ENERGY BARGE

Building a Green Energy and Logistics Belt

Project Code: DTP1-175-3.2

D 3.2.2 Transnational Scenarios for Biomass Demand in the Bioenergy Sector

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Content

I. About the ENERGY BARGE project 6
II. About this document 8
1 Background 9
2. Introduction 10
3. Methodology and Approach 13
4. Energy Demand Scenarios 16
4.1 Overview Scenarios 16
4.2 Development of bioheat in the Danube region 18
4.2.1 Biomass for heat (Bioheat) – BAU 18
4.2.2 Biomass for heat (Bioheat) - Best Case 20
4.2.3 Biomass for heat (Bioheat) - Worst Case 21
4.3 Development of bioelectricity in the Danube region 23
4.3.1 Bioelectricity – BAU 23
4.3.2 Bioelectricity - Best Case 24
4.3.3 Bioelectricity - Worst Case 25
4.4 Development of liquid biofuels in the Danube region 27
4.4.1 Liquid Biofuels – BAU 27
4.4.2 Liquid Biofuels - Best Case 28
4.4.3 Liquid Biofuels - Worst Case 30
5. Summary & Discussion 32
6. Conclusion & Recommendations 37
7. References and data sources 39
Annex Tables BAU Scenario 51
Austria 51
Bulgaria 57
Croatia 61
Germany 68
Hungary 81
Romania 92
Slovakia 97

List of tables

Table 1: Gross final energy consumption, overall RES and bioenergy in the partner countries in 2014 (ktoe). 11
Table 2: Overview on the development of bioenergy demand in the Danube partner countries in the BAU Scenario 16
Table 3: Overview on the development of bioenergy demand in the Danube partner countries in the Best Case Scenario 17
Table 4: Overview on the development of bioenergy demand in the Danube partner countries in the Worst Case Scenario 17
Table 5: AUSTRIA - Main factors influencing the development of biomass for heat and derived heat 51
Table 6: AUSTRIA - Main factors influencing the development of biomass for Bioelectricity 54
Table 7: AUSTRIA - Main factors influencing the development of biomass for biofuels 55
Table 8: BULGARIA - Main factors influencing the development of biomass for heat and derived heat 57
Table 9: BULGARIA - Main factors influencing the development of biomass for Bioelectricity 58
Table 10: BULGARIA - Main factors influencing the development of biomass for biofuels 59
Table 11: CROATIA - Main factors influencing the development of biomass for heat and derived heat 61
Table 12: CROATIA - Main factors influencing the development of biomass for Bioelectricity 64
Table 13: CROATIA - Main factors influencing the development of biomass for biofuels 66
Table 14: GERMANY - Main factors influencing the development of biomass for heat and derived heat 68
Table 15: GERMANY - Main factors influencing the development of biomass for Bioelectricity 73
Table 16: GERMANY - Main factors influencing the development of biomass for biofuels 76
Table 17: HUNGARY - Main factors influencing the development of biomass for heat and derived heat 81
Table 18: HUNGARY - Main factors influencing the development of biomass for Bioelectricity 84
Table 19: HUNGARY - Main factors influencing the development of biomass for biofuels 88
Table 20: ROMANIA - Main factors influencing the development of biomass for heat and derived heat 92
Table 21: ROMANIA - Main factors influencing the development of biomass for Bioelectricity 94
Table 22: ROMANIA - Main factors influencing the development of biomass for biofuels 95
Table 23: SLOVAKIA - Main factors influencing the development of biomass for heat and derived heat 97
Table 24: SLOVAKIA - Main factors influencing the development of biomass for Bioelectricity 100
Table 25: SLOVAKIA - Main factors influencing the development of biomass for biofuels 102

List of Figures

Figure 2: Share of energy from renewable sources in the EU. 10
Figure 3: Evolution of gross final energy consumption of bioenergy 2006-2015 in the Danube partner countries (ktoe). 12
Figure 4: BAU Scenario : Evolution of bioheat in 2006-2015 and projections until 2030 in the partner countries. 18
Figure 5: BAU Scenario: Bioheat in 2015 and projection for 2030. 19
Figure 6: Best Case Scenario: Evolution of bioheat in 2006-2015 and projections until 2030 in the partner countries. 20
Figure 7: Best Case Scenario: Bioheat in 2015 and projection for 2030. 21
Figure 8: Worst Case Scenario: Evolution of bioheat in 2006-2015 and projections until 2030 in the partner countries. 22
Figure 9: Worst Case Scenario: Bioheat in 2015 and projection for 2030. 22
Figure 10: BAU Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries. 23
Figure 11: BAU Scenario: Bioelectricity in 2015 and projection for 2030. 24
Figure 12: Best Case Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries. 24
Figure 13: Best Case Scenario: Bioelectricity in 2015 and projection for 2030. 25
Figure 14: Worst Case Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries. 26
Figure 15: Worst Case Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries. 26
Figure 16: BAU Scenario: Evolution of liquid biofuel demand in 2006-2015 and projections until 2030 in the partner countries. 27
Figure 17: BAU Scenario: Liquid biofuel demand in 2015 and projection for 2030. 28
Figure 18: Best Case Scenario: Evolution of liquid biofuel demand in 2006-2015 and projections until 2030 in the partner countries. 29
Figure 19: Best Case Scenario: Liquid biofuel demand in 2015 and projection for 2030. 29
Figure 20: Worst Case Scenario: Evolution of liquid biofuel demand in 2006-2015 and projections until 2030 in the partner countries. 30
Figure 21: Worst Case Scenario. Liquid biofuel demand in 2015 and projection for 2030. 31
Figure 22: Projections of bioheat until 2030 in the partner countries. 33
Figure 23: Projections of bioelectricity until 2030 in the partner countries. 34
Figure 24: Projections of liquid biofuels until 2030 in the partner countries. 35

I. About the ENERGY BARGE project

The Danube region offers a great potential for green energy in the form of biomass. The main objective of ENERGY BARGE is to exploit this potential in a sustainable way, considering the Renewable Energy Directive 2009/28/EC, thereby increasing energy security and efficiency in the Danube countries. The project will bring together key actors along the entire value chain, biomass companies and Danube ports as well as relevant public authorities and policy stakeholders. The project will map value chains and facilitate the market uptake of biomass, support better connected transport systems for green logistics and provide practical solutions and policy guidelines. FNR coordinates the project with its fourteen partners from Austria, Bulgaria, Croatia, Germany, Hungary, Slovakia and Romania.

Project coordinator

Agency for Renewable Resources Fachagentur Nachwachsende Rohstoffe e.V.	FNR	Germany

Project partners

BioCampus Straubing GmbH	BCG	Germany
Deggendorf Institute of Technology	DIT	Germany
Austrian Waterway Company	VIA	Austria
Port of Vienna	PoVi	Austria
Bioenergy2020+ GmbH	BE2020	Austria
International Centre of Applied Research and Sustainable Technology	ICARST	Slovakia
Slovak Shipping and Ports JSC	SPaP	Slovakia
National Agricultural Research and Innovation Center	NARIC	Hungary
MAHART-Freeport Co. Ltd.	MAHART	Hungary
International Centre for Sustainable Development of Energy, Water and Environment Systems	SDEWES Centre	Croatia
Public Institution Port Authority Vukovar	PoVu	Croatia
Technology Center Sofia Ltd.	TCS	Bulgaria
Romanian Association of Biomass and Biogas	ARBIO	Romania
Federation of owners of forests and grasslands in Romania	Nostra Silva	Romania

II. About this document

This report corresponds to "D.3.2.2. Transnational Scenarios for Biomass Demand in the Bioenergy Sector" of ENERGY BARGE. It has been prepared by:

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1 Background

The deliverable "D 3.2.2 Transnational Scenarios for Biomass Demand in the Bioenergy Sector" is based on the task as described in the latest approved version of the Application Form of the project ENERGY BARGE (Project Code: DTP1-175-3.2).

Deliverable D 3.2.2 feeds into Activity 3.2, which aims at providing a systematic insight into the integrated bioenergy landscape along the Danube. With the transnational demand scenario analysis of biomass demand, further insight into the potential future development of the demand for bioenergy-feedstock shall be gained in order to reduce uncertainty with regards to business development and policy making. On the basis of this analysis, the goal is to formulate and disseminate recommendations for market actors from the biomass supply chains and the Inland Waterway Transport (IWT)/ Danube logistics how to target their business development activities in line with potential future pathways. Policy recommendations on national, Danube region-wide and EU wide levels shall also be formulated. Part of the deliverable also is to develop a brief communication and dissemination plan in accordance with the communications work package of the project, as to disseminate the recommendations in a targeted and user-friendly fashion. Ideally, stakeholders in the Danube region can then act consequently in a more informed way.

The specific aspects of the scenario analysis conducted under ENERGY BARGE shall be the following:

- Demand analysis: the focus shall be on the demand for biomass - primarily for utilisation for energy generation;
- Transnational character: the future demand in the Danube Region as a whole (with focus on ENERGY BARGE partner countries) shall be assessed

Activity 3.2 focusses on the biomass and bioenergy business sector, with the aim of mapping the state of the business landscape working along the bioenergy value chain via a transnational inventory of biomass and bioenergy companies. Maps are to be created to gain insight into the potential future development of the demand for bioenergy-feedstocks via a scenario analysis (D 3.2.2), and the current development state of biomass and bioenergy sectors is to be explored in case studies. In this Activity the project's port and logistics partners' expertise will be incorporated, integrating the project's transport aspect. Data from Activity 3.2 combined with input from Activity 3.1 and supplemented by input from WP4 form the basis for the Danube transnational biomass and bioenergy atlas (Output 3.1). This online-based tool will function as a one-stop-shop for improved value chain management, providing systematic transnational market insight for relevant market actors such as biomass producers, traders and producers of bioenergy products, public and private deployment actors and regional planners. Activity 3.2 feeds in Activity 3.3 and in WP4, 5 and 6.

2. Introduction

Renewable energy in the EU has grown strongly in recent years. The share of energy from renewable sources in gross final energy consumption has almost doubled in the last 12 years, from around 8.5% in 2004 up to 17.0% in 2016 (Eurostat, 2018).

This positive development has been prompted by the legally binding targets for increasing the share of energy from renewable sources enacted by the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. While the EU as a whole is on course to meet its 2020 targets, some Member States will need to make additional efforts to meet their obligations regarding the two main targets: the overall share of energy from renewable sources in the gross final energy consumption (Figure 1) and the specific share of energy from renewable sources in transport. Regarding the project partner countries, Bulgaria, Croatia, Hungary and Romania have already reached their 2020 target, whereas Austria, Germany and Slovakia still need to make additional efforts to meet the target values.

On 30 November 2016, the European Commission presented a proposal for a recast of the directive on the promotion of renewable energy sources (RES), as part of the broader 'Clean Energy for all Europeans' package. The main purpose of the revised RES directive is to increase the share of RES in the EU energy mix to at least 27% by 2030.

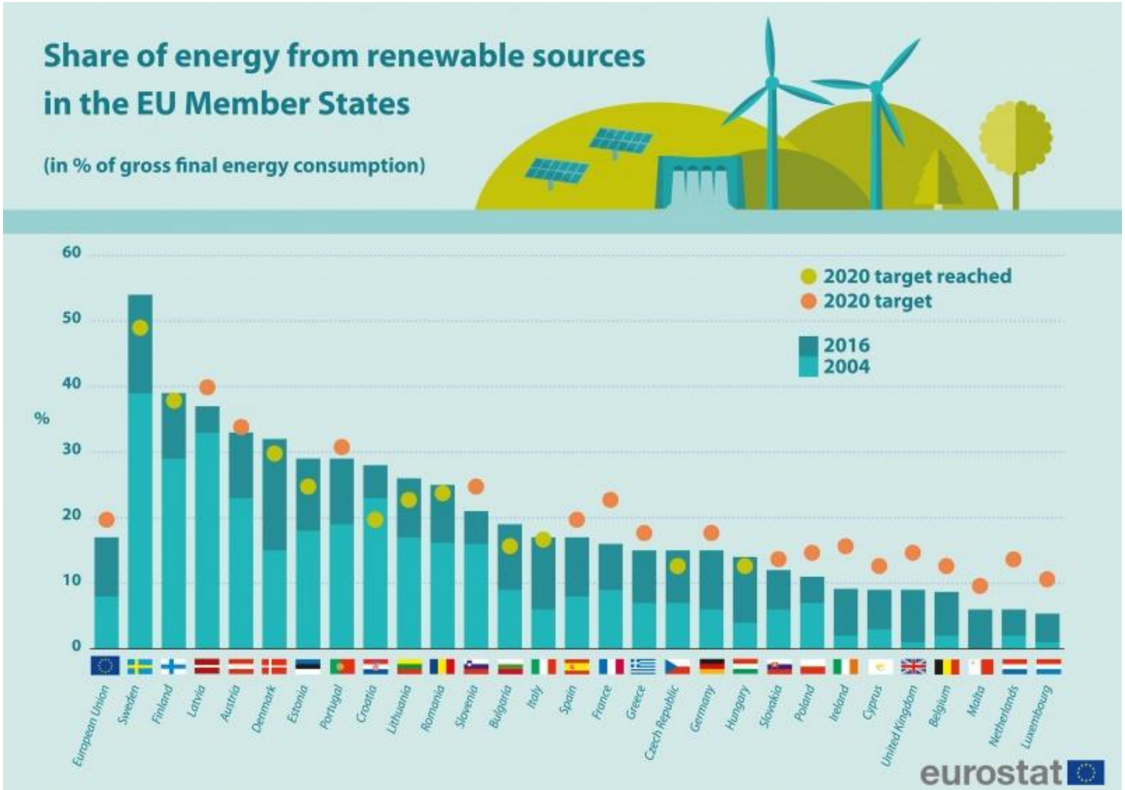

Figure 1: Share of energy from renewable sources in the EU.
Source: Eurostat, 2018

The renewable share of energy use for electricity and heat has nearly doubled in the EU in just a decade. This reflects a robust expansion of bioenergy, driven by the availability of highly efficient, highly economical, long-proven technologies for using biomass in combined heat and power plants, urban district heating plants, and modern boilers and stoves (AEBIOM, 2016). Among renewable energies, the most important source in the EU-28 was wood and other solid biofuels as well as renewable wastes, accounting for 49.4% of primary renewables production in 2016 (Eurostat, 2018). Hence, wood and other solid biomass continue to be the largest contributors to the mix of renewable energy sources. The Danube region has a large natural potential for bioenergy development in all three main feedstock categories of bioenergy (agriculture, forestry and waste), supporting its three main uses for transport, heat and electricity.

Table 1 shows the gross final energy consumption, the overall consumption of renewable energy sources and the bioenergy consumption in the Danube partner countries. In all partner countries the share of bioenergy in renewable energy sources (RES) is over 50%, in Hungary even over 85%. The share of bioenergy in the total final energy consumptions is between 7 and 19%.

Table 1: Gross final energy consumption, overall RES and bioenergy in the partner countries in 2014 (ktoe).
Data Source: EUROSTAT, 2018; AEBIOM, 2016

	TOTAL	RES	% RES/Total Final energy	Bioenergy	% Bioenergy/Total Final energy	% Bioenergy/ RES
AT	26,802	9,316	34.8%	4,861	18.1%	52.2%
BG	9,012	1,816	20.2%	1,097	12.2%	60.4%
DE	208,881	29,116	13.9%	18,171	8.7%	62.4%
HR	6,241	1,979	31.7%	1,109	17.8%	56.0%
HU	14,929	1,531	10.3%	1,314	8.8%	85.8%
RO	21,712	6,071	28.0%	3,716	17.1%	61.2%
SK	10,057	1,193	11.9%	748	7.4%	62.7%
Total	**297,634**	**51,022**	**17.2%**	**31,016**	**10.4%**	**60.8%**

In Figure 2 the evolution of bioheat, bioelectricity and biofuel consumption in the Danube partner countries between 2006 and 2015 is presented. The bioenergy consumption increased from 21,695 ktoe (=kiloton of oil equivalent) in 2006 to 32,455 ktoe in 2015. The consumption of biomass for heat increased by almost 50% from 16,142 ktoe in 2006 to 23,705 ktoe in 2015, the consumption of liquid biofuels increased only by about 5% to 4,162 ktoe. The consumption of bioelectricity (2015: 4,588 ktoe) almost tripled in the Danube partner regions in the considered time period (Eurostat, 2018).

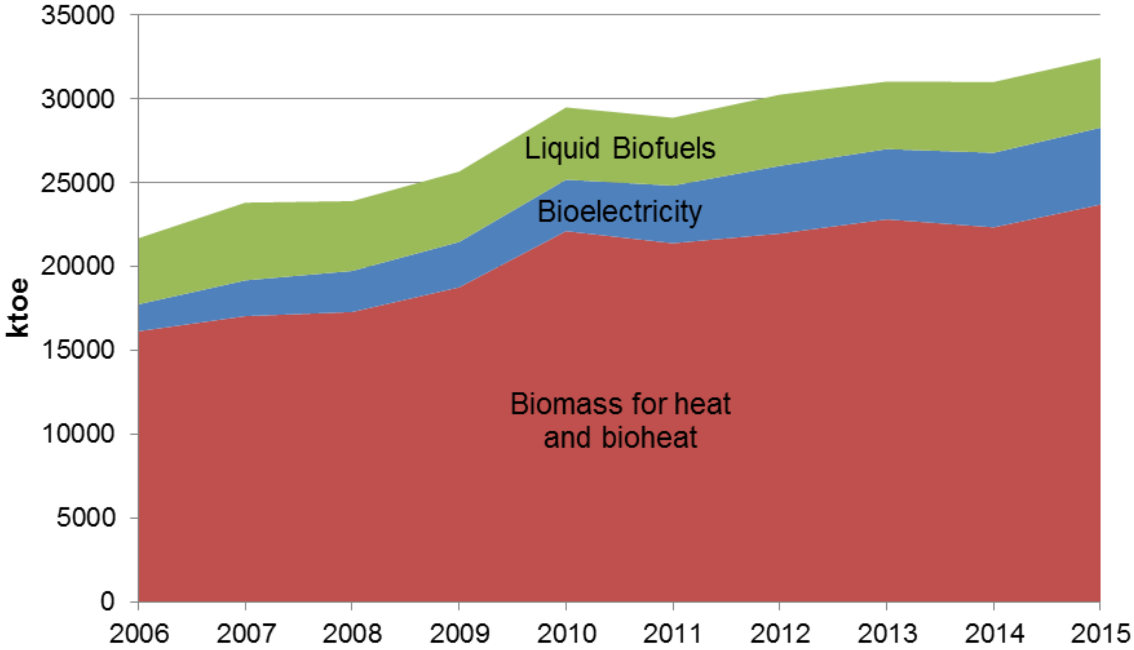

Figure 2: Evolution of gross final energy consumption of bioenergy 2006-2015 in the Danube partner countries (ktoe).
Data Source: EUROSTAT, 2018

The aim of this report is to provide a comprehensive analysis of the expected use of bioenergy between 2015 and 2030 in the project partner countries in the Danube region based on three different scenarios. The scenarios should support stakeholders for targeted business development and policy making via recommendations. In the following chapter the approach for the scenario development is explained. Afterwards the three different scenarios for the development of energy demand in the Danube region are presented in detail. The results are discussed in chapter 5 "Summary & Discussion", followed by recommendations in chapter 6.

3. Methodology and Approach

The methodological basis of the deliverable is a scenario analysis. Scenario analysis is a methodology employed to examine plausible, divergent futures based on uncertainty about the drivers of change. By examining different future pathways, it becomes possible for individuals and organisations to improve their capability and capacity to make robust decisions. Scenario planning is based on a qualitative approach that stands in contrast to quantitative tools that consider predicted futures (van Notten, 2006). A number of scenario analyses for biomass supply and demand have been conducted in the scientific European realm. For example, these include:

- Global analysis of biomass supply and demand 2011 – 2050, nova institute (Piotorowski et al., 2016)
- EU Reference Scenario 2016 Energy, EU Commission, DG Energy (EU Commission, 2016)
- Market Analysis Renewable Raw Materials, Fachagentur Nachwachsende Rohstoffe (FNR, 2014)
- Scenarios for sustainable lignocellulosic biomass supply, S2BIom Project (S2Biom Project Consortium, 2014).

However, these scenarios are partly outdated and since the focus of the project is on future bioenergy demand particularly in the Danube region, the project consortium decided to develop their own demand scenarios for bioheat (application fields: residential, industrial, services and derived heat), bioelectricity (application fields: CHP plants, electricity only plants) and liquid biofuels (application fields: transport, types: biodiesel, bioethanol) in the project partner countries.

Scenario analysis, which is one of the main forms of projection, does not try to show one exact picture of the future. Instead, it presents several alternative future developments. Consequently, a scope of possible future outcomes is observable. In this case, the scenarios should show a scope of possible developments of bioenergy demand in the project partner countries in the Danube region if:

- the current legal, economic and technical conditions for bioenergy remain the same (Business-as-usual/BAU Scenario)
- favourable economic, technical and legal frameworks for bioenergy are maintained or, if missing, are established (Best Case Scenario)
- the legal, economic and technical conditions for bioenergy change for the worse (Worst Case Scenario)

For this purpose, three transnational scenarios integrating the information from the seven Danube partner countries have been formulated for the time-frame of 2016 to 2030 for each of the three bioenergy sectors. The BAU scenario assumes that the existing frameworks for bioenergy production would undergo no significant change in the future, whilst the worst case and best case scenarios consider the long-term shifts in bioenergy demand with and without considering further constraints or support measures respectively. However, climate change and related extreme weather conditions are not considered in the scenario development. The time

horizon was set for 2030, since the EU countries have agreed on a new 2030 framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030.

In order to develop a reliable "**Business-as-Usual Scenario"** for bioenergy demand given the assumption that the current framework and conditions in the partner countries stay the same. The BAU Scenario is based on latest official statistics, literature and the country specific know-how (see Annex Tables BAU Scenario). In order to consider recent changes in policy and market conditions which cannot be observed in the historic data and to identify main factors influencing the development of bioenergy, the project partners were asked to fill in a standardized questionnaire considering following qualitative influencing factors:

- Effect of oil/gas price development,
- Legislation (EU/national): support schemes,
- Legislation (EU/national): emission caps and CO2 certificate trading systems,
- Legislation (EU/national): approval procedures & similar administrative conditions,
- Legislation (EU/national): sustainability targets,
- Technology development,
- Main feedstock types used, as well as an
- Overall assessment for the BAU Scenario on increase, decrease or stagnation.

The final conclusion if the bioenergy demand will increase (↑), decrease (↓) or stagnate (→) are made by the expert opinion of the project partners based on their research regarding the current framework conditions. The results of this analysis are presented in the Annex.

The qualitative descriptions are the basis for the discussion and, in addition, have been transformed into quantitative developments for a Business-as-Usual Scenario for the evolution of bioenergy up to 2030 based on annual Eurostat data from 2006 to 2015.

The **BAU Scenario** is based on the assumption that the current economic, technical and legal frameworks in the partner countries continue to develop under the conditions currently in place until 2030. Hence, the qualitative descriptions are transformed as follows:

- **Expected increase** based on the current economic, technical and legal framework:
  - If the demand for bioenergy (bioheat, bioelectricity, liquid biofuels) increased between 2006 and 2015, the trend is continued with the same average annual growth rate until 2030.
  - If the demand for bioenergy (bioheat, bioelectricity, liquid biofuels) decreased between 2006 and 2015, the trend is reversed.
- **Expected decrease** based on the current economic, technical and legal framework:
  - If the demand for bioenergy (bioheat, bioelectricity, liquid biofuels) decreased between 2006 and 2015, the trend is continued with the same average annual rate until 2030.
  - If the demand for bioenergy (bioheat, bioelectricity, liquid biofuels) increased between 2006 and 2015, the trend is reversed.

- **Expected stagnation** based on the current economic, technical and legal framework:
    - From 2016 to 2030 the demand stagnates based on the year 2015.

Based on the assumptions above, the development of the bioenergy demand between 2016 and 2030 are calculated, indicated as "own calculation" in the figure caption.

In addition to the BAU Scenario a Best Case Scenario and a Worst Case Scenario are presented as upper and lower limits for the development of bioenergy consumption in the Danube region countries.

In the **Best Case Scenario** it was assumed that favourable economic, technical and legal frameworks for bioenergy are maintained or, if missing, are established. Hence, if there was a positive trend between 2006 and 2015, the demand increases with the same average annual growth rate until 2030. A stagnation was also transformed into a positive trend using a growth rate of 2.5% per year. A decreasing development between 2006 and 2015 was stopped for the Best Case Scenario.

In the **Worst Case Scenario** it was assumed that economic, technical and legal frameworks for bioenergy will further deteriorate. Thus, all increasing developments between 2006 and 2015 were transformed into a stagnation. Decreasing developments are continued with the same average annual rate until 2030, continuing the trend between 2006 and 2015 (higher deterioration rates are not assumed since investments in the energy sector are long-term investments and energy appliances will usually be replaced after a lifecycle between 15 and 25 years).

4. Energy Demand Scenarios

4.1 Overview Scenarios

As mentioned before, the BAU Scenario is based on latest official statistics, literature and the country specific know-how (see Annex Tables BAU Scenario).

Table 2 shows an overview of the bioenergy demand development in the Danube region given the assumption that the current framework and conditions in the partner countries stay the same until 2030. While the demand for bioheat and bioelectricity from CHP plants is expected to remain constant or even increase in the project partner countries, the consumption of bioelectricity from electricity only plants is going to decrease. Regarding the liquid biofuels, it seems that the market share of biodiesel will decrease, except in Bulgaria, Romania and Slovakia.

Hence, it turns out, that current legal frameworks and business conditions hardly promote the further expansion of renewable energies. This is also the case for the project partner countries that have not yet reached their 2020 targets.

Table 2: Overview on the development of bioenergy demand in the Danube partner countries in the BAU Scenario

		Austria	Bulgaria	Croatia	Germany	Hungary	Romania	Slovakia
Bioheat	Residential	→	→	→	→	→	→	↗
	Industry	→	→	→	→	→	→	→
	Services	→	→	→	→	→	→	→
	Derived Heat	→	→	→	→	→	→	↗
Bioelectricity	CHP plants	→	→	↗	↗	→	↗	↗
	Electricity only plants	↘	→	→	↘	↘	→	→
Liquid biofuels	Bioethanol	→	→	→	↘	→	↗	→
	Biodiesel	↘	→	↘	↘	↘	↗	→

Table 3 and Table 4 show an overview of the bioenergy demand development in the Danube region in the Best Case and the Worst Case Scenario. In the Best Case Scenario it was assumed that favorable economic, technical and legal frameworks for bioenergy have been established. Hence, the bioenergy demand is increasing until 2030 or at least stagnates at the level of 2015.

Table 3: Overview on the development of bioenergy demand in the Danube partner countries in the Best Case Scenario

		Austria	Bulgaria	Croatia	Germany	Hungary	Romania	Slovakia
Bioheat	Residential	↗	↗	➚	↗	↗	→	↗
	Industry	↗	↗	→	↗	↗	→	↗
	Services	↗	↗	↗	↗	↗	↗	↗
	Derived Heat	↗	↗	↗	↗	↗	↗	↗
Bioelectricity	CHP plants	→	↗	↗	↗	↗	↗	↗
	Electricity only plants	→	↗	↗	→	→	↗	➚
Liquid biofuels	Bioethanol	↗	↗	↗	→	↗	↗	↗
	Biodiesel	↗	↗	→	→	↗	→	→

In the Worst Case Scenario it was assumed that economic, technical and legal frameworks for bioenergy will further deteriorate. Hence, all increasing developments were transformed into a stagnation and former decreasing developments are continued with the same average annual rate until 2030.

Table 4: Overview on the development of bioenergy demand in the Danube partner countries in the Worst Case Scenario

		Austria	Bulgaria	Croatia	Germany	Hungary	Romania	Slovakia
Bioheat	Residential	→	→	→	→	→	↘	↘
	Industry	→	→	→	→	→	→	→
	Services	→	→	→	→	→	→	→
	Derived Heat	→	→	→	→	→	→	→
Bioelectricity	CHP plants	↘	→	→	→	→	→	→
	Electricity only plants	↘	➘	➘	↘	↘	➘	➘
Liquid biofuels	Bioethanol	→	→	→	↘	→	→	→
	Biodiesel	↘	→	↘	↘	↘	→	→

The following chapters will take a closer look at the expected developments in the specific sectors.

4.2 Development of bioheat in the Danube region

4.2.1 Biomass for heat (Bioheat) – BAU

In the BAU Scenario the demand for bioheat in the Danube partner countries will increase from 23,705 ktoe in 2015 to almost 24,475 ktoe in 2030 (Figure 3). More than half of the heat produced from biomass will be consumed by households (13,923 ktoe in 2030). This is only counting the biomass directly consumed in households for the production of heat, excluding district heating. The residential sector is followed by 4,822 ktoe of biomass for heat in industry in 2030. Mainly woody biomass is used for bioheat production in the Danube region in this scenario.

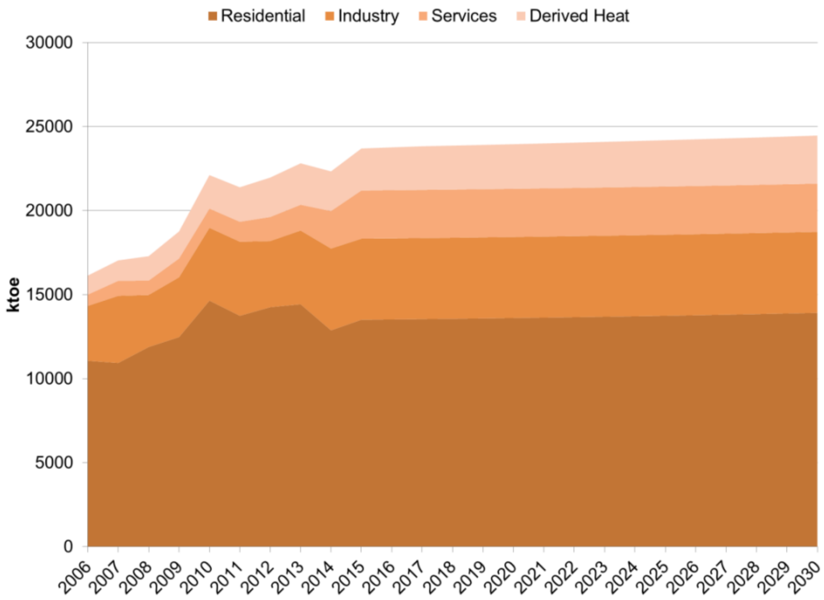

Figure 3: BAU Scenario : Evolution of bioheat in 2006-2015 and projections until 2030 in the partner countries.

Data Source: EUROSTAT and own calculations

Figure 4 shows the projection for bioheat demand on country level in 2030. The demand for bioheat in the residential sector is expected to increase in Slovakia (from 24.4 to 50.7 ktoe), Austria (from 1,581 to 2,128 ktoe) and Bulgaria (from 716 to 964 ktoe) and to stagnate in Croatia, Germany and Hungary. In the BAU Scenario, only in Romania, biomass use for the residential heating sector will decline, from 2,951 ktoe in 2015 to 2,538 ktoe in 2030. The bioheat demand in the industry and service sectors will stagnate in all partner countries. However, the demand for derived heat, which can also be used for industry and production processes, is expected to increase in most countries.

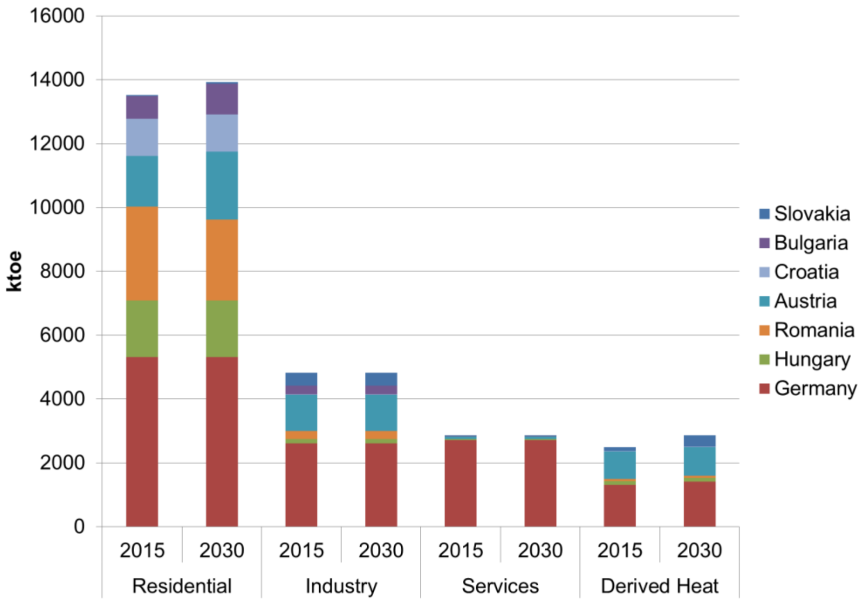

Figure 4: BAU Scenario: Bioheat in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

4.2.2 Biomass for heat (Bioheat) - Best Case

In the Best Case Scenario the bioheat consumption increases from 23,705 to 32,145 ktoe until 2030 (Figure 5). In particular, the demand in the residential heating sector increases from 13,515 ktoe in 2015 to 18,535 ktoe in 2030, in the industry sector from 4,822 to 6,420 ktoe and in the service sector from 2,869 to 4,216 ktoe. The consumption of derived heat increases from 2,499 kto in 2015 to 2,974 ktoe in 2030.

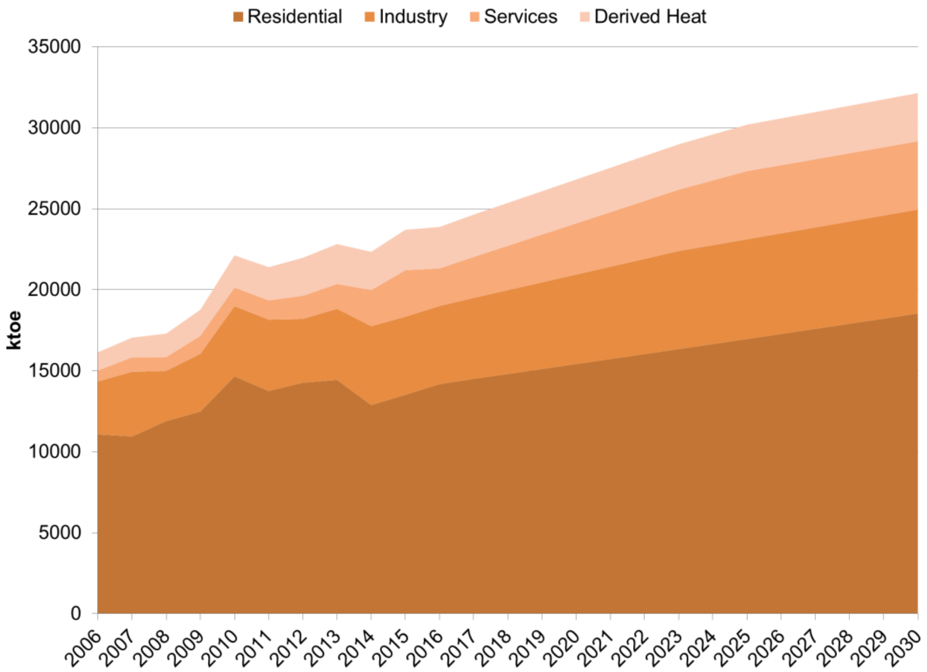

Figure 5: Best Case Scenario: Evolution of bioheat in 2006-2015 and projections until 2030 in the partner countries.

Data Source: EUROSTAT and own calculations

Figure 6 shows the projection for bioheat demand on the country level in 2015 compared to 2030. In Hungary, the bioheat demand in the residential sector almost tripled between 2006 and 2015. Therefore, a substantial growth can also be observed in the Best Case Scenario until 2030: from 1,765 ktoe in 2015 to 4,806 ktoe in 2030. In the other countries, the growth rates are more moderate. The use of biomass for heat production in other sectors has also become more important in recent years and will continue to grow accordingly until 2030.

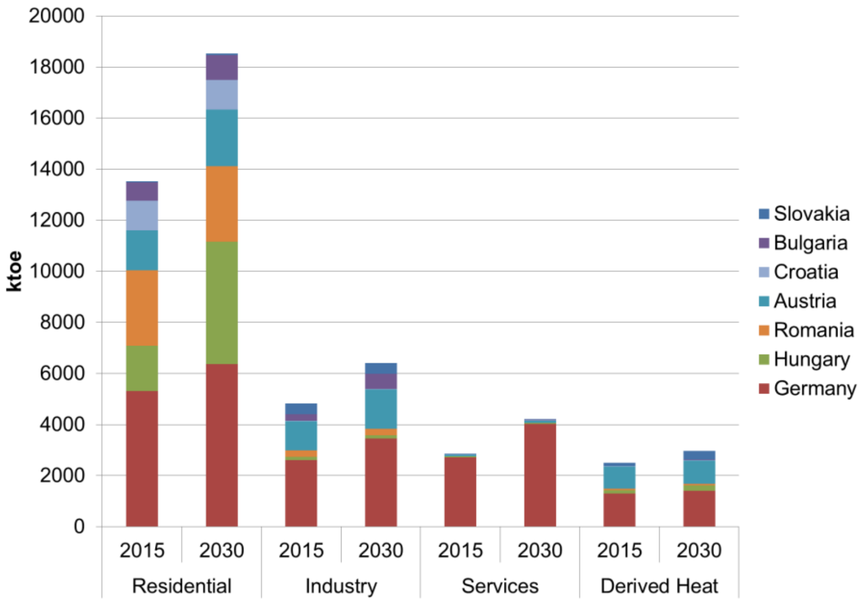

Figure 6: Best Case Scenario: Bioheat in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

4.2.3 Biomass for heat (Bioheat) - Worst Case

In the Worst Case Scenario the bioheat consumption decreases slightly from 23,705 to 23,267 ktoe by 2030 (Figure 7). The demand in the residential heating sector decreases to 13,079 ktoe in 2030 compared to 13,515 ktoe in 2015. In the other sectors the use of biomass for heat production remains almost on the same level.

Figure 8 shows the projection of the Worst Case Scenario for bioheat demand on the country level in 2015 compared to 2030. In most countries the bioheat demand stagnates. However, in Romania the bioheat demand of the residential sector decreases from 2,951 ktoe in 2015 to 2,538 ktoe in 2030 and in Slovakia from 24 ktoe in 2015 to about 1 ktoe in 2030.

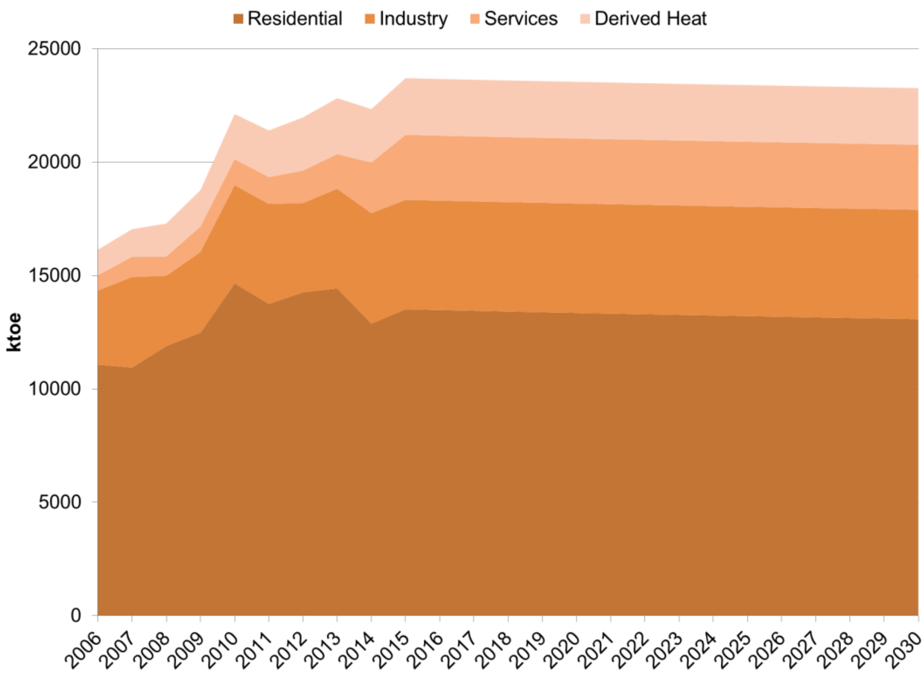

Figure 7: Worst Case Scenario: Evolution of bioheat in 2006-2015 and projections until 2030 in the partner countries.

Data Source: EUROSTAT and own calculations

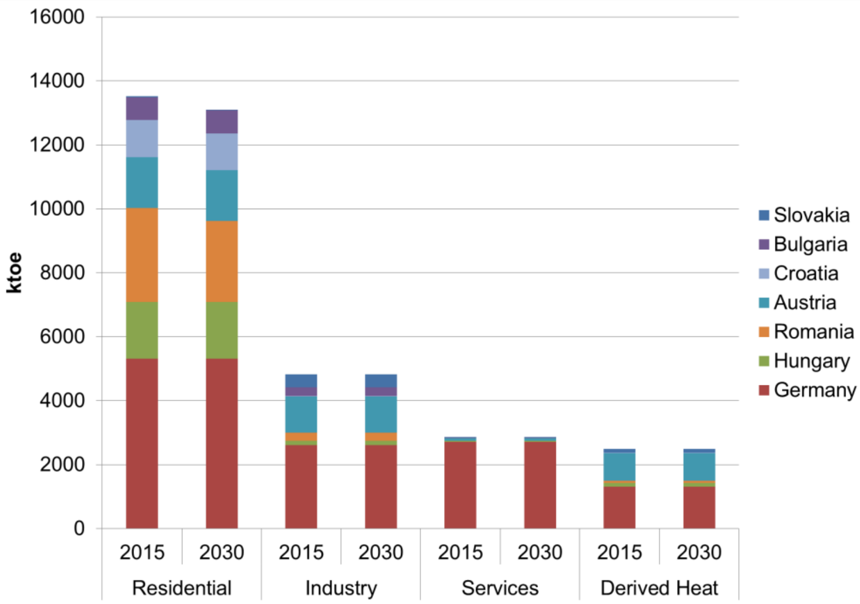

Figure 8: Worst Case Scenario: Bioheat in 2015 and projection for 2030.

Data Source: EUROSTAT and own calculations

4.3 Development of bioelectricity in the Danube region

4.3.1 Bioelectricity – BAU

Figure 9 shows the bioelectricity development in the BAU Scenario. In this scenario the demand for bioelectricity from CHP plants will increase from 3,098 ktoe in 2015 to 3,807 ktoe in 2030. In contrast, the demand for bioelectricity from electricity only plants will decrease from 1,450 ktoe in 2015 to 388 ktoe in 2030. The production of bioelectricity from electricity only plants is quite inefficient. The plants were only built because of high subsidies and these support schemes have expired. For bioelectricity production mainly woody biomass and different kind of waste materials (agricultural residues, animal litter etc.) are used.

Figure 10 shows the projection for bioelectricity consumption on the country level in 2030. In the following countries the bioelectricity demand from CHP plants will have continued increase in the BAU Scenario by 2030: Croatia (from 20.8 to 52 ktoe), Germany (from 2,620 to 3,227 ktoe), Romania (from 33.3 to 69 ktoe) and Slovakia (from 130.7 to 239 ktoe). In Hungary and Bulgaria the bioelectricity demand is expected to stagnate. Only in Austria the development of bioelectricity from CHP is expected to decrease from 199 ktoe in 2015 to 126 ktoe in 2030 due to the expiration of the feed in tariffs in accordance with the Green Electricity Act without subsequent regulation.

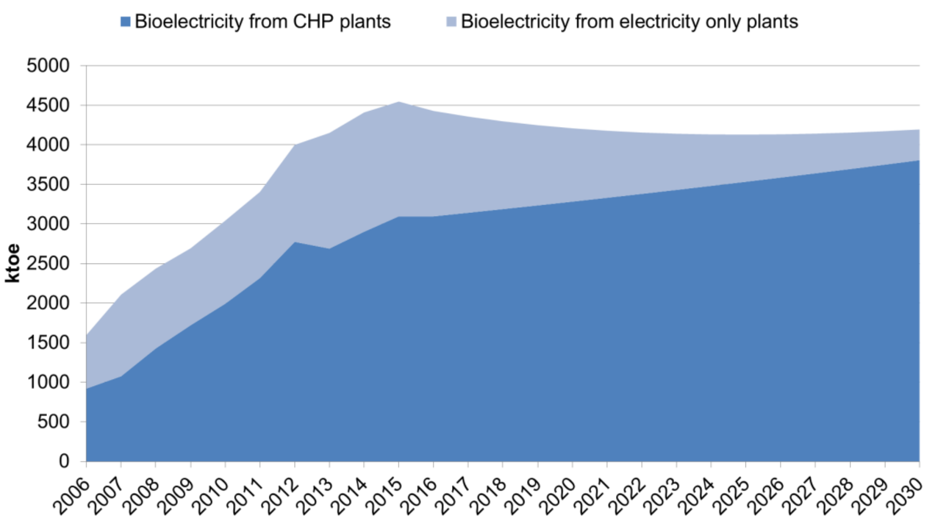

Figure 9: BAU Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries.
Data Source: EUROSTAT and own calculations

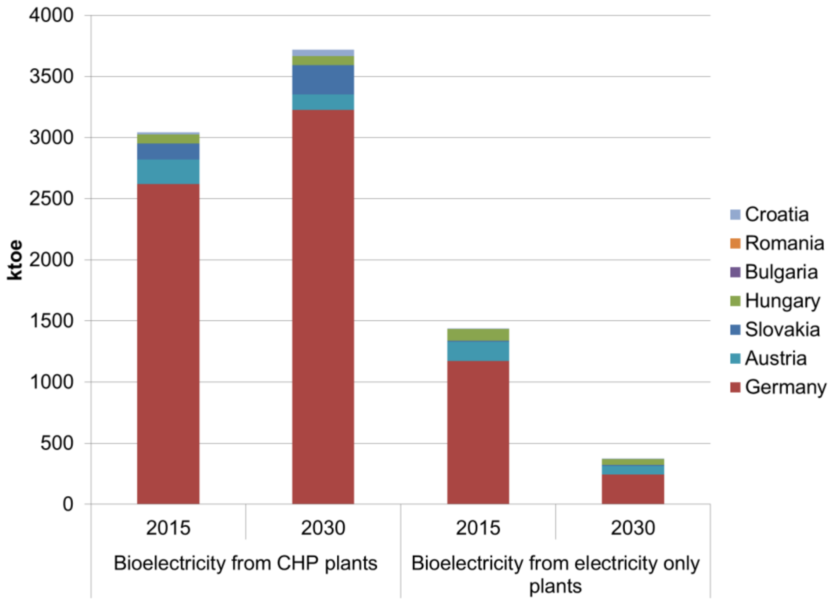

Figure 10: BAU Scenario: Bioelectricity in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

4.3.2 Bioelectricity - Best Case

Figure 11 shows the development of bioelectricity in the Best Case Scenario. Bioelectricity from CHP only plants increases from 3,098 ktoe in 2015 to 3,931 ktoe in 2030. Even in the Best Case Scenario, only a slight increase of bioelectricity consumption of electricity only plants can be observed (from 1,450 ktoe in 2015 to 1,471 ktoe in 2030). In total, the bioelectricity demand amounts to 5,402 ktoe in 2030.

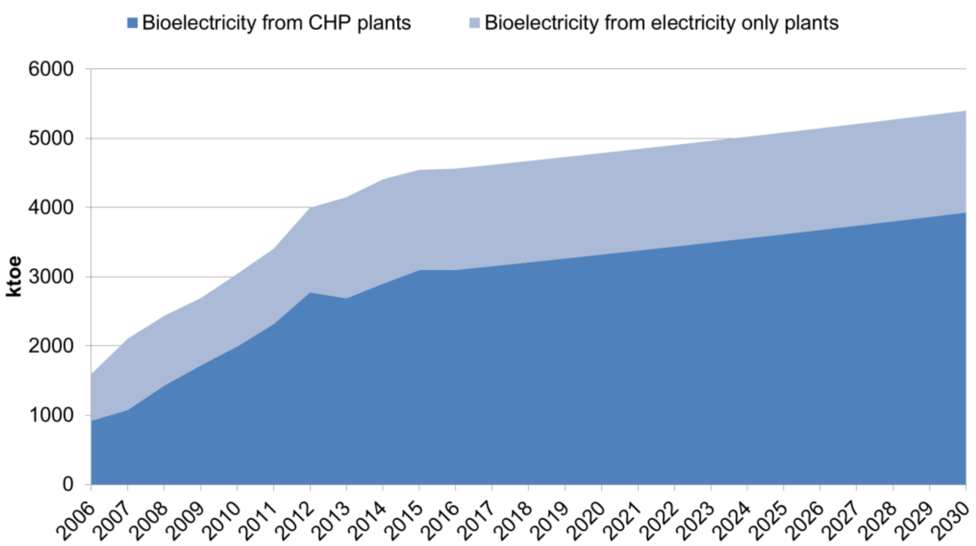

Figure 11: Best Case Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries.
Data Source: EUROSTAT and own calculations

Figure 12 shows the projection for bioelectricity demand on the country level in 2015 compared to 2030. In Austria, the expansion of bioelectricity plants had already taken place before 2008. Hence, development also will stagnate (355 ktoe) by 2030. Bioelectricity is not very popular in the southern partner countries: the shares of bioelectricity are increasing in Bulgaria (50 ktoe), Croatia (58 ktoe) and Romania (91 ktoe) from a very low level. Therefore the Best Case Scenario is quite similar to the BAU – Scenario for these countries. In contrast, the total bioelectricity demand in Germany and Slovakia increases from 3,815 ktoe and 143 ktoe in 2015 to 4,400 ktoe and 245 ktoe in 2030.

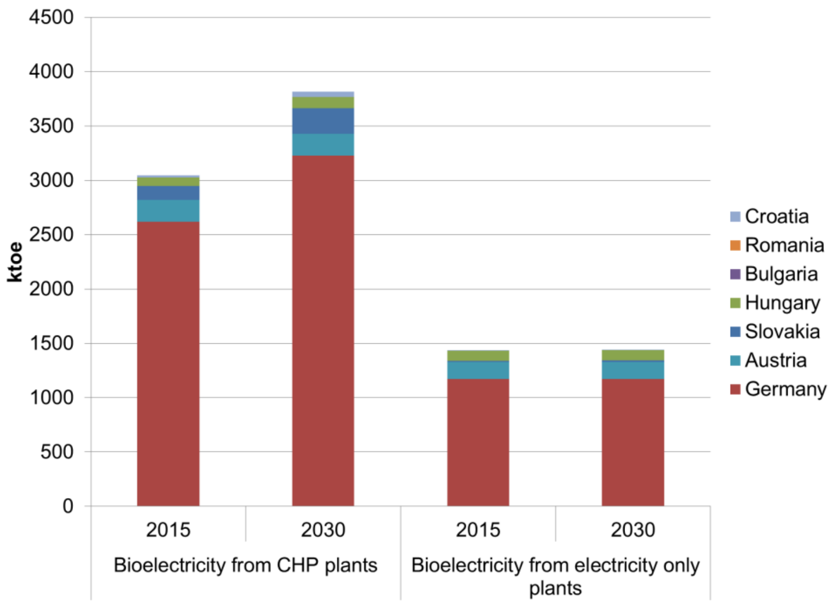

Figure 12: Best Case Scenario: Bioelectricity in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

4.3.3 Bioelectricity - Worst Case

Figure 13 shows the development of bioelectricity in the Worst Case Scenario. Bioelectricity from CHP plants decreases from 3,098 ktoe in 2015 to 3,025 ktoe in 2030. Furthermore, a radical decrease of bioelectricity consumption of electricity only plants can be observed: from 1,450 ktoe in 2015 to 390 ktoe in 2030. Hence, the total bioelectricity demand only amounts to 3,415 ktoe in 2030.

Figure 14 shows the projection for bioelectricity demand on the country level for 2030 compared to 2015. In the Worst Case Scenario the demand for bioelectricity from CHP plants stagnates in most countries. However, in Austria the consumption drops from 199 ktoe in 2015 to 126 ktoe in 2030. The bioelectricity consumption from electricity only plants substantially decreases in all partner countries in this Worst Case Scenario: from 1,173 ktoe in 2015 to 242 ktoe in 2030 in Germany; from 156 ktoe to 72 ktoe in Austria; from 93 ktoe to 47 ktoe in Hungary. In Bulgaria, Romania, Croatia and Slovakia the bioelectricity demand from electricity only plants remains under 10 ktoe in 2030.

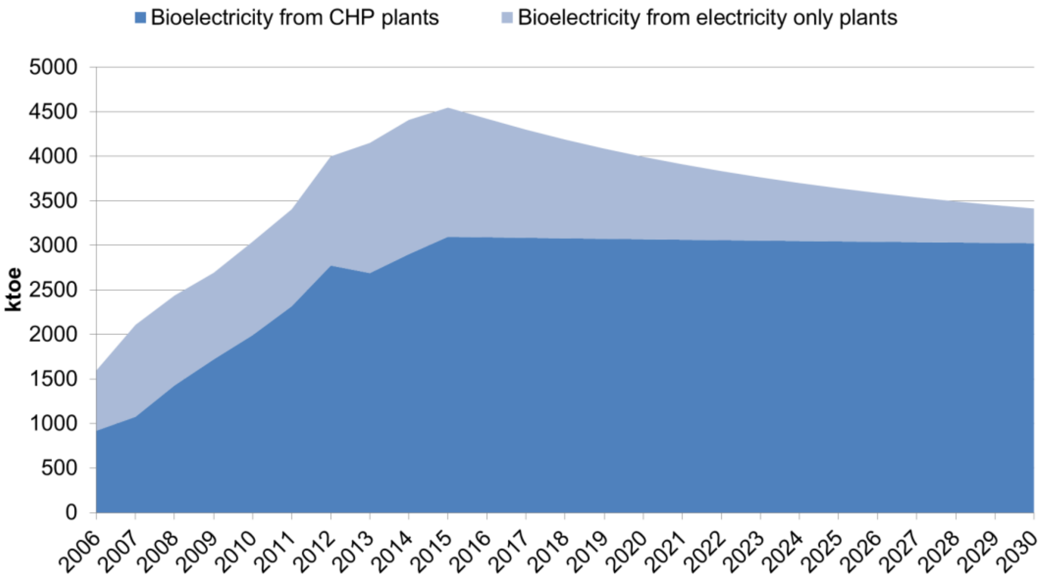

Figure 13: Worst Case Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries.

Data Source: EUROSTAT and own calculations

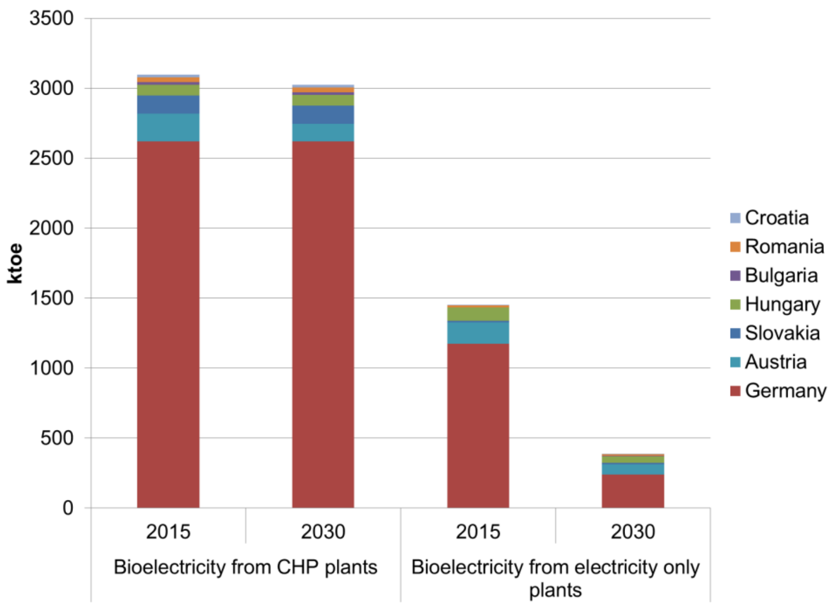

Figure 14: Worst Case Scenario: Evolution of bioelectricity in 2006-2015 and projections until 2030 in the partner countries.

Data Source: EUROSTAT and own calculations

4.4 Development of liquid biofuels in the Danube region

4.4.1 Liquid Biofuels – BAU

Due to the current legal framework and business conditions, the demand and supply of liquid biofuels decreases from 4,162 ktoe in 2015 to 2,583 ktoe in 2030 in the BAU Scenario (Figure 15). Bioethanol demand is expected to decrease to 415 ktoe and biodiesel demand to 2,168 ktoe by 2030. The main reason for this development seems to be the proposal for a recast of the Renewable Energy Directive for 2021-2030, in which the European Commission cut the limit for crop-based (first generation) biofuels in Europe's transport energy mix from 7% to 3.8%. Only in Bulgaria and Romania a positive development of liquid biofuels can be assumed (Figure 16).

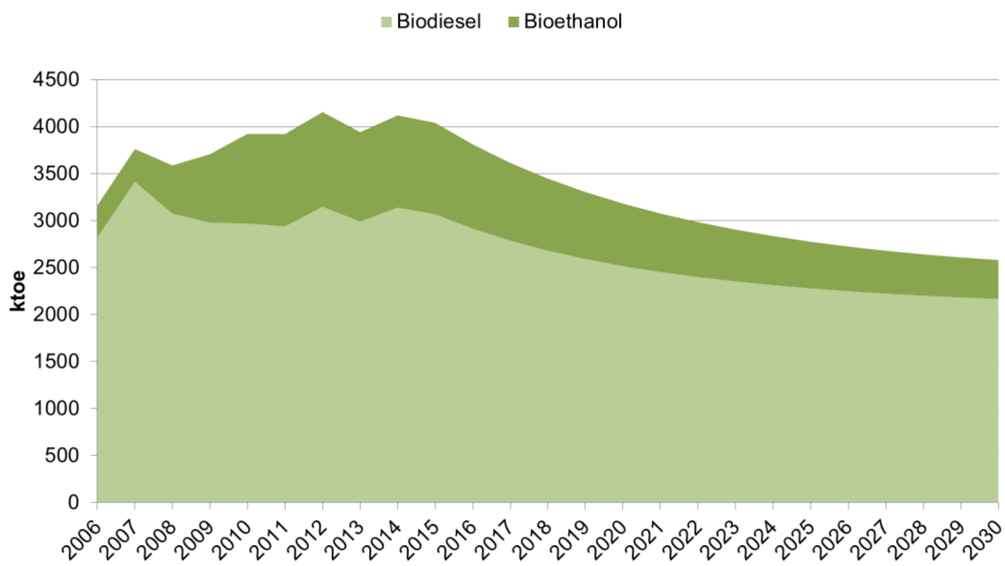

Figure 15: BAU Scenario: Evolution of liquid biofuel demand in 2006-2015 and projections until 2030 in the partner countries.
Data Source: EUROSTAT and own calculations

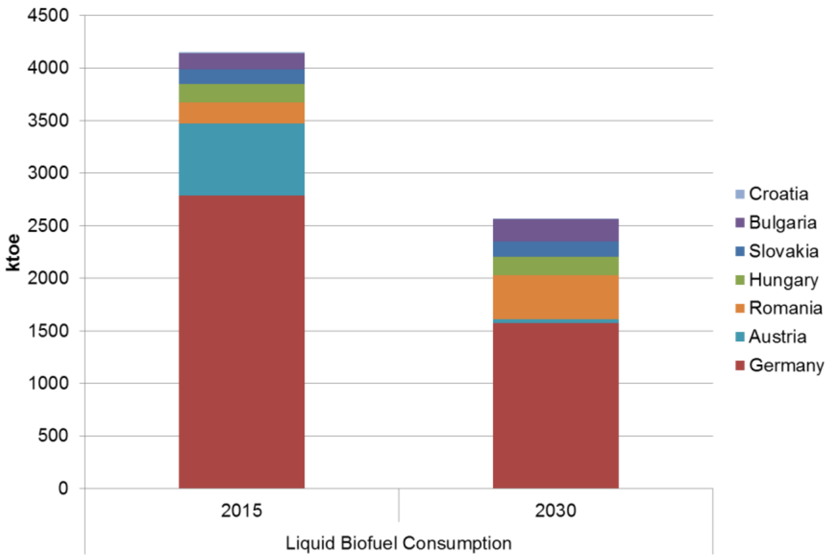

Figure 16: BAU Scenario: Liquid biofuel demand in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

4.4.2 Liquid Biofuels - Best Case

Figure 17 shows the development of liquid biofuels in the Best Case Scenario. The total demand for liquid biofuels increases from 4,162 ktoe in 2015 to 4,419 ktoe in 2030. The demand for biodiesel increases from 3,070 ktoe in 2015 to 3,303 ktoe in 2030, and the demand for bioethanol increases from 973 ktoe to 1,116 ktoe in the Best Case Scenario.

Figure 18 shows the projection for the demand of liquid biofuels on the country level in 2015 compared to 2030. In Germany, the demand for biodiesel decreased between 2006 and 2015, and the demand for bioethanol decreased in the year 2012 and onwards. Hence, the demand for liquid biofuels remains at the same level of 2,670 ktoe in the Best Case Scenario. In the other countries, the demand for liquid biofuels will have increased by 2030: in Austria up to 886 ktoe; in Bulgaria to 168 ktoe; in Croatia to 24 ktoe; in Hungary to 197 ktoe; in Romania to 208 ktoe and in Slovakia to 267 ktoe.

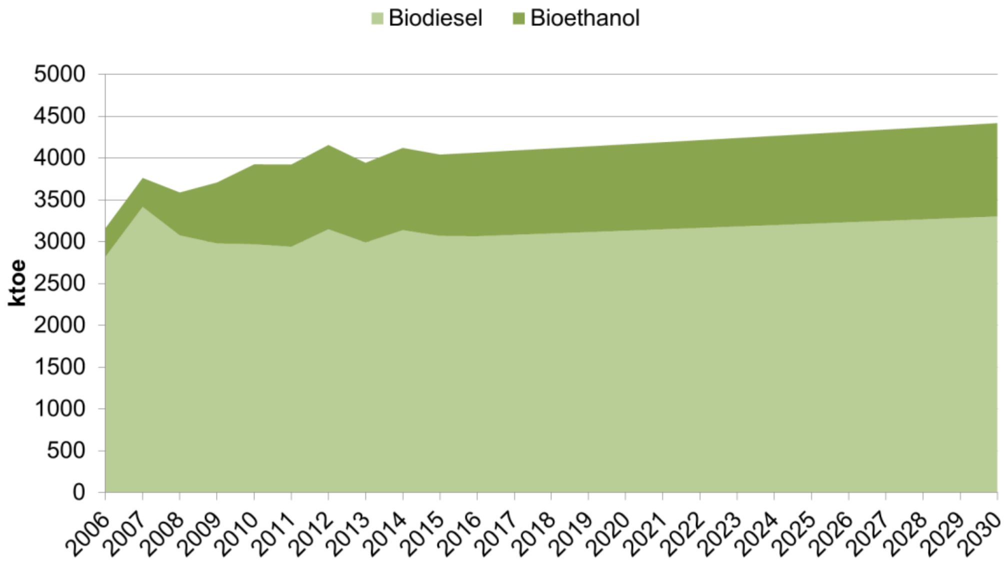

Figure 17: Best Case Scenario: Evolution of liquid biofuel demand in 2006-2015 and projections until 2030 in the partner countries.
Data Source: EUROSTAT and own calculations

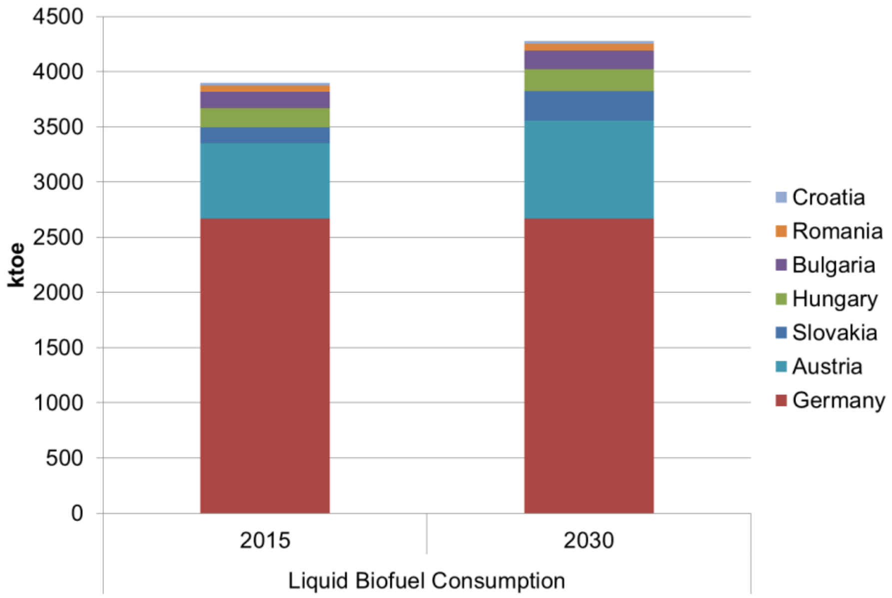

Figure 18: Best Case Scenario: Liquid biofuel demand in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

4.4.3 Liquid Biofuels - Worst Case

Figure 19 shows the development of liquid biofuels in the Worst Case Scenario. In this scenario, the total demand for liquid biofuels decreases from 4,162 ktoe in 2015 to 1,430 ktoe in 2030. The demand for biodiesel decreases from 3,070 ktoe in 2015 to only 970 ktoe in 2030, and the demand for bioethanol drops from 973 ktoe to 459 ktoe.

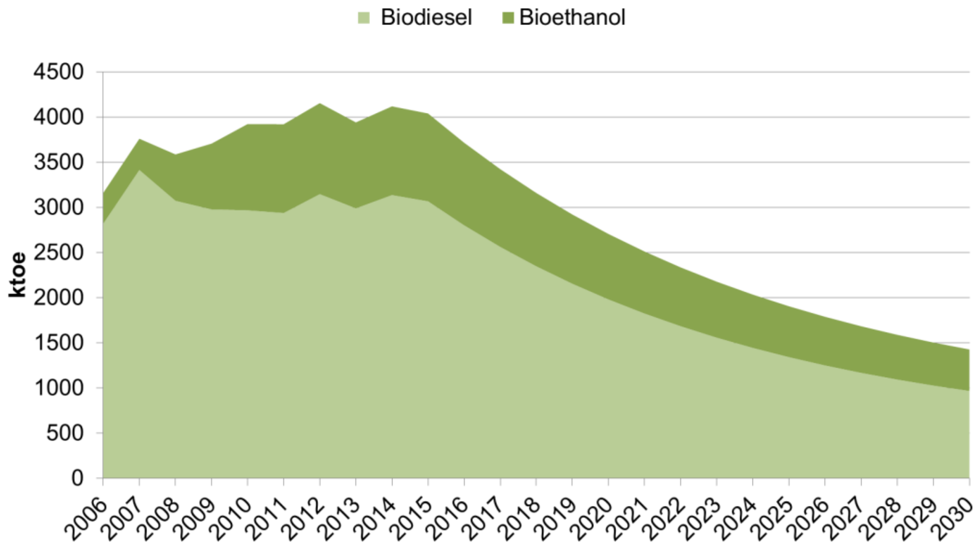

Figure 19: Worst Case Scenario: Evolution of liquid biofuel demand in 2006-2015 and projections until 2030 in the partner countries.
Data Source: EUROSTAT and own calculations

Figure 20 shows the projection for the liquid biofuel demand on the country level in 2015 compared to 2030. In the Worst Case Scenario the consumption of liquid biofuels substantially decreases in most partner countries: from 2,788 ktoe in 2015 to 609 ktoe in 2030 in Germany; from 683 ktoe to 188 ktoe in Austria; from 174 ktoe to 81 ktoe in Hungary; from 36 ktoe to 27 ktoe in Croatia. In Bulgaria, Romania and Slovakia the consumption of liquid biofuels will stagnate by 2030.

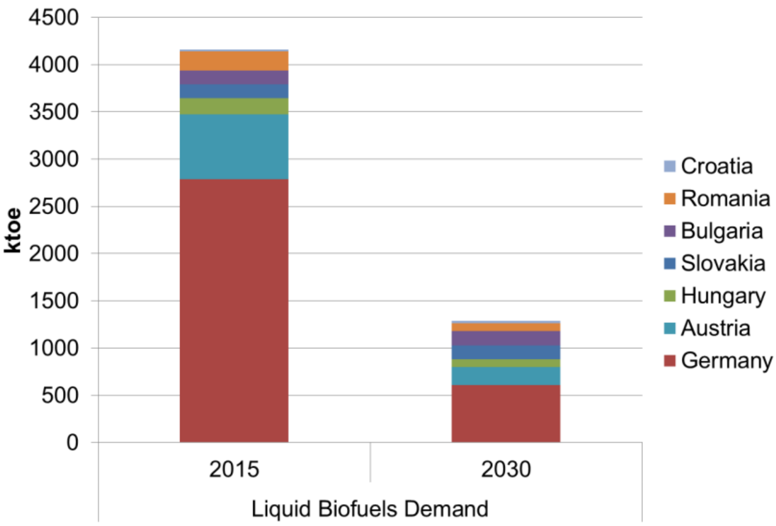

Figure 20: Worst Case Scenario. Liquid biofuel demand in 2015 and projection for 2030.
Data Source: EUROSTAT and own calculations

5. Summary & Discussion

The expected developments of heat and electricity generation from biomass as well as the demand for liquid biofuels in the ENERGY BARGE partner countries under Business-as-Usual (BAU), Best Case and Worst Scenarios are summarised and compared in Figures 22-24. The scenarios are based on Eurostat data from 2006 to 2015 and calculations produced by ENERGY BARGE.

The BAU Scenarios are based on the assumption that the economic, technical and legal framework conditions in the partner countries will largely remain the same in 2030 as in 2015. For the Best Case Scenarios the growth rate until 2030 is predicted on the respective levels of the growth rate as between 2006 and 2015. The same decrease rates until 2030 as between 2006 and 2015, or a reversal of the growth rates, are assumed for setting up the Worst Case Scenarios.

When comparing the scenario projections for the three bioenergy sectors as depicted below in Figures 22, 23 and 24, the following picture for bioenergy demand development in the Danube region can be drawn: The demand for bioheat will remain on the current level, even taking the Worst Case perspective. Under the Best Case Scenario, a significant increase in current levels by about 25% can be assumed.

Bioelectricity demand will drop below current levels both in the case that framework conditions remain as currently in place (BAU) as well as under Worst Case assumptions. Worst Case Scenario framework conditions would lead to demand levels as were visible in 2010/2011. A slight increase of between 10 and 15% compared to current demand levels could be achieved given the Best Case assumptions would apply.

Demand for biofuels will significantly drop under current levels if the conditions in place today remain the same (BAU) and even more significantly when Worst Case conditions are assumed. Given Best Case conditions the demand might rise again, but it will not meet past demand levels in peak times as recorded for the year 2007.

Hence, based on the framework selected for this scenario analysis, a Danube region utilizing bioenergy in the future will remain focused on bioheat as the main source of bioenergy. Regarding electricity derived from biomass, only the efficient combined production in CHPs will remain on the market in all scenarios and the increase from current levels will only be minor even in the Best Case. In all scenarios, biofuels will not play an overall decisive role for the road transport sector in the Danube region.

In the following, the scenario results are discussed in more detail and in light of bioenergy scenarios for the EU level as presented in current literature.

According to Figure 22, heat generation from biomass under the Best Case Scenario is expected to slightly increase up to approx. 32,145 ktoe in 2030. In comparison, heat generation from biomass under the BAU and Worst Case Scenarios stagnates, or rather will slightly decrease. One of the main factors that inhibit the installation of new biomass heating systems is the low price

for oil and natural gas (Lücke, 2015), but after 2020, global oil prices are expected to increase constantly by approx. 2.3% per year until 2030 (Capros et al., 2016).

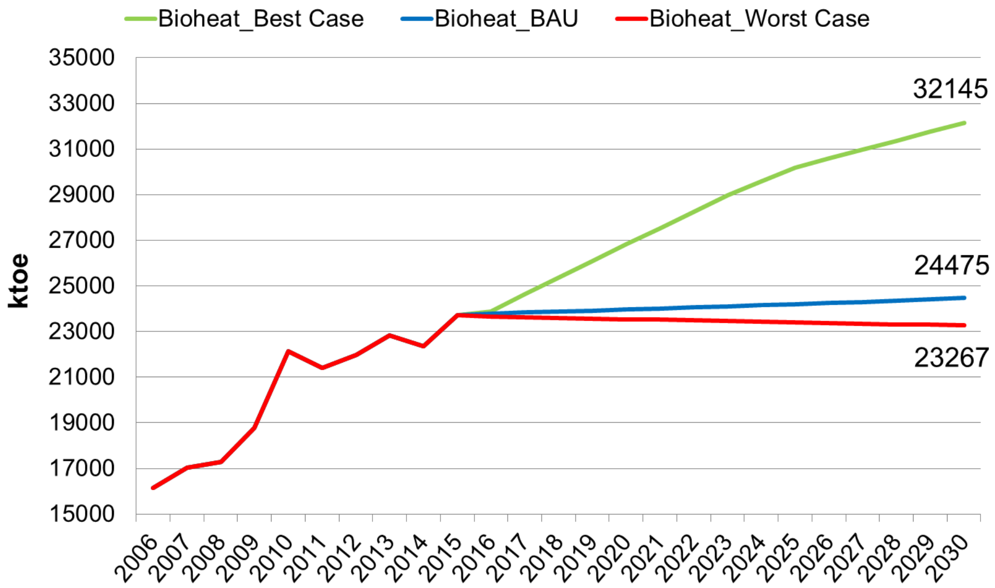

Figure 21: Projections of bioheat until 2030 in the partner countries.
Data Source: Own calculations

Capros et al. (2016) expect a slight increase of the heat and steam demanded in EU28 from 2020 to 2025, mainly driven by the demand of industry and households, and a constant level afterwards until 2030. Furthermore, the authors assume a gradual shift from gas and solids district heating boilers to biomass and waste boilers on the European level.

The overall amount of cogeneration in heat and steam supply is supposed to remain around 60% until 2030. This applies also for the expected amounts of biomass and waste used in CHP plants (Capros et al., 2016). CHP plants will need to be able to react more flexibly in the future to the heat demand in case less heat from renewable sources is available (Umweltbundesamt, 2017b). Besides the efficient combined heat and power generation, solid biomass, e.g. in the form of wood pellets, will continue to a limited degree for the provision of non-combined heat (BMWi, 2017).

An increased utilisation of biomass for heating purposes in private households can have negative impacts on air quality and thus affect the environment and human health. The burning of wood emits particulate matter and other substances into the air, which can for example cause respiratory diseases. It is estimated by the European Commission that the combustion of solid fuels in households accounts for approx. one third of the particulate matter emissions in the EU per year (European Parliament, 2015). In this context, the relatively high amounts of firewood used e.g. in Romanian households should be assessed critically. In order to avoid negative impacts on the environment, modern stoves and boilers as well as dust filters should be promoted.

The investment costs of biomass heating systems are relatively high compared to conventional heating systems, because, besides the change of the heating boiler, additional investments are needed, e.g. modification of the storage location for biomass (Schütte, 2015).

Regarding electricity generation from biomass, it is estimated that the current amount of approx. 4,500 ktoe in the partner countries of the ENERGY BARGE project will slightly decrease to less than 4,200 ktoe according to the BAU Scenario by 2030. The Best Case Scenario assumes that the generation of electricity will increase to over 5,400 ktoe, whereas under the Worst Case Scenario a decrease to 3,415 ktoe is estimated (Figure 22).

For the generation of electricity and heat, the utilisation of CHP plants is the most efficient way to use biomass in these two sectors. Flexible operating CHP plants can be used to balance the alternating electricity supply from wind and solar power (BMWi, 2017). Contrary to the BAU and Wort Case Scenarios in Figure 23, the utilisation of biomass and waste for generating electricity is supposed by Capros et al. (2016) to increase slightly between 2020 and 2030 in the European Union. Small pure biomass plants as well as co-firing applications in solid fuel plants are mainly expected to contribute to this development.

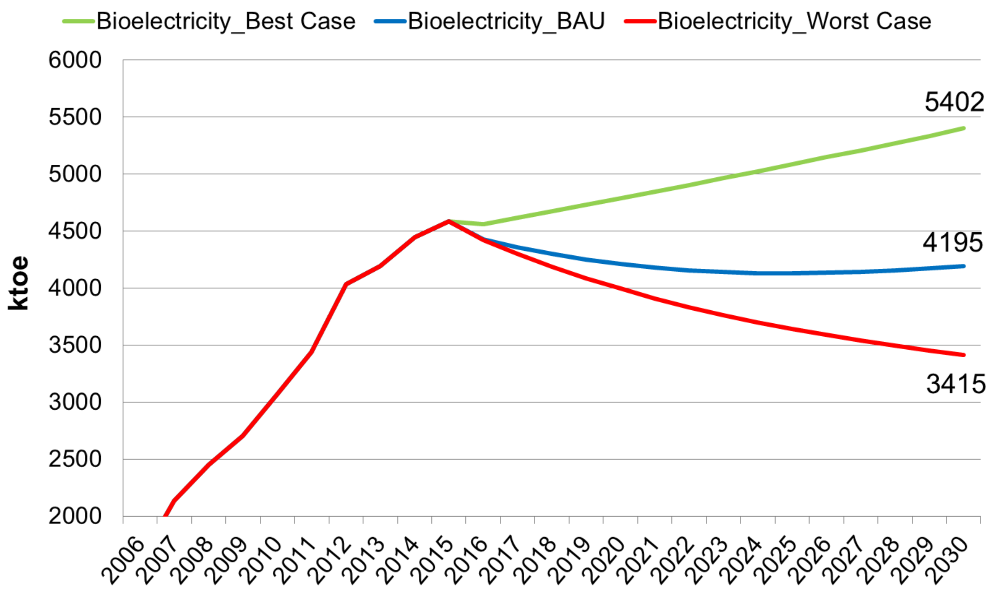

Figure 22: Projections of bioelectricity until 2030 in the partner countries.
Data Source: Own calculations

Figure 24 depicts the development of liquid biofuels until 2030 in the partner countries. A slight increase to 4,419 ktoe under the Best Case Scenario is expected, while the projections show declining amounts of biofuels for the BAU and the Worst Case Scenario. These BAU and Best Case Scenarios are similar to the scenarios described by Baker et al. (2017), where a slight decrease by 2030 for the MEDIUM Scenario and a slight increase for the HIGH Scenario respectively are also outlined. However, in the Danube partner countries, even the Best Case Scenario does suggest that the overall level of biofuel demand will not reach the past peaks observed in 2006 and 2007 again by 2030.

Biofuels currently account for 4.7% of the final energy consumption in the EU transport sector. Due to higher costs, alternative fuels are not yet able to compete with regular fossil fuels. Regulatory measures (e.g. maximum emission levels for CO_2), monetary measures (e.g. subsidies, tax benefits) and infrastructure measures (e.g. filling station network) are strongly influencing the development of the market uptake of alternative fuels (Baker et al., 2017).

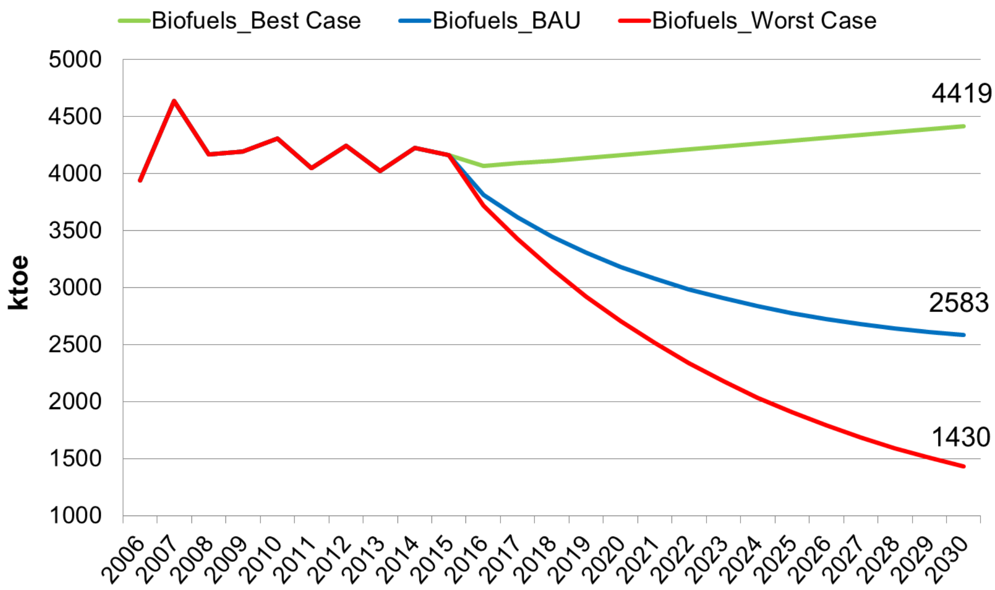

Figure 23: Projections of liquid biofuels until 2030 in the partner countries.
Data Source: Own calculations

The use of fuels in the transport sector in general is expected to decrease by 11% for diesel and by 13% for petrol by 2030 (DG AGRI & JRC, 2017). A general reduction of fuels would also affect the demand for biofuels as they are mostly admixed to fossil fuels. If the percentage of admixture of biofuels would remain until 2030 on the current level, a reduction of used fuels would affect biofuels the same amount. In general, the demand of biofuels is highly dependent on the political framework (DG AGRI & JRC, 2017).

In the EU Agricultural Outlook for the period from 2017 to 2030, it is estimated that the market share of advanced biofuels will increase by 2030 only up to 0.68 to 0.83% as investments in the production of advanced biofuels over the long term are currently limited. Further, the share of biofuels is expected to reach a level of approx. 5.8% by 2020 and remain afterwards on a constant level with slight decreases by 2030 in the case that no further targets are adopted on EU level after 2020 (DG AGRI & JRC, 2017). This development is also supported and suggested in the scenarios derived here.

Second generation biofuels are currently still in the research and demonstration stage. For the time horizon until 2020, no noteworthy contributions from these biofuels based on solid biomass (e.g. wood, straw, etc.) are to be expected. In the longer term, assuming a successful market launch, due to the reduced energy requirement in the heating sector, corresponding biomass volumes could be shifted from the heating market to the fuel market (Austrian Biomass

Association, 2017). Similarly, the German Federal Ministry for Economic Affairs and Energy expects a shift in the use of biomass as an energy source from electricity (incl. heat generation in CHP plants) to transport and industry (BMWi, 2017). The expected increase of electric vehicles in road transport is supposed to be one factor in replacing certain amounts of biomass in this sector. The aviation and shipping sectors will rather remain dependent on the use of biofuels in order to reduce their respective emission levels (BMWi, 2017).

According to the proposal on the new renewable energy directive (RED II) for the period 2020-2030, the limit of biomass fuels, if produced from food or feed crops, shall be no more than 7% of final consumption of energy in road and rail transport in the Member States in 2021. The limit shall be reduced to 3.8% in 2030 so that first generation biofuels will remain on the market, but their share will decrease significantly (European Commission, 2017a). This is the main reason for the depicted decrease under the BAU and Worst Case Scenario in Figure 24.

In the RED II proposal it is outlined that the share of advanced biofuels and biogas produced from feedstock as listed in the Annex of the proposal shall increase from at least 1.5% in 2021 to a minimum of 6.8% in 2030. Suitable feedstocks for advanced biofuels are e.g. cultivated algae, bio-waste and straw (European Commission, 2017a). Dammer et al. (2017) recommend setting a target of at least 15% of renewable energies in the transport sector by 2030 to ensure a sufficient contribution of this sector to achieve the EU's climate and energy targets for the year 2030. This should also involve keeping the share of 7% of biofuels, produced from food or feed crops, in contrast to the RED II proposal. In accordance with the RED II proposal, Dammer et al. (2017) recommend to set a target for other sustainable and renewable biofuels, e.g. advanced biofuels, of 6.8%.

According to scenarios as described by Baker et al. (2017), the use of alternative fuels in the transport sector is supposed to increase especially from 2030 until 2050 due to higher shares of electric vehicles and a higher utilisation of biofuels. The share of biomass products in the passenger car market is estimated to reach 31% in the MEDIUM Scenario and 47% in the HIGH Scenario in 2050. However, the ENERGY BARGE scenarios for the Danube partner countries for 2030 do not support this increasing trend scenario.

6. Conclusion & Recommendations

Despite the positive developments in the past and the significant biomass potential (JRC, 2014), the further expansion of bioenergy in the Danube region cannot be taken for granted as shown in the scenario analysis. Administrative, legal, technical and various market-related factors have a decisive influence on the demand, and the bioenergy market remains a volatile one. Even maintaining the current demand levels will require active support from policy stakeholders, researchers and market actors, both on the supply and the demand side. Without acting on those factors that can be influenced (policy support mechanisms, sustainability schemes, approval procedures, CO_2 reduction measures, technology development), the scenario analysis suggests that the overall demand for bioenergy in the Danube region will decrease.

Of particular interest is the electricity sector, which is characterised by worldwide technological development in the field of renewable energies and storage technologies. Climate protection, e-mobility, digitalisation, flexible storage and the conversion of industrial processes to electricity are the drivers for renewable energy technologies and the conversion of our energy system. Furthermore, bioenergy technologies are competitive regarding providing commercial heat use from co-generation plants and co-firing with coal, and are generally suitable for providing low-emissions process heat in industry. Regarding the heating/cooling sector, the comprehensive renovation of the building stock, which must include the thermal renovation as well as the renewal of heating systems, is the only way to reduce total energy consumption and at the same time keep the bioheat demand constant.

In addition, the expansion of renewable energy generation, the consistent implementation of energy efficiency and the establishment of intelligent grids and flexible structures are essential for the energy transition towards renewable energies. Overall energy efficiency could be improved by using more efficient energy equipment (e.g. heating and cooling appliances), energetic renovation of buildings and changes to energy consuming behaviour (Capros et al., 2016). In the short term, a significant increase of fossil fuel prices is not expected; meaning the motivation of citizens, companies and public institutions will remain limited to invest in renewable energy sources (Schütte, 2015). On the contrary, Capros et al. (2016) expect that the current policies will lead to a slightly lower energy demand by 2030 due to policies which increase the efficiency rates in the medium term. In the long term, the lack of policies is also expected to reduce the rate of improvements in the energy sector.

As the demand of biofuels is highly dependent on political framework conditions, it is essential that the countries within the Danube region set up effective funding programmes to promote an increased use of sustainable biomass in the industrial as well as the residential sectors. State subsidies and tax reliefs would be an essential factor for a change or improvement of renewable heating systems as those amendments are often related to relatively high investment costs (Schütte, 2015).

The reduction of existing subsidies which contribute to climate change is a central element to enable fairness and climate protection in the long term. However, it is crucial to consider all external environmental and climate-related external costs by comparing subsidy instruments for renewable and fossil fuels. Hence, it is essential that the countries within the Danube region

set up effective funding programmes to promote an increased use of sustainable biomass in the industrial as well as the residential sector as those amendments are often related to relatively high investment costs (Schütte, 2015).

Currently, the climate impact of different energy sources is not yet reflected in their price. The current price of CO_2 in the European emissions trading system does not have a sufficient enough impact to make investments in low-emission technologies attractive enough to reach the climate targets. Therefore, a higher pricing of CO_2 across all sectors of the economy needs to be established on a transnational level (Bals et al., 2017). More and more countries are therefore opting for CO_2 taxes. These usually start low and increase continuously, while reducing other costs.

Given the Danube region as a whole is aiming to maintain or even increase the demand for sustainable bioenergy in order to reach and/or keep NREAP goals, make use of the domestic biomass potential and avoid harming the bioenergy market actors, this scenario analysis suggests that irrespective of how the oil and gas markets will develop, actions must be taken in order to keep and improve favourable legal, technical and market-related framework conditions for sustainable bioenergy demand. The following recommendations for EU-level and national policy makers are formulated based on the present report in combination with the results of the other ENERGY BARGE deliverables of Work Package 3, 4 & 6 (http://www.interreg-danube.eu/approved-projects/energy-barge/section/deliverables):

- Soundly evaluate the effects of current policy changes on EU and national levels in the RES sector on the demand for bioenergy, especially with regard to types of measures applied (e.g. incentives, quotas)
- Provide consistent frameworks for sustainability criteria of bioenergy and feedstock
- Consider abolition of subsidies for non-renewable energy sources in order to support competitiveness of low-emission RES technologies and subsequent willingness to invest
- Support further development of low-emission technologies and their application, especially in Southern Danube countries with a currently high share of traditional wood burning for household purposes
- Enhance development of infrastructure as well as updating of existing housing stock for improved energy efficiency
- Increase information basis and approval procedures for industrial applications/ commercial use of bioenergy
- Set up a functioning transnational monitoring system for sustainable biomass feedstock availability

Under the assumption that the Danube region's demand for bioenergy purposes will stagnate or decline as under the BAU and the Worst Case Scenarios, general biomass availability will not be a challenge and imports will remain on a low level, as is currently observable (JRC, 2014). Moreover, biomass might become available to other paths of utilisation, e.g. for chemical-material uses.

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Annex Tables BAU Scenario

The following tables were filled in by the project partners based on an extensive literature and database research as well as on country specific expert know-how provided by the project partners. Each category includes an assessment if the presented framework condition/statement is resulting in an increasing (↑), decreasing (↓) or stagnating (→) bioenergy demand for the BAU Scenario.

Austria

Table 5: AUSTRIA - Main factors influencing the development of biomass for heat and derived heat

Austria	Residential	Industry	Services	Derived Heat
Effect of oil / gas price development:	The price for oil and natural gas can be marked continuously low. This circumstance has a strong influence on the structure of the boiler market and is equally effective in the sector of new buildings as well as renovations and exchange of boilers. (Biermayr et al., 2017) →/↑	Biomass cannot compete with the low gas/oil prices in new projects (AEBIOM, 2016). →/↓		N/A
Legislation (EU/national): support schemes	The Austrian Climate & Energy Fund provides a subsidy scheme for private households for the implementation of pellet and wood-chip central heating systems and pellet stoves. The subsidy applies to the substitution of fossil-fuel-based heating systems with renewable-energy-based ones. Installations must be operated either with wood chips or pellets. Log wood boilers are not subsidised. The financial support in the form of a non-refundable investment cost subsidy amounted to € 2,000 for pellet and wood chip boilers. For pellet stoves the investment subsidy amounted to € 500. Private households receive also subsidies	The Kommunalkredit Public Consulting (KPC) usually carries out the financial support of commercial and industrial biomass applications as well as biomass district heating plants (biomass heating plants and CHP) on national level. The number of funded plants installed decreased over the last two years. (Biermayr et al. 2017) →/↑		The Kommunalkredit Public Consulting (KPC) usually carries out the financial support of (KPC, 2018): • Installations for the extraction of derived heat from industrial and commercial processes • The feed-in of derived heat into existing or new local and district heating networks by means of a transport line and distribution center • Distribution grids with transfer stations • Heat pumps for the central

	according to the specific requirements of the respective province. A part of the subsidies are handled through the residential building subsidy programme. For farmers there are separate subsidy programmes. The funding opportunities are easy to access; however, the funding volume decreased over the last several years. The biomass boilers and stoves sectors have a lasting downward tendency that reduced the sales figures by half in a short time. (Biermayr et al. 2017) →/↓			temperature increase of derived heat for heating purposes • Low-temperature or power grids with consumer-side heat pumps to harness the derived heat →/↑
Legislation (EU/national): emission caps and CO2 certificate trading systems	Since the introduction of the test standard EN 303-5 "Heating boilers for solid fuels" in Austria and the implementation of the applicable strict legal requirements for efficiencies and emissions, a significant improvement of the tested technologies is shown. Today, automatic firing systems (pellets, wood chips) as well as modern log wood boilers consistently achieve efficiencies of more than 90%. Carbon monoxide (CO) emissions as a guide to combustion quality have been steadily decreasing for biomass boilers over the past 30 years. (Austrian Biomass Association, 2017) →/↑	N/A	N/A	N/A
Legislation (EU/national): approval procedures & similar administrative conditions	N/A	N/A	N/A	N/A
Legislation (EU/national): sustainability targets	The Ecodesign Directive 2009/125 / EC has created the basis for setting ecodesign requirements for energy-related products (ErP) at the European level. In product-	N/A	N/A	N/A

	specific implementation measures, minimum ecological requirements have been developed for new products, and thus also for biomass boilers and room heaters (Biermayr et al. 2017) →/↑			
Technology development:	Higher investment costs of bioenergy systems relative to fossil systems; The funding of the installation of biomass boilers to the highest state of the art facilitates the introduction of contemporary technology into the market. For the economic success of Europe, future-oriented technical standards as well as the obligatory control of harmonized regulations are required (Biermayr et al. 2017) →/↓	N/A	N/A	N/A
Main feedstock types used:	The biomass used for heat production was 92% wood-based, with firewood accounting for the highest shares of 58 PJ and wood waste (wood chips, sawmill by-products, bark) accounting for 56 PJ. With 75 PJ of electrical energy, more than one third of total electricity consumption (219 PJ) was used for heat generation in 2015 (Austrian Biomass Association, 2017) →/↑			
Overall assessment for the BAU Scenario (Increase, decrease, stagnation)	Stagnation/Increase →/↑	Stagnation →	Stagnation →	Stagnation →

Table 6: AUSTRIA - Main factors influencing the development of biomass for Bioelectricity

Austria	Consumption from CHP plants	Electricity only plants
Effect of Oil / gas price development:	Rising prices of biomass fuels and raw materials cannot compete with low fossil fuel prices (AEBIOM, 2016). ↓	Rising prices of biomass fuels and raw materials cannot compete with low fossil fuel prices (AEBIOM, 2016). ↓
Legislation (EU/national): support schemes	No major growth is expected due to lack of support. The support given to plants was guaranteed for up to 15 years, which will be reached by 2020 in most of the cases. If new supports are not implemented, it is expected that Austria will lose about 80% of its biomass and biogas CHP plants (AEBIOM, 2016). The expiration of the feed in tariffs in accordance with the Green Electricity Act without subsequent regulation leads to uncertainty among the plant operators. Most of the biomass CHP plants are not profitable without special feed in tariffs due to the high biomass prices compared to low electricity prices (Austrian Biomass Association, 2017). →	No major growth is expected due to lack of support and inefficiency of the plants (AEBIOM, 2016). →
Legislation (EU/national): emission caps and CO2 certificate trading systems	N/A	N/A
Legislation (EU/national): approval procedures & similar administrative conditions	The Green Electricity Act (Ökostromgesetz ÖSG 2012) sets the following targets for new installations until 2020: Hydro 1,000 MW, Wind 2,000 MW, PV 1,200 MW, Biomass and Biogas 200 MW. A feed-in tariff scheme under the Green Electricity Act supports the recovery of the investments. For green electricity plants based on solid and liquid biomass as well as biogas, an amount of EUR 10 million is available as an annual support volume in accordance with § 23 (3) Z 2 ÖSG 2012. Of this, EUR 3 million are designated to plants based on solid biomass. According to § 16 (1) no. 1 ÖSG 2012, the duration of the general contracting obligation for green electricity plants based on solid and liquid biomass or biogas is 15 years. The level of feed-in tariffs is set in the "Ökostrom-Einspeisetarifverordnung". On 28.02.2017 an amendment to the ÖSG 2012 was released in order to create a better framework for wind, hydropower and photovoltaics. Overall, the aim is to increase efficiency and to reduce bureaucracy and the compensation energy costs in the green electricity sector. For highly efficient second-generation biogas plants with higher efficiency, new seven-year follow-on tariffs have been introduced. Operators of unprofitable biogas plants receive a compensation if they shut down the biogas plants. An amendment concerning the biomass heat and power plants is still pending. ↓	

Legislation (EU/national): sustainability targets	With the help of Bioenergy the EU wants to provide an important contribution in the long-term goal to develop a competitive, resource efficient and low carbon economy by 2050 (European Commission, 2011). CHP plants will play a certain role in this movement, because they are very energy-efficient. With the directive on the promotion of high-efficiency cogeneration (European Commission, 2004) the member states are encouraged to implement (and fund) these plants. ↑	N/A
Technology development:	Further development of micro-CHP to market maturity and activation of the market through a correspondingly consistent funding portfolio from basic research up to market diffusion (Biermayr et al. 2017). →	N/A
Main feedstock types used:	Mainly woody biomass (=3.1% of renewable power production; 1.5% lye, 0.9% biogas) (Austrian Biomass Association 2017). →	
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Stagnation or decrease depending on the development of feed-in tariffs →/↑	Decrease ↓

Table 7: AUSTRIA - Main factors influencing the development of biomass for biofuels

Austria	**Bioethanol**	**Biodiesel**
Effect of oil / gas price development:	Strong dependency on fossil oil and diesel price levels →/↓	
Legislation (EU/national): support schemes	The introduction of biofuels was supported by the parallel introduction of different tax tariffs for fuels with and without biofuel. Pure biofuels are completely exempt from mineral oil tax (Umweltbundesamt, 2017). ↑	
Legislation (EU/national): emission caps and CO2	As of 1 January 2009, the substitution target, regarding the energy content, is 5.75% based on the total amount of fossil gasoline and diesel fuel released or used in Austria. This goal can be achieved by adding 7% biodiesel to diesel fuel and 5% ethanol to gasoline fuels. As of 1 October 2020, the substitution target, regarding the energy content, is 8.45% based on the total amount of petrol and diesel fuel released or used in	

certificate trading systems	Austria (Umweltbundesamt, 2017). →	
Legislation (EU/national): approval procedures & similar administrative conditions	National biofuel register elNA: all producers, dealers and stores of sustainable biofuels operating in Austria have been required to register in the elNa system since 2013. The production and use of liquid biomass, in particular vegetable oils, biodiesel and HVO as well as bioethanol and biogas, are subject to precisely defined sustainability criteria in the EU. The elNa system developed by the Federal Environmental Agency maps all trade flows of sustainable biofuels in Austria and provides evidence of the sustainability of biofuels, as well as controlling and documenting them. →	
Legislation (EU/national): sustainability targets	With the ordinance of the Federal Minister for Sustainable Development and Tourism on the quality of fuels and the sustainable use of biofuels (Fuel Ordinance = "Kraftstoffverordnung" 2012), the contents of the corresponding EU directives have been transposed into national law. In particular, the Fuel Ordinance regulates the specifications of the different fuel types, the level of substitution obligations and the sustainability issues of biofuels. Austria currently has an obligation to substitute 5.75% (measured in terms of the energy content of all fossil gasoline and diesel fuels put into circulation) with biofuels. According to the revised version of the KVO (Kraftstoffverordnung) of 2012, biofuels and other renewable fuels may only be counted towards the greenhouse gas reduction and substitution targets if they meet the sustainability criteria (§12) (BMNT, 2018).	
Technology development:	Second generation biofuels are currently still in the research and demonstration stage. For the time horizon until 2020, no noteworthy contributions from these biofuels based on solid biomass (e.g. wood, straw, etc.) are to be expected in Austria. In the longer term - assuming a successful market launch - due to the reduced energy requirement in the heating sector, corresponding biomass volumes could be shifted from the heating market to the fuel market (Austrian Biomass Association, 2017). →/↓	
Main feedstock types used:	For ethanol production about 60% cereals and 40% corn were used (Umweltbundesamt, 2017). Stron dependency on 1st generation biomass ↓	The biodiesel production consists of 49% rapeseed, 51% used cooking oil, animal fats and fatty acids. Again, no palm oil was used for the production of biodiesel in Austria. ↓/→
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Stagnation →	Decrease ↓

Bulgaria

Table 8: BULGARIA - Main factors influencing the development of biomass for heat and derived heat

Bulgaria	Residential	Industry	Services	Derived Heat
Effect of oil/gas price development	N/A	N/A	N/A	N/A
Legislation (EU/national): support schemes	Tax Reliefs: In the Local Taxes and Taxes Act, the buildings granted with certificate A, received under the terms of the Energy Efficiency Act, are exempt from tax for a period of 10 years; buildings that have been granted a B certificate are exempt for a period of 5 years if they apply measures to use the RES for the needs of the building (Ministry of Finance, 2018). ↑/→	N/A	The obligations to use renewable sources for energy production are defined in Art.15, para. 2, item 1 of the Energy Efficiency Act, according to which any investment in a project for a new building with a floor area of more than 1000 m^2 should be in line with the possibilities of using decentralized systems for production and consumption of energy from renewable sources and are also envisaged in the draft of the Law on Renewable Energy (Ministry of Energy, 2015). →	N/A
Legislation (EU/national): emission caps and CO2 certificate trading systems	N/A	N/A	N/A	N/A
Legislation (EU/national): approval procedures & similar administrative conditions	N/A	N/A	N/A	The "Law for Energy from renewable sources" envisages the creation of a new administrative structure: The Agency for Sustainable Energy Development (ASED) to support the use of renewable energy sources (Ministry of Energy, 2011a). ↑/→

Legislation (EU/national): sustainability targets	N/A	N/A	N/A	N/A
Technology development	N/A	N/A	N/A	N/A
Main feedstock types used:	Firewood, pellets, briquettes →/↑	From animal farms - faeces, litter (mixture of faeces and straw), sewage, food waste. →/↑	N/A	In Bulgaria, wood residues from logging and wood processing are one of the main sources of biomass →/↑
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase/Stagnation (estimation provided by Technology Center Sofia Ltd.) ↑/→	Stagnation (estimation provided by Technology Center Sofia Ltd.) →	Stagnation (estimation provided by Technology Center Sofia Ltd.) →	Increase/Stagnation (estimation provided by Technology Center Sofia Ltd.) ↑/→

Table 9: BULGARIA - Main factors influencing the development of biomass for Bioelectricity

Bulgaria	Consumption from CHP plants	Electricity only plants
Effect of oil/gas price development	N/A	N/A
Legislation (EU/national): support schemes	N/A	The setting of new, higher preferential prices for the sale of electricity from power plants using biomass with an installed capacity of up to 10 MW, determined by Decision No. Ц-018 / 28.06.2012 of SEWRC on the grounds of Art. 32 of the Renewable Energy Act (State Energy and Water Regulatory Commission, 2012). However, no further investment in new plants are expected (due to the high investment costs) →
Legislation (EU/national): emission caps and CO2 certificate trading systems	N/A	N/A
Legislation (EU/national): approval procedures & similar	N/A	N/A

administrative conditions		
Legislation (EU/national): sustainability targets	N/A	N/A
Technology development	N/A	N/A
Main feedstock types used:	N/A	from animal farms - faeces, litter (mixture of faeces and straw), sewage, food waste →/↑
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Stagnation (estimation provided by Technology Center Sofia Ltd.) →	Stagnation (estimation provided by Technology Center Sofia Ltd.) →

Table 10: BULGARIA - Main factors influencing the development of biomass for biofuels

Bulgaria	Bioethanol	Biodiesel
Effect of oil/gas price development	N/A	N/A
Legislation (EU/national): support schemes	N/A	N/A
Legislation (EU/national): emission caps and CO2 certificate trading systems	Under Art. 12, para. 1 and 4 of the Bulgarian "Law for Energy from renewable sources" biofuels and bioliquids are mentioned to support the objective to reduce greenhouse gas emissions per unit of energy over the whole life cycle per 6% by the end of 2020 (Ministry of Energy, 2011a). →/↑	
Legislation (EU/national): approval procedures & similar	N/A	N/A

administrative conditions		
Legislation (EU/national): sustainability targets	The National Longterm Programme to Promote Consumer Consumption biofuels in the transport sector 2008-2020: the following national target values for the consumption of biofuels in the transport sector are: 2008 - 2%, 2009- 3.50%; 2010 - 5.75%; 2015 - 8.00%; 2020 - 10.00% (Ministry of Economy and Energy, Ministry of Transport, 2007). Ordinance on Sustainability Criteria biofuels and bioliquids: Adopted by Council of Ministers Decree № 302 of 26.11.2012, prom. 95 of 4.12.2012, in force from 4.01.The Regulation lays down criteria for the sustainability of biofuels and liquid fuels biomass fuels. ↑/→	
Technology development	N/A	N/A
Main feedstock types used:	agricultural crops and residues →/↑	agricultural crops and residues →/↑
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase/stagnation (estimation provided by Technology Center Sofia Ltd.) ↑/→	Increase/Stagnation (estimation provided by Technology Center Sofia Ltd.) ↑/→

Croatia

Table 11: CROATIA - Main factors influencing the development of biomass for heat and derived heat

Croatia	Residential	Industry	Services	Derived Heat
Effect of oil / gas price development:	Low prices of oil and gas will prevent future installations of biomass devices in households. Areas where the gas pipelines have not yet been installed will continue using biomass as primary source of heat. (Hrvoje Pozar, 2015) →	Most of the industry relies on natural gas and is therefore similarly affected as the households. (Hrvoje Pozar, 2015) →	Public spaces are mainly heated by either district heating sources (mostly gas powered - 80%) or by their own heating facilities (again, gas powered). Unless there's a significant price surge, the status is not likely to change. →	N/A
Legislation (EU/national): support schemes	From 2014, training and certification of installers for small RES systems, according to the Directive 28/2009/EC has been in force with smaller amendments added recently (OG, 56/2015, 12/2017). Also, Fund for Environmental Protection and Energy Efficiency supports efficient technologies through public tenders. These relate to e.g. substitution of old boilers with better, modernized biomass boilers. (FZOEU, 2017) ↑/→	N/A	N/A	N/A
Legislation (EU/national): emission caps and CO2 certificate trading systems	By adopting the Regulation on Unit Charges, Corrective Coefficients and Detailed Criteria and Benchmarks for Determination of the Charge for Carbon Dioxide Emissions into Environment (OG, 73/07) the Government of the Republic of Croatia introduced carbon	Industiral facilities must also comply with the regulation of minimum 20MW nominal power for generation of heat energy to be regarded as an activity covered by the emission trading system and emission caps. (OG, 73/07) →		N/A

	dioxide emission charges for all stationary sources emitting more than 450 tonnes of CO_2 per year. Facilities burning biomass, biodegradable waste and sludge are excluded. This applies to all categories. ↑/→			
Legislation (EU/national): approval procedures & similar administrative conditions	N/A	N/A	N/A	As a precondition for being eligible for the support scheme, the plant operator as natural or legal person needs to acquire the status of a privileged producer. (HROTE, 2018) Becoming a privileged producer is a demanding administrative task. →/↓
Legislation (EU/national): sustainability targets	Due to the phase out of using fuel oil for residential heating, the expansion of the gas network, and the national sustainability targets for the participation of RES in heating/cooling being almost met, there will not be too much of a drive to have more of the residential sector switch to heat produced from biomass sources. (Hrvoje Pozar, 2015) →	Industry not related to wood processing is not likely to have the heat produced from biomass feedstock due to the the national goals being almost met. (IEA Bioenergy, 2016) →	Services use most of the electric energy for all purposes (including heating) with only 1% being from renewables. Trends in recent years show no improvement of the use of RES, with only fuel oil being replaced by electricity. (Hrvoje Pozar, 2015) →	With full membership of the EU on 1 July 2013 and pursuant to Directive 2009/28/EC, Croatia committed to increasing the renewable energy share in final consumption of energy to 20%. The target is also embedded in the Strategy of Energy Development of the Republic of the Croatia (adopted on October, 2009) (OG, 130/2009) ↑/→
Technology development:	There are more producers of pellets and furnaces, employing new technologies, but the installation prices for novel systems (pellets) are too high compared to the expanding gas network which could cause more households to make a switch from	Industrial zones are currently located in urban areas, mostly covered by the gas network and also used by the facilities. Other than the wood processing industry /	Public services are also mostly dependant on the overall investment prices, and could only use biomass in cases that they are located in areas without the gas	N/A

	burning firewood to gas than the ones from gas to biomass (final price per unit of energy is similar but initial investment is higher for biomass) (Polythecnik, 2017, Turboden, 2014) ↓	farming (biogas) which has a direct source of feedstock, even with advanced biomass facilities, urban areas are not likely to make the switch. (Kraljić Roković, 2012) →	network or are in the immediate vicinity of a biomass feedstock source. CHP and district heating facilities, mostly located outside of the urban areas, or in smaller urban areas, are most likely to benefit from employing new technologies. It is not likely, however, to have the novel development done within the country, but to use already known and well tested solutions. →	
Main feedstock types used:	Wood →	Wood →	Wood →	Wood →
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Stagnation →	Stagnation →	Stagnation →	Stagnation →

Table 12: CROATIA - Main factors influencing the development of biomass for Bioelectricity

Croatia	Consumption from CHP plants	Electricity only plants
Effect of Oil / gas price development:	Current situation is benefiting gas over biomass. However, with almost 75% of planned facilities still not in operation and being suspected as speculative projects keeping the quotas, there is significant potential of increasing the number of facilities in operation. (Raguzin, 2011) ↑	Electricity only plants have not been planned in the near future; therefore the prices of gas/oil have no effect in this case. →
Legislation (EU/national): support schemes	Since 1 January 2016, renewable energy in Croatia is promoted through an incentive in the form of a guaranteed purchase price after undergoing a tendering process. Applicable both to CHP and electricity only plants. (HROTE, 2018) ↑	
Legislation (EU/national): emission caps and CO2 certificate trading systems	The European Commission allocates free emission units to HEP's (Croatian Electric Energy Operator) boilers with more than 20 MW nominal power for the generation of heat energy, which is delivered to the district heating system i.e. the so-called "central-leakage" plants, i.e. plants which are under the risk of transferring their generation into countries which are not EU-ETS operators. Croatian Electric Energy Operator handles the majority of the district heating systems firing mostly gas and oil, but introduced two bioenergy plants in 2017. (HEP, 2018) →	Pursuant to Art. 28 of the RES Act the government will issue a special decree on the determination of quotas for the promotion of electricity production from renewable energy sources for the period from 2016 to 2020. (OG, 100/2015) This Decree has not been adopted yet. ↑/→
Legislation (EU/national): approval procedures & similar administrative conditions	Long and in some elements vague procedures for obtaining the approvals for connection to the electricity/district heating network (in urban areas). (HROTE, 2018) ↓/→	Long and in some elements vague procedures for obtaining the approvals for connection to the electricity network. The Electricity market act is amended in order to simplify and shorten administrative procedures for RES-E projects, particularly small projects. The Tariff System for the Production of Electricity from Renewable Energy Sources and Cogeneration

		(OG 133/13; 151/13; 20/14; 107/14; 100/15) introduced feed-in tariffs that were set up for new technologies production costs and usage of renewable energy sources in a more efficient way. ↓/→
Legislation (EU/national): sustainability targets	With full membership into the EU on 1 July 2013 and pursuant to Directive 2009/28/EC, Croatia committed to increasing the renewable energy share in final consumption of energy to 20%. The target is also embedded in the Strategy of Energy Development of the Republic of the Croatia (adopted on October, 2009) (OG, 130/2009) ↑	
Technology development:	Most of the 75% of planned CHP projects will rely on imported know-how and technology,and global development and installation prices will have a predominant influence on future investments and production.	Since there are no specific plans for electricity only plants, only development of a technology which would provide a significant increase in the efficiency would have an inluence in changing this.
Main feedstock types used:	Wood →	Wood →
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase/Stagnation ↑/→	Stagnation →

Table 13: CROATIA - Main factors influencing the development of biomass for biofuels

Croatia	Bioethanol	Biodiesel
Effect of oil / gas price development:	Current low oil/gas prices present an unfavorable indicator for the development of bioethanol production. ↓	Current low oil/gas prices present an unfavorable indicator for the development of biodiesel production. ↓
Legislation (EU/national): support schemes	Incentives for bioethanol/biodiesel producers were discontinued in 2015 after a change in national legislation in 2012 in regard to incentive payments and due to a lack of funds. (Poslovni.hr, 2016) ↓	
Legislation (EU/national): emission caps and CO2 certificate trading systems	The national CO_2 certificate trading system is in line with EU ETS legislation and prescribed by the Air Protection Act. Planned revenue allocation from the auctions includes measures for stimulating the production and use of biofuels in transport and research and development of technologies for the production of biofuels from renewable sources. Measures have not been implemented as they need to be aligned with the normative framework in the area of renewable energy and the excise system which has not yet been established. (MZOIP.hr, 2018) ↓/→	
Legislation (EU/national): approval procedures & similar administrative conditions	Croatian Energy Market Operator (CEMO) issues licenses for biofuels production, storage and trade (except for the production of biofuels produced exclusively for own use or production of energy up to 1 TJ per year, retail of biofuels and storage of biofuels exclusively for own purposes). CEMO hasn't issued any licenses in 2016 as there are currently no producers of bioethanol in Croatia. (HROTE, 2018) ↓/→	Croatian Energy Market Operator (CEMO) issues licenses for biofuels production, storage and trade (except for the production of biofuels produced exclusively for own use or production of energy up to 1 TJ per year, retail of biofuels and storage of biofuels exclusively for own purposes). CEMO has issued only three licenses in 2016 for production (1), storage (1) and trade of biodiesel (1). (HROTE, 2018) ↓/→
Legislation (EU/national): sustainability targets	Targets are defined in Directives 98/70/EC, 2009/28/EC and 2015/1513/EC which prescribe an obligation of ensuring that the share of energy from renewable sources is at least 10% in gross final energy consumption in all forms of transport in 2020 (98/70/EC) and require suppliers of fuel or energy to reduce by 31 December 2020, at least 6% of life cycle greenhouse gas emissions per unit of energy of fuels used in the Member State (2009/28/EC). To be considered sustainable, biofuels must achieve greenhouse gas savings of at least 35% in comparison to fossil fuels. This savings requirement rises to 50% in 2017. In 2018, it rises again to 60% but only for new production plants. All life cycle emissions are taken into account when calculating greenhouse gas savings. This includes emissions from cultivation, processing, and transport. Share of 1st generation shall be no	

	more than 7% of the final consumption of energy in transport in the Member States in 2020 (2015/1513/EC). Directive 2015/1513 remains to be implemented in Croatian legislation. None of the targets have been met. National action plan for production and use of biofuels in transport for the period 2011 – 2020 defines target productions for each year, but these have not been met. (OG, 1/2014) ↓/→	
Technology development:	There is no production of bioethanol in Croatia. →	No major technology development is excpected as only 1st generation biofuels are produced, and due to a huge drop in biodiesel production (only 6.031 t of biodiesel in 2016, which is a 65.4% reduction in production compared to 2015) after the incentives were discountinued. (Poslovni.hr, 2016) ↓
Main feedstock types used:	There is no production of bioethanol in Croatia (potentials could be corn and sugar beet). →	Rapeseed (93,2%), waste edible oil (6,6%), sunflower oil (0,2%) (HERA, 2017) ↓
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Stagnation →	Decrease ↓

Germany

Table 14: GERMANY - Main factors influencing the development of biomass for heat and derived heat

Germany	Residential	Industry	Services	Derived Heat
Effect of oil / gas price development:	Low oil and gas prices inhibit the installations of biomass heating systems in households as such systems might be considered by investors as less economic. (Lücke, 2015) ↓	N/A	N/A	N/A
Legislation (EU/national): support schemes	The Renewable Energy Heating Act (EEWärmeG) came into force in January 2009 and serves as an instrument to promote the use of renewable energies in the heating sector. All buildings with an effective area of more than 50 m^2, which have been built since 1st January 2009, must cover the heat demand through a proportionate use of renewable energies. The source of renewable energies can be decided by the owner. 50% of the heating energy must be met by solid biomass. This requirement can be replaced by measures like heat pumps, heat recovery or high-efficiency cogeneration plants (FNR, 2018b). The EEWärmeG was amended in May 2011. Since then the regulations also apply for public buildings (FNR, 2018b). The Market Incentive Program (MAP) supports the EEWärmeG through appropriate subsidies. Funding is possible for the construction and expansion of biomass plants for thermal utilisation of 5 to	If a company converts to a renewable energy plant with more than 100 kW of rated output, funding under the Market Incentive Program (MAP) for renewable energy from the Federal Ministry for Economic Affairs and Energy (BMWi) can be received. The MAP is implemented for the BMWi by the KfW program „Erneuerbare Energien – Premium". For heat pumps and biomass plants, the repayment subsidy is up to 50,000 € per single plant, for particularly innovative plants even up to 100,000 € (BMWi, 2018). To increase the efficiency in the area of electricity and heat generation, the Federal Government supports the	N/A	The BMWi promotes companies involved in modernisation, expansion or new construction of facilities for an efficient use of waste heat. The funding is conducted in the form of grants or low-interest loans by KfW with repayment subsidies. Repayment subsidies amount to up to 40% of the eligible costs of small and medium-sized companies and 30% for large companies. In case the waste heat is used off-site, the repayment subsidies can be up to 50% (BMWi, 2017). Companies can finance up to 100% of their eligible costs through low-interest loans by KfW. The maximum loan per investment is 25 million € (BMWi, 2017). ↑

	100 kW nominal heat output (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2018a). The Incentive Energy Efficiency Program (APEE) promotes the modernisation of heating system which use renewable energy sources through an additional bonus for the replacement of particularly inefficient heating systems (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2018a). ↑	expansion of combined heat and power, in particular through the the Combined Heat and Power Act (KWKG). The KWKG provides support for heat and cooling grids (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2018b). EU: The directive on the promotion of high-efficiency cogeneration (2004/8/EC) strengthens the member states to foster the development of CHP plants. How the member states encourage the wider implementation is a matter of the country itself (European Commission, 2004). ↑		
Legislation (EU/national): emission caps and CO2 certificate trading systems	The Energy Saving Ordinance (EnEV) requires that boilers which are older than 30 years need to be shut down, except low temperature and condensing boilers. The Renewable Energy Heat Act requires that owners of newly constructed buildings cover a specific share of the heat demand from renewable sources (Umweltbundesamt, 2016). The 1st German Federal Immission Control Ordinance (BImSchV) comprises thresholds for air pollutant emissions and exhaust gas losses of boilers and limits nitrogen oxide emissions. Exhaust gas losses and dust	Biomass plants, according to their legal immission permission, are not subject to emissions trading systems if they only use sewer gas, landfill gas, biogas or biomass (DEHSt, 2017). CHP plants with a rate thermal input of 20 MW are basically part of emission trading in Germany (Umweltbundesamt, 2014). →/↑	N/A	N/A

	emissions have to be regularly measured by chimney sweepers (Umweltbundesamt, 2016). →/↑			
Legislation (EU/national): approval procedures & similar administrative conditions	In the EEWärmeG it is stated that all buildings with an effective area of more than 50 m², which have been built since 1st January 2009, must cover the heat demand through a proportionate use of renewable energies. The source of renewable energies can be decided by the owner. 50% of the heating energy must be met by solid biomass. This requirement can be replaced by measures like heat pumps, heat recovery or high-efficiency cogeneration plants (FNR, 2018b). →/↑	The approval procedures according to the Federal Immission Control Act (BImSchG) take all environmental impacts of a plant into account. The size of a plant or the production throughput, which refers to the exceeding of certain thresholds in terms of pollutant emissions, is crucial for whether it is subject to authorisation or not. In more than 30 implementing ordinances (BImSchV) to the BImSchG, the main technical details that are essential for the authorization, the practical application and the monitoring of a plant are regulated (FNR, 2018a). Unless the limit values for emissions or immissions are laid down in the implementing regulations, the values from the nationally uniform administrative regulations such as the Technical Instructions on Air Pollution Control (TA Luft), the Technical Instructions for Protection against Noise (TA	N/A	N/A

		Lärm) and other apply (FNRa, 2018). →		
Legislation (EU/national): sustainability targets	In order to foster the climate protection and reduce the utilisation of fossil resources and dependency of energy imports, the aim of the EEWärmeG is to enable a sustainble development of the energy supply and of technologies to generate heat from renewable resources. The goal of the EEWärmeG is to increase the share of renewable energies at the overall energy need for heat up to 14% by 2020 (EEWärmeG, 2015). The EEWärmeG traces back to the Renewable Energy Directive from 2009 (2009/28/EC), which sets the target for Germany to increase the share of renewable energies at the total energy consumption up to 18% by 2020. →/↑	N/A	N/A	Almost 70% of the final energy demand of the industry are currently related to fuels. Accordingly, the accruing amount of heat and waste heat are relatively high. Those amounts of heat shall be used in the future even more extensively for industrial processes and in residential areas (BMUB, 2016). →/↑
Technology development:	Through technical improvement and optimisation of combustion technologies and combustion control, the carbon monoxide and dust emissions have been largely reduced. New wood central heating systems for logs, pellets and wood chips and pellet stoves achieve boiler efficiency rates of up to 95% (FNR, 2013). →/↑	N/A	N/A	N/A

Main feedstock types used:	Biogenic solid fuels, used in households, provided 40.4% of the overall heat supply from renewable energies in 2016. The share of biomass of the entire heat supply from renewable energy sources amount to 88.1% in 2016 (FNR, 2017b). Private households in 2014: Log wood: 22.2 million solid cubic meters, waste wood: 2.1 million solid cubic meters, wood chips 0.5 million solid cubic meters, wood pellets: 2.3 million solid cubic meters, wood briquettes: 0.5 million solid cubic meters (FNR, 2016) →	Biogenic solid fuels, used for industrial processes, provided 14.9% of the overall heat supply from renewable energies in 2016 (FNR, 2017b). →	Biogenic solid fuels, used in the trade and service sector, provided 9% of the overall heat supply from renewable energies in 2016 (FNR, 2017b). →	N/A
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	The investment costs of biomass heating systems are relatively high compared to conventional heating systems. Mostly because not only must the heating boiler be changed, but also because additional investments are needed, e.g. a storage location for the biomass (Schütte, 2015). More than 50% of German families are living on rented premises. The landlord can only partly allocate the investment costs for a biomass heating system and thus often does not have an interest to invest in a biomass heating system. Even though e.g. pellet heating systems could have economic benefits in apartment buildings with relatively high heat demands, a change from fossil to biomass heating systems is often	The investment costs for larger biomass plants, e.g. for the utilisation of straw, can also be inhibiting and only partly be compensated by lower fuel costs (Schütte, 2015). Stagnation →	Stagnation →	The decarbonisation of the energy supply and the associated strong expansion of renewable energies lead to multiple challenges for CHP plants. They can contribute to a reduction of greenhouse gas emissions by displacing uncoupled power and heat generation. The use of CHP plants must be oriented more strongly towards the electricity market in the future in order to integrate renewable electricity in a better way into the overall energy system. Therefore, the flexibilisation of electricity generation by CHP plants is essential (Umweltbundesamt, 2017). The heat supply from CHP plants also constitutes an import challenge in the future. Due to a reduced heat demand in existing buildings in combination with an increasing integration of heat from renewable sources,

	not conducted (Schütte, 2015). For fossil fuels it can be expected in the short term that the prices will stay on a relatively constant level. Thus the motivation to change the heating system in private and public construction projects will probably still be limited during the next years, unless in the frame of the EEWärmeG, the financial support schemes of the MAP or in terms of tax incentives for a change of the heating system towards renewable energy carriers would be supported (Schütte, 2015). Stagnation →			the importance of CHP plants in the heating sector will decrease prospectively. Thus, CHP plants will need to be able to react more flexibly to the heat demand in case less heat from renewable sources is available (Umweltbundesamt, 2017b). The utilisation of biomass for remote heat is supposed to increase in the time frame by 2050 (Schlesinger et al., 2014). Stagnation/Increase →/↑

Table 15: GERMANY - Main factors influencing the development of biomass for Bioelectricity

Germany	Consumption from CHP plants	Electricity only plants
Effect of Oil / gas price development:	Low oil and gas prices inhibit the installations of biomass heating systems in households as such systems might be considered by investors as less economical (Lücke, 2015). ↓	N/A
Legislation (EU/national): support schemes	National: With the amendment of the Combined Heat and Power Act (KWKG) in 2016, goals for the generation of electricity with CHP were set: 110 TWh by 2020 and 120 TWh by 2025. The regulations of the new law are intended to improve the framework conditions for cogeneration. It was also stipulated that CHP systems with an electrical output of between 1 and 50 megawatts must be tendered in the future (Bundesnetzagentur, 2017). This leads to uncertainties that have an influence on the	National: In the amendment of the Renewable Energy Act in 2012 (EEG), the use of heat is legally required. If the plant operator does not stick to it, the subsidy will be reduced (EEG, 2012). ↓

	expected CHP development. Achieving the KWKG goals is therefore difficult to predict at the moment (Umweltbundesamt, 2017a). The use of heat, however, is considered very useful, since the efficiency of the plant can be increased to 90% (FNR, 2017a). EU: The directive on the promotion of high-efficiency cogeneration (2004/8/EC) strengthens the member states to foster the development of CHP plants. How the member states encourage the wider implementation is a matter of the country itself (European Commission, 2004). ↑	
Legislation (EU/national): emission caps and CO2 certificate trading systems	CHP plants with a thermal firing rate of 20 MW are basically part of emission trading in Germany. Plants that are only fired with biomass must report on their emissions, but do not have to take part in the emission certificate trade systems (Umweltbundesamt, 2014). ↑	Similar to CHP plants, electricity only plants that are fired with biomass or waste do not have to take part in the emission certificate trade system (Ausfelder and Wagner, 2015). ↑
Legislation (EU/national): approval procedures & similar administrative conditions	For new CHP plants with an electrical output of max. 50 kWel, the Federal Office for Economic Affairs and Export Control (BAFA) has set up a simplified approval procedure based on a general directive. An electronic notification to the BAFA is required (BAFA, 2017). CHP systems with an electrical output of between 1 and 50 megawatts must be tendered (Bundesnetzagentur, 2017). On 6 October 2017, the Federal Network Agency opened the first tendering round for combined heat and power plants for the bid date of 1st December 2017. 20 bids with a total volume of 225 MW were received. Seven bids with a bid size of 82 MW were approved. The next bidding dates are set for 1st June 2018 and 1st December 2018 (Bundesministerium für Wirtschaft und Energie, 2018). →/↑	The generation of electricity from biomass is supported under the Renewable Energy Sources Act (EEG). The EEG takes into account whether the plant provides capacity for flexible power generation. Higher fees are also paid to plants that ferment biowaste or manure (<75 kW) (Bayerische Staatsregierung, 2018). ↑
Legislation (EU/national): sustainability targets	National: Because of the energy-efficiency and the flexibility in size CHP plants help to reach the sustainability goals of the Federal Government of Germany (Bundesregierung, 2018). EU: With the help of Bioenergy the EU wants to provide an important contribution in the long-term goal to develop a competitive, resource efficient and low carbon economy by 2050 (European Commission, 2011). CHP plants will play a certain role in	National: The low efficiency compared to CHP plants results in a lower contribution to the sustainability goals of the Federal Government (Bundesregierung, 2018a). Furthermore the subsidies for this kind of plants have been cut down (EEG, 2012). ↓

	this movement, because they are very energy-efficient. With the directive on the promotion of high-efficiency cogeneration (European Commission, 2004) the member states are encouraged to implement (and fund) these plants.	
Technology development:	The combined heat and power plant is a facility within a cogeneration plant. Within this part the technical process of cogeneration takes place. CHP plants can be based on different techniques: steam turbine, gas turbine, gas and steam turbine, internal combustion engine, steam engine, stirling engine, ORC system or fuel cell. The techniques differ within their power factor, electrical efficiency and overall efficiency. Depending on the type of installation, the following fuels can be used in CHP: gases, coal, mineral oils, solid and liquid biomass and waste. There exists a relation between the type of fuel and the type of CHP plant (Umweltbundesamt, 2017b). →/↑	There are different ways of generating electricity from biomass (Thrän et al., 2016): • Carbonation • Gasification • Pyrolysis • Anaerobic Digestion The largest share of bioenergy electricity was generated in 2016 in approximately 9,000 biogas plants. Electricity generation from landfill gas, on the other hand, declined slightly (Bundesverband Bioenergie, 2018). →
Main feedstock types used:	Net electricity generation from CHP (2016): Gases 63,5 TWh; Renewable Energies 31,6 TWh; Stone coal 11,0 TWh (Baten et al., 2017) Net heat production from CHP: Gases 100,7 TWh; Renewable Energies 49,6 TWh; Stone coal 31,4 TWh (Baten et al., 2017) Fuel input of CHP: Gases 733,9 PJ; Renewable Energies 432,4 PJ; Stone coal 195,1 PJ (Baten et al., 2017) →/↑	Electricity generation from biomass 2016: Biogas: 62,7% Biogenic solid fuels: 21,3% Biogenic fraction of waste: 11,6% Sewage gas: 2,8% Biogenic liquid fuels: 0,9% Landfill gas: 0,7% (FNR, 2017b) →
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase ↑	Decrease ↓

Table 16: GERMANY - Main factors influencing the development of biomass for biofuels

Germany	Bioethanol	Biodiesel
Oil / gas price development:	Strong dependency on oil price Price of E5 depends on the oil price. If the oil gets cheaper, E5 also gets cheaper. So the price advantage of E10 decreases. This tempts people to choose E5. Medium-term slightly rising prices, from 2022 onwards possibility of strong increase in oil prices because of increasing demand from developing countries. This can lead to a supply bottleneck which is due to missing investments in oil production technology during the last several years (Wetzel, 2017) Increasing gas price due to the shrinking oil reserves (Schöndelen, 2015) ↑/→	Strong dependency on fossil diesel price levels Medium-term slightly rising prices, from 2022 onwards possibility of increasing oil prices because of strong increase in demand from developing countries. This can lead to a supply bottleneck which is due to missing investments in oil production technology during the last several years (Wetzel, 2017) Increasing gas price due to the shrinking oil reserves (Schöndelen, 2015) ↑/→
Legislation (EU/national): support schemes	EU: Energy tax directive 2003/96/EWG demands that member states revise their taxation of energy products and electricity National: Implementation of 2003/96/EW with the EnergieStG (energy tax law) Entering into force: 01.08.2006 The support of biofuels through reduced energy taxation was taken back continuous until 2013. Now the taxation for biofuels is 45.03 Cent/l, the same amount as for fossil fuels. There are some exceptions for especially grant-worthy (cellulosic ethanol, synthetic hydrocarbons) biofuels and for the usage in agricultural holdings and forestry. (FNR, 2018c) This leads to a weakening role of biofuels on the market. Biofuels lost their price advantage against fossil fuels	National: 10. BImSchV Entering into force: 31.01.2009 Allows the sale of diesel fuels with a maximum share of 7 vol. % FAME (Before it was 5%) This raises the sales of biodiesel (ADAC, 2018) National: Implementation of 2003/96/EW with the EnergieStG (energy tax law) Entering into force: 01.08.2006 The support of biofuels through reduced energy taxation was taken back continuous until 2013. Now the taxation for biofuels is 45.03 Cent/l, the same amount as for fossil fuels. There are some exceptions for especially grant-worthy (cellulosic ethanol, synthetic hydrocarbons) biofuels and for the usage in agricultural holdings and forestry. (FNR, 2018c)

	EU: The European policy about fuel quality (Directive 2009/30/EC) forces all member states to bring petrol with up to 10 vol. % bioethanol (as E10) to market. National: Implementation of 2009/30/EC in national law within the framework of 10. BImSchV (E10-Kraftstoff, 2018) This supports the production of bioethanol EU: Draft proposal: Changes of the renewable energy directive (RED) for the period after 2020: The goals (10% share of renewable sources in the energy sector until 2020) shall be changed and the share of conventional biofuels (based on food crops) shall be decreased to a maximum share of 7% until 2021; and a maximum share of 3.8% until 2030. Progressive biofuels (based on waste and residues) shall be promoted with a share of 6.8% on the total fuel consumption. The fear is that this strengthens the sale of fossil fuels as there are not enough progressive fuels available (EURACTIV, 2017). Leads to innovations in the sector of progressive biofuels, but political U-Turns make it difficult for entrepreneurs to invest, because there is no reliable political framework Overall, high dependency on legislative support schemes, no market viability on its own for 1. Generation bioethanol, cellulosic ethanol market is currently benefiting from political support schemes ↑/→	This leads to a weakening role of biofuels on the market. Biofuels lost their price advantage against fossil fuels EU: Draft proposal: Changes of the renewable energy directive (RED) for the period after 2020: The goals (10% share of renewable sources in the energy sector until 2020) shall be changed and the share of conventional biofuels (based on food crops) shall be decreased to a maximum share of 7% until 2021; and a maximum share of 3.8% until 2030. Progressive biofuels (based on waste and residues) shall be promoted with a share of 6.8% on the total fuel consumption. The fear is that this strengthens the sale of fossil fuels as there are not enough progressive fuels available. The stop of EU support for conventional biofuels could lead to an end of the rape cultivation due to high losses → High impact on biodiesel production (EURACTIV, 2017) Leads to innovations in the sector of progressive biofuels, but political U-Turns make it difficult for entrepreneurs to invest, because there is no reliable political framework Overall, high dependency on legislative support schemes, no market viability on its own. 1. Generation biodiesel will have no substantial market in case RED II draft proposal is set into force ↓
Legislation (EU/national): emission caps and CO2 certificate trading systems	National: Biokraftstoffquotengesetz BiokraftQuG (Biofuel quota law) – Part of § 37 a BImSchG (Federal Control of Pollution Act) – Implementation of Directive 2003/30/EC (support of biofuels); 2003/96/EC (Taxation of energy products); 98/34/EC (information procedure) Entered into force: Jan 2007 Climate protection quota for the reduction of greenhouse gas emissions from fuels Improvement of the greenhouse gas balance of fuels through addition of biofuels GHG reduction quota: -as of 2015: 3% - as of 2017: 4.5% - as of 2020: 6% Before (until 2014) it was regulated through a diesel-, petrol- and overall quota of fuel consumption	

	Problem: Producers of biofuels are victims of their own success – the more efficient the biofuels get, the less biofuel is added from the fuel producer to reach the reduction goals; therefore the sales of biofuels decreased during the last years (VDB, 2018) →/↓
Legislation (EU/national): approval procedures & similar administrative conditions	National: Biokraftstoff Nachhaltigkeitsverordnung (Biofuel sustainability regulation) – for the implementation of the sustainability criteria of regulation 2009/28/EC (Renewable resources regulation). Entered into force: 01.01.2010 Regulation about the requirements on sustainable biofuel production. Only biofuels which fulfill designated requirements on environmental protection and sustainable agriculture can be credited to the biofuel quota. Requirements: - saving 50% greenhouse gas emission compared to fossil fuels - no areas worth protecting are allowed to be plowed or deforested The Bundesanstalt für Landwirtschaft und Ernährung, BLE(German Federal Agency for Agriculture and Food) is responsible for the approval and control of the certification schemes and authorities (BMEL, 2014) Guarantees quality of national and imported biofuels. Moreover, only biofuels for transport are subject to sustainability standards, all other energy generated from biomass is not regulated in terms of feedstock sustainability. This can lead to barriers for investors and market distortions. →/↓
Legislation (EU/national): sustainability targets	EU: Directive 2009/28/EC on the promotion of the use of energy from renewable sources (23.04.2009) Sets binding goals on the promotion of the use of renewable resources for the whole EU until 2020 - at least a 20% share for renewables in final energy consumption - at least a 10% share for renewables in the transport sector Differentiated national overall objectives – EU member states have to set out their measures and expansion paths to reach their binding national goals with a national action plan (BMWi, 2018) National: National Action Plan of Germany Measures and expansion paths to reach the national goals – Implementation of 2009/28/EC Goals: - at least a 18% share for renewables in final energy consumption - at least a 10% share for renewables in the transport sector (Bundesrepublik Deutschland, 2009) Forces a change from fossil sources to renewable sources or electric vehicles National: Biokraftstoff Nachhaltigkeitsverordnung (Biofuel sustainability regulation) – for the implementation of the sustainability criteria of

<table>
<tr><td></td><td colspan="2">directive 2009/28/EC (Renewable resources regulation). Entering into force: 01.01.2010
Regulation about the requirements on sustainable biofuel production. Only biofuels, which fulfill designated requirements on environmental protection and sustainable agriculture, can be credited to the biofuel quota.

Requirements:
- saving 50% greenhouse gas emission compared to fossil fuels
- no areas worth protecting are allowed to be plowed or deforested

The Bundesanstalt für Landwirtschaft und Ernährung, BLE (German Federal Agency for Agriculture and Food) is responsible for the approval and control of the certification schemes and authorities (BMEL, 2014)
Guarantees quality of national and imported biofuels. Moreover, only biofuels for transport are subject to sustainability standards, all other energy generated from biomass is not regulated in terms of feedstock sustainability. This can lead to barriers for investors and market distortions.
→/↓</td></tr>
<tr><td>Technology development:</td><td>Research on 2./3. Generation biofuels ongoing, TLR:
2. Generation: biomethane or cellulose ethanol
3. Generation: algae-fuel (higher biomass productivity)
→ Higher technical and financial effort, therefore these biofuels (except biomethane) cannot be produced economically yet.

e-Mobility:
Is supported through the government program ‘electric mobility’, which provides the strategy and instruments to develop Germany as lead market and lead supplier in the domain of electric mobility:
- until 2020 there shall be 1 Mio electric vehicles (6 Mio until 2030)
- subventions when purchasing an electric vehicle
- tax incentives
-exclusive parking spots at charging stations, reduced or even no parking fees

Electric mobility can contribute to decrease environmental impacts of the transport sector. It is also an environmental friendly alternative to fossil fuels (BMUB, 2017)

Due to this governmental support, electric mobility can become a competitor of biofuels.</td><td>Research on 2./3. Generation biofuels ongoing, TLR:
2. Generation: BtL (Biomass-to-Liquid) fuels
3. Generation: algae-fuel (higher biomass productivity)
→ Higher technical and financial effort, therefore these biofuels cannot be produced economically yet.

e-Mobility:
Is supported through the government program ‘electric mobility’, which provides the strategy and instruments to develop Germany as lead market and lead supplier in the domain of electric mobility:
- until 2020 there shall be 1 Mio electric vehicles (6 Mio until 2030)
- subventions when purchasing an electric vehicle
- tax incentives
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Due to this governmental support, electric mobility can become a competitor of biofuels.</td></tr>
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	Otherwise the climate goals can just be reached with an application of both alternatives (electric mobility and biofuels). Additional to the notified 6 Mio electric vehicles, there should be a share of 20% of biofuels in the total fuel consumption. But this is not attainable at the moment with the biofuel quota law. (Baumann, 2017) ↓	Otherwise the climate goals can just be reached with an application of both alternatives (electric mobility and biofuels). Additional to the notified 6 Mio electric vehicles, there should be a share of 20% of biofuels in the total fuel consumption. But this is not attainable at the moment with the biofuel quota law. (Baumann, 2017) ↓
Main feedstock types used:	Plants with sugar content: e.g. sugar beet, sugar cane (1G) Plants with starch content: e.g. crops, potatoes, maize (1G) Cellulose containing raw materials: e.g. straw or wood (2G) (BDBe , 2018) Overall strong dependency on 1G feedstock; therefore potentially decreasing political support for these kinds of feedstock due to sustainability reasons Residue material technologies needed ↓	Canola oil (70%) (1G) Used edible fat (22%) (2G) Palm oil (4%) (1G) Animal fats & fatty acids (3%) (1G) Soya oil (2%)(1G) (FNR (b); 2016) Overall strong dependency on 1G feedstock; therefore potentially decreasing political support for these kinds of feedstock due to sustainability reasons Residue material technologies needed ↓
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Decrease: 2G bioethanol currently benefiting from political framework, market might increase. Currently, economically viable production in large scale quantities not existing. 'victim of own success' Political U-turns & dependency on support schemes → lacking investor reliability Political focus on alternatives (e-mobility) Possible change of the goals for energy from renewable sources (decrease of the support) ↓	Decrease: 'victim of own success' Political U-turns dependency on support schemes → lacking investor reliability Political focus on alternatives (e-mobility) Possible change of the goals for energy from renewable sources (decrease of the support) ↓

Hungary

Table 17: HUNGARY - Main factors influencing the development of biomass for heat and derived heat

Hungary	Residential	Industry	Services	Derived Heat
Effect of oil / gas price development:	Create consistency between the cost-based and the value-based pricing, because the price of biomass matches to the international stock exchange oil prices, which is typical for ESCOs. (MEKH, 2017) (An energy service company (ESCO) is a commercial or non-profit business providing a broad range of energy solutions including designs and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management.) The biomass use in the residential heating sector could be increased with suitable support measures, but this is held back by low gas prices and the reduction of energy consumption through the insulation of houses. Due to reduced gas prices, many households that had already changed to biomass heating systems returned to gas boilers, using wood stoves only as a supplement. ↓			
Legislation (EU/national): support schemes	Various measures within the New Széchenyi Plan are designed to promote the energetic utilisation of agricultural and forestry by-products, waste and also the establishment of biofuel capacities. The use of biomass systems in public buildings and district heating systems are also supported. (Miniszterelnökség Hungary, 2011) ↑	N/A	N/A	N/A
Legislation (EU/national): emission caps and CO2 certificate trading scheme	N/A	N/A	N/A	N/A

Legislation (EU/national): approval procedures & similar administrative conditions	N/A	N/A	Hungarian Act Scheme for the Utilisation of Renewable Sources, 2010-2020: one of the purposes is the simplification of the licensing procedures. (MEKH, 2017) ↑/→	N/A
Legislation (EU/national): sustainability targets	Sustainable use of biomass needs to achieve the objectives of promoting on-site processing and the use of renewable energy in the agricultural and forestry sector. (Ministry of National Development, 2012) →	N/A	N/A	N/A
Technology development:	Heat-generating units or small power plants can be installed near the field of cultivation of woody and soft-stem energy crops; however, the economical utilisation of waste heat should be monitored at this time. (Crossborder Bioenergy - IEE project, 2012) →	Regarding the NREAP, the government is planning to support the establishment of district heating systems. Part of the district heating systems have already been established but require reconstruction and modernisation, and infrastructures must be established as well. (Ministry of National Development, 2010) →	Improving the technical standard of the service can no longer be postponed (insular operations interconnectable in the long run, transition to low-temperature secondary service, assessing the possibility of district cooling, developing a service quality control system, setting up a system of efficiency criteria, individual controllability and metering and the development of village district heating systems). A reasonable solution and a possible natural gas alternative could be the increased utilisation of thermal waste utilisation (waste incineration subject to strict environmental requirements, in district heating, which may even offer a solution to the problem of declining heat demand. In the case of district heating systems, pipelines and the heat centre network must essentially be modernised, renewable energy sources, primarily biomass and geothermal energy, must be used and communal wastes non-utilisable in their materials must be utilised for energy generation. (Ministry of National Development, 2010) ↑	
Main feedstock types used:	Fire wood Biomass utilisation in Hungary is heavily reliant on the utilisation of firewood for energy. Part of the firewood is used for generating electricity, whereas			

	the rest is used for heat energy in the district heating system and individual heating. Forestry dendromass is the major basis for biomass-based heat production in Hungary presently. Waste material which is not suitable for industrial utilisation can, however, be used for heating. The amount that is used by households for heating and by power plants is significant. Potential: Waste materials (Wojciech and Harmat, 2014; Crossborder Bioenergy – IEE Project, 2012) →/↑	
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Hungary is at an adequate level to meet the 2020 renewable energy targets. Based on the Hungarian Energy and Public Utility Regulatory Authority, the country has already reached the target level. (MEKH, 2017) Unlike former practices, which calculated the use of firewood mainly on the basis of forestry statistics, firewood use is now calculated from the survey of household energy consumption. The recalculation of domestic heating households' energy use was due to an EU regulation (European Commission 431/2014), which obliges the Central Statistical Office (KSH) to provide more detailed information than previously. Further questions are raised by EU legislation that is changing after 2020. According to the amending proposal of the renewable directive, only sustainable forestry biomass that can be justified on the source side to renewable targets in 2020 can be used . Natural gas vulnerability in heating/cooling may be reduced primarily through the use of renewable energy sources (biomass, biogas, solar and geothermal), whereas appropriate price and support policies are required in order to ensure the competitiveness of investments. In any case, in terms of the use of renewable energy sources in heat generation, the priority of energy efficiency must be taken into consideration.	Besides the encouragement of improving the efficiency of high-capacity power plants, the targets set are best served by utilisation of local heat generation appliances and, in the case of electricity, the establishment of low to medium-capacity local power plants with regional development potential. It is important to note that a significant percentage of renewable energy sources are available cheaply, and at the same time, regions in the countryside could be able to fulfil a considerable part of their own energy demand from their own resources in an environmentally sound way and at lower costs. Based on the District Heating Development Action Plan (DHDAP) and Hungary's Renewable Energy Utilisation Action Plan 2010–2020 (NAP), renewable energy targets are based primarily on a significant increase in the utilisation for district heating of biomass and geothermal energy and, to a smaller extent, of heat generated by waste incineration. More than half of the total green electricity and over 60% of bioenergy used for district heating are generated by Hungarian forest wood. (Ministry of National Development, 2010; Wojciech and Harmat, 2014) Stagnation →

	Developing the support and incentive scheme, the prices of natural gas will be critical in terms of the competitiveness of renewable energies. (Ministry of National Development, 2012) Stagnation →	

Table 18: HUNGARY - Main factors influencing the development of biomass for Bioelectricity

Hungary	**Consumption from CHP plants**	**Electricity only plants**
Effect of oil / gas price development:	N/A	N/A
Legislation (EU/national): support schemes	The new renewable support scheme Renewable Support Scheme (METÁR) regarding electric energy entered into force from last year. The former Obligatory Off-take (KÁT) system worked well and ensured a balance in the electricity system - but times are changing, and the frequent overproduction of renewable energy and rapid technological progress required the introduction of a more flexible legal framework. The introduction of the new legislation also means that the KÁT system is gradually changed to METÁR, with a transitional period, until the termination of the last effective agreement which includes KÁT, but not later than year 2045. The key feature of the new support scheme is that the producers of renewable energy receive the aid as a paid premium over the market reference price (e.g. the average price of the regulated market). Producers with a performance under 0.5 MW and with demonstration projects are exempt from the METÁR premium system, they remain under the scope of KÁT. Producers with between 0.5 – 1 MW performance are not obliged to participate in tender procedures, they are entitled to receive the so-called administrative premium over the market price. The most fundamental innovation compared to KÁT is that that bigger energy producers, with over 1 MW capacity may only be entitled to state aid, the so-called premium support, if they participate and win a tender, announced and coordinated by HEPURA. Apart from the above green premium system, METÁR also introduces the so-called "brown premium" to promote the generation of electricity from biomass or biogas sources. In this special procedure carried out by HEPURA the producer should request the brown premium after the procedure, and if HEPURA accepts the request, eligibility is granted for 5 years. Government Decree No. 389/2007 (XII.23.) on the obligatory dispatch and purchase of electricity generated from waste or from renewable energy sources (Gullai, 2017; RES LEGAL, 2017) →/↓	

Legislation (EU/national): emission caps and CO2 certificate trading scheme	N/A	N/A
Legislation (EU/national): approval procedures & similar administrative conditions	N/A	N/A
Legislation (EU/national): sustainability targets	The majority of renewable electricity is currently generated by the burning of biomass (primarily firewood) in obsolete coal power plants at a low efficiency rate. However, the energy utilisation of biomass requires the definition and application of sustainability criteria. With regard to the above, the local utilisation of verified firewood purchased from forest farmers engaging in sustainable forestry, biomass from energy plantations and agricultural by-products should primarily be utilised, preferably in CHP plants. Eligible electricity generation must use biomass which originates from authorised logging and falls into a timber category inferior to sawmill trunk. When forestry biomass is used, the seller is required to give proof of the origin of such biomass in the form of a certificate of origin issued by the forestry authority or - in the case of forestry biomass originating from a third country - in the form of an FSC (Forest Stewardship Council) certificate; for other biomass, the seller is required to issue a statement that the biomass used is not suitable for human consumption. When biomass or biogas is used (new entrants) the seller needs to provide proof of compliance with the efficiency requirements under the MOT Decree. (Ministry of National Development, 2010) →/↓	
Technology development:	The adaptation of used technology to domestic conditions required major technical changes in the largest straw-powered power plant in Hungary. After analysing the regional fuel supply options and the equipment and operational procedures which were optimally designed for firing bales of dry cereal straw the equipment had to be transformed. So now the new block could use bales with higher moisture content from other arable crops (maize and sunflower residues). As one can see, the present energy utilisation of biomass is largely unsustainable. Considering the fact that the lion's share of biomass is used in large scale power stations requiring deliveries from large distances, biomass should mostly be used for energy purposes in local scale units	N/A

	within decentralised energy systems, where electricity is generated by many small energy producers, close to where it is used, rather than at large power plants located far from the consumers. As mentioned above, in this way transmission losses and also the effects of possible outages of the power grid would be minimised. In addition, under these conditions the energy production would be more efficient, since the waste heat could be used in a larger extent, due to proximity of the consumers. The operation and expansion of CHPs is mostly influenced by the limited heat market. Besides producing electricity, the main functions of large and small power plants are providing district heat, and heat for flats and plants connected to the district heating network. From the aspect of raw material supply it is theoretically possible to establish 3-4 straw-fired CHP plants with a total capacity for each heat and electricity of 15 MW. Communal power plants established for the purpose of waste combustion are a good example for CHP. One such power plant operates east of Budapest. Household-size cogeneration (using Stirling-engine powered by vegetable oil, natural gas, or solid biomass) small equipment producing electricity and heat energy have not yet spread among the population, because of their high investment costs on the one hand, and due to lengthy and complicated licensing procedures on the other hand. Concerning biogas plants there are more ways to continue development: use of alternative substrates (plants that have not been used so far, locally available agricultural by-products, animal wastes). Beyond these, it is also important to take into account the increasing utilisation of biomethane as a transport fuel and as a material which can be fed into the natural gas network. Regarding the Hungarian NREAP in respect to biomass-based electricity generation, it is an important structural improvement that we intend to achieve through the installation of local, small-settlement-level combined power plants with a maximum installed power of 20 MWe. The use of such plants could represent an important means of integrated rural development in the future, and could reinforce microregional cohesion and economic cooperation. Power plants with a maximum installed power of 25 MWe could be justified in cases where it is required by heat demands (e.g. district heating systems in large cities). (Wojciech and	

	Harmat 2014; Tóth et al., 2014; Crossborder Bioenergy – IEE Project, 2012; Ministry of Development, 2010) ↓/→	
Main feedstock types used:	straw (wheat, rye, barley, oats, triticale), baled herbaceous agricultural by-product biogas plants: biodegradable wastes – from households, parks, kitchens, restaurants, and also agricultural and other industrial organic wastes (such as sewage sludge). (Wojciech and Harmat, 2014; Crossborder Bioenergy – IEE Project, 2012) →	wood chips and sawmill by-products (Wojciech and Harmat, 2014; Crossborder Bioenergy – IEE Project, 2012) →
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	In its National Renewable Energy Action Plan, Hungary undertook to fulfil EU Commission requirements by ensuring it has a 14.65% ratio of renewables within its gross final energy consumption by 2020, over the obligatory 13% prescribed for Hungary as national overall target in the RED (Ministry of Development, 2010). In line with Commission Regulation (EU) No 431/2014, the Hungarian Energy and Public Utility Regulatory Authority has produced statistics on household energy usage based on a new methodology for 2015. The changes were backed up in the energy balance to 2010. The biomass utilisation of the population has been underestimated by the methodology used so far. Based on the new data, domestic renewable energy consumption is higher than before. Growth also affects the domestic share of renewable energy. Thus, Hungary is currently above the target rate, and has almost reached the 2020 target. Most EU markets are expected to grow at a minimum. The growth is driven by small industrial, business and renewable CHP sectors. In Hungary, significant CHP capacities are still unused. CHP power production will stagnate or decrease in the business-as-usual case. Supporting both micro-CHP and bio-CHP can lead to a path of	Decrease ↓

	growth. The advantages are a more energy efficiency and a system more compatible with intermittent renewable generation. A first assessment indicates that the total capacity might be doubled by 2030. CHP is the most efficient energy conversion technology of a primary fuel to electricity and heat achieving up to 30% primary energy savings or even more compared to separate production of heat and electricity. Flexible CHP electricity generation also fits very well with intermittent generation from renewables. In some cases, the realization of new investments did not materialize because of the resistance of the local population. (MEKH, 2017) ↓/→	

Table 19: HUNGARY - Main factors influencing the development of biomass for biofuels

Hungary	Bioethanol	Biodiesel
Effect of oil / gas price development:	In terms of national plants, the market for bioethanol is primarily not regulated by fuel quotation (petroleum supply and demand), but by the 2010 EU Renewable Energy Directive. In the summer of 2015, the European Commission has cut the previous bio-ratio to be mixed with fuels from 10% to 7%. Currently, regulation in Hungary has a value of 4.9%. (Wolters Kluwer, 2017) ↓/→	N/A
Legislation (EU/national): support schemes	Regulations for the use of biofuels have existed in Hungary since 2005. In the first period, which lasted until 2009, the state provided incentives for the use of biofuels through tax reliefs. Excise duties on bioethanol and biodiesel admixed to fuels, as well as on their ETBE bioethanol component, were recoverable. The relevant rules will be tightened slightly by the new Directive (ILUC Directive) to be published in 2015, which provides for a restriction in the production of first-generation (crop-based) biofuels. This brings about changes in terms of the use of biofuels as described in the relevant Hungarian strategy to the extent that the share of first-generation biofuels should not exceed 7% of final energy consumption in transport in 2020. Importantly,	

	however, it does not result in a change in the Hungarian biofuel policy. Nevertheless, in addition to first-generation biofuels currently significantly contributing to productivity in agriculture, increasing attention must be paid to promoting less mature technologies, i.e. advanced biofuels (non-crop-based biofuels) and other environment-friendly solutions such as hybrid or all electric vehicles. Biofuels quota: there is a target for biofuels, determined as the share of pure biofuels and biofuels added to conventional fuels in the total quantity of petrol placed in the market (§ 5 (1) Act No. CXVII of 2010). The quota has been redefined by a Government Decree for a three-year period (§ 5 (3) Act No. CXVII of 2010) in 2014 and will be 4.9% until 31 December 2018 (5 (4) Decree No. 343/2010). Only certified bio-fuels satisfying specific sustainability criteria can be taken into account for fulfilling the prescribed quota (§§ 2, 3 Decree No. 343/2010). Subsidy Programmes: For example, within the TOP, subsidies are allocated for sustainable development of the transport sector under the priority section which targets projects for a low carbon economy, especially with a focus on urban areas. In this respect, renewable energies can form a complementing element within infrastructural projects (Government Decision 1005/2016 (I. 18.) (TOP)). (Wolters Kluwer, 2017; RES LEGAL, 2017) ↑/→	
Legislation (EU/national): emission caps and CO2 certificate trading systems	For plants put into operation before on or before 5 October 2015, the use of biofuels has to result in 35% (until 2018: 50%) lower greenhouse gas (GHG) emission levels than if conventional fuels were used. For plants put into operation after the 5 October 2015, the use of biofuels has to result in 60% lower greenhouse gas (GHG) emission levels than if conventional fuels were used. In general, the sustainability ratio is assessed based on the GHG-savings compared to the use of fossil fuels (§§ 3 (1-2) Decree No. 279/2017). Decree No. 39/2017. (X. 9.) (Wolters Kluwer, 2017; RES LEGAL, 2017) →	N/A
Legislation (EU/national): approval procedures & similar administrative	N/A	N/A

conditions		
Legislation (EU/national): sustainability targets	The sustainability criteria for biofuels as well as the procedure for certification are regulated by law (Decree No. 279/2017 and § 3 (1) Act No. CXVII of 2010). The biofuel manufacturer must certify that the product meets the sustainability requirements and that the raw material has been produced in a sustainable way. A certificate must be issued for the product by the producer. (Wolters Kluwer, 2017; RES LEGAL, 2017) →	
Technology development:	The European Committee considers second-generation ethanol technology based on cellulose (wood and agricultural by-products, sawdust, plant residue) instead of grain maize as a more appropriate process. Currently this technology is only used in small plants worldwide. (Crossborder Bioenergy - IEE project, 2012; Tóth et al., 2016) →	According to European regulations, 4.8% of biodiesel can be mixed with diesel in Hungary. Of course, there is nothing to prevent it from being more (according to KSH data, in 2014 it was 6.9%). Collecting used oil is important not only because of the production of biodiesel but also because it can cause pluging into the canal and it will appear as a difficult decomposable material. In regards to the use of biofuels, with direct admixture and the current technological limitations, the spreading of vehicles capable of utilising engine fuels with high biofuel contents will be essential. This must be supported especially in the field of public transportation. Besides biofuel, the use of alternative fuels is also important, including the establishment of electric, hybrid and hydrogen-based systems and their economic and infrastructural background. (Crossborder Bioenergy - IEE project, 2012; Tóth et al., 2016) →
Main feedstock types used:	Grain maize Prior to the emergence of bioethanol production, the 4-5 million tonnes of maize surplus were sold as crops in unprocessed form by Hungarian producers, which in many cases led to a significant fall in prices and caused a serious loss for farmers year after year. Nowadays the demand of the ethanol industry is nearly 2 million tons of maize per year, and hopefully the processing could reach the level soon, that requires 3 million tons of maize yearly. (Sz.S.P., 2017).	Fresh vegetable oil (rape, sunflower) and used cooking oil (basis of IPPC Permit.) In terms of biodiesel production, the domestic capacity is sufficient for the production of the quantities in accordance with the relevant Directives, whereas there is a surplus bioethanol production capacity based on surplus quantities of maize. (Sz.S.P., 2017). ↑/→

	↑/→	
Overall assessment for the BAU Scenario (Increase, decrease, stagnation)	With regard to the contradiction between biofuel and food production, Hungary's clear intention is to ensure a secure food supply. Second generation bioethanol and biodiesel could be provided with a secure market through the EU's long-term objectives regarding biofuel admixture, and their national adaptation. This is supported by the EU condition that if they comply with sustainability criteria, the use of second generation biofuels counts doubly towards the fulfilment of biofuel commitments. However, the 2020 renewable energy targets were not fully met, as the share of renewable energy sources in transport energy consumption is still below 10%. The wrong idea is that only biofuel is considered the product of the ethanol industry. Alcohol, valuable protein concentrate, and protein feed is also produced. Hungary, just as is the case with the European Union in general, is a net importer of protein. The National Protein Feed Program announced at the end of 2017 (see Ministry of Agriculture: http://www.kormany.hu/en/ministry-of-agricultur) that the three-year research & development programme is being launched in the interests of fully replacing imported genetically manipulated soy in Hungarian animal feeds with domestic protein-based plants. For the implementation of the program, not only the soybean but also the by-products arising from industrial processing of maize and sunflower, as well as the protein-by-product of bioethanol production in animal husbandry are taken into account. Increase/Stagnation ↑/→	In terms of biodiesel production, the domestic capacity is sufficient for the production of the demanded quantities. Road freight transport is mostly carried out by Diesel vehicles. Since in Hungary, the production of first generation biodiesel cannot be increased at a significant rate based on domestic raw materials, the share of rail and water transport should be substantially increased in the sustainable transport of goods. Decrease/Stagnation ↓/→

Romania

Table 20: ROMANIA - Main factors influencing the development of biomass for heat and derived heat

Romania	Residential	Industry	Services	Derived Heat
Effect of oil / gas price development:	Low prices of oil and gas will prevent future installations of biomass devices in households. Areas where the gas pipelines have not yet been installed will continue using biomass as primary source of heat. New reserves of gas discovered in the Black Sea might lead to an extension of the gas pipeline network and increased use of gas for residential heating. →/↓	Most of the industries rely on natural gas and are therefore similarly affected as the households. →/↓	Public spaces are mainly heated by either district heating sources (mostly gas powered) or by their own heating facilities (again, gas powered). Unless there's a significant price surge, the status is not likely to change. →/↓	N/A
Legislation (EU/national): Support schemes	N/A	N/A	N/A	N/A
Legislation (EU/national): emission caps and CO2 certificate trading systems	N/A	Industrial facilities with an nominal capacity of >20MW are regarded as activities covered by the emission trading system and emission caps (ANRE, 2017; Parliament of Romania, 2007). →/↓		There is a national register for CO_2 emissions with free initial allocations for district heating (Government of Romania, 2006). →
Legislation (EU/national): approval procedures & similar administrative conditions	N/A			

Legislation (EU/national): sustainability targets	Targets for 2020 regarding RES are reached in Romania because of the huge proportion (60%) of residential houses using fire wood for heating. (Romanian Energy Strategy, 2016; ANRE,2016; Forest Code of Romania, 2008; Parliament of Romania, 2016) →			
Technology development:	There are more producers of pellets and furnaces employing new technologies, but the installation costs are too high compared to the expanding gas network which could cause more households to make a switch from burning firewood to gas than the ones from gas to biomass (final price per unit of energy is similar but initial investment is higher for biomass). →/↓	Industrial zones are currently located in urban areas, mostly covered by the gas network and also used by the facilities. Other than the wood processing industry / farming (biogas) which has a direct source of feedstock, even with advanced biomass facilities, urban areas are not likely to make the switch. →	Public services are also mostly dependant on the overall investment costs and could only use biomass in cases that they are located in areas without gas network or are in the immediate vicinity of a biomass feedstock source. →	CHP and district heating facilities, mostly located outside of the urban areas, or in smaller urban areas, are most likely to benefit from employing new technologies. →
Main feedstock types used:	Wood (Romanian Energy Strategy, 2016) →			
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Stagnation/Decrease →/↓	Stagnation →	Stagnation →	Stagnation/Increase →/↑

Table 21: ROMANIA - Main factors influencing the development of biomass for Bioelectricity

Romania	Consumption from CHP plants	Electricity only plants
Effect of oil/gas price development	N/A	N/A
Legislation (EU/national): support schemes	The law 220/2008 introduced a support scheme by issuing green certificates. The intensity of support was too low for bioenergy and combined with lack of resources, the effect was insignificant (Parliament of Romania, 2010). →/↓	No major growth is expected due to lack of support. →/↓
Legislation (EU/national): emission caps and CO2 certificate trading systems	The support aims to reduce emissions in existing capacities based on fossil fuels rather than supporting new capacities based on biomass. →/↓	
Legislation (EU/national): approval procedures & similar administrative conditions	Long and in some elements vague procedures for obtaining the approvals for connection to the electricity/district heating network (in urban areas). ↓	
Legislation (EU/national): sustainability targets	N/A	N/A
Technology development:	Most of the planned CHP projects will rely on imported know-how and technology. Global development and installation costs will have a predominant influence on future investments and production. →/↑	N/A

Main feedstock types used:	Wood →	Wood →
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase/Stagnation →/↑	Stagnation →

Table 22: ROMANIA - Main factors influencing the development of biomass for biofuels

Romania	**Bioethanol**	**Biodiesel**
Effect of oil / gas price development:	Current low oil/gas prices present an unfavorable indicator for the development of bioethanol/biodiesel production. ↓	
Legislation (EU/national): support schemes	There are no incentives for bioethanol producers. (Capatana, 2016) ↓	There is a minimum 5.5% content of biodiesel mandatory, to increase RES in transport. (Capatana, 2016) →/↑
Legislation (EU/national): emission caps and CO2 certificate trading systems	National CO_2 certificate trading system is in line with EU ETS legislation and prescribed by the Air protection act. Planned revenue allocation from the auctions includes measures for stimulating the production and use of biofuels in transport and research and development of technologies for the production of biofuels from renewable sources. Measures have not been implemented as they need to be aligned with the normative framework in the area of renewable energy and the excise system which has not yet been established. (Capatana, 2016) →	
Legislation (EU/national): approval procedures & similar administrative conditions	There is a quality standard SR EN 14214 and laboratories authorized to certify compliance with the standard. (PNAER, 2010) →/↑	
Legislation (EU/national): sustainability targets	Targets are defined in Directives 98/70/EC,2009/28/EC and 2015/1513/EC which prescribe obligations to ensure the share of energy from renewable sources is at least 10% of gross final energy consumption in the transport sector in 2020 (98/70/EC) and require suppliers of fuel or energy to reduce by 31 December 2020, at least 6% of life cycle greenhouse gas emissions per unit of energy of fuels used in the Member State (2009/28/EC). To be considered sustainable, biofuels must achieve greenhouse gas savings of at least 35% in comparison to fossil fuels. This savings	

	requirement rises to 50% in 2017. In 2018, it rises again to 60% but only for new production plants. All life cycle emissions are taken into account when calculating greenhouse gas savings. This includes emissions from cultivation, processing, and transport. Share of 1st generation shall be no more than 7% of the final consumption of energy in transport in the Member States in 2020 (2015/1513/EC). Directive 2015/1513 remains to be implemented in Romanian legislation. None of the targets have been met. National action plan for production and use of biofuels in transport for the period 2011 – 2020 defines target productions for each year, but these have not been met. (Romanian Energy Strategy, 2016) →	
Technology development:	Clariant - a world leader in the chemical industry - announced the investment in a new full-scale commercial cellulosic ethanol plant based on sunliquid technology. (Clariant, 2017) ↑	
Main feedstock types used:	Production capacity of 96,000 tones based on corn as raw material. The rest from straw. Total production of bioethanol is estimated at 176,000 tones/year. (Capatana, 2016; Bio Fuel, 2009) →	Rapeseed →
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase ↑	Increase ↑

Slovakia

Table 23: SLOVAKIA - Main factors influencing the development of biomass for heat and derived heat

SLOVAKIA	Residential	Industry	Services	Derived Heat
Effect of oil/gas price development	N/A	N/A	N/A	N/A
Legislation (EU/national): support schemes	Rural development programme of the SLOVAK REPUBLIC, the Ministry of agriculture and rural development 2014 – 2020 SR, January 2016 (investment on building facilities for the energy use of forest biomass for the production of electricity and heat) (MPSR, 2016) ↑/→	N/A	N/A	The European Commission proposal introduces a "one-stop-shop" (single point of contact) for the processes of issuing permits for renewable energy projects and the simplified notification for distributors for demonstration projects and devices with the power of up to 50 kW. It also allows consumers to enjoy actually produced energy from RES without restrictions and communities to participate in the market. But a fundamental disagreement with the obligation to implement SR MH has expressed a "one-stop-shop" for RES projects and is not inclined to favour the self-consumers of renewable energy. (European Commission, 2018) →
Legislation (EU/national): emission caps and CO2 certificate trading systems	In the light of developments in the years 2020-2030, it is necessary to improve policy concerning biomass, in order to maximize the benefits in mitigating the impacts of climate change, increasing the efficiency of the use of resources in the field of bio-economy, reduction of production of greenhouse gas emissions and their negative environmental impacts (Personal comment ICARST). ↑/→			

Legislation (EU/national): approval procedures & similar administrative conditions	The promotion of renewable energy is an essential part of EU energy policy, as recognised in Article 194 TFEU, and largely contributes to the implementation of the Energy Union Framework strategy. The new regulatory framework for after 2020 proposed by the Commission as part of the 'Clean Energy for All Europeans' package in November 2016 builds upon the experience accumulated under the existing Renewable Energy Directive (European Commission, 2017a). ↑/→	N/A	N/A	First ideas for a new governance system based on national plans for competitive, secure, and sustainable energy. These plans will follow a common EU approach. They will ensure stronger investor certainty, greater transparency, enhanced policy coherence and improved coordination across the EU. (Euractiv, 2013). ↑
Legislation (EU/national): sustainability targets	State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU, Brussels, 28.7.2014, (COM, 2014) →	The Ministry of environment of the Slovak Republic, the criteria for the sustainable use of biomass in the regions of Slovakia for the period 2014-2020 co-financed from focusing on wood biomass, September 2016 Tract No. 271/2011 Coll. Ministry of Environment SR, laying down the criteria for sustainability, and targets for the reduction of greenhouse gas emissions from the fuels Ordinance. 295/2011 Coll., which implements section §9 art. 2 of the law No. 309/2009 Coll. on the promotion of renewable energy sources and	Regarding the timber harvested, according to the valid SR regulations, only wood whose technical parameters no longer allow for industrial or other processing with higher added value (quality assortment class VI produced by the production and handling of wood) can be used for the production of fuels and energy generation as waste). Wood burning is considered to be the least socially desirable use of wood harvested.	The international market for biomass can be inhibited by national criteria for sustainability, a possible solution to avoid this could be the introduction of technical standards at the EU level (COM, 2014) →

		highly efficient production and on amendments to certain laws, as amended (SWD, 2014) →	(COM, 2014) ↓/→	
Technology development	N/A	N/A	N/A	N/A
Main feedstock types used:	Solid biomass continues to remain by far the largest contributor to renewable heat production. (COM, 2014) →	Due to natural conditions and structure of land use, woody biomass from forestry, non-forest land and wood wastes are the main source for solid biofuels in Slovakia. Agricultural biomass is utilised as well. The share of woody biomass of total annual consumption of biomass for energy production is 88%, while agriculture provides 12% of the biomass for energy use (Oravec and Slamka, 2013). ↑/→	N/A	Plant biomass (like willow, poplar, silvergrass) - however, there is a lack of science-based information on the potential production of biomass in different soil-ecological and climatic conditions of the Slovak Republic. (Oravec and Slamka, 2013) ↑/→
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase ↑	Decrease ↓	Decrease ↓	Increase ↑

Table 24: SLOVAKIA - Main factors influencing the development of biomass for Bioelectricity

SLOVAKIA	Consumption from CHP plants	Electricity only plants
Effect of oil/gas price development	N/A	N/A
Legislation (EU/national): support schemes	Energy markets alone cannot deliver the desired level of renewables in the EU, meaning that national support schemes may be needed to overcome this market failure and spur increased investment in renewable energy. If these public interventions are not carefully designed however, they can distort the functioning of the energy market and lead to higher costs for European households and businesses. (European Commission, 2018) →/↓	The national action plan for energy resources from renewable resources MH SR, 6.10.2010 Act No. 309/2009 on Support of Renewable Energy Sources and High Efficiency CHP (Energy Sector, Distribution/Storage, Energy Sector, CHP, Energy Sector, Electricity Generation, Energy Sector, Electricity Generation, Renewable, Energy Sector, Electricity Generation, Renewable, Bioenergy) Ministry of Finance of the Slovak Republic. (Ministry of Economy and Construction of the Slovak Republic, 2010) →/↑
Legislation (EU/national): emission caps and CO2 certificate trading systems	The energy-efficient low-carbon EU economy (known as the 20-20-20) sets fundamental objectives in reducing greenhouse gas emissions (20%), increasing the share of renewable energy sources (20%) and saving primary energy consumption (20%). The objectives are incorporated in the National Renewable Energy Action Plans (NREAPs). (Ministry of Economy and Construction of the Slovak Republic, 2010) ↑	Tract No. 270/2014 Coll., amending Decree No. 410/2012 Coll., implementing certain provisions of the Clean Air Act (the definition of medium-sized and large combustion plants as sources of air pollution within the meaning of the Decree NO No. 410/2012 Coll., implementing certain provisions of the Clean Air Act, as amended). (Ministry of Environment of the Slovak Republic, 2012). →/↓

Legislation (EU/national): approval procedures & similar administrative conditions	Brussels has proposed to extend the use of compulsory schemes, energy efficiency or alternative policy measures beyond 2020, however this has taken in the aspect of energy poverty. The objective of the mandatory schemes should be set at 10 years (2021-2030) and, consequently, should be regularly renewed. Any alternative measures should, however, be exercised only on the part of end users. According to the existing directive on energy efficiency, a variation of energy saving targets, combining the capabilities of mandatory systems and policies, should be introduced by 2020. (EU Directive, 2012) →/↑	N/A
Legislation (EU/national): sustainability targets	Directive of the European Parliament and of the Council (EU) 2015/2193 of 25. November 2015 on the limitation of emissions of certain pollutants into the air from large combustion plants. (European Parliament, 2015) In 2015 the Ministry of Economy of the Slovak Republic established an expert working group (including NGOs and independent experts) and postponed all calls for biomass projects until the sustainability criteria are defined. This process is one of the biggest Slovakian successes for the sustainable use of EU funds. Slovakia, in this case, went beyond existing legal requirements as the European Union itself did not create any binding conditions to ensure the sustainability of energy generation from solid biomass. (Ministry of Environment of the Slovak Republic, 2016). The aim of the Slovak Energy Policy (EP SR) is to contribute to the sustainable growth of the national economy by securing long-term sustainable energy. The priority is the reliability and stability of energy supplies, its efficient use at optimal cost and the protection of the environment. The SR belongs to the category of vulnerable countries in terms of energy security. Therefore, it supports the promotion of energy self-sufficiency through an optimal energy mix with low-carbon technologies and increased energy efficiency. The main target for sustainability are: - creation or improving the conditions for the rapid development of the complex wood processing technology in forestry - growth of wood production in forest land and unused forest land - increasing the supply of wood biomass (http://www.mhsr.sk) →	
Technology development:	The conversion of biomass-to-energy technologies varies greatly in its effectiveness. The efficiency of combustion of clean biomass to generate electricity only is about 30-35%, but the burning of the same material for the production of heat is usually more than 85% more efficient. Discussions focused on the vast growth opportunities arising from the clean energy transition	N/A

	and on ways to improve the industrial underpinning for renewables in the EU. There was wide consensus that, with an advanced, ambitious and stable regulatory framework for the period from 2020-2030 under development, a strong European industrial base in the renewables sector is essential if the EU wants to fully support the clean energy transition and be at the vanguard of these technologies in the world. (JRC, 2015) →/↑	
Main feedstock types used:	There is a wide variety of biomass resources, including tree and grass crops and forestry, agricultural, and urban wastes. (Panoutsou et al., 2013) ↑	N/A
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase ↑	Decrease ↓

Table 25: SLOVAKIA - Main factors influencing the development of biomass for biofuels

SLOVAKIA	**Bioethanol**	**Biodiesel**
Effect of oil / gas price development:	The effect of oil/gas price development on the development of biomass for biofuels like bioethanol and biodiesel is strong. (McKie, 2015) →/↓	
Legislation (EU/national): support schemes	Directive 2009/28/EC on energy from renewable sources by a Member State does not impose the obligation to develop sustainability criteria for energy utilisation of biomass, other than biofuels and bioliquids. In the future however, the directive assumes their	The European Parliament Committee for environment and health voted on the proposal to terminate the mandatory addition of the current generation of biofuels into the fuel gradually over the next decade. While biofuels produced from canola, corn or sugar beet are to end in the year 2030, fuel made from Palm

	application. Therefore, the European Commission (EC) Member States shall submit recommendations on the development of the criteria. (European Commission, 2017a) →	oil has to be disabled in the year 2021. (European Commission, 2017a) ↓
Legislation (EU/national): emission caps and CO2 certificate trading systems	EU Directive 2015/652 has the aim of establishing a methodology for calculating the greenhouse gas savings during the life cycle of the fuel and the requirements for the submission of annual reports on these savings to be achieved. (EU Council Directive, 2015) →	Electricity, transport and heating and cooling sectors are all targeted with a number of concrete measures, while it is proposed to use 2020 national targets as baseline for Member States' further progress after 2020. In relation to bioenergy, the Commission has proposed to strengthen the EU sustainability framework for bioenergy by extending it to also cover biomass and biogas used for heat and power in large energy installations. (European Commission, 2018) ↓
Legislation (EU/national): approval procedures & similar administrative conditions	On administrative barriers, Member States have made progress on removing them, but this progress has not been uniform across the Union and there is still ample room for improvement, especially for automatically granting the permit after the administrative procedure's deadline and for establishing one-stop shops. (Panoutsou et al., 2013) →	N/A
Legislation (EU/national): sustainability targets	On biofuel sustainability, the majority of biofuels consumed in the EU are produced within the Union from domestic feedstock. No significant direct adverse effects on biodiversity, soil and water, food security nor on developing countries have been identified. However, risks of indirect land use change impacts remain of concern (European Comission, 2017a) →/↑	N/A
Technology development:	Next-generation biofuels, such as cellulosic bioethanol, biomethane from waste, synthetic biofuels obtained via gasification of biomass, biohydrogen, and others, are currently at the centre of the attention of technologists and policy makers in search of the more sustainable biofuel of tomorrow. To set realistic targets for future biofuel options, it is important to assess their sustainability according to technical, economical, and environmental measures. (Zinoviev et al., 2010)	N/A

	↑	
Main feedstock types used:	The first generation bioethanol - corn The second generation bioethanol - agro-waste (wheat straw) and fast-growing grass. (Jureková et al., 2015) →/↑	Oilseeds (rape, sunflower) and waste oils (Jureková et al., 2015) →/↑
Overall assessment for the BAU Scenario (Increase, decrease, stagnation	Increase ↑	Stagnation →

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