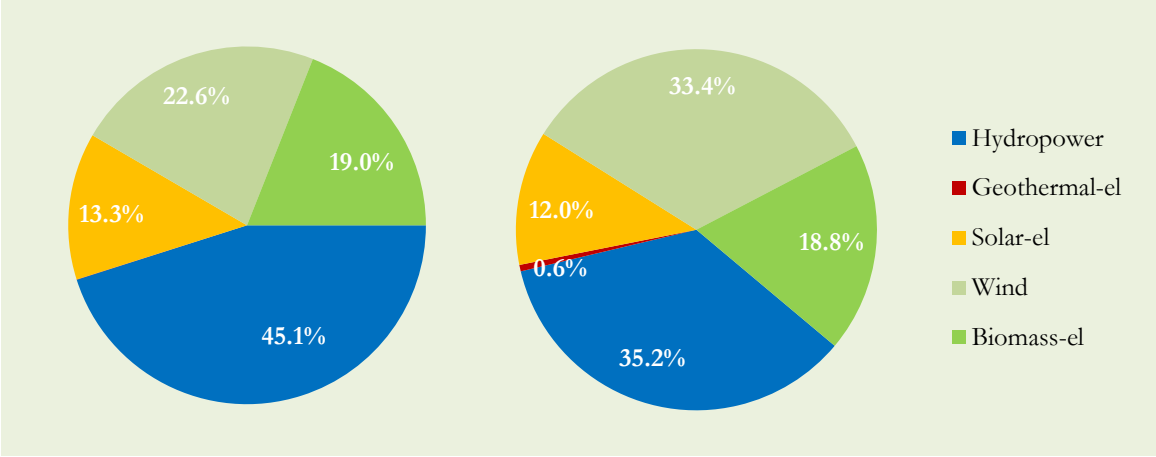


Figure 31. Breakdown of renewable electricity in Danube region, 2013 (left) – 2020 (right)[69]

Almost 12% of renewable electricity in the Danube region in 2013 originated from EnC countries. Montenegro's renewable electricity was totally hydropower, while in Serbia, and Bosnia & Herzegovina this share was above 99%. In Croatia, Moldova and Ukraine the share of hydropower was above 90% whereas in Hungary this contribution was the lowest, only 8.4%. The highest level of renewable electricity from hydropower was found in Austria, at 36 TWh, and the lowest in Moldova, at only 45 GWh. EnC countries contributed 1.5% to renewable electricity from photovoltaics, coming almost totally from Ukraine. The highest penetration of this technology in final renewable electricity was found in Czech Republic (23.2%) and the lowest in Bosnia & Herzegovina (0.1%). The leading Danube region country in 2013 was Germany, with more than 83% of renewable electricity originating from photovoltaics. 638 GWh or 1% was the contribution of EnC in Danube region to the renewable electricity originated from wind power in 2013, generated almost totally in Ukraine. Wind power penetration in renewable electricity in the Danube region countries was highest in Germany (36.0%) and Hungary (26.6%) whereas the lowest penetration of this technology was in Serbia (0.007%).

The leading country was Germany, with 52.7 GWh, covering 83% of total renewable electricity from this technology in the Danube region. Germany was the only Danube region country that reported a contribution of 80 GWh on renewable electricity from geothermal technology. The proposed changes to the structure of renewable electricity in EnC countries of the Danube region involving new technologies, wind power and photovoltaics should by 2020 boost the contribution of those countries to 12.8% final renewable electricity. EnC countries will contribute with 24.5% in the expected 2020 renewable electricity from hydropower whereas for other technologies/sources the contributions will be 4.8% in photovoltaics, 6.5% in wind power, 7.3% in biomass and 5.2% in geothermal.

In 2020 hydropower will have the highest penetration in renewable electricity in Bosnia & Herzegovina (89.4%), Slovenia (83.6%), Serbia (83.2%), Montenegro (81.5%) and Austria (80.4%). Wind power is expected to dominate, with a share of 77% in renewable electricity in Moldova, and photovoltaics are expected to cover 22.6% of renewable electricity in Czech Republic.

[69] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

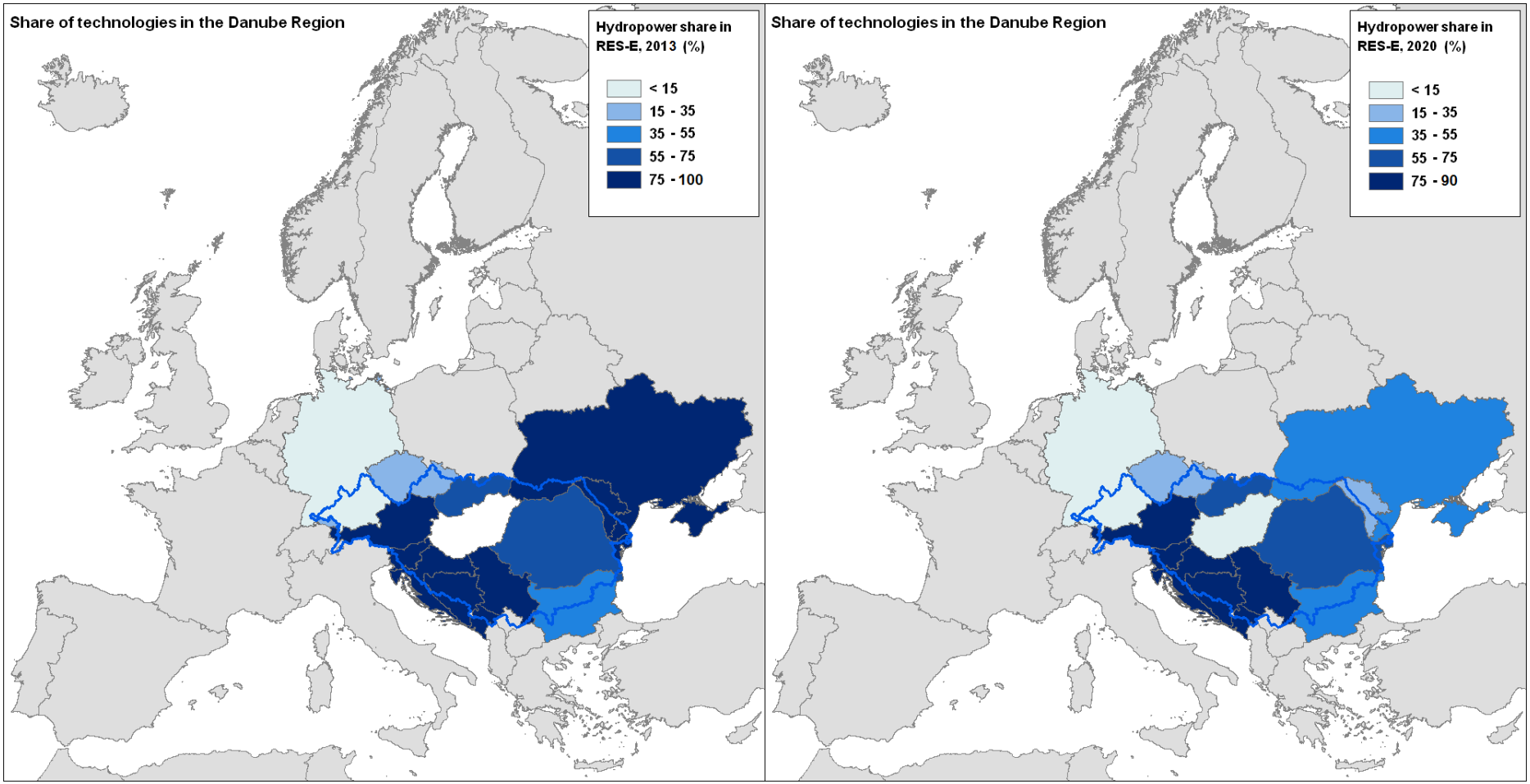


Figure 32. Relative contribution of hydropower technology in each Danube region country final renewable electricity consumption,2013 (left) – 2020(right)[70]

[70] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

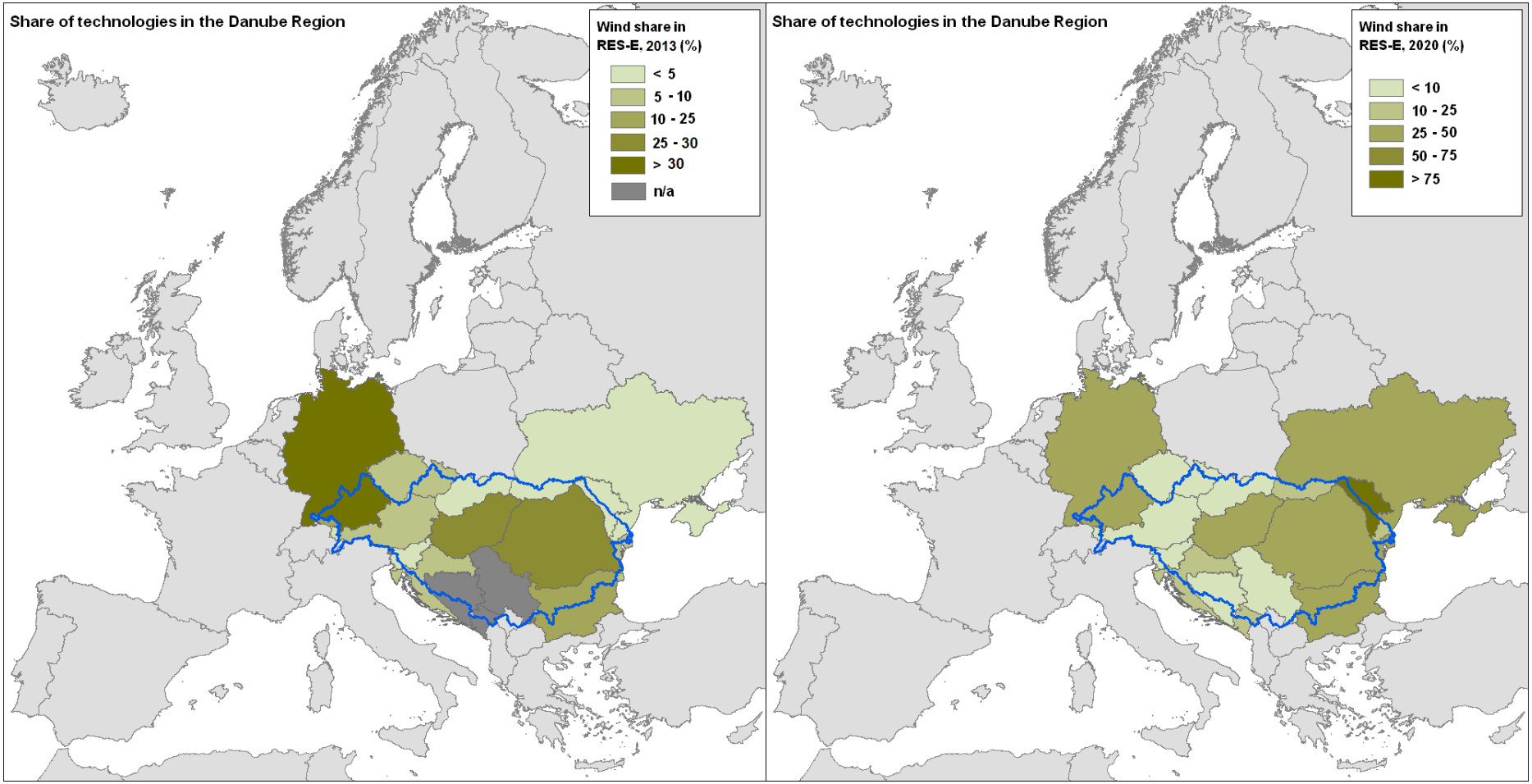


Figure 33. Relative contribution of windpower technology in each Danube region country final renewable electricity consumption, 2013 (left) – 2020(right)[71]

[71] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

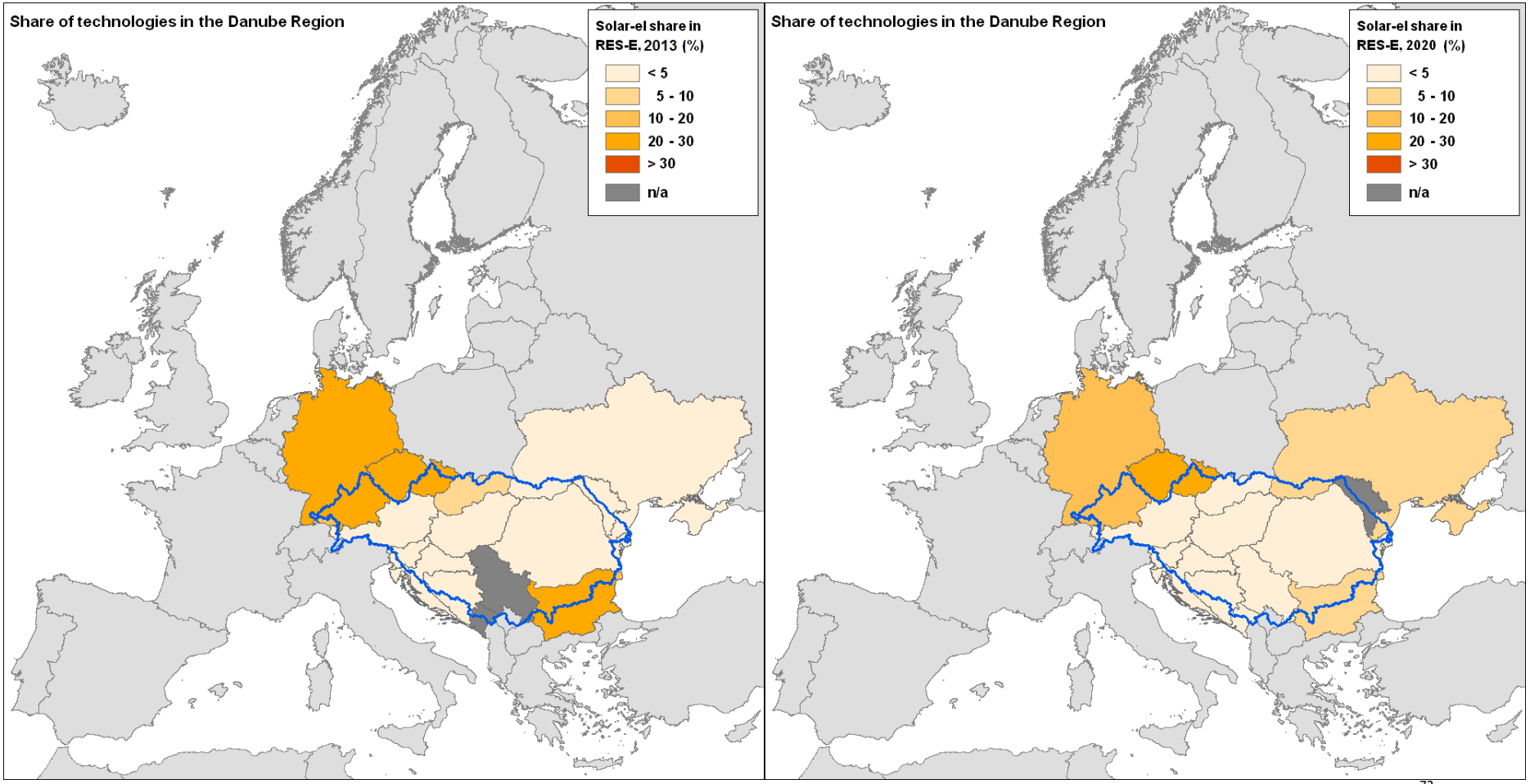


Figure 34. Relative contribution of solar technology in each Danube region country final renewable electricity consumption, 2013 (left) – 2020(right)[72]

[72] Raw data can be found at Tables A 17, A 18, A 25 and A 26 in the Electronic Annex of this report.

Final renewable energy in heating/cooling sector

Renewable energy in the Danube region's heating/cooling sector reached 30 Mtoe (1260 PJ)[73], 8.4% above the 2010 level. Biomass was the main source of renewable heat in 2013, but the figure of 92.5% was slightly lower than the contribution of 93.7% in 2010. Heat pump technology's share was 3.7%, 0.8 pp higher than in 2010. The contribution of solar thermal increased to 2.7% in 2013 from 2.5% in 2010. Geothermal's contribution, at 314 ktoe, provided only 1.0% of renewable heat in the Danube region.

Up to 2020 renewable heat consumption in the Danube region is expected to increase by 29% (+8.7 Mtoe). The penetration of technologies such as heat pumps, solar and geothermal will increase in the final consumption of renewable heat, whereas the contribution from biomass will drop to 84.5%.

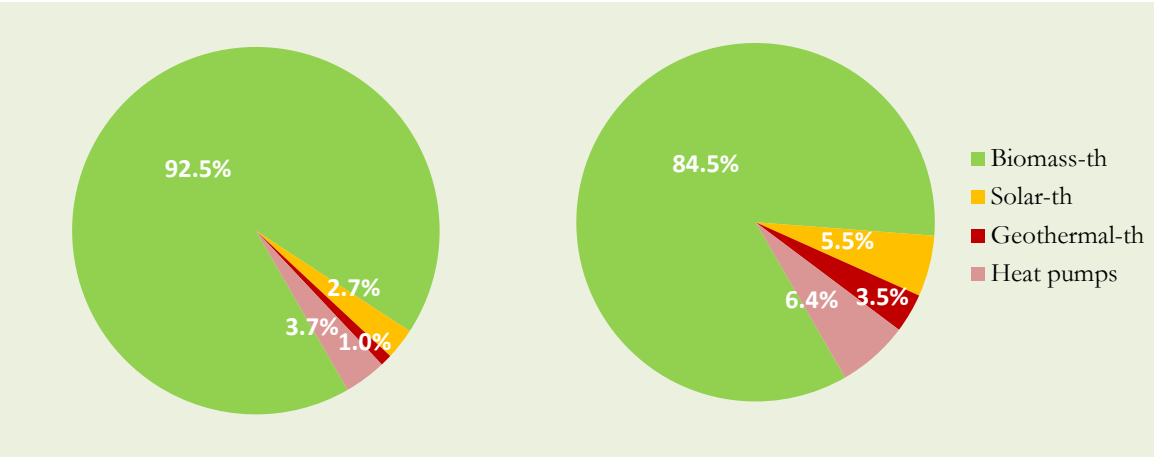


Figure 35. Breakdown of renewable energy heat in Danube region, 2013 (left) – 2020 (right)[74]

About 13.6% of renewable heat in the Danube region in 2013 was consumed in EnC countries with Ukraine, Serbia and Bosnia & Herzegovina accounting respectively for 42.8%, 25.3% and 23% of this consumption. Montenegro had the lowest consumption of renewable energy in the heating/cooling sector with only 94 ktoe (3.9 PJ). Among EU countries of the Danube region, Germany made the biggest contribution in 2013, with 41.8% (10.9 Mtoe).

Biomass used for heating/cooling[75] purposes in the Danube region reached the level of 27.9 Mtoe (1166 PJ) in 2013, equivalent to 35.5% of renewable energy originated by this source in the EU the same year. By 2020 the use of biomass is expected to have increased by 17.7%, reaching 32.8 Mtoe (1373 PJ).

Heat pumps were the second source of renewable heat in the Danube region in 2013 with 1108 ktoe (46.4 PJ), equivalent to 15% of renewable energy originating from this source in the EU for the same

[73] Ukraine reported for 2013 only the final renewable energy consumption in heating/cooling sector. In order to be consistent with the Ukraine NREAP the final renewable energy consumption in this sector is distributed between biomass and heat pumps, keeping for heat pumps the same figure reported in the NREAP for 2009.
[74] Raw data can be found at Tables A 29 and A 30 in the Electronic Annex of this report.
[75] More on biomass used in the Danube region in 2013 for heating/cooling purposes can be found in bioenergy section of this report.

year. The EnC countries contributed 3.9%, less than the contribution of 5.4% in 2010. The highest penetration of this technology in final renewable heat consumption was found in Germany (6.8%), Bulgaria (5.7%) and Montenegro (4%). Seven countries of the Danube region (HU, RO, SI, SK, RS, MD and BA) have not yet introduced this technology in the heating/cooling sector.

Up to 2020 this technology is expected to double its absolute contribution, reaching 2492 ktoe (104.3 PJ), equivalent to 20.2% of the expected contribution from this technology in the EU. The highest absolute contributions are expected from Germany (1145 ktoe) and Ukraine (600 ktoe).

Solar technology in heating/cooling in the Danube region increased by more than 25% between 2010 and 2013 reaching 824.8 ktoe (34.5 PJ), equivalent to 44.2% of the contribution of this technology in the EU in the same period. Among EnC countries only Montenegro introduced this technology in 2013, with 1.0 ktoe and a share of only 1.1% in its final renewable heat consumption. The highest penetration of this technology in the Danube region reached 5.4% in Germany and 3.9% in Austria.

Solar heat/cold is expected to reach 2134 ktoe (89.3 PJ) in 2020 increasing yearly with an average growth rate of 14.5%. EnC countries are expected to increase up to 12.5% their contribution in the final solar heat/cold in the region. Ukraine is expected to provide 75% of this contribution. The fastest development of this technology among Danube region countries is expected to take place in Romania with a CAGR of 130% from the very low level of 0.2 ktoe in 2013. The highest penetration of this technology in final renewable heat expected in 2020 will be found in Croatia (16%) and Germania (8.6%).

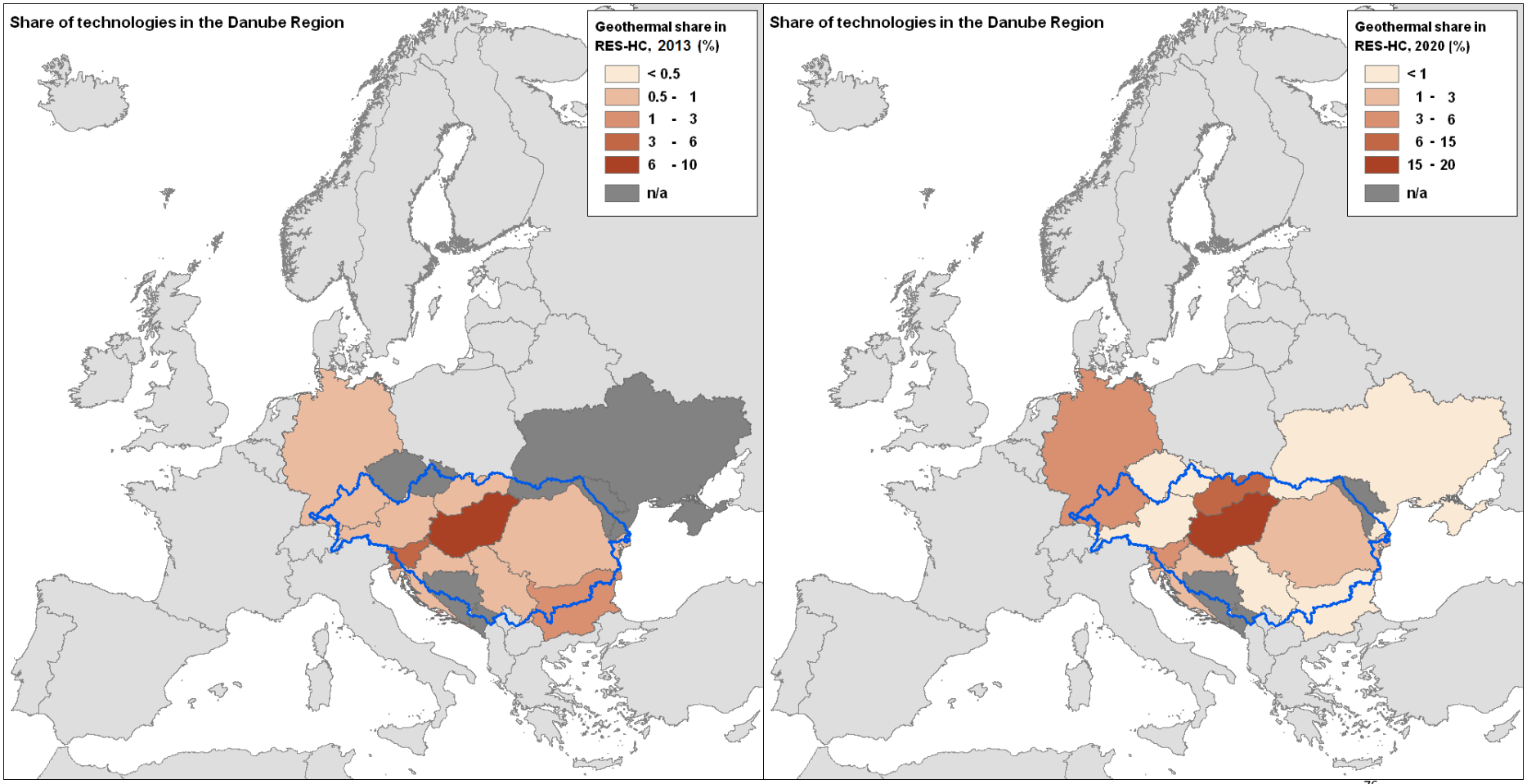


Figure 36. Relative contribution of geothermal technology in each Danube region country final renewable heat, 2013 (left) – 2020(right)[76]

[76] Raw data can be found at Tables A 17, A 18, A 29 and A 30 in the Electronic Annex of this report.

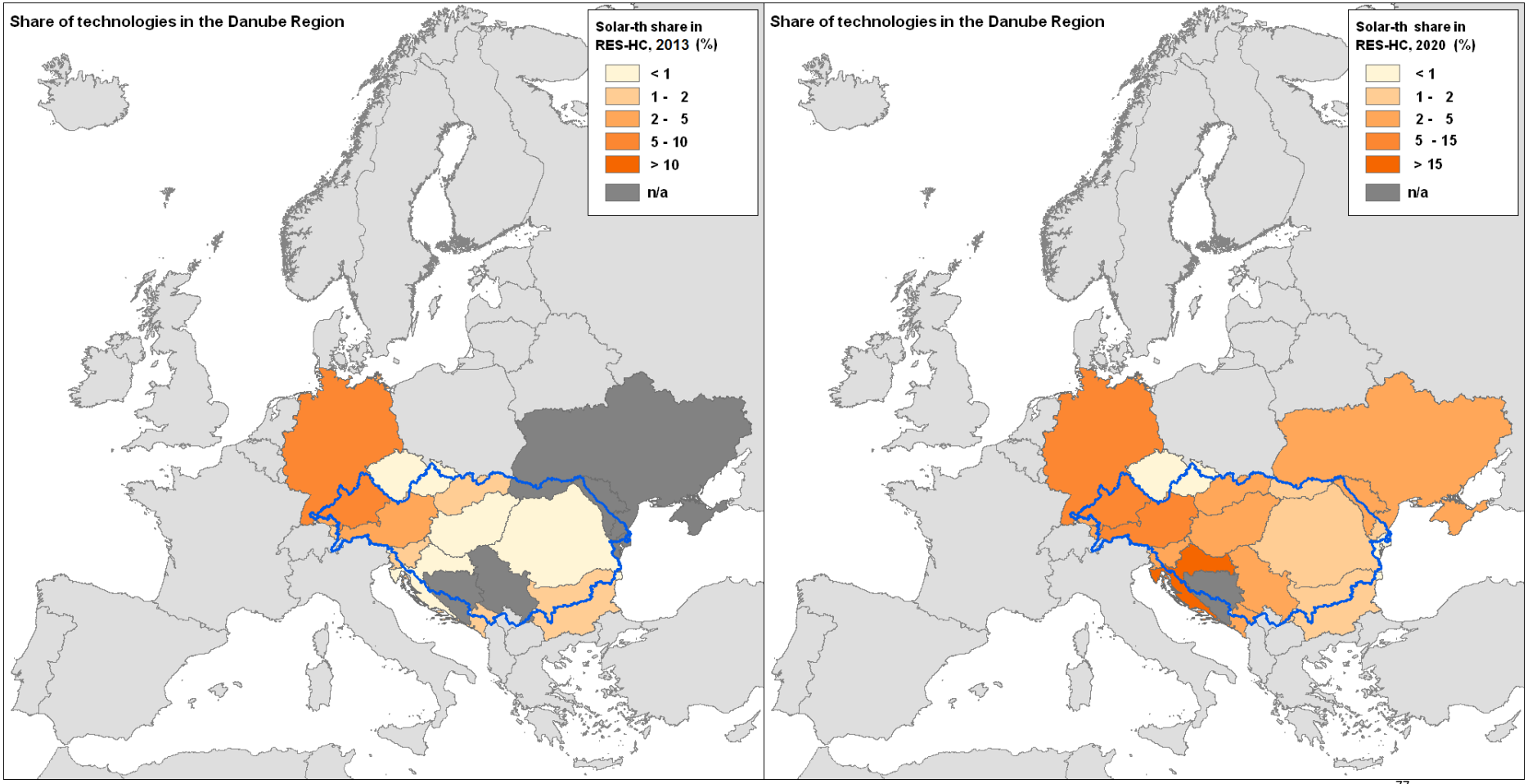


Figure 37. Relative contribution of solar technology in each Danube region country final renewable heat consumption, 2013 (left) – 2020(right)[77]

[77] Raw data can be found at Tables A 17, A 18, A 29 and A 30 in the Electronic Annex of this report.

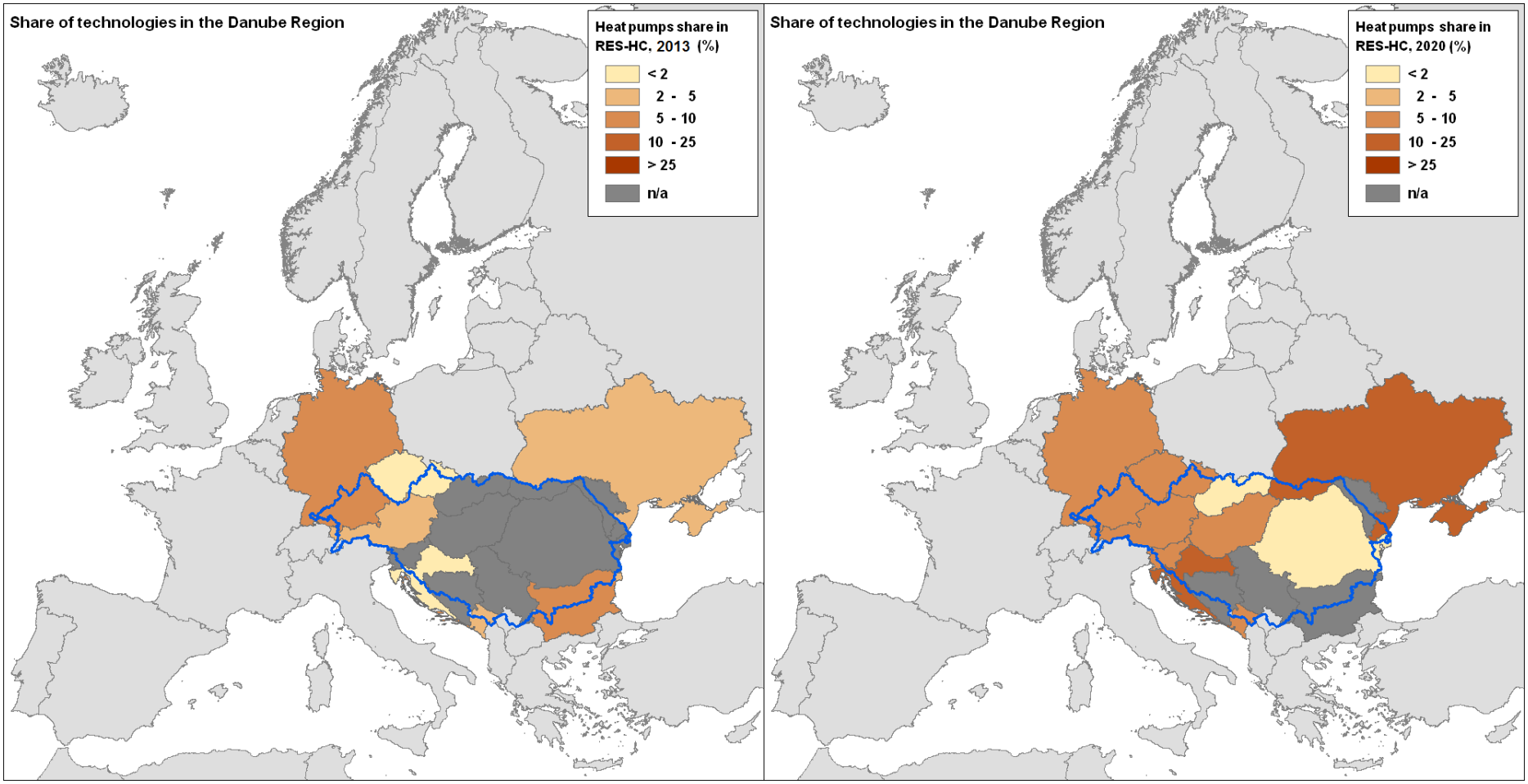


Figure 38. Relative contribution of heat pumps technology in each Danube region country final renewable heat consumption, 2013 (left) – 2020(right)[78]

[78] Raw data can be found at Tables A 17, A 18, A 29 and A 30 in the Electronic Annex of this report.

Final renewable energy in transport sector

Final renewable energy consumption in the Danube region's transport sector amounted to 4801 ktoe (201 PJ) in 2013, equivalent to 35.4% of final renewable energy consumed in the same sector in the EU. In this year the Danube region use 7% more renewable energy in transport sector compared with year 2010.

In terms of Danube region's final consumption of renewable energy and gross final energy consumption in 2013, the shares of renewables in transport sector were respectively 8.1% and 1.1%. The consumption of renewable energy in the transport sector amounted to 5.3% of gross final energy consumption in this sector. The EnC countries' contribution was marginal in 2013, at only 2.5% of the final consumption of renewables in this sector, mainly Ukraine's contribution.

The final consumption of renewables in the Danube region's transport sector is expected to reach 10.6 Mtoe (443 PJ) by 2020, equivalent to 32.7% of expected final consumption of renewables in the EU in the same year.

The contributions to final consumption of renewable energy and gross final energy consumption in the Danube region are respectively 12.7% and 2.4%, whereas the contribution to gross final energy consumption in transport is expected to be 10.7%. The EnC countries will increase their contribution in 2020 to 8.8% due to the very fast increase planned with a CAGR of 33.8%. The increase in final consumption of renewables in this sector in EU countries is expected to entail a CAGR of 10.9% reaching 9649 ktoe (404 PJ).

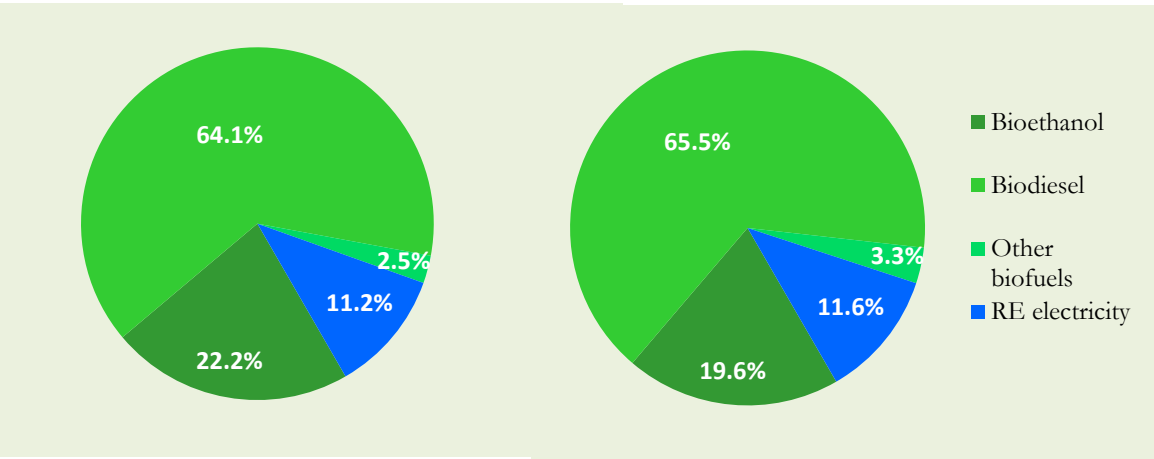


Figure 39. Breakdown of renewable energy in transport sector, Danube region, 2013 (left) – 2020 (right)[79]

Biofuels[80] contribution to final consumption of renewable energy in the transport sector in the Danube region in year 2013 was 88.7%, almost the same level as in 2010. In 2013 biodiesel was the main source of renewable energy used in this sector contributing with 64%. Bioethanol contributed with 22.2% whereas the rest was covered by renewable electricity (11.2%) and other biofuels (2.5%). By

[79] Raw data can be found at Tables A 33 and A 34 in the Electronic Annex of this report.
[80] More details on biofuel use in the Danube region's transport sector can be found in the bioenergy section of this report.

2020 it is expected that the contribution of biofuels will have decreased slightly to 88.4 %. Biodiesel will still be the main source with a higher contribution (65.5 %), followed by bioethanol (19.6 %) and other biofuels (3.3 %).

Renewable electricity in transport sector amounted to 538 ktoe (22.5 PJ) in which the contribution of Enc countries counted for 13.7% (74 ktoe), thanks to Ukraine's (65 ktoe), Bosnia & Herzegovina's (5.4 ktoe) and Montenegro's (3.4 ktoe).

Among EU countries, use of renewable electricity in this sector was highest in Germany and Austria, covering more than 80 % of the EU countries' contribution. In 2020 the use of renewable energy in Danube region transport sector is expected to more than double in absolute terms even that its relative contribution will increase slightly to 11.6%. The use of renewable electricity in the transport sector is expected to increase faster in EU countries (CAGR +11.4 %) compared with EnC countries (CAGR +7.4 %).

Germany will remain the leading country in the Danube region as regards use of renewable electricity in the transport sector in 2020 and together with Austria will cover more than 75% of the total contribution. Ukraine plans to increase the use of renewable electricity by 2020 with a CAGR of 8.5 %, covering almost 90 % of the expected use in EnC countries.

Bioenergy in the Danube region

Final renewable energy from both bioelectricity, bioheat and biofuels (bioenergy) totalled 36.7 Mtoe in 2013 and is expected to reach 48.6 Mtoe in 2020; in 2013 bioenergy contributed to almost 62.7 % of the final renewable energy in the Danube region, a contribution that is expected to decrease to 59 % in 2020; Solid biomass was the main source of bioenergy covering more than three quarters of final bioenergy consumption, a contribution that will decrease to 68 % in 2020;

Final renewable energy from both bioelectricity and bioheat reached 32.4 Mtoe in 2013, more than 88% of bioenergy, and is expected to increase up to 39.2 Mtoe by 2020 but with a lower share at 81%.; Bioheat was the main form of Danube region bioenergy in 2013 and this is not expected to change in 2020.

In 2013 total primary energy from biomass (biomass supply) for use in electricity and heating/cooling sectors in the Danube region amounted to 36.3 Mtoe, of which almost 95 % was domestically produced. This supply is projected to increase by nearly 38% up to 47.6 Mtoe in 2020; domestic forestry was the main biomass feedstock used for energy purposes with more than 69% contribution in total domestic biomass used for electricity and heating/cooling.

The countries of the Danube region provide current data and projections of the expected development of bioenergy up to 2020 in three main sectors (electricity, heating/cooling and in transport sector) and the availability of three main feedstock categories: agriculture, forestry and waste.

Bioenergy[81] final consumption for energy purposes in the Danube region increased annually in average by 3.2 % between 2010 and 2013, amounting to 36.7 Mtoe (1536.6 PJ), equivalent to 35.5 % of final energy from three biomass markets in the EU.

In 2013 final consumption of bioenergy contributed 62.7 % to the final renewable energy mix in the Danube region and only 8.7 % of gross final energy consumption was covered by bioenergy. In 2013 almost 76% of bioenergy contribution in the Danube region was used for heat purposes whereas electricity and transport profited respectively by receiving 12.5% and 11.6% of final bioenergy consumed in the same year. In 2013 bioenergy consumption per capita in the Danube region was 175.6 kgoe/capita (7.4 GJ/capita), which was lower than consumption in the EU, at 204.2 kgoe/capita (8.5 GJ/capita). Austria had the highest final consumption of bioenergy per capita, 605.2 kgoe/capita (25.3 GJ/capita), whereas Ukraine had the lowest, 38.6 kgoe/capita (1.6 GJ/capita).

[81] Final renewable energy from bioenergy is the sum of both final renewable electricity and final renewable heat from biomass and biofuels use in transport sector. In this section bioenergy final consumption for energy purposes or bioenergy use refers to the final renewable energy from bioenergy. Hereafter "bioelectricity" will refer to the final renewable electricity from biomass and "bioheat" to the final renewable heat from biomass. Bioelectricity and bioheat comprises three categories: solid biomass, biogas and bioliquids.

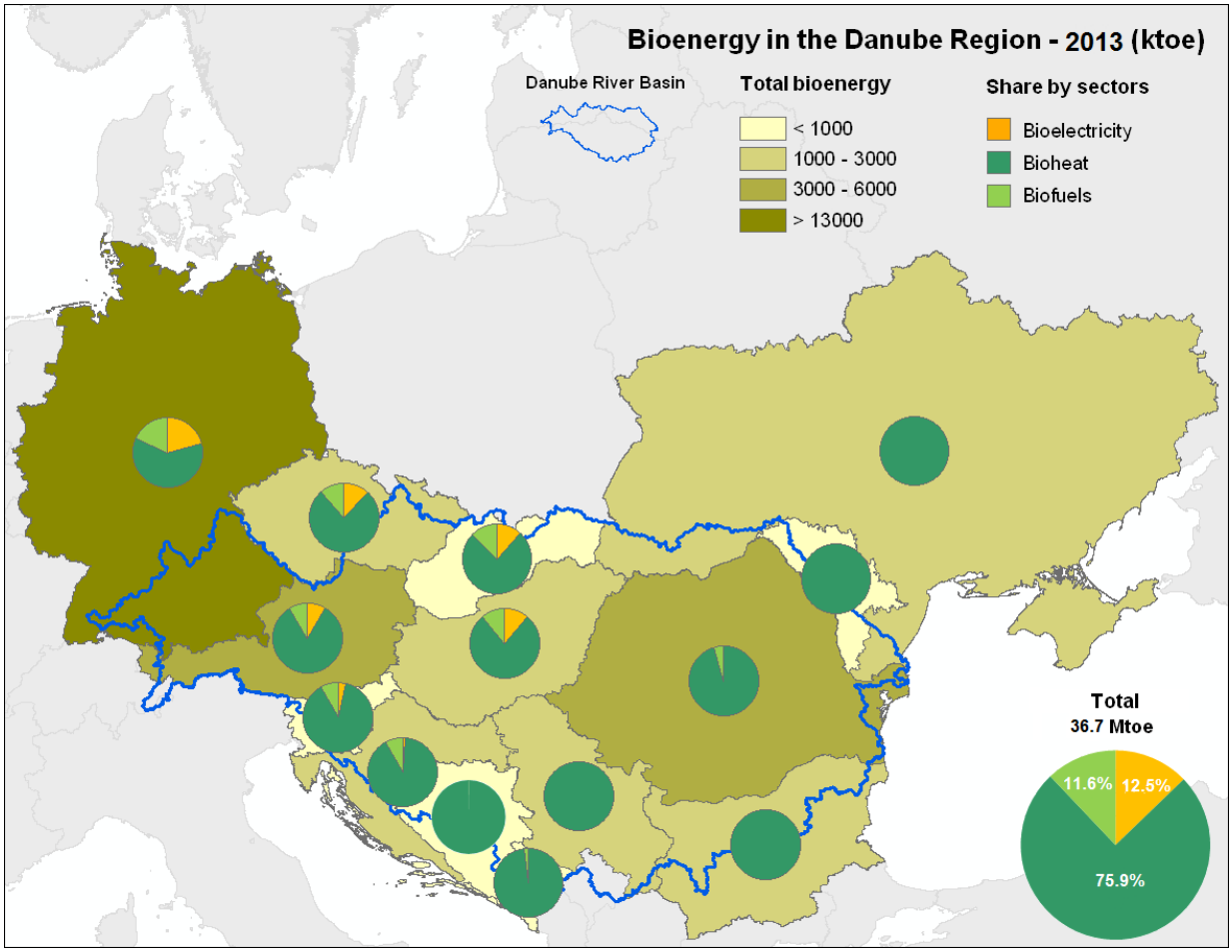


Figure 40. Breakdown of final consumption of bioenergy in Danube region, 2013[82]

EnC countries contributed just over 11% in 2013 to final consumption of bioenergy in the Danube region, of which more than 90% was developed in Ukraine (43%), Serbia (25.2%) and Bosnia & Herzegovina (23%). Germany had the highest absolute bioenergy production in 2013 in the countries from the Danube region with 15.7 Mtoe (658.7 PJ) that together with Austria (5.1 Mtoe) and Romania (4 Mtoe) covered more than 2/3 of total bioenergy in the Danube region. The development of bioenergy was faster than planned in seven countries of Danube region (BG, HU, AT, RO, SI, HR and RS).

The contribution of bioenergy in the Danube region is expected to increase until 2020 with a CAGR of 4.1% to reach 48.6 Mtoe (2033.2 PJ), equivalent to 34.8% of expected bioenergy contribution in the EU.

Despite this increase in absolute terms, bioenergy's relative contribution to the final renewable energy mix in the Danube region will decrease to 59% whereas the contribution in gross final energy consumption will increase to 11.8%. The use of bioenergy for heat purposes is expected to decrease in 2020 with a 67.5% contribution to final bioenergy in the Danube region whereas the contributions in electricity and transport will increase respectively to 13.2% and 19.2%. By 2020 the leading countries in bioenergy use will be Germany (21.1 Mtoe), Ukraine (5.8 Mtoe), Austria (4.63 Mtoe), Romania (4.62

[82] Raw data can be found at Table A 35 in the Electronic Annex of this report.

Mtoe) and Czech Republic (3.4 Mtoe), covering more than 80% of expected bioenergy in the Danube region.

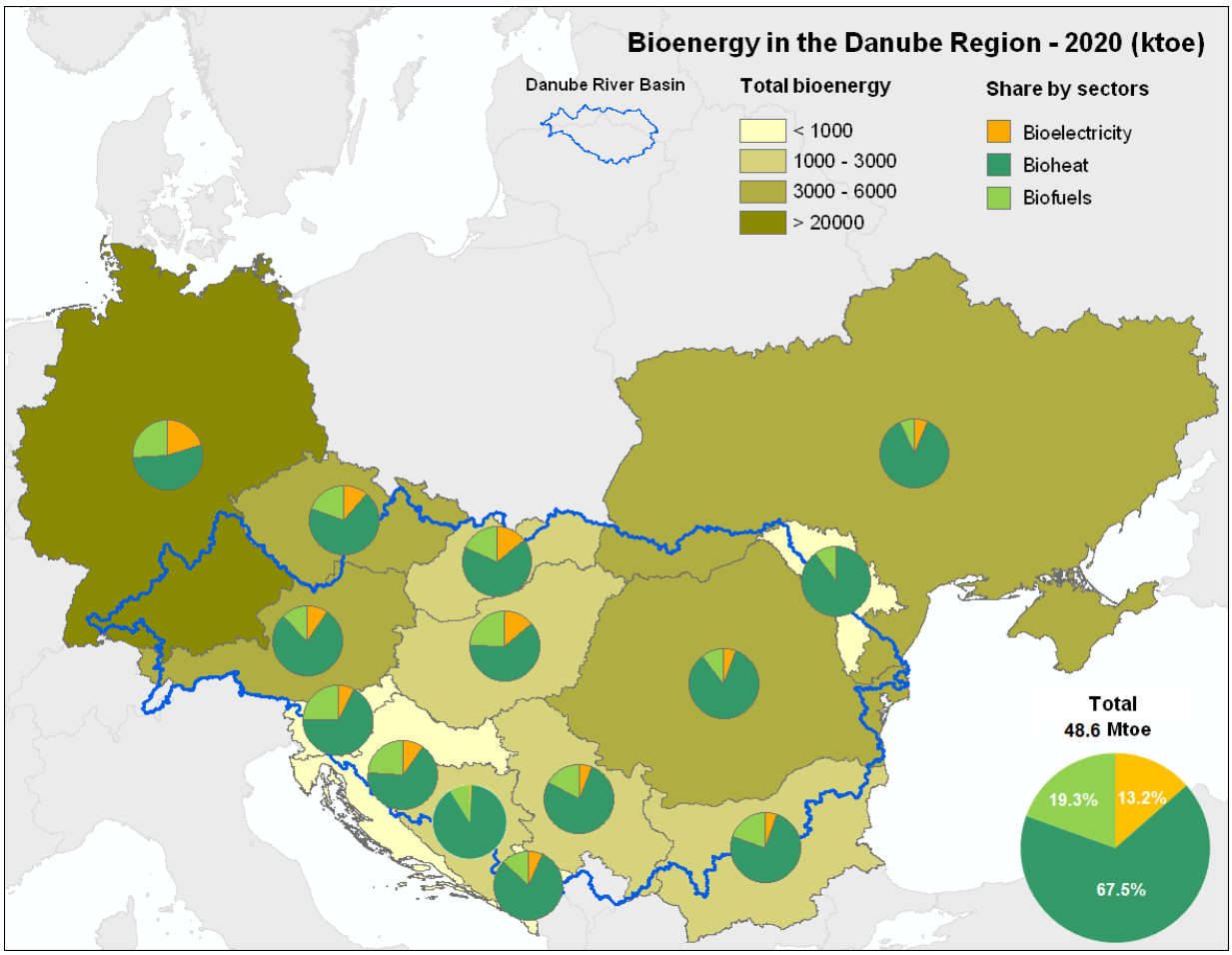


Figure 41. Expected breakdown of final consumption of bioenergy in Danube region, 2020[83]

The EnC countries' contribution in terms of final bioenergy expected to be use should double by 2020, reaching 18.3%, due to rapid development in Ukraine, which will cover almost two fourth of EnC countries' contribution. Ukraine's bioenergy use during 2013-2020 will rise the fastest with a CAGR of 18.5%. The development of bioenergy in other EnC countries of the region will entail a CAGR of 5.2% (Montenegro), 4.9% (Moldova), 4.8% (Serbia) and 3.5% (Bosnia & Herzegovina).

In per capita terms the expected bioenergy consumption in the Danube region will increase to 235 kgoe/capita (9.85 GJ/capita). Austria will still have the highest bioenergy consumption per capita with 527 kgoe/capita (22 GJ/capita) whereas Moldova will have the lowest, at 109 kgoe/capita (4.6 GJ/capita).

[83] Raw data can be found at Table A 36 in the Electronic Annex of this report.

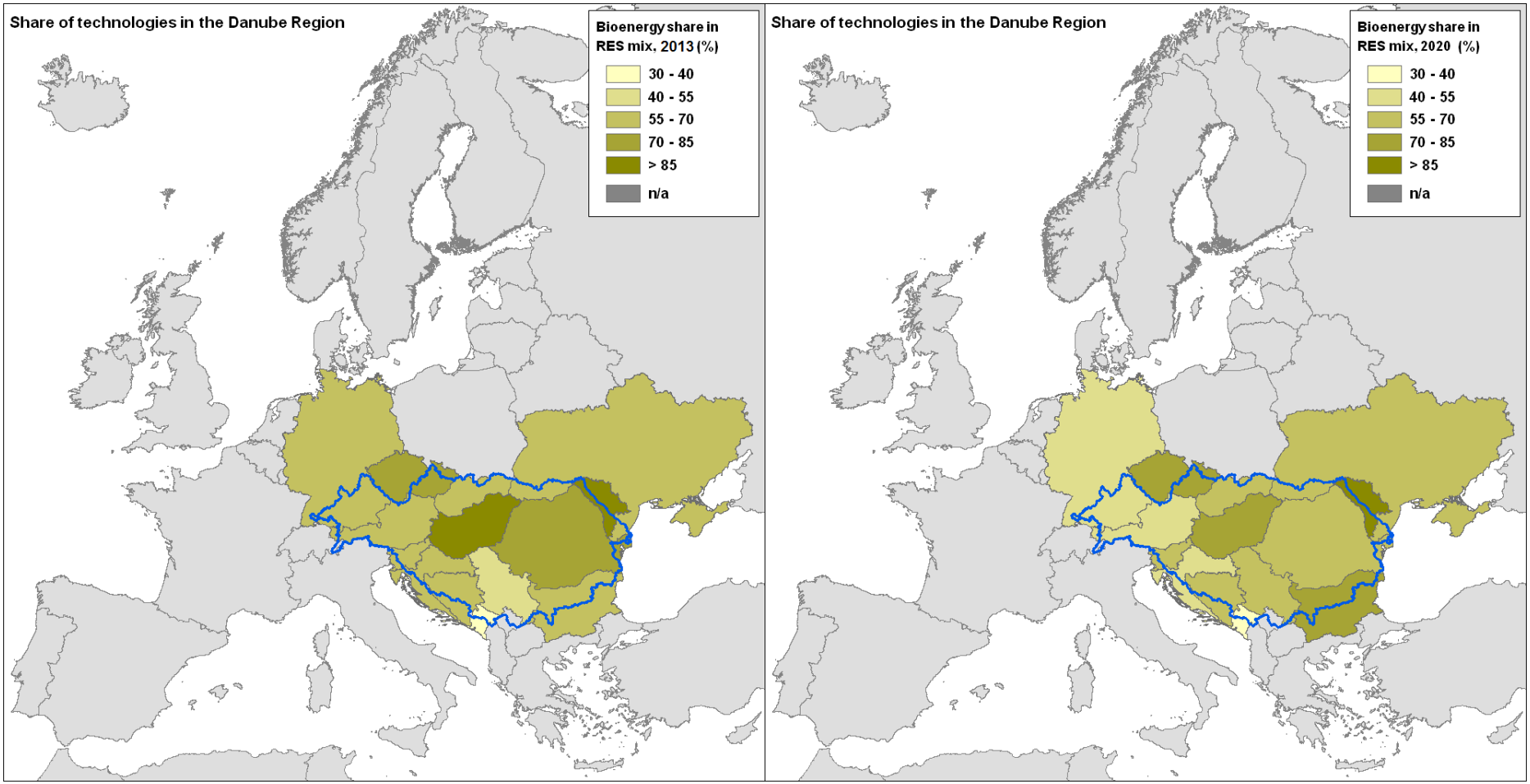


Figure 42. Relative contribution of bioenergy in each Danube region country final renewable energy, 2013 (left) – 2020(right)[84]

[84] Raw data can be found at Tables A 17, A 18, A 35 and A 36 in the Electronic Annex of this report.

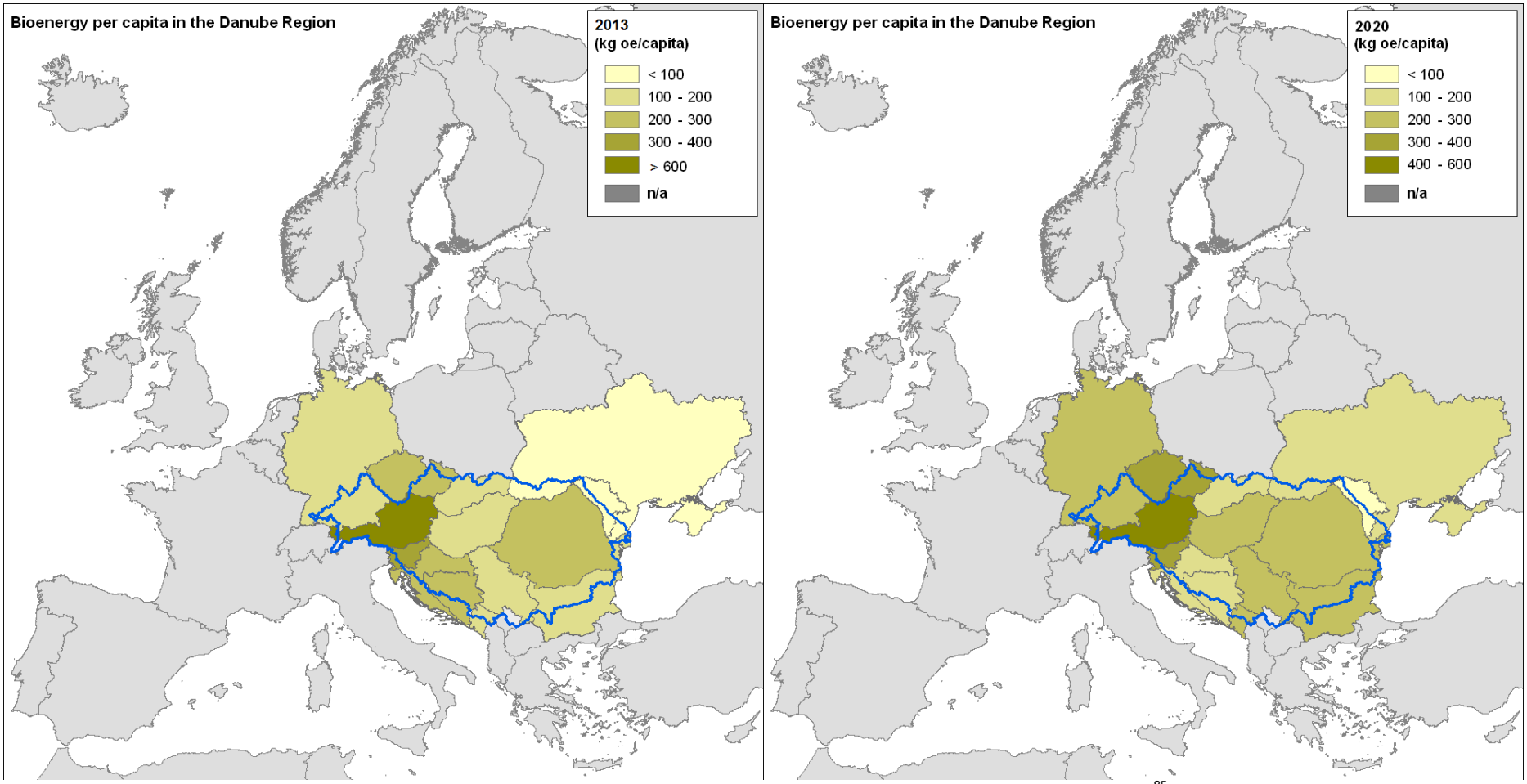


Figure 43. Bioenergy per capita in each Danube region country , 2013 (left) – 2020(right)[85]

[85] Raw data can be found at Tables A 1, A 35 and A 36 in the Electronic Annex of this report.

Final energy from biomass

Final energy from biomass[86] in the Danube region reached 32.4 Mtoe (1358 PJ) in 2013, equivalent to more than 88 % of final bioenergy in the area. In this year bioheat covered almost 86% of final consumption of biomass for energy. In 2013 biomass shared 55.4% of final renewable energy in the Danube region whereas 7.7 % was the contribution in gross final energy consumption. Per capita final consumption of biomass in 2013 was 155 kgoe (6.5 GJ/capita), lower than the EU's consumption of biomass in the same year, at 180.3 kgoe/capita (7.5 GJ/capita). The highest per capita figure was found in Austria, 543.2 kgoe/capita (22.7 GJ/capita) and the lowest in Ukraine, 37.7 kgoe/capita (1.6 GJ/capita).

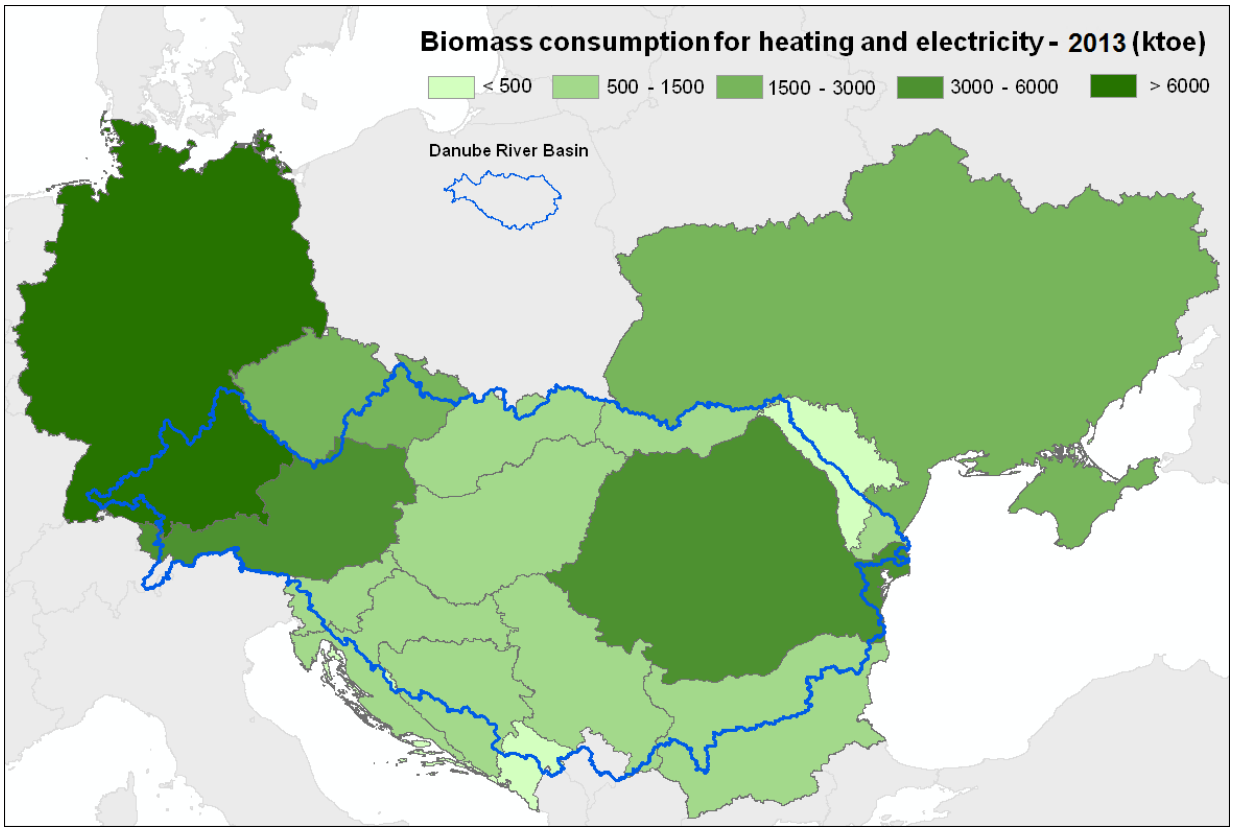


Figure 44. Final consumption of biomass for energy in Danube region countries, 2013[87]

In EnC countries biomass was the main form of bioenergy (98.8%), sharing in 2013 more than 58 % of their final renewable energy but only 4.9 % of gross final energy consumption in these countries. In 2013 biomass originating from EnC countries contributed 12.5 % of final consumption of biomass for energy in the Danube region, mainly in Ukraine (42.3%), Serbia (25.5%) and Bosnia & Herzegovina (23.3%). The EU countries biomass contribution in final renewable energy and gross final energy consumption of the area was respectively 48.5 % and 6.7 %.

[86] Final consumption of biomass in electricity and heating/cooling sectors is calculated as the sum of bioelectricity and bioheat.
[87] Raw data can be found at Table A 35 in the Electronic Annex of this report.

Germany was the leading country in the Danube region, covering nearly 40% of final consumption of biomass in 2013. The final consumption of biomass for energy (bioheat) in Croatia, Austria and Slovenia was in 2013 higher than what these countries have planned even for year 2020.

By 2020 the absolute figure of final consumption of biomass is expected to reach 39.2 Mtoe (1642 PJ), increasing with a CAGR of 2.7%. The contribution in final renewable energy and gross final energy consumption will be 47.6% and 9.2%. Even though the final electricity from biomass will develop faster (CAGR of 4.9%), bioheat will still be the main form of final renewable energy from biomass in the Danube region.

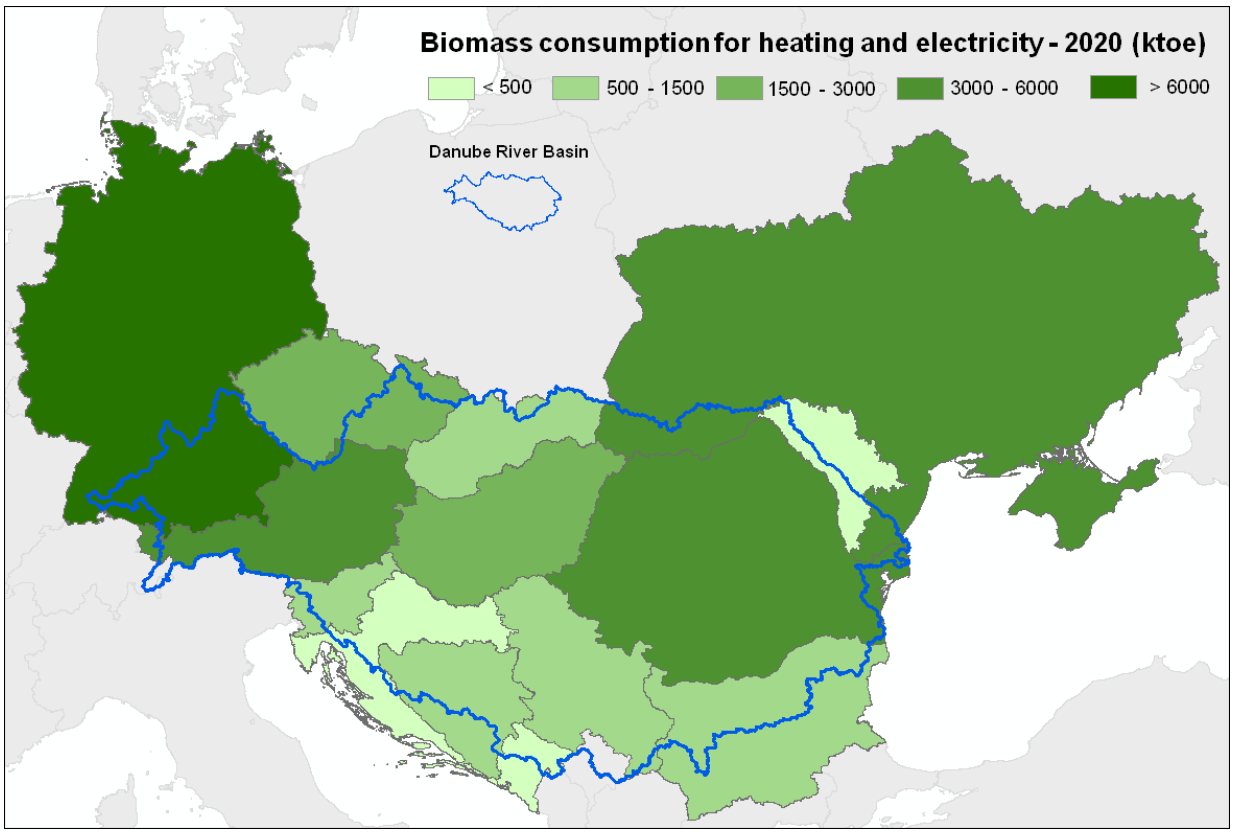


Figure 45. Expected final consumption of biomass for energy in Danube region, 2020[88]

Until 2020 the increase of final renewable energy from biomass in EnC Danube countries is expected to entail a CAGR of 10.4%, reaching 8095.3 ktoe (339 PJ), equivalent to 20.6% of final renewable energy from biomass in the Danube region. The final renewable energy from biomass in EnC Danube countries will in 2020 represent 9.8% of region final renewable energy and 1.9% of expected gross final energy consumption. Ukraine will experience the biggest increase among Danube countries with a CAGR of 17.7% followed by Montenegro with a CAGR of 4.0%.

The increase of final renewable energy from biomass in EU countries of the area is expected to take place with a CAGR of only 1.3% to reach 31.1 Mtoe (1303 PJ), equal to 79.4% of biomass expected in Danube region. The contribution from EU countries to the renewable energy and gross final energy

[88] Raw data can be found at Table A 36 in the Electronic Annex of this report.

consumption is expected to be respectively 37.8% and 7.2%. The fastest development among EU countries in biomass use is expected in Slovakia and Hungary with a CAGR of 6.0% and 4.3%.

In 2020 per capita final consumption of biomass in the Danube region is expected to reach 190 kgoe/capita (7.9 GJ/capita) with the highest final consumption in Austria, at 460.5 kgoe/capita (19.3 GJ/capita), and the lowest in Moldova, at 97.8 kgoe/capita (4.1 GJ/capita).

Final energy from solid biomass

Solid biomass was the main source of bioenergy in the Danube region reaching 27.64 Mtoe (1157.3 PJ) in 2013 with a share of 75.3%, equivalent to 34% of solid biomass used in the energy sector of the EU the same year. 6.3% of solid biomass in 2013 was used for electricity purposes and the rest fed the heating/cooling sector in the Danube region.

Just 15% of solid biomass used in the Danube region for energy purposes in 2013 originated from EnC countries with more than 91% developed in Ukraine (42.8%), Serbia (25.7%) and Bosnia & Herzegovina (22.6%). The main use of solid biomass in these countries was for heat purposes

Leading countries in the final consumption of solid biomass for energy purposes in 2013 were Germany with 9.0 Mtoe (377.8 PJ), Austria with 4.5 Mtoe (188 PJ), Romania with 3.6 Mtoe (152 PJ), Czech Republic with 2.0 Mtoe (92.8 PJ) and Ukraine with 1.7 Mtoe (71.6 PJ). Austria, Slovenia and Croatia exceeded in 2013 their respective plans for 2020 in solid biomass use for energy purposes.

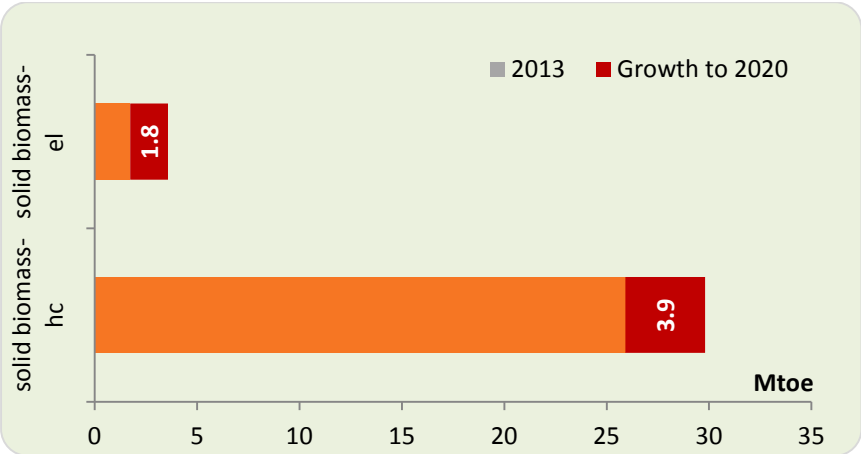


Figure 46. Current and expected growth of bioenergy from solid biomass in Danube region[89]

By 2020 the final consumption of solid biomass for energy purposes in the Danube region is expected to increase with a CAGR of 2.7% to the planned figure of 33.4 Mtoe (1397.3 PJ), equivalent to 35.4% of solid biomass expected to be used in the EU. Despite the increase in absolute terms, the share of solid biomass in final consumption of bioenergy expected in 2020 will decrease to 70.5%. In 2013 the share of solid biomass use in the electricity sector was expected to reach 10.7%.

[89] Raw data can be found at Tables A 27, A 28, A 31 and A 32 in the Electronic Annex of this report.

Due to the rapid increase expected in the final consumption of solid biomass in EnC countries of the region with a CAGR of 10%, the relative contribution of these countries in 2020 will double to 23.3%. With the highest CAGR (+17%) between 2013 and 2020, Ukraine will be the main source of solid biomass within EnC countries of the region, covering two thirds of their contribution. The development of solid biomass in other EnC countries up to 2020 is expected to entail a CAGR of 3.7% in Montenegro and 3.2% in Moldova.

The development of solid biomass in EU countries is expected to entail a CAGR of only 1.1%. The fastest increase between 2013 and 2020 is expected to occur in Slovakia and Hungary and with a CAGR of respectively 4.1% and 3.6%.

The leading countries in the final consumption of solid biomass in the energy sector in 2020 will be Germany with 11 Mtoe (463 PJ) followed by Ukraine with 5.1 Mtoe (214 PJ), providing almost half of the expected contribution of solid biomass.

Final energy from biogas

Final consumption of biogas for energy purposes in the Danube region covered 12% of bioenergy amounting to 4.38 Mtoe (183.2 PJ) in year 2013, equivalent to 60.5% of biogas use in the EU. Just under two thirds of biogas in the Danube region was consumed for electricity purposes in 2013.

The EnC countries' contribution in the final consumption of biogas for energy purposes in 2013 was very marginal, at only 1%, almost totally for electricity purposes. Only Bosnia & Herzegovina used more than 98% of its biogas for heating/cooling purposes.

The leading country in biogas use for energy in the Danube region in 2013 was Germany with 3.8 Mtoe (159.6 PJ), providing more than 87% of the biogas used in the region. Czech Republic was the second provider of biogas for energy with 343.8 ktoe (14.4 PJ), followed by Austria with 99.3 ktoe (4.2 PJ). The development of biogas for energy in Austria was faster than anticipated, exceeding by 50.5% its 2020 plan.

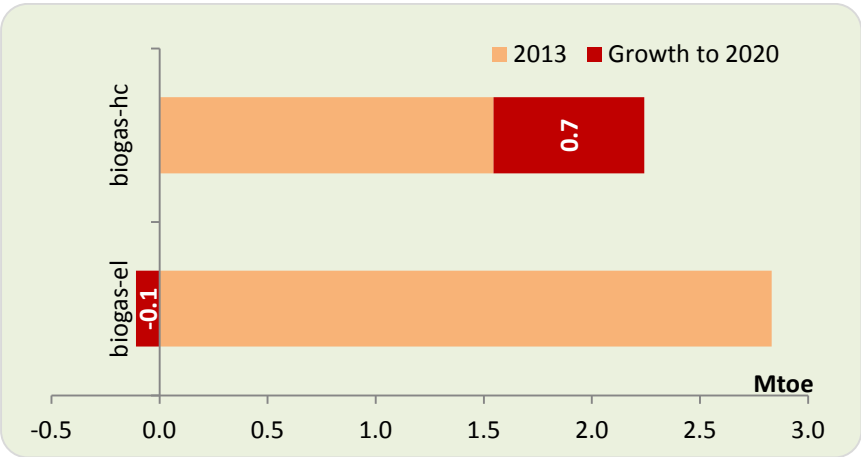


Figure 47. Current and expected growth of bioenergy from solid biomass in Danube region[90]

[90] Raw data can be found at Tables A 27, A 28, A 31 and A 32 in the Electronic Annex of this report.

According to the aggregated NREAPs, final consumption of biogas in the energy sector of the Danube region is expected to reach 4.96 Mtoe (207.8 PJ) by 2020, 13.5% higher than in 2013 and equivalent to 49.5% of the expected biogas use in the EU. The share of biogas in total bioenergy in the Danube region in 2020 is expected to decrease to 10.2%. The fast development of biogas in electricity sector (3.8% above the 2020 plan in 2013) in Danube region might change the 2020 expected contribution.

More biogas for heating purposes is expected to be use in the Danube region in 2020, increasing the share in the final consumption of biogas to 45.2%. The EnC countries' contribution is expected to be boosted with a CAGR of 86.4% due to a significant increase in the final consumption of biogas for the energy sector in these countries. Ukraine has planned a significant increase with a CAGR of 123% up to 2020 whereas the development in Serbia, Moldova and Bosnia & Herzegovina is expected to entail a CAGR of respectively 53.5%, 46.4% and 22.3%.

The leading countries in the Danube region for the biogas consumption in the energy sector will be Germany with 3.7 Mtoe (155.2 PJ) followed by Czech Republic with 429 ktoe (18 PJ) and Ukraine with 259 ktoe (11 PJ).

Bioelectricity

Bioenergy's contribution to the electricity sector (bioelectricity) in the Danube region reached 4587 ktoe (192 PJ) in 2013, equivalent to 35.4% share in final bioenergy consumption in the electricity sector in the EU the same year. The contribution of bioelectricity to the final renewable electricity in the Danube region reached 19% in 2013 whereas only 4.7% of gross final energy consumed in the electricity sector was provided by bioelectricity.

In per capita terms the final consumption of biomass in the electricity sector in 2013 was 22 kgoe/capita (0.9 GJ/capita). Austria and Germany had the highest final consumption of biomass in electricity per person, respectively 46.7 kgoe/capita (1.95 GJ/capita) and 43.94 kgoe/capita (1.84 GJ/capita).

The final consumption of biomass for electricity purposes in EnC countries of the Danube region in 2013 was very low, at 7.0 ktoe, making a minimal 0.15% contribution to the total bioelectricity in the region. More than 70% of bioelectricity in EnC countries was developed in Ukraine (53%) and Bosnia & Herzegovina (17.6%).

More than three quarters of the Danube region's bioelectricity was used in Germany, 3538.6 ktoe (148.2 PJ), followed by Austria with 394.4 ktoe (16.5 PJ) and Czech Republic with 342 ktoe (14.3 PJ).

Renewable electricity from Combined Heat and Power (CHP)[91] units in Danube region totalled to 2360.2 ktoe (98.8 PJ) in 2013, or 9.8% of renewable electricity final consumption in the region, equal to 34% of CHP renewable electricity in EU the same year. As a whole Danube region consumed in the CHP units more than half of its bioelectricity in 2013. Only three countries (CZ, SK and MD) consumed

[91] For the aims of this report the renewable electricity from CHP units in the Danube region is assumed totally biomass originated. Hereafter "bioelectricity consumed in CHP" means "renewable electricity originated from biomass in CHP units".

their total bioelectricity in CHP units in year 2013. In other countries this share ranged from 19.8% in Hungary to 98.8% in Slovenia. Germany consumed the highest amount (1640 ktoe) of bioelectricity in CHP units followed by Czech Republic (342 ktoe) and Austria (230.3 ktoe) whose contribution in final consumption of biomass in CHP units in Danube region was almost 94%. The highest share in final consumption of renewable electricity of biomass consumed in CHP units in Danube region countries was found in Czech Republic with 45.5% followed by Slovakia with 15%, Germany with 13% and Hungary with 12.7%.

The Danube region will be using more biomass in the electricity sector by 2020, with a planned CAGR of 4.9% reaching 6425.3 ktoe (269 PJ), equivalent to 32% of expected bioelectricity in the EU. 6.0% of gross final electricity consumption in the Danube region will be covered by bioelectricity whereas 18.8% will be the contribution in final renewable electricity consumption.

The use of bioelectricity in EnC Danube countries in 2020 is expected to entail a CAGR of 82.2% to reach the figure of 469 ktoe (19.6 PJ), equivalent to 7.3% of bioelectricity in the Danube region. Up to 2020 the EnC countries will experience the fastest development of biomass use in the electricity sector. Ukraine is expected to have the biggest increase with a CAGR of 92.3% followed by Serbia (72.2%), Moldova (46%) and Bosnia & Herzegovina (35%)..

In 2020 bioelectricity expected to be consumed in CHP units would reach 3688.7 ktoe (154.4 PJ) or 10.8% of planned renewable electricity in Danube region. EnC countries of Danube region are expected to consume in their CHP units more than 10% of region bioelectricity. Ukraine has the intention to consume all bioelectricity in the cogeneration process in 2020 whereas for Serbia and Montenegro the proportion of bioelectricity in the cogeneration would reach respectively 15.3% and 39.8%. More than 95% of EnC Danube region countries bioelectricity consumed in CHP units will be in Ukraine.

Five of the Danube region EU countries (BG, CZ, RO, SI and SK) will consume all their bioelectricity in the cogeneration process whereas in other EU countries of the region the proportion of bioelectricity consumed in CHP units would range from 42% in Germany to 90% in Hungary. The highest share of bioelectricity consumed in cogeneration process in final renewable electricity would be found in Hungary (53.4%) followed by Czech Republic (42.4%), Slovakia (21.4%) and Ukraine (16.2%).

Solid biomass and biogas used for electricity

Both solid biomass and biogas installed capacities in the Danube region amounted to 8.9 GW in 2013, or 97% of biomass installed capacity in the region, equivalent to 33% of respective capacities in the EU. With 4.9 GW biogas installation covered more than half of biomass installed capacity in 2013. The contribution of EnC countries in both solid biomass and biogas capacity was very marginal in 2013, at only 0.4%.

Germany was the leading country with a total installed capacity for both solid biomass and biogas of 6.2 GW, more than two thirds of both these biomass sub-categories' capacity.

By 2020 the capacity of both solid biomass and biogas in the electricity sector is expected to increase with a CAGR of 5.8% (+4.3 GW) covering almost 98% of expected biomass capacity in the Danube region. Germany will remain the leading country, keeping the same contribution in relative terms.

The fastest increase of installed capacity of these biomass sub categories will take place among EnC countries as Ukraine (CAGR of 65%) and Serbia (CAGR of 62%). The installed capacity of both solid biomass and biogas in EnC countries will cover almost 9% of the expected total capacity of these biomass sub-categories in 2020, of which almost 84% will be found in Ukraine.

Renewable electricity in the Danube region originating from both solid biomass and biogas amounted to 53.1 TWh (191 PJ), equivalent to 36.2% of renewable electricity in the EU coming from the same sources. The share in final biomass consumed in the Danube region for energy purposes reached 14.1%, to which biogas contributed 62%.

The use of both solid biomass and biogas for electricity purposes in EnC countries of the Danube region was minimal in 2013, only 67 GWh, mainly in Ukraine (64.3%), Serbia /CAGR of 32.4%) and Bosnia & Herzegovina (21.3%).

Just over three quarters of renewable electricity coming from both solid biomass and biogas was covered by Germany (40.9 TWh). Contributions from Austria and Czech Republic were next biggest, at respectively 4.6 TWh (16.7 PJ) and 4.0 TWh (14.3 PJ). The highest penetration in total biomass was found in Germany (27%) together with Czech Republic (14.6%) and Slovakia (14.1%).

Up to 2020 the contribution of these two biomass sub-categories is expected to increase with a CAGR of 4.7% reaching 73.2 TWh (263.6 PJ), equivalent to 33.3% of the use of both solid biomass and biogas in the EU. The share in biomass in 2020 is expected to increase to 19.2% in which the contribution of solid biomass will dominate with 60.8%.

The use of both solid biomass and biogas in the electricity sector of EnC countries is expected to make a contribution of 7.3%, increasing with a CAGR of 86.7% to reach 5.3 TWh (19.2 PJ). Ukraine is expected to provide more than 79% of this contribution followed by Serbia with 18.4%.

Almost two thirds of expected renewable electricity in the Danube region from both solid biomass and biogas will be covered by Germany with 48 TWh (172.8 PJ), which will also have the highest penetration (26.5%) in total biomass. Hungary will have the second highest penetration in both these sub-categories of biomass with 18.2%, followed by Slovakia with 17.6%.

Bioheat

With 27.85 Mtoe (1166 PJ) bioheat was the main source of bioenergy (almost 76%) in the Danube region in 2013, equivalent to 35.5% of the final consumption of bioheat in the EU. Bioheat contributed 92.5% in final consumption of renewable heat in the Danube region in 2013 whereas it accounted for almost 13% of the gross final energy consumption in this sector. In 2013 the final consumption of bioheat exceeded the 2020 plans in Croatia (+810 ktoe), Austria (+590 ktoe) and Slovenia (+90 ktoe).

Only in Bulgaria, Germany and Hungary was the penetration of biomass in the heating/cooling sector found to be slightly lower than 90% of their final consumption of renewable heat. In all other countries of the Danube region the contribution of biomass in their final renewable heat was between 90% and 100%.

Leading countries in the consumption of biomass for heat purposes in absolute terms were Germany (9.4 Mtoe), Austria (4.2 Mtoe) and Romania (3.8 Mtoe), constituting more than 62% of final biomass consumed in the Danube region for such purposes.

Moldova's and Bosnia & Herzegovina'sfinal bioenergy in year 2013 was almost totally bioheat whereas in other countries this penetration was above 80% except for Germany (60.2%), Czech Republic (74%), Hungary (78%) and Slovakia (73.4%).

EnC countries contributed 14.5% of the final consumption of bioheat in the Danube region in 2013. More than half of final consumption of biomass for energy in those countries is situated in Ukraine, Serbia and Bosnia & Herzegovina that together cover more than 91% of the EnC contribution. Montenegro had in 2013 the lowest absolute figure, only 89 ktoe of final biomass consumed for heating/cooling purposes.

The main use for bioheat in the Danube region is in households, with a share of 67.1% of the final bioheat in 2013, equivalent to 43.6% of biomass used in households in the EU in the same year. This contribution is higher than the corresponding figure for the EU (54.7%) for this biomass category.

Leading countries in the use of biomass in households in 2013 were Germany (5.6 Mtoe), Romania (3.1 Mtoe), Austria (1.7 Mtoe), Ukraine (1.7 Mtoe) and Croatia (1.1 Mtoe) that covered more than 72% of this biomass use in the region. Almost 21% of households' biomass use in the Danube region occurred in EnC countries, where the share of this biomass category in their final bioheat was more than 90%. In Ukraine bioheat was used totally in households whereas Slovakia had the lowest penetration of biomass for households with only 8.2%.

The use of 1.9 Mtoe (79.4 PJ) of biomass in district heating in the Danube region resulted in a share of 6.8% in final Danube region bioheat, equal to 21.9% of biomass in district heating in the EU the same year. This contribution came almost totally from the EU countries of the Danube region among which Austria had the highest absolute contribution (902 ktoe) whereas Slovakia the highest penetration in its final consumption of bioheat with 36.4%. Serbia and Romania had the slowest shares of this biomass use in their final bioheat consumption respectively 0.02% and 0.5%.

By 2020 bioheat in the Danube region is expected to reach 32.8 Mtoe (1373 PJ), increasing with a CAGR of 2.4%, and increasing to 36.3% share in final bioheat in the EU. The contribution in final consumption of renewable heat is expected to decrease to 84.5% whereas the share in gross final energy consumption in the heating/cooling sector will be 14.9%. Bioheat's share in final biomass consumption will decrease to 83.6% whereas the share in final bioenergy will reach almost 68%.

The EnC countries are expected to contribute almost twice as much as in 2013 due to an anticipated CAGR of +9.5% against only 0.8% of CAGR in the contribution of EU countries. Ukraine is expected to have the greatest increase in bioheat with a CAGR of 16.6%.

By 2020 in Moldova (99.2%) and Bosnia & Herzegovina (99.1%) almost all biomass will be used for heating/cooling purposes, and these countries will have also the highest penetration in final renewable heat (respectively 97.7% and 100%). In other countries this penetration will still remain high, above 80%, except Hungary (68.8%) and Germany (78.7%).

The penetration of bioheat in final bioenergy in 2020 will decrease in most of the countries of the Danube region, remaining above 80% only in Romania, Montenegro, Ukraine, Moldova and Bosnia & Herzegovina.

Solid biomass and biogas used for heating/cooling

In 2013 the Danube region consumed 27.5 Mtoe (1151 PJ) of both solid biomass and biogas for heating purposes, or 75% of bioenergy, equivalent to 36.4% of the consumption of these biomass sub-categories in the EU. The share in total biomass used in the Danube region for energy reached 84.8% in 2013.

The EnC countries' contribution reached 4.0 Mtoe (169.2 PJ) with a share of 14.7% in total solid biomass and biogas used in the Danube region for heat purposes. In those countries both solid biomass and biogas were used almost totally for heating purposes. Ukraine had the highest absolute figure for both solid biomass and biogas used in this sector, at 1707 ktoe (71.5 PJ), and together with Serbia (1028 ktoe) and Bosnia & Herzegovina (941 ktoe) covered more than 91% of both solid biomass and biogas used in EnC countries for heating purposes.

Leading countries in the use of solid biomass and biogas for heating purposes were Germany with 9.3 Mtoe (390.2 PJ) followed by Austria with 4.2 Mtoe (175.7 PJ) and Romania with 3.6 Mtoe (151.2 PJ), covering more than 62% of both solid biomass and biogas used in the Danube region for heat/cold. The penetration of both solid biomass and biogas in final consumption of biomass for energy in EU countries was mostly above 80% except for Germany (71.6%). Austria, Slovenia and Croatia exceeded in year 2013 their 2020 plans for the consumption of both solid biomass and biogas in the heating/cooling sector.

By 2020 the consumption of both solid biomass and biogas for heating purposes is expected to increase with a CAGR of 2.2% to reach 32 Mtoe (1341.5 PJ), equivalent to 37.5% of the solid biomass and biogas expected in the EU. Despite this increase the share of final consumption of both solid biomass and biogas for heating purposes in final consumption of bioenergy will drop to 66% due to the increased consumption of these biomass subcategories in the electricity sector. The EnC countries' share is expected to more than double to 23.8% (7.6 Mtoe) by 2020.

The biggest increase is expected in Ukraine with a CAGR of 16.6% (+3.3 Mtoe) that will provide almost two-third of both solid biomass and biogas expected to be consumed in EnC countries for heat/cold. Germany will still be the main contributor of both solid biomass and biogas for heating purposes in the

Danube region with 10.6 Mtoe (445.6 PJ) and together with Ukraine will cover almost than half of heating needs from these two biomass categories. The penetration of both solid biomass and biogas in final bioenergy is expected to decrease in all Danube countries with the highest figure in Bosnia & Herzegovina (90.2 %) and the lowest in Germany (50.5 %).

Biofuels

Biofuel use in the transport sector of the Danube region amounted to 4263 ktoe (178.5 PJ) in 2013, equivalent to 35.2 % of the EU's final use of biofuels in that sector. The contribution of biofuels in final bioenergy in 2013 was 11.62% whereas in the final consumption of renewable energy in the transport sector and in gross final energy consumed in this sector reached respectively 89 % and 4.7 %.

The leading country was Germany with 2718 ktoe (113.8 ktoe) covering almost 64 % of total use of biofuels in the Danube region. The highest relative contributions of biofuels in final bioenergy were found in Germany (17.3%), Slovakia (14.5%) and Czech Republic (13.2%)

Only 1.1% (47 ktoe) was in 2013 the contribution of EnC countries in Danube region final biofuels use, Ukraine (42 ktoe) and Montenegro (5 ktoe).

By 2020 the use of biofuels in the Danube region is expected to have developed with a CAGR of 11.9 % reaching 9.35 Mtoe (391.3 PJ), equivalent to 32.2 % of total biofuels planned to be used in the EU. Almost one fifth of Danube region bioenergy in 2020 is expected to be in the form of biofuels. The contribution in final renewable energy expected to be used in the transport sector will decrease slightly to 88.4 % whereas the share in gross final energy planned to be consumed in this sector will almost double (9.5 %).

The EnC countries are expected to contribute with 8.5 % (798 ktoe) in 2020 expected use of biofuels, 90% of which mainly in Ukraine (390 ktoe) and Serbia (245 ktoe).

With 3076 ktoe (128.8 PJ) biodiesel was in 2013 the main source (72.1%) of biofuels in Danube region equivalent to 34% of the biodiesel use in EU the same year. The leading country in absolute terms of biodiesel use was Germany with 1892 ktoe (79.2 PJ) covering almost 62% of final biodiesel use in the region. The penetration of biodiesel in Danube region countries' biofuels was in 2013 above 75 % except for Germany (69.6 %). The contribution of EnC in final use of biodiesel in year 2013 was very marginal since only Montenegro used this biofuel in its transport sector.

Biodiesel will remain the main source of biofuels in the Danube region in 2020, increasing its relative contribution to 74.2% (6932 ktoe), equal to 33% of the expected use of biodiesel in the EU the same year. The use of biodiesel in EnC countries is expected to be significant, a contribution planned to increase with a CAGR of 89 %, equivalent to 6.2 % of expected biodiesel use in the Danube region. The main contribution from Serbia, with 220 ktoe (9.2 PJ), should provide more than half of EnC countries' biodiesel contribution whereas the fastest development will be in Montenegro with a CAGR of 19.3 %. In Montenegro biodiesel is likely to be the only form of biofuel used in the transport sector whereas Ukraine will have the lowest penetration in terms of biofuel expected to be used in the transport sector, at only 18 %.

In 2020 Germany will still be the main user of biodiesel in the transport sector with 4.4 Mtoe (186 PJ), followed by Czech Republic with 495 ktoe (20.7 PJ), Austria with 410 ktoe (17.2 PJ) and Romania with 326 ktoe (13.6 PJ).

Bioethanol/bio-ETBE amounted to 1065 ktoe (44.6 PJ) in 2013 or 25% of bioethanol/bio-ETBE use in the region, equal to 41.8% of total bioethanol/bio-ETBE used in the EU the same year. Germany was in 2013 the main Danube region user of bioethanol/bio-ETBE in transport with 779 ktoe (32.6 PJ), equivalent to 73% of such use. Bioethanol/bio-ETBE had the highest penetration in biofuels in Germany (28.7%), Hungary (26.2%) and Czech Republic (20.7%). The EnC countries' contributed with only 3.9% in the final bioethanol/bio-ETBE totally used in Ukraine (42 ktoe).

Bioethanol/bio-ETBE use in the transport sector is expected to increase with a CAGR of 9.9% reaching 2069 ktoe (86.6 PJ) in 2020, equivalent to 28.3% of expected bioethanol/bio-ETBE use in the EU. The share in biofuels will decrease to 22.4%, lower than the anticipated share of 25.2% in the EU.

The EnC countries' contribution will account for 17.2% of total bioethanol/bio-ETBE expected to be used in the Danube region in 2020 thanks to Ukraine's plan to use 320 ktoe (13.4 PJ) of this biofuel category, 89.2 of the expected EnC countries' contribution.

The use of bioethanol Germany will provide the highest absolute figure of 857 ktoe (36 PJ) which, together with Ukraine's contribution, will cover 57% of expected total bioethanol/bio-ETBE use in 2020 in Danube region.

The use of other biofuels (biogas and vegetable oils) in the transport sector of the Danube region reached only 122 ktoe (4.9 PJ) in 2013 or 2.9% of final use of biofuels, equivalent to 53.8% of the same biofuel category used in the EU. Only Germany and Austria made use of other biofuels in the transport sector respectively with 47 ktoe (2 ktoe) and 75 ktoe (3.1 PJ).

The use of other biofuels is expected to reach 345 ktoe (14.4 PJ) in 2020, equivalent to 46% of the anticipated use of other biofuels in the EU sharing 3.7% in final use of biofuels. By 2020 it is expected that eight countries (BG, CZ, DE, HU, AT, RO, SK and HR) will use these categories of biofuels, with Germany making the highest absolute contribution of 173 ktoe (7.2 PJ), covering half the expected use.

Biofuels from waste, residues, non-food cellulosic material, and ligno-cellulosic material defined in Article 21.2 of the Directive 2009/28/EC amounted to 488 ktoe (20.4 PJ) in 2013 or 11.4% of total biofuels, equivalent to 25.4 % of the same biofuels category used in the EU transport sector. Only Germany and Slovenia reported on the use of Article 21.2 biofuels in their transport sector, with Germany having the highest contribution at 430 ktoe (18 PJ). The main origin of Article 21.2 biofuels in 2013 was biodiesel. Only 2 % of bioethanol/bio-ETBE used in the Danube region was in the form of Article 21.2 biofuel in 2013.

In 2020 the Danube region is likely to be using treble the amount of Art.21.2 biofuels for transport purposes compared with 2013, equivalent to 51% of expected use of these biofuels in the EU with a

CAGR of the increase in the Danube region more than 3.5 times higher than the CAGR for the EU. The share in biofuels will increase to 14.3%, higher than the corresponding EU share of 9%.

Only Ukraine within the EnC countries will make use of Art.21.2 biofuels in its transport sector, with 390 ktoe (16.3 PJ), equivalent to 29% of the expected use of these biofuels in Danube region in 2020.

The highest consumption of Art.21.2 biofuels in 2020 is expected to be in Germany with 405.5 ktoe (17 PJ) which together with Ukraine's contribution will cover almost 60% of the expected use of these biofuels in the Danube region. One quarter of Art.21.2 biofuels expected to be used in the Danube region will be in the form of bioethanol/bio-ETBE.

In 2013 the Danube region made use of 642 ktoe (26.9 PJ) imported biofuels, equivalent to 19.3% of imported biofuels used in the transport sector in the EU. The share in total biofuels reached 15% in 2013, almost half of the corresponding share in the EU (27.4%). Half of Danube region countries (BG, CZ, AT, RO, SI, HR and ME) used imported biofuels in their transport sector in this year; Austria (299 ktoe), Czech Republic (106 ktoe) and Bulgaria (90 ktoe) had the highest figures covering more than 77% of total imported biofuels in the region. More than 13% of imported biofuels were in the form of bioethanol/bio-ETBE in 2013, equivalent to only 1.2% of total bioethanol/bio-ETBE in the region.

The use of imported biofuels in the Danube region in 2020 is expected to be almost six times higher compared with 2013, amounting to 3694 ktoe (154.7 PJ), equivalent to 33.7% of the biofuels planned to be imported into the EU the same year. About 40% of biofuels expected to be used in the Danube region in the transport sector will come from imports, slightly higher than the corresponding share in the EU (37.7%).

Only 5.5% of imported biofuels will be used in EnC countries in 2020, with Serbia having the highest absolute figure, at 146.2 ktoe (6.1 PJ), covering 72.4% of the contribution of these countries. Almost 9% of imported biofuels expected to be used in the Danube region will be in the form of bioethanol/bio-ETBE.

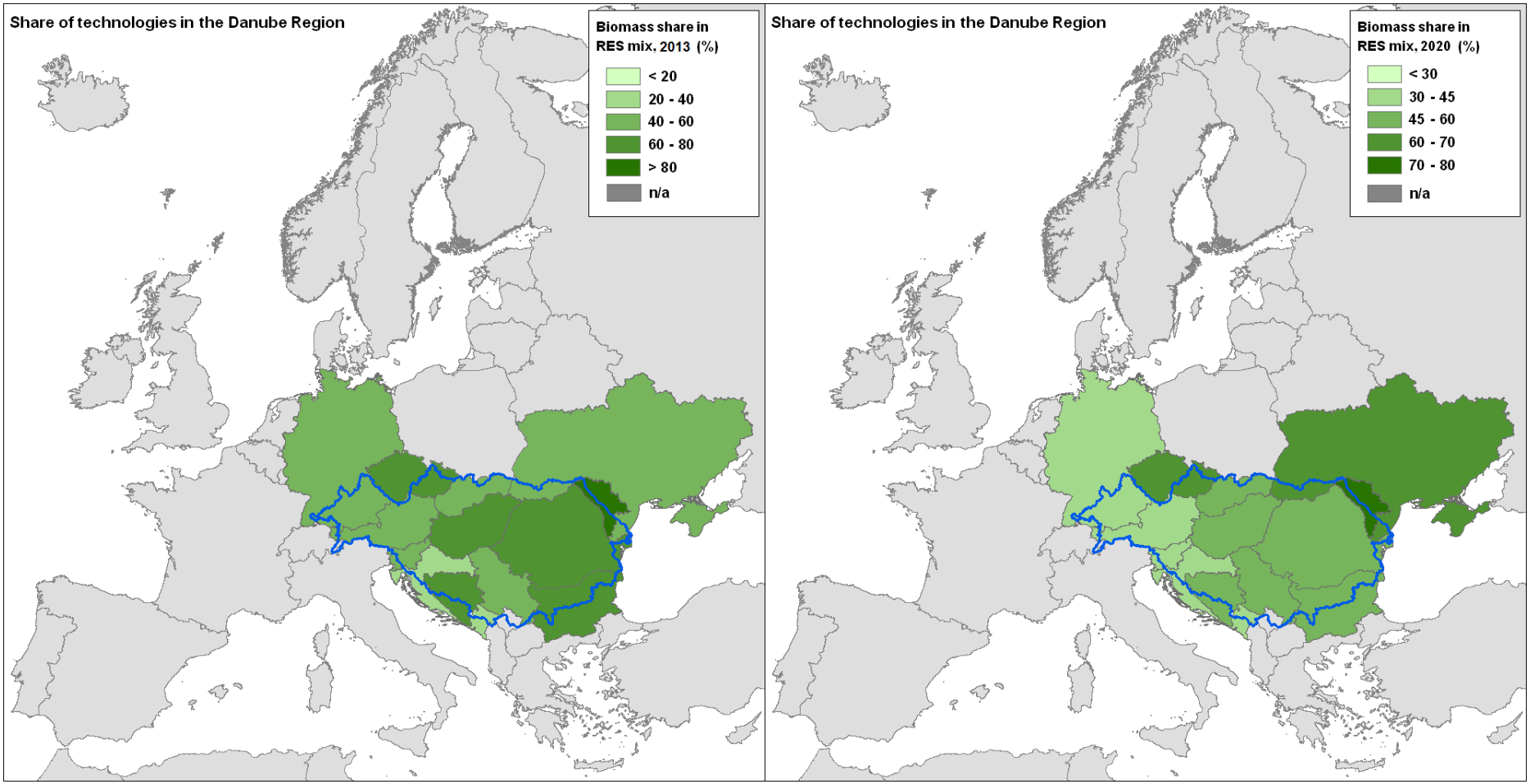


Figure 48. Relative contribution of biomass in each Danube region country final renewable energy mix, 2013 (left) – 2020(right)[92]

[92] Raw data can be found at Tables A 17, A 18, A 35 and A 36 in the Electronic Annex of this report.

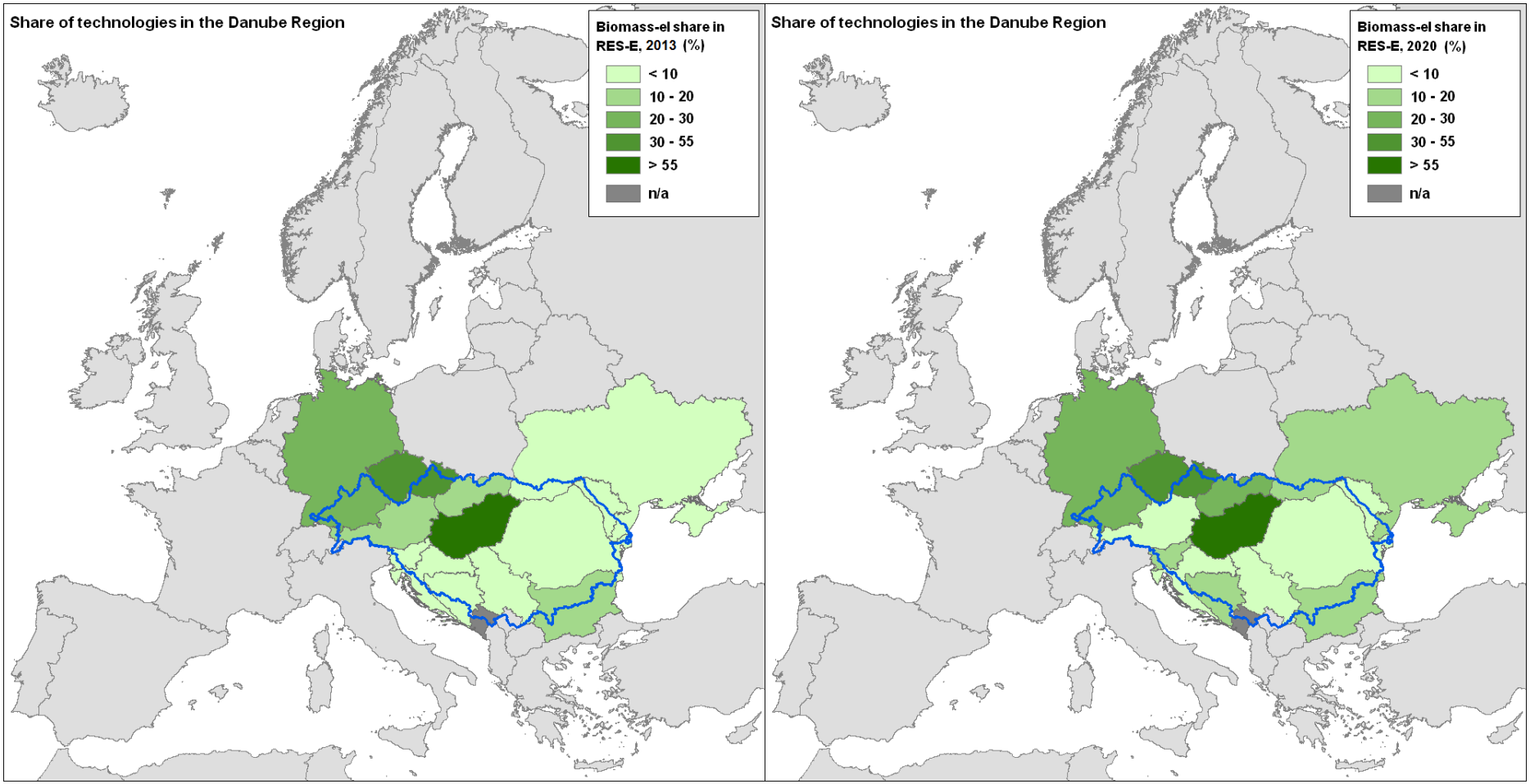


Figure 49. Relative contribution of biomass in each Danube region country final renewable electricity consumption, 2013 (left) – 2020(right)[93]

[93] Raw data can be found at Tables A 17, A 18, A 35 and A 36 in the Electronic Annex of this report.

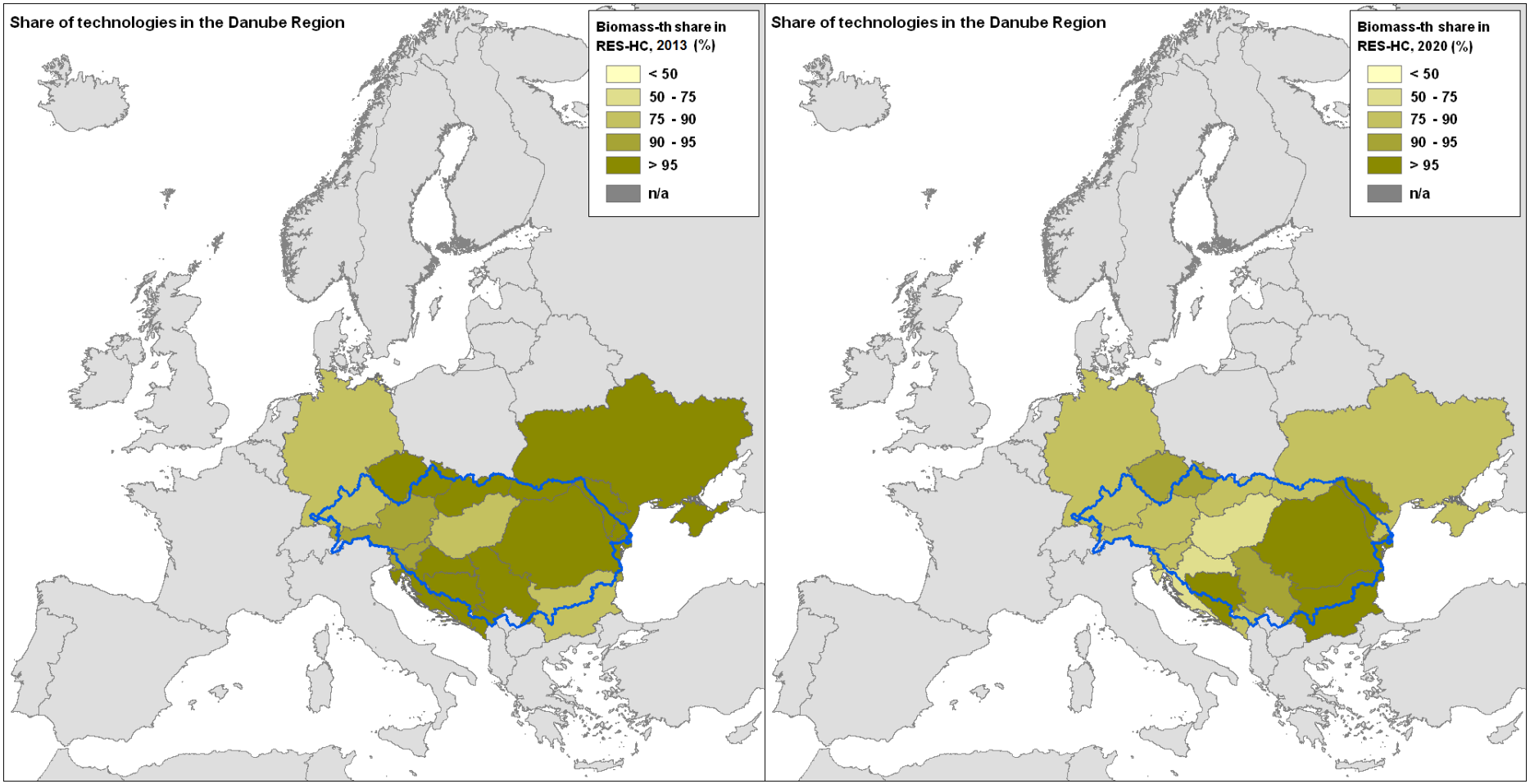


Figure 50. Relative contribution of biomass in each Danube region country final renewable heat consumption, 2013 (left) – 2020(right)[94]

[94] Raw data can be found at Tables A 17, A 18, A 35 and A 36 in the Electronic Annex of this report.

Biomass supply

Biomass supply for electricity and heat [95]

In 2013 the primary energy of biomass supply in the Danube region for electricity and heating/cooling purposes totalled 36.3 Mtoe (1519 PJ) or 95.3 % of total biomass supplied in the region for energy purposes. This primary energy was equivalent to 32.8% of total primary energy of biomass supplied in the EU the same year for the same purpose. More than 95% (34.6 Mtoe) of this supply was met from domestic sources whereas 4.3% was imported from EU countries and only 0.4% from non EU countries.

Domestic forestry was the main biomass feedstock used for electricity and heat purposes, accounting for 24.5 Mtoe (1029 PJ) or more than 69% of total domestic biomass in the Danube region, equivalent to almost 41% of domestic biomass from forestry supplied in the EU the same year.

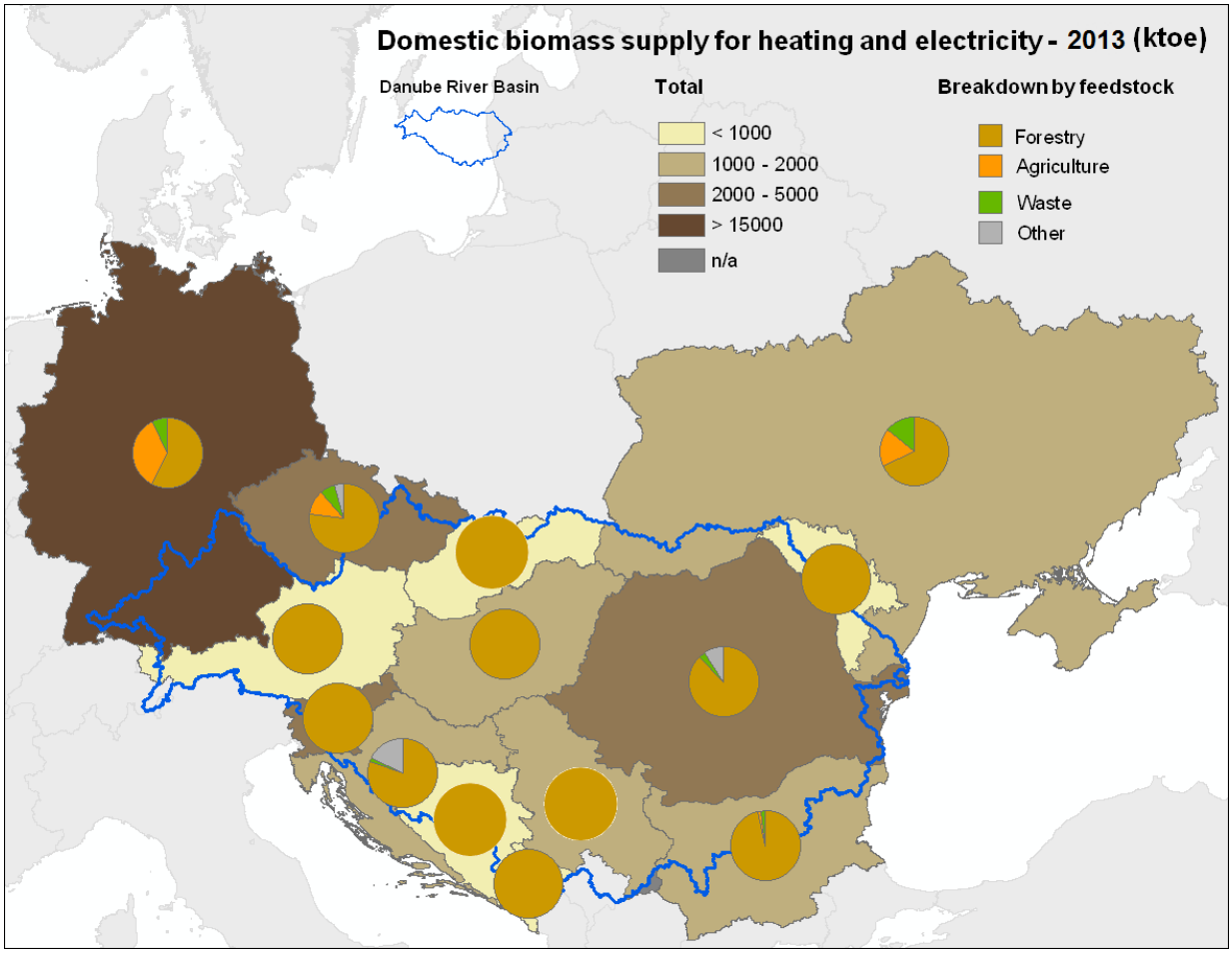


Figure 51. Domestic biomass supply in Danube region countries, 2013[96]

[95] This section is focussed exclusively on biomass supply for electricity and heat due to the scarce reporting by Danube region countries on biomass supply in the transport sector. Only six Danube region countries (CZ, HR, AT, RO, SK and UA) reported in the biomass supplied in transport sector in year 2013. The contribution of Serbia (1059 ktoe) and Bosnia & Herzegovina (792 ktoe) in the baseline year of their NREAPs is taken in consideration in the analysis reported in this section.

[96] Raw data can be found at Table A 37 in the Electronic Annex of this report.

According to the aggregated progress reports of Danube region countries the total volume of forest raw material (direct and indirect)[97] used in 2013 for electricity and heating/cooling purposes was estimated 95 Million m^3 in which more than 65% (65.3 Million m^3)was the volume of direct forestry raw material. The domestic forest raw material in Danube region supplied for electricity and heating/cooling purposes was estimated 86.2 Million m^3, or 90.8%, from which 63.5 Mm^3 was the volume of the direct use of forest domestic raw material.

More than 9% (8.8 Million m^3) of the total volume of forestry raw material was imported mainly from EU countries which in year 2013 exported to the Danube region countries 8.2 Million m^3 raw forestry material. More than 94% of these imports were dedicated for the indirect use of forests raw material. The volume of raw material from energy crops used for electricity and heating/cooling purposes was estimated 528.3 thousand m^3 in 2013.

In 2013 the primary energy of agriculture residues supply[98] constituted almost one fifth (7.0 Mtoe) of total primary energy of domestic biomass supplied in the Danube region, equivalent to more than 56% of biomass feedstock supply in the EU. Agriculture residues were an important part of domestic supply of biomass in Germany, Ukraine and Czech Republic.

The primary energy of domestic biomass supply from waste[99] in the Danube region amounted to a share of 6.7% (2.3 Mtoe), equivalent to 7.3% of the same biomass feedstock in the EU. The rest of domestic biomass supply was divided almost equally between energy crops (0.7%) and other biomass feedstock (1.3%).

Germany was the main biomass supplier in the Danube region, providing more than half of domestic biomass supplied for electricity and heating purposes.

More than 10% of biomass supply primary energy for electricity and heating purposes was used in EnC countries with 3606.7 ktoe (151 PJ)[100] mainly in Ukraine (39.6%), Serbia (29.4%) and Bosnia & Herzegovina (22.0%). More than 85% of this biomass primary energy was originated from direct forestry (3080.5 ktoe) and the rest was split between indirect forestry (1.5%), agriculture by-products (8.4%) and waste (4.7%). Almost 4% of Danube region primary biomass energy originated from agriculture by-products was developed within EnC countries whereas more than 7% was the share of these countries in the primary biomass energy from waste.

[97] An average conversion factor of 0.57 tonnes/m3 was used for Germany, Romania and Slovakia that reported on forestry raw material in "tonnes" [36].

[98] Only Czech Republic and Ukraine have reported on the amount on domestic raw material from agricultural by-products / processed residues and fishery by-products respectively 6594 and 1104 tonnes.

[99] The amount of biomass from waste in year 2013 in Danube region was estimated 0.88 Million tonnes (BG, DE, HU, RO, RS, ME and MD didn't report on the 2013 amount of raw material from waste).

[100] All EnC countries of the region reported lower values of biomass primary energy used for electricity and heating compared with the final consumption of biomass for these two purposes. No data on biomass imports were available at the EnC countries progress reports.

Biomass supply for energy in 2020[101]

Biomass supply for energy in the Danube region is expected to increase by 37.8% over the upcoming 7-year period, amounting to 47.6 Mtoe (1949 PJ)[102] equivalent to almost 30% of expected biomass supply in the EU. EnC countries are likely to account for 9.3% of final biomass supply, expecting to almost treble their overall contribution.

The largest increase in biomass feedstock up to 2020 is expected to occur in agriculture residues supply with +149% (+10.5 Mtoe) whereas waste and forestry feedstock will increase respectively by 44% and 20.8%.

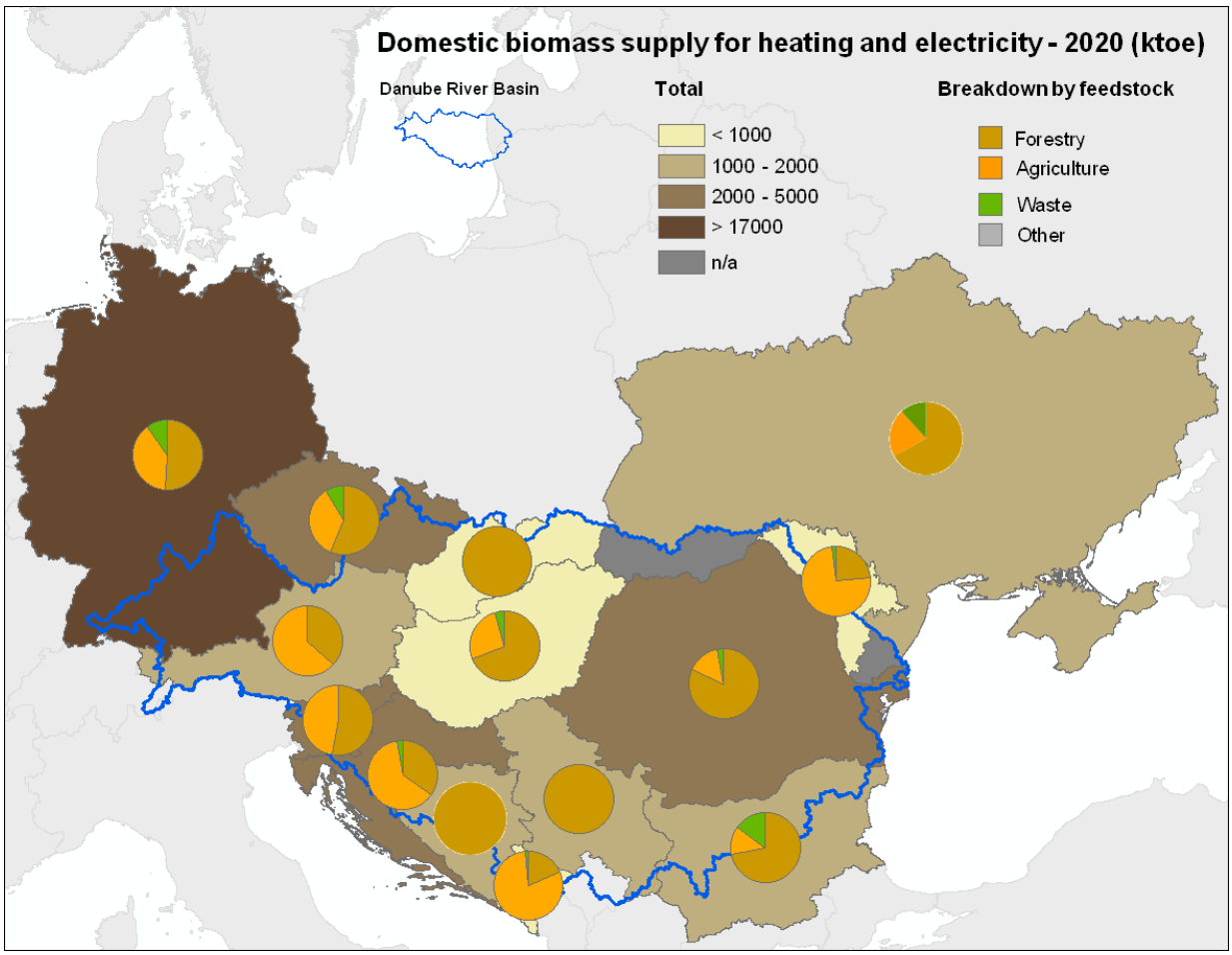


Figure 52. Domestic biomass supply for energy in Danube region countries, 2020[103]

Domestic forestry supply for energy in the Danube region is expected to amount to 26.8 Mtoe (1087 PJ), equivalent to nearly 32% of the same biomass feedstock supply expected in the EU. Its contribution to the biomass supply for electricity and heat is expected to decrease, covering in 2020

[101] According to the Table 7a of NREAPs template only domestic biomass supply for energy is reported for years 2015 and 2020. The domestic biomass reported in this table is assumed to be supplied only for electricity and heat purposes.
[102] Ukraine didn't report in its NREAP according to Table 7a on 2020 domestic biomass supply for energy purposes. For the aim of this report the biomass supply for energy purposes in Ukraine for year 2020 is assumed equal to the contribution in year 2013 keeping the same share between biomass feedstock categories.
[103] Raw data can be found at Table A 38 in the Electronic Annex of this report

only 56.4% of total domestic biomass supply. Only Slovenia and Bosnia & Herzegovina reported the expected biomass supply in 2020 totally from domestic forestry. Forestry will contribute more than 70% in Serbia (99.6%), Austria (81.5%) and Bulgaria (72%). The lowest share of forestry contribution in the domestic biomass was found in Moldova (23.5%), Slovakia (34.9%) and Hungary (36.7%).

The 2020 domestic forestry raw material in Danube region supplied for electricity and heating/cooling purposes was estimated 105.5 Million m^3; only 4.4% from EnC countries of the region.

The contribution of agriculture residues in the Danube region is expected to cover just below 37% (17.5 Mtoe) of biomass supply in electricity and heating/cooling sectors. In some countries the contribution of agriculture residues will be significant; in Montenegro it is expected to provide 80% of biomass supply whereas for Moldova, Hungary and Slovakia the likely contributions will be respectively 74.7%, 63.3% and 62.6%. The lowest shares of agriculture contribution in total domestic biomass supply will be found in Austria (15.4%), Ukraine (24.4%) and Croatia (26.5%).

The amount on domestic raw material from agricultural by-products / processed residues and fishery by-products in Danube region in year 2020 is estimated 73.7 Million tonnes.

Domestic biomass supply from waste will cover only 6.7% (3.2 Mtoe) of the Danube region's energy needs in 2020. Bulgaria's biomass feedstock will have the highest penetration in final biomass supply with 15%. The lowest penetration of biomass supply from waste will be in Serbia, at 0.4%. The amount of biomass from waste in year 2020 in Danube region was estimated 22.1 Million tonnes.

Danube region as integral part of EU 2020 climate strategy

Over 23 years the greenhouse gas emissions in Danube region decreased by more than 42% reaching 1848 Mt CO_2 eq in year 2013. This decrease is almost double the decrease of greenhouse gas emission in the EU (21.2% less in 2013 compared with 1990). Energy is the main source of greenhouse gas emissions in the region with a contribution to nearly 80%. In 2013 the region's GHG emissions per capita decreased to 8.8 t CO_2 eq equal to the EU figure the same year

Development of renewable energy in the Danube region resulted in an increase by 7.4% (+19 Mt CO_2 eq) of greenhouse gas emission savings between 2012 and 2013. During the same period greenhouse gas emissions in Danube region decreased by 6.8% (-134 Mt CO_2 eq) in which the savings of emissions due to the contribution of renewable energy counted for 14.2%.

Renewable electricity increased by more than 8% the greenhouse gas emissions between 2012 and 2013 contribution with more than 65% in the final savings of these emissions.

Greenhouse gas emissions in Danube region[104]

In 1990 the GHG emissions from the Danube region countries (excluding LULUCF[105]) amounted to 3209 Mt CO_2 eq. Between 1990 and 2013 the total GHG emissions dropped with a CAGR of -2.4% reaching 1848 Mt CO_2 eq. In absolute values this reduction amounted to 1361 Mt CO_2 eq, higher than the absolute GHG emissions reduction in the EU, 1193 Mt CO_2 eq, during the same time frame. In 2013 GHG emitted from the Danube region countries constituted 41.4% of emissions released in the EU in the same year from the same pollution sources, lower than the respective figure of 56.7% in 1990. Between 2012 and 2013 the GHG emissions in Danube region decreased by 6.8% (19 Mt CO_2 eq less) contributing by 14.2% in the GHG emissions reduction in the EU (-134 Mt CO_2 eq) over the same time frame. More than two thirds of the Danube region's total GHG emissions in 1990 occurred in EU countries, representing nearly 38% of total GHG emissions released in the EU in the same year.

In 1990 GHG emissions in the Danube region were 14.5 t CO2 eq per capita, higher than the corresponding figure in the EU (11.8 t CO_2 eq per capita). In 2013 the region's GHG emissions per capita decreased to 8.8 t CO_2 eq equal to the EU figure the same year.

In 1990 Germany accounted for almost 60% of GHG emissions released from the EU countries of the Danube region whereas Ukraine's GHG emissions represented more than 85% of emissions released

[104] 2013 detailed data on greenhouse gas emissions for all countries of Danube region were not available in the time this report was prepared. For this reason this section includes a detailed analysis of greenhouse gas emissions in Danube region countries over the 22 year period (1990-2012). Short information on the total greenhouse gas emissions in the region for year 2013 is also inserted in this section.

[105] LULUFC (Land use, land use change and forestry) is defined by the United Nations Climate Change Secretariat as "A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities."

from the EnC countries of the region. Just above two thirds of total GHG emissions were released in Germany (39%) and Ukraine (29%).

In 2013 GHG emissions released in EU countries of the Danube region raised their relative share by more than 13 percentage points compared to 1990, covering almost 80% of total GHG emissions released in the region. Germany and Ukraine remained the countries with the highest contributions, respectively 51% and 16.3% of total GHG emissions released in 2013. Germany's relative contribution to the GHG emissions from EU countries of the Danube region increased to 65% whereas Ukraine's contribution decreased to 78% compared with 85% in 1990.

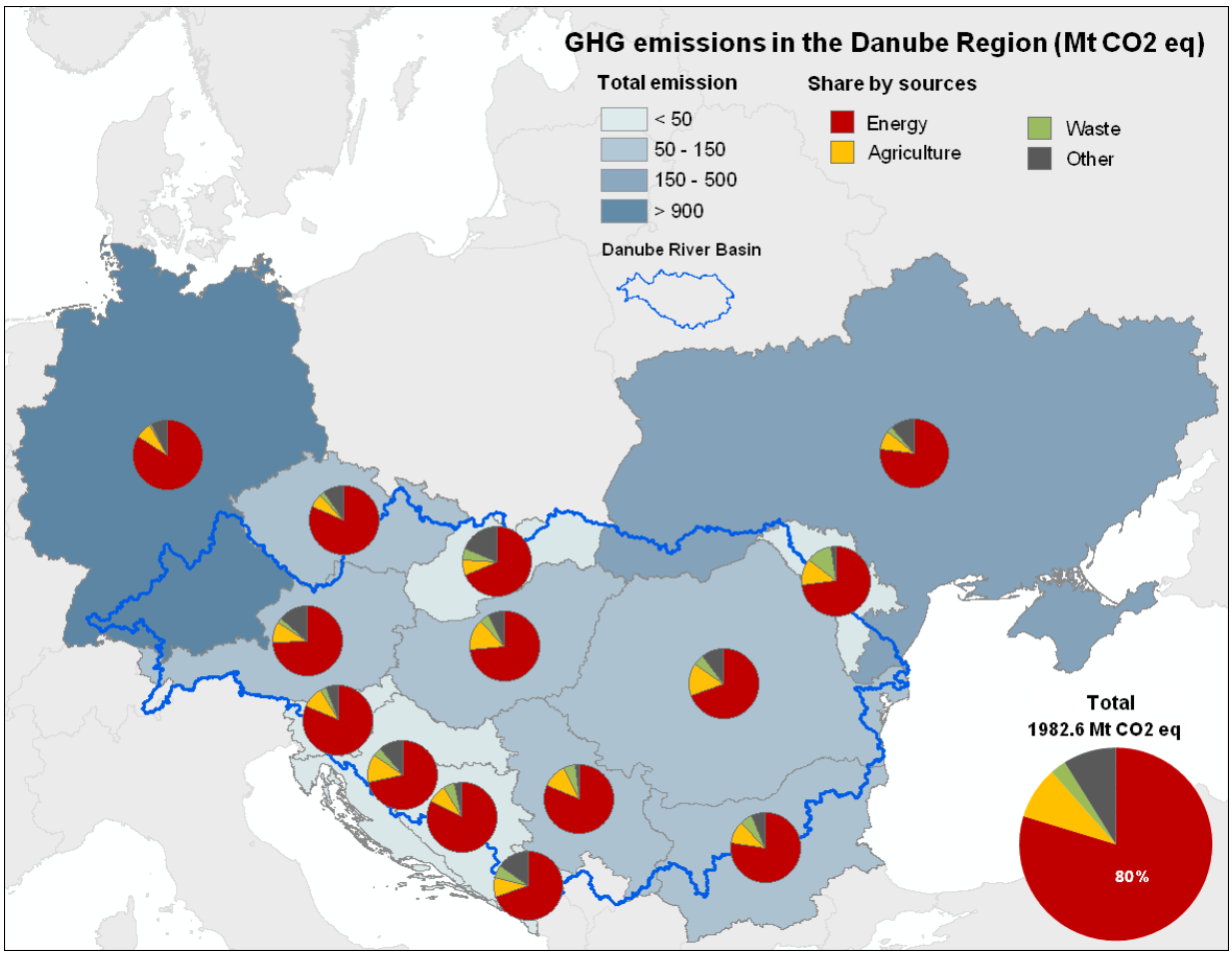


Figure 53. GHG emissions breakdown by sources in Danube region countries, 2012[106]

Energy-related[107] GHG emissions in the Danube region in 1990 accounted for 78.7% of total GHG emissions with a figure of 1580.3 Mt CO_2 eq. Only in Montenegro did energy-related GHG emissions cover half of the total GHG emissions in the country. In all other Danube countries the energy-related GHG emissions covered more than 70% of each country's total emissions.

In the period from 1990 to 2012 energy-related GHG emissions decreased with a CAGR of -2.1% (-945.3 Mt CO_2 eq) but their relative share in the total GHG emissions in 2012 increased to almost 80%.

[106] Raw data can be found at Table A 15 in the Electronic Annex of this report.
[107] Energy related GHG emissions include the GHG emissions from transport. Without Bosnia & Herzegovina energy related GHG emissions in the Danube region in 1990 and 2012 were respectively 2500 Mt CO_2 eq and 1557.2 Mt CO_2 eq.

The absolute reduction of energy-related GHG emissions in the Danube region between 1990 and 2012 was 945.3 Mt CO_2 eq, higher than the corresponding reduction in the EU, at 720.6 Mt CO_2 eq, during the same time span. The trend of energy-related GHG emissions in the Danube region between 1990 and 2012 followed the trend of gross inland consumption as shown in Figure 58.

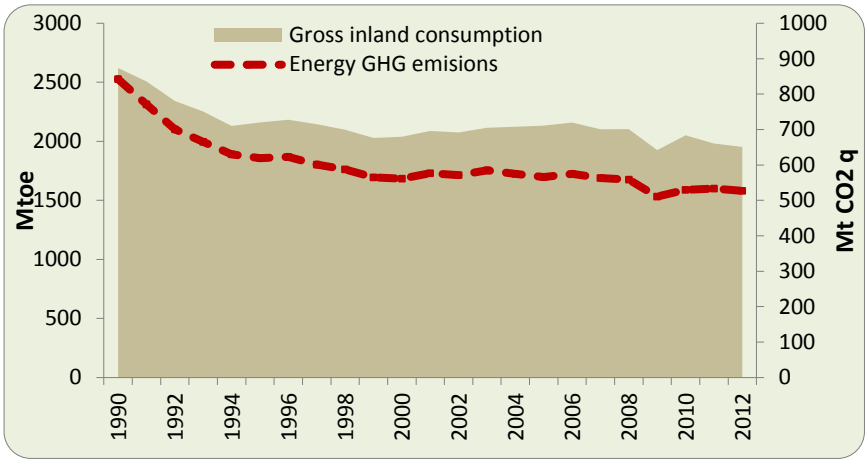


Figure 54. Trend of GIC and energy GHG emissions in Danube region, 1990 - 2012[108]

Germany and Ukraine are the two largest emitters of greenhouse gases related to energy in the Danube region. Between 1990 and 2012 energy-related emissions in these two countries dropped by respectively 58.8% and 23% from the 1990 levels of 750.3 Mt CO_2 eq and 1019 Mt CO_2 eq.

Between 1990 and 2012 energy-related GHG emissions in the Danube region dropped in almost all countries except Austria and Slovenia, whose energy-related emissions in 2012 were respectively 7.7% and 7.5% higher than in 1990. The steepest drop in energy-related GHG emissions occurred in Moldova with 75.5% (-26 Mt CO_2 eq) whereas the lowest was in Montenegro with 8.3% (-0.2 Mt CO_2 eq). Despite the decrease in absolute figures the share of energy-related GHG emissions in each country's total emissions increased to more than 75% except Romania (69.2%), Slovakia (68.5%) and Montenegro (69.6%).

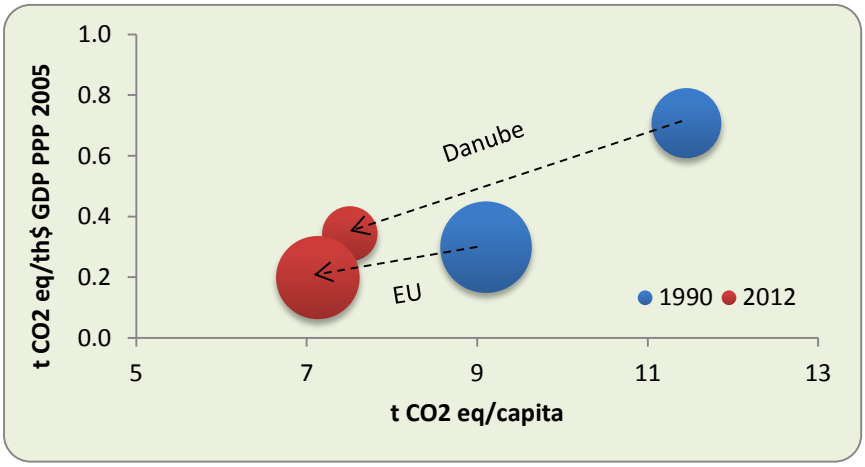


Figure 55. Energy related GHG emissions intensity in EU and Danube region, 1990 - 2012[109]

[108] Raw data can be found at Tables A 5, A 6 and A 15 in the Electronic Annex of this report.

Energy-related GHG emissions per capita in the Danube region in 1990 were 11.7 t CO_2 eq/capita, nearly 30 % higher than the same indicator for the EU (9.1 t CO_2 eq/capita).

Energy related GHG emissions intensity[110] in Danube region in 1990 was almost 2.5 times higher than the same indicator for the EU. Between 1990 and 2012 these two indicators changed as shown in Figure 44. The Danube region's energy-related GHG emissions per capita fell much more between 1990 and 2012 (35 % below the 1990 level), compared with the EU (21.7 % below the 1990 level).

Energy-related GHG emissions intensity in the Danube region in 2012 reached the level of 0.34 t CO_2 eq/1000 $ GDP (PPP), almost half of the 1990 level for this indicator, equivalent to the level of this indicator in the EU in 1990.

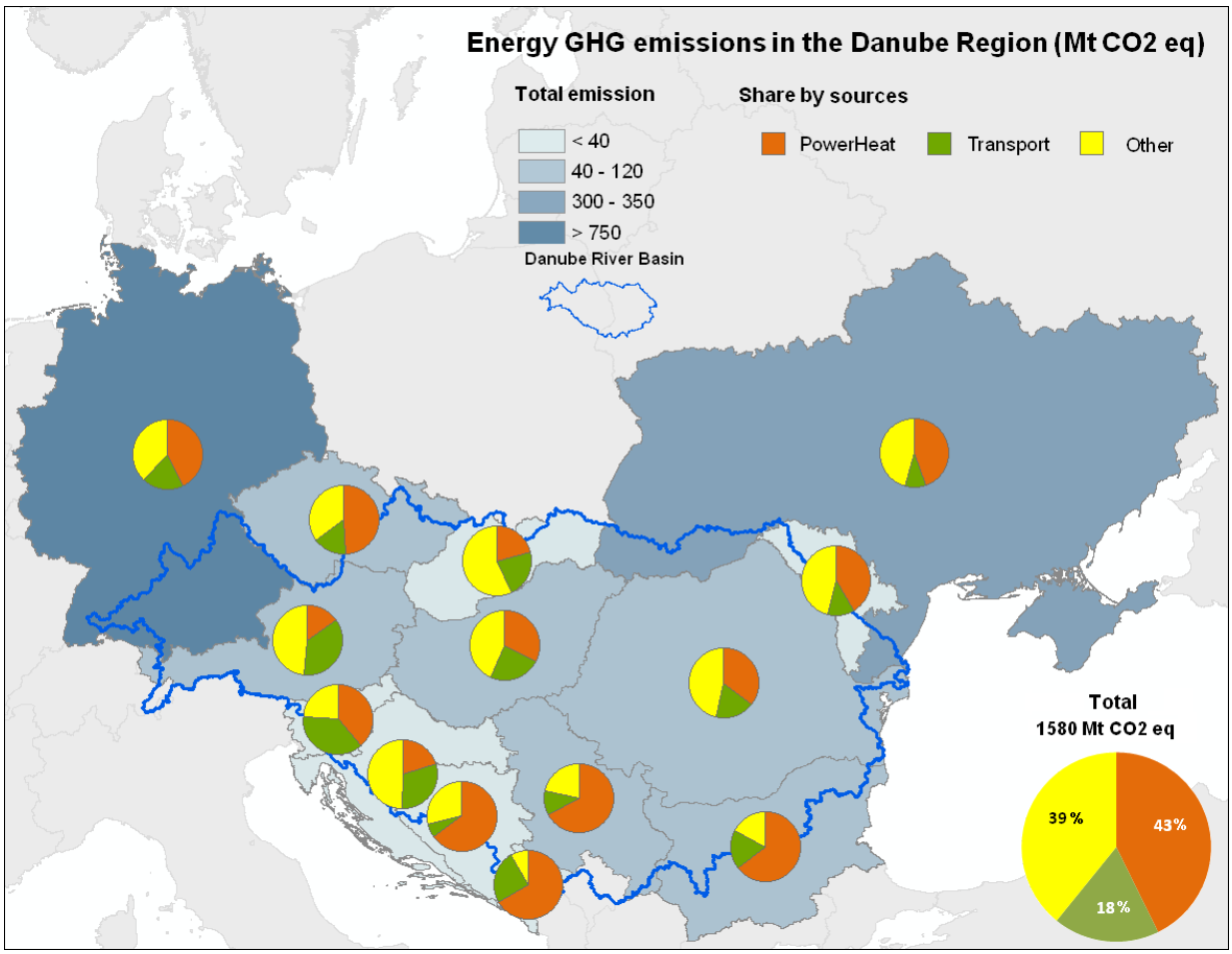


Figure 56. Energy related GHG emissions breakdown by sources in Danube region countries, 2012[111]

In 1990 GHG emissions from agriculture were 323 Mt, contributing 10.1 % to the total GHG emissions of the Danube region, whereas from waste only 2.5 % of total GHG emissions were released.

[109] The size of bubbles indicates total annual energy related GHG emissions in Danube region and EU respectively for 1990 and 2012. Raw data can be found at Tables A.2 and A.15 in the Electronic Annex of this report.
[110] Calculations are based on GDP PPP 2005 USD prices (See Glossary for the definition)
[111] Raw data can be found at Table A 16 in the Electronic Annex of this report.

Up to 2012 GHG emissions from agriculture and waste decreased with CAGRs of respectively -2.8% and -1.9%, reaching 173.5 Mt CO_2 eq and 52.6 Mt CO_2 eq. Their contribution to total GHG emissions in the Danube region in 2012 was respectively 8.8% and 2.7%. The absolute reduction of GHG emissions in the Danube region from agriculture and waste was respectively 148 Mt CO2 eq and 27.7 Mt CO_2 eq, lower than the reduction of the same type of emissions in the EU.

In 1990 the share of GHG emitted from agriculture was equivalent to around 58% of emissions from the same source in the EU whereas the share of GHG emissions from waste was nearly 40%.

The relative share of GHG emissions from agriculture and waste in 2012 was found to be 37%, equal for both these sources of pollution. The relative share of GHG emissions from other sectors was higher, at 53.3%.

In 1990 the principal emitters of GHG from agriculture in the Danube region were Ukraine (32%), Germany (27.2%) and Romania (11.4%). In 2012 these countries were still the main source of GHG emissions from agriculture but in a different order, with Germany making the biggest contribution of 40% followed by Ukraine at 20% and Romania with 10%.

In per capita terms the GHG emissions from agriculture dropped from 14.5 t CO_2/capita in 1990 to 9.5 t CO_2/capita in 2012. Ukraine had in 1990 the highest GHG emissions per capita sourced from agriculture (18.2 t CO_2 eq) whereas in 2012 it was Czech Republic that had the highest figure, 12.5 t CO_2 eq/capita.

In 1990 GHG emissions related to public power and heat sectors in the Danube region amounted to 973.4 Mt CO_2 eq. This figure represented one third of total GHG emissions and nearly 40% of energy-related GHG emissions in the region.

Between 1990 and 2012 GHG emissions related to public power and heat sectors decreased with a CAGR of -1.6%, double the CAGR for EU emissions from the same sectors, reaching 675 Mt CO_2 eq. In 2012 the relative contributions of these emissions to total GHG emissions and energy-related emissions in the Danube region increased to 42.7% and 34% respectively. 57% of public power and heat GHG emissions in 1990 originated in the EU countries of the Danube region whereas in 2012 this share increased to 72%.

Serbia and Montenegro had the highest share of GHG emissions from power and heat sectors in their energy-related emissions in 1990, respectively 63.2% and 53%. The lowest shares were in Croatia (16.2%) and Austria (19.7%). In 2012 the highest shares of GHG emissions from those sectors were found in EnC countries of the Danube region: Serbia (67.3%), Montenegro (66.5%) and Bosnia & Herzegovina (65%). Austria contributed the least to these energy-related emissions (15.2%).

In 1990, 4.4 t CO_2 eq of GHG emissions per capita was released from public power and heat sectors. Ukraine had in this year the highest GHG emissions in per capita terms, at 6.8 t CO_2 eq, followed by Czech Republic with 5.2 t CO_2 eq/capita. In 2012 GHG emissions per capita from public power and heat sectors dropped to 3.2 t CO_2 eq. Czech Republic and Serbia had the highest GHG emissions per capita, respectively 5 t CO_2 eq and 4.3 t CO_2 eq. With 290 Mt CO_2 eq, GHG emissions from transport

accounted for 9% of total emissions in the Danube region in 1990 and represented 11.5% of energy-related emissions. Even though in 2012 these emissions decreased by 3.4 Mt CO_2 eq (CAGR of -0.1%), the share in total emissions and energy-related emissions in the Danube region increased to 18.1% and 14.4% respectively.

In 1990, 78% of the GHG emissions in the EU countries of the Danube region were from transport whereas in 2012 this share increased to 86%. Austria with 17.9%, Czech Republic with 14.8% and Germany with 13.2% had in 1990 the highest share of transport-related GHG emissions in their total emissions. The lowest share of these emissions in total GHG emissions was found in Czech Republic with 3.95%. In 2012 the share of transport-related emissions in total GHG emissions increased in all countries of the Danube region. Slovenia with +15.7 pp and Montenegro with +11.3 pp had the highest absolute increases from 1990, reaching respectively 30.5% and 18.8%. After Slovenia, Austria had the second biggest share of these emissions with 27%.

Germany had in 1990 the highest GHG emissions per capita in the Danube region, at 2.1 t CO_2 eq/capita, followed by Austria (1.84 t CO_2 eq/capita), Romania (1.37 t CO_2 eq/capita) and Ukraine (1.1 t CO_2 eq/capita). The lowest GHG emissions from transport in per capita terms were found in Bosnia and Herzegovina, at 0.48 t CO_2 eq/capita. In 2012 the highest emissions from transport per capita were reported for Slovenia (2.8 t CO_2 eq/capita), Austria (2.57 t CO_2 eq/capita), Germany (1.94 t CO_2 eq/capita), Czech Republic (1.6 T CO_2 eq/capita) and Croatia (1.34 t CO_2 eq/capita).

Greenhouse gas emission savings due to RES (2012-2013)

The development of renewable energy in Danube countries resulted in a net GHG emission saving of 7.4% higher in 2013[112] compared with 257.7 Mt CO_2 eq in year 2012, being equivalent to 36% of the EU's net GHG emission savings in the same year from the same source of energy.

Renewable electricity development in Danube countries contributed 65.3% (180.7 Mt CO_2 eq) to the total net GHG emission savings in 2013, more than 8% higher than the contribution in year 2012.

Renewable heat increased during this period its contribution in the final greenhouse gas savings by almost 7% reaching 87.2 Mt CO_2 eq (31.5% in relative terms). The contribution of transport sector decreased in 2013 slightly to 3.2% (8.8 Mt CO_2 eq) from 3.6% (9.4 Mt CO_2 eq) in 2012.

During this two years the main GHG emission savings due to renewable energy were found in Germany (151 Mt CO_2 eq in 2013) and Romania (41.4 Mt CO_2 eq in 2013). Romania had during this period the highest increase in absolute contribution with +11.1 Mt CO_2 eq above the savings in year 2012. Five countries (BG, CZ, HU, AT and SK) in the region reported in 2013 less savings on GHG emissions due to renewable energy compared with year 2012.

[112] This section includes the analysis of greenhouse gas emission savings due to RES in Danube region during period 2012-2013. The analysis doesn't include the contribution of Bosnia & Herzegovina because this country has submitted up to know only its NREAP while the reporting of the role of renewable energy in the reduction of greenhouse gas emissions is part of progress reports template.

The EnC countries'[113] absolute contribution remained almost unchanged during this period, at 14.3 Mt CO_2 eq, split between renewable electricity (65%), renewable heat/cold (34%) and renewables use in transport (1.1%). Serbia had the main contribution with 56.8% followed by Ukraine with 26% and Montenegro with 17.3**%.** In Montenegro the total GHG emissions would have been more than 48% higher without the contribution of renewables, in this case dominated by hydropower technology. In other countries this contribution ranged from 1.2% in Ukraine to 28.6% in Croatia

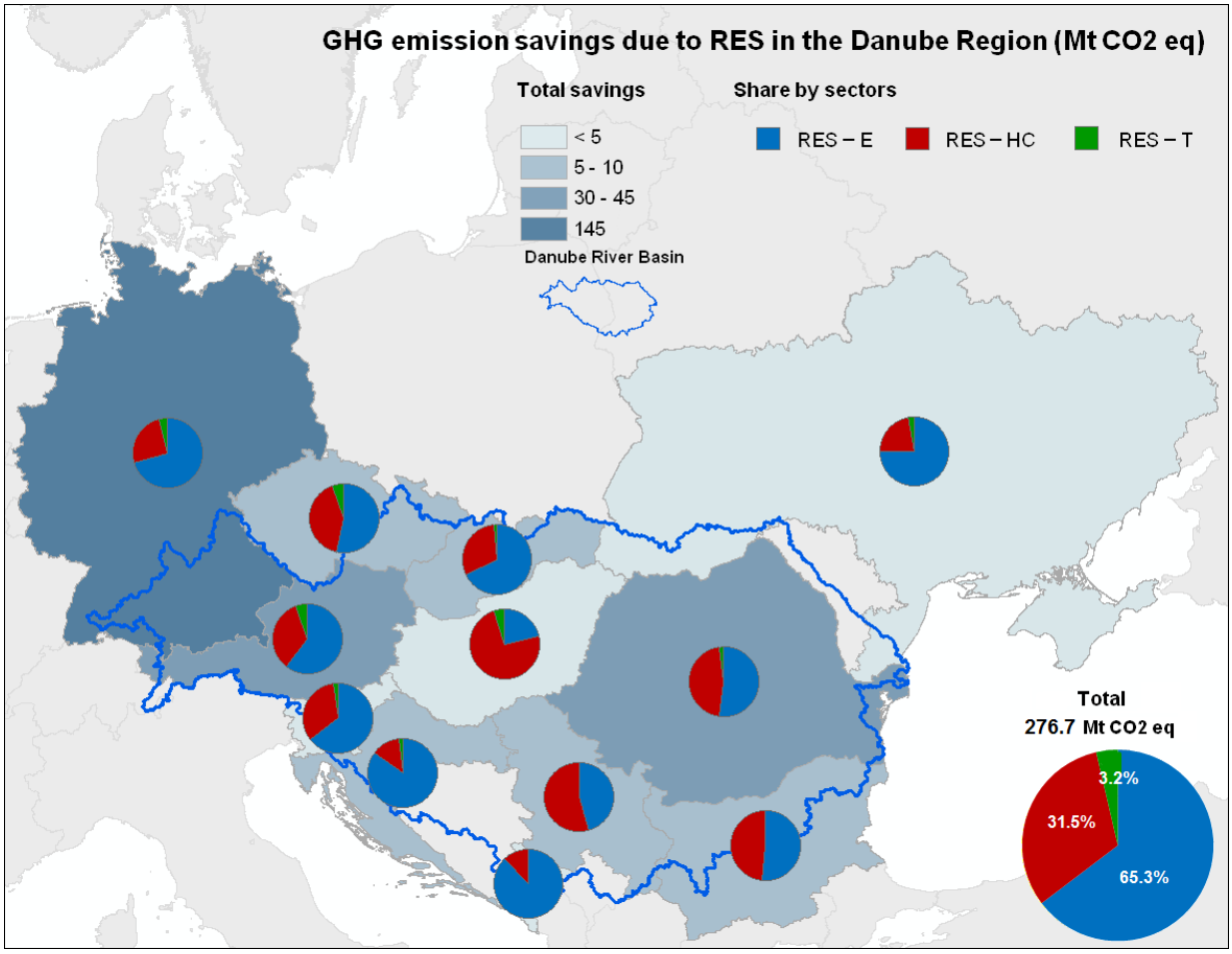


Figure 57. GHG emission savungs due to RES breakwdown by sectors, 2013[114]

The absolute contribution of EU Danube region countries accounted for almost 95% of the total GHG emissions saved due to renewable energy use in 2013 (262.5 Mt CO_2 eq). Germany's contribution to this saving was significant, amounting to nearly 58% of GHG emissions saved in the EU part of the Danube region. Romania and Austria contributed respectively 15.8% and 11.3% in GHG emission savings due to renewable energy use in Danube region in year 2013.

Between 2012 and 2013 the greenhouse gas emission savings due to renewable energy use increased by 7.4% (+19 Mt CO2 eq). During the same period greenhouse gas emissions in Danube region decreased by 6.8% (-134 Mt CO2 eq) in which the savings of emissions due to renewable energy counted for 14.2%.

[113] Moldova didn't report on GHG emission savings due to RES for period 2012-2013.
[114] Raw data can be found at Table A 7 in the Electronic Annex of this report.

Without these savings the total GHG emissions in the Danube region during period 2012-2013 would have been 11.5% – 13% higher[115]. Savings in GHG emissions from both renewable electricity and heat in 2012 amounted to 248.4 Mt CO_2 eq. The Danube region's GHG emissions from public power and heat sectors in 2012 would have been 27.3 % higher without the contribution of renewable electricity and heat and Austria's GHG emissions would have been almost 76 % higher. In Croatia and Montenegro renewable electricity and heat contributed respectively 60.3 % and 60.8 %, with renewable electricity having a dominant share of more than 85 % in the final renewable energy mix of these two countries. The contribution of renewable electricity and heat in terms of GHG emission savings was significant also for Romania (50.5 %), Slovakia (49.8 %) and Slovenia (43.8 %).

The composition of final renewable energy determines not only the absolute GHG savings but also how much GHG is saved from one unit of renewable energy. Moving more towards new renewable energy technologies brought to a higher average GHG savings intensity in EU countries of the region, at 5.1 t CO2 eq/ toe, compare with 2.6 t CO2 eq/toe the GHG savings intensity in EnC countries.

[115] Due to the fact that no detailed data on GHG emissions for year 2013 were available for all Danube region countries in the time this report was prepared this paragraph contains a short analysis based on 2012 data available. The contribution of Bosnia & Herzegovina in total GHG emissions is not taken in consideration for the calculation of the role of renewable energy in the reduction of GHG emissions in the region. The methodology followed to estimate the relative contribution of GHG emission savings is described in [11].

Glossary

B

Biomass: means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste;
Directive 2009/28/EC, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

Biofuels: means liquid or gaseous fuel for transport produced from biomass;
Directive 2009/28/EC, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

D

District heating or District cooling: means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production through a network to multiple buildings or sites, for the use of space or process heating or cooling;
Directive 2009/28/EC, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

E

Energy Efficiency: A value-based, philosophical concept. In this report, two different concepts of energy efficiency are discussed, a technical and a more broad, subjective concept. In the technical concept, increases in energy efficiency take place when either energy inputs are reduced for a given level of service or there are increased or enhanced services for a given amount of energy inputs. In the more subjective concept, energy efficiency is the relative thrift or extravagance with which energy inputs are used to provide goods or services.
US Energy Information Administration: http://www.eia.gov/emeu/efficiency/ee_gloss.htm

Energy Intensity: Energy intensity of the economy is a sustainable development indicator that measures the energy consumption of an economy and its overall energy efficiency. It is calculated as the ratio between the Gross Inland Consumption of Energy and the Gross Domestic Product calculated for a calendar year.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Energy_intensity

Energy dependency rate shows the proportion of energy that an economy must import. It is defined as net energy imports divided by gross inland energy consumption plus fuel supplied to international maritime bunkers, expressed as a percentage. A negative dependency rate indicates a net exporter of energy while a dependency rate in excess of 100 % indicates that energy products have been stocked.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Energy_dependency_rate

F

Final Energy Consumption: is the total energy consumed by end users, such as households, industry and agriculture. It is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Final_energy_consumption

G

Gross Inland Consumption: is the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration. Gross inland consumption of energy covers: consumption by the energy sector itself; distribution and transformation losses; final energy consumption from end users; 'statistical differences' (not already captured in the figures on primary energy consumption and final energy consumption).
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Gross_inland_consumption

Gross Domestic Products: is a basic measure of a country's overall economic health is equal to the sum of the gross value added of all resident institutional units (i.e. industries) engaged in production, plus any taxes, and minus any subsidies, on products not included in the value of their outputs.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Gross_domestic_product_(GDP)

Gross domestic product (GDP) in purchasing power standards is gross domestic product (GDP) converted into purchasing power standards (PPS), an artificial currency unit. This conversion is done via purchasing power parities, based on the theory that the exchange rate between two currencies is at equilibrium when their domestic purchasing powers at that exchange rate are equivalent. The GDP in PPS represents pure volume, after subtracting for price-level differences between countries.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Gross_domestic_product_(GDP)_in_purchasing_power_standards

Gross Final Energy Consumption: means the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission;
Directive 2009/28/EC**,** http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

Greenhouse gases: Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
UNFCCC: http://unfccc.int/resource/cd_roms/na1/ghg_inventories/english/8_glossary/Glossary.htm

L

Land use, Land-Use Change and Forestry: Total emissions and removals from activities relating to land use, land-use change and forestry (from the following categories: forest land, cropland, grassland, wetlands, settlements and other land).
UNFCC: http://unfccc.int/ghg_data/online_help/definitions/items/3817.php

P

Primary Energy Production: is any extraction of energy products in a useable form from natural sources. This occurs either when natural sources are exploited (for example, in coal mines, crude oil fields, hydro power plants) or in the fabrication of biofuels.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Primary_production_of_energy

Primary energy consumption: measures the total energy demand of a country. It covers consumption of the energy sector itself, losses during transformation (for example, from oil or gas into electricity)

and distribution of energy, and the final consumption by end users. It excludes energy carriers used for non-energy purposes (such as petroleum not used not for combustion but for producing plastics).
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Primary_energy_consumption

R

Renewable energy sources: means energy from renew able non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases;
Directive 2009/28/EC**,** http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

S

Support scheme: means any instrument, scheme or mechanism applied by a Member State or a group of Member States, that promotes the use of energy from renewable sources by reducing the cost of that energy, increasing the price at which it can be sold, or increasing, by means of a renewable energy obligation or otherwise, the volume of such energy purchased. This includes, but is not restricted to, investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct price support schemes including feed-in tariffs and premium payments
Directive 2009/28/EC**,** http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

T

Tonne(s) of oil equivalent, abbreviated as toe, is a normalized unit of energy. By convention it is equivalent to the approximate amount of energy that can be extracted from one tonne of crude oil. It is a standardized unit, assigned a net calorific value of 41 868 kilojoules/kg and may be used to compare the energy from different sources.
Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Toe

Data Sources[116]

The report analysis makes use of different data sources as listed in the table below:

Data Sources	Description
Directorate for Energy, Transport and Climate, Joint Research Centre, European Commission http://iet.jrc.ec.europa.eu/remea/national-renewable-energy-action-plans-nreaps	Database of NREAPs and progress reports of the EU Member States' established by the Energy Efficiency and Renewables Unit
Energy Community https://www.energy-community.org/portal/page/portal/ENC_HOME/AREAS_OF_WORK	NREAPs and progress reports of Energy Community Contracting Parties
Eurostat http://ec.europa.eu/eurostat/web/energy/data/database	Population, Energy balances (nrg_10), energy imports (nrg_12), energy exports (nrg_13), energy intensity of the economy (tsdec360), energy dependence (tsdcc310).
IEA http://www.iea.org/countries/membercountries/austria/policiesandmeasuresdatabases/	IEA/IRENA Joint Policies and Measures Database. Historic energy data for UA, MD and BA
IEA http://www.iea.org/countries/	Historic and current countries energy statistics
UNFCCC Data Interface http://unfccc.int/ghg_data/items/3800.php	Historic GHG emissions inventory (Annex I and non-Annex I Parties)
World Resource Institute CAIT Climate Data Explorer http://cait.wri.org	Historic and current GHG emissions inventory
World Bank – World Development Indicators http://data.worldbank.org/data-catalog/world-development-indicators	GDP (constant 2005 USD) GDP PPP/capita (2005 USD)

[116] Last updated data May 2016

Abbreviations

PEP – Primary Energy production
GIC – Gross Inland Consumption
GFEC – Gross Final Energy Consumption
FEC – Final Energy Consumption
EnC – Energy Community
EU – European Union
EE – Energy Efficiency
GHG – Greenhouse gas
NREAP – National Renewable Energy Action Plans
NEEAP – National Energy Efficiency Action Plan
UNFCCC – United Nations Framework Convention on Climate Change
CAIT – US Climate Action Initiative
GDP PPP – Gross Domestic Product (Purchasing Power Parity)
IEA – International Energy Agency
QA – Quality Assurance
RES – Renewable energy sources
RES-E – Renewable energy sources in electricity sector
RES-HC – Renewable energy sources in heating/cooling sector
RES-T – Renewable energy sources in transport sector
PJ - Petajoule
FIT – Feed in tariff
FIP – Feed in premium
PRIMES - Partial equilibrium model of the energy system
EEG - Erneuerbare-Energien-Gesetz (Renewable Energy Act – Germany)
QA – Quality Assurance
CAGR - Compound Annual Growth Rate
EUSDR – European Union Strategy for Danube Region
GW - Gigawatt
MW - Megawatt
LULUCF – Land use, land use change and forestry

Danube Region countries ISO Code[117]

BG - Bulgaria
CZ – Czech Republic
DE - Germany
HR - Croatia
HU - Hungary
AT - Austria
RO - Romania
SI - Slovenia
SK – Slovakia
RS - Serbia
ME - Montenegro
MD - Moldova
UA - Ukraine
BA – Bosnia and Herzegovina

[117] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Country_codes

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