NATIONAL ENERGY AND CLIMATE PLANS IN THE DANUBE REGION

REKK

2020 December

National Energy and Climate Plans in the Danube Region

- Final Report-

MINISTRY OF
FOREIGN AFFAIRS AND TRADE
OF HUNGARY

The study was prepared for the Ministry of Foreign Affairs and Trade, Hungary

Produced by: REKK, Hungary

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10.12.2020.

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ABBREVIATIONS

AC	Alternating Current
ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserve
BAT	Best available technology
BAU	Business-as-usual
bcm	billion cubic meter
CCGT	Closed cycle gas turbine
CEE	Central Eastern Europe
CEF	Connecting Europe Facility
CESEC	Central and South Eastern Europe energy connectivity
CFD	Contract for Differences
CHP	Combined Heat and Power
CNG	Compressed natural gas
CWE	Central Western Europe
DR	Danube Region
DSO	Distribution System Operator
EE	Energy efficiency
EEAG	Guidelines on State aid for environmental protection and energy
EED	Energy Efficiency Directive (Directive 2012/27/EU)
EEOS	Energy Efficiency Obligation Scheme
EnC	Energy Community
EPBD	Energy Performance of Buildings Directive (Directive 2010/31/EU)
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ESCO	Energy Service Company
ESD	Effort Sharing Directive (EU) No 525/2013
ESR	Effort Sharing Regulation (EU) 2018/842
ETS	EU Emission Trading Scheme
EU	European Union
EUA	European Union Allowance
EV	Electric Vehicle

FEC	Final energy consumption
F-gas	Fluorinated greenhouse gases
FRL	Forestry Reference Level
GHG	Greenhouse gas
GO	Guarantee of Origin
HVAC	Heating, Ventilation and Air Conditioning
ICE	Internal combustion engine
INDC	Intended Nationally Determined Contribution
LIP	Local implementation project
LNG	Liquified Natural Gas
LULUCF	Land use, land-use change, and forestry
mFRR	Manual Frequency Restoration Reserve
aFRR	Automatic Frequency Restoration Reserve
MMR	Monitoring Mechanism Regulation (525/2013/EU)
Mtoe	Million tons of oil equivalent
NDC	Nationally Determined Contributions
NECP	National Energy and Climate Plan
NEEAP	National energy efficiency action plans
NIR	National Inventory Report
NRA	National Regulatory Agency
NREAP	National renewable energy action plans
NZEB	Nearly zero-energy buildings
OCGT	Open cycle gas turbine
PCI	Project of Common Interest
PEC	Primary energy consumption
PECI	Project of Energy Community Interest
PM	Particulate Matter
PPA	Power Purchase Agreement
PV	Photovoltaic
PX	Power Exchange
RED II	2018 Renewable Directive
RES	Renewable energy source
RES-E	Electricity based on renewable sources

RES-H&C	Energy in the heating & cooling sector based on renewable sources
RES-T	Renewable fuels in the transport sector
SDAC	Single Day-Ahead coupling
SIDC	Single Intraday Coupling
TAP	Trans Adriatic Pipeline
TSO	Transmission System Operator
TPES	Total Primary Energy Supply
TYNDPs	Ten-Year Network Development Plans
UNFCCC	United Nations Framework Convention on Climate Change
WAM	With Additional Measures
WB6	West Balkan Six Countries (Serbia, Bosnia and Herzegovina, Macedonia, Albania, Montenegro, and Kosovo)
WEM	With Existing Measures

Country codes

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

EXECUTIVE SUMMARY

The purpose of the current study is to evaluate the targets, measures and expected outcomes laid down in the National Energy and Climate Plans (NECPs) of EU member states belonging to the Danube Region (DR) (Austria, Bulgaria, Czech Republic, Croatia, Germany, Hungary, Romania, Slovakia, and Slovenia) and energy strategies of the non-EU Danube Region countries where NECPs are in progress (Bosnia and Herzegovina, Moldova, Montenegro, Serbia, and Ukraine). The analysis focuses on the planned development of sustainable energy systems receiving special attention in NECPs: decarbonisation, deployment of renewable electricity, renewable heating and cooling, transport, the energy efficiency in buildings, the decarbonisation of the industry sector, energy security and the functioning of electricity and natural gas markets, as well as hydrogen deployment and market coupling.[1]

The analysis of the different policy areas includes the a) overview of the targets set in the different countries, 2) the policy instruments aimed at reaching the targets, 3) and the evaluation of the projected impacts of these measures on the most important output variables under the 'with existing measures' (WEM) and 'with additional measures' (WAM) scenarios.

Decarbonisation

Installations falling under the EU ETS in the EU countries will accomplish the common mitigation goal jointly with a gradually decreasing EU-wide emission cap. As regards the sectors outside of the ETS mechanism, all member states have binding reduction targets set in the Effort Sharing Regulation. The climate policy of the non-EU Danube Region countries shows a different picture. Albeit all are signatories to the Paris Agreement having submitted INDCs to the UNFCCC, progress in formulating sector-related targets and measures vary substantially. Montenegro has the most advanced climate policy, introducing a cap-and-trade system with a carbon floor price for large emitters in February 2020. Ukraine, being an Annex I country to the Kyoto Protocol, submits national emission inventories to the UNFCCC. However, the harmonisation with the relevant EU legislation and the establishment of the required institutional background is still under process in these countries.

Only three Danube Region countries - Austria, Germany, and Slovenia - decided to phase out fossil fuel subsidies. Germany, Croatia, and Slovenia apply a carbon price to small installations or fuels in the non-ETS sectors. The GHG reduction targets set by the DR countries belonging to the EU mostly correspond to their obligations under the Effort Sharing Regulation, except for Slovakia and Slovenia aiming to achieve 20% decrease in their non-ETS emissions.

If the additional measures planned by DR countries will deliver the expected results, the estimated total GHG emission savings by 2030 will amount to 1410 Mt CO_2eq compared to 1990 (increasing to 1431 Mt CO2eq if the conditional national contribution of Bosnia and

[1] Policy areas that are not closely related to the energy sector, such as the agriculture, waste sectors, F-gases are beyond the scope of this study. The closely related and important policy area of energy poverty will be the subject of other, dedicated studies.

Herzegovina and Moldova will be realized). 18% of this reduction will be achieved in the period after 2015.

Renewable electricity

Among EU DR countries, Austria, Germany, and Croatia have high ambitions of increasing their RES-E shares supported by well elaborated action plans. Slovakia, Czechia, Bulgaria, and Romania have relatively low ambitions, while Slovenia and Hungary rank in the middle. As regards non-EU DR countries, only Moldova has a 15% renewable electricity target in its energy strategy.

The deployment of renewable electricity technologies is mainly promoted through operating and investment support, but financial policies (e.g., exemptions from taxes and levies, preferential loans, etc.) and administrative policies are also in place (e. g. frameworks for self-consumption to enhance small scale investments). Tenders for ensuring a cost-competitive level of operating support are already being held in Germany, Croatia, Hungary, and Slovenia, and are planned in four other countries. Amending legislation to make RES financially sustainable through competitive bidding and in line with State Aid Guidelines 2014-2020 is also a key issue for the countries of the Energy Community. Montenegro has already held locational auctions for solar PV and onshore wind. Only two countries have plans to create favourable legal environment for private power purchase agreements (PPA) for renewable electricity, and two EU DR countries (AT and DE) have legislation in place related to energy communities. NECPs put little emphasis on information campaigns and awareness raising activities in relation of renewable electricity, which is contrary to the purpose of putting consumers at the heart of energy transition.

While the current capacity mix of the Danube Region is dominated by hydro power plants (excluding pumped storage), growth in installed capacities by 2030 will mainly be driven by solar PV and onshore wind energy. Decreasing technology costs, good natural potentials and low environmental concerns make solar PV the most attractive RES-E technology over the next decade. Installed capacities will grow by 79 GW in EU DR countries and at least by 490 MW in the non-EU DR countries. Onshore wind will also attract significant investment, with 40 GW of new installed capacities in EU DR countries and at least 877 GW in the non-EU countries.

Due to the expected growth in the intermittent electricity production of wind and solar, the question of renewable integration is stressed in almost all NECPs and strategic documents, and non-EU DR countries also emphasize the need for analysing grid constraints and investments in storage and balancing. Research in advanced technologies to enabling RES integration ranks highly among the research priorities listed in the NECPs.

Renewable heating and cooling

EU regulation does not contain specific mandatory targets for the share of renewable heat consumption, but most EU member states set voluntary targets. RED II sets out a number of requirements for the share of renewable use in the sector, including 1.3% annual growth from 2021; setting a minimum level of RES for new buildings; and 1 percentage point increase in the renewable and waste heat share in district heating.

The heating and cooling sector plays a very important role in reaching the overarching RES targets of EU DR countries, Renewable heat represents more than 20% of heat demand with the exception of Germany and Slovakia, and 5 countries have shares around 40% or higher. Biomass use of the residential heating sector is responsible for most of this renewable use, burning wood (often mixed with coal or trash) in outdated, heavily polluting stoves. There are no plans in any of the countries to replace these inefficient biomass-fired installations, only the change of fossil-based heating systems will be mandated or supported (for example in Austria, Germany, Romania, Slovenia, and Bulgaria).

All countries aim to mitigate fossil fuel reliance, mainly using biomass. Solar heat and heat pumps are also encouraged in case of individual heating, and the use of waste heat and geothermal resources is promoted in the district heating sector, mainly through investment support. Upgrading and expanding district heating networks is planned in all EU DR countries, in Germany targeting modern low-temperature heat networks. Awareness raising programmes related to heating and cooling are rarely mentioned in the strategic documents, only Austria, Bulgaria, Slovakia, and Moldova mention them among the policy instruments.

Unfortunately, the 2030 WEM and WAM projections are not available for the non-EU DR countries and are also missing from the NECPs of some EU DR countries, Therefore, it is not possible to present the expected change in the share of renewable heating and cooling in the region. However, based on the available data, some countries have very ambitious goals compared to the present status, aiming to increase their renewable shares in heating by around 10 percentage points (except for Croatia, already having a high share).

Biomass resources

EU Member States in the Danube Region report strong plans for biomass use in their NECPs. Biomass-to-heat and biomass-based electricity together are expecting a 35% increase in the next decade, and the 5 non-EU DR countries also have targets and measures to increase their biomass energy use. This kind of growth does carry the risk of losing forest carbon stocks to the atmosphere. It can be inferred from plans related to the LULUCF sectors that the EU countries of the Danube Region expect their LULUCF carbon sinks to decline by about 70% between 2018 and 2030, implying a massive loss of forest biomass in most cases.

Climate policy makers need to be aware of the risks imbedded in these plans. It is one-sided climate policy to financially support the burning of the ubiquitous and affordable forestry biomass, to award its burning with zero accounted carbon emissions and to ignore the climate economic value of forest sequestration and storage of carbon. Another decade of such a large-scale increase in biomass could have serious consequences, but with timely action this policy failure can still be avoided. Policy instruments should be redesigned to avoid loss of natural sequestration potential caused by forest management favouring production of biomass for energy markets rather than absorbing carbon.

Transport

Danube Region countries are committed to the RES-T target required by regulation, which is 14% by 2030. Almost all EU countries encourage electric vehicle penetration through the development of charging networks and purchase subsidies but support for railway development is also considerable. However, non-motorized transport such as bicycle and

footpath infrastructure are hardly mentioned in the NECPs. Furthermore, there is little detail regarding sustainable transport development, only strategic goals are highlighted without presenting detailed measures. While national e-mobility plans exist, road development continues to be a common objective. Consumer awareness campaigns are planned only in a few countries.

The strategic documents of the non-EU countries are less detailed regarding sustainable transport development: mainly strategic goals rather than elaborated measures appear in most of them. Most targets and specific measures aim to improve energy efficiency of transportation by replacing old petrol/diesel cars with new vehicles, but road development is also a common objective. This is in a sharp contrast to measures in EU countries where electromobility is much more in focus.

Despite the current trend of steadily increasing GHG emissions stemming from rising demand for transportation, all countries project emission reductions by 2030 compared to 2018 in their WAM scenarios, ranging between -7% (BG) and -35% (AT). At the same time, energy consumption is also expected to decrease, except for Czechia, Hungary, and Romania (for AT no data is available) suggesting that these countries are rather optimistic about being able to decouple demand growth and GHG emissions.

Energy efficiency of buildings

The EU considers energy savings the most important source of decarbonisation in the energy sector, applying a mandatory renovation rate for public buildings, the preparation of a long-term renovation strategies, energy standards for new buildings and energy audits for larger companies. Due to the existing EU targets and policies, all EU DR countries already have a range of measures in place, many of which will continue to apply in the 2021-2030 period, often with some modifications and extensions to help achieve 2030 targets. Financial instruments (investment grants, preferential loans, tax incentives) and building standards are in place in all EU DR countries, Nearly-zero energy requirements are under revision in many member states, aiming to make the standards stricter and extending their application to building renovations. Energy efficiency obligation schemes have been introduced in four EU DR countries (AT, BG, HR, HU). Energy savings contracting is also a widely available option.

Training, knowledge sharing and awareness raising programs are mentioned in nearly all NECPs and also in the strategic documents of non-EU DR countries. Almost all countries implemented or plan to introduce detailed billing and disclosure of information on previous consumption levels. Supporting digitalization and innovative methods is planned in less than half of the EU DR countries. Non-EU DR countries place emphasis on awareness raising and information sharing, the upgrading of their district heating systems, and the renovation of public buildings.

Energy savings in buildings will result in reduced energy consumption of the residential and service sectors. Unfortunately, the results of model calculations were not included in all the NECPs, with the WAM scenario data missing for Austria, Bulgaria, and Slovakia. In the other EU DR countries the additional measures are expected to result in 10-15% lower energy consumption in Germany and Czechia, and over 20% energy savings in Hungary and

Slovenia. Romania expects a smaller decrease, (-2%), while Croatia envisages a small increase (about +2%) in the energy use of these two sectors.

Industry

Only three countries (Austria, Bulgaria, and Germany) devote special attention to the industry sector in their NECPs. Germany would like to strengthen its reputation as an industrial powerhouse, through increased energy efficiency based on lower energy inputs and through the development of technologies for certain industrial processes. Austria's aim is to develop successful technologies and solutions that will allow Austrian industry to position itself as an innovation leader on the global technology markets. Bulgaria would like to preserve the competitiveness of its basic energy-intensive industries while limiting the risks of carbon leakage.

The relative underrepresentation of industry in the NECPs is partially due to the binding template of NECPs, not placing much emphasis on the area of industrial decarbonisation. Because decarbonisation of industry is only now emerging as a key long-term EU policy objective and experience is limited, industry-specific strategies are still being developed. It is also possible, that the 2030 agenda of some countries have not yet been clearly designed with the mindset of zero emissions in 2050. For non-EU countries especially, the balance between economic growth and decarbonisation is still sensitive.

Policy measures included in the NECPs target energy efficiency improvements and process innovation. Incentives for energy efficiency improvements include CO2 tax for non-ETS installations, tax allowances, preferential loans, and investment support for energy efficiency investments, as well as the inclusion of industrial energy savings in the energy efficiency obligation schemes. Process innovation is mostly encouraged through innovation support, grants to pilot projects and demonstration programmes, as well as facilitating participation in information platforms and knowledge-sharing.

Less than half of the EU DR countries have presented estimates for the final energy consumption and emissions in the industrial sector in their NECPs, all expecting to reduce their emission intensity. Only Bulgaria and Romania estimate an increase in industrial emissions compared to 2015. For non-EU countries data from Serbia and Moldova are available, both planning to increase the final energy consumption of the sector until 2030. The level of industrial decarbonisation efforts appears highly dependent on the perspectives of accession into the EU for Bosnia and Herzegovina and Moldova.

There is still a debate over the appropriate level of regulation for the industrial sector. Some instruments (such as the potential extension of EU ETS system for new activities and new geographical areas) require EU level agreement while others can be implemented nationally. It is important to clarify the role of direct support mechanisms, financial initiatives, and regulatory measures to minimize market distortion. Industrial decarbonisation must not hamper the development of economic relations between the EU and non-EU countries and it must be ensured that stricter EU rules do not export industrial production to countries that have weaker climate regulation.

Natural gas

The share of gas in the total primary energy supply of the Danube Region is 23%, very similar to the average of the EU28, while the contribution of solid fossil fuels is much higher (26% compared to 14% in the EU28). The average import dependency in the gas sector is 73%, being close to 100% in half of the DR countries. On average, households use most of the natural gas (41%) followed by the electricity and heat sectors (26%) and industry (24%). The future role of natural gas in the Danube Region highly depends on the national decarbonisation plans for these sectors.

As regards power and heat generation, there is a general tendency to install new CHPs in the DR countries, however in most of the cases this is done to replace existing solid fossil fuel units with more efficient gas or renewable energy. Three groups are distinguishable among DR countries in this regard: most plan or even incentivise switching to gas based CHPs to exit less efficient solid or liquid fossil-based units; several plan to replace part of the retiring CHPs with RES based units; while Austria and Hungary are one step ahead, planning measures to switch from fossil based to renewables in the district heating sector without temporarily incentivising natural gas.

Industrial gas consumption is less impacted by measures and volume shifts to date, as the full decarbonisation plans need further technological development. The contribution of natural gas in the next decades will depend on the pace of industrial process innovation, the availability of low-cost zero carbon electricity and hydrogen, as well as the price evolution of carbon capture, storage, and use.

Measures related to household natural gas consumption reflect that replacing old, fossil-based furnaces by new and efficient gas is allowed in almost all countries, only Austria will ban new gas connections (with some exemptions). In general, gas heating in households will remain in a substantial role in the long term, despite general support for RES installations Based on the national strategic documents, measures providing the household segment with a competing decarbonised alternative to gas heating are not available. On the other hand, significant gas volumes are planned to be saved via renovations in the building sector.

There is a clear trend in the countries that still have gas production or proved reserves to make use of the domestic resources by accelerating their development. On a regional level, gas production is expected to grow by 7 bcm/year, mostly in Ukraine.

Based on the country-level documents, total gas consumption of the Danube Region is expected to drop by 3% in the period of 2020-2030 (~6 bcm/yr). The total DR investment is estimated to be EUR 14.7 billion, the outline roughly EUR 15 Bn investment in gas infrastructure despite the marginal change in demand forecasts, 97% of which is in EU countries. There is a contradiction in some of the NECPs between plans to reduce gas consumption (AT, CZ, DE, HU, HR) to 2030 while still investing EUR 9.5 billion into gas infrastructure. Most of this investment and capacity is linked to the Russian diversification strategy.

Electricity

There are great visions for the future generation mix and priority projects in the Danube Region, but NECPs and energy strategies fall short of describing the route to the envisioned

fleet of power plants. Coal fired power generation is expected to undergo significant contraction in all EU member countries but remain an indispensable element of European power systems in 2030. Several NECPs are referring to gas as a transitional fuel, but there is no evidence of the "coal to gas" switch. According to the power mix visioned for 2030, coal-based power generation is replaced mainly by renewable and nuclear power. A large group of CEE countries (Czech Republic, Slovak Republic, Hungary, Romania, and Bulgaria) support nuclear power extensions and expansions.

Non-EU counties that are not yet exposed to carbon prices are planning to preserve their coal and lignite fired capacities which provide energy security. However, in the last few years dramatic changes unfolded in the region and intermittent renewable capacities expanded rapidly owing to their cost advantage, pushing them to revise their official energy strategies and embrace green transition.

NECPs provide a detailed description of major upgrades and capacity additions for the transmission network and planned interconnectors in priority corridors. Despite long lists of proposals for cross-border projects there are few indications of the level of investments required. Distribution networks are less elaborated, but about half of the Danube Region countries have specific targets and measures in association with battery storages, energy communities, demand side response, aggregators, smart meters, and smart grids. Most plans are very broad with only some containing identifiable measures. Non-EU countries are still concentrating on the reduction of technical and commercial network losses and increasing supply quality through the reconstruction and modernization of obsolete network equipment and the construction of missing elements.

CEE countries provide detailed descriptions of ongoing and planned market coupling projects aiming to integrate day-ahead, intraday, and balancing markets into the European market. These projects are of particular importance for 4MMC countries (CZ, SK, HO, RO), Bulgaria and Serbia, suffering from limited liquidity and high electricity prices. Non-EU countries are lagging behind in terms of market maturity without a proper institutional foundation to enter into market coupling projects. These countries are concentrating on liberalizing and opening their market to competition, setting up market infrastructure (organizing power exchanges, operating day-ahead and intraday markets), and adopting EU energy regulation into law (unbundling, price deregulation).

Sector coupling

Overall, sector coupling policies are widely discussed in the NECPs of EU DR countries. For some, policies are more mature and already implemented (Germany, Austria and to some extent Czechia). Others acknowledge the importance of sector coupling but measures and policies linked to these goals remain vague and underdeveloped.

Policies related to the electrification of transport and buildings are mature in the DR, through direct financial subsidies for e-mobility, the development of charging infrastructure and e-mobility support, and electrification of heating by heat pump installations.

Hydrogen offers another option for sector coupling, but due to high losses of transformation, electrification is usually the preferred alternative. Measures related to hydrogen and synthetic gases are mentioned in the German and Austrian NECPs, but otherwise it is mostly part of the transport sector only at the agenda setting level.

INTRODUCTION

National Energy and Climate Plans (NECPs) governed by the Regulation on the Governance of the Energy Union and Climate Action (2018/1999/EU) serve as the most important planning tools for the wider decarbonisation of the EU economy. The plans must holistically consider energy use and related greenhouse gas emissions in all sectors, requiring coordinated policy formulation across all energy-related policy areas. The plans cover the period of 2021-2030 with long-term objectives of the member states matching the decarbonisation ambition of the EU. They must follow the same basic template so that they can be more easily evaluated in aggregate to ensure that the contributions of member states will jointly deliver the results required to meet the EU level climate and energy policy targets.

The purpose of the current study is to evaluate the targets, measures and expected outcomes laid down in the National Energy and Climate Plans of the Danube Region. EU member states (Austria, Bulgaria, Czechia, Croatia, Germany, Hungary, Romania, Slovakia, and Slovenia) had to submit their NECPs by the end of 2019. As Energy Community members, the non-EU countries, (Bosnia and Herzegovina, Moldova, Montenegro, Serbia, and Ukraine) are also required to draft NECPs but since they are currently under preparation this study relies on their available energy strategy documents.

FIGURE 1: DANUBE REGION COUNTRIES

Source: http://www.interreg-danube.eu/about-dtp/participating-countries

NECPs share a common template integrating the 5 pillars of the Energy Union Strategy: (1) decarbonisation, (2) energy efficiency, (3) energy security, (4) integrated energy markets, and (5) research, development, and competitiveness. The NECPs are structured in a way that the five dimensions are addressed across all main sections of the document, to ensure that they are considered during policy formulation. They map out objectives and targets, the

relevant measures designed to achieve them, and the expected outcomes in areas such as renewable energy, transport, industry, natural gas, electricity, transport, etc.

This analysis is structured around the policy areas which are closely linked with the development of sustainable energy systems and receive special attention in the NECPs: measures targeting decarbonisation, the deployment of renewable electricity (RES-E), renewable heating and cooling (RES-H) and transport (RES-T), the energy efficiency in buildings, and heavy industry. It also covers questions related to energy security and the functioning of electricity and natural gas markets, grid flexibility and the role of power to gas in the coupled sectors of the future. Policy areas that are not closely related to the energy sector, including agriculture, waste and F-gases are beyond the scope of this study. The closely related issue of energy poverty will be the subject of a separate study.

The analysis of the specific policy fields cover

- the overview of the targets set in by the different countries
- evaluation of the policy tools and measures aimed at reaching the targets
- projected impact of these measures considering the 'with existing measures' (WEM) and 'with additional measures' (WAM) scenarios.

The evaluation relies on a slightly modified version of the policy cycle approach[2], a theoretical framework that describes the typical steps in the policymaking process. The approach identifies 5 basic stages:

1. Agenda-setting: identifying problems that need policy intervention
2. Policy formulation: setting goals and identifying the steps to achieve them with stakeholder input
3. Decision-making: Elected leadership specifying the details of policy instruments
4. Implementation: tasks executed by the responsible organisation overseeing them
5. Policy evaluation: the process of improving and refining the policy instruments

Figure 2 shows the simplified policy stages with colour coding.

FIGURE 2: APPLIED POLICY EVALUATION FRAMEWORK

not in target/no information	proposed but no targets or measures
policy formulation / decision making	implementation

Often, it was difficult to decide whether a measure was not planned or used, or it was simply omitted from the NECP. To denote this, we used the white-coloured category. Many of the NECPs contained ideas about the possible measures that could be applied in different policy areas, but no further details on the subject, status, timing, or available budget were provided, this category is marked with yellow colour. The policy formulation and decision-making stages were difficult to distinguish based on the contents of the NECPs, therefore we merged these stages into the light green category, while the dark green colour marks

[2] M. Ramesh and Michael P. Howlett (1995): Studying Public Policy: Policy Cycles & Policy Subsystems

those measures which have been put in place and are under implementation. This category basically corresponds to the existing measures, while additional measures fall into the light green or the yellow categories. We have not considered the policy evaluation stage in our framework.

Unfortunately, the availability of up-to-date information on the targets, measures, and expected impacts of the applied policies in case of the non-EU countries was limited, therefore the analysis of their climate and energy policies is less comprehensive.

The paper is composed of 4 chapters. The first presents the climate policy objectives of the European Union and the most important pieces of regulation guiding the actions of member states. It provides an update on 2020 targets and gives a summary of the most common factors that hinder target achievement. The second chapter explains the role and common structure of National Energy and Climate plans, and third chapter includes the detailed analysis of the most important energy policy areas. The last chapter discusses the most important areas of cooperation for the Danube Region countries and provides recommendations for further regional cooperation.

1. CLIMATE POLICY GOALS AND INTERIM EVALUATION

1.1. CLIMATE POLICY GOALS OF THE EUROPEAN UNION

As a party to the Kyoto Protocol, countries of the European Union (EU15 at the time) established a common target to reduce greenhouse gas (GHG) emissions by 8% in the first commitment period (2008-2012) compared to 1990. In 2009 the EU27 set the following legally binding '20-20-20' targets:

- 20% cut in GHG emissions compared to the 1990 level
- 20% reduction in energy consumption relative to the projected 2020 baseline (no more than 1474 Mtoe primary and 1078 Mtoe final energy use)
- 20% share of renewable energy use in gross final energy consumption.

The Energy Union Strategy released in February 2015 (COM/2015/080) laid the foundation for reforming European energy policy, emphasizing the role of regional cooperation, energy security and solidarity, equitable transformation, and market competition. The Clean Energy for all Europeans package revised and updated the EU legislation to serve as a basis for the implementation of the 2030 framework strategy:

- Reducing greenhouse gas emissions by at least 40% compared to 1990
- Decreasing primary/final energy consumption by at least 32.5% compared to the forecasted energy use in 2030 (maximum 1128 Mtoe primary and 846 Mtoe final energy consumption in the EU-27 without the United Kingdom)
- Increasing the share of renewable energy in gross final energy consumption to 32%
- Minimum 15% share of electricity interconnection.

The GHG reduction target was already specified under the EU's Nationally Determined Contribution as a signature party to the Paris Agreement. The 2030 renewable and energy efficiency targets are binding at the EU level and will have to be delivered by the contributions of all member states. The Governance Regulation. forms a part of the 'Clean energy for all Europeans' package.

The main policy tools used for achieving the **emission reduction target** are the EU Emission Trading Scheme (ETS) and the Effort Sharing Mechanism. The EU Emission Trading Scheme (ETS) is a cap-and-trade system obliging large emitting companies in the energy and industrial sectors to purchase allowances (EUA) for each ton of carbon dioxide they emit, either from the market or in national auctions. The ETS covers about 40 percent of total EU emissions[3]. The Effort Sharing Mechanism[4], meanwhile, covers small installations outside of

[3] The EU ETS covers power stations and other combustion plants with thermal capacity ≥20MW, industrial plants including oil refineries, coke conversion, steel, cement, clinker, glass, lime, bricks, ceramics, pulp, paper and board, aluminium, and petrochemicals plants, as well as aviation. The covered greenhouse gases are listed in the ETS directive 2003/87/EC. The consolidated version is available at: https://eur-lex.europa.eu/eli/dir/2003/87.

[4] (EU) 525/2013 - Effort Sharing Directive (ESD) and (EU) 2018/842 - Effort Sharing Regulation (ESR).

the ETS, as well as the transport, agriculture, buildings, and waste sectors. It prescribes a linear trajectory of maximum emissions which member states must comply with annually. Required reductions range between 0% (BG) and 40% (LU and SE). The regulation offers flexibility and trading options to help comply with the targets. Another important piece of legislation is the LULUCF Regulation (EU 2018/841), which is meant to ensure that pursuing decarbonisation goals does not deteriorate the ability of lands and forests to store and sequester carbon and help regulating the climate. To this end, the regulation makes the countries responsible for at least maintaining the level of their sinking ability.

The Energy Efficiency Directive (2012/27/EU) (EED) set binding **energy savings targets** for EU primary and final energy consumption, corresponding to a 20% compared to the business-as-usual (BAU) projections. Accordingly, Member States must set national targets and publish national energy efficiency action plans (NEEAPs) every 3 years. The energy efficiency directive includes several measures to facilitate efficiency improvements in residential and public buildings, companies, transport, supply of heating and cooling, energy transformation, transmission, and distribution. These include among other things: a mandatory renovation rate for public buildings; energy efficiency obligation schemes for energy companies to achieve annual savings in their sales; the establishment of long-term renovation strategies; application of energy efficiency standards and energy labelling; roll out of smart meters; mandatory energy audits for large companies; ensuring access to individual metering and historical consumption data for energy users. The revised Energy Efficiency Directive (2018/2002) increased the 2030 target to 32.5%, corresponding to a maximum 1128 Mtoe primary and 846 Mtoe final consumption. The sister piece of legislation facilitating energy efficiency improvements is the Energy Performance of Buildings Directive 2010/31/EU (EPBD) amended by (EU 2018/844). The directive requires Member states to set long-term renovation strategies that will decarbonise the building stock by 2050. This should be done cost-effectively according to standardized energy performance certificates that are conferred upon real estate transactions. The nearly zero-energy buildings requirement came into effect 1 January 2021. The directive also includes provisions promoting smart solutions and electromobility.

The 2020 and 2030 **targets for renewable deployment** stem from the Renewable Energy Directive ((2009/28/EC) (RED I) updated in 2018 (EU 2018/2001) (RED II). RED I set the 20% 2020 target and RED II 32% in 2030 at the EU level. This does not specify targets for renewable electricity (RES-E) or renewable heat (RES-H), but for transport (RES-T) 10% and 14% respectively, with a 7% hard cap on conventional biomass. RED II allows Member States which do not want to promote conventional biomass any longer, to decrease their RES-T targets to 7%, and reach that proportion through advanced biomass, biomass from wastes, biogas, or renewable electricity.

To facilitate the efficient achievement of Energy Union **objectives in the electricity sector**, the revised Regulation on the internal market for electricity (2019/943/EU) and the Directive (2019/944/EU) on the common rules for the internal market for electricity set rules for non-discriminatory market access, consumer empowerment, distributed generation, system flexibility increasing options enhancing renewable energy integration, and cross-border electricity exchanges. The latter is also supported by the 15% interconnection target under COM(2014)330, expressed as the nominal transmission capacity over installed renewable

generation capacity in 2030. The electricity market regulation proposes pathways for coal phaseouts with the European Commission taking an active advisory role.

In late 2019, the European Commission released its plans for the European Green Deal (COM (2019) 640) increasing EU climate ambitions and providing a roadmap to 2050 climate-neutrality. This begins with a higher mid-term emissions reduction target of 55% and will require raising the other two targets as part of a revision of all relevant EU legislation. It follows that revised NECPs to be prepared by 2024 will need to take this into account.

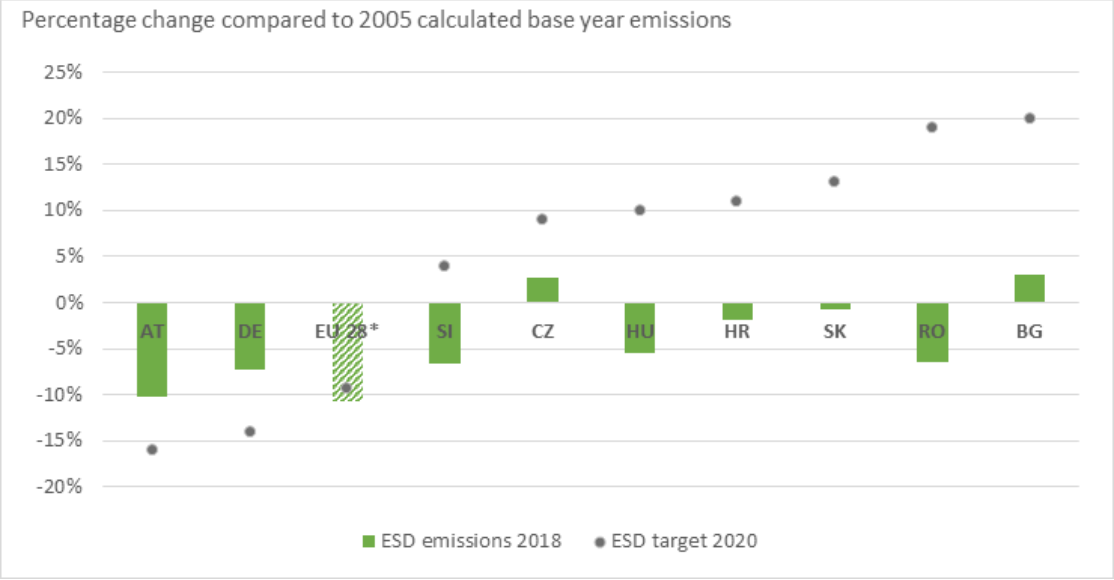
1.2. STATUS OF 2020 TARGET ACHIEVEMENT

The next subchapters present the status of 2020 target achievement, based on the latest available data.

1.2.1. 2020 GHG TARGETS

Data shows that the EU is expected to meet its overall 2020 greenhouse gas emission reduction target of 20% compared with 1990.[5] However, countries perform differently. Figure 3 shows the progress of EU countries towards their ESD targets.

FIGURE 3: PROGRESS OF EU DR COUNTRIES TOWARDS THEIR EFFORT SHARING EMISSION REDUCTION TARGETS



*Source of data: Eurostat. * EU 28 target for 2030*

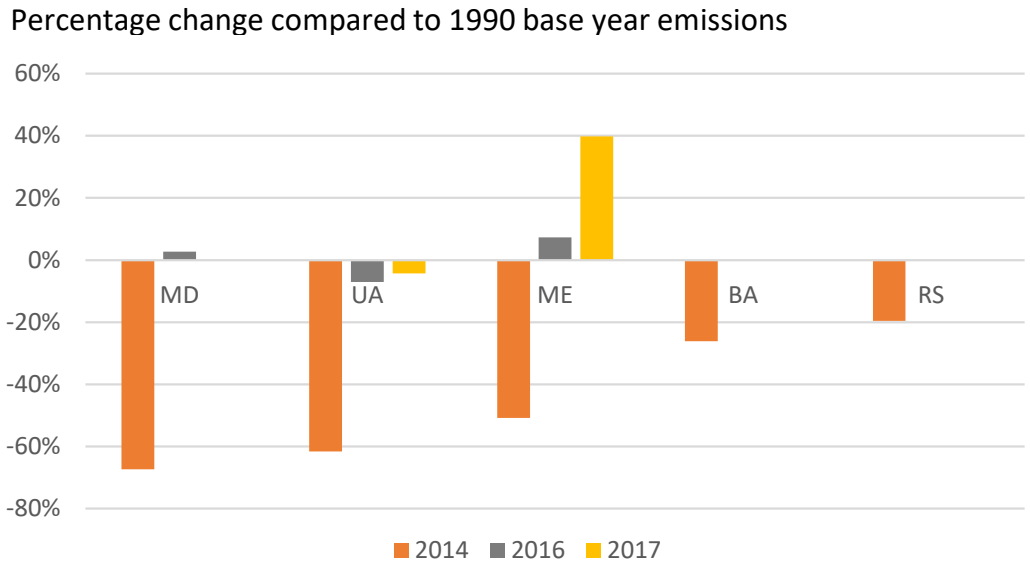
The binding **national Effort Sharing targets** for 2020 were set according to gross domestic product (GDP) per capita, so targets for several Danube Region countries (BG, CZ, HR, HU, RO, SI, SK) even allow for some growth in national Effort Sharing emissions, compared with 2005 levels. Despite this, emission levels decreased in Slovenia, Czechia, Croatia, Romania,

[5] Source: European Environment Agency (2020): Trends and projections in Europe 2020. Download: https://www.eea.europa.eu/publications/trends-and-projections-in-europe-2020

Hungary and Slovakia. Meanwhile, Austria and Germany look to have difficulties with reaching their respective targets.

The non-EU countries report their GHG reductions under the United Nations Framework Convention on Climate Change (UNFCCC). As depicted on Figure 4, these countries achieved significant GHG emission reductions compared to 1990 but as their economies grow, emissions also rise.

FIGURE 4: GHG EMISSION REDUCTIONS OF NON-EU DR COUNTRIES COMPARED TO 1990 LEVELS



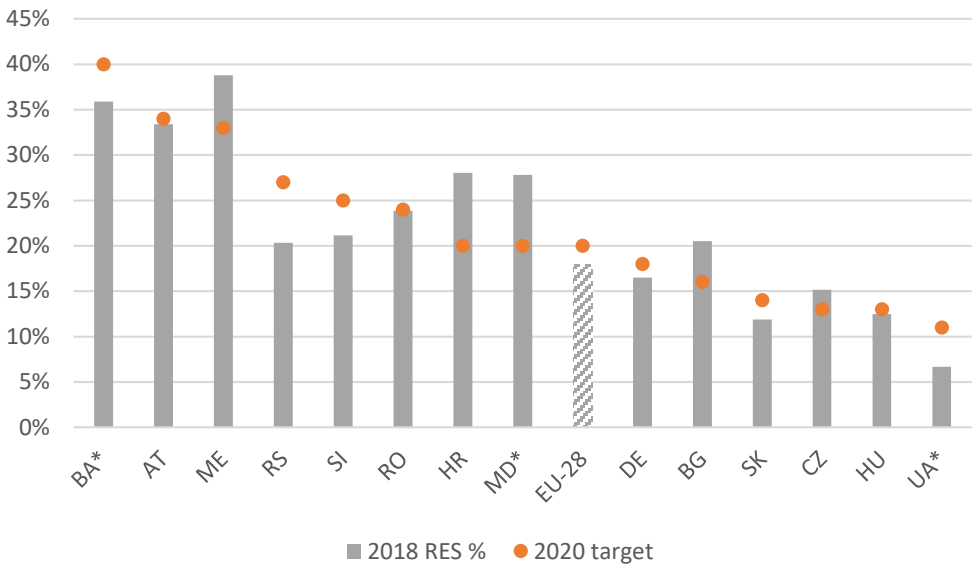
Source of data: UNFCCC National Communications, INDC reports

1.2.2. 2020 RENEWABLE ENERGY TARGETS

Annex 1 part A of Directive 2009/28/EC set mandatory targets for the share of energy from renewable sources in gross final energy consumption for each EU member state. National Renewable Energy Action Plans (NREAPs) elaborate on sectoral 2020 targets for the share of renewables in the electricity, heating and cooling and transport. It is the same for non-EU countries. According to 2018 Eurostat data (Figure 5) overall renewable energy targets already have been reached in five countries of the Danube Region (BG, CZ, HR, ME, and MD). Three appear on track with promising growth in recent years (AT, DE, SK). A downward trend in Romania and Hungary could jeopardise achieving the target. Slovenia, Bosnia and Hercegovina and the Ukraine have the largest gaps of more than 4 percentage points[6]. At the time of this report it was unclear whether Danube Region countries that fail to reach their overall RES share will make use of the **statistical transfers**[7] to help target compliance.

[6] In case of BA, MD and UA the latest data available are for 2017.
[7] Article 6 of Directive 2009/28/EC (RED I)

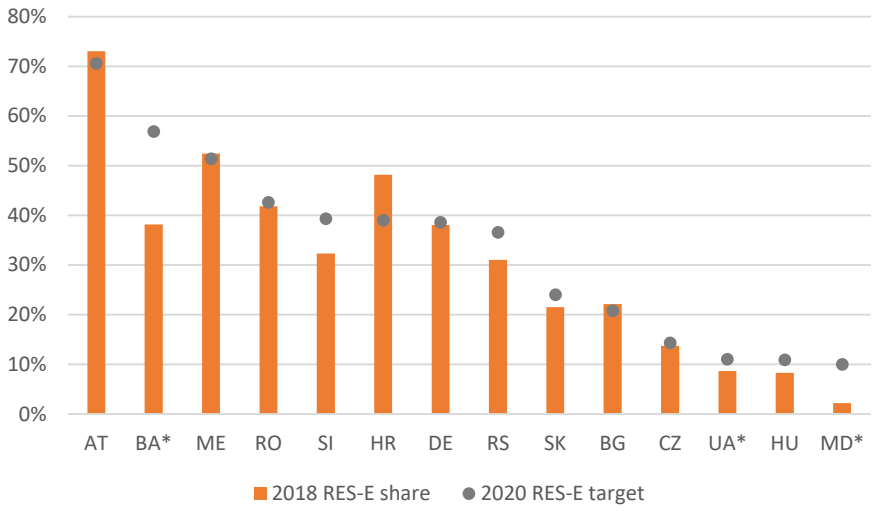
FIGURE 5: RES SHARE IN DR COUNTRIES, 2018 AND 2020 TARGETS (%)



*Source of data: Eurostat, NREAPs. * 2017 data in case of BA, MD and UA*

The **sectoral renewable energy targets** for the electricity and heating and cooling sectors are not mandatory. Figure 6 and Figure 7 show that several countries have already surpassed their 2020 targets.

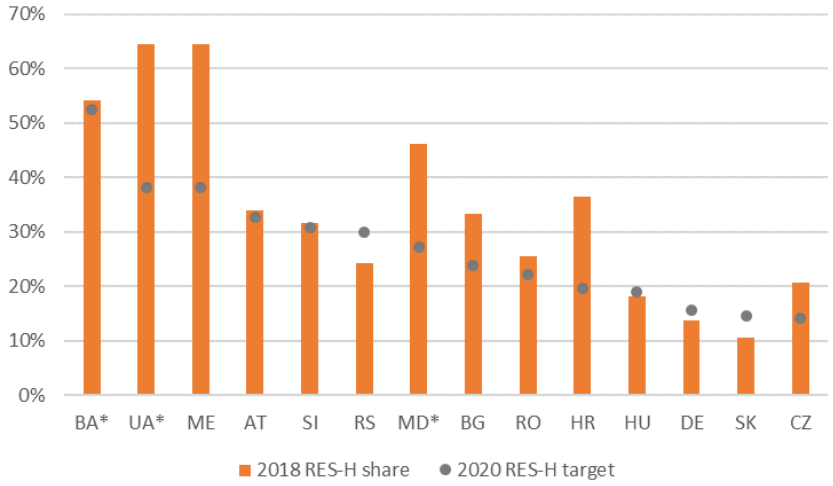
FIGURE 6: SHARE OF RENEWABLE ENERGY SOURCES IN ELECTRICITY PRODUCTION, 2018 DATA AND 2020 TARGET (%)



Source of data: EUROSTAT; BA, UA MD: Progress Reports on RES, EnC[8]

[8] Third Renewable Energy Progress Reports of non-EU DR countries. Please see links under 'Cited policy documents' at the end of the study.

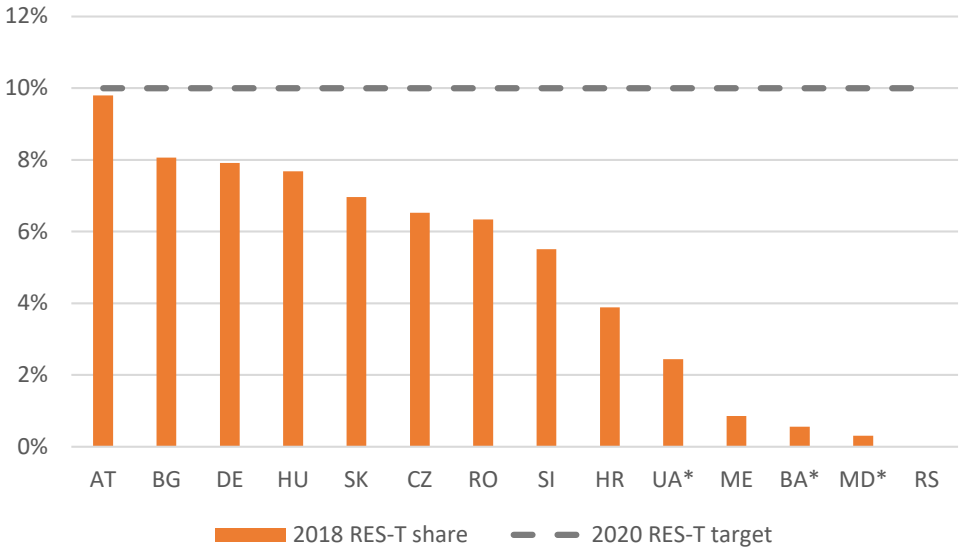
FIGURE 7: SHARE OF RENEWABLE ENERGY SOURCES IN FINAL HEAT CONSUMPTION, 2018 AND 2020 TARGETS (%)



Source: EUROSTAT, BA, UA and MD: Progress Reports on RES, EnC

Figure 8 shows that almost all Danube Region countries need to raise efforts in the **transport sector** to achieve the 10% target.

FIGURE 8: SHARE OF RENEWABLE ENERGY SOURCES IN TRANSPORT, 2018 AND 2020 TARGET (%)

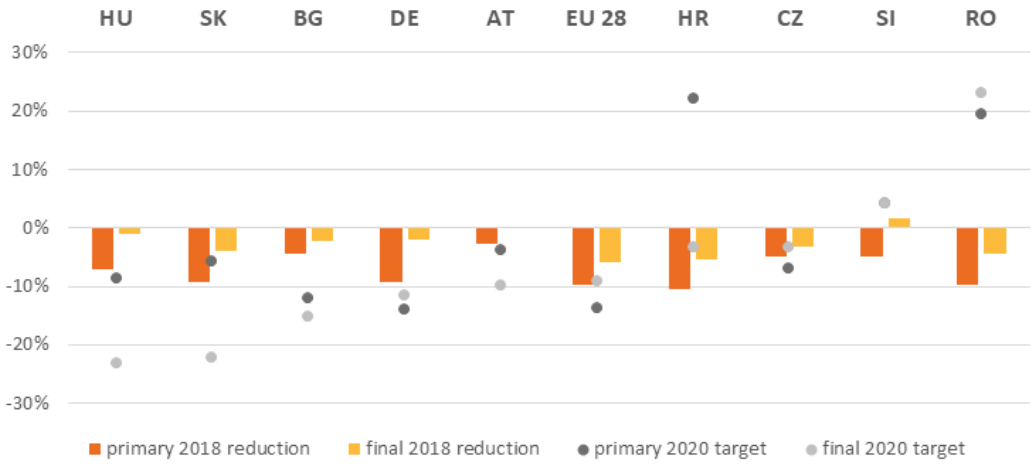


Source of data: EUROSTAT, BA, UA, MD: Progress Reports on RES, EnC

1.2.3. 2020 ENERGY EFFICIENCY TARGETS

The achievement of the EU 2020 energy efficiency targets expressed in both primary and final energy consumption values remain uncertain. EU primary and final energy consumption increased from 2015 recovering from the 2008 global recession.

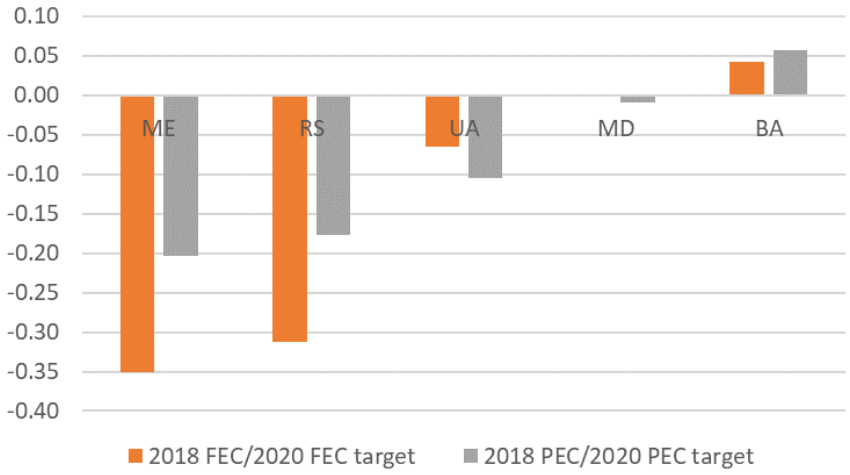
FIGURE 9: COMPARING PRIMARY AND FINAL ENERGY CONSUMPTION IN EU DR COUNTRIES, 2005 AND 2020 TARGETS (%)



Source of data: Eurostat

Between 2005 and 2018 **primary energy consumption** fell in all EU member Danube Region countries, but several lag in energy efficiency for non-binging 2020 targets (AT, BG, DE, HU). **Final energy consumption** fell in the EU countries, but not enough for Austria, Bulgaria, Germany, Hungary, and Slovenia to be on track for achieving the 2020 target[9]. Figure 9 compares targeted and achieved energy use in member states.

FIGURE 10: ACTUAL LEVELS COMPARED TO ENERGY EFFICIENCY TARGETS IN NON-EU DR COUNTRIES (RATIO BETWEEN 2018 DATA AND 2020 TARGET CONSUMPTION LEVELS)



Source of data: Energy Community Secretariat. FEC- final energy consumption, PEC- primary energy consumption

[9] See also: European Environment Agency (2020): Trends and projections in Europe 2020. Download: https://www.eea.europa.eu/publications/trends-and-projections-in-europe-2020

According to 2018 and 2020 primary and final energy consumption data, Montenegro, Serbia, Moldova, and the Ukraine are on track to meet 2020 energy efficiency targets. Primary and final energy consumption levels were above the 2020 target in 2018 in Bosnia and Hercegovina as can be seen on Figure 10, showing the ratio of 2018 consumption levels to 2020 targets. Several countries work on achieving full compliance with Directive 2012/27/EU.[10]

1.3. FACTORS HINDERING TARGET ACHIEVEMENT

This section summarizes forces working against achievement of the targets.

Energy efficiency goals can be realized only if authority price regulation does not distort information regarding cost of service for end-users of energy. If prices are kept below costs for certain users, typically households, payback time for investment into energy efficiency is extended, and this weaken the incentive for energy efficiency measures.

As for household energy efficiency, financing can be problematic. Even with short payback periods, most of the households simply cannot finance the upfront investment themselves. Banks are often reluctant to run affordable energy efficiency credit programs because of uncertainty of related risks. Energy poverty adds to the problem. In regions that are less economically developed, the low value of residential buildings questions the added value of energy efficiency efforts.

Renewable transport is based on biofuels and electrification. The introduction of sustainability criteria capped the share of first-generation biofuels, abruptly slowing the development of the previously prioritized conventional biodiesel and bioethanol., while advanced biofuels are still expensive.

Electromobility is still in its infancy. Several countries have provided support for infrastructure development and roll-out of electric fleets, but it is still lacking, and penetration levels are low. Much of the policy potential lies in sustainable urban planning (public transport services, modality hubs, etc.)

Renewable electricity has been among the most successful subsectors but still faces obstacles. Wind electric projects are especially ousted from non-welcoming neighbourhoods and areas of natural protection. Siting is foreseen to becoming the single biggest stumbling block in the way of onshore wind electricity growth. Solar PV technology is growing the most, to the point there are worries about ground-mounted large-scale PV competing for land with agriculture.

Renewable heat is a sector of huge climate potential. It is a compound sector of industrial process heat and final consumption of energy for space heating. Industrial process heat can use large quantities of biomass in existing combustion installations. With the present technologies for industrial processes, it would be very difficult or too expensive to achieve zero carbon emissions. The production of energy intensive materials, like coke, pig iron or

[10] Energy Community Secretariat (2020): Annual Implementation Report 2020. https://www.energy-community.org/dam/jcr:0af3b17a-3759-4a23-a2ef-3134784e217c/EnC_IR2020.pdf

cement clinker is a major source of carbon emissions, due to combustion of fuels for heat and release of carbon dioxide during manufacturing processes.

Residential space heating consists of two segments: **district heating** and individual space heating. District heating is a well-established technology with large communities of users in the Danube Region, typically owned by municipalities or large utilities that can finance operations. The renewable applications are mostly **biomass combustion** or geothermal heat, though both present significant technical challenges. Biomass combustion for district heating is feasible only if local air quality can absorb additional emissions. Therefore, district heat producers in urban areas do not have this option. Even equipped with state-of-the-art emission control devices, the heavy logistical requirements of large-scale biomass combustion are not suitable to most urban locations.

Geothermal resources in the Danube Region are naturally suitable for heat production. Low-temperature district heating systems are built with significantly larger heat exchanger surfaces to provide the same end-use comfort, but the temperature requirement of most district heating systems currently operating is usually beyond what local geothermal resources provide. Here urban planning is indispensable. This technology can be a game-changer for renewables to prevail: new housing blocks, residential building projects, commercial buildings can be obliged to join newly established, low-temperature district heating systems tapping on low-temperature renewable sources like geothermal or ambient heat. Another obstacle is that heat cannot be transported over long distances, requiring that the source matches the actual demand for heat.

Price regulation is also important for the development of renewable heat. Poorly designed price regulation triggers growth in individual natural gas space heating which works against individual renewable heating or district heating. Price regulators are under pressure to keep household prices low, too low to ensure asset replacement and new investment.

Individual **household heating** is currently the single largest renewable energy segment in most of the Danube Region countries. This segment is **dominated by low efficiency direct biomass heating, wasting much of the input resources (mostly forest wood) and heavily polluting indoor and outdoor air.** Yet, there is usually not a financial instrument readily available to help replace outdated biomass heating with high efficiency biomass units or other renewable technology. A combination of low-income households and low prices for residential buildings in rural areas of economically depressed areas further deters climate finance (either renewable heating or energy efficiency). As evidenced by NECPs, government administrations also struggle to encapsulate this segment into climate policy. Without proper policy and regulation, the environmental integrity of poor rural areas will continue to decline, raising the risk of carbon lock-in (coal, natural gas, etc.). Another obstacle is that heat cannot be transported over long distances, requiring that source match the actual local demand.

Decarbonisation of the electricity and the heating sector and the coal phase-out will be key to meeting climate targets. Nonetheless, there are many obstacles to coal phase-outs. Several countries prioritize reducing import dependency and increasing reliance on locally available sources, which is usually coal. As long as climate policy is secondary to this energy policy objective, many Danube Region countries will keep coal in their portfolio. Countries with a very carbon-intensive mix of electricity tend to promote natural gas for

heating (BG) as opposed most EU countries endorsing electrification for decarbonisation in the heating sector. Signs of ongoing promotion for natural gas is worrying from the perspective of long-term decarbonisation and energy transition. Natural gas, albeit less carbon intensive than coal, is a fossil fuel that must be phased out by 2050, meaning there is risk of stranded assets. Furthermore, **institutional factors** such as non-compliant inventory or reporting systems, lack of institutional capacities and legal competencies, can hamper decarbonisation efforts.

General concerns

The NECPs reviewed in this document were mostly designed to meet a 40% reduction in GHG emissions by 2030. In the meantime, however, the EC has been stepping up its 2030 climate ambition to secure an airtight delivery of full climate neutrality by 2050. In its strategic document, (COM(2020)562) the EC has proposed a new 55% target by 2030.

One of the important factors slowing progress is long lead times in land-use, transport and buildings. In these sectors, it takes significantly longer to change track of GHG emissions and there are specific features that deteriorate chances of success. For land-use there are factors of natural irreversibility (loss of primary ecosystems, loss of soil) and policy related carbon feedback loops (subsidizing agricultural use of land). The buildings sector also faces a double challenge: investing heavily into buildings (decarbonisation and energy efficiency) while remaining socially affordable. The transport sector, besides long lead times of fleet changes, is also determined by its pre-existing legacy infrastructure.

Economic sectors are driven by business decisions which need to incorporate climate policy measures to prevent carbon lock-in and stranded assets. In most of the Danube Region, these policies have not yet been integrated and more work is needed. In all the economic sectors, there is an urgent need to provide a solid platform of policy measures to prevent locking our economies in carbon intensive assets and technologies. An economy-wide carbon pricing is badly needed and severely missing from the policy landscape.

2. THE ROLE OF NATIONAL ENERGY AND CLIMATE PLANS

2.1. THE ROLE OF NATIONAL ENERGY AND CLIMATE PLANS

The European Commission's Communication on a Framework Strategy for the Energy Union adopted in February 2015 raised the need for the application of an integrated planning and monitoring system across the EU in order to review the actions of individual member states taken to reach the Energy Union objectives. National planning was supposed to be the basis for this transparent governance system, integrating country level targets and implementing measures. The Governance Regulation states that the goals set for 2030 should be determined with a view on the long-term EU objectives in line with its commitments under the Paris Agreement.

The NECPs are to be elaborated in an integrated way, embracing all energy production and consumption areas which must contribute to decreasing the harmful effects of energy use on the environment. For some of these, separate plans had to be submitted previously (e.g., renewable energy and energy efficiency action plans). The NECPs take a holistic approach, guiding the development in all the relevant areas and subsectors, recognising the interactions and the required coordination in the different fields, increasingly demanded for establishing flexible energy systems and coupled energy sectors.

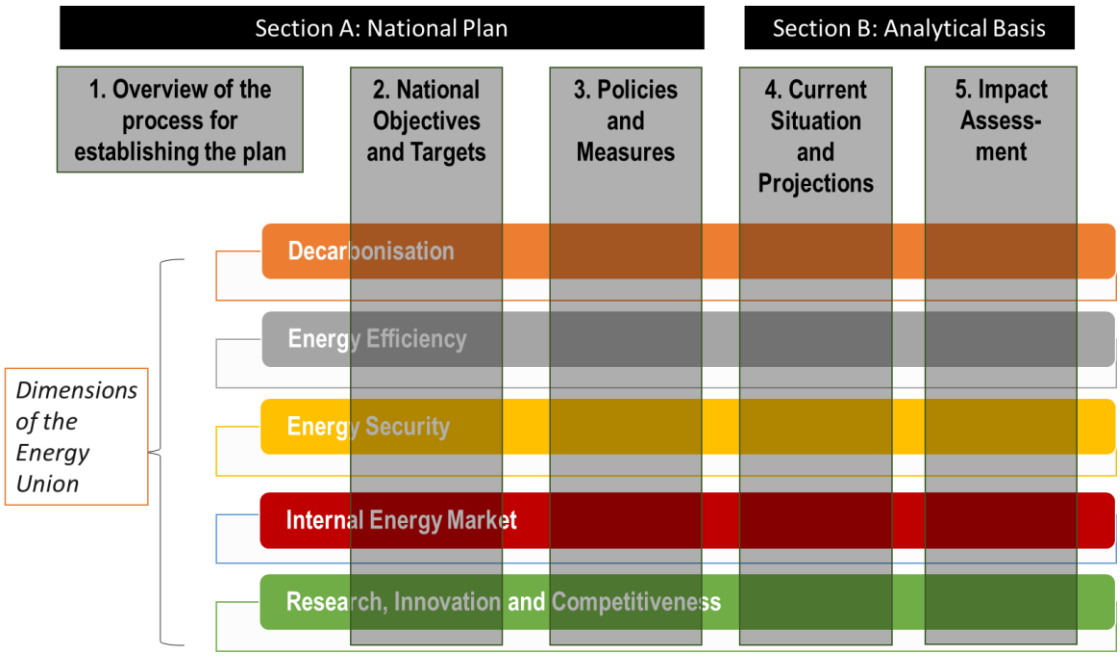
Besides the 10-year national energy and climate plans the governance regulation requires member states to prepare their long-term strategies to 2050. Both documents serve the important role of directing the actions of economic actors by providing long-term guidance and predictability, shaping investment decisions to take sustainability considerations into account.

The planning and reporting requirements are standardized for easy evaluation and comparison between member states and making it possible to aggregate the ambitions of the countries to see whether their collective action can deliver on the objectives to be reached at the EU level. During the process of setting up their national plans, the countries are required to consult with their neighbouring member states on key issues which might have cross-border relevance.

2.2. STRUCTURE AND REQUIRED CONTENT

As mentioned above, the NECP outlines policy targets and the means of reaching those targets across relevant policy areas. This approach allows for a better coordination of planning and implementation across national decision-making and implementing bodies. As illustrated in Figure 11, the structure is designed in a way to ensure that the five dimensions of the Energy Union strategy cross all policy areas.

FIGURE 11: THE STRUCTURE OF THE NATIONAL ENERGY AND CLIMATE PLANS



NECPs consist of two main sections**:**

- **Section A** includes: the national plan describing the policy background and stakeholder consultation process; the national objectives and targets related to all Energy Union dimensions; policy instruments which will be applied.
- **Section B** provides: a summary of the background information used for the sectoral analysis with the modelling outcomes under the WEM („with existing measures") and WAM („with additional measures") scenarios.

Under **Section A,**

- **Chapter 1** presents an overview of the plan and describes the process of establishing it. It includes the executive summary, an overview of the current policy situation in which the plan was developed, details of the public consultation planning process, and covers issues which were negotiated and jointly agreed upon with other member states. The involvement of the commission in the process of elaborating the NECP is also described here.
- **Chapter 2** sets out the national objectives and targets related to the five dimensions of the Energy Union. The **targets related to decarbonisation** have to specify the GHG emission mitigation goals for ETS and non-ETS sectors and renewable energy deployment in the electricity, heating and cooling and transport sectors. Bioenergy and LULUCF also merit special attention. Regarding **energy efficiency**, long-term indicative milestones have to be provided for the 10-year periods until 2050, indicating sectoral targets and strategies in the buildings, transport and heating and cooling sectors. Objectives under **energy security** include the diversification of energy sources and increasing the resilience of energy systems, the reduction of

import dependency, and the improvement of grid flexibility facilitating the integration of renewable sources. The targets related to the **internal energy market** include interconnectivity, the planned advancement of key electricity and gas transmission infrastructure projects, and the national objectives enhancing the effective functioning of the interlinked electricity markets including from decentralized sources and prosumers. Private and public **research and innovation** activities with assigned funding targets and competitiveness are also included here.

- **Chapter 3** includes the policy instruments and measures for achieving targets from Chapter 2. Under the **decarbonisation dimension**, regional cooperation is included in policy tools encouraging GHG mitigation and the deployment of renewable electricity, heat and transport. Administrative procedures and the methods of providing information and training to consumers is demonstrated in this dimension.. The subchapter related to **energy efficiency** must cover the policy tools used to reach targets under the energy efficiency obligation schemes or alternative policy measures outlined in Article 7 of the EED, the instruments facilitating cost effective deep renovation of buildings under their long-term renovation strategies, the way they promote energy services and energy performance contracting, the role of public procurement in enhancing energy efficiency, as well as the measures used to exploit energy saving potentials of the gas and electricity infrastructure. For **energy security,** planned regional cooperation and the use of financing measures have to be outlined. Under the **internal energy market**, countries have to present the policy instruments to achieve the required interconnectivity of their electricity systems, the delivery of key infrastructure projects in the gas and electricity sectors, the tools enhancing system flexibility, the measures to protect vulnerable consumers, and the roll-out of intraday market coupling and cross-border balancing markets. This also covers policies and measures, cooperation with other member states and financing measures associated with **research, innovation and competitiveness**.

Section B, Chapter 4 presents the exogenous factors used to project GHG emission and energy use, including microeconomic forecasts, sectoral developments, and global price trends. This part includes the most important outputs under the WEM scenario. **Chapter 5** includes the impact assessment of planned policies and measures corresponding to the main results of the model calculations under the WAM scenario.

Member states were also required to submit excel files with the most important information used and projected in section B. Unfortunately, this data is not publicly available and some of the planned analysis could not be carried out for all the countries of the Danube Region.

3. OVERVIEW OF NECPS AND RELATED DOCUMENTS BY POLICY AREAS

3.1. DECARBONISATION

As mentioned earlier, Danube Region countries which are also members of the European Union are subject to two main regulatory obligations driving greenhouse gas emission reductions in the 2021-3030 period: the European Emission Trading Scheme (ETS) and the Effort Sharing Regulation (ESR). National Energy and Climate Plans were drafted under the Existing Climate and Energy Policy Framework with a 40 percent emissions reductions target, corresponding to a 43% reduction under the EU ETS and a 30% reduction in the sectors covered by the Effort Sharing Regulation.

Installations falling under the EU ETS will accomplish the mitigation goal jointly through gradually decreasing EU-wide emission cap. Outside of this, EU member states have binding reduction targets set in the Effort Sharing Regulation.

The climate policy development of non-EU Danube Region varies substantially. Montenegro has the most advanced climate policy, introducing a cap-and-trade system with a floor price in February 2020. Ukraine, being an Annex I country to the Kyoto Protocol, submits national emission inventories to the UNFCCC. However, the harmonisation with the relevant EU legislation and the establishment of the required institutional background is still underway in all of these countries.

This section first presents the overall GHG emission reduction targets of the Danube Region countries. As the decarbonisation dimension is an overarching aspect of energy transition, this section overviews only those measures with sizable economy-wide effects, while sector-specific targets and measures will be discussed in the subsequent chapters. The objectives and policy tools related to LULUCF are assessed in a dedicated chapter.

The analysis does not address the objectives and policies of non-energy related ESR sectors, such as agriculture, waste management and F-gases.

After the assessment of the main targets and measures the chapter provides an analysis of the projected outcomes of WEM and WAM scenarios. Because such modelling outcomes are not consistently available for all the non-EU DR countries, we quantify their emission reductions assuming that their reduction goals will be realized.

3.1.1. TARGETS

As shown in Table 1, four of the nine EU DR countries have set an overall GHG emission reduction target. Czechia intends to reduce its emissions by 44 Mt CO_2eq compared to 2005, which corresponds to a 30 percent decrease. The Czech NECP also includes indicative targets for 2040 and 2050, corresponding to an 80% EU reduction goal by 2050. The German NECP, which was submitted in July 2020 already incorporated the increased climate ambition of the EU, setting 55% emission reduction target for 2030. This translates into a 38% reduction compared to 2005, or 344 MtCO_2eq. Hungary's 40% reduction goal corresponds to a 7 % reduction relative to its 2015 emissions level, 4.4 Mt CO_2eq if LULUCF

is taken into account. The Romanian ambition is high relative to 1990, which translates into a 6% increase from the 2015 level by 2030.

TABLE 1: 2030 GHG MITIGATION TARGETS FOR EU DR COUNTRIES

	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Reduction of total GHG emissions			at least 44 Mt CO_2 eq. compared to 2005 (-30 %)	-55% compared to 1990		-40% compared to 1990 (max. 56.19 Mt CO_2eq by 2030)	-50% compared to 1990		
Reduction in non-ETS sectors compared to 2005	-36%	0%	-14%	-38%	-7%	-7%	-2%	-20%	-20%

Source: NECPs

Although not indicated in the table, three countries set goals for their ETS sectors (DE, HR, RO) equal to the overall EU target (-43%). Some countries also included their LULUCF related targets, corresponding to the provisions set by the LULUCF regulation (841/2018/EU) (BG, CZ, DE, SI). The fourth set of targets is related to the sectors falling under the Effort Sharing Regulation. Other than Slovenia and Slovakia, these are the same as their binding targets set by the Effort Sharing Regulation. Sectoral targets were also determined by some member states. Austria set goals its

transport and building sectors while Germany and Slovenia disaggregated their overall reduction targets into specific sectoral goals.

Because **non-EU Danube Region countries** have not finalized NECPs the working assumption is that they will strive to achieve the GHG emission reductions indicated in their Nationally Determined Contributions submitted to the UNFCCC as parties to the Paris Agreement. Table 2 presents these commitments.

TABLE 2: GHG MITIGATION TARGETS FOR NON-EU DR COUNTRIES BY 2030

	BA	MD	ME	RS	UA
Unconditional	2% reduction compared to BAU (18% above 1990 level)	70% GHG reduction compared to 1990	30% reduction below 1990 level	9.8% reduction compared to 1990	60% reduction below 1990 level
Conditional	23% reduction compared to BAU (3% below 1990 level)	88% reduction below 1990 level	-	-	-

Source: Nationally Determined Contributions, UNFCCC

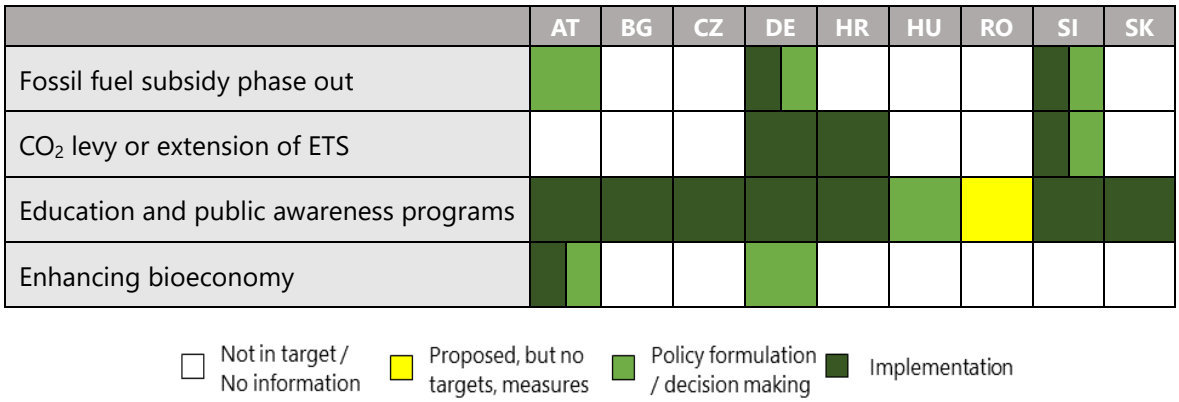
All non-EU Danube Region countries plan to lower their emissions compared to 1990 except for Bosnia, which expects growth of 18% without international support. Moldova has

recently updated its NDC, increasing its unconditional target from 67 to 70% and its conditional target from 78 to 88%.

3.1.2. POLICIES AND MEASURES

This section assesses measures which can drive decarbonisation across all sectors. Among the most important are the phase-out of fossil fuel subsidies, the introduction of carbon levies, and those addressing consumer behaviour through awareness raising. Coal-phase out will be addressed in the sections covering electricity, heat and natural gas. The measures related to National Adaptation Strategies are also discussed in the NECPs and energy strategies of the Danube Region countries, as almost all of them have relevant strategies and action plans in line with the guidelines provided by the European Commission in its EU Adaptation Strategy package. Although these are very important elements of climate regulation, they set out a strategy for adapting to the effects of climate change, and do not focus closely on the means of reaching decarbonisation. The next table provides information on the status of relevant policies in DR EU member states.

TABLE 3: DECARBONISATION MEASURES IN THE EU MEMBER DR COUNTRIES



As Table 3 shows, Austria is **phasing out fossil fuel subsidies** while Germany and Slovenia are doing some partially. All three countries will identify and gradually remove subsidies and incentives that are counterproductive to achieving climate policy goals. Germany evaluates the existing incentives biannually according to their ecological and social effects, planning to remove the majority of them by the end of 2027. Slovenia intends to phase them out in the next decade.

A **carbon pricing mechanism** is applied to small installations or fuels in the non-ETS sectors in Germany, Croatia and Slovenia. Germany has established a national fuel emissions trading scheme for heating and transport sectors through which fuel suppliers are required to purchase and surrender allowances for emissions attributable to the fuels they sell. The scheme avoids placing a double burden on EU ETS participants. During the introductory phase, quotas have a fixed price, increasing from 25 EUR/t in 2021 to 55 EUR/t in 2025, at which point allocation is auctioned. Slovenia will introduce a carbon levy on fossil fuels to facilitate clean energy consumption. The levy will increase gradually to reach the average price of EU ETS allowances (or at least 30 EUR/t) by 2030. Croatia has a CO_2 emission tax in

place for the non-ETS stationary sources emitting more than 450 tons of CO_2 per year. The measure will be extended to the period 2021 -2030 with some modifications to increase its efficiency as the option of transforming it into a fossil fuel emission tax is under consideration.

Educating consumers in the residential, business and tertiary sectors is a goal for all EU and non-EU Danube Region countries with the aim of raising awareness, changing detrimental consumer practices, and facilitate knowledge transfer.

Supporting the development of bioeconomy is among the horizontal action areas in Austria, Germany, and Croatia. Bioeconomy will be an important contributor to decarbonisation, aiming to replace raw materials and energy sources produced from fossil fuels with products made of biological resources. Croatia will create a Platform for Bioeconomy to serve as an information and education program involving key stakeholders (farmers, food and wood processing businesses, chemical companies).

In addition to the above measures, some other policies spanning all sectors appear in the NECPs. Austria and Slovenia intend to implement **forward-looking spatial planning**, addressing the efficient allocation of lands for different purposes, such as transport infrastructure, residential areas, renewable energy generation, etc. while also ensuring the conservation of the natural environment and biodiversity. Well-designed spatial development strategies can also contribute to the higher acceptance of different land uses by the local residents and the general public.

Apart from the above-mentioned actions, many Danube Region rely on nuclear energy as an emission-free electricity generating technology (CZ, HU, RO, SK). Another means of 'decarbonisation' is the transition from coal to natural gas in the heating and in the electricity sectors. Romania plans to replace part of its coal-based generation facilities with nuclear, renewable and gas plants, while Bulgaria plans to transition to gas across several sectors. Czechia, Bulgaria, Romania, and Croatia will continue to rely on coal-based generation.

Most **non-EU DR countries** are at an earlier phase of formulating and implementing decarbonisation measures. The only exception is Montenegro, which introduced a cap-and-trade system for its major industrial and energy plants in February 2020. The minimum price set for the system is EUR 24/t CO_2. Although all 5 non-EU countries have prepared GHG inventories for the UNFCCC[11], they are in the process of adopting the necessary measuring and verification system and the Monitoring Mechanism Regulation (MMR) regulation (525/2013/EU) to join the EU ETS. They also prioritize energy independence utilizing domestic fossil fuel resources, which conflicts with decarbonisation targets. Bosnia and Herzegovina intends to decommission many of its thermal power plants by 2031, but some are planned to remain in operation after 2035. Serbia's energy strategy outlines a vision for renewable energy sources and application of "clean coal". Ukraine plans to upgrade

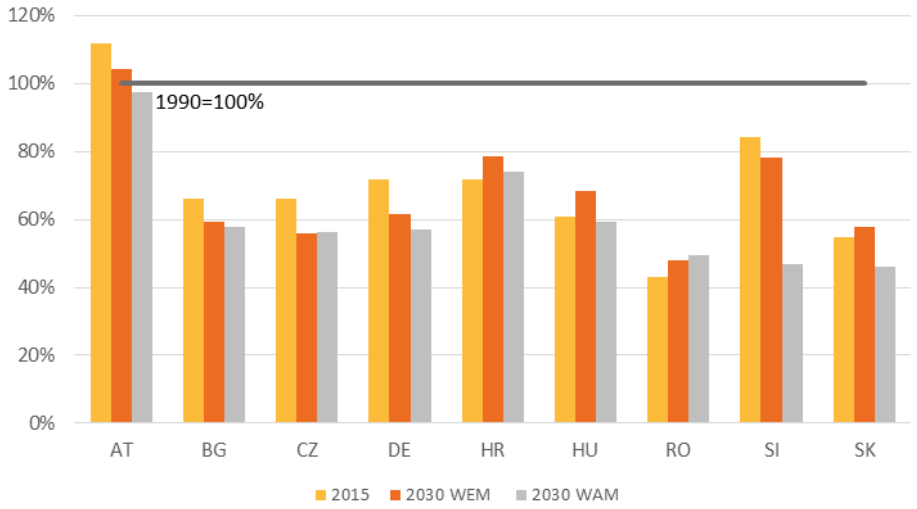
[11] United Nations Framework Convention on Climate Change, unfccc.int

capacities after 2025, using a combination of coal, nuclear and gas power while remaining a dominant hydrocarbon producer (natural gas and oil) in the region.

3.1.3. EXPECTED OUTCOMES

Figure 12 presents the 2015 and the projected 2030 WEM and WAM GHG emissions of the EU countries in the Danube Region compared to 1990. All countries except Austria have achieved substantial reductions by 2015. WAM model results have higher emissions compared to 2015 in Croatia and Romania, but the results are still lower than the 2030 targets set for these countries. According to the projections, even the additional measures will not deliver the required reductions for Austria. The NECP indicates that additional measures will be required to reduce an additional 5.1 tons of CO2eq including flexibility measures available under the ESR.

FIGURE 12: GHG EMISSIONS OF EU MEMBER DR COUNTRIES IN 2015 AND PROJECTIONS FOR 2030



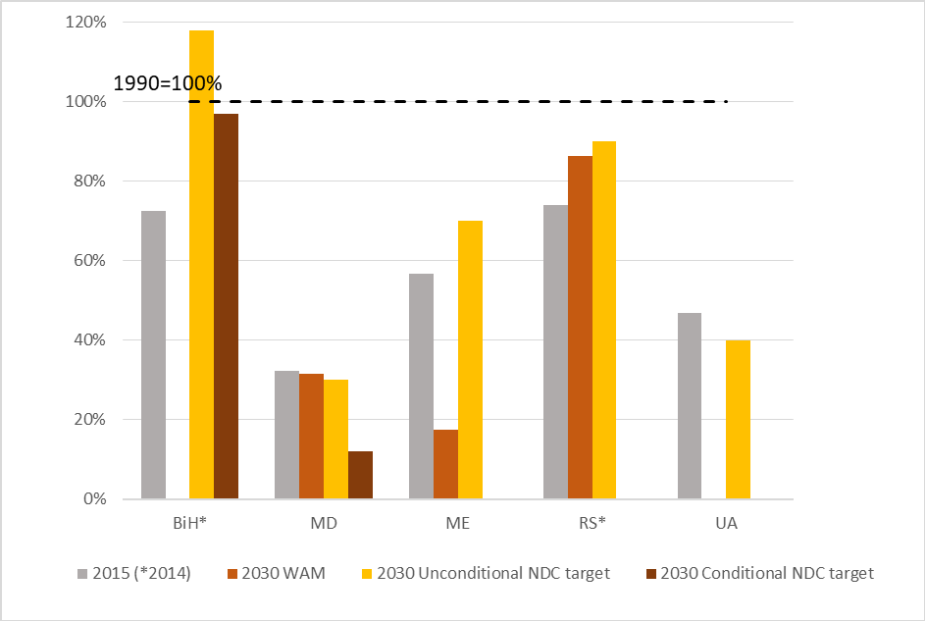
Source: Eurostat, NECPs

WAM projections were only available for three non-EU DR countries as submitted to the UNFCCC. The historic GHG data availability also differed across countries, e.g., only 2014 emission data were available for Bosnia and Herzegovina and Serbia[12]. Figure 13 includes 2014 or 2015 emissions and the WAM projections, together with the NDC conditional and unconditional targets. Bosnia and Herzegovina and Moldova set conditional targets in their NDCs. For Bosnia, the unconditional target is predicted to exceed the 1990 emission level by 18%. In the case of more developed countries providing financial assistance, emissions can fall 3% below the base year level. The projected WAM emission for Moldova is close to the unconditional target of the country, while the conditional target is set substantially lower. Montenegro estimated much lower emissions in 2030 under the WAM scenario than

[12] Serbia had low electricity output from its thermal power plants in 2014 due to flooding in lignite mines, also affecting GHG emissions. Source: Ministry of Mining and Energy, Republic of Serbia.

its unconditional target. In Serbia, the two values are similar, with the estimated value below the target.

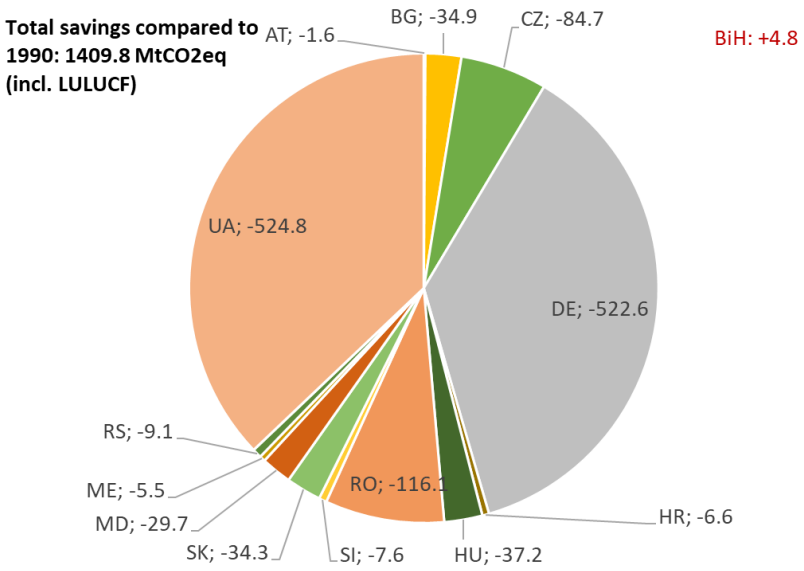
FIGURE 13: ACTUAL AND PROJECTED 2030 GHG EMISSIONS OF NON-EU DR COUNTRIES



Source: Eurostat, NECPs, NDCs, National Communications

Adding up the differences between projected GHG emissions under WAM scenarios and the 1990 emission levels, a total of 1410 Mt CO_2eq GHG emission savings is estimated by 2030. Figure 14 illustrates country contributions to this emission reduction. Ukraine and Germany are by far the largest contributors, partly owing to the large size of their energy sectors.

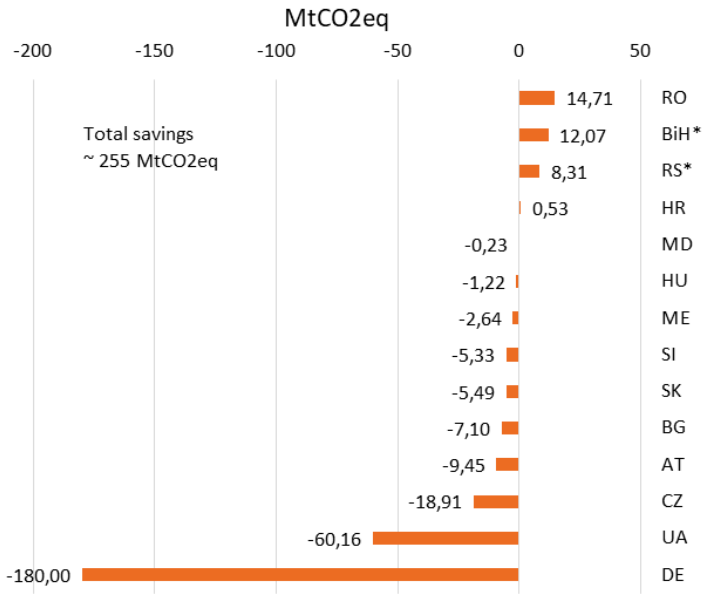
FIGURE 14: PROJECTED GHG EMISSION SAVINGS IN THE DANUBE REGION BASED ON PROJECTED WAM EMISSIONS AND UNCONDITIONAL TARGETS



Source: REKK calculation, based on NECPs, NDCs, National Communications

If the conditional targets of BA and MD can be achieved, the total savings increase to 1431 $MtCO_2eq$. As Figure 15 shows, overall emissions reductions after 2015 would amount to approximately 255 $MtCO_2eq$. Most of this is achieved in Germany and Ukraine, while rising in four of the DR countries as a factor of economic growth.

FIGURE 15: PROJECTED GHG EMISSION SAVINGS BETWEEN 2015 AND 2030 BASED ON PROJECTED WAM EMISSIONS AND UNCONDITIONAL TARGETS



*Source: REKK calculation based on NECPs, NDCs, National Communications.*Base year is 2014.*

The amount of projected GHG mitigation for the period of 2015-2030 is 18% of the total decline to be achieved by 2030 compared to 1990, suggesting that the additional policy actions planned in the strategic documents will contribute about one fifth of the planned emission reductions.

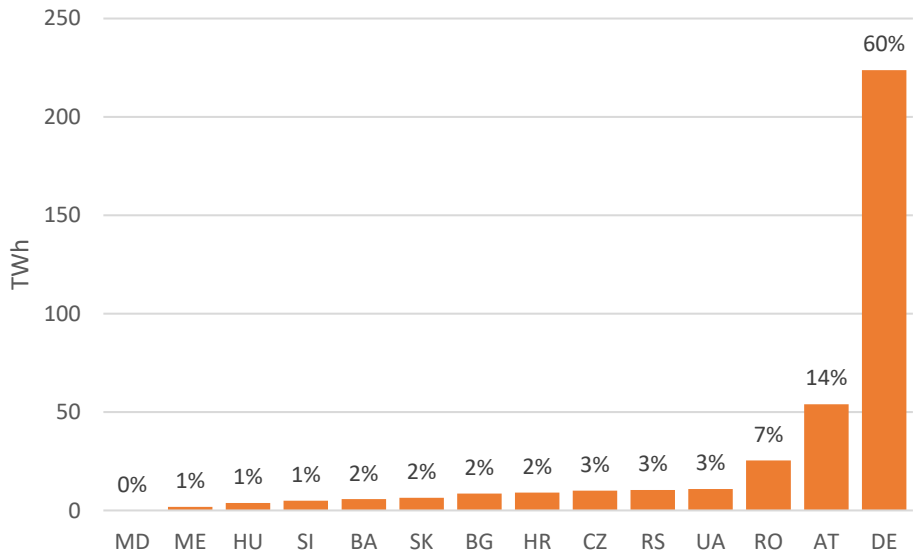
3.2. RENEWABLE ELECTRICITY

Renewable electricity generation experienced significant growth over the last decade in the DR and across the EU. DR countries have large potential for hydro power, biomass, wind, and solar energy generation. Up to now, renewable electricity generation was predominately hydro-based, the NECPs and strategic documents[13] indicate future growth in wind and solar PV.

Germany is the EU pioneer and leader of renewable energy production, with wind and solar PV capacities accounting for 86% of the Danube Region's wind and solar capacities. It produces 375 TWh renewable electricity generation which is 60% of the electricity produced in the Danube Region (see Figure 16).

[13] Please find the exact references at the end of the document, under 'Cited policy documents".

FIGURE 16: RES-E GENERATION IN THE DANUBE REGION, 2018 (TWH, % OF TOTAL DR RES-E GENERATION)



*Source of data: Eurostat, NREAP of Moldova and Ukraine. *2017 data in the case of MD and UK*

3.2.1. TARGETS

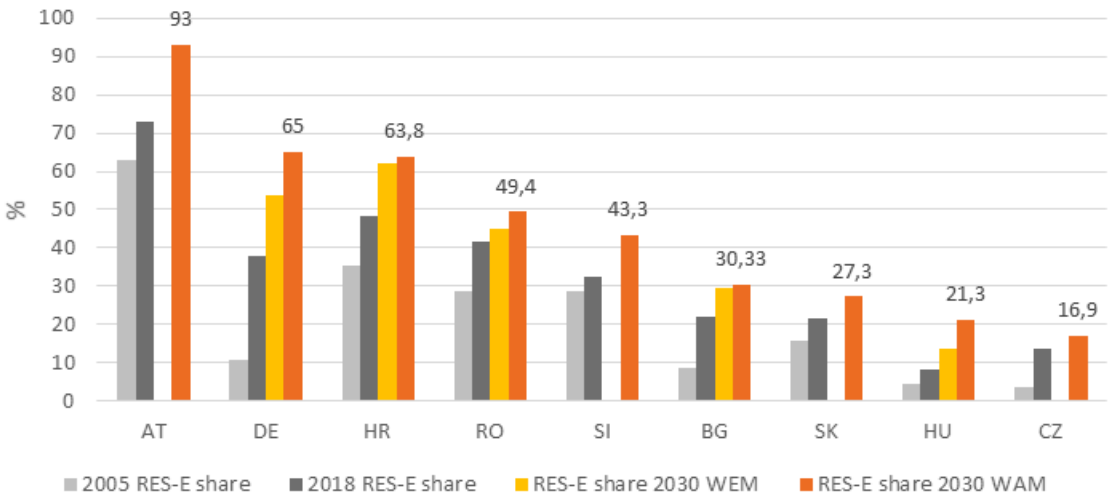
The 2030 Energy and Climate Framework of the EU requires member states to contribute to a 32% EU wide renewable energy target by 2030. While the revision of the Renewable Energy Directive (2018/2001) includes sub-targets for 2030 in heating and cooling[14] (non-binding) and transport[15] (binding), there are no targets for the share of renewable energy sources in electricity (RES-E share). However, the Governance Regulation ((EU) 2018/1999) include reference points, and the NECPs contain estimated **trajectories** for renewable energy shares by sector.

Figure 17 shows a comparison of the RES-E shares in the EU member states of the Danube Region countries. Germany grows the most by 2030 under the WAM scenarios in terms of percentage points (27 percentage points), followed by **Austria** (19.9 percentage points), **Croatia** (15.7 percentage points) and **Hungary** (13 percentage points).

Albeit starting from an already high RES-E share in 2005 due to significant hydro generation, **Austria** stands out with its plan to reach a 93% RES-E share by 2030. In its climate and energy strategy #mission2030 the country committed itself to generate 100% of total electricity consumption from RES by 2030.[16] Czechia targeted the lowest RES-E share for 2030 (16.9%).

[14] Article 23 (1) of RED II
[15] Article 25 (1) of RED II
[16] This 100% RES-E target refers to the "national balance", which means that balancing and control energy for grid stabilisation purposes is not included. Source: Austrian NECP

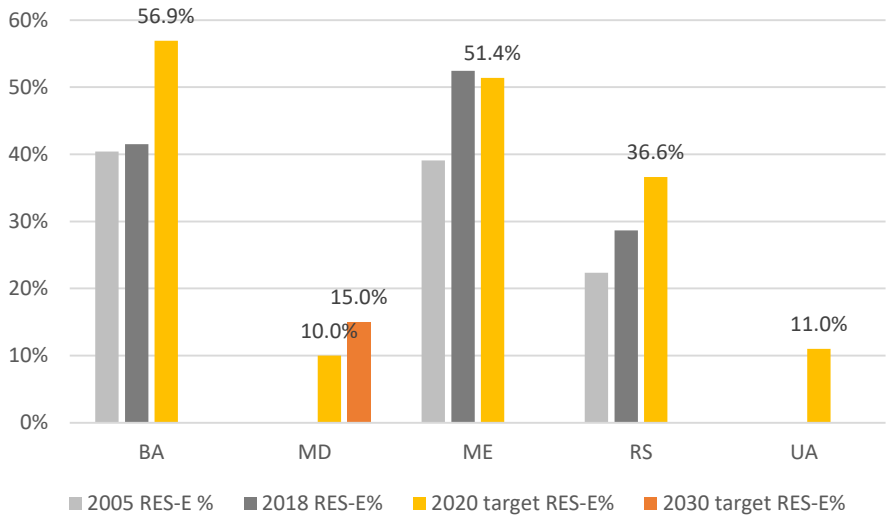
FIGURE 17: RENEWABLE ELECTRICITY SHARES IN 2005, 2018 AND IN THE 2030 WEM AND 2030 WAM SCENARIOS (%)



Source of data: NECPs, Eurostat

In the **non-EU** strategic documents do not contain sectoral targets for renewable energy consumption, with the exception of Moldova planning to reach 15% RES-E by 2030. Figure 18 shows the RES-E shares for 2018, the 2020 non-binding sectoral RES-E targets according to Directive 2009/28/EC, and the RES-E share for 2030. Montenegro already achieved its 2020 RES-E target in 2018. The share of renewable energy sources within the electricity production is already high in Bosnia-Herzegovina, Montenegro, and the Republic of Serbia due to significant hydro power capacity.

FIGURE 18: RES-E SHARES IN NON-EU DANUBE REGION COUNTRIES (%)



Source of data: Eurostat SHARES, NREAPs[17], Energy Strategy of Moldova

[17] National Renewable Energy Action Plans. See 'Cited policy documents' for exact references.

3.2.2. POLICIES AND MEASURES

Policies and measures that support the deployment of renewable electricity technologies can be grouped into the following:

- Support schemes that decrease upfront investment costs (investment support) or allow for stable and/or preferential revenues (operating support)
- Financial policies (e.g., exemptions from taxes and levies, preferential loans, etc.)
- Administrative policies (i.e., streamlining of permission procedures, spatial planning regulations, frameworks for self-consumption, etc.)
- Information and training

Directive 2009/28/EC and RED2 require member states to incorporate certain frameworks and measures into their legislation. When assessing the NECPs we assume that Directive 2009/28/EC has been fully transposed by the EU member states, meaning that frameworks for proportionate administrative procedures (Article 13), information and training (Article 14), guarantees of origin (Article 15), and access to and operation of the grids (Article 16) are in place. WEM scenarios demonstrate that these measures will have a significant effect on reaching targets. The transposition deadline for Directive 2009/28/EC was 2014 for the Energy Community countries, although some countries lag behind with the full transposition[18].

This section summarises the main policies and measures that seek to increase renewable electricity generation in the Danube Region, focusing on policies and measures introduced by RED II (e.g., self-consumption, energy communities) and other emerging issues that may help the uptake of RES-E generation in the next decade (e.g., frameworks for repowering or private PPAs).

3.2.2.1. OPERATING SUPPORT SCHEMES

The main policy measure to support the uptake of RES-E installations remains operational support for renewable energy power plant operators. As can be seen in Table 4, almost all Danube Region countries will have established a support scheme before 2020, mostly applying the feed-in tariff.

Several countries with feed-in tariff schemes are beginning to move towards more market-based schemes following guidance of the EEAG State Aid Guidelines[19] and RED II. Market premium schemes are already in place in Bulgaria, Czechia, Croatia, Germany, Hungary, and Slovenia, being developed in Slovakia, and planned in Austria, Bulgaria and Romania[20]. Operating support is mainly granted to decentralised and large-scale renewable energy generators, while in Germany (below 100 kW), Bulgaria (below 30 kW) and Slovakia (below

[18] See also: Annual Implementation Report 2020, Energy Community Secretariat. Download: https://www.energy-community.org/implementation/IR2020.html

[19] Guidelines on State aid for environmental protection and energy 2014-2020, (2014/C 200/01) (EEAG Guidelines)

[20] In several countries after the introduction of market premium small-scale RES-E producers may further receive feed-in tariff support, in line with the EEAG Guidelines.

30 kW for solar PV) small-scale and household installations are also eligible for feed-in tariffs.

TABLE 4: OPERATING SUPPORT SCHEMES IN THE DANUBE REGION COUNTRIES

Operating support	AT	BA	BG	CZ	DE	HR	HU	MD	ME	RO	RS	SI	SK	UA
Feed-in tariff support			*	*			*							*
Feed-in tariff support for small-scale/household RE-E (<100 kW)														
Quota support										*				
Market premium support														
Tendering scheme for operating support														

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

**Support scheme not available for new RES-E plants..*

Since 2014 operating support for new entrants in Czechia ceased following the 2011 solar boom. New hydropower plants up to 10 MW and new cogeneration plants are the exceptions, remaining eligible under the Promotion Act. **Bulgaria** ended operational support in 2018 for new wind, solar and biomass power plants. Auctions for market premium would be launched in 2025 if targets are in jeopardy. The **Romanian** quota scheme for new installations ended in December 2016. According to the Romanian NECP the implementation of a "Contracts for Difference mechanism" (market premium scheme) is planned to achieve 2030 targets.

The **non-EU countries** also introduced operating support schemes: Bosnia and Herzegovina, Montenegro, Serbia and the Ukraine operate feed-in tariff schemes and Moldova plans to set up a feed-in tariff scheme according to its energy strategy. A premium scheme is already in operation in **Republika Srpska of Bosnia and Herzegovina** and is envisaged in Ukraine after 2020. For Moldova it is a condition for functional competitive electricity markets.

Tenders for ensuring a cost-competitive level of operating support are already being held in Germany, Croatia, Hungary, and Slovenia, and planned in Czechia (legislation in place), Slovakia (legislation in place), in Austria and Bulgaria (after 2025 if needed for target achievement). Amending legislation to make RES financially sustainable through competitive bidding and in line with State Aid Guidelines 2014-2020 is also a key issue for the countries of the Energy Community[21]. **Montenegro** held locational auctions for solar PV

[21] Source: Janez Kopac (2018): State of Play of Renewables in the Energy Community – Where are we and where are we going?, 24. April 2018. Download: https://www.energy-community.org/dam/jcr:c0d2604e-68e0-4f7f-ac7e-4a1e3ca349ea/ECPP_ECS_RES_042018.pdf

and onshore wind. In these auctions, investors were not competing for support but offering a land lease price for the right to build plants on state-owned land and sell electricity at the market price[22].

3.2.2.2. INVESTMENT SUPPORT SCHEMES

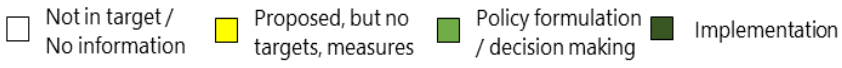
Investment support schemes are frequently used to mitigate the upfront investment costs of RES-E installations as Table 5 presents. Limited information is available from the NECPs on exact programmes, but investment support is mainly financed by the state budget, carbon credit revenues (EU ETS mechanism) or EU structural funds. **Hungary** plans to fund small scale PV plants, seasonal storage and battery storage, smart networks, smart metering projects through the EU structural funds. **Romania's** support scheme for "less exploited sources" aims to increase electricity and heat production with biogas, biomass and geothermal by covering 45% of investment costs for installations. Medium sized enterprises can receive up to 55%, and small and microenterprises 65% of funding. The **Slovenian** NECP emphasises the aim to develop geothermal (and hydro) installations via investment support schemes. **Bulgaria** and **Hungary** mentioned the EU Modernisation Fund.

Best practice – Austria "The '100,000 rooftops' solar panel and small-scale storage programme is intended to encourage private individuals and businesses to make greater use of roof areas for photovoltaic modules. Moreover, focus will implicitly be on a combination of solar panels and storage by applying a self-supply rate as a ranking criterion for investment support." Source: Austrian NECP

The non-EU member states gave little or no information about investment support schemes in national strategic documents. One exception is the **Solarni Katuni project in Montenegro** which is part of an initiative to support electricity supply in the rural areas whereby the government covers up to 70% of the investment costs for rooftop solar PV systems on shepherds' cottages.

TABLE 5: INVESTMENT SUPPORT SCHEMES IN THE EU MEMBER COUNTRIES

Investment support	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Investment support for large scale RES-E									
Investment support for small scale/household sized RES-E									



3.2.2.3. OTHER SUPPORT SCHEMES

A wide range of further support schemes are in place and are to be implemented in the Danube Region countries, summarized in Table 6 .

[22] Source: Energy Community Secretariat (2020): WB6 Energy Transition Tracker. Download: https://www.energy-community.org/dam/jcr:2077a2ba-805a-4ca2-afcb-91c90ecc0878/EnC_WB6_072020.pdf

TABLE 6: OTHER SUPPORT SCHEMES IN THE EU COUNTRIES

Other support schemes	AT	BA	BG	CZ	DE	HR	HU		MD	ME	RO	SI	RS	SK	UA
Support for financing (preferential loans) or tax relief															
Support for existing installations															
Support for repowering															

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Financial schemes are often used to ease the investment burden of RES-E installations. In Czechia and Austria self-consumed electricity is exempted from electricity tax. Preferential loans for RES-E installations are available in Germany, Croatia, Hungary, Slovenia and Serbia. Hungary plans to implement a Geothermal Guarantee Fund to decrease the geological and drilling risk of geothermal electricity and heat production. The Ukraine grants VAT exemption on imports of certain wind and solar equipment.

Best practice – Germany The „KfW Renewable Energy Programme–Standard" gives low interest loans for investments in installations for electricity production indiscriminate of the technology in accordance with the EEG. The financial support is a long-term and low-interest loan with a fixed interest period of 5 or 10 years including a repayment-free start-up period. Also available are similar credit lines KfW Renewable Energy Premium (for deep geothermal electricity production), the KfW Programme for offshore wind energy, and the KfW Renewable Energy Programme Storage. Source: www.kfw.de

Support schemes are mainly applicable to new installations, leaving **support for existing installations** subject to certain conditions. The EEAG State Aid Guidelines allow support to further the operation of biomass and biogas plants because they would otherwise stop operations before the end of their lifetimes or switch to fossil fuels. **Hungary** applies this so-called brown premium which will be introduced in Slovakia and Czechia. Czechia also plans to implement a bonus support scheme for electricity produced in modernised facilities which must meet the conditions imposed on new plants. In **Austria** solid biomass plants with feed-in tariff contracts expiring between January 2017 and 31 December 2019 can extend them for a maximum 36 months.

EU member states that introduced support schemes in the early 2000s will see a wave of installations reaching the end of support periods after 2020. According to the "CEER Paper on unsupported RES[23]" onshore wind turbines will be most affected, as more than 2500 MW of capacity exits support schemes between 2021 and 2027 in the EU. A framework or support scheme for repowering is only mentioned in the NECPs of **Austria** and **Germany**, who envisage premium support for **repowered** onshore wind, but no details are mentioned. The

[23] CEER Paper on Unsupported RES, 2020. Download: https://www.ceer.eu/documents/104400/-/-/9e615e4c-3735-597f-f4e2-5fecaf93aaae

need for modernising and repowering existing hydro power plans is described in the Austrian NECP and in the strategic documents of Serbia and the Ukraine.

3.2.2.4. ADMINISTRATIVE POLICIES

To assist target achievement by 2030 the RED II demands that governments provide long-term certainty for investors and speed up procedures to receive permits for projects.

TABLE 7: ADMINISTRATIVE POLICIES IN THE DANUBE REGION COUNTRIES

Administrative policies	AT	BA	BG	CZ	DE	HR	HU	MD	ME	RO	RS	SI	SK	UA
Framework for self-consumption / prosumers	■	■	■		■	■	■			■		■	■	
Framework for renewable energy communities	■		■	■	■	■	■					■	■	
Framework for PPAs						■				■				
Framework for site selection and spatial planning	■			■	■	■			■			■		■
Framework for streamlining administrative procedures	■	■	■	■		■			■	■		■	■	■

□ Not in target / No information ■ Proposed, but no targets, measures ■ Policy formulation / decision making ■ Implementation

RED II also puts the consumer at the centre of the energy transition with a clear right to produce and consume own renewable energy. EU member states must transpose RED II by 30th June 2021, which tends to be reflected in the NECPs in less detail (see Table 7).

Along with the aim to put the consumers at the heart of the energy transition, several countries have developed frameworks for the **self-consumption** of the self-generated renewable electricity (mainly solar PV). Net-metering is used in Hungary (below 50 kW) and Bosnia-Herzegovina, while in Romania a net-billing scheme (below 27 kW) is in place. However, the EU and regulators prefer self-consumption schemes that are more market based and operate with cost-reflecting network tariffs – those of AT, DE and SK. Austria introduced a scheme for **collective self-consumption** into the Austrian Green Electricity Act and the Austrian Electricity Act in 2017. Bulgaria and Croatia are planning to develop new schemes for self-consumption, while Hungary and Slovenia plan to align their schemes with the provisions of the Clean Energy Package.

A legal framework for **energy communities** has only been rendered in Austria and Germany. With the exception of Romania,[24] all EU DR countries aim to develop the framework for renewable energy communities, though the agendas are not elaborated. It is not mentioned in non-EU DR strategic documents.

[24] Among the policies and measures for renewable energies the Romanian NECP states that "policies and measures to promote the role of local renewable energy communities" are not applicable. However, smart communities are mentioned in the sections of the internal energy market dimension (*see also Chapter 3.9.3 of this report)*.

Best practice – Germany "Access to renewable energy communities is open to end consumers in Germany in a non-discriminatory manner, as is the access of renewable energy communities to the existing support schemes. Germany has given special privileges to 'citizen energy communities' in calls for funding in the area of onshore wind energy. If selected, these renewable energy communities receive funding not just on the basis of their own bid value but based on the bid value of the highest bid accepted on the same bid date (uniform pricing). The Federal Government is assessing whether changes to the existing regulatory framework are required for the implementation of Article 22 of Directive (EU) 2018/2001." Source: German NECP

Site selection for RES-E installations is becoming a crucial issue with the rapid deployment of these technologies. Environmental concerns for nature protection sites and grid issues are governed by **site selection and spatial planning**, associated with hydro power plants and onshore wind farms. According to the NECPs, site selection measures are already being applied in Czechia and Germany and additional measures are being developed in Austria, Croatia, Slovenia, and Montenegro. The National Renewable Energy Action Plan 2014-2020 (NREAP) of **Montenegro** stated that the Law on Energy obliges local governments to develop local energy plans anticipating the method of matching demand with types of energy supply. Land zoning rules are to be eased in the **Ukraine** to achieve cost savings for investors. Several NECPs mention the need to streamline **administrative procedures** (permitting, grid connections).

With falling technology costs, renewable energy projects will be developed increasingly through **power purchase agreements** (PPA) instead of support schemes. For now, only Croatia and Romania mention PPAs in their NECPs.

3.2.2.5. INFORMATION CAMPAIGNS, AWARENESS

Danube Region countries put little emphasis on information campaigns and awareness raising activities for renewable electricity, as Table 8 demonstrates. The **Croatian** NECP contains a long list of targeted measures (e.g. implementation of educational programmes on the use of RES in kindergartens and schools, setting up and organizing an advisory service with experienced practitioners, promotion of reconstruction of old mills and water mills into small hydropower plants, promoting the use of RES on islands, etc.), while other countries keep with general agenda setting or list already implemented activities (e.g. information on training possibilities, lists of certified installers, etc.) (AT, BG, SK) as requested by Directive 2009/28/EC

Among the non-EU countries, **Ukraine** plans to attract foreign strategic and financial investors into the RES market using international communication campaigns. The **Serbian** energy strategy states that education and information is an integral part of the overall strategy of the sustainable energy sector.

TABLE 8: POLICIES FOR INFORMATION AND AWARENESS RAISING FOR RES-E IN THE DANUBE REGION

Information and awareness raising	AT	BA	BG	CZ	DE	HR	HU	MD	ME	RO	RS	SI	SK	UA
Information, training, and awareness raising policies f														

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

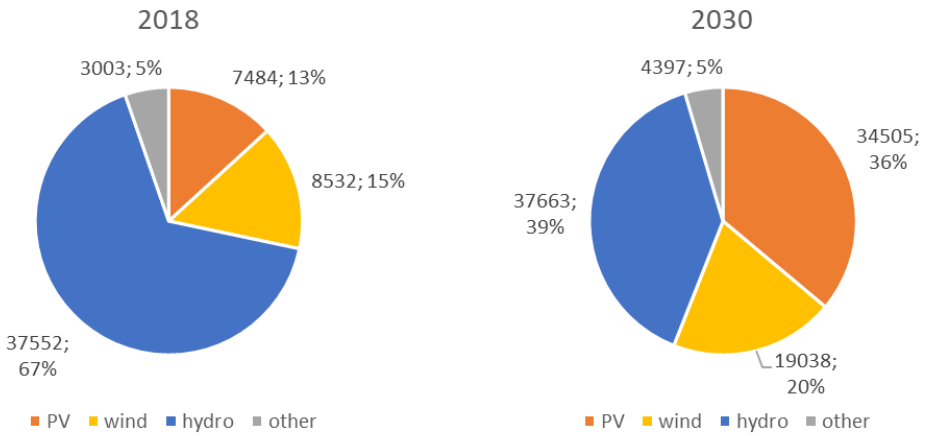
3.2.3. EXPECTED OUTCOMES

The targets indicated in Section 3.2.1. show that all Danube Region countries have committed themselves to increase their shares of renewable electricity generation. This can be achieved by increasing the capacities of renewable electricity installations and by decreasing fossil fuel capacities (*see Chapter 3.9.1*). This section presents trends in renewable energy capacities between 2018 and 2030 using the forecasts described in the NECPs and strategic documents.

3.2.3.1. EXPECTED RES-E CAPACITY INSTALLATIONS

While the current capacity mix of the Danube Region is dominated by hydro power plants (data excluding pumped storage), growth in installed capacities by 2030 will be driven by solar PV and onshore wind. This will significantly change the capacity mix by 2030 (see Figure 19, data without Germany and the Ukraine[25]).

FIGURE 19: RES-E CAPACITY MIX IN THE DANUBE REGION COUNTRIES, 2018 AND 2030 (MW, %) (EXCLUDING DE AND UA)



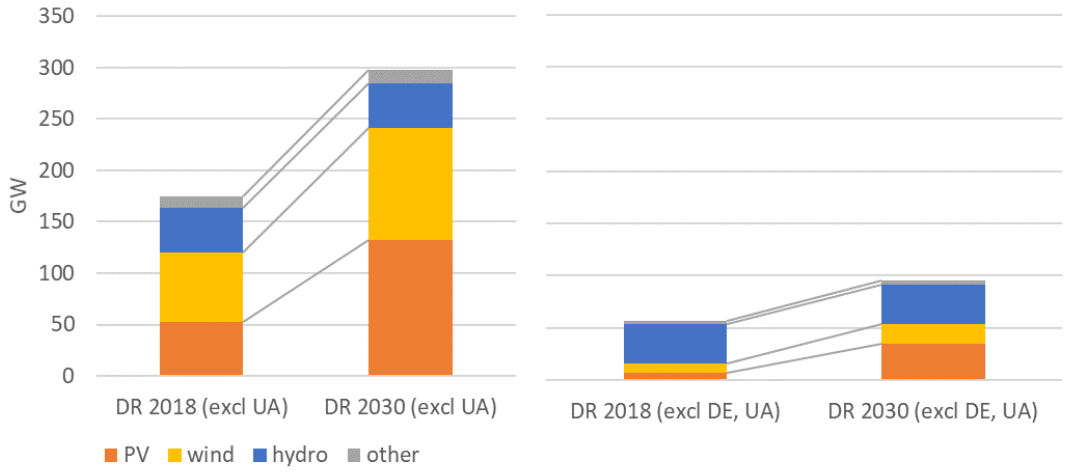
Source of data: Eurostat, NECPs, strategic documents of non-EU countries

[25] Figure 19 does not include data from Germany, as Germany will probably to account for more than 65% of RES-E installed capacities in 2030 and thus the capacity mix with Germany would not picture the change in technologies to be achieved in the latecomer countries. No capacity data are available for the Ukraine for 2030.

Declining costs, endowment, and small environmental footprint make solar PV the most attractive RES-E technology over the next decade in the Danube Region.

Installed capacities are expected to grow by 79 GW in EU members (52 GW from Germany) and at least by 490 MW[26] in the Energy Community countries between 2018 and 2030. Onshore wind will also attract significant investment, with 40 GW new installed capacities in EU members of the Danube Region (31 GW of which in Germany, 13.6 GW being new offshore wind capacities) and 877 MW in the Energy Community countries[27]. Hydro capacities are expected to fall slightly in the EU countries (by 155 MW) but will increase in the non-EU countries (by at least 347 MW[28]).

FIGURE 20: INSTALLED RES-E CAPACITIES IN THE DANUBE REGION (DR) COUNTRIES, 2018 AND 2030 (GW)



Source of data: Eurostat, NECPs, strategic documents

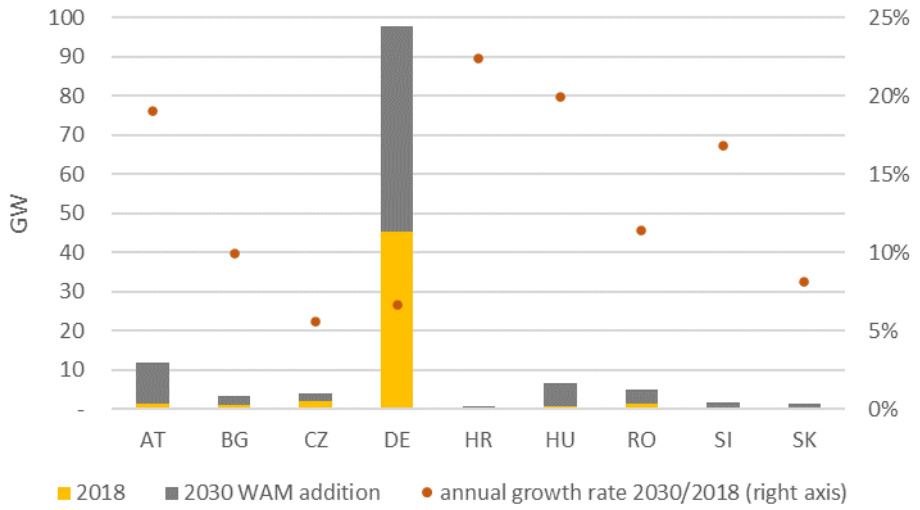
Due to uncertain data for 2030 in the non-EU countries, the following graphs contain only data from the EU members of the Danube Region.

3.2.3.2. SOLAR PV

Among the EU countries the biggest increase in installed solar capacities is expected in Germany, Austria, Hungary and Romania in terms of added capacities and in Croatia, Hungary, Austria and Slovenia in terms of annual growth rates (see Figure 20 and Figure 21). In Germany and Czechia, and Slovakia annual growth rates will remain below 10%.

[26] Uncertain data for the Energy Community countries for 2030, no data for the Ukraine.
[27] No data are available for 2030 capacities in the Ukraine.
[28] Uncertain data for the Energy Community countries for 2030, no data for the Ukraine.

FIGURE 21: SOLAR PV CAPACITIES IN EU DR COUNTRIES, 2018 AND 2030, GW AND %

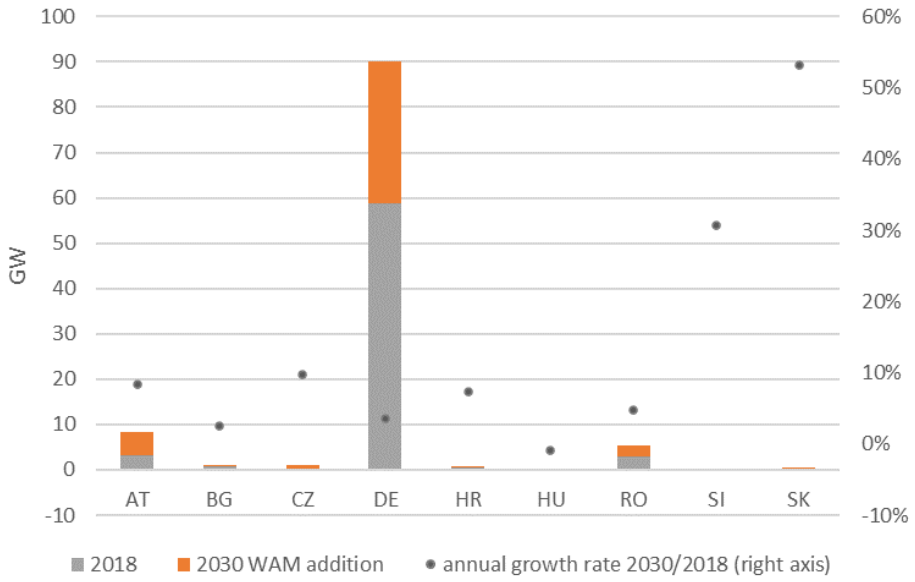


Source of data: NECPs

3.2.3.3. WIND ENERGY

Except for Hungary all NECPs envisage a growth in the installed capacity of wind power plants. The largest capacity additions are expected in Germany, Austria and Romania, and highest growth rates in Slovakia, Slovenia and Czechia due to a low level of current installations (see Figure 20 and Figure 22). There are no plans for adding new wind capacities to Hungary's electricity system. Germany plans to extend its 6.4 GW offshore capacity (2018) to 20 GW by 2030.

FIGURE 22: WIND ENERGY INSTALLED CAPACITIES AND ANNUAL GROWTH RATES IN EU DR COUNTRIES, IN 2018 AND 2030, GW AND %



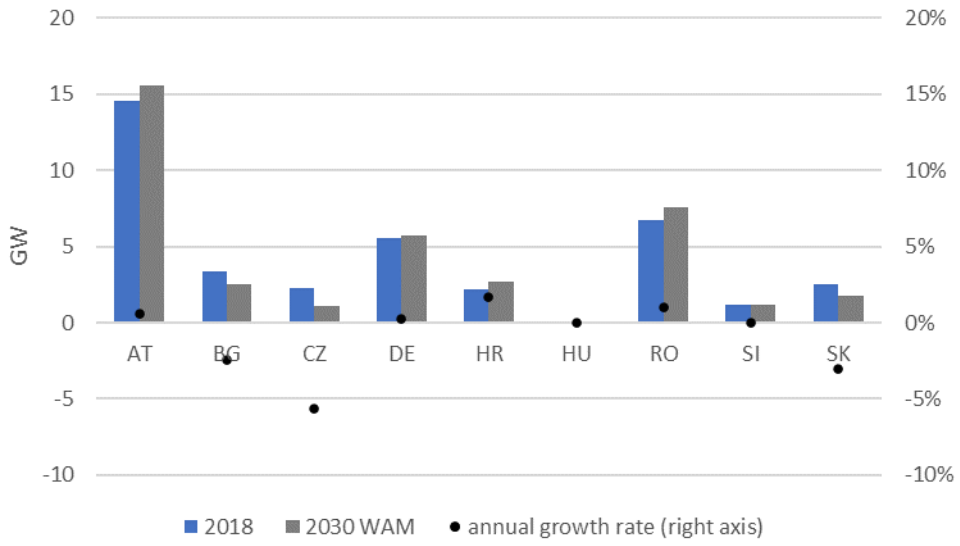
Source: NECPs

3.2.3.4. HYDRO POWER PLANTS

Traditionally most Danube Region countries use hydro power as the central piece of the renewable electricity portfolios due to favourable natural conditions. Nevertheless, hydro power will play less of a role in achieving the 2030 climate and energy targets with most EU members of the Danube Region stepping away from hydro development due to environmental concerns.

The non-EU DR countries are concerned with the impact of hydro power on nature conservation and the plans for modernising hydro capacities and new installations are subject to spatial planning and site restriction measures (*see Section 3.2.2)*

FIGURE 23: HYDRO POWER INSTALLED CAPACITIES IN 2018 AND 2030, AND ANNUAL GROWTH RATES IN EU DR COUNTRIES (GW, %)



Source of data: NECPs

3.2.3.5. OTHER RES-E CAPACITIES: BIOMASS AND BIOGAS, GEOTHERMAL

Most Danube Region countries plan to continue to develop **solid biomass and biogas** installations, although at a smaller scale compared with solar PV and wind energy. According to the NECPs, solid biomass and biogas capacities will actually fall in Germany and Romania by 2030. (For more information about solid biomass use see Chapter 3.4)

Geothermal power plants currently operate in Austria, Germany, Croatia, Hungary, and Romania and will increase over the next decade. In addition, Slovakia, Czechia, and Serbia plan to start operating geothermal power plants till 2030.

3.2.3.6. EXPECTED RES-E GENERATION

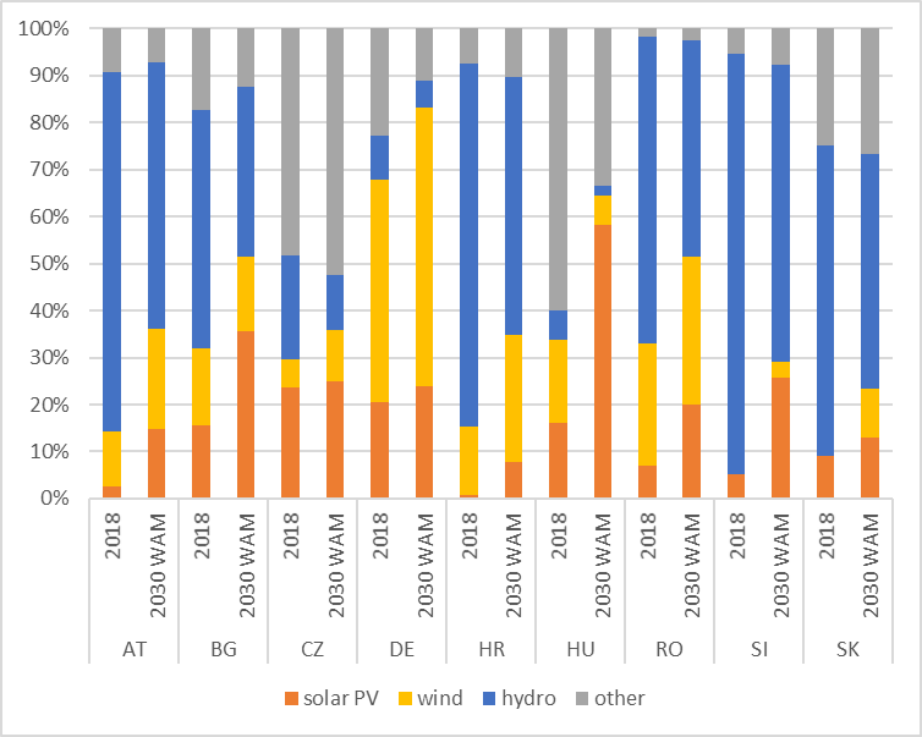
Although RES-E deployment has grown in several countries and German RES-E investments are slowing, Germany will still produce 61% of renewable electricity of the Danube Region countries in 2030 as Figure 24 illustrates.

FIGURE 24: EXPECTED RES-E GENERATION IN THE DANUBE REGION IN 2030 (TWH, %)

Source of data: NECPs, strategic documents

Generation mixes will change over the next decade, with new RES-E investments increasing the proportion of solar PV and wind. According to Figure 25, the proportion of solar PV and wind energy increases across all countries. "Other" RES-E generation (mainly biomass) becomes more significant in Czechia, Croatia, Slovenia, and Slovakia according to the WAM scenarios.

FIGURE 25: CHANGE IN GENERATION MIXES OF THE EU DR COUNTRIES, 2018-2030 (%)



Source of data: NECPs

3.3. RENEWABLE HEATING AND COOLING

The heating and cooling sector plays a very important role in reaching the overarching RES targets of EU DR countries, Renewable heat represents more than 20% of heat demand with the exception of Germany and Slovakia, and 5 countries have shares around 40% or higher (see Figure 7 in section 1.2.2). Biomass use of the residential heating sector is responsible for most of this renewable use, burning wood (often mixed with coal or trash) in outdated, heavily polluting stoves. There are no plans in any of the countries to replace these inefficient biomass-fired installations, only the change of fossil-based heating systems will be mandated or supported (for example in Austria, Germany, Romania, Slovenia, and Bulgaria).

3.3.1. TARGETS

The Renewable Energy Directive and its recast (RED II) do not contain specific targets for the share of renewable heat consumption.

The first targets for renewable heat production were set by the 2012 Energy Efficiency Directive (EED, 2012/27/EU). The EED required Member States to carry out a comprehensive assessment and cost-benefit analysis of the feasibility of high-efficiency cogeneration (based on useful heat demand) and efficient district heating[29]. Where the benefits outweigh the costs, Member States are to take appropriate measures to develop efficient district heating/cooling infrastructure.

The 2018 Renewable Directive (RED II) sets out a number of specific requirements for the use of renewable energy sources for heating. On the one hand, it requires Member States to increase the share of renewable energy in the heating and cooling sector by an indicative annual average of 1.3 percentage points from 2021 onwards. On the other hand, it obliges Member States to set a minimum level of RES in their building regulations for new buildings and buildings subject to major renovation, if economically and technically feasible.

RED II also sets a quantified target for the district heating sector to increase the share of renewable and waste heat: Member States shall seek to increase the share of renewable energy, waste heat and waste cooling in their district heating and cooling systems by 1 percentage point annually. District heating companies are obliged to connect providers with these heat sources to their network unless it is not feasible, in which case they have to submit detailed reasoning and list the conditions for possible connection.

The above-mentioned directives are generally applicable for the EU Member States although some can be modified according to specific local conditions, e.g., the mandatory growth rate is 1.15% in Bulgaria and 1.1% in Czechia. At the same time, Slovakia will follow a 1.4% growth rate between 2020-2025. Most countries project the contribution of the heating and cooling sector to the overall renewable target, but only Hungary and Germany set a numerical sectoral target which differs from the projections of the modelled scenario

[29] District heating systems using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat (EED).

results. Hungary aims to raise the renewable target to 30% and in Germany to 27%. The Austrian NECP does not present any projection or trajectory in this sector.

Austria is working on a targeted 'Heating Strategy' expected to be completed in 2020. The aim of the strategy is to mitigate dependency on fossil fuels and instead relying on biomass, solar heat, and ambient heat. In addition, the existing contribution of heat from waste management and industrial waste heat is planned to be maintained and possibly expanded. **Bulgaria** aims to reduce the country's final energy consumption in the heating and cooling sector 2% by 2030 from 2020, building partly on the decrease of district heating losses. The planned growth in biomass consumption includes the use of biodegradable waste, which will grow from 36 ktoe (414 GWh) in 2020 to 75 ktoe (873 GWh) in 2030.

Czechia has reached its RES target (20.7 % in 2018) and would find even the lowered, 1.1 percent annual growth, problematic. **Germany** adopted the Energy Efficiency Strategy for Buildings in 2015, which is based on decarbonised district heating and funding programmes to support biomass boilers and heat pumps in individual heating. **Hungary** builds on the efficient use of biomass in both individual heating equipment and in district heating and geothermal energy in district heating. **Romania's** goals are based on the availability of sustainable biomass, backed by heat pumps or solar panels on rooftops. According to **Slovenia's** NECP, energy consumption in the heating and cooling sector is expected to fall by 4746 GWh in 2030. Slovenia supports renewable energy use of buildings.

As regards the non-EU DR countries, only targets for 2020 are available. In **Bosnia and Herzegovina** RES based energy usage in the sector will increase 34.6 % by 2030. **Moldova** set a 27% target in the heating and cooling sector for 2020 compared to 19.36% in 2009. **Montenegro** aims to double the country's renewable energy consumption in the heating and cooling sector from 61.2 to 121.5 ktoe between 2009-2020, leading to a 38.2% RES share in 2020. The national RES-H target of the **Serbian** H&C sector is 36.6% in 2020, up from 25.6% in 2009. **Ukraine** still promotes natural gas in individual heating as well as in CHPs. However, the country points out ambitions to increase the RES share to 12.4% by 2020 from 3.4% in 2009.

3.3.2. POLICIES AND MEASURES

Compared to other energy sectors, the heating and cooling sector does not have well established, continuous forms of support like the feed-in-tariff or premium system in the renewable electricity sector. The most common form of promoting RES-H is investment support, which is usually provided inconsistently. District heating receives most of the support for renovations and RES integration.

Policies and measures that support the deployment of renewable fuels in the sector can be grouped into the following categories:

- regulatory measures: these measures aim to establish the proper administrative processes, frameworks, and procedures that remove regulatory obstacles impeding renewable growth,
- financial instruments: support schemes that reduce upfront investment costs (investment support), allow for stable and/or preferential revenues (operating

support, price subsidy, tax exemption), or take the form of refundable aids and guarantees of origin

- infrastructure: measures to promote the deployment of new district heating systems and renovations and measures regarding individual heating installations,
- promotion of RES fuels: this group of measures includes targeted promotion of specific renewable fuels or technologies, incentives to replace fossil fuel installations, and general information and awareness raising programs.

The applied policies can be grouped into these four categories depending on the form and the subject of support, as can be seen in Table 9.

TABLE 9: MEASURES IN THE H&C SECTOR

		Policies by the subject of support	
		infrastructure	promotion of RES fuels
Policies by the form of support	regulatory measures	e.g., mandatory connection of district heating from renewable sources	e.g., ban on the installation of fossil-based heating systems
	financial instruments	e.g., investment support for building new district heating networks	e.g., introduction of guarantees of origin

The most impactful policies are presented in the following paragraphs. Please note that the targets and policies related to biomass burning and use of heat pumps are covered in the dedicated chapters on sector coupling (Chapter 3.11) and biomass (Chapter 3.4) and therefore not discussed in this chapter.

One of the main goals of the Member States is to access and distribute the EU funds and streamline the administrative procedures.

The Austrian and the German NECP both emphasize the need to remove regulatory obstacles and harmonize the legal framework for the RES expansion. Bulgaria will strengthen the role of central and local authorities to enable higher penetration of renewable energy. Czechia reduced the administrative requirements for the connection and installation of small sources. The Hungarian NECP mentions the need of regulatory support for RES based 'village heating plants' within the framework of energy communities. Slovakia proposed the most ambitious measures for RES in district heating with mandatory connection from renewable sources. They will also change to a FIT system in the longer term.

TABLE 10: FINANCIAL INSTRUMENTS IN THE H&C SECTOR

Financial instruments	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Investment support									
Operating support									
Price subsidy									
Refundable aid									
Guarantees of origin									

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

Financial instruments promoting RES are grouped into five categories: investment support, operating support, price subsidy, refundable aid and guarantee of origin (GO).

In **Austria** the most important financial instrument to promote RES in the heating sector is the Domestic Environmental Support scheme. It aims to employ a more cost-effective support system without increasing the budget. Guarantees of origin system is also planned for the heat sector. **Bulgaria** plans to adjust legal requirements for the issuance of guarantees of origin and will utilize the Modernisation Fund for RES projects in the period 2021-2030. **Czechia** provides investment and operating support. In addition, RES installations have an exemption from immovable property tax. It proposes the introduction of the Annual Green Bonus system which, through auctions, will build new biogas, biomass and geothermal power plants and compensate for the difference in RES and non-RES fuel costs.

Germany plans to provide support for the construction of new district heating networks with a high share of renewable energy and waste heat. It also transforms existing large-scale, fossil-fuel based heating networks, most of which will progressively undergo the process of transformation into modern low-temperature heat networks with high shares of renewable energies and waste heat. **Croatia** provides investment and operating support for RES-H projects. **Hungary** has been promoting biomass and geothermal share in district heating since 2014 and now plans to encourage the construction of new biomass and geothermal district heat generation capacities. Non-refundable aid from operational programmes in 2021-2027 will be directed at RES-based district heating and their efficient upgrade. Refundable aid supports the establishment of cogeneration biogas plants processing agricultural waste.

In **Romania**, an upgrade of the 'Heat and Comfort' District Heating Programme will provide funding for upgrades, rehabilitation and extension or deployment of centralised heat supply systems for localities. The financial pillar of the new **Slovenian** support scheme beginning in 2021 will be transformed into investment grants for technologies close to being competitive relative to end-user prices. **Slovakia's** RES support focuses on the electricity sector with a FIT for cogeneration plants, with an emphasis on biomass fuelled CHP plants. There are plans to introduce support for efficient district heating projects from public sources and operating aid that will promote new plants producing heat from biomass, biogas, biomethane, geothermal, solar energy, and aerothermal, geothermal, and hydrothermal heat pumps.

Table 11 presents the status of national measures targeting infrastructure development in the EU DR countries.

TABLE 11: INFRASTRUCTURE SUPPORT IN THE H&C SECTOR OF EU DR COUNTRIES

Infrastructure	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Building new RES based district heating									
Refurbishment of existing systems									
Individual heating									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

In **Austria**, maintenance and optimization of existing biomass-based district heating networks is a priority funding area of the Domestic Environmental Support scheme. As a part of the proposed provincial support for the construction of buildings, thermal development of buildings will include replacement of heating systems in the private and business sectors. An assessment of infrastructure measures needed for district heating and cooling from renewable energy sources will be carried out during the drafting of the Renewable Energy Expansion Act.

The **Bulgarian** Renewable Energy Act promotes the construction of heat transmission networks based on renewable sources, the installation of small, decentralized heating and/or cooling systems and the connection of renewable heat generation units to heat transmission networks also supporting the purchase of RES-H, where it is technically feasible and economically viable. There are plans in Bulgaria to install new district heating networks and assess the potential rehabilitation of heat transmission systems. **Czechia** recognizes the need to build new RES-based district heating and cooling infrastructure and plans to support the modernization of existing heat supply systems, as well as the development of smaller renewable heat supply networks. In **Germany,** the amendment to the existing 'Heating Networks 4.0' covers district heating. One priority area is the expansion of low temperature networks and the transformation of existing heating systems. They also have to prepare and convert them for the supply of high share of RES and waste heat. For individual heating, the programme covers renovation support, too.

In **Croatia**, RES in district heating and renewable technologies in individual buildings (solar thermal systems, heat pumps etc.) will be promoted. **Hungary** aims to replace natural gas-based district heating with renewable heat generation through implementation of the Green District Heating Programme. RES usage is supported with non-refundable aid. In **Slovenia** development of RES based district heating systems is promoted within the framework of the EKP operative programme and the Rural Development Programme. **Slovakia** supports the renovation of heat distribution pipes and plans to enable the connection of heat produced by own-consumption and energy communities in the district heating system. It also supports the expansion of district heating systems in the case of market interest.

Among several measures in force and planned, family houses and apartment buildings can apply for aid in the form of a voucher for small installations using renewable energy sources.

TABLE 12: PROMOTION OF RES FUELS IN EU DR COUNTRIES

Promotion of RES fuels	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Geothermal energy									
CHP									
Solar heat									
Replacement of fossil fuels									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Measures targeting the promotion of specific renewable fuels or technologies to incentivize the replacement of fossil-fuel based heating installations are listed in Table 12.

Austria has already introduced a program to replace oil-fired heating by innovative RES powered heating systems or efficient district heating with a budget of EUR 62.7 million in 2019. In **Bulgaria,** several renewable fuels and technologies will be supported with small-scale geothermal projects and a cost-benefit analyses of RES potential will be performed by the end of 2020. In **Czechia** investment support will be provided for geothermal and biomass plants. **Germany**'s 'Heating Networks 4.0.' programme initiates a stakeholder dialogue on heating transition among other measures. Programmes are operating to replace oil heating and a national energy efficiency label was introduced for old heating installations. Funding for mini cogeneration plants is available until the end of 2020 for highly energy-efficient installations up to 20 kW in residential and non-residential buildings. The **Croatian** NECP does not speak to this topic beyond the general promotion of renewable based systems in buildings (solar thermal systems, heat pumps, biomass stoves and boilers). **Hungary** supports heat pumps, burning of biomass in efficient individual heating equipment, and the establishment of decentralised community heating plants with grants. The core objective for RES heating is to replace natural gas imports. **Romania** aims to maintain the 'Casa Verde Plus' programme to foster the development of the national heat pump market and the use of solar panels. **Slovenia** will ban on the sale and installation of new oil boilers beginning in 2023 at the latest. In **Slovakia** both existing and new CHP plants using RES are receiving operating aid.

Austria plans to introduce **awareness-raising** programmes to promote RES usage for heating and cooling purposes. Bulgaria aims to provide final consumers with information about the energy performance and the share of renewable energy in heating and cooling systems. Slovakia will introduce an information obligation for district heating suppliers to inform customers of the RES share in the supplied heat.

3.3.2.1. MEASURES IN THE NON-EU COUNTRIES

Measures in the non-EU member countries are summarized in this section to give a brief picture of the policies for 2020 only.

The strategic documents from **Bosnia and Herzegovina** compel the Federal Government to decide on issuing the Guarantee of Origin for heat energy generated using RES. Feasibility studies in the topic of district heating optimization, expansion and development of networks is placed further down the timeline. It also articulates the need to regulate utilisation of the minimum levels of energy from RES for construction, renovation, and the introduction of an obligation for large consumers of heat energy.

The **Moldavian** Renewable law written in 2013-14 established the framework for RES development towards 2020 targets and further defined RES priorities. There were several measures among the plans, like the introduction of certification/qualification schemes for small-scale biomass boilers and stoves, solar PV and solar thermal systems, shallow geothermal systems, and heat pumps. The introduction of specific administrative procedures (authorisation, certification, and licensing) was planned for 2014. Moldova highlights several programs in the NREAP (2014) to raise awareness and inform people about different renewable heating modes, like supporting research, organizing events, developing guidance on the RES technologies, and media coverage.

Montenegro promotes RES usage in households through interest-free credit lines for installation of solar-thermal systems and heating systems using modern biomass fuels (pellets, briquettes) for households.

Expansion of RES usage in **Serbia** will be predominately through biomass in CHP plants and district heating systems (84 ktoe) and biomass usage in households (50 ktoe). Replacing the usage of coal and fuel oil by biomass (and natural gas) is an important pillar of Serbian policy. The local self-government is the competent authority to support the use of RES in district heating. RES in individual heating is also supported both from international and national sources.

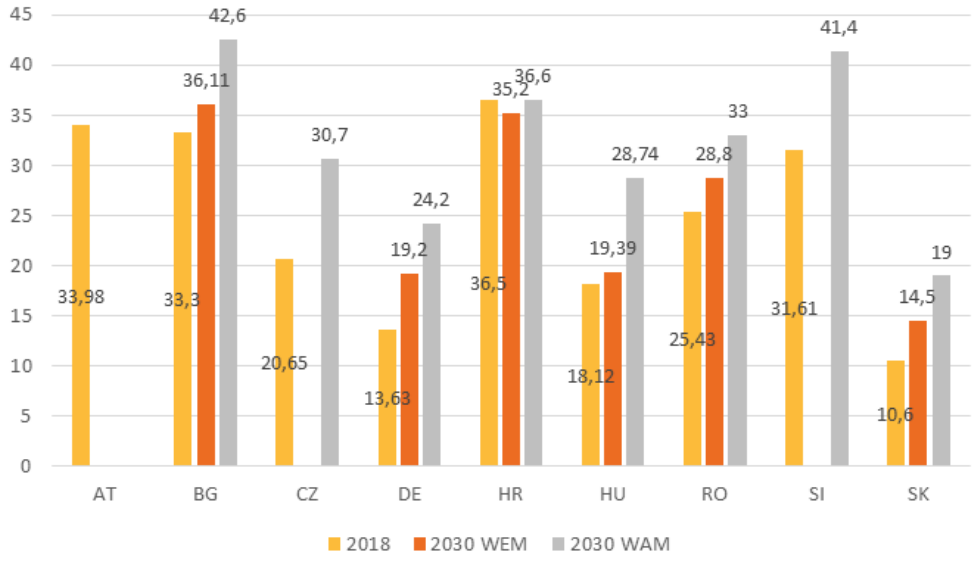
In **Ukraine** RES expansion in the H&C sector is based on the utilization of solid biomass and to a lesser extent heat pumps. Measures to promote switching district heating networks to renewable fuels are planned. An important element of the strategy is the implementation of tariff setting for heat generation from renewable sources and the development of an energy biomass market in Ukraine. (NREAP, 2014)

3.3.3. EXPECTED OUTCOMES

This section presents the expected effects of the measures based on the projections presented in the NECPs. Since non-EU member countries do not yet have NECPs with projections for 2030, only the expected developments in EU DR members are analysed here. As estimations for scenarios with existing measures (WEM) and with additional measures (WAM) were provided separately. The effects of the planned policy measures can be defined as the difference between the results of the WEM and the WAM scenarios.

Figure 26 displays the WAM projections for 2030 and compares them with the current (2018) status and the WEM projection for the same year.

FIGURE 26: SHARE OF RENEWABLE ENERGY IN THE H&C SECTOR (%)



Source: SHARES database, NECPs of the presented countries

Unfortunately, data for the WEM scenario are not presented in the Czech and the Slovenian NECPs and none of the 2030 scenarios are included in the Austrian NECP.

As we can see, the countries set very ambitious RES share goals compared to the present status. The only exception is Croatia where the current share is already very high. Going deeper into the projected development trends, we can conclude that the countries expect that their additional measures will have a substantial effect, resulting in 2-3 times larger increase in RES shares compared to the WEM scenarios (except HR). The biggest difference can be observed between the Hungarian scenarios, where the additional measures result in more than eight times larger growth in RES share than the scenario with existing measures.

These substantial effects should be interpreted in the context of the measures. In the previous chapter, many already implemented (dark green) measures were presented, which represent the WEM scenario. The additional effects (WAM to WEM) are associated with the proposed (yellow and light green) measures, including the expansion and enhancement of the existing measures.

3.4. BIOMASS RESOURCES, BIOMASS USE AND EFFECTS ON LULUCF

This study applies a complex climate policy approach to integrate two aspects of biomass – resources and use – and assess efficacy of policy measures. This chapter reviews forestry related objectives and measures coupled with its anticipated use for energy purposes. First, we compare forestry carbon sequestration targets with baseline trends and evaluate the measures proposed by the national administrations. Then we review biomass-to-energy objectives, with a special focus on transformation to electricity and heat and final energy consumption in biomass-to-heat by households. To conclude the chapter, we provide an integrated evaluation of biomass related policies.

3.4.1. BIOMASS RESOURCES

This chapter focuses on primary solid biomass from forestry, meaning wood material originating form thinning and felling of timber, that includes felling residues and utilized dead wood. Short rotation tree plantations are not included to the extent of the NECP policies. Post-consumer wood is categorized as waste which along with agricultural products and by-products are not explicitly covered in this study. Yet, several countries (AT, BG, DE, HU) include "final energy consumption of combustible biomass" as biodegradable waste.

3.4.1.1. TARGETS – BIOMASS RESOURCES

Throughout all DR countries, forestry has been an invaluable reservoir of sequestered carbon. When forests are compromised (pests, drought spells, fires, extreme wind, etc.) the natural process of forest expansion could reverse due to spikes in tree mortality. Such conditions of net carbon loss by forests may last for years and decades.

Apart from natural and manmade disasters, the forestry sectors have provided massive negative emissions in the DR. It is therefore puzzling that governments do so little in accounting for the expansion of their naturally driven free sequestration potential. The NECPs do mention the importance of the forest carbon sinks but do not elaborate concrete quantitative targets for enhancing forest sequestration. At the most these are written statements of 'objectives' and some reference to implementing 'measures' but qualify only as "agenda setting" at best.

The narrative objectives can be categorized into two subsets:

1. **safeguarding existing carbon reservoirs –** preserving forest stock on current forest area and no loss of forest area, sustaining soil carbon, making forests more resilient to climate change related damaging factors and possibly increasing the intensity of carbon sequestration for existing forests
2. **enhancing natural carbon sequestration beyond existing forests** – increasing forest area by reforestation and afforestation, increasing the sink potential of added reservoirs by species selection and optimization of harvest rotation and locking away forest-sunk carbon into products through more intensive timber use by processing and building industries

Implementation measures can be grouped into four categories: (i) forest management, (ii) financial instruments, (iii) regulatory control, (iv) information and awareness-oriented measures. Our findings are summarised in Table 13.

The matrix in Table 13 suggests a rich landscape of measures that the governments are aware of to help achieve objectives. The actual force of policy measures depends on how far those measures advance in the policy cycle. In forestry policy, only a few measures have progressed to the implementation stage, but most are in the preliminary stage. Whether they will progress to be implemented remains to be seen.

TABLE 13: POLICY GOALS AND RELATED MEASURES IN THE FORESTRY SECTOR

goal category	goal	forest management	financial incentives	regulatory control	information, awareness
safeguarding natural carbon reservoirs	**preventing loss of forest biomass**	improving forest management	compensatory payments to forest owners for losses due to exploitation limitations, funding the protection of carbon sinks	protecting vulnerable sites, ban on deforestation, preventing fires, preventing illegal logging	improve forestry information systems; stable funding for the National Forest Inventory
	improving forests' resilience	increasing climate resilience	remediation of forests damaged by bark beetle calamity	forest barriers	monitoring sinks and ecosystem functions
	increasing carbon stock	age structure changed gradually to decrease area of old stands	financial programs to prevent forest degradation	soil carbon accounting	training and workshops for forest owners
enhancing natural carbon sequestration beyond existing forests	**afforestation, reforestation**	-	funds for seed production and tree nurseries	identifying agricultural or protected land for forestation	indigenous, site-adapted species
	increasing sink potential	increase biodiversity		-	select fast growing species
	more use of timber products	increase wood harvesting	national emissions trading	buildings regulation to use more timber; sustainable timber into green public procurement	-

3.4.1.2. POLICIES AND MEASURES – BIOMASS RESOURCES

In this section we break down the identified forestry policy goals into measures at the national level.

The first set of objectives focus on **safeguarding natural carbon reservoirs,** mostly forests, but also natural grasslands and some other natural land covers. The first of the related measures is *prevention of losing forest biomass*, which contained few measures in current NECPs (Table 14).

An effective ban on deforestation is only mentioned in Bulgaria. The most 'on the agenda' measures are found in Romania, Bulgaria and Slovenia. The most intriguing measure provides funding for forest owners in return for keeping carbon sequestered in their forest. It is most explicit in the German NECP ("funding the protection of carbon stocks") and similar in Romania, though using more subtle terminology ("compensatory payments to forest owners for losses due to exploitation limitations").

TABLE 14: MEASURES TO PREVENT LOSS OF FOREST BIOMASS IN EU DR COUNTRIES

preventing loss of forest biomass	AT	BG	CZ	DE	HR	HU	RO	SI	SK
improving forest management									
compensatory payments to forest owners for losses due to exploitation limitations									
funding the protection of carbon sinks									
protecting vulnerable sites									
ban on deforestation									
preventing forest fires									
preventing illegal logging									
improve forestry information systems									
stable funding for the National Forest Inventory									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Measures to *improve forests' resilience* are on the agenda in 7 out of the 9 EU countries, as can be seen in Table 15. Most are concerned with resilience to damages caused by climate change but no plans worked this further up the policy making ladder.

TABLE 15: MEASURES TO INCREASE FORESTS' RESILIENCE IN EU DR COUNTRIES

improving forests' resilience	AT	BG	CZ	DE	HR	HU	RO	SI	SK
increasing climate resilience									
remediation of forests damaged by bark beetle calamity									
forest barriers									
monitoring sink and ecosystem functions									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

An interesting idea in Romania encourages forest barriers, a strip of shrubs to provide natural physical protection to forest edges. Slovenia has implemented a remediation program to compensate for the huge losses caused by bark beetles, categorized here as a resilience measure for remediation that improves species distribution, though it is not mentioned in the NECP text.

Table 16 highlights the measures directly aiming to *increase carbon stock* of existing forests.

TABLE 16: MEASURES TO ENCHANCE CARBON STOCK IN EU DR COUNTRIES

increasing carbon stock	AT	BG	CZ	DE	HR	HU	RO	SI	SK
age structure changed gradually to decrease area of old stands									
financial programs to prevent forest degradation									
soil carbon									
training and workshops for forest owners									

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

Three of the countries (DE, SI, SK) consider the potential of adding to the carbon stock of their existing forests by gradually decreasing the relative share of old stands, with Slovenia already formulating concrete measures to boost sequestration. On the other hand, Austria and Croatia focus on the forest floor soil - undisturbed forests keep sinking carbon perpetually into the forest ecosystem, and into soils in particular. Slovenia has scheduled trainings and workshops for forest owners about the carbon stock.

Table 17 reveals that only Germany has begun to implement its afforestation policy.

TABLE 17: MEASURES TO INDUCE AFFORESTATION AND REFORESTATION IN EU DR COUNTRIES

afforestation, reforestation	AT	BG	CZ	DE	HR	HU	RO	SI	SK
increasing forest area									
funds for seed production and tree nurseries									
identifying agricultural or protected land for forestation									
indigenous, site-adapted species									

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

Many governments plan to identify agricultural or protected land for afforestation (BG, CZ, HR, RO). The Austrian government has expressed priorities for indigenous, site-adapted species for afforestation. Croatia has considered making financial funds available for saplings production and tree nurseries.

The three countries that do not specify afforestation within their policy agenda (AT, SI, SK) nevertheless elaborate on carbon sink potential beyond the threshold of their existing forest

stock, possibly because they suffered from more acute natural disasters (weather and pest related damages). This is presented in Table 18. As an outcome they appreciate the trade-off between forest sinks and stores at fast-growing tree species and site-adapted, biodiverse range of species. Fast-growing species (in the focus of AT and HR) remove carbon from the atmosphere faster but are more sensitive to pests and hard weather conditions. More site-adapted species (favoured by AT, RO, SI, SK) might grow slower and thus provide lengthier carbon sequestration cycles but are more resilient as a carbon stock in the long run. Austria seems to consider all options and take a complex approach. Slovenia is the closest to implementation.

TABLE 18: MEASURES TO INCREASE SINK POTENTIAL IN EU DR COUNTRIES

increasing sink potential	AT	BG	CZ	DE	HR	HU	RO	SI	SK
increase biodiversity									
select fast growing species									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

As shown in Table 19, Slovenia and Austria are the only two countries in the region that specify to enhance the amount of permanent carbon removals by more use of timber products. This includes sustainable wood harvesting with building regulations that require more use of timber and processed wood products in construction.

TABLE 19: MEASURES TO INDUCE MORE USE OF TIMBER PRODUCTS IN EU DR COUNTRIES

more use of timber products	AT	BG	CZ	DE	HR	HU	RO	SI	SK
increase sustainable wood harvesting									
national emission trading									
buildings regulation to use more timber									
integrate sustainable timber into green public procurement									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Both countries plan to integrate timber into green public procurement programs. Slovenia is more advanced in all the three measures compared to Austria.

Germany is the third country interested in timber products and a national emissions trading scheme will be introduced for the sectors outside of the European Emissions Trading Scheme (EU ETS). This will put a carbon price on every processed product according to carbon intensity. Timber products are not only low carbon emission goods but sequester

carbon and thus will have a favourable market position over more carbon intensive alternatives.

3.4.1.3. BIOMASS RESOURCES IN NON-EU DR COUNTRIES

For the five non-EU DR countries the INDC submissions under the Paris Agreement and the National Communications and Biennial Reports under UNFCCC were used in place of NECPs.[30] The content and reporting templates of these documents are different from EU NECPs especially with respect to biomass resources and use.

TABLE 20: MEASURES REGARDING BIOMASS RESOURCES IN NON-EU DR COUNTRIES

	BA	ME	MD	RS	UA
	preventing loss of forest biomass				
improving forest management					
funding the protection of carbon sinks					
protecting vulnerable sites					
ban on deforestation					
preventing forest fires					
preventing illegal logging					
improve forestry information/certification systems					
knowledge transfer from European models					
	improving forests' resilience				
increasing climate resilience					
remediation of forests damaged by bark beetle					
increasing protected forest area					
monitoring sink and ecosystem functions					
	increasing carbon stocks				
age structure gradually shifting to younger stands					
financial programs to prevent forest degradation					
improve forest density, soil carbon					
training and education for forest owners					
	afforestation, reforestation				
increasing forest area					
identifying land for forestation					
indigenous, site-adapted species					
	increasing sink potential				
increase biodiversity					
select fast growing species					
	more use of timber products				
increase sustainable wood harvesting					

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

[30] National Communications of non-EU DR countries to the UNFCCC, see the 'Cited policy documents' section for exact references. Source of the Ukrainian data: (2017): Ukraine 2050 Low Emission Development Strategy, 2017.; download: https://unfccc.int/sites/default/files/resource/Ukraine_LEDS_en.pdf - Nov. 2020.

As Table 20 illustrates, these five countries show real dedication to the forestry sectors. Each has measures to increase forest area and there is general concern for maintaining protected forests, (BA, UA) biodiversity (ME, MD) and forests' resilience (MD, RS). Montenegro and Bosnia and Herzegovina seem the most determined to protect their carbon stocks by preventing forest fires, illegal logging and by means of improved certification. Montenegro is implementing sink-enhancing measures with ongoing financial programs to prevent forest degradation.

3.4.1.4. EXPECTED OUTCOMES – LULUCF AND BIOMASS RESOURCES

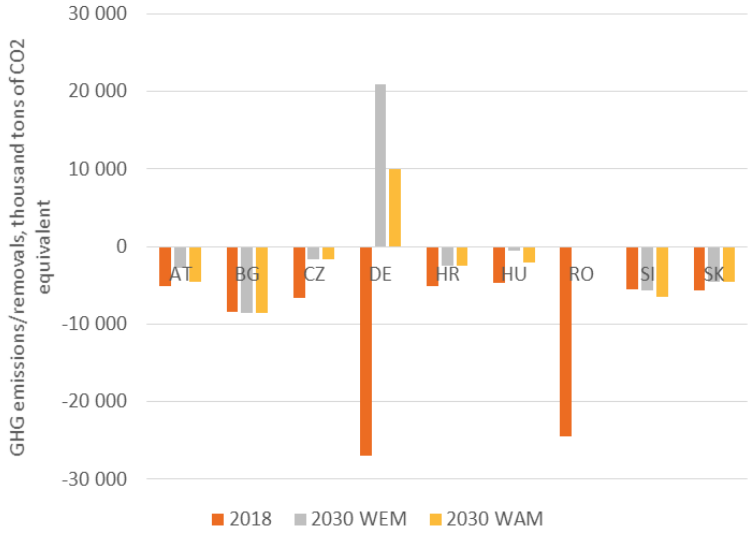
This section provides a quantitative summary of the impacts of LULUCF related measures comparing the NECPs of EU Member States. As mentioned previously, explicit quantitative targets for carbon sequestration are not specified in the forestry sectors. Typically, as shown above, forestry and grasslands are net sinking subsectors, while croplands, wetlands, settlements are massive net emitters.

In several countries, forestry sequestration has been declining due to:

- natural disruptions of live forest stock due to weather-related damages and pest-related calamities (CZ, SI)
- aging of living forest stock slowing down carbon sequestration

We project a significant drop in net sequestration from 68 million tons of CO_2eq in 2018 to 20 million by 2030. Figure 27 shows the last available inventory and projections of LULUCF emissions and removals.

FIGURE 27: EMISSIONS AND REMOVALS BY LULUCF - 2018 INVENTORY DATA AND PROJECTIONS FOR 2030, WEM AND WAM SCENARIOS



source: NIRs[31], NECPs

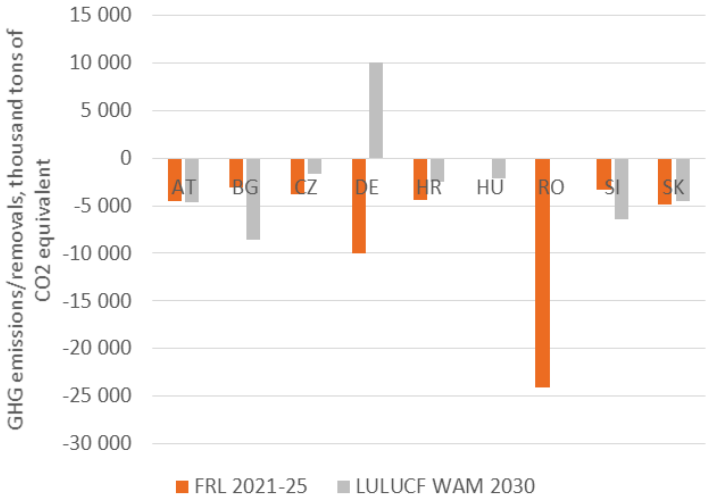
[31] NIR - National Inventory Reports by Annex-I Parties under UNFCCC, download: https://unfccc.int/ghg-inventories-annex-i-parties/2020 - Nov. 2020

In most countries WEM and WAM maintain robust forestry sequestration to keep the whole LULLUCF sector in net removal position, with the exception of Germany, where the LULUCF sector flips from net sink in 2016 (-14 mt CO_2eq) to net emitter by 2020 (+30 mt CO_2eq). This is due to:

- shifting distribution of age classes of trees – declining growth and reducing sink effect; average sequestration by Germany's forests from 46 million tons of CO_2eq per year in the decade between 2000 and 2009 to 12 million tons by 2020
- changing use patterns of wood products – constantly growing demand for forest wood from the processing industries as raw material
- major conversion of grassland to arable land – up to 2016 this process has been significant, and the effect is long term rise in LULUCF emissions.

Germany is likely meeting the no-debit requirement of the LULUCF Regulation (EU 2018/841) by using most of the compensation allowance approved in Article 13[32] and following the Forestry Reference Level (FRL). According to our calculations, annual changes of LULUCF emissions (WAM emission minus FRL) add up to 133.1 million tons of CO_2eq between 2021 and 2025, which is less than the cumulative compensation limit of 138 million tons allowed for Germany in the same period.

FIGURE 28: FORESTRY REFERENCE LEVELS AND LULUCF PROJECTIONS IN 2030, WAM



source: NFAPs[33], NECPs

Figure 28 presents the national Forestry Reference Levels (FRL) and the LULUCF WAM projections. FRLs project how carbon stocks of managed forest land would develop in the compliance period of 2021-2025, if forest management practices (i.e.: rotation lengths, rates

[32] „For the periods from 2021 to 2025 and from 2026 to 2030, taking into account the flexibilities provided for in Articles 12 and 13, each Member State shall ensure that emissions do not exceed removals, calculated as the sum of total emissions and total removals on its territory in all of the land accounting categories referred to in Article 2 combined, as accounted in accordance with this Regulation."

[33] NFAP: National Forestry Accounting Plans. See the 'Cited policy documents' section for the references.

of thinning and felling, species distribution, etc.) observed in the reference period of 2000-2009 remain unchanged (LULUCF Regulation).[34]

Note the following limitations imbedded in Figure 28:

- FRLs cover the 5-year period between 2021 and 2025 while LULUCF WAM projections are for 2030.
- WAM projection for LULUCF was provided by national administrations at the end of 2019 and many had not finalized their National Forest Accounting Plans (NFAP) with the FRLs by that time; some FRLs depicted here were published several months later than the NECPs.
- The FRLs should assume a constant ratio between solid use and energy use of forest biomass as documented in the period from 2000 to 2009; the projected effects on emissions and removals of additional measures in the LULUCF sector are free from this constraint allowing for a changing ratio between solid and energy use of forest biomass.

Even with more climate minded forestry policies in some countries the LULUCF sector is projected to decline (DE, CZ, HR) whereas for others additional measures are expected to enhance sequestration (BG, SI, HU)

To sum up our findings, with the desire to radically cut national GHG emissions, the massive potential for LULUCF to cheaply sequester and store carbon is not given enough attention by most governments.

The trend is similar in the non-EU countries. **Ukraine** ("Ukraine 2050 - Low Emission Development Strategy, 2017) has gone through an extensive phase of agricultural development where development of cropland has been detrimental to the net sink land sectors (grassland, forestland). Its forestry has lost 5 million tons or more than 10% of its annual absorption of carbon in 2020 compared to 1990. The trend seems to be irreversible with another 5 million tons (10%) expected to be lost by 2030 and a further 6 million tons by 2050 (9%) in the BAU scenario. The "Forward Looking Scenario" slows the trend only by reducing cropland and even the "Forward Looking Scenario with Optimum Forest Cover" is not expected to enhance or even stabilize forestry sequestration. Compared to 2020, it falls by 4.7% and 5.4% in 2030 and 2050, respectively.

Bosnia and Herzegovina draws three different emission scenarios in its National Communication (BA 3rd). Without the measures it loses about 10% of its forestry sink by 2050. The most ambitious scenario would increase the national forestry sink by about 10%.

In **Moldova**, the BAU scenario projects the LULUCF sector to shift into net emission by 2030 as a result of significantly growing emissions from croplands and loss of 15% of forests from 2020 to 2030 (4th National Communication of Moldova, MD 4th). With existing and additional measures, Moldova hopes to keep its LULUCF sector just below net emitting status by enhancing its forestry sequestration. For a country with over 3 million tons of net sinking in

[34] By definition of the LULUCF Regulation, 'the mere presence of carbon stocks is excluded from accounting'. So FRLs only account for net changes in forest carbon stocks.

2010, Moldova will be challenged to keep its LULUCF sectors below zero (0.35 million tons of net sinking) by 2030.

3.4.2. BIOMASS USE

As in the previous chapter on *Biomass Resources,* the next chapter on *Biomass Use* is limited to the energy use of primary solid biomass from forestry and the available details. Non-energy use and non-forest biomass are only referenced to a limited extent.

3.4.2.1. TARGETS – BIOMASS USE

The summary of biomass-to-energy policies are divided into two categories of targets:

- **goals to determine** the role of biomass in energy production and consumption – directly or indirectly controlling how much electricity and heat is produced by biomass and how much is used directly in final energy consumption
- priorities for biomas**s-to-energy issues** – concerns about biomass sustainability and air quality

The measures are categorized in Table 21 as: (i) financial incentives, (ii) regulatory control, (iii) information and awareness-oriented measures.

TABLE 21: POLICY GOALS AND RELATED MEASURES IN THE FORESTRY SECTOR

goal category	goal	financial incentives	regulatory control	information, awareness
determine role of biomass in energy production and consumption	**biomass-to-electricity**	operational support; technology specific tenders; unlocking biomass from waste and agriculture; continue support after current regime and contracts expire	increase capacity; decrease capacity; no more agricultural land for bioenergy;	appraise available forest and non-forest biomass potential;
	biomass-to-heat	investment grant to high efficiency CHP; operational support; stop funding cultivated biomass; new funding for wastes and residues to CHP; indirect support	increase production, decrease production; review of price regulation for DH;	promote technology research; promote flagship projects
	final energy consumption of biomass	public aid for efficient household heating	minimum efficiency requirements; technology preference	assess socioeconomic aspects and vulnerable households using biomass
set priorities about biomass-to-energy issues	**sustainability**	support for cascading use of wood	work out criteria for non-RED-II categories; priority for timber use;	bioenergy dialogue about scarcity, sustainability and other issues
	air pollution	aid to novel technologies;	license high efficiency bio CHP only	educate households for proper burning techniques

Renewable energy policies have been around for several years and administrations are much more experienced compared to biomass. The next section summarizes how DR countries have developed each policy goal outlined above.

3.4.2.2. POLICIES AND MEASURES – BIOMASS USE

Biomass-to-electricity was preferred in the early 2000s with a widely shared conviction about the climate benefits of biomass combustion, the easily manageable co-firing with coal or the complete fuel switch from coal to solid biomass without significant asset investments made it the cheapest renewable energy technology to scale. After almost two decades, several countries are planning to expand biomass electricity capacities (BG, HU, SI) while others are curtailing biomass out of concern for forest wood combustion and the low energy efficiency (DE, RO). Support is mostly planned to be delivered for winners of technology-specific but competitive procurement tenders (AT, BG, DE, SI). All but two governments have stated an objective to use residues, by-products, wastes and agricultural biomass to produce electricity as opposed to wood. (AT, BG, DE, HR, HU, RO, SI). Only Austria's NECP includes explicit measures with follow-up support for previously commissioned biomass-to-electricity producers after the expiration of the earlier support regime. Other countries might also have similar measures without mentioning it in their NECPs. Table 22 presents the relevant measures.

TABLE 22: MEASURES ABOUT BIOMASS TO ELECTRICITY IN EU DR COUNTRIES

biomass-to-electricity	AT	BG	CZ	DE	HR	HU	RO	SI	SK
administrative operational support									
technology specific tenders									
involve biomass from waste and agriculture									
follow-up support after running out of previous financial incentives									
increase capacity									
decrease capacity									
no more agricultural land for bioenergy									
appraise available forest and non-forest biomass potential									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Biomass-to-heat is a more widely shared application among DR countries. Table 23 includes the related measures. All but one country (BG) already provides or will soon provide direct investment grants to high efficiency CHP for district heating. While Germany will exclude cultivated biomass from support programs and intends to reduce the absolute amount of biomass-to-heat in the long run, 5 governments are planning to increase biomass-to-heat

production (AT, CZ, HU, SI, SK). Hungary will revisit its current district heat price regulation with the intention of supporting biomass. Croatia is planning to fund novel technologies in biomass-to-heat. Austria is developing flagship projects for promotional purposes. Only the Czech NECP refers to indirect support measures: real estate tax exemption for biomass-to-heat projects, municipal solid waste landfilling charges increased to promote selective waste management, prohibition of landfilling recoverable waste.

TABLE 23: MEASURES ABOUT BIOMASS-TO-HEAT IN EU DR COUNTRIES

biomass-to-heat	AT	BG	CZ	DE	HR	HU	RO	SI	SK
investment grants to high efficiency CHP									
operational support									
stop funding cultivated biomass									
indirect support									
increase production									
decrease production									
review of price regulation for DH									
promote technology research									
promote flagship projects									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Households tend to consume the most biomass as a share of final energy consumption, but industrial process heat is also important in several countries. The most common measure supporting biomass in households is public aid for installing more efficient biomass boilers and stoves as Table 24 shows.

TABLE 24: MEASURES ABOUT FINAL BIOMASS CONSUMPTION IN EU DR COUNTRIES

final energy consumption of biomass	AT	BG	CZ	DE	HR	HU	RO	SI	SK
public aid for efficient household heating									
minimum efficiency requirements									
assess socioeconomic aspects and vulnerable households using biomass									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

5 out of the 9 DR countries have some sort of policy ranging from agenda setting (HU) to implementation (CZ). There are minimum efficiency requirements for installed units in two countries only (CZ, BG). Croatia and Slovenia are focusing on the socioeconomic aspect of household biomass with applied research in the former and an aid scheme in the latter. Slovenia provides financial support for the poorest households to replace wood biomass and fossil combustion units with high-efficiency renewable alternatives.

The second group of measures set **priorities for biomass-to-energy**. Firstly, we discuss sustainability issues. Table 25 might seem to show a very limited interest in sustainability. In reality, measures prefer biodegradable waste, residues and agricultural by-product rather than forestry wood. Germany is the outlier supporting the circular economy by limiting wood use, developing sustainability criteria beyond the requirements of RED II, and facilitating community dialogue about bioenergy.

TABLE 25: MEASURES ABOUT SUSTAINABILITY OF BIOMASS

sustainability	AT	BG	CZ	DE	HR	HU	RO	SI	SK
support for cascading use of wood									
work out criteria for non-RED-II categories									
priority for timber use									
bioenergy dialogue about scarcity, sustainability and other issues									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Biomass combustion impacts ambient air quality by releasing PMs, NO_x, and other harmful substances.[35] Pollution-related measures are shown in Table 26.

TABLE 26: MEASURES FOR BIOMASS-TO-ENERGY AIR POLLUTION IN EU DR COUNTRIES

air pollution	AT	BG	CZ	DE	HR	HU	RO	SI	SK
aid to novel technologies									
license high efficiency bio CHP only									
educate households for proper burning techniques									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Czechia prefers automated feed of biomass fuel; while Slovenia and Slovakia choose biomass gasification to generate syngas or H_2 but all promise to consume biomass energy

[35] Particulate Matter and Nitrogen Oxides

in a more advanced way that reduces air pollutants. Several countries promote high efficiency combined heat-and-power (CHP) despite the combustion technology: high efficiency CHP has low specific emissions relative to its energy production (AT, BG, CZ, HR, SI, SK). Slovenia appears most concerned about biomass related air pollution and the government is planning to educate consumers about the proper way of burning biomass in household appliances.

3.4.2.3. BIOMASS USE IN THE ENERGY COMMUNITY COUNTRIES OF THE DANUBE REGION

Most of the Energy Community countries refer biomass to energy in strategic documents but few of them have very concrete targets and measure in this area as shown by Table 27.

TABLE 27: MEASURES REGARDING BIOMASS ENERGY IN THE NON-EU DR COUNTRIES

	BA	ME	MD	RS	UA
	biomass-to-electricity				
operational support					
technology specific tenders					
increase co-firing of biomass with fossil fuels					
increase capacity / generation					
decrease capacity					
no more agricultural land for bioenergy					
	biomass-to-heat				
increase biomass in district heating					
stop funding cultivated biomass					
indirect support					
increase production					
decrease production					
	final energy consumption of biomass				
free loans for efficient biomass household heating					
encourage process heat use in sectors					
assess socioeconomic aspects and vulnerable households using biomass					
	sustainability				
support for cascading use of wood					
work out criteria for non-RED-II categories					
priority for timber use					
bioenergy dialogue about scarcity, sustainability, and other issues					
	air pollution				
aid to novel technologies					
license high efficiency bio CHP only					
educate households for proper burning techniques					

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Biomass-to-electricity and biomass-to-district heating are the exemptions in MD and BA, and Montenegro has measures in place to increase final household consumption of wood

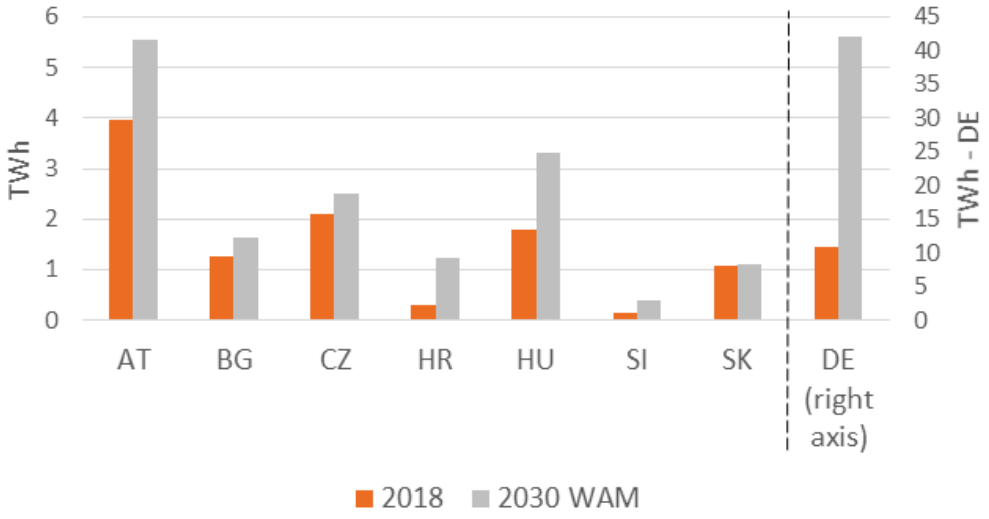
for space heating. Other countries plan to increase biomass electricity (BA, ME, RS) and biomass heat (BA, RS). There are no targets or measures related to sustainability and air pollution issues of biomass use in these countries.

3.4.2.4. EXPECTED OUTCOMES – BIOMASS USE

Biomass-to-energy seems to remain an appealing option for DR countries. Ubiquitous and affordable, biomass continues to serve the dominant share of total renewable energy, mostly in the form of household heating. Moreover, biomass switching is cheap for fixed assets in electricity or heating facilities, so it looks a promising target for administrations to effectively enhance renewable energy in large scale.

Figure 29 summarizes the outcomes of additional biomass measures and targets from the NECPs.

FIGURE 29: BIOMASS ELECTRICITY PRODUCTION IN 2018 AND 2030 WAM, TWH



source: EUROSTAT SHARES, NECPs (missing: RO)

Biomass electricity is expected to grow significantly across the WAM scenarios. For the whole DR (except RO) the overall increase is surprisingly large, from 21.5 TWhs in 2018 to 57.7 TWhs in 2030, or an increase of 268%. Germany, Croatia and Slovenia each more than double biomass electricity.

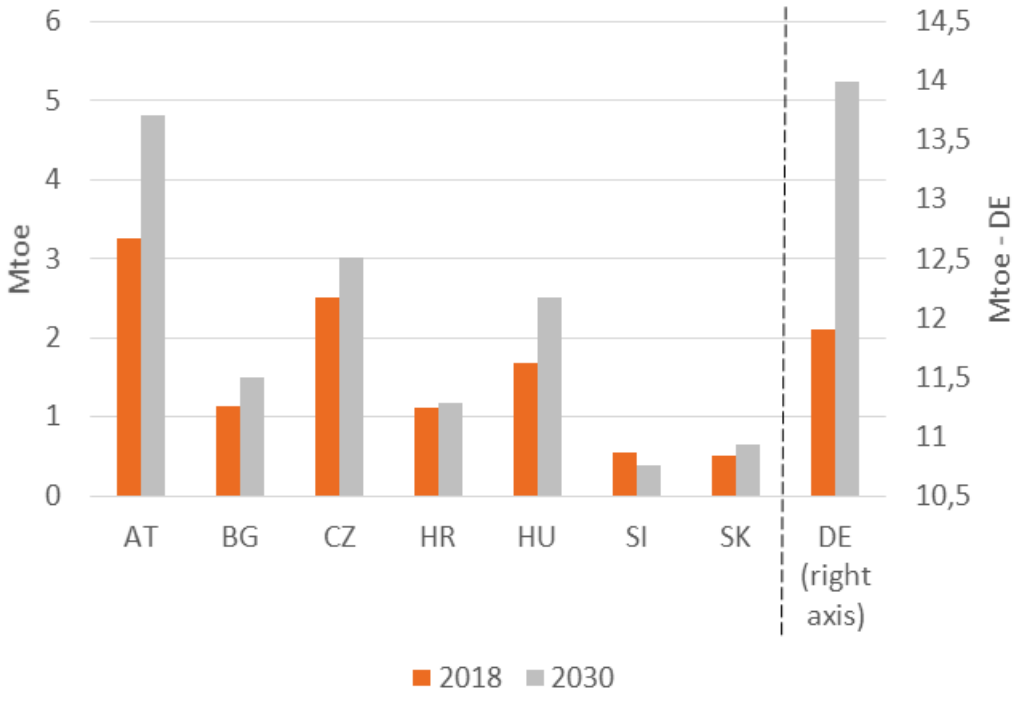
The desire to increase biomass in electricity is clearly visible in Figure 30, showing biomass power plant capacity additions. Croatia and Romania are the only two DR countries planning to lower biomass in electricity capacities. The outcome is net increase of 15% for the whole region (without AT). If Germany is removed, the rest of the region will invest 35% more into biomass electricity capacity compared to 2020.

FIGURE 30: INSTALLED BIOMASS ELECTRICITY CAPACITIES IN 2020 AND 2030; WAM, MW

Source: NECPs (missing: AT)

The ambitions are lower in the biomass-to-heat segment, as shown by Figure 31. Slovenia is the one country aiming to significantly lower biomass-to-heat. EU DR countries will increase biomass heating by 24% from 22.7 Mtoe in 2018 to 28.1 Mtoe in 2030. This is a modest growth plan compared to biomass in electricity, which is growing 168% in the same period.

FIGURE 31: BIOMASS HEAT PRODUCTION IN 2018 AND 2030 WAM, MTOE



Source: NECPs (missing: RO)

This is an unexpected outcome given the common understanding of the difference in energy efficiency between the two technologies. Biomass-to-electricity is usually produced at net efficiency rates of 30% to 40%, and even the best available technologies are not able to surpass 45%. In the meantime, if the same amount of biomass was applied to heat technology, the net rate of energy efficiency would spike 70-80%, with the best available technologies delivering 85-90%.

Given all the worries about scarcity and unsustainability of biomass resources, the fact that biomass in electricity wastes about half of the useful energy available from biomass-to-heat should matter but it is not considered in the NECPs. This is a question that needs to be answered when strategic documents are next updated.

A clear intention is found among non-EU countries of the DR to further increase their energy use of biomass.

Ukraine is planning to support co-firing biomass with fossil fuels in power plants and direct final use of biomass for process heat in agriculture and forestry. **Serbia** is preparing to add 1000 MW of new biomass boilers by 2050 and there is 57% increase of biomass and natural gas CHP in its WAM scenario between 2030 and 2050[36]. **Moldova** does not possess significant biomass reserves and rather plans to expand wind and solar resources. Yet, a quarter of total final energy and almost half of its heating and cooling energy originates from biomass. Investors are encouraged by feed-in tariffs to produce biomass electricity while no anticipated effects on scarce biomass resources are discussed. **Montenegro** plans to add 117 GWhs of biomass thermal power plants to its electricity system. It has also launched free loans for households to use modern forms of biomass (pellets, briquettes, wood chips) for space heating. **Bosnia and Herzegovina** judges its biomass electricity potential (800 MW) and has targeted an additional 30-60 MW biomass CHP capacity by 2030. BA has already partially implemented a program dedicated to grow the share of biomass in district heating.

3.4.3. EXPECTED OUTCOMES

EU Member States in the DR report strong plans for biomass use in their NECPs. Biomass-to-heat has been the single largest renewable energy segment and there is more to come (24% increase between 2018-2030). Biomass electricity, though a much smaller segment than biomass heat, is expecting major growth in the next decade (168% increase). The two combined will grow from 1027 PJ in 2018 to 1383 PJ in 2030 (35% increase).

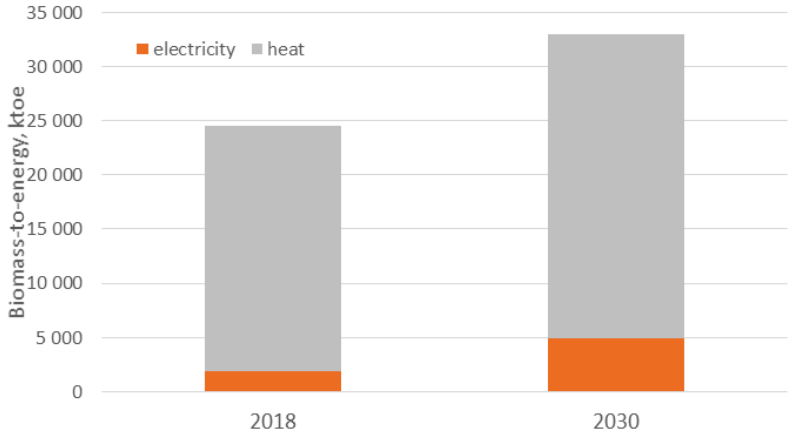
This kind of growth does carry the risk of losing forest carbon stocks to the atmosphere. Although there is not enough data in the NECPs to evaluate this issue with its complexity, we can infer from plans regarding the LULUCF sectors that the EU countries of the DR expect their LULUCF carbon sinks to decline (70% loss between 2018 and 2030), implying a massive loss of forest biomass in most cases.

Our findings are summarized in Figure 32 and Source: NECPs, NIRs

[36] Second National Communication of The Republic of Serbia under UNFCCC, 2017.; https://unfccc.int/documents/39803

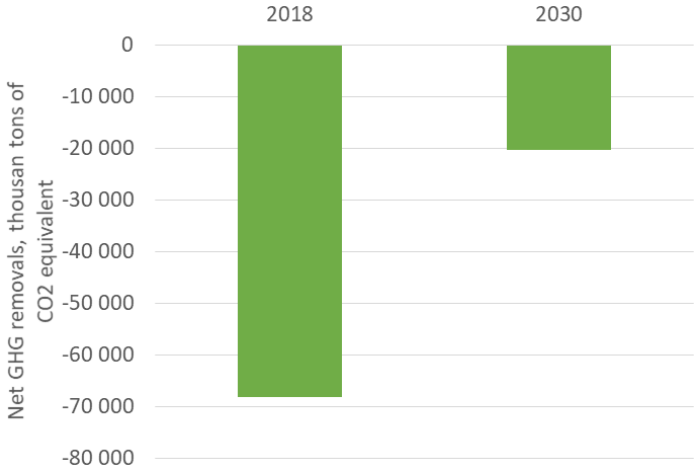
Figure 33.

FIGURE 32: HEAT AND ELECTRICITY PRODUCED FROM BIOMASS (KTOE) IN 2018 AND 2030 WAM



Source: NECPs, NIRs

FIGURE 33: NET REMOVALS BY LULUCF (GG CO_2EQ) IN 2018 AND 2030 WAM



Source: NECPs, NIRs

Note: Heat and electricity produced from biomass is not equal to the biomass that is needed for this amount of useful energy. The net efficiency rate for electricity production is approximately 30-40% and heat 70-80%. So, the amount of input biomass is significantly higher.

These two graphs combined show an alarming picture. Climate policy makers need to be aware of the risks imbedded in these plans. It is one-sided climate policy to financially support the burning of the ubiquitous and affordable forestry biomass, to award its burning with zero accounted carbon emissions and to ignore the climate economic value of forest sequestration and storage of carbon. Another decade of such a large-scale increase in biomass could have serious consequences, but with timely action this policy failure can still be avoided. Policy instruments should be redesigned to avoid loss of natural sequestration potential caused by forest management favouring production of biomass for energy

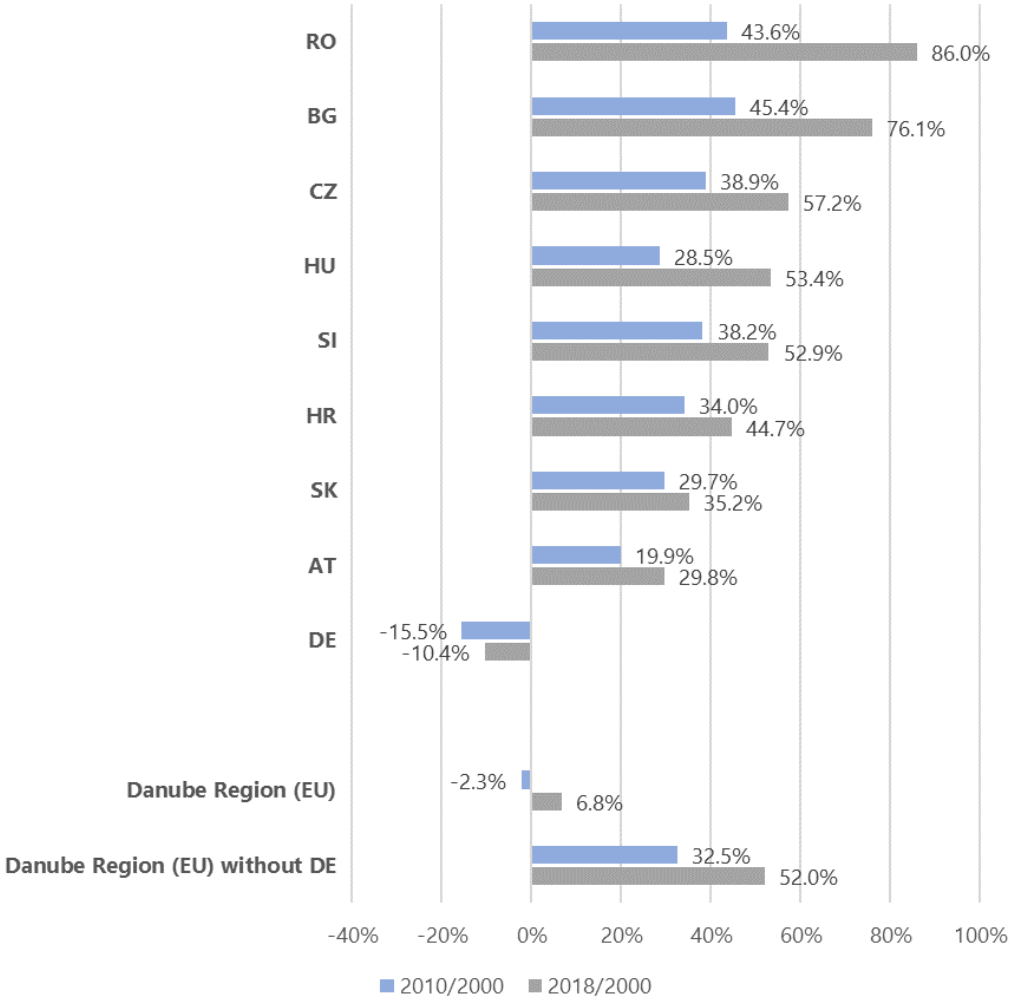
markets rather than absorbing carbon. Without integrated climate policy instruments to capture the holistic effect of biomass, planned support for biomass-to-energy should be re-evaluated.

The 9 EU countries and the 5 non-EU countries have targets and measures to increase their biomass energy use with further objectives in the policy pipeline, on a track to lose a significant share of LULUCF carbon stocks and the corresponding carbon sequestration potential.

3.5. TRANSPORT

Transportation is the only sector to see a rise in emissions over the last two decades. While the EU28 reduced total GHG emission by 18.6% between 2000 and 2018, transport emissions grew by 2.4%. Thus, the sector became the second biggest source of emission accounting for 24% of total GHG emissions.

FIGURE 34: CHANGE IN TRANSPORT EMISSIONS, EU DR COUNTRIES, 2000-2018

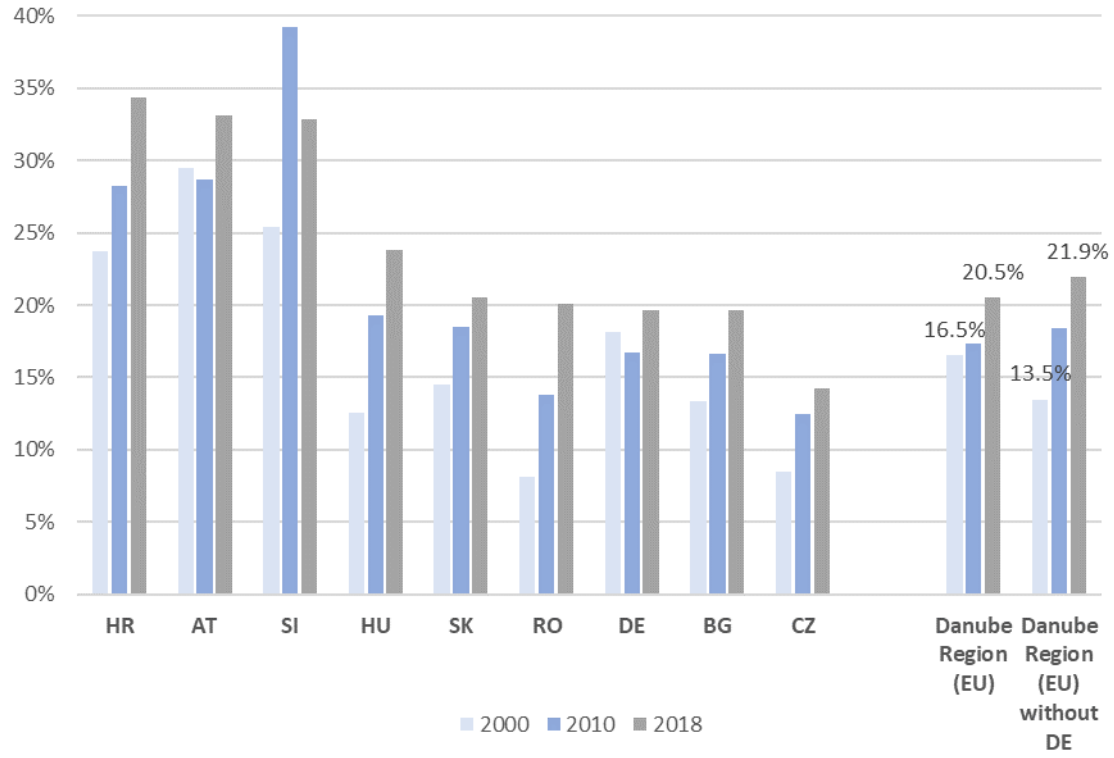


Source: Eurostat

In the Danube Region[37] transport sector emissions grew faster than the EU average, especially excluding Germany, which is the only country in the region to reduce emissions while responsible for two-thirds of released GHG in the DR. Figure 34 shows that for all EU DR countries sectoral emissions grew by only 6.8% in the period 2000-2018 but excluding Germany the growth rate was 52%.

The total GHG emissions in the region have fallen by 14% over the same period while the share from the transport sector climbed from 16.5% to 21.9%. Figure 35 presents the sector's share in total GHG emissions in 2000, 2010 and 2018. The shares vary between 14.2% (Czechia) and 34.4% (Croatia), but the trend is similar across all countries.

FIGURE 35: SHARE OF TRANSPORT IN TOTAL GHG EMISSIONS OF EU DR COUNTRIES, 2000, 2010 AND 2018



Source: Eurostat

The growing trend in emission demonstrates that gains in fuel efficiency and emission standards are not enough to offset the additional emissions caused by rising demand. Application of renewable energy is not only crucial to limit the emission of the transport sector, but it opens the door to an entirely carbon-free transportation. This chapter looks at the transport-related renewable targets set by the NECPs, the measures used to achieve these targets; and the outcomes of the measures in terms of renewable share, decarbonisation and energy consumption.

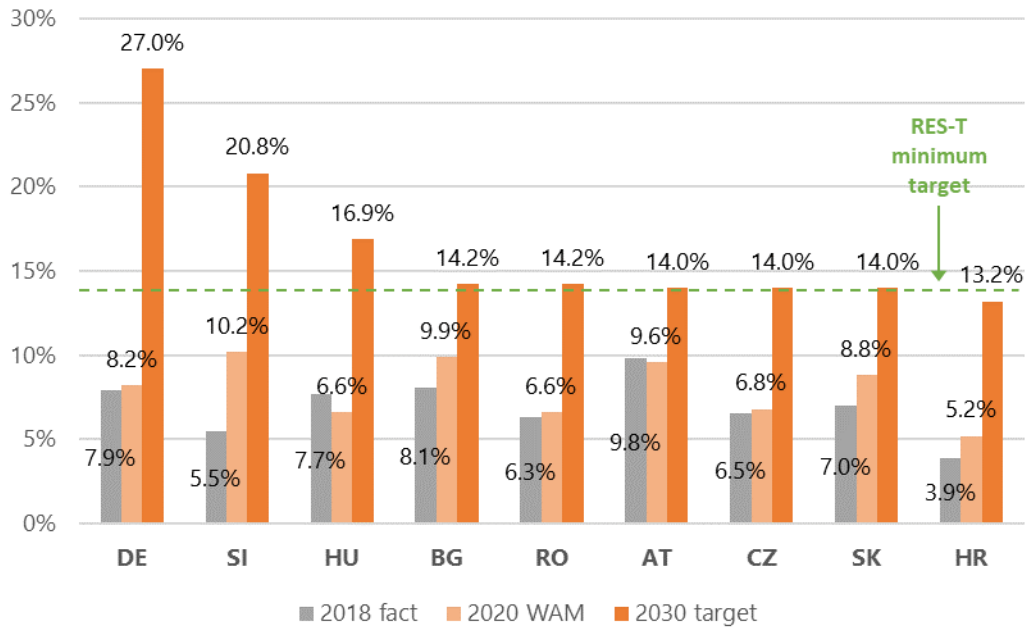
[37] This chapter focuses on the EU member countries of the Danube Region since strategic documents from the other non-EU countries do not address the sector in detail or are outdated. Section 3.5.4. presents the transport related policy plans in the non-EU member states of the Danube Region.

3.5.1. TARGETS

DR countries committed to achieve a target share of renewable energy within the total energy consumption of the sector (RES-T). RED II sets a minimum of 14% target for 2030 EU member states but using multipliers[38] this can be met with a lower actual share.

Figure 36 presents the 2030 targets from NECPs, the actual share for 2018 and the projected share for 2020 under the WAM scenario. Only three countries (DE, SI, HU) committed to a significantly higher RES-T share than the obligatory minimum. Bulgaria and Romania published a 14.2% target, while Austria, Czechia and Slovakia committed to the minimum. Croatia is the only country that set a lower target, stating openly that the country cannot reach the minimum share.

FIGURE 36: 2030 RENEWABLE ENERGY TARGETS IN THE TRANSPORT SECTOR, EU DR COUNTRIES



Source of data: Eurostat (for 2018 data), NECPs (for 2020 and 2030 values)

Comparing the 2030 targets with the current (2018) RES-E shares, we cannot detect a strong connection, with the exception of Croatia, where the low target can be explained by the very low current RES-T. Austria had the highest share in 2018 (with high RES-E in the country) but still it did not commit to a higher RES-T than the minimum required share. In this context, the most ambitious country is Slovenia, where the target is almost a fourfold share in 2030 compared to 2018.

3.5.2. POLICIES AND MEASURES

The policies aiming to reduce the GHG emissions can be categorised based on the following:

[38] The multiplier is 4 for RES in road vehicles and 1.5 times for rail transport.

- **Fuel Switch**: To promote the switch from fossil fuels (mainly gasoline and diesel) to electricity, biofuels or other alternative fuels (e.g. Hydrogen) with less environmental impact. Fostering the penetration of electric vehicles, increasing the share of biofuels, and electrification of railways also belong to this category.
- **Modal Shift**: To make the more efficient and less emitting transport modes (public transportation, non-motorised modes such as cycling and walking, railway for freight transportation) more competitive and attractive for users.
- **Efficiency Improvement:** Fuel switch and modal shift both lead to higher energy efficiency, however, it is also crucial to enhance the efficiency of the conventional transport modes and technologies.

These policy goals can be achieved with a variety of policy measures in various combinations as Table 28 presents.

TABLE 28: POLICY GOALS AND RELATED MEASURES IN THE TRANSPORT SECTOR

Goal category	Goal	Infrastructure investments	Financial incentives	Regulatory obligations	Information, awareness
Fuel Switch	Electric vehicles (road)	EV charger network	Purchase subsidy Tax/fee allowances CO_2-based taxes, tolls	Green public procurement obligations Restriction for purchase on use of ICEs	Promoting EVs
	Biofuels	-	-	Biofuel mandates	-
	Electrification of railways	Network development	-	-	-
	Hydrogen and other advanced fuels	same as for EVs			
Modal Shift	To public transportation	Network development	Taxation, tolls and fees of car use	-	-
	To non-motorised modes	Bicycle roads, B+R	Taxation, tolls and fees of car use	-	Promoting cycling and healthy mobility
	To rail (freight transport)	Network development	Taxation, tolls and fees of car use	-	-
Efficiency Improvement	Energy efficiency	-	Taxation, tolls and fees of car use	Emission standards Restriction for purchase or use of ICEs	Eco-driving trainings

The largest measure-categories are infrastructure investments, financial incentives (subsidies, taxes and fees), regulatory obligations and raising awareness by providing information and organising campaigns.

The measures influence the target in several ways. For example, emission-based taxation of passenger cars can accelerate the penetration of electric cars (Fuel Switch) but can also divert people to public transportation or non-motorised transport modes (Modal Shift), while getting drivers to choose cars that consume and pollute less (Efficiency Improvement). The first two effects lead to higher renewable electricity usage while all the three reduce the total energy consumption of the transport sector. By making environmentally friendly alternatives more price competitive, passengers and companies will make these choices economically. Additionally, direct obligations for renewable sources like biofuel mandates or green public procurements are also part of the policy landscape.

The chapter is organized according to the type of policy rather than the policy goals themselves.

3.5.2.1. INFRASTRUCTURE INVESTMENTS

Five groups of measures targeting infrastructure investments were developed based on the affected modes: development of electric vehicle (EV) chargers; the electrification and general development of railway systems; bicycle and pedestrian infrastructure. Table 29 summarizes the status of measures in each country.

TABLE 29: INFRASTRUCTURE INVESTMENTS IN THE TRANSPORT SECTOR, EU DR COUNTRIES

Infrastructure investments	AT	BG	CZ	DE	HR	HU	RO	SI	SK
EV charger network									
Electrification of railways									
Railway development									
Bicycle infrastructure									
Pedestrian infrastructure									

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

The spread of electric cars (and thus the reduction of transport emissions) depends on development of the **charging network**. Most EU DR countries have taken measures and all re planning more in the future.

In **Czechia**, the investment support is provided by the Operational Programme in transport for the construction of a core network of charging stations with a target for 2030 between 17,000 and 35,000 charging points. **Slovakia** announced its first call for the construction of AC[39] charging stations for municipalities and local government (planned volume EUR 500 000) in 2019 and further calls are expected in the near future. **Austria** and **Germany** have

[39] AC: alternating current

ambitious goals for 2030: Austria plans to achieve 100% network coverage at rest stops on motorways and expressways, while Germany aims to have 1 million charging points. In addition to continued funding programs for public charging stations, Austria also supports the construction of private e-charging stations in apartment buildings and stations for employees, customers and guest parking spaces. **Slovenia** adopted a regulation for embedding e-charging points in dense residential neighbourhoods and larger apartment blocks with standardized connections. Considered as an individual measure, **Croatia** is planning the introduction of charging stations for electric vehicles with energy storage. In **Romania**, the network is still in its infancy and the government would like to prepare a plan for the implementation of public charging networks.

The development and the **electrification of railways** is also a main area of measures where most countries are already taking active steps. Some of the countries primarily focus on the development of railway passenger transport (SK, RO), while others (AT, HU, CZ, DE, HR, SI) also take measures to increase the share of rail relative to road freight transport. Austria considers the use of battery technology or fuel cells in conjunction with renewable hydrogen as another option in the future.

Most countries also see the potential for reducing emissions in the development of **cycling infrastructure**, which can replace several forms of motorized transport. Some of the countries (CZ, DE) have complex national cycling development strategies and programmes, emphasizing the importance of secure and modern parking facilities.

Only two countries (SI, AT) have a strong focus on the development of **footpath infrastructure**. Austria is currently working to introduce pedestrian priority zones and pedestrian areas in towns, cities, and municipalities.

3.5.2.2. FINANCIAL INCENTIVES

Measures introduced or to be introduced to achieve a greener transport sector are widespread in all the examined countries. Electric cars and public transport are supported through purchase subsidies, tax allowances and other operating subsidies as shown by Table 30.

Governmental **subsidies (purchase premium or bonus) for the purchase of EVs** (and in some cases for plug-in hybrids) are active programmes in most EU DR countries and they are not expected to be phased out by 2025. In Germany, the purchase premium is paid by the Federal Government and the manufacturers. In Czechia, the measures target the electrification of the business sector. Slovenia gradually lowers vehicle incentives (2020-2025) and set an upper limit for the value of the vehicle for eligibility. In Austria, switching from used conventional vehicles to EVs can be used as a purchase bonus.

Purchase subsidies for public transport vehicles aim to increase the number of more eco-friendly alternatives in each country. In some cases, this means purchasing electric buses (AT, HU, RO), in others switching bus lanes to eco-friendly alternatives (trolleys, trams, subways), and in some, CNG (compressed natural gas) or hydrogen-based buses. While Austria procures electric buses to close out its diesel fleet, Hungary intends to procure Euro 6 diesels.

TABLE 30: FINANCIAL INCENTIVES IN THE TRANSPORT SECTOR, EU DR COUNTRIES

Financial incentives	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Purchase subsidy for EVs									
Purchase subsidy for public transport vehicles									
Allowances (taxes, tolls, fees) for EVs									
CO_2-based taxes, tolls and fees									
Subsidising rail transport									

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

Like the previous two financial incentives, different types of **tax allowances** for EVs have become prevalent in the evaluated countries. Exemption (or reduction) from the registration fee and motor vehicle tax are commonly used measures (AT, HU, DE, CZ, RO) and in some of the countries, electric and hydrogen vehicles are exempted from company car taxation (DE, HU, AT). In most countries it is not specified how long the subsidies will be maintained, except for Austria (until 2025 or when 10% penetration rate of zero-emissions vehicles is achieved). In addition to these tax allowances, countries/local governments are also trying to promote electric cars with other incentives, such as exemption from parking fees, entry to low-emission zones, exemption from tolls on toll roads. Austria and Germany have envisaged and already apply taxes based on **vehicles' CO_2 emissions**. In Germany from 1 January 2021, new registrations will depend primarily on the CO_2 test value per km and will be increased in stages above 95 g CO_2/km. Austria's Tax Reform Act 2020 links the level of the current motor vehicle taxation for motorcycles and cars to the CO_2 emission level.

Regarding the **support of rail transportation**, countries have two objectives. For one, they want to provide an alternative to highly polluting transport modes. Germany plans to reduce taxes on train tickets and increase air transport taxes, while Slovenia plans to introduce new toll policies to shift traffic flows to railways and suburban trains and relieve daily commute traffic. Other measures target increasing the share of rail freight (AT, HR).

3.5.2.3. REGULATORY OBLIGATIONS

Another toolbox of actions are the regulatory obligations listed in Table 31. The **green public procurement** obligations introduced or to be introduced are very similar in all countries: either a ratio is set for newly acquired vehicles or a target for the whole fleet is set for different years. In most countries, the regulation applies to public service cars, but in Czechia it also extends to the purchase of public transport vehicles. Several countries (DE, SI, SK, CZ) have already executed public procurement specifically to lower the emissions of the vehicle fleet.

TABLE 31: REGULATORY OBLIGATIONS IN THE TRANSPORT SECTOR

Regulatory obligations	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Green public procurement obligations									
Biofuel mandates (general)									
Promotion of advanced biofuels									
Restriction on purchase and use of conventional vehicles									
Restricted areas									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

The objectives of some countries can be considered ambitious. For example, Czechia aims to achieve at least a 50% share of alternative-drive vehicles in the total public administration fleet by 2030. For Germany, it is 100%. Croatia's objective is 75% of implemented public procurement procedures that apply green public procurement criteria in 2030.

For **first-generation biofuels**, several countries are setting escalating mandated blending rates, from between 5 and 8 percent, growing 2 - 3 % in the next decade. Germany is unique in limiting the share of first-generation biofuels under the Renewable Energy Directive to 5.3% in 2030 in accordance with the 2020 level. The promotion of **advanced biofuels** is a goal for all countries. However, most countries are still in the early stages of action. Currently, there is an active regulation for blending rates in Slovakia, Bulgaria and in Czechia, while several countries want to introduce this regulatory tool in the future. Germany is the most ambitious, increasing its share of advanced biofuels to at least 1.75% by 2030. Germany and Czechia intend to introduce a new support scheme for the production of advanced biofuels in the near future.

In order to reduce sectoral emissions, several countries plan and apply regulations **restricting the purchase and use of conventional vehicles**. Bulgaria and Romania plan to ban imports of motor vehicles with Euro 3 and Euro 4 ratings. Austria has set targets for newly registered taxis and rental vehicles which must operate emissions-free from 1 January 2025.

Low-emission zones are geographically defined areas that limit access of vehicles on the basis of their emissions in order to improve air quality. According to the NECPs, some of the countries (HR, BG) are only planning to establish and regulate these zones while others have already implemented measures (CZ, SK).

3.5.2.4. INFORMATION AND AWARENESS CAMPAIGNS

Another way to reduce emissions is through various information campaigns that raise public awareness for a specific mode of transport or the concept of sustainable transport in general. In addition to campaigns, trainings that help to teach eco-friendly driving skills can also be included. These measures are less mature than others but can have a bigger impact on the sector's emissions in the future. Table 32 provides and insight into how the awareness-raising activities appear in the NECPs of EU DR countries.

TABLE 32: INFORMATION AND AWARENESS CAMPAIGNS IN THE TRANSPORT SECTOR

Information, awareness	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Sustainable transport (general)									
E-mobility									
Cycling									
Eco-driving trainings									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

Slovenia mentioned raising public awareness for **sustainable forms of transport**, however, the details of the campaign were not presented. Bulgaria, Austria, and Germany also plan to implement an information campaign promoting **e-mobility**. Germany promotes a campaign to increase the share of EVs in publicly owned fleets. Austria and Croatia plan to introduce programmes teaching **eco-friendly driving forms**. The promotion of **cycling** will also play a role in Germany, Austria and Slovakia.

3.5.3. EXPECTED OUTCOMES

This chapter provides an overview on the expected effects of the measures published in NECPs. Because countries provided estimates for scenarios with existing measures (WEM) and with additional measures (WAM) separately, the effects of the planned policy measures can be defined as the difference between the results of the WEM and the WAM scenario.

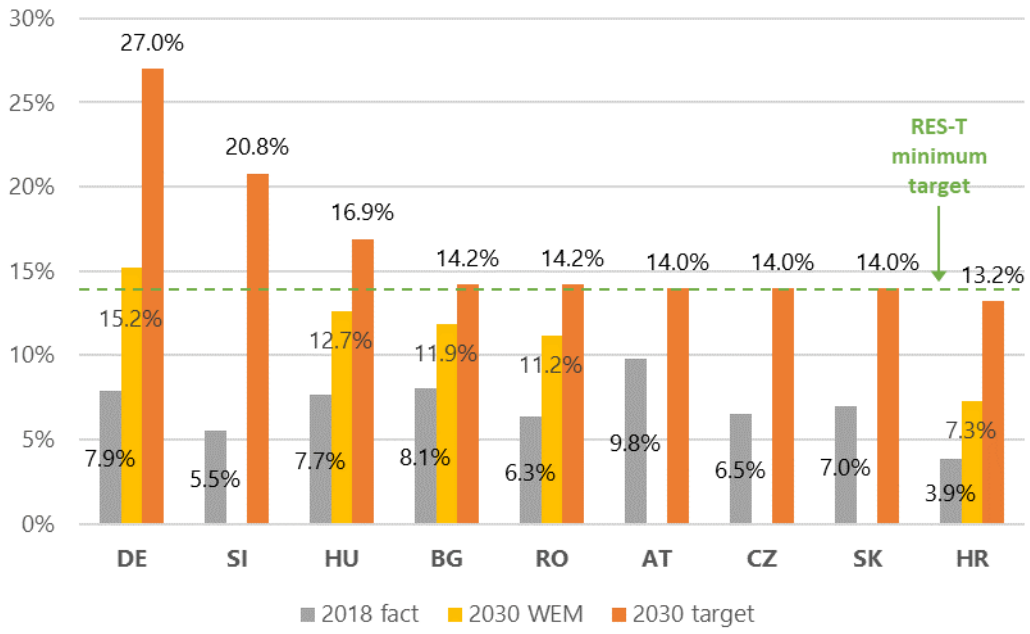
As presented in the 3.5.1 section, the transport-related policy targets are associated with the share of renewable energy in the total energy consumption of the sector. For this reason, we start the analysis with the achievement of the RES-T targets supplemented with national projections for energy consumption and GHG emissions.

3.5.3.1. RENEWABLE ENERGY

Figure 37 displays the RES-T targets for 2030 compared to the present (2018) level and the WEM projection for 2030. Four countries did not provide information on the RES-T in the WEM scenario (AT, CZ, SI, SK). For these countries, the effects of the measures cannot be

calculated. For the others it is clearly visible that countries committed to higher RES-T target would reach a high renewable share *with existing measures*. According to the projections, Germany would outperform the 14% minimum target without any additional measures, and Hungary would nearly do it.

FIGURE 37: EFFECTS OF THE PLANNED MEASURES ON THE SHARE OF RENEWABLE ENERGY IN THE TRANSPORT SECTOR, EU DR COUNTRIES



Source of data: Eurostat (for 2018 data), NECPs (for 2030 values)

Going deeper into the projected development trends, governments expect the measures to have a substantial effect. In the WEM scenario, the projected increase in the amount of renewable transport energy by 2030 is between 47% (BG) and 90% (DE, HR), while in the WAM it is between 76-240%. This implies a 1.2-1.8 times faster development in the WAM scenario than in the WEM scenario. Interestingly, the best and worst performing countries (DE and HR) estimated the biggest rise. These substantial effects should be interpreted in the context of the measures. As shown in the previous chapter, a great amount of already implemented (dark green) measures are in place, the effect of which are considered in the WEM scenario. The additional effects (WAM to WEM) are associated with the proposed (yellow and light green) measures, as well as the further expansion and enhancement of the existing measures.

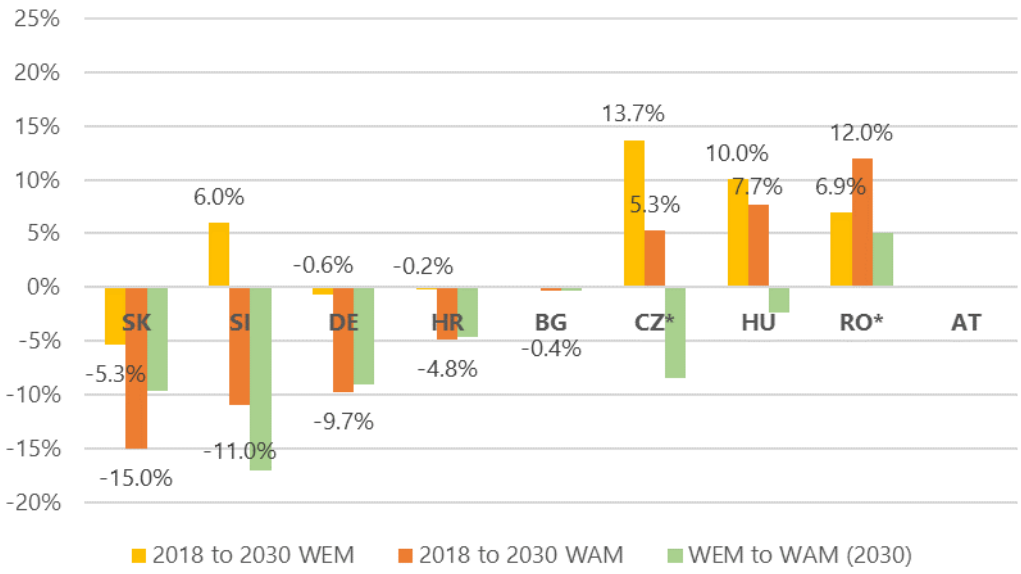
3.5.3.2. ENERGY CONSUMPTION

Reaching a high share of renewable energy does not necessary imply reductions in GHG emission. The continuously rising transportation demand boosts the energy consumption in the region, which is not offset by the improved energy efficiency.

According to the NECPs, only Slovakia projects a real decline in energy consumption for the WEM scenario, while Germany, Croatia and Bulgaria predict a flat rate. The other countries projected significant (5 to 14%) growth in energy consumption under existing measures. All

countries reported lower energy consumption in the WAM scenario (except Romania which used a significantly higher GDP assumption), but only Slovenia expects that the measures will turn the trend of consumption. Considering the difference between the WEM and the WAM scenario, Slovenia, Slovakia, Germany and Czechia[40] predicted the highest effects, while Bulgaria expects that the proposed measures will have a close to zero effect on energy consumption. (Figure 38)

FIGURE 38: EFFECTS OF THE PLANNED MEASURES ON ENERGY CONSUMPTION IN THE TRANSPORT SECTOR, EU DR COUNTRIES



Source of data: Eurostat (for 2018 data), NECPs (for 2030 values).

** CZ provided a "without savings" scenario instead of WEM.*

**RO used significantly higher GDP assumption for WAM scenario than for WEM.*

As three countries (CZ, HU, RO) estimate not only increasing renewable energy usage but also growing energy demand in the transport sector, it is worth revisiting the consequences on non-renewable energy consumption. Figure 39 is a modified version of Figure 38 where the renewable energy consumption is deducted from the total consumption (based on the factual and projected RES-T shares presented in the previous section[41]).

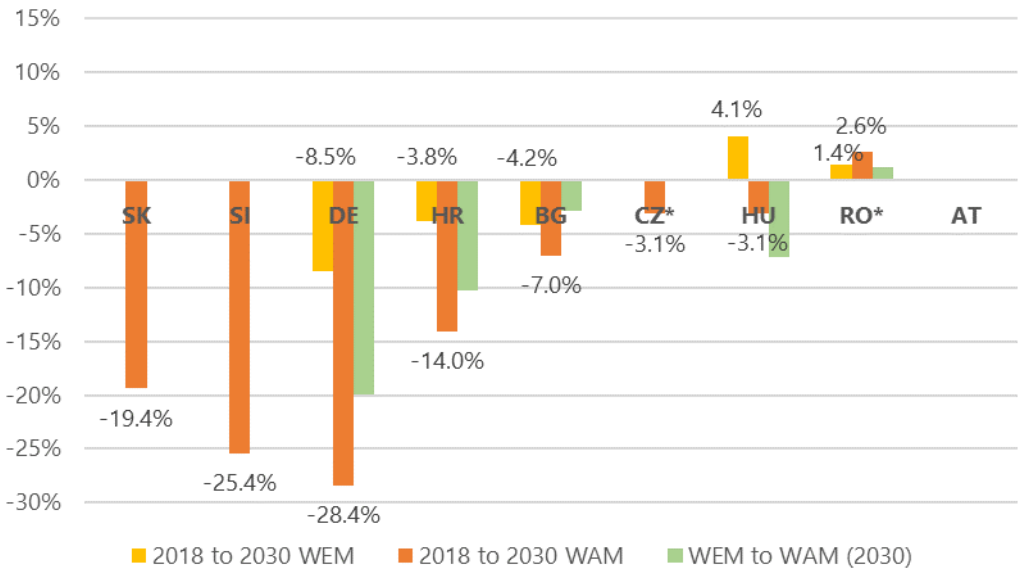
The results show lower values for all countries in both scenarios, which means that it is generally true that renewable energy will grow faster than the total energy consumption of the transport sector. Moreover, all countries (except Romania) are projected to reduce their non-renewable energy consumption in the WAM scenario. Thus, according to the predictions, the proposed measures will reverse the trend of non-renewable energy

[40] The high effects in CZ are attributable to a „without savings" scenario where efficiency improvements are not considered at all. This scenario is not equivalent to a WEM scenario by which certain levels of efficiency gains are expected.

[41] As the RES-T share is calculated with multipliers, the real renewable shares are lower and real non-energy consumption higher, and the change in real non-energy consumption is lower than the presented values. For countries that did not report RES-T in WEM scenario, only the 2018 to 2030 WAM value can be calculated.

consumption in Czechia and Hungary. In this comparison, the effects (WEM to WAM) are the highest in the countries that projects the fastest growth in RES-T share (DE, HR).

FIGURE 39: EFFECTS OF THE PLANNED MEASURES ON NON-RENEWABLE ENERGY CONSUMPTION IN THE TRANSPORT SECTOR



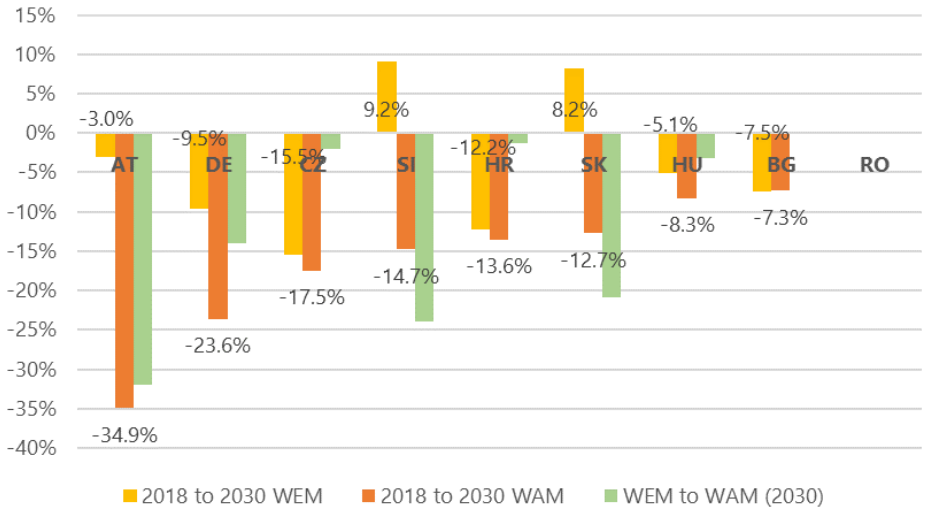
Source of data: Eurostat (for 2018 data), NECPs (for 2030 values)

** CZ provided a "without savings" scenario instead of WEM. RO used significantly higher GDP assumption for WAM scenario than for WEM.*

3.5.3.3. DECARBONISATION

Figure 40 presents the projected trends in GHG emissions from the transport sector.

FIGURE 40: EFFECTS OF THE PLANNED MEASURES ON GHG EMISSIONS IN THE TRANSPORT SECTOR, EU DR COUNTRIES



Source of data: Eurostat (for 2018 data), NECPs (for 2030 values)

Most of the countries expect that the existing measures are enough to reverse growing GHG emissions by 2030, and only Slovenia and Slovakia found that additional measures were needed.

The change in GHG emissions is between +9 (SI) and -15% (CZ) in the WEM scenario and -7 (BG) and -35% (AT) in the WAM scenario. Austria, Slovenia and Slovakia estimate the highest effects from proposed measures while Czechia, Croatia and Hungary do not expect the proposed measures to have a substantial impact on GHG emissions. Bulgaria reported slightly higher emission in the WAM than WEM scenario, meaning the decarbonisation measures would actually lead to higher emissions.

3.5.4. NON-EU COUNTRIES

Strategic documents of non-EU DR countries don't address the transport sector in detail and are outdated compared to the NECPs. Without known specific RES-T targets for 2030, this short analysis focuses on the proposed measures and the projections regarding the sector's GHG emission.

3.5.4.1. POLICIES AND MEASURES

The key observation is that most non-EU DR countries stipulate broad goals (or agenda setting) rather than specific measures. As Table 33 shows, only Montenegro and Moldova describe implemented measures - namely modernization of railway infrastructure (ME), tax allowance for hybrid vehicles (MD) and restrictions and higher duties for imported cars (MD). On the top of that, Bosnia and Herzegovina mentioned measures that are already in progress (payment of fees based on emissions, ban on the highly emitting vehicles, road infrastructure development).

Broadly speaking, they focus more on efficiency improvement than the fuel switch or modal shift. They emphasize the goal of renewing the car fleet and regard road infrastructure development as a climate-protection measure (contributing to the reduction of fuel consumption). Taxation measures are not mentioned.

Both promotion of electric vehicles and biofuels are cited as very general goals without specific measures (Montenegro mentions the charger network as a substantial condition). Electrification of railways is only mentioned by Montenegro, which also plans to promote CNG buses. Enhancing public transportation is among the goals in every strategic document, but the only measure (network development) is also very broad. Three countries mentioned the importance of non-motorised modes, two with more concrete measures: Montenegro plans to construct cycling lanes and launch a "bike share" system, while Moldova intends to develop urban cycling infrastructure. In the context of freight transportation, the development of railways is mentioned only in Montenegro and Ukraine.

As mentioned above, the strategic documents focus mostly on efficiency improvement, with the most detailed measures listed in this area. Serbia has the longest list of measures, containing taxation issues, mobility management, energy efficiency improvement in public transport and freight transport, fuel marking and quality monitoring, but also regulations on tires (promotion of efficient tires, mandatory replacement of summer tires).

TABLE 33: TRANSPORT-RELATED GOALS AND POLICY MEASURES IN THE NON-EU MEMBER COUNTRIES OF THE DANUBE REGION

Goal category	Goal	BA	ME	MD	RS	UA
Fuel Switch	Electric vehicles (road)	*without measure*	*EV charger network*	Taxation		*without measure*
	Biofuels	*without measure*	*without measure*	*without measure*	*without measure*	*without measure*
	Electrification of railways		*without measure*			
	Hydrogen and other advanced fuels		CNG buses			*without measure*
Modal Shift	To public transportation	*without measure*	*without measure*	*without measure*	*without measure*	Network development
	To non-motorised modes	*without measure*	Cycling and pedestrian infrastructure	Cycling infrastructure		
	To rail (freight transport)		Infrastructure development			Network development
Efficiency Improvement	Renewal of car fleet	Emission standards Taxation	*without measure*	Taxation		Emission standards Taxation
	Other	Road infra-structure development	Subsidy for new public transport vehicles	Road infrastructure development	Eco-driving trainings Regulation of tyres	

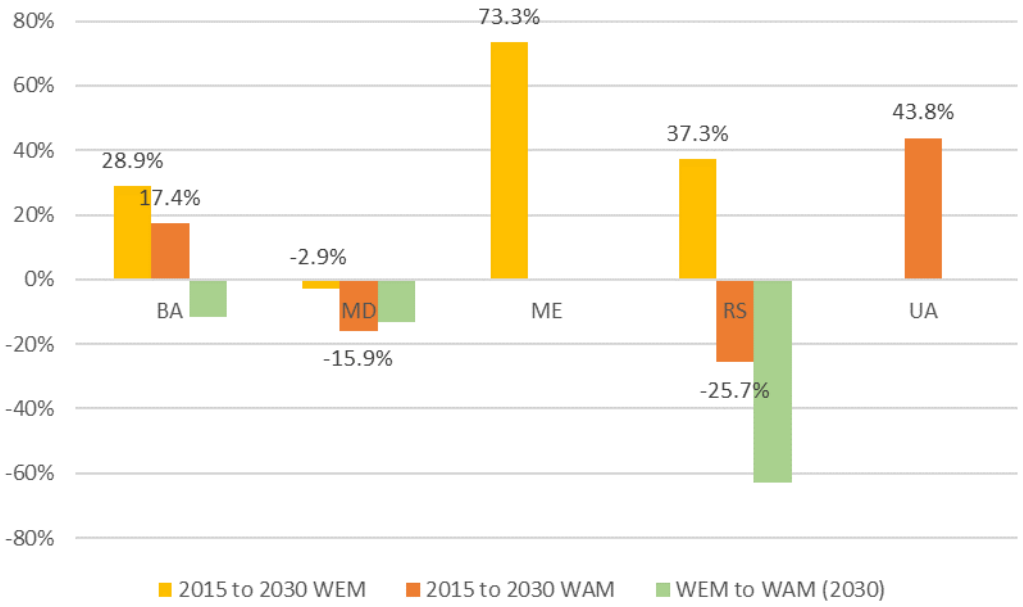
Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

3.5.4.2. PROJECTED GHG EMISSIONS

Among the five countries, three (BA, MD, RS) provided GHG emission data in a WEM-WAM structure, while Montenegro published only baseline projections and Ukraine only an emission reduction goal for 2030.

Starting with the latter, Ukraine's target is to reduce the sector's GHG emissions by 60% compared to 1990. Emissions in 2015 were 72% lower than 1990, meaning this target implies a 44% increase. Montenegro projects a massive increase (+73%) of emissions without estimating the impacts of the listed measures.

FIGURE 41: PROJECTED GHG EMISSIONS IN THE TRANSPORT SECTOR



Source: Strategic documents, NDCs, national communications of the countries

Of the three countries with the full range of projections, Bosnia published an increase in GHG emissions under both scenarios with the lowest climate benefits from measures. On the other hand, it submitted another scenario considering more significant mitigation, that would result in only a 3% rise of GHG emissions. Serbia projected even higher emissions but expects the measures to have a significant effect reversing this to achieve a 25% reduction. Moldova estimates a small reduction of released GHG in the WEM scenario, which grows substantially due to the proposed policies. Moldova submitted a BAU scenario whereby emissions would rise by 12% between 2015 and 2030.

3.6. ENERGY EFFICIENCY IN BUILDINGS

The energy efficiency dimension in the NECPs mainly covers policies targeting energy savings in the transport, buildings (household and services) and the industry sectors. This chapter focuses on energy efficiency measures aiming to decrease energy use in buildings. Policies related to transport and industry are discussed in the relevant chapters (Chapters 3.5 and 3.7).

3.6.1. TARGETS

European Parliament's Energy Efficiency Directive (EED) establishes the framework for measures to reach efficiency improvement targets which are set individually by each Member State contributing to the overall EU target. The following EU policies determine the energy efficiency related targets of the Member States in the buildings sector:

- Article 2a of the Energy Performance of Buildings Directive (EPBD): All EU countries must establish a long-term renovation strategy to support the renovation of their

national building stock into a highly energy efficient and decarbonised building stock by 2050.

- EPBD (Directive 2010/31/EU): all new buildings must be nearly zero-energy buildings (NZEB) from 31 December 2020.
- Article 5 of the EED (binding target): renovation of at least 3 % of the total floor area of buildings with a total useful floor area over 250 m^2, where the buildings are owned and occupied by central government and which simultaneously do not meet the minimum requirements for the energy performance of buildings of Class C – Efficient
- Article 7 of the EED (2018, binding target): EU countries decide whether to use energy efficiency obligation schemes (energy savings of 0.8% each year of final energy consumption for the 2021-2030 period) or alternative policy measures (energy or CO_2 taxes, energy labelling schemes etc.), or both.

The Directives set very strict directions, but some targets are altered for different countries, for example, Bulgaria has set 5% target for renovation of public buildings, and Croatia has set the target of 0.00489 PJ per year in equivalent savings instead of the 3% renovation rate for public sector buildings.

Some countries added sub-targets or objectives which determine their paths towards improving energy efficiency. **Bulgaria** highlights the importance of high-efficiency heating and cooling systems, development of high-efficiency cogeneration, new district heating networks and the rehabilitation of existing ones. It also aims to reduce district heating network losses using BAT technology (high-power density systems). The **Hungarian** NECP states that the country's biggest energy saving potential lies in the modernization of buildings and heating systems and aims to avoid up to ¼ of the country's natural gas imports through energy efficiency gains. **Slovenia** targets a 20% reduction in final energy use in buildings, reducing GHG emissions from buildings at least 70% by 2030 compared to 2005. The country has started developing a strategy for efficient heating and cooling, a district heating action plan and heat maps.

The energy strategy documents of non-EU DR countries do not address the buildings sector in detail and subsequent analysis is therefore limited, mostly focusing on the 2020 targets.

- According to the NEEAP proposal of **Bosnia and Herzegovina**, the housing sector could save 6.41 PJ (153.1 ktoe) by 2020. Savings in the commercial and services sector would be 1.98 PJ (47.3 ktoe) by 2020.
- The National Development Strategy of **Moldova** sets to reduce energy consumption in buildings 10% by 2020 and reach a 10% share of renovated public buildings by 2020.
- According to the National Energy Strategy of **Montenegro**, 46.3 ktoe saving can be realized by 2030 by the country's energy efficiency policy and 99.6 ktoe if efficiency improvements are led by the market in the residential and services sector.
- In **Serbia**, final household energy consumption in 2010 (3148 ktoe) is expected to grow to 3349.5 ktoe in 2030 in the reference scenario, compared to 3113.4 ktoe with the application of energy efficiency measures.

- According to the **Ukrainian** NREAP (2014) gross final energy consumption is set to grow in the heating and cooling sector, to 53780 ktoe in the reference scenario, compared to 47100 ktoe achievable with additional efficiency measures.

3.6.2. POLICIES AND MEASURES

Due to the above-mentioned EU targets and policies, all EU DR countries already have a range of measures in place, many of which will continue to apply, often with some modifications and extensions, to help achieve 2030 targets. Table 34 presents those policies and measures, mentioned in the NECPs, which belong into the categories of regulatory, market based and fiscal instruments, targeting energy efficiency improvements.

Measures related to **innovations, information, and knowledge** are presented in Table 35.

TABLE 34: MEASURES TO SUPPORT BUILDING RENOVATION IN EU DR COUNTRIES

Types of instruments	Building renovation	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Regulatory instruments	Standards/ regulations									
	Public procurement									
	Energy efficiency obligation scheme (EEOS)									
	Labelling, certification									
Market-based	Energy savings/ performance contracting									
Fiscal instruments and incentives	Tax incentive									
	Subsidies, grants, preferential loans									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

As the table reveals, standards and financial instruments supporting **building renovation** and **upgrade of heating** in buildings are in place (and are indicated by the NECPs) in all EU DR countries, albeit many of them have their building standards under revision.

Austria plans to phase out old fossil-fuel heating systems and replace them by high efficiency renewable-based alternatives. The government has already implemented measures to promote renovations, like the support of investment in thermal building renovation and promoting high-efficiency home technology and energy management systems in buildings. For public buildings energy savings contracting are also in force. It considers the reduction of the depreciation for energy efficiency related investments to attract more investors in this field. The government is also defining a thermal renovation rate, seeking to double it in the period 2020-2030. The main measure will be targeted funding for renovation works. **Bulgaria** aims to provide financial support for the improvement of the energy efficiency of public, industrial, and residential buildings through deep renovation, and plans to convert existing buildings into nearly-zero energy buildings.

They also support the implementation of measures to improve the energy efficiency of small and medium enterprises and local authorities. Public contracting entities must purchase products, services and buildings with the highest energy efficiency indicator. Bulgaria prescribes the mandatory decommissioning of solid-fuel heating devices and their replacement with new heating devices in residential buildings. **Czechia** intends to continuously apply its financial support schemes for building renovation after 2020. It intends to continue supporting Energy Performance Contracting. The standard established for 'near-zero' buildings is under revision.

Germany provides the most detailed description of the renovation measures and has implemented policies in most of the categories. This includes support for energy consulting offered both to residential and public buildings and funding for energy performance contract consulting for non-residential buildings. Application procedures are simplified by combining access to support for multiple purposes, e.g. efficiency improvements and renewable energy use. Tax incentive is offered for residential building owners as an alternative to the investment funding programmes. Germany aims at further developing standards for energy labels and ecodesign. **Croatia** has an Energy Efficiency Obligation Scheme in place. The country aims to clarify rules regarding energy auditors and consultants. Croatia is elaborating comprehensive energy renovation programmes in 2020, both for multifamily buildings, family houses, heritage buildings and also for public sector buildings until 2030. Besides new buildings, nearly-zero energy standard will be promoted also in case of the renovation of existing buildings. **Hungary**, the Building Energy Performance Tender Programme with a budget of HUF 0.4 billion provides funding for the energy efficiency actions and the construction of low energy buildings. Hungary prescribes more stringent legal obligations to exploit the energy saving potential in the operation of public buildings and has developed an incentive scheme for operators of public bodies, clarifying rules for implementing proposals from energy auditors and consultants. An Energy Efficiency obligation scheme has recently been introduced, and ESCO type financing schemes are facilitated.

Romania aims to introduce and apply restrictions to the sale or rental of buildings in the lower energy performance categories and to establish performance standards for the renovation of envelope elements of buildings and of HVAC (Heating, Ventilation and Air Conditioning) systems. Romania also aims to promote thermal insulation both for public buildings, residential blocks, single-family houses and commercial buildings. In **Slovenia**, several measures have already been in force and plan to be upgraded, for example the system of buildings evaluation and the energy efficiency aid provided for vulnerable consumer groups. Financial incentive schemes take several shapes, like the support for the renovation of multi-owner buildings, renovation of heritage buildings, or the eco-fund loans and incentives. A system of certification scheme, training, maintenance, financing, and renovation model is being established for the sustainable evaluation and renovation of buildings. In the public sector, renovation is also complemented with other approaches like energy contracting, energy management systems, and the application of energy efficiency return scheme to improve the monitoring of the effects of loans received (Eco fund, etc.) to reduce energy use. Energy contracting related instruments, introduced earlier, are planned to be continued and upgraded by extending the support to the housing sector. **Slovakia** promotes programs leading to lower primary and final energy consumption, either through

energy efficiency improvements or switching from fossil energy use to renewable-based solutions in buildings, through a combination of loans with grants

TABLE 35: INNOVATIONS, INFORMATION, KNOWLEDGE IN THE FIELD OF ENERGY EFFICIENCY IN EU DR COUNTRIES

Innovations, information, knowledge	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Innovation, research									
Information, training, awareness raising									
Detailed billing and disclosure programmes									
Digitalization									
Local energy communities									
Energy advisory									

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

Austria puts a lot of emphasis on innovative measures. The preparation and implementation of pilot projects for 'energy efficient towns/cities' and 'energy efficient villages' is already underway, with support for municipalities to use energy more efficiently. Austria also aims to introduce efficiency related educational and awareness raising programmes. **Bulgaria** has implemented consumer information and training programmes and an applied research programme in the area of energy efficiency of buildings (2015-2030). The country aims to drive innovations in the construction sector as well, with the preparation and launch of a digital platform for the Bulgarian construction sector beginning in 2021 to support the preparation and the implementation of digital reform in the sector. **Czechia** operates energy consulting for public buildings and plans to launch an Energy Consultation and Information Centre.

Germany operates consumer information and training programmes, with the Building the Energy Transition Initiative serving to improve awareness of energy innovations through targeted research communication. Energy advisory services are also established and widely available for those interested. The German NECP also aims to continue with the very successful Urban Development Funding Programme. **Croatia** emphasizes information campaigns and educational programmes. It established an integrated information system for monitoring energy-efficiency, energy savings and the resulting reduction in greenhouse gases. Bills are also very informative in Croatia to raise consumer awareness over their consumption profile to help them consume less energy. The National Network of Energy Engineers was set up in 2017, responsible for supporting the energy efficient operation of public bodies. **Hungary's** NECP is reconsidering the energy efficiency measures applied so far and develops new incentives for awareness raising. An energy efficiency program is also necessary and will build on the enhancement of knowledge-sharing, readily comprehensible

advice provided by the more easily accessible advisory network, and on the priority of investments.

Romania plans to assess its energy savings potential and aims to increase training and upskilling programmes, support efficiency related research and the development of pilot and demonstration projects. A smart monitoring system will play an important role in prioritizing energy efficiency requirements. **Slovenia** operates a network of energy advisors in line with the relevant regulation, and plans to establish a portal of energy properties of buildings based on all available data to provide comprehensive spatial insight into the state of buildings and to enable quality planning of measures. **Slovakia** will establish a Regional Energy Center to promote energy efficiency improvements and RES development in regions, districts, self-governments, and higher territorial units.

3.6.2.1. MEASURES IN THE NON-EU COUNTRIES

Measures in the non-EU member countries are presented in the following paragraphs to provide a brief picture of the policies which mostly look ahead to 2020 only.

In **Bosnia and Herzegovina** there are several enacted measures that promote energy efficiency, including envelope renovations to improve energy performance both for residential and public buildings. The NEEAP mentions further strengthening institutional capacities responsible for energy efficiency. Awareness raising programs and campaigns are already very important parts of the Bosnian energy efficiency measures informing the customers via education and informative billing.

Moldova established the Energy Efficiency Agency (EEA) in 2013 which serves as the single information centre for investors in RES and energy efficiency projects and supports scientific and informational programmes as the main platform for knowledge-sharing in the field of energy efficiency. Moldova aims to run programs promoting energy efficiency at the local level, which is unique compared to other countries.

According to **Montenegro's** 2030 Energy Development Strategy the main programs to support energy efficiency by the end of 2020 were the completion and harmonization of the legal framework, supporting investment projects in public lightning, water supply and other utility services, and informing and educating citizens about efficient energy use. Determination of the energy efficiency potential in buildings is already underway with the establishment of a national building inventory that will be used for defining the reference buildings and determining cost-optimal levels of efficiency.

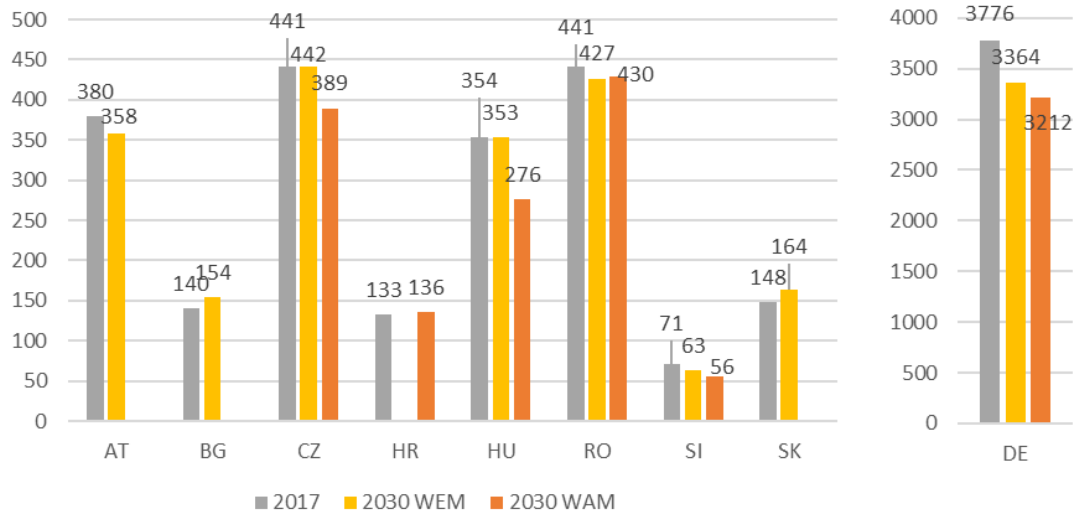
In **Serbia**, one main pillar of energy efficiency measures is the rehabilitation of the district heating systems aiming to improve their operation, improve energy efficiency and reduce fossil fuel use, replacing coal and fuel oils with biomass and natural gas. Reduction of network losses by modernization and renovation is also highlighted. Foreseen strategic actions include the implementation of consumption-based billing. Energy efficiency measures defined in the energy Efficiency Action Plans target all energy consumption sectors. Measures target efficiency improvements in residential buildings, new construction regulations and energy performance certificates, promotion of energy efficient appliances in households, and utilization of ESCO funding. The Energy Sector Development Strategy also considers it important that customers are well-informed about their energy usage.

Ukraine adopted the EU directive on energy efficiency of buildings and set up the Energy Efficiency Fund in 2017. According to a study on Ukraine's natural gas and electricity reforms, the necessity of efficiency measures is enormous in Ukraine.[42] In 2016, the Ukrainian government spent roughly 70 times more on subsidies for public utilities than it did on energy efficiency. Over the next 15 years, Ukraine is projected to undertake modernization programmes for buildings owned by national or local governments with a budget that is a fraction of the 2017 budget. This means that in the absence of new investments, the government will continue to spend more on energy subsidies than on efficiency improvements. Ukrainian legislation stipulates that all public buildings should be equipped with heat meters as a part of special budget program to enable heat savings. Municipalities will have to take role in implementing energy-saving interventions, like the modernization of district heating systems or thermal renovation of public buildings (efficient insulation of external walls and roofs, replacement of energy inefficient glazing with efficient ones).

3.6.3. EXPECTED OUTCOMES

This section provides an overview of the expected effects of the measures as published by NECPs. Policy related energy efficiency targets in the buildings sector are associated with the final energy consumption values in the related consumer sectors. It is important to note that energy consumption levels are dependent on several factors, like GDP growth assumptions, change in the residential area (demographic developments) and change in the structure of the economy, among others. This means that the expected change in final energy consumption might not fully reflect the efforts made towards efficiency improvements, as other factors can work in the opposite direction.

FIGURE 42: FINAL ENERGY CONSUMPTION OF HOUSEHOLDS AND SERVICES IN EU MEMBER STATE DANUBE REGION COUNTRIES, PJ



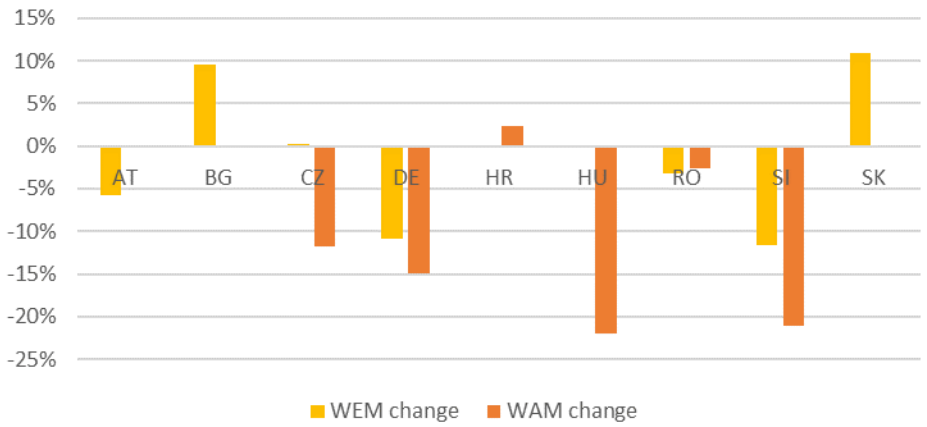
Source: NECPs

[42] Bayramov, A.-Marusik, Y. (2019): Ukraine's unfinished natural gas and electricity reforms: one step forward, two steps back, Eurasian Geography and Economics, 60:1, 73-96, DOI: 10.1080/15387216.2019.1593210

Figure 42 displays the WAM projections for 2030 and compares it with the current (2018) status and the WEM projection for 2030. Unfortunately, the data is incomplete, with the WAM scenario missing in the Austrian, Bulgarian and Slovakian NECPs and WEM scenario missing from Croatia. In most of the cases the presentation of the sectoral breakdown for households and services is missing.

Figure 43 compares the results of estimated scenarios with existing measures (WEM) and with additional measures (WAM) to see the additional effects of the planned policy measures.

FIGURE 43: RELATIVE CHANGES IN THE 2030 WEM AND WAM SCENARIOS COMPARED TO 2017



Source: NECPs

Based on the two figures, we can see that the WEM scenario results in higher final energy consumption in Bulgaria and Slovakia, while in Croatia, even the WAM scenario shows a small increase in energy use. The WAM scenario shows 10-15% reduction of final energy consumption in Czechia and Germany compared to 2017, and over 20% energy savings in Hungary and Slovenia.

3.7. INDUSTRY DECARBONISATION

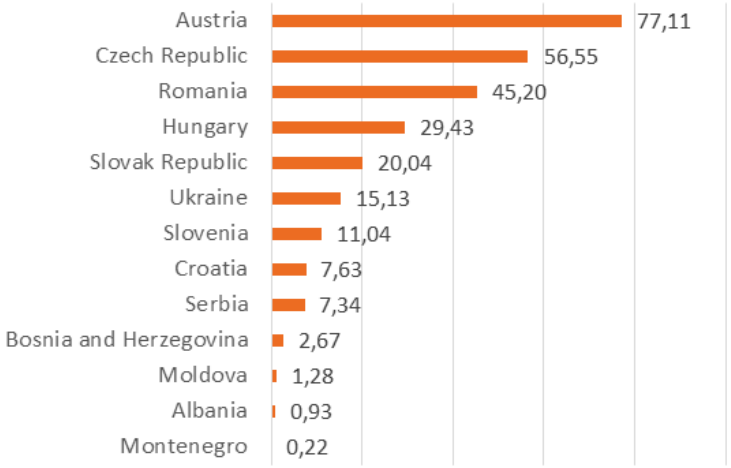
This chapter describes the impact of the NECPs and other national policy documents on the planned decarbonisation of the manufacturing sector.[43] Industrialization is key for economic development, however the vast majority of the current industrial processes are still highly carbon intensive, especially for the production of basic materials, such as cement, steel or aluminium. The manufacturing of these industrial products accounts for around 16% of European and 25% of global greenhouse gas emissions.[44]

[43] In our analysis we follow the statistical approach of OECD about the classification of manufacturing activities. Manufacturing comprises Tabulation Category D and Divisions 15-37 in the International Standard Industrial Classification (ISIC).
[44] https://climatestrategies.org/projects/european-climate-friendly-materials-platform/

Based on the latest available data [45], the industrial production in the Danube Region increased rapidly in the recent period between 2015 and 2019. Data shows growing industrial production in each DR country except Montenegro compared to 2015, varying from 1.6% to 28.1%. Ten countries performed better than the 6.5% EU27 average growth rate in the same period (SI, RO, HU, RS, CZ, SK, BG, AT and HR), while Bosnia and Herzegovina and Germany achieved 2.0% and 1.6% increase and Montenegro was 10% below its 2015 level of manufacturing production.

The role of manufacturing varies significantly from country to country in the Danube Region.

FIGURE 44: VALUE ADDED OF MANUFACTURING SECTOR IN DANUBE REGION WITHOUT GERMANY IN 2018 (CURRENT US$, IN BILLION)



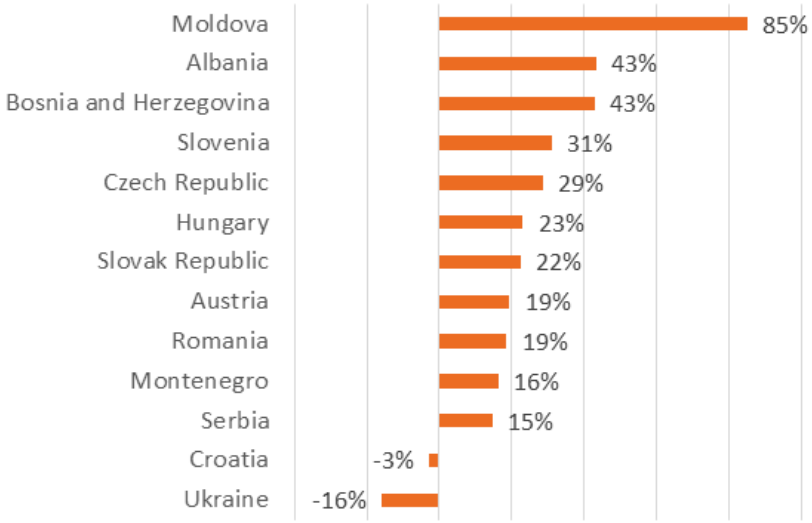
Source: WorldBank[46]

Figure 44 shows the value added of the manufacturing sector of Danube Region countries. German data was excluded from the figure since it is more than 10 times higher than the second highest value in the region. The German added value of manufacturing sector achieved USD 806 billion in 2018.

The gross value added of the manufacturing sector increased in most of Danube Region countries, as Figure 45 reveals. The dynamic was the highest in the relatively under-industrialized countries such as Moldova, Albania and Bosnia and Herzegovina. In Croatia, the structural reforms of the economy slightly reduced the performance of the industrial sector, while in case of Ukraine military actions in the Crimea, Donetsk and Luhansk regions resulted in a significant reduction of the industrial output.

[45] Volume index of production, 2015=100, source: Eurostat, (online data code: STS_INPR_A). The datasheet does not include data for Ukraine and Moldova.
[46] The datasheet does not include data for Bulgaria.

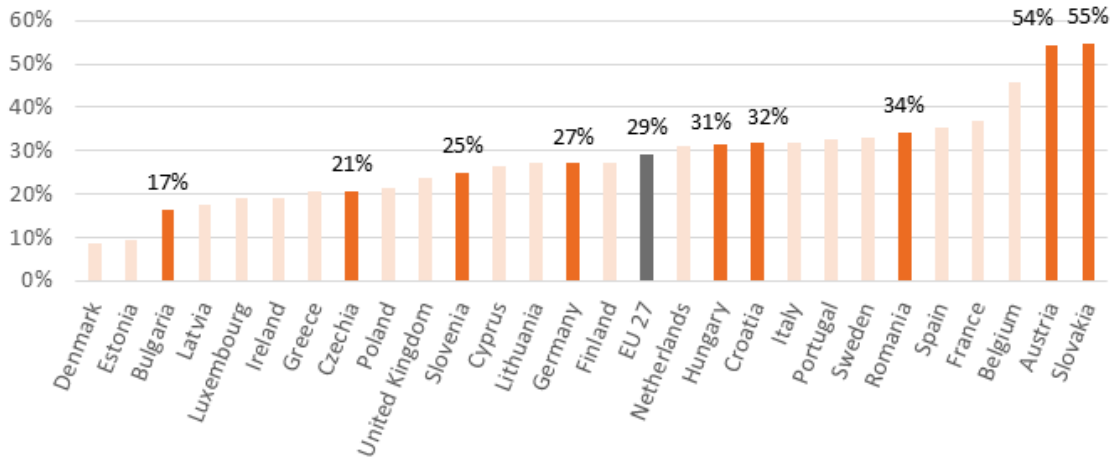
FIGURE 45: CHANGES IN VALUE ADDED OF MANUFACTURING SECTOR IN DANUBE REGION EXCLUDING GERMANY BETWEEN 2010 AND 2018



Source: WorldBank

From a decarbonisation perspective, it is important to consider the current share of industry in CO_2 emissions of Danube Region countries (Figure 46). The latest statistics show that the share of industry in total CO_2 emissions of EU 27 was 29% in 2018. Five of the nine EU member states of the Danube Region performed above the EU average.

FIGURE 46: SHARE OF CO_2 EMISSION OF THE MANUFACTURING SECTOR IN 2018 COMPARED TO THE TOTAL EMISSIONS IN THE EU AND EU DR COUNTRIES

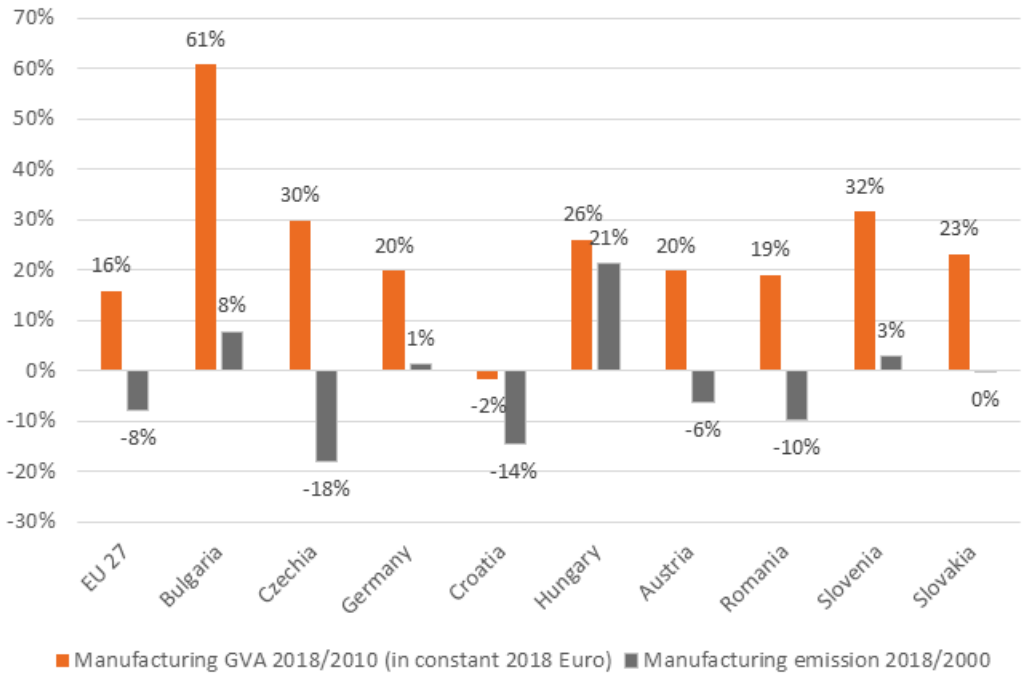


Source: EUROSTAT

Figure 47 reveals that in the period of recovery from the economic recession most countries were successful in decoupling growth from manufacturing sector CO_2 emissions. Hungary is an exception, with industrial emissions increasing rapidly while total country level

emissions fell in the same period. In Bulgaria lower emissions are an outcome of lower economic activity (falling production).

FIGURE 47: CHANGES IN THE CO_2 EMISSIONS AND MANUFACTURING VALUE ADDED BETWEEN 2010 AND 2018 IN DANUBE REGION COUNTRIES



Source: EUROSTAT

Unfortunately, similar data is unavailable in non-EU members of the Danube Region. General data published by the World bank shows that the average per capita CO_2 emissions decreased from 4.31 to 3.99 metric tons per capita in the 5 assessed countries between 2010 and 2016[47], although the change in the individual values vary significantly. Besides Ukraine, which shows a 32% reduction, this value decreased only in Montenegro (by 17%) and increased in the rest of the countries (by 12%, 6%, and 2% in BA, MD and RS, respectively). It is important to note, however, that these values correspond to changes in the whole economy, and do not reflect industry sector developments.

It will be challenging in the upcoming period for the countries to decouple economic growth from GHG emissions. If they do not limit the level of industrial emissions, the envisaged carbon border adjustment mechanism raised by the EU Green Deal Communication will derail regional cooperation between them and their EU partners.

3.7.1. TARGETS

Only a few Danube Region countries have defined industry-specific targets in their NECPs. It is important to underline, that this does not mean the industrial transition is not in focus

[47] WorldBank. Indicator: EN.ATM.CO2E.PC

since several have prepared or plan to prepare industry-specific policy documents, including detailed pathways.

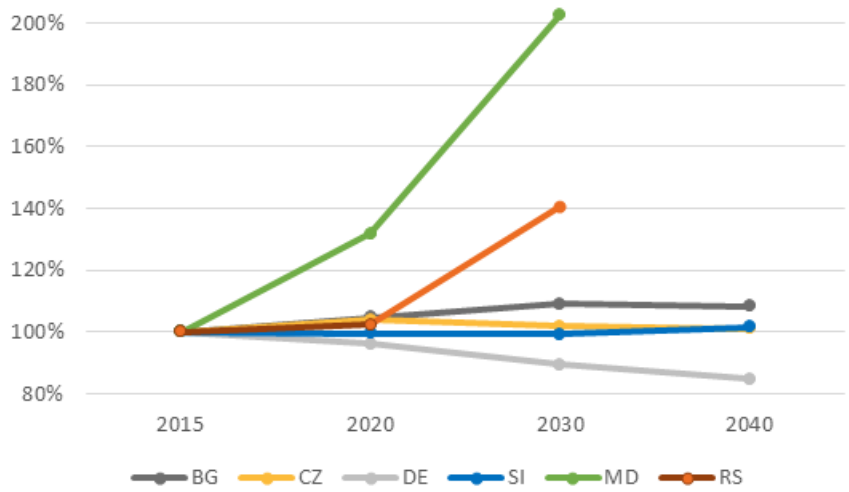
Only three countries (Austria, Bulgaria and Germany) devote special attention to the industry sector in their NECPs. Germany would like to strengthen its reputation as an industrial powerhouse, through increased energy efficiency based on lower energy inputs and through the development of technologies for certain industrial processes in which the emissions are difficult or even impossible to abate (e.g., cement manufacturing). Austria's aim is to develop successful technologies and solutions that will allow Austrian industry to position itself as an innovation leader on the global technology markets. Bulgaria would like to preserve the competitiveness of its basic energy-intensive industries while limiting the risks of carbon leakage.

The Austrian and German documents also highlight the importance of ensuring a level playing field for local industrial producers implementing carbon mitigation measures by putting a carbon price on imports from third countries and thus minimising market distortions.

Less than half of the assessed EU countries have presented numerical estimates for the final energy consumption of the industrial sector in their NECPs. For non-EU countries only data from Serbia and Moldova are available, both planning to increase the final energy consumption of the sector until 2030 as a part of their (re)industrialization strategy.

The predicted evolution of final energy consumption in the industrial sector is shown in Figure 48.

FIGURE 48: PREDICTED FINAL ENERGY CONSUMPTION IN INDUSTRY (2015=100%)



Source: NECPs and Energy strategies

The majority of EU member states plan to reduce their industrial emissions according to the EU 2050 decarbonisation strategy. Czechia plans to reduce the emission intensity of final industrial energy consumption to 1.45 tCO_2eq/toe by 2040 from 1.49 in 2015. Germany projects it will reduce emissions from the manufacturing sector to 99 $mtCO_2eq$ by 2040 from

127 $mtCO_2eq$ in 2015. A specific GHG emission target for the industrial sector in Germany of 55% is laid down in its Climate Action Plan 2050.

Slovakia plans to lower industrial emissions to 3.7 $mtCO_2eq$ by 2040 compared to the 6.7 $mtCO_2eq$ in 2015. The Slovenian sectoral target for industrial plants not covered by the EU ETS is a 43% reduction compared to 2005.

In contrast, Bulgaria estimates a significant increase in industrial emissions compared to 2015. This is owing to the national industrialization and intensive gasification strategy that entails industrial restructuring with a growing petrochemical sector. Romania is following this model as well, according to NECP modelling a 14.59% rise is expected in the final energy demand for its industry in the next 10 years.

Considering the non-EU countries, the level of industrial decarbonisation efforts appears highly dependent on the perspectives of accession into the EU for Bosnia and Herzegovina and Moldova. The Ukrainian INDC declares that industrial decarbonisation will play an important role in reaching the 40% GHG emission reduction target by 2030 (compared to 1990).

3.7.2. REMARKS TO INDUSTRIAL DECARBONISATION POLICIES

The relative underrepresentation of industry in the NECPs is partially due to the binding template of NECPs, not placing much emphasis on the area of industrial decarbonisation. Because decarbonisation of industry is only now emerging as a key long-term EU policy objective and experience is limited, industry-specific strategies are still being developed. It is possible, that the 2030 agenda of some countries have not yet been clearly designed with the mindset of zero emissions in 2050. For non-EU countries especially, the balance between economic growth and decarbonisation is still sensitive, where industry is underdeveloped or affected by economic or political strain.

There is still a debate over the appropriate level of regulation for the industrial sector. Some instruments (such as the potential extension of EU ETS system for new activities and new geographical areas) require EU level agreement while others can be implemented nationally. It is important to clarify the role of direct support mechanisms, financial initiatives, and regulatory measures, to minimize market distortion. Industrial decarbonisation must not hamper the development of economic relations between the EU and non-EU countries. It must be ensured that stricter EU rules do not export industrial production to countries that have weaker climate regulations.

3.7.3. POLICIES AND MEASURES

NECPs contain only a small number of industry-specific measures. As alluded to above, this does not mean policies are missing since they will adopt existing measures of European regulation such as the ETS system or the mandatory energy audits. This chapter summarizes planned additional country-specific measures which are explicitly mentioned in the national policy documents, grouped into the following categories:

- Investment support for pilot projects and demonstrations
- Financial incentives (taxes and levies)

- Regulatory obligations
- Other measures (education, training)

As most planned measures focus on the emission reduction and energy efficiency dimensions of NECPs, country-level measures are summarized in two related sections.

3.7.3.1. REDUCTION OF GREENHOUSE GAS EMISSIONS

Table 36 summarizes the industry-specific measures found in the NECPs. It is important to repeat, that the empty cells of the table do not mean that the topic is being ignored since strategic documents outlining industry decarbonisation are planned.

Investment support, grants to pilot projects, and demonstration programmes related to the industry sector are mentioned in the NECP of 6 countries. In Austria, as a part of Flagship 9 project of the Austrian Climate and Energy Strategy the government will support breakthrough technologies for industry which enable raw material and energy consumption to plummet, emissions to fall significantly and raw material and energy independence to increase whilst maintaining constant output.

TABLE 36: INDUSTRY-SPECIFIC MEASURES IN GHG REDUCTION

Reduction of GHG emission	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Investment support for innovative technologies									
Financial initiatives									
Regulatory obligations									
Information platforms, knowledge sharing									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

The Austrian NECP allocated 1,366 million Euro for R&D and implementation in field of bioeconomy. Czechia plans to develop aid for technologies contributing to climate and energy goals. The German national decarbonisation programme includes a funding programme for development, demonstration, and market launch of new technologies. Germany has defined a research and innovation agenda on using carbon from industrial CO_2 emissions as a raw material to support a carbon-neutral circular economy. Romania plans to support the implementation of BAT technologies for industrial actors through financial aid from the Innovation Fund. Slovenia will make available non-refundable financial incentives for industrial GHG emission mitigation through circular economy measures. It also initiated plans for a non-refundable support scheme to reduce process emission in industry.

Financial initiatives are considered by three countries**.** Austria considers the introduction of an 'energy transition bond' for renewable energy and efficiency projects in the sector. In Croatia, a CO_2 tax has to be paid by non-ETS industrial facilities, providing an incentive to

invest in mitigation technologies. Romania plans to develop voluntary agreements to finance the improvement of industrial processes.

Regulatory obligations will be put in place in Austria, which plans to introduce cost-effective sectoral targets for all sectors not covered by the EU Emissions Trading Scheme (non-ETS). Croatia will establish a Programme for the calculation and reduction of carbon footprints of non-ETS economic operators. Germany is working together with the EU Commission on defining a minimum price for the EU emissions trading system.

Croatia and Czechia engage in programs related to **information platforms and knowledge-sharing.** Croatia plans to create a circular economy platform which is a cross-sectoral thematic working group to identify stakeholders from industry and suppliers of raw materials, energy-generating products, and packaging. Czechia will participate in the Program 'RESINDUSTRY', together with Spain, Malta, Austria, Poland and Finland, supporting knowledge transfer between EU countries related to the renewable energy use in industry.

3.7.3.2. ENERGY EFFICIENCY

Table 37 summarizes the industry-specific energy-efficiency measures found in the NECPs.

TABLE 37: INDUSTRY-SPECIFIC MEASURES IN ENERGY EFFICIENCY

Reduction of GHG emission	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Investment support									
Financial initiatives									
Regulatory obligations									
Information platforms, knowledge sharing									

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

The following list includes the planned (or partially implemented) industry-specific energy efficiency measures of the EU member states of Danube Region.

Investment support grant to pilot projects, demonstrations, programmes: Austria allocated EUR 4 billion for the development of heating and cooling systems in the non-ETS industrial sector. Bulgaria plans to develop grant assistance for the implementation of energy efficiency and renewable energy measures under operational programmes. Slovakia targets higher energy efficiency through competitive measures. This programme provides support for projects only to the extent necessary for their implementation, which will in turn result in significant savings of public funds. Slovenia continues the development of its Energy Efficiency Obligation Scheme and RES incentive scheme, with national and EU funds for industrial actors and SMEs.

Financial initiatives: Croatia plans to introduce a tax system which incentivises industrial actors to continuously conduct energy audits, even SMEs. In Hungary, a tax incentive was

introduced in 2017 in relation to efficiency-improving investments. Slovakia plans to implement a new credit line to promote the development of energy efficiency and RES sources for industry.

Regulatory obligations: Bulgaria has introduced an energy efficiency obligation scheme (EEOS). As an alternative measure to EEOS, the country also applies individual energy savings targets for owners of industrial systems. Hungary will introduce an energy efficiency obligation scheme from 2021. While the EEO is not an industry-specific measure, all obliged parties will have the opportunity to execute industrial energy efficiency projects independently from their consumer portfolio. Germany underlined the importance of new, more ambitious standards for energy labels and eco-design. Romania would like to enhance the investment of industrial actors into energy efficiency through energy audits. The introduction of new minimum performance standards and regulation for industrial processes is also part of the planned measures.

Slovakia plans to create an **information platform** for industry about energy efficiency opportunities. The country would like to extend the voluntary energy saving agreements to new sectors. The main goal of the measure is to increase the number of actors that will actively contribute towards the achievement of the objective with industry or other relevant associations in this scheme. Slovenia plans to promote the introduction of energy management systems.

3.8. NATURAL GAS

This chapter aims to summarize how individual NECP targets and related measures will impact the natural gas sector. Since there are no targets explicitly requested for the natural gas sector, the structure of this chapter will differ to some extent from the other topical areas.

First, the chapter provides a broad overview of the current state of play in the natural gas markets of the Danube Region in terms of gas consumption volumes, share of natural gas in the energy mix and import dependency. Second, it will assess measures that are expected to foster decarbonisation, though in certain countries the natural gas market plans are not necessarily synchronized with the decarbonisation agenda. The three main gas consuming sectors (electricity and heat generation, industry, and household & services) will be discussed separately. Third, it will summarize the security of supply of the gas sector according to the NECPs to reduce import dependency, gas infrastructure related investment plans, and enhance regional cooperation.

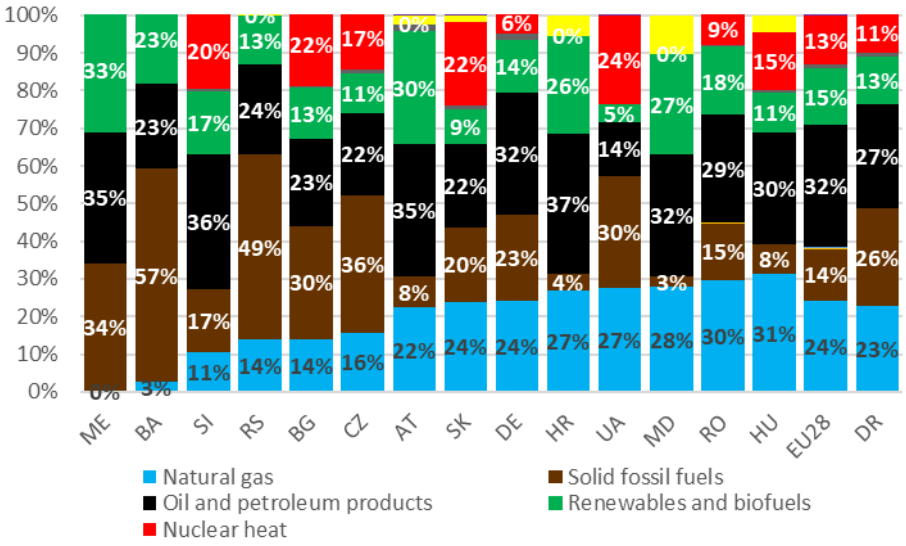
3.8.1. GAS CONSUMPTION OVERVIEW

The share of gas in the total primary energy supply (TPES[48]) for the Danube Region is 23%, very similar to the average of the EU28. What makes the Danube Region unique under the

[48] Total Primary Energy Supply: Total energy supply is one of the most important aggregates of energy balance and represents the quantity of energy necessary to satisfy inland consumption (inland fuel deliveries) of the geographical entity under consideration. See https://ec.europa.eu/eurostat/documents/38154/4956218/ENERGY-BALANCE-GUIDE-DRAFT-31JANUARY2019.pdf/cf121393-919f-4b84-9059-cdf0f69ec045.

decarbonisation agenda is the high share of solid fossil fuels used to meet its energy needs, especially coal and lignite. The DR share of coal is 26% compared to the EU's 14%. On the other hand, the 27% share of oil and petroleum products in the Danube Region is slightly lower than the EU28 (32%). The share of gas in the individual Danube Region countries varies between 0 and 31%. The share of gas in the supply mix is above EU28 average in Hungary, Romania, Ukraine, Moldova, and Croatia (Figure 49).

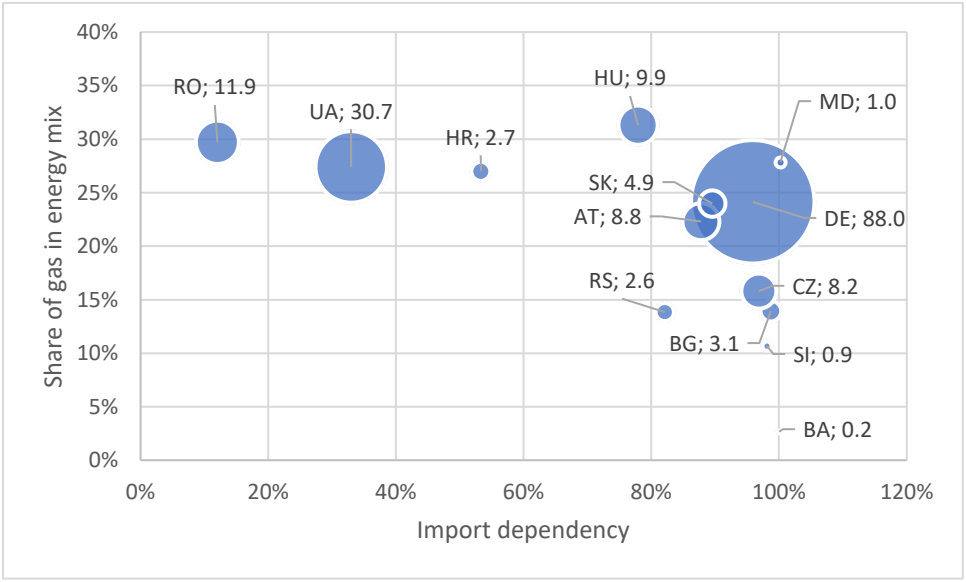
FIGURE 49: FUEL MIX OF THE TOTAL PRIMARY ENERGY SUPPLY IN THE DANUBE REGION AND IN THE EU28 (2018)



Source: Eurostat. The yellow colour denotes net electricity import, also included in TPES by Eurostat.

The Danube Region total gas consumption was ~170 bcm/yr in 2018, with Germany alone accounting for almost ~90 bcm/yr, followed by Ukraine with ~30 bcm/yr.

FIGURE 50: SHARE OF GAS IN THE ENERGY MIX AND GAS IMPORT DEPENDENCE BY COUNTRY, 2018

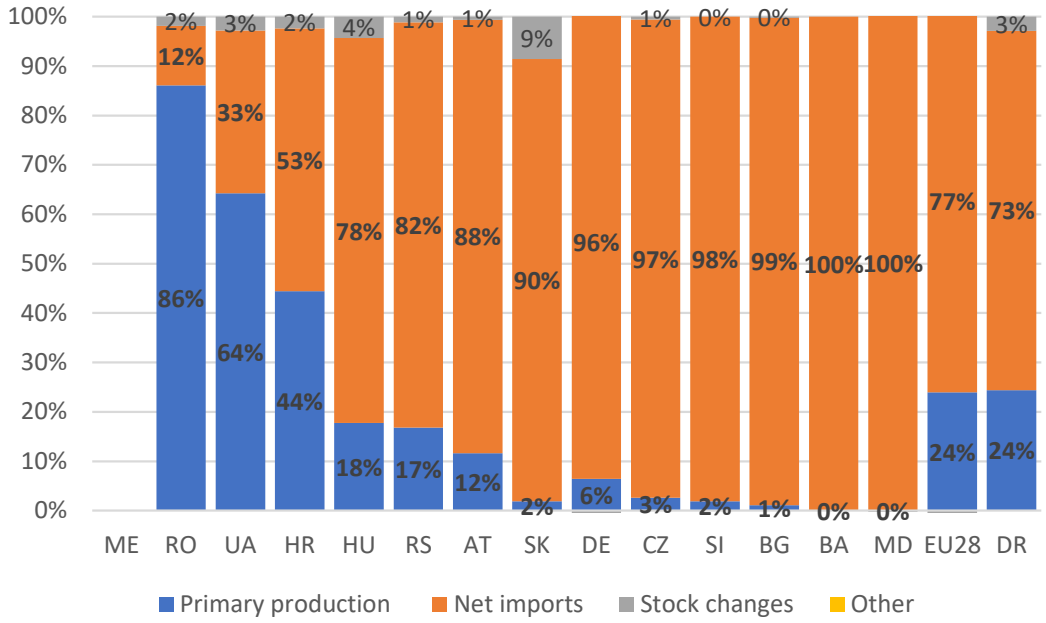


Source: REKK based on Eurostat. Circle size and caption indicate gas market size in bcm/year (2018)

The region is very heterogeneous, with some large and mature gas markets around ~10 bcm/yr (Romania, Hungary, Austria Czechia) and ~ 5 bcm (Slovakia, Bulgaria and Croatia) followed by smaller countries with less than 2 bcm/yr markets (Bosnia & Herzegovina, North Macedonia, Moldova, Serbia, Slovenia). Montenegro does not have gas in its fuel mix (Figure 50).

The share of domestic gas production for the Danube Region in the gas supply mix is similar to that of the EU, around 24%. (Figure 51).

FIGURE 51: SUPPLY STRUCTURE OF THE GAS MARKETS IN THE DANUBE REGION AND IN THE EU28, % (2018)

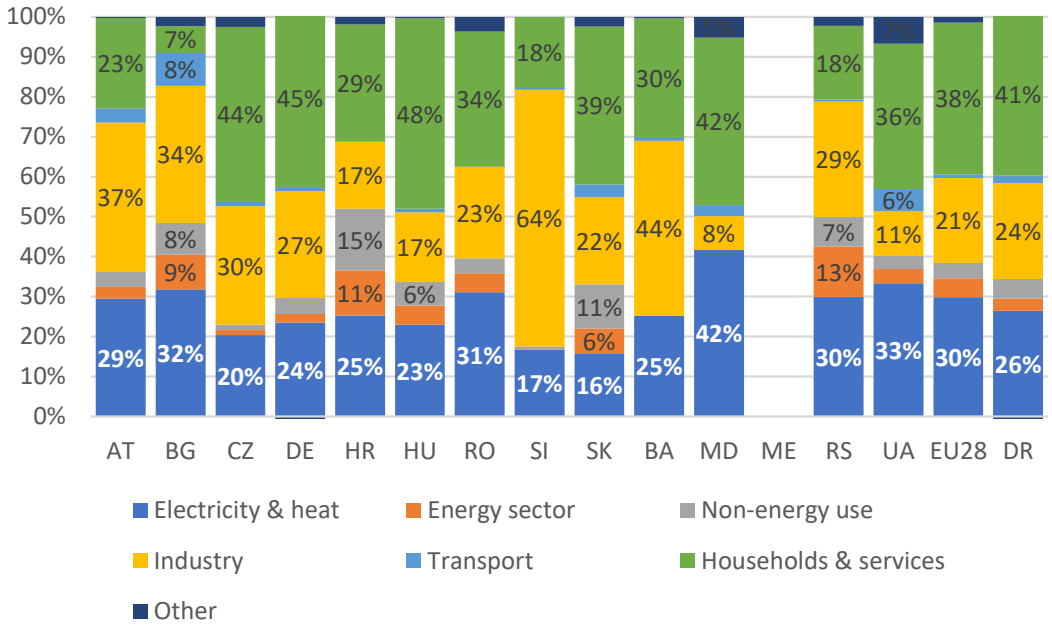


Source: Eurostat. Note: the share of the 'other' category is negligible.

Import dependency in the region is high on average (73%), and above 80% in 10 out of the 14 DR countries. Import dependency is close to 100% in Bosnia and Herzegovina, Bulgaria, Czechia, Moldova, Slovenia, and Slovakia.

On a regional average, the sectoral distribution of the gas consumption varies slightly compared to the EU28. The share of gas used for power generation is lower and the share of household, services and industrial consumption is higher. Here again there are massive differences between individual countries (Figure 52).

FIGURE 52: STRUCTURE OF GAS CONSUMPTION BY SECTORS IN THE DANUBE REGION (2018)



Source: Eurostat

The following subchapter assesses the NECP sectoral development plans and measures including the impact on the current structure.

3.8.2. DECARBONISATION MEASURES' IMPACT ON GAS CONSUMPTION

The next subsections investigate the plans of DR countries for future gas consumption, and the role of natural gas in the decarbonisation of the main gas using sectors; the electricity and heat generation, the industry, and the building sector (households and services).

3.8.2.1. DECARBONISATION OF ELECTRICITY AND HEAT GENERATION

The decarbonisation agenda impacts the role of natural gas in electricity and heat generation in two ways:

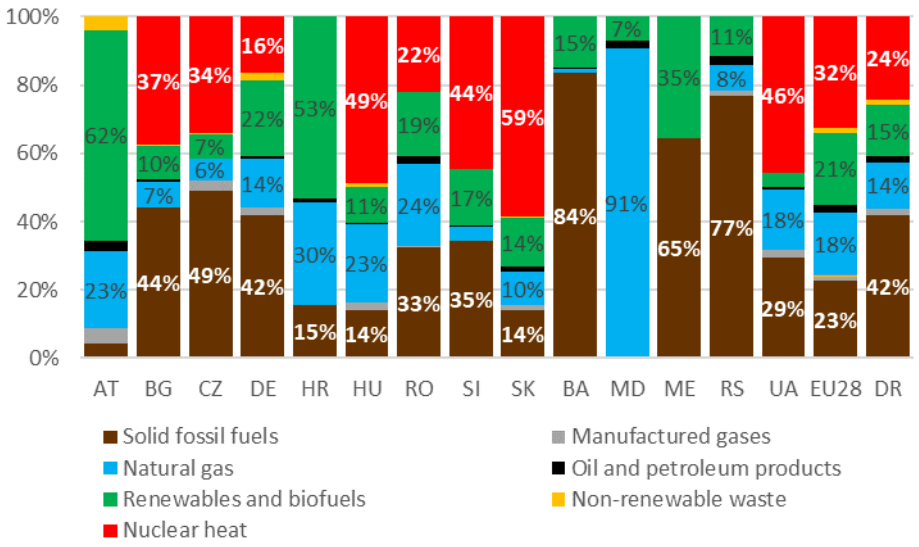
(i) the phase out of coal fired units provides a temporary window of opportunity for increased gas consumption

(ii) in the long run natural gas as a fossil fuel will need to be phased out making investment decisions on CCGTs and gas fired CHPs based on shorter lifetimes.

Figure 53 reveals that solid fossil fuels play a significant role in the electricity and heat generation of some DR countries (BG, CZ, DE, BA, ME, RS), and coal represents a high share (42%) in the generation mix of the Danube Region. Natural gas plays an important role in five countries, but with lower shares (around 20-30%)[49].

[49] The generation fuel statistics of Moldova consider only a small proportion of domestic consumption, please see section 3.9.1.

FIGURE 53: FUEL MIX OF THE ELECTRICITY AND HEAT GENERATION IN THE DANUBE REGION AND IN THE EU28 (2018)



We found that the decarbonisation plans of the DR countries vary widely. Non-EU countries rarely set coal phase out dates, similarly to some EU countries: Bulgaria, Czechia, Romania, Slovenia, and Croatia. Others made the decision to accelerate the phaseout and aim for a full decarbonisation of the power sector by 2040 (Austria). Hungary and Germany will be fully phasing out coal before 2040 (Hungary by 2030 and Germany by 2038) and switching partly to gas. (For more on the coal phase outs see Section 3.9.)

It is not possible to compile a proper dataset based on NECPs (for the EU) and strategy documents (for the non-EU countries) for natural gas investment plans. Based on the existing measures, there is a general tendency to install new CHPs, however in most of the cases this is done to replace existing solid fossil fuel units with more efficient gas or RES. As Table 38 illustrates, three groups are distinguishable among DR countries in this regard: most plan or even incentivise switching to gas based CHPs to exit less efficient solid or liquid fossil-based units; several plan to replace part of the retiring CHPs with RES based units; Austria and Hungary are one step ahead, planning measures to switch from fossil based to renewables in the district heating sector without temporarily incentivising natural gas.

TABLE 38: MEASURES RELATED TO FUEL SWITCH IN THE ENERGY SECTOR

Electricity production and district heating	AT	BG	CZ	DE	HR	HU	RO	SI	SK	BA	MD	ME	RS	UA
Coal phase out														
District heating switch to gas														
District heating switch to RES-H														

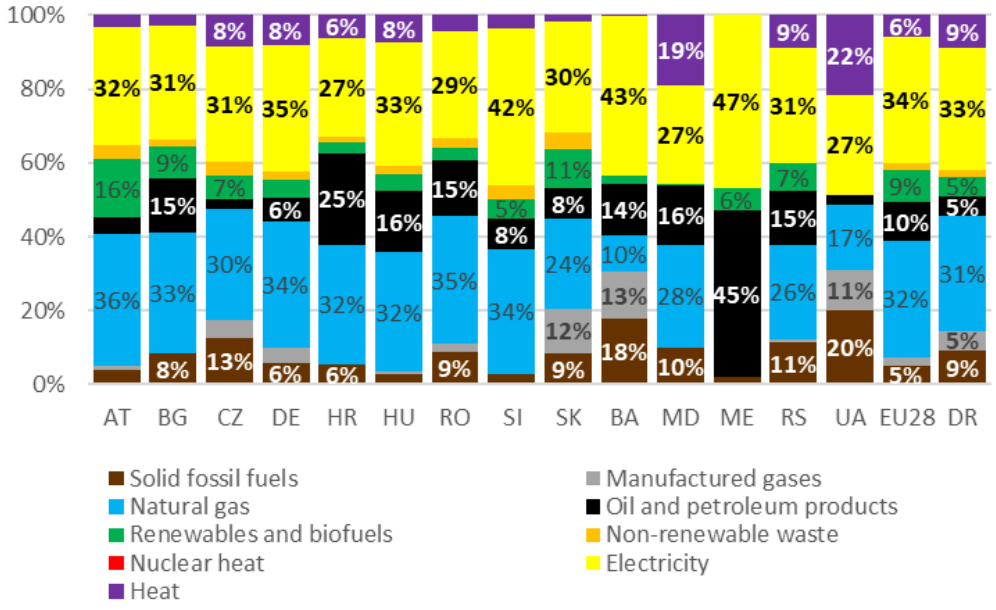
Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

Altogether, the decarbonisation agenda does not have a tremendous impact on the gas consumption of the gas-based electricity and heat consumption sector according to the NECPs up until 2030. Retired coal units will be replaced with gas fired units in Bulgaria and Romania, inducing higher gas consumption, but coal will be an important part of the mix still in 2040 (See Figure 60).

3.8.2.2. DECARBONISATION OF INDUSTRY

The industrial fuel mix in the Danube Region is very similar to that of the EU. Gas has a substantial share (31%), and, switching from coal to gas can have a role to play (Figure 54).

FIGURE 54: FINAL ENERGY CONSUMPTION OF THE INDUSTRY SECTOR IN THE DANUBE REGION AND IN THE EU28, %, 2018



Source: Eurostat

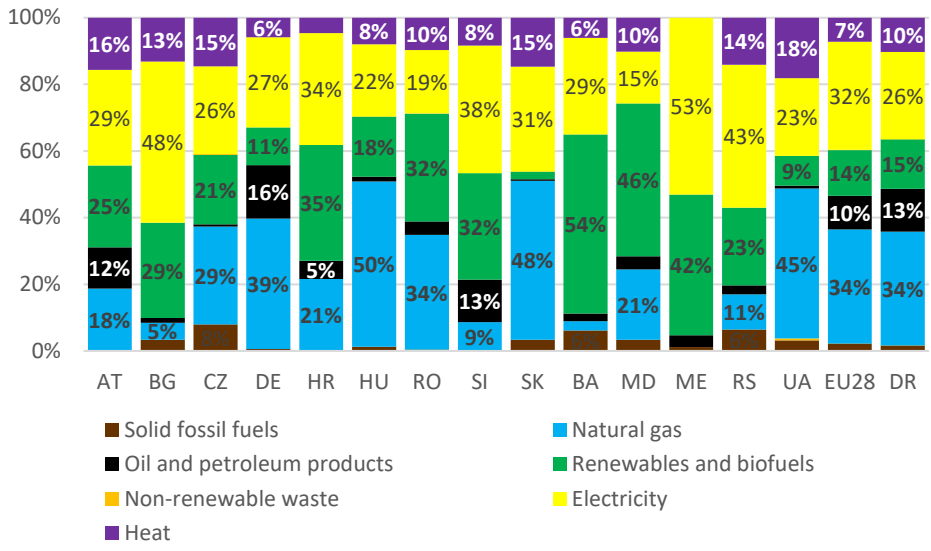
Based on the NECPs and long-term energy strategies of non-EU countries there is little reference to the impact of proposed measures on the industry segment. Some countries refer to goals without any specific measures, especially those with huge potential to decrease energy intensity (e.g. Ukraine, Moldova).

Industrial gas consumption is less impacted by measures and volume shifts to date, as the full decarbonisation plans need further technological development. The contribution of natural gas in the next decades will depend on the pace of industrial process innovation and the availability of low-cost zero carbon electricity and hydrogen, as well as the price evolution of carbon capture, storage, and use.

3.8.2.3. DECARBONISATION OF HOUSEHOLD AND SERVICES

Figure 55 displays the composition of final energy consumption in the household and services sectors by fuel.

FIGURE 55: COMPOSITION OF HOUSEHOLD AND SERVICES FINAL ENERGY CONSUMPTION BY FUEL IN THE DANUBE REGION AND IN THE EU, %, 2018



Source: Eurostat

In smaller gas markets the residential sector is constrained by missing distribution networks, and the typical heating fuel of the households is biomass or electricity (Bosnia and Herzegovina, Bulgaria, North Macedonia, Serbia). Strategic documents usually include plans for extending the gas distribution network and connecting household consumers to provide efficient and clean heating alternative to biomass, oil, or electrical heating. Yet, concrete plans and measures are only found in North Macedonia, where distribution system development is ongoing.

Another group of countries that already have well-developed gas distribution systems and substantial gas-based heating in the household segment typically aim to reduce gas consumption via energy efficiency to decarbonise and achieve more energy independence. Hungary fits this mould, planning to reduce household gas consumption by 2 bcm/yr in 2030 and switch from gas to RES in the district heating sector. This is the only country with plans to decommission parts of the gas DSO system (those parts with under 10% utilization rate). Other countries where energy efficiency measures are expected to reduce natural gas consumption in the residential sector are Austria, Croatia, Germany, Romania, and Ukraine.

As Table 39 shows, some EU countries will do fuel switch by gradually phasing out old fossil furnaces in households with a deadline banning new installations (e.g. in Austria, Bulgaria and Slovenia). However, replacing old, fossil-based furnaces by new and efficient gas is possible, only Austria explicitly bans new gas connections, but here again exemptions are allowed. In general, **gas heating in households will remain in a substantial role in the long term**, despite general support for RES installations. **Based on the national strategic documents, measures providing the household segment with a competing decarbonised alternative heating to gas are not available**. On the other hand, significant volumes are planned to be saved via renovations in the building sector (see more on these measures in the chapter 3.6). Energy efficiency obligation schemes are planned and

designed in Hungary and Croatia with the aim of decreasing gas consumption in the household sector.

TABLE 39: MEASURES RELATED TO THE DECARBONISATION OF HOUSEHOLDS AND SERVICES

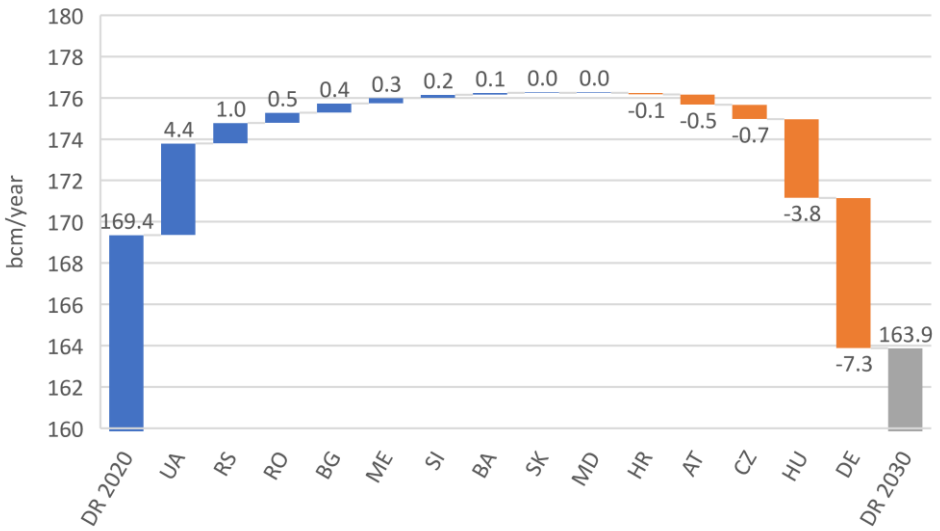
Household measures	AT	BG	CZ	DE	HR	HU	RO	SI	SK	BA	MD	ME	RS	UA
Energy efficiency targeting gas use														
Phasing out oil/old (coal) burning furnaces														
Support for switch to (efficient) gas heating														
Phasing out gas from household heating														
No new connection to grid/ no gas allowed in new buildings														
Existing gas change to RES														
Support RES in household														

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

3.8.2.4. SUMMARY OF GAS CONSUMPTION OF THE DANUBE REGION BY 2030 BASED ON NECPS AND NATIONAL STRATEGIES

Based on the country-level documents, total gas consumption of the Danube Region is expected to drop by 3% in the period of 2020-2030 (~6 bcm/yr).

FIGURE 56: CHANGE IN GAS CONSUMPTION IN THE DANUBE REGION 2020-2030 (BCM/YR)



Source: NECPs and, national strategy documents. The changes refer to the difference between 2020 WEM and 2030 WAM projections

The change in the gas consumption of the DR countries is shown in Figure 56 and Table 40.

TABLE 40: GAS CONSUMPTION IN DANUBE REGION COUNTRIES (2020, 2030) BCM/YEAR

	2018	2020 WEM	2030 WEM	2030 WAM	Other strategic document 2030	Combined
	bcm/year	bcm/year	bcm/year	bcm/year	bcm/year	bcm/year
AT	8.8	8.5	8.0	n.d.	-	8.0
BG	3.1	3.3	4.1	3.7	-	3.7
CZ	8.2	8.4	7.7	n.d.	-	7.7
DE	88.0	82.6	78.9	75.3	-	75.3
HR	2.7	2.8	2.7	n.d.	-	2.7
HU	9.9	12.0	11.4	8.2	-	8.2
RO	11.9	12.1	12.6	n.d.	-	12.6
SI	0.9	0.9	n.d.	1.0	-	1.0
SK	4.9	6.5	n.d.	6.5	-	6.5
BA	0.2	0.2	n.d.	n.d.	0.3	0.3
MD	1.0	n.d.	n.d.	n.d.	n.d.	n.d.
ME	0.0	0.0	n.d.	n.d.	0.3	0.3
RS	2.6	3.0	n.d.	n.d.	4.0	4.0
UA	30.7	29.1	n.d.	n.d.	33.5	33.5
Region total	172.8	169.4	-	-	-	163.9

Source: NECPs and other strategic documents (Energy Strategies, Gas master plans). n.d.: no data
Combined refers to 2030 WAM where available, in absence 2030 WEM or strategic documents

According to the projections, Ukraine, Serbia, Romania, Bulgaria, Montenegro, Bosnia & Herzegovina and Slovenia (6.9 bcm/yr) will grow, while about twice as much gas volumes will be saved (12.4 bcm/yr) in mature markets of Germany, Hungary, Czechia and Austria**. This marginal change in volumes does not require huge pipeline investments, there is only one plan that cannot be served by the current gas network in place: the gasification of Montenegro.** Montenegro on the other hand does not plan to use enough gas in the long term to justify investment into gas transmission networks even on other countries' territory (Albania and Croatia).

3.8.3. INFRASTRUCTURE INVESTMENTS

In this section we overview how the expected changes in gas import dependency, gas infrastructure investments and regional cooperation outlined in the NECPs and strategic documents will improve security of supply in Danube Region.

3.8.3.1. IMPORT DEPENDENCY OF GAS

As discussed above, the Danube Region imports 77% of its gas requirements. Based on the NECPs and **national forecasts we anticipate that the gas import dependency will stagnate or slightly increase with the exception of Ukraine, Hungary and Romania**, which will increase domestic gas production by 2030.

TABLE 41: GAS IMPORT DEPENDENCY OF COUNTRIES IN THE DANUBE REGION, % 2018-2030

	AT	BG	CZ	DE	HR	HU	RO	SI	SK	BA	MD	ME	RS*	UA
2018	80	99	97	96	32	96	10	100	98	100	100	0	79	33
2030	80	99	98	97	47	70	1	100	98	100	100	100	95	0

*Source: NECPs and national strategy documents, * Ministry of Mining and Energy, Republic of Serbia*

3.8.3.2. DOMESTIC GAS PRODUCTION

There is a clear trend in the countries that still have gas production or proved reserves to make use of the domestic resources by accelerating their development. On a regional level, gas production is expected to grow by 7 bcm/year, mostly in Ukraine.

TABLE 42: GAS PRODUCTION OF COUNTRIES IN THE DANUBE REGION, % 2018-2030

Production (bcm/year)	AT	BG	CZ	DE	HR	HU	RO	SI	SK	BA	MD	ME	RS	UA	DR
2018	1.34	0.14*	0.25	5.83*	0.9*	1.7	10	0	0.14	0	0	0	0.3	22	**43**
2030	no data	0.29	0.25	2.71	1.45	2.4***	12.26	0	0.1	0	0	0	0.2**	30	**50**
Plans to incentivise domestic production		Black Sea			concession	concession	Black Sea							regulation	

**2020 data, **2023 data, ***2040 data. Source: NECPs and national strategy documents*

Hungary and Croatia have established concession schemes, and Ukraine is eliminating the regulatory obstacles that have prevented investment in the past. Romanian and Bulgarian NECPs plan to develop new offshore gas fields in the Black Sea.

3.8.3.3. INTERCONNECTORS, GAS STORAGE AND LNG PLANS

With no big changes in gas consumption or production, the number of gas projects listed in the Danube Region as 'planned to be implemented by 2030' is astoundingly long.

Diversification of imported natural gas has been high on the political agenda in the DR since the 2009 crisis. This aims to increase the resilience of the system to supply shocks and develop competitive wholesale markets with more suppliers.

FIGURE 57: SUMMARY OF PROJECTS UNDER CONSTRUCTION AND PRIORITY GAS INFRASTRUCTURE PROJECTS

This map serves for illustration purposes. Not all projects mentioned in the NECPs and strategies are included. Bold lines indicate the large transmission projects of outside suppliers. Arrows indicate that existing pipeline has capacity extension or reverse flow. Cross border projects within region are depicted only when both countries explicitly mention the importance of the project in the NECP. Source: NECPs and national strategy documents.

Without referring to projects individually, we provide categorical summaries of project types prioritized in NECPs:

- **New LNG terminals** in the region are top priorities in the NECPs: one is under construction in Croatia with a regional focus; and two terminals are planned in Germany
- **Storage** There are huge gas storage capacities in the region already and still further development is referred to in some countries, usually related to capacity extensions of existing facilities.
- **Cross border pipeline projects**: EU countries' national plans usually refer to the European TYNDP (ten-year network development plan) projects with cross-

border relevance and especially to the Projects of Common Interest (PCI) (Figure 57).

- Some NECPs refer to **internal projects** addressing national bottlenecks without cross border effects with priority for market integration (e.g. in Germany).
- Many NECP **projects** and national strategies are not part of the European TYNDP and instead **related to the Russian diversification projects**. The Danube Region is impacted by Russia's large offshore transmission infrastructure investments: Nord Stream 1-2 entering Germany (NS 2 94% ready) and Turk Stream 1-2 already reaching Turkey. The route of the Russian gas has already partly changed (since 2020 no flows on Transbalkan e.g., UA-MD-RO-BG-TR) and will again be reshaped when Nord Stream 2 and Balkan Stream are commissioned. **From the North** the onshore projects that connect these Russian investments are already part of the national TYNDP in Germany, and related investments in Czechia and Slovakia are partly implemented or highly advanced**. From the South** the Balkan Stream, entering Bulgaria and stretching via Bulgaria and Serbia to Hungary, is also under construction, enabling flows from the south in Hungary up to Slovakia (see Figure 57).
- TAP (Trans Adriatic Pipeline) is the iconic project of the EU Southern priority corridor that was commissioned in 2020, bringing **Azeri gas** to Greece and Italy. Connection projects from this new source are far less developed or prioritized than those from Russia. (e.g. Southern Interconnector of Bosnia & Herzegovina or gasification of Montenegro via Albania).

As shown by Table 43, there is a clear **regional divide between countries** in terms of future plans with the existing natural gas transmission networks.

TABLE 43: MEASURES RELATED TO GAS INFRASTRUCTURE

Infrastructure	AT	BG	CZ	DE	HR	HU	RO	SI	SK	BA	MD	ME	RS	UA
Storage														
LNG														
distribution system development														
distribution system decommissioning														
transmission system upgrade to H_2														

Not in target / No information | Proposed, but no targets, measures | Policy formulation / decision making | Implementation

EU countries usually mention the plan to test/develop their system in order to transport some hydrogen (**blending hydrogen**). This goal is not yet entrenched in the non-EU countries, mostly **prioritizing DSO system development** with the aim of gasification for

heating purposes in district heating and households. There were no cost estimates in NECPs related to pipeline blending.

Table 44 summarizes the capacity extension of the planned infrastructure projects, based on REKK estimate.

TABLE 44: GROWTH OF ENTRY CAPACITIES IN THE DANUBE REGION COUNTRIES

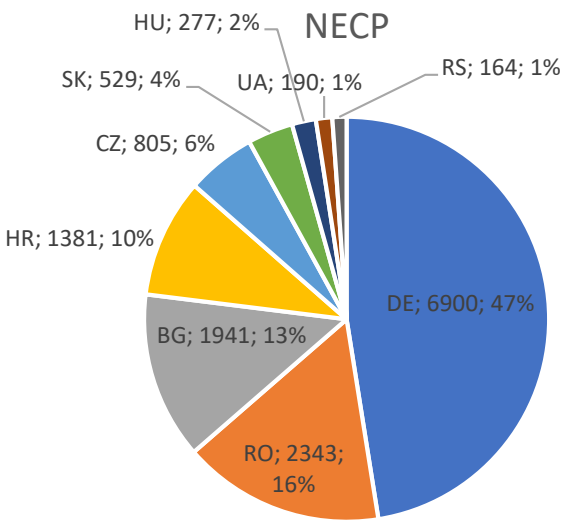
	Entry 2019	Entry ENTSOG FID	NECP	Growth according to NECP	
	GWh/d	GWh/d	GWh/d	%	Million EUR
AT	2126	0	167	8%	100
BG	1405	1222	626	45%	1941
CZ	1807	2238	2593	143%	805
DE[1]	7413	4287	4442	60%	6900
HR	132	272	1587	1202%	1382
HU	811	151	1900	234%	277
RO	1174	42	672	57%	2343
SI	149	0	165	111%	0
SK	3490	1505	1851	53%	529
BA	18	0	154	857%	101
ME[2]	94	42	42	45%	0
MD[3]	0	0	17		0
RS[4]	142	415	759	535%	164
UA	9335	29	376	4%	190
TOTAL	28094	10203	15348		14732

[1] Cost from DE NECP; [2] Cost at HR; [3] Cost at RO; [4] cost without Balkan Stream RS section.

Since NECPs do not provide data on the projects but refer to them as part of the ENTSOG[50] TYNDP and their national plans, those data sources are used. The first column shows the existing capacities of total entry points to a national system, and the second shows additional capacities labelled by ENTSOG TYNDP 2018 as projects with a final investment decision (FID). It is assumed that the projects with an FID will be implemented. The next column shows the capacity increment according to NECP project priorities. If the NECPs projects are implemented, Croatia would increase its entry capacities by more than 1000%. In absolute terms, the largest capacity extension is in Germany despite an expected drop in gas consumption. The highest investment figure is therefore related to the German projects: EUR 6.9 billion, alone accounting for almost half of the total investment costs. Figure 58 shows the composition of infrastructure investment needs by country.

[50] ENTSOG: European Network of Transmission System Operators for Gas.

FIGURE 58: ESTIMATED GAS INFRASTRUCTURE INVESTMENT NEEDS UNTIL 2030



Source: NECP listed projects and ENTSOG data

The total DR investment is estimated to be EUR 14.7 billion, the majority of which is in EU countries (97%) that would mark a 76% increase in gas entry capacities as Table 45 shows.

TABLE 45: COMPARISON OF GROWTH OF ENTRY CAPACITIES

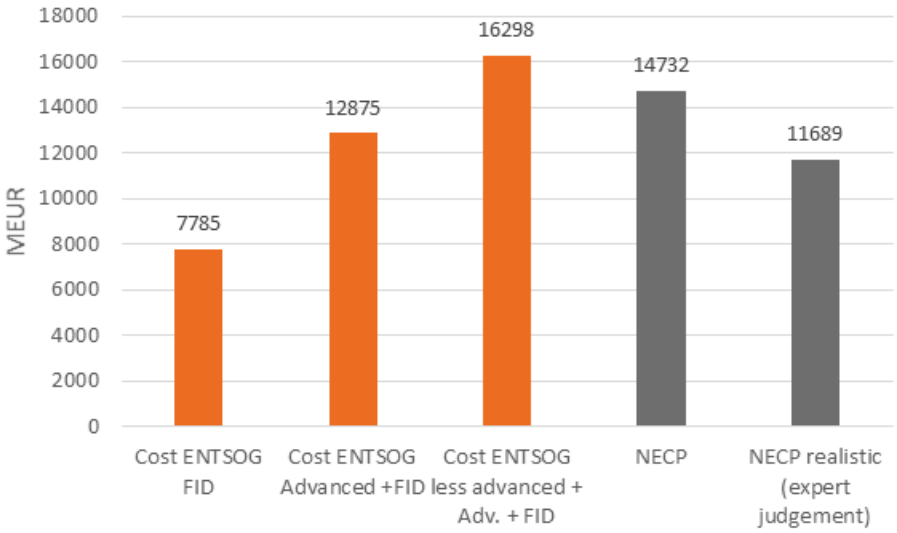
	Entry 2019	Entry ENTSOG FID	NECP	Growth according to NECP	NECP
	GWh/d	GWh/d	GWh/d	%	Million EUR
DR-EU	18 506	9 717	14 000	76%	14 277
DR-Non EU	9 588	486	1 348	14%	455
Countries with decreasing gas consumption	12 157	6 676	9 100	75%	9 464
Countries with increasing gas consumption	15 938	3 527	6 247	39%	5 268

There is a contradiction in NECPs between plans to reduce gas consumption (AT, CZ, DE, HU, HR) to 2030 while still investing EUR 9.5 billion into gas infrastructure. Most of this investment and capacity is linked to the Russian diversification strategy.

A closer look at the NECPs reveals that many countries do not commit to the investments, with the exception of Germany, they just keep them on the list to be consistent with previous PCI and ENTSOG documents. The NECPs often add that project implementation depends

on "market interest". A simple algorithm was applied to screen the projects so that only those supported by national strategies are added to the list. This reduces the investment costs to EUR 11.7 billion (Figure 59).

FIGURE 59: GAS INFRASTRUCTURE INVESTMENT COST ESTIMATES FOR THE DANUBE REGION TO 2030



Source: NECPs, national strategy documents for BA, MD, ME, RS, UA and ENTSOG

3.9. ELECTRICITY

The NECPs devote considerable attention to measures designed to increase the share of renewable resources in the electricity mix, but mostly ignore plans for conventional and dispatchable power generation technologies. The vision for future generation mixes and priority projects exist, but NECPs and energy strategies fail to describe the route to the envisioned fleet of power plants. This vagueness stems from the EU regulatory framework for electricity markets: supporting tools applied for renewable electricity generation (including investment and operating aid) are accepted or even expected while for conventional power plants regulatory or financial assistance from governments is subject to strict state aid rules. Securing availability of dispatchable generation capacities with some form of technology neutral capacity mechanisms is not ruled out, but capacity mechanisms cannot be applied to support any individual project or technology. That makes the planning of the future electricity systems rather challenging, resulting in ambiguous wording in strategic documents.

Planning network infrastructure is easier with TSOs (and DSOs) as regulated monopolies, being obliged to prepare long-term network development plans to submit them to the national regulatory authority for approval. Based on the TYNDPs, the NECPs provide detailed descriptions of major upgrades and capacity additions to transmission networks, as well as new interconnections planned to build, especially projects related to priority corridors. At the distribution network level, concrete plans and deadlines are replaced with general ambitions to upgrade and modernize. The only exception are deadlines and targets set for mass deployment of smart metering.

Actions to improve the functioning of electricity markets and planned activities integrating day-ahead, intraday, and balancing markets are standard elements of NECPs. Information on planned or ongoing regional projects aiming at market coupling or establishment of balancing platforms (implementing guidelines and network codes) can be easily taken from parties involved in the projects (TSOs, power exchanges and national regulatory agencies). Similar to transmission network development, plans for market integration originate in TSO working groups or power exchanges, with policy makers drafting NECP following the lead.

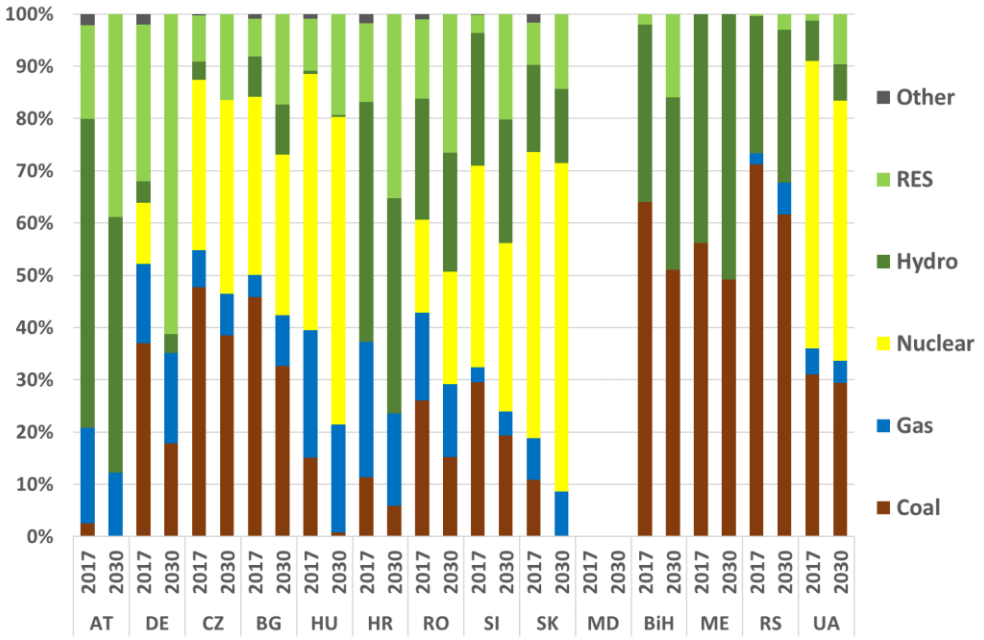
3.9.1. POWER MIX: VISION OR PLAN?

The future of the electricity sector envisioned by policymakers imbued in strategic energy documents is ultimately about the power mix (the size and composition of the power generation capacities) and the fuel mix (the volume and shares of different energy resources in power generation). The fuel mix determines the carbon intensity of the power sector, and different power generation technologies have a large influence over its operability, flexibility, and reliability. The ratio of conventional dispatchable technologies to intermittent/variable power generation capacities (VER) is a matter of critical importance. The reliance on different energy resources has serious consequences for import dependency and security of supply. Indigenous resources (coal/lignite and renewable resources) are considered to protect against import dependency. Even importing coal or nuclear fuel is widely regarded as more secure compared to natural gas because of diversified resources and political stability of suppliers.[51]

Although the characteristics of the power mix have a profound impact on the electricity system, the virtues and shortcomings of the generation fleet do not determine its future. Import dependency can be alleviated by diversification of suppliers and transport routes. Flexibility and reliability can be supported by demand response, smart grids, well-built transmission networks (and market integration), energy storage and sector coupling. Smart regulation (motivating RES producers to locate generation capacities near the network, to adjust their production to market prices and to keep to schedule) and liquid spot markets can soften the system costs and ease the stress caused by variable energy resources put into electricity systems. All of these instruments are mentioned in the NECPs and good practices appeared.

[51] According to the German NECP: „Imports of hard coal are widely diversified. Given the liquid global market and international supply structures, the security of supply for hard coal is regarded as high." (Germany NECP, p. 52)

FIGURE 60: ELECTRICITY GENERATION MIX OF THE DANUBE REGION COUNTRIES 2017-2030 (%)



Source: National Energy and Climate plans of EU Member States, Energy Strategies and Energy Policies of non-EU countries[52]

The NECPs of EU member DR countries uniformly declare the need for decarbonising their electricity generation and increasing the share of renewable generation. Their strategies, however, differ. As can be seen on Figure 60, some countries (e.g., Germany, Austria) are pushing ahead with aggressive expansion of renewable generation, network development and market integration. There is a large group of CEE countries (Czechia, Slovak Republic, Hungary, Romania, and Bulgaria) putting great emphasis on nuclear power generation, and many express scepticism about the prospects of renewable electricity generation. Countries in the third group of the WB6, (Bosnia and Herzegovina, Montenegro, Serbia) not yet fully exposed to carbon prices are planning to preserve their coal and lignite fired capacities on energy security grounds.

Coal fired power production is undergoing significant contraction but will remain an indispensable element of the European power systems in 2030. The largest reduction is expected in the EU member states, where the increasing prices of ETS allowances diminish profitability of coal plants and erode their competitiveness. Most NECPs are expecting

[52] Power mix for Moldova is excluded because of the very special position of the country: the electricity produced by entities located in the region of Transnistria (de jure part of Moldova, de facto independent state) is referred to as imported electricity, leaving Moldova with 383 MW installed power generation capacity, 18% of total electricity consumption (IRENA (2019), Renewables Readiness Assessment: Republic of Moldova, https://www.irena.org/publications/2019/Feb/Renewables-Readiness-Assessment-Republic-of-Moldova, p.6)

carbon prices to double (up to 35 €/t) by 2030[53], resulting in sharp (50%) contraction of coal-based electricity generation in the EU members of the Danube Region.

Germany is adding regulatory pressure to the gradual market pathway, declaring a total phase-out by 2038.[54] The "phase-out law" (adopted by the German Parliament in July 2020) set out a clear roadmap for shutting down the country's remaining coal and lignite fired power capacities, and assigned a fund for compensation payments. The law stipulated that the regulator organise "decommissioning tenders" inviting operators to submit compensation claims for shutting down.[55] Successful bidders are receiving a "hard coal premium" for the capacity they take offline. In addition, plant operators who replace an existing lignite or coal fired CHP plant with one fuelled by gas, waste or biomass will receive "coal replacement bonus", a one-off payment (determined according to the capacity and the age of the plant).[56] A separate law assigned financial support for the regions and federal states affected by the coal phase-out (up to EUR 40 billion).

Slovakia and Hungary also declared a phase-out by 2030, but that is more a result of economic consideration than an administrative decision.[57] Detailed plans for the transformation of respective power plants has been drafted, usually aiming to replace old units with modern gas fired plants (and installation of PV panels on recultivated open-cast mines).[58] Other countries of the region are planning gradual declines in coal fired electricity generation without declaring full exits. Czechia has more ambitious plans to reduce the share of its coal fired electricity generation from 50% in 2016 to 11-21% in 2040 (and replacing coal capacities with nuclear reactors), but large part of expected reduction would take place after 2030.[59]

Decarbonisation plans for individual power plants usually rely on state owned companies' implementing plans drafted by the government. However, there are plans to attract private investors into the process. For example, Slovakia aims to replace coal in cogeneration and the district heating sector with waste and renewables. As part of this process, the Slovak Innovation and Energy Agency created a Thermal Map of the country with detailed information on locations with sufficient heat-demand to introduce district heating systems relying on cogeneration.[60]

[53] However, NECPs are not consistent in that respect, with each country making its own projection, resulting in different levels of coal, gas and carbon prices. Germany (p. 128, NECP), Romania (Figure 15) and Czech Republic (p. 184-186, NECP) are expecting carbon prices of 30-35 €/t, but the Bulgarian NECP expects 60 €/t (p.167).
[54] https://www.cleanenergywire.org/factsheets/spelling-out-coal-phase-out-germanys-exit-law-draft
[55] Germany NECP, p. 110
[56] ClientEarth (2020): Funding for CHP in Germany's Coal Phase-out Law
[57] Although Slovakia approved an action plan Transformation of the Upper Nitra Coal Region (closing mining and the Novaky power plant), the future of Vojany is unclear. According the NECP „its future operation will remain dependent on the development of prices and market conditions" (p. 194).
[58] Hungarian NECP set out decarbonisation plan for its remaining Mátra lignite fired power plant, envisioning new gas fired unit, PV park and industrial energy storage unit (p. 26). The Romanian NECP has similar plans for decarbonisation of the 3 GW Oltenia coal complex, replacing decommissioned units with gas fired units and PV panels (p. 112)
[59] Czech Republic NECP p. 56.
[60] Slovakia NECP, p. 181.

Bulgaria is softer on coal, although it is anticipating almost 20% reduction in the production of coal fired power plants. The Bulgarian NECP aims at "making maximum use of the existing potential of indigenous coal", considered a strategic energy resource tied to energy security.[61]

WB6 countries (including Montenegro, Bosnia and Herzegovina, and Serbia) share Bulgaria's position in considering coal the guarantor of energy independence, but they are even more dependent on the large fleet of coal-fired power plants (based on indigenous coal, owned and operated by state owned companies), making up 55-70% of total electricity generation. Emissions from electricity and heat production amounted to nearly 70% of total emissions in the WB6, resulting in critically high carbon intensity.[62]

As part of the above strategy focusing on energy security, the WB6 countries came up with ambitious plans to refurbish existing units and construct new coal-fired power plants, intended to replace the most obsolete capacities. On the one hand, refurbishment is a must: to comply with the EU Large Combustion Plant Directive (LCPD) and stay below strict emission limits, coal fired units must go ahead with refurbishment and install emissions abatement technology (flue gas desulphurization, electrostatic precipitators, bag filters).

On the other hand, long-term plans for coal is immensely dangerous: introduction of carbon pricing or EU carbon border tax (intended to control dramatic increase in imports of coal-based electricity from non-EU countries where there are no levies on CO_2 emissions) may severely hamper the profitability of coal plants, and new construction intended to enhance energy security and economic sovereignty may turn into an „economic disaster".[63]

WB6 energy strategies depicting the unbroken development of coal fired capacities date back to the middle 2010s; Montenegro adopted its energy policy in 2011 and action plan in 2015, Serbia published its energy strategy in 2016.[64] The newest energy strategy is Bosnia's, adopted in 2018. Therefore, these plans could not possibly reflect the EUs energy targets for 2030 since the Winter Package of power market reforms establishing these targets was unveiled in 2016, and the directives and regulations were adopted in 2018.

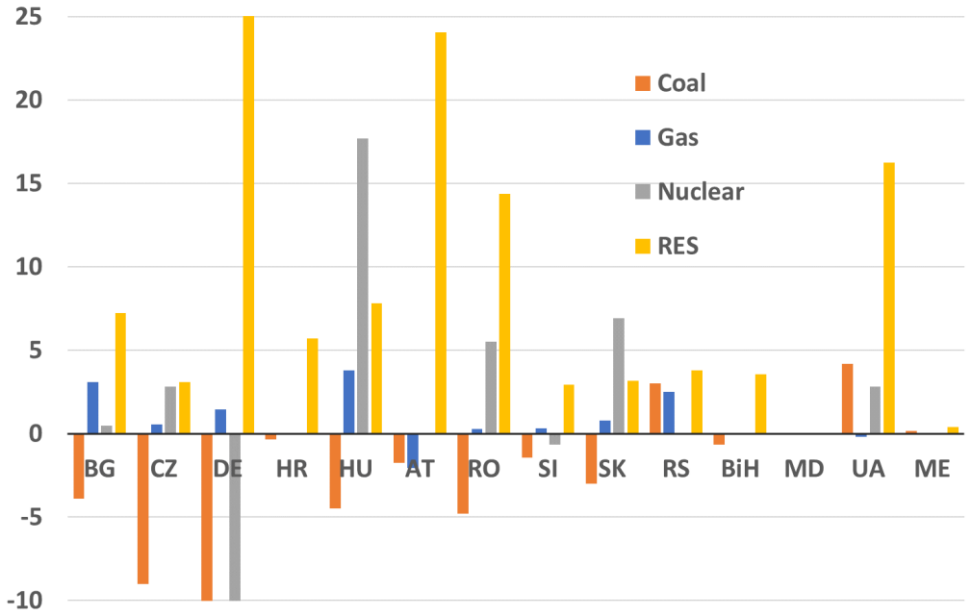
In the subsequent few years, dramatic changes unfolded in the electricity sector for non-EU countries with the rapid expansion of intermittent renewable capacities.[65] Several non-EU countries began communicating possible changes in official strategies and embracing the green transition. Montenegro's economy minister in charge of energy explained in 2020 that "the intention is not to stop at 60% of power from renewable energy sources annually,

[61] Bulgaria NECP, p. 25
[62] Energy Community Secretariat (2020): Energy Transition Tracker, p.7
[63] According to Janez Kopac, director of the Energy Community Secretariat, the introduction of a carbon tax in the Western Balkan region is inevitable within the next few years. https://balkangreenenergynews.com/set-2020-introduction-of-carbon-tax-in-western-balkans-is-inevitable/
[64] The energy strategy of Moldova was adopted in 2012 and Ukraine in 2017.
[65] Official statistics are not easily available, but new data is published through online platforms. The latest developments in the West Balkan region are reported by the Balkan Energy News: https://balkangreenenergynews.com/wind-farms-solar-power-plants-set-to-push-coal-out-of-market/. The changing landscape is Ukraine is reported by Kosatka Media: https://kosatka.media/en/category/vozobnovlyaemaya-energia/news/moshchnost-zelenoy-energetiki-vozrosla-do-4-6-gvt

but to achieve 100%".[66] Ukraine Ministry of Energy and Environmental Protection presented the Concept of "green" energy transition of Ukraine by 2050. The new strategy aims at slashing power demand by 50%, taking all coal power plants offline by 2050, and achieving 70% share of clean energy sources by 2050 and carbon-neutrality by 2070.[67]

The erosion of coal fired power generation raises the question of how intermittent renewable energy resources can replace dispatchable coal and lignite units? Are more flexible load-following gas fired plants (CCGTs or OCGTs) needed as a "transition fuel" until other flexibility providers (demand side management, storage, grids and sector coupling) allow full renewable integration? Several NECPs (Romania, Bulgaria) refer to gas as a transitional fuel, but data does not confirm significant "coal to gas" switching.

FIGURE 61: CHANGE IN THE POWER MIX OF DANUBE REGION COUNTRIES, 2017-2030 (TWH)



Source: NECPs of EU member states, energy strategies and energy policies of non-EU DR countries.

According to the power mix visioned for 2030, coal-based power generation is replaced mainly by nuclear and renewable power. With the exception of Bulgaria and Hungary, gas power plants show only moderate growth, not in proportion to the reduction in coal-based electricity generation (see Figure 61).

The explanation for the discrepancy in wording (referring to gas as transition fuel) and projections (showing only slight growth in electricity generation of gas fired power plants) is found in the replacement of old, inefficient gas fired power plants with high-efficiency cogeneration plants. The Romanian NECP clearly states the aim to „replace several coal-based units with natural gas-supplied combined cycle units", but capacity addition (1400

[66] https://balkangreenenergynews.com/montenegro-leading-energy-transition-in-region/
[67] https://www.euractiv.com/section/energy-environment/news/ukraines-own-green-deal-aims-to-slash-energy-imports/

MW by 2024) would be offset by decommissioning old units.[68] The other factor is the decarbonisation of the heat sector replacing coal fired units with natural gas. Transition from coal to natural gas in Bulgaria means expansion of household gasification, replacing electricity heating with natural gas heating (considered to be an environmentally friendly alternative to the highly carbon intensive grid mix of electricity).[69] Serbia is planning to replace coal in district heat generation with natural gas in the form of combined heat and power plants (CHP).[70]

Another explanation for „switching to gas without a significant increase in electricity production" is ensuring flexibility services. Maintaining gas fired capacities in the system to ensure balancing and other ancillary services for system operators doesn't result in high capacity factor or significant increase in electricity production. Hungary is planning to prevent the closure of dispatchable power plant capacities by establishing "a business environment that ensures the availability of gas-fired capacities in a sufficient quantity for ensuring Hungary's security of supply and system flexibility."[71] However, the growth in CCGT electricity generation is expected to lag behind nuclear expansion.

The majority of CEE countries (Czechia, Slovakia, Hungary, Romania, and Bulgaria) plan for nuclear to replace fossil fuels in the electricity sector. All five countries are going ahead with lifetime extensions of existing reactors, and all are in different stages of new construction projects. New reactors at Mohovce NPP in Slovakia are about to begin commercial operation. The Paks 2 project in Hungary is in the middle of securing licensees, expecting two new units coming online by 2030. Romania is planning to finish new blocks by 2030, although the project is in the early phase of development. Czechia has by far the most ambitious plans for nuclear expansion, envisaging 46-59% of total electricity production coming from nuclear power plants by 2040.

The NECPs are very good at projecting future nuclear capacities but bad at explaining measures to meet the ambition. Romania is the only country referring to a support mechanism designed to promote low-carbon technologies: renewables, storage and nuclear power. It is considering the introduction of Contract for Differences (CfD) „bringing about enhanced safety and stability of revenues by removing exposal to the volatile prices on the wholesale market".[72] Czechia has taken steps to promote newly built nuclear capacities and the government agreed to provide an interest-free loan of up to 70% of expected

[68] „As regards the projected trend in the natural gas-fired capacities, although the Development and Decarbonisation Plan for CE Oltenia 2020-2030 presents an additional natural gas-fired capacity of 1 400 MW as from 2024…, considering the age of the current natural gas-fired capacities, it has been estimated that the decrease due to their decommissioning will exceed the increase foreseen through the new capacities." (Romania NECP, p.57)

[69] Supported by mandatory staged decommissioning of solid-fuel stoves and boilers that do not meet the requirements of the Eco-Design Regulations from 2020 to 2024. (Bulgarian NECP, p.136)

[70] Energy Sector Development Strategy of the Republic of Serbia (p.47-48). The Slovak NECP has similar wording: the share of natural gas in cogeneration significantly increases with focus on combined heat and power (CHP) in the electricity sector (Slovakia NECP, p.32)

[71] Hungary NECP, p. 87

[72] Romania NECP, p. 129. In 2019 the Romanian Government approved a memorandum on the "general principles for the implementation of a support mechanism through contracts for difference (CfD) for the production of electricity with low carbon emissions." https://www.ecovis.com/global/renewable-energy-in-romania-ppa-available-cfd-in-the-pipeline-implementation-to-follow/

construction cost while promising to buy power from the unit at a price determined from the agreed construction cost, though these measures were not mentioned in the NECP.[73]

NECP positions on security of supply and generation adequacy is similar to that of nuclear development: most countries are confident that construction of power plants, network developments and market integration guarantee security of supply, with only a few planning to implement additional measures to preserve resource adequacy. Austria is good example of a country relying on market mechanisms and market integration to ensure security of supply: permitting price peaks ('scarcity prices'), limiting intervention in pricing mechanisms and regional cooperation (common regional generation adequacy assessments performed by the Pentalateral Energy Forum) being the only "measures" necessary to ensure adequacy.[74]

Some countries are hesitating with concrete measures. The Slovak NECP states that the country "may, in the future, set or update its strategic objectives for ensuring electricity system adequacy", while the Hungarian NECP relies on the incentives given by the ancillary services market to ensure that gas fired capacities are recovering their investment costs. If these incentives prove to be insufficient, "other possibilities should be explored".[75]

Nevertheless, several countries are planning to implement some kind of capacity mechanism or other incentives to ensure investments into generation, transmission or "demand side" infrastructure. Czechia and Germany voted for strategic reserves, while Romania and Bulgaria are still considering which type of intervention should be implemented. However, these statements are lacking any detailed information about the result of adequacy forecasts, the planned mechanism (e.g., volume of capacities planned to put into reserve) or the preparatory steps taken.

The only exception is Germany, which has already implemented two types of capacity mechanisms: capacity reserve ("to compensate for net output deficits in the event that the security or reliability of the electricity supply system is at risk or disrupted") and network reserve (to relieve grid congestion and provide voltage maintenance and restoration of the supply), together covering nearly 9 GW of capacities.[76] In addition to the capacity reserves, the regulator is actively exploring the potential for voluntary, market-based load reduction.

3.9.2. NETWORK DEVELOPMENT

Transmission network development plans include different types of investments. Several DR countries need to strengthen internal transmission capacities and replace outdated 220 kV voltage level networks with 400 kV transmission lines. The reconstruction works raise the reliability of transmission systems (important consideration in WB6 countries), support the integration of renewable capacities (wind parks installed in distant areas of the country with insufficient grid infrastructure) and contribute to the development of priority transmission

[73] The loan would be interest-free during construction but upon operation 2%.
https://www.reuters.com/article/czech-nuclear-idUSL5N2ER31R
[74] Austria NECP, p.95, p.62
[75] Hungary NECP, p. 87.
[76] Germany NECP, p. 102. In legal terms the „network reserve" is not a capacity mechanism (and does not need to be approved by the European Commission), but de facto there is no real difference.

corridors. But even countries with well-built networks are planning to strengthen and expand internal lines. Austria plans to upgrade and expand transmission infrastructure in several regions to deal with planned expansion of wind parks and to prepare for the challenge posed by the country's central location in Central Europe (large north-south electricity flows) and further cement its role as an important hub for the European electricity market.[77] Germany has ambitions to expand its internal transmission network (7700 km of cables, only 10% related to interconnectors) to relieve congestion caused by the immense restructuring/relocation of northern power generation.[78]

Best practice measures taken to facilitate network development in Germany are conventional measures taken to launch network development (the approval of the long-term network development plan and related costs by the regulator) that proved to be lengthy and complicated, causing tensions between renewable integration and grid operation/development. Germany took additional measures to facilitate grid development through a complex legal environment. A new law (Energy Line Expansion Act) simplifies and streamlines the planning of grid expansion projects and transfers the planning responsibility from the state to federal level to avoid the fragmentation of tasks. It provides for higher harmonised compensation payments to farmers who will endure underground cables or power line pylons on their land and offers premiums if planning procedures are fast-tracked.[79] The legal framework was supplemented by specific timetables with milestones for each project, regular progress reports and powerful monitoring and controlling activity involving TSOs, the NRA, states and the federal government.

Development plans for cross-border capacities are standard elements of NECPs, with detailed descriptions of planned cross-border lines. These investments promote market integration, increase competition (vital for small countries without liquid spot market), provide security of supply, and integrate renewable capacities into the electricity market (allowing intermittent renewable generation to spread across a larger area and get absorbed by a regional market).

Despite long wish lists of desired cross-border projects, there are few indications of what extent these investments actually increase the interconnectivity of the respective countries. However, NECPs of Danube Countries state that cross-border network developments by respective countries are in line with the EU's 2030 interconnectivity target of 15 % (defined

[77] Austria NECP, p. 89, 93-94

[78] Within a few years, 8 GW nuclear and over 10 GW coal fired capacities will retire, mostly in southern part of Germany, and over 10 GW offshore wind power capacities will be installed on the North Sea by 2025 (Source: Germany NECP, p.44, p.182). This relocation of electricity production results in huge north-south flows, threatening grid congestion and loop-flows.

[79] https://www.bmwi.de/Redaktion/EN/Artikel/Energy/electricity-grids-of-the-future-02.html, https://www.cleanenergywire.org/news/german-parliament-passes-law-faster-grid-expansion-ensure-renewables-growth

as import capacity over installed generation capacity in a Member State) and 30% (defined as import capacity over peak load).[80]

It should be stressed that the transmission grid in Central Europe is highly meshed, CEE countries are well connected, and many are already above prescribed targets today.[81] The amount of added transfer capacity (MW) or the rate of increase (%) resulting from network developments envisioned in NECPs is not easily quantifiable, but calculations made by the Commission Expert Group on electricity interconnection targets are instructive. According to the above calculation based on the TYNDP 2016 scenarios, the interconnection level as measured in relation to the peak load is over 60% in EU Member States of the CEE region.[82]

It must be noted that indices of interconnectivity and nominal transfer capacities of cross-border transmission lines tend to overestimate real transmission capabilities, because congestions on internal networks limit the possibilities of cross-border trade. As a result, TSOs can refuse to allocate the total cross-border capacities for market participation, which is a real limiting factor. In 2017, ACER calculated that on average 28% of the maximum thermal capacities of the AC interconnectors for meshed and non-meshed networks is made available to the market in the CEE region (and 19% in the SEE region).[83] Aside from potential faults in the above calculation, this points to the importance of improved capacity calculation, congestion management and capacity allocation, as a precondition for increased market integration.

The position of Western Balkan countries (Bosnia and Herzegovina, Serbia, and Montenegro) is somewhat different. On the one hand, they are physically well interconnected (sharing the internal network of former Yugoslavia), they are candidate countries sharing a high level of "regulatory convergence" with the EU, and as members of the ENTSO-E fully involved in European network planning and complying with operational rules. On the other hand, they share an aging network infrastructure, small, immature, and illiquid markets and insufficient market infrastructure.

Moldova and Ukraine are in a much more complicated situation. Their top priority for transmission network development is integration of their electricity system into the EU energy market with synchronised operation on ENTSO-E Continental Europe zone. Both countries suffer from high energy dependency, and market integration is considered as the most feasible way to ensure energy security. As the Energy Strategy of Ukraine asserts: *The ESU [Energy Strategy of Ukraine] aims primarily at solving problems of energy security against the background of the urgent need for ensuring state sovereignty in the conditions of external*

[80] There are three kind of targets set by the EU: (1) 15%; (2) the nominal transmission capacity of interconnectors is over 30% of peak load; (3) the nominal transmission capacity of interconnectors is over 30% of renewable installed generation capacity (Towards a sustainable and integrated Europe. Report of the Commission Expert Group on electricity interconnection targets, 2017) The NECPs use the (1) and (2) metrics.
[81] In 2017, the electricity interconnection level in Austria was 15.3% (Austria NECP, p. 91) In the Czech Republic the share of the maximum load in relation to the installed capacity corresponds to 53 % in 2017 (well above the 30% target) (Czech Republic NECP).
[82] Towards a sustainable and integrated Europe. Report of Commission Expert Group on electricity interconnection targets (2017), p. 31.
[83] ACER/CEER (2018): Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2017. Electricity Wholesale Markets Volume, p. 28

aggression involving both advanced types of weapons (information and hybrid war methods), and non-military influences."[84]

Naturally, granularity of development plans for distribution networks lags behind transmission network development plans. Instead of listing individual projects, distribution network plans provide more of an overview, revealing orientations and priorities of network developments. In CWE (Central Western Europe) and CEE (Central and Eastern European Countries**)** countries the main focus is deployment of advanced metering and smart networks (7 countries set targets for mass deployment of smart meters) to enable demand side response, network automation (remote control elements), network digitalisation and advanced approaches in diagnostics and monitoring (predictive diagnostics). Also, more attention is going to operational improvement of network management, pushing DSOs to take an active role in system operation, establishment of local flexibility markets (for voltage regulation or congestion management), and increased cooperation between transmission and distribution system operators.

Finally, several NECPs stress the need for expanding the medium-voltage distribution network due to increased demand from e-car charging points, renewable energy installations and heat pumps. The grid infrastructure must be adapted to greater decentralised production and consumption, increased flow rates and higher volatility.

To mee these challenges, Austria adopted administrative simplification of power line regulation by way of an exemption from approval under its electricity law for medium-voltage power lines of up to 45 kV.[85] Slovenia is considering a development-oriented regulatory framework for network tariff regulation to ensure financial resources for the additional investments of distribution companies.[86]

Non-EU countries place greater emphasis on reduction of technical and commercial (non-technical) network losses and increasing supply quality through the construction of missing substations and lines, reconstruction and modernization of obsolete network equipment (many of them over their planned lifetime), optimisation of the network design, raising capacities, and automation of plant elements. Harmonisation with EU directives and energy packages is another priority for these countries: unbundling (separation of the functions of the distribution system operator from the functions of supply) and upgrading of regulatory mechanisms (adopting incentive-based tariff setting methodology).

3.9.3. SYSTEM FLEXIBILITY, SMART GRIDS AND DEMAND RESPONSE

Table 46 presents an overview of the **targets** with respect to innovative solutions and new technologies targeting system flexibility in the NECPs of EU DR countries.

[84] Energy Strategy of Ukraine for the period up to 2035 „Safety, energy efficiency, competitiveness", p. 8
[85] Austria NECP, p. 153.
[86] Slovenia NECP, p. 19, p. 21

TABLE 46: PROPOSED 2020-2030 DANUBE REGION TARGETS FOR INNOVATIVE SOLUTIONS AND NEW TECHNOLOGIES TO INCREASE SYSTEM FLEXIBILITY

AT	BG	HU	HR	RO	RS	SI	SK
Until 2020 80% of the metering points, until 2022 95% should be equipped with smart meters	Installation of 150 MW energy storage capacity, and 200 MW combined storage capacity with renewable power plant until 2030	Installation of 1,000,000 smart meters until the end of 2030	Installation of 150 MW energy storage capacity until 2030	Installation of 400 MW energy storage capacity until 2030	Installation of 3,000,000 smart meters until the end of 2030	Increase the share of undergrou nd medium voltage networks from 35% to 50% until 2030	Installation of 390 849 smart meters until the end of 2020
				Installation of 4,034,430 smart meters until the end of 2028		Until 2020 80% of the metering points, until 2025 100% should be equipped with smart meters	

Source: National Energy and Climate plans for EU member states, Energy Strategies and draft Energy strategies for non-EU countries

For most of the countries, targets were set for the installation of energy storage capacities and deployment of smart meters. There are very few instances with clear goals beyond these two measures. The NECPs of Bulgaria, Croatia and Romania contain capacity targets for electricity storage. Bulgaria will build 150 MW storage and 200 MW combined PV and storage by 2030, Croatia plans 150 MW of new storage, and Romania 400 MW.

With respect to smart meters, many countries have set quantitative goals in the NECP such as, Austria, Hungary, Romania, Slovenia and Slovakia, and Serbia in its energy strategy. Austria and Slovenia are aiming to install smart meters for (almost) all metering points by 2022 and 2025, respectively. In both countries the current share of smart meters is high with 80% coverage targeted for 2020. A mass installation of smart meters is expected in the 2020s in Hungary, Romania and Serbia, replacing one, four and three million conventional meters, respectively. Slovakia sets a 2020 target for smart meter installation, mentioning the need for further expansion to 2030.

Slovenia aims to increase the share of underground medium voltage networks to 50% by 2030 from 35% today. Germany took a different approach, referring to energy only markets

which would result in the expansion of the cheapest technologies. As opposed to central planning, this precludes the need for exact targets since it is left to the market.

There are several related **measures** formulated in the strategic documents that can be distilled into four interlinked, main categories, presented in Table 47: energy storage systems (excluding pumped hydro storage), community energy projects, demand side response and smart grids and systems.

TABLE 47: PROPOSED MEASURES TARGETING THE DEVELOPMENT OF INNOVATIVE SOLUTIONS AND NEW TECHNOLOGIES

	AT	BA	BG	CZ	DE	HR	HU	MD	ME	RO	RS	SI	SK	UA
Storage														
Energy Communities														
Demand side response/aggregators														
Smart meters/grids														

Not in target / No information; Proposed, but no targets, measures; Policy formulation / decision making; Implementation

As the table shows, **Germany** already implemented several measures polishing the existing regulation or further enhancing existing support mechanisms. Community energy projects are already part of national regulation. An auction system is in place for demand side aggregators. The NECP stipulates that renewable energy sources, providers of demand flexibility, storage facilities and conventional producers operate within the same conditions in the electricity market. For this reason, measures aiming to improve the system, such as shortening product period in the ancillary service market, are planned. Germany is in the implementation phase for installing smart meters, supplemented with other important measures such as the implementation of research and innovation programs.[87] Meanwhile, the implementation of energy storage is not yet underway for all types of storages. For mid- and large-size storage, the NECP states additional investments are needed. Combined PV and household electricity storage has been implemented with a financial support programme, but it was ended in 2018 with only 5% of the installed 40 000 homes.

In **Austria**, a program called E5 will be further developed in the 2020s to support energy communities. The aim of the program is to support municipalities to use energy in a more efficient and environmentally friendly way. Based on the NECP the E5 program has approximately 220 participants. **Slovenia and Austria** are at a very advanced stage of smart meter installations, aiming to reach 80% coverage by 2020. In Slovenia, these targets will be

[87] Seventh Energy Research Program and the Smart Energy Showcases – Digital Agenda for the Energy Transition' programme (SINTEG)

supplemented with a mandatory reinvestment scheme for state owned energy companies. According to the scheme, 15% of these companies' profits will have to be reinvested into the integration of renewable sources and the development of the distribution grid.

There are other countries which are in the early stage of smart meter deployment. According to the NECP of **Romania**, the country should start mass deployment in 2019, replacing 250 000 regular meters, followed by the installation of approximately 400 000 new smart meters each year until 2028.

In other countries there are several cross border smart system pilot initiatives. One example is the ACON, cross-border smart grid project linking **Czech-Republic and Slovakia**. The aim of the project is to integrate the two national energy systems through the construction of new optical cables, smart-meters and distribution grid lines. The project is on the European Commission's 'project of common interest '(PCI) list.

Another cross-border initiative is planned between **Hungary and Slovakia** called the Danube Intelligent grid project, which would facilitate the cross-border integration of renewable energy through smart solutions. And finally, there is an additional cross border pilot project called SINCO.GRID, planned to enhance the cooperation between **Slovenian and Croatian** balancing and reserve markets through smart solutions.

Bulgaria marked all four innovation categories as important but does not have well-defined measures in its NECP. The strategies of non-EU DR countries consider some of the innovative solutions important, but no clear pathway is set for progress.

As regards the possible outcomes of measures, only **Romania** highlights the expected outcome of installing 400 MW energy storage by 2030. Based on the modelling result, the completion of targeted capacity would increase system adequacy by 10%. Other general outcomes include a flexible decentralised energy system and the large-scale use of digitalised smart equipment.

3.9.4. MARKET DEVELOPMENT

The "Market integration" chapters of CEE NECPs usually reiterate guidelines of the European market integration process, describing the state of individual projects. The first priority for the 4MMC countries (Czechia, Hungary, Romania and Slovakia) is the implementation of the DE-AT-PL-4MMC ("Interim Coupling") project, ensuring full integration of the CEE day-ahead markets into the European common market. The WB6 countries and Bulgaria are next.[88]

The integration of intraday and balancing markets is a safeguard for increasing renewable electricity production and balancing capabilities for security of supply. The intraday market coupling (Single Intraday Coupling, SIDC) is realised through 'local implementation projects' (LIPs), bringing together power exchanges and transmission system operators in a given area or region (Austria, Bulgaria, Czechia, Germany, Poland, Hungary, Romania, Croatia and

[88] Bulgaria takes part in several market coupling initiatives: with Romania and Greece by 2020-2021 and launching negotiations for a trilateral coupling with Serbia and Croatia, and separately with North Macedonia in the framework of the Western Balkan 6 market coupling initiative (WB6). (Bulgaria NECP, p. 156-157)

Slovenia).[89] The integration of balancing markets is expected to advance via transnational platforms for sharing and activating balancing energy bids for standard balancing products (manual Frequency Restoration Reserve, mFRR, and automatic Frequency Restoration Reserve, aFRR).

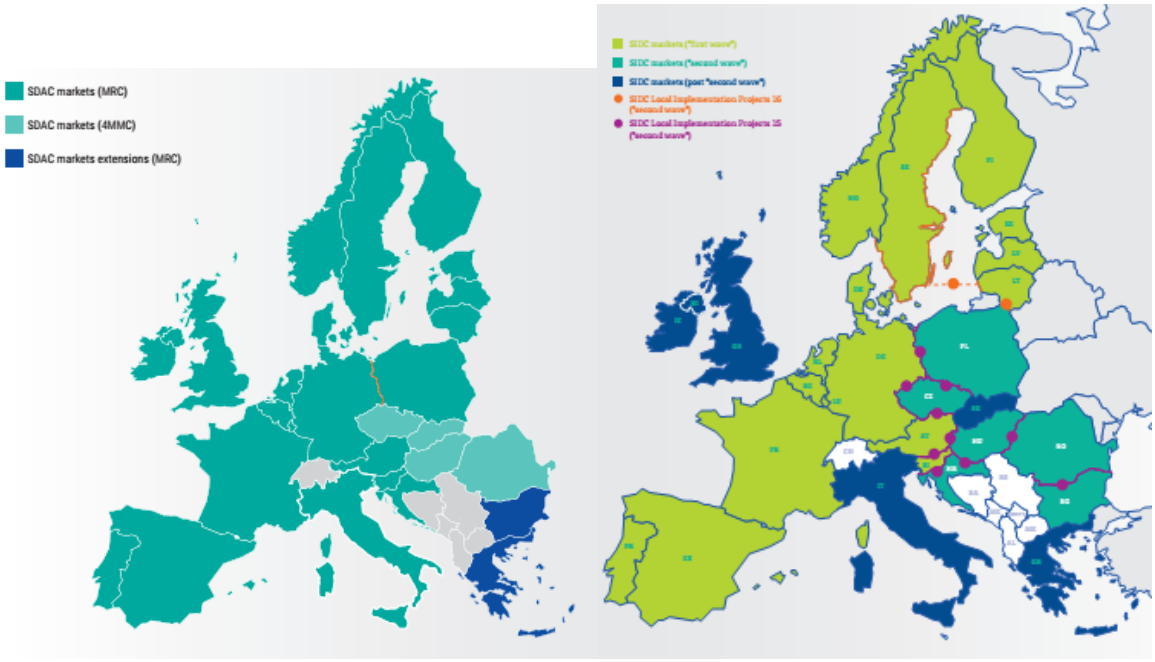
The majority of non-EU countries lack the institutional setting and market maturity to join above-mentioned market integration projects. With the exception of Serbia, these countries do not have operational power exchanges, a precondition for participating in market coupling projects. They are usually small markets (with the exception of Ukraine), dominated by state-owned electricity production companies with depreciated assets and state subsidies.[90] Wholesale markets have low liquidity handicapped by special rules (public service obligations)[91] and retail markets are dominated by incumbent companies supplying end-users at regulated prices.

The energy strategies of the non-EU countries highlight the importance of market liberalization, implementing EU energy regulation (unbundling of network operation, opening markets etc.), setting up market infrastructure (organizing power exchanges, operating day-ahead and intraday markets), promoting market competition and market integration (implementation of day-ahead and intraday market coupling and common capacity calculation for cross-border capacities in regional context), and implementing price deregulation.

Non-EU countries expressed the following strategic objectives: „creation of full-fledged natural gas and electricity markets in accordance with the EU energy legislation", „joining the general European market will help liberalize and demonopolize internal energy markets",[92] "electricity sector restructuring to achieve mature market liberalisation",[93] "reorganization and restructuring of companies in energy sector",[94] "open the market by removing regulated tariffs",[95] „define tariff and pricing policy for energy on the market principles taking into account real costs… and return on investments",[96] "eliminating state influence on electricity price regulation and elimination of „social" component and regulated price system".[97]

[89] Two additional regional intraday market operations are relevant: LIP 14 (covering Italian and some SEE borders) and newly established LIP 17 (covering some borders of CZ-SK-PL-HU).
[90] In the WB6 countries incumbent producers control over 90% of the total electricity production (Energy Community Secretariat (2020): Energy Transition Tracker)
[91] A good example is the Ukrainian electricity wholesale market opening in 2019. „In fact, the single buyer market model that should have been replaced by a competitive electricity market structure, allowing market participants to buy and sell electricity on the bilateral, day-ahead and intraday markets … is still in place in practice with little electricity of the incumbent generators being sold on the free market. In fact, 53% of generated electricity was being traded on the open market in the first two months." (…)
[92] Energy Strategy of Ukraine for the period up to 2035 „Safety, energy efficiency, competitiveness", p.11, 15 (2017, approved by Resolution of the Cabinet of Ministers of Ukraine)
[93] Framework Energy Strategy of Bosnia and Herzegovina until 2035, p.88
[94] Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030, p. 36 (Republic of Serbia Ministry of Mining and Energy, 2016)
[95] Energy Strategy of the Republic of Moldova to the year 2030, p.42 (2012)
[96] Energy Policy of Montenegro until 2030, p.3,8 (2011)
[97] Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030, p. 44 (Republic of Serbia Ministry of Mining and Energy, 2016)

FIGURE 62: CURRENT DAY-AHEAD (SDAC) AND INTRADAY (SIDC) MARKET COUPLING

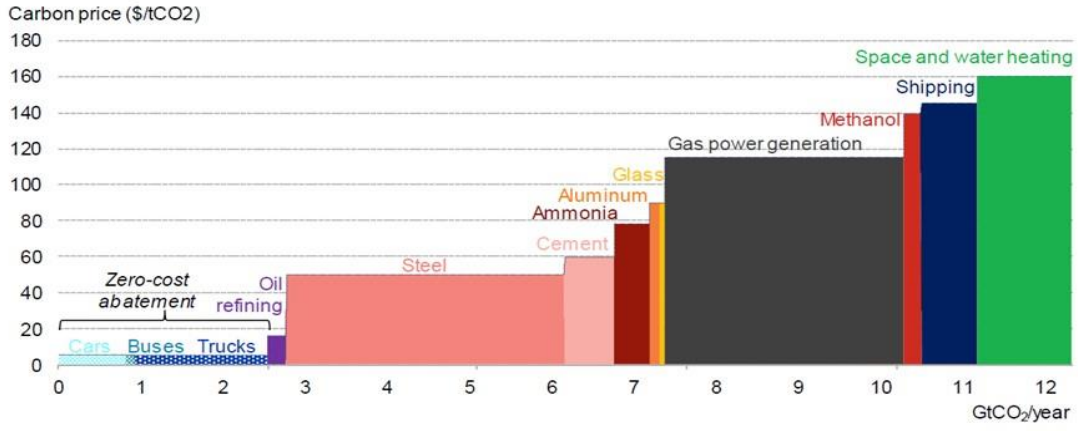


Source: ENTSO-E Market Report 2019, 2020

3.10. RENEWABLE GASES – HYDROGEN, POWER-TO-GAS AND BIOMETHANE

Low carbon hydrogen is an alternative fuel which might replace fossil fuels in many sectors and power the road to 2030 decarbonisation targets. While the share of hydrogen in the EU energy mix remained under 2% until 2018[98], recent technology developments ensure a momentum for hydrogen solutions.

FIGURE 63: THE UNIT COST OF REPLACING FOSSIL FUELS WITH HYDROGEN, BY SECTOR



Source: Bloomberg, Hydrogen Economy Outlook, March 2020

[98] Eurostat

However, the feasibility and the cost differ sector by sector. The main cost components are related to the upgrading of existing infrastructure to accommodate H_2 and the production of hydrogen. The future evolution of ETS price should play an important role in the economic feasibility of H_2 replacements (Figure 63).

Hydrogen can be produced from many different sources. Currently, the majority of hydrogen used in Europe and globally is produced from natural gas or coal (grey H_2), which cannot be considered low carbon. Blue H_2 is also fossil based hydrogen but combined with carbon capture and storage. Green hydrogen is produced from renewable electricity. Within the terms of this analysis, the last two processes that avoid GHG emission will be the focus. The EU taxonomy declares $174 gCo_{2eq}/kWh_{H2}$ specific carbon emission as low carbon.

The Power-To-Gas (P2G) technology ensures that low-carbon renewable electricity can be stored in the form of hydrogen (Power-To-Hydrogen or P2H) or synthetic methane (Power-To-Methane). With Power-To-Gas technology, electricity is used to transform water into hydrogen and oxygen via electrolysis. After the electrolysis there are two options: 1) the process stops with hydrogen as output or 2) CO_2 and H_2 are further processed and converted into methane. Methane is equivalent to natural gas and could be injected into existing gas infrastructure without any conversion. Both hydrogen and synthetic methane are good options to store energy for long periods.

3.10.1. HYDROGEN TARGETS IN NECPS

Only two countries have set H_2 consumption targets for 2030: Austria plans to use 96 ktoe and Slovenia 10 ktoe H_2 in 2030.

Electricity generation from hydrogen is feasible in existing gas power plants or in new hydrogen-based power plants. The NECPs do not yet include this option on the agenda, and related targets are also missing. Only Romania and Slovenia mention H_2 as a possible source of electricity. However, there are ongoing R&D projects that allow for a better understanding of the process in detail.

Hydrogen appears in the NECPs as a means of the decarbonisation in the transport sector and as an enabler of energy system flexibility. Only Germany plans to consider using hydrogen in the heating and household sectors. It is rarely on the agenda for replacing fossil fuels in other sectors. Sector coupling will be covered in the next section.

3.10.2. HYDROGEN-RELATED MEASURES

Tax incentives for hydrogen fuelled vehicles are already implemented in many countries. The tax allowances set in Austria, Czechia, Romania and Slovakia for low emission vehicles also extend to H_2 propulsion. In Germany, there is a planned allowance for heavy duty hydrogen vehicles (fuel cell) including a carbon surcharge truck toll, effective from 2023. In Austria, the law ensures that green hydrogen produced from renewable sources is entitled to full tax exemption. A **guarantee of Origin scheme** for hydrogen is also envisaged in some NECPs, but specific regulation is in the planning phase only in Bulgaria.

Several countries plan to develop a national **Hydrogen Strategy** to support the uptake of hydrogen-based technologies (e.g. Germany, Austria, Hungary). Croatia will establish a

Platform for Hydrogen Technologies to explore the possibilities of financially stimulating hydrogen production and consumption. The Slovenian NECP envisages the development of a renewable gas market as part of the natural gas market or as a standalone market.

Several NECPs **envisage regulatory environment upgrades**. Slovenia plans for regulatory support for renewable gas alternatives and hydrogen for road transport as well as for renewable gas alternatives in the natural gas network. In Germany, the Federal Government has set out requirements for an expansion of the hydrogen infrastructure in its climate package. In Hungary, there is a plan to review the regulation concerning the feed-in of hydrogen into the natural gas infrastructure.

R&D funding for pilot projects are mentioned in Hungary, Slovenia and Romania, to explore the maximum permissible fraction of hydrogen in the natural gas network in the period up to 2030. Thus, the role of hydrogen could be better understood and planned as part of 2050 carbon neutrality. Hungary considers the use of hydrogen for seasonal storage. Slovenia supports the implementation of pilot projects for the production of synthetic methane and hydrogen (with an indicative target 10% share of renewable methane or hydrogen in the transmission and distribution network by 2030), while in Romania, the implementation of demonstration projects for hydrogen use in the industrial sector will be supported.

3.10.3. ROLE OF P2G AND BIOMETHANE IN THE NECPS

Biomethane is upgraded from biogas with similar characteristics to fossil natural gas, allowing it to be injected into the gas infrastructure and used for the same purposes. As previously mentioned, synthetic methane can also replace natural gas.

Power to Gas aims to contribute to flexibility in most of the NECPs. Countries plan to ensure appropriate technical capacity for the conversion of renewable electricity into renewable gas, hydrogen, or synthetic methane to facilitate the seasonal storage of renewable energy.

Greening the gas sector (replacing a significant share of natural gas use) is on the policy agenda in many DR countries, such as Hungary, Slovakia, Czechia, Slovenia, and Romania. Austria and Germany have relevant policies in place already. In Germany, the transmission system operators are planning to convert individual natural gas pipelines into hydrogen pipelines and construct new, dedicated pipelines. The Federal Government has set out requirements for the expansion of the hydrogen infrastructure in its climate package, even across national borders.

Some countries already support biomethane production. There is dedicated tax scheme for biomethane in Austria. In Czechia, there is financial and institutional support for both the transformation of existing biogas stations to biomethane, synthetic gas, and hydrogen production, including their connection to the gas system. Promotion of synthetic methane production is on the agenda in Bulgaria, Czechia, Hungary, and Slovenia. Bulgaria is planning a pilot project for a hydrogen plant with total installed capacity of 20 MW.

3.11. SECTOR COUPLING

Sectoral coupling refers to the integration of power, heat and transport sectors and the gradual introduction of renewables to meet those energy needs. In other words, sectoral coupling means electrification of heat, industry and transport using electric vehicles or power-to-X technologies[99].

We cannot identify specific targets and outcomes related to sector coupling, but as a cross-cutting policy, many points of sector coupling may already be found under the description of other sectors. For this reason, a concise summary is provided for each sector where sectoral coupling is mentioned in NECPs.

3.11.1. POLICIES AND MEASURES RELATED TO SECTOR COUPLING

Overall, sector coupling policies are widely discussed in the Danube Region EU member states, but two distinct regions can be identified. Policies are more mature and robust in Germany, Austria and to some extent in Czechia. Other DR countries acknowledge the importance of sector coupling and consider it as an important part of decarbonisation, however, the measures and policies linked to these goals remain vague and under-developed. Measures related to the different areas are presented in Table 48.

TABLE 48: MEASURES RELATED TO SECTOR COUPLING IN EU MEMBER STATES

Infrastructure investments	AT	BG	CZ	DE	HR	HU	RO	SI	SK
Electrification of transport									
Buildings: Heat pump									
Power-to-X, Hydrogen									
Electrification in industry									

Not in target / No information | Proposed, but no targets, measures | Under policy formulation / decision making | Implemented measure

Policies related to the electrification of transport by direct financial subsidies for e-mobility, the development of charging infrastructure and e-mobility support are mature in nearly all Danube Region EU Member states. Hydrogen in mobility is less developed. Overall, sector coupling measures are most developed in the transport sector. The NECPs do not all provide detailed sectoral targets for the share of electricity and hydrogen by 2030.

[99] Power to X is used to denote energy conversion processes that can be used to store surplus power from renewable sources and can later be used for different purposes. P to H (power to heat) and P to G (Power to Gas) are among the possible technologies.

Sector coupling in the building sector translates to the installation of heat pumps. Implementation is underway in Germany, Czechia and Slovakia. Heat pump capacity is expected to double in Czechia and triple in Slovakia.

Electrification or increased use of green hydrogen in industry processes is only mentioned in the German, Slovenian and Austrian NECPs. Other plans do not refer to industry sector coupling at all. As industry processes are highly diverse and unique, actual measures for electrification and increased use of hydrogen were only mentioned in the German NECP.

Implemented measures for hydrogen solutions are present in the German and Austrian markets. In Austria, preferential treatment is given by exempting hydrogen from taxation. However, in other countries hydrogen is only mentioned or considered as a pilot project.

It is worth comparing the share of electrification and hydrogen in the individual sectors by 2020 and 2030 to interpret the actual effect of policies as predicted by the NECP WAM scenarios. However, this kind of detailed accounting for volumes of hydrogen and electricity by sector was not included in all NECPs. In the few cases which were identified, electricity and hydrogen accounted for less than 5% of the transport sector. This means that even though sector coupling is most developed in the transport sector, the actual contribution to the energy consumption is still low compared to the other energy sources (e.g., petroleum and oil products).

In **Austria**, the NECP for mobility includes electrification plans for road transport, support for alternative drive vehicles, and increased electrification of rail infrastructure. E-mobility is a flagship program of the Austrian NECP. Heat pumps are mentioned as a potential solution, and a heat pump technology roadmap already exists, but 2030 targets for heat pumps are absent. Renewable hydrogen is promoted with an exemption from taxation in the Natural Gas Tax Act. Hydrogen and renewable gases are seen as a balancing solution for electricity and greening of the natural gas sector and receive support as such. For the industry sector, it is mentioned that promotion of renewable energy for heating and cooling is supported, but no specific sector-coupling related measures were found in the NECP. R&D measures target breakthrough technologies for industrial use, which would allow for higher energy efficiency, lower raw material use and increased RES.

The **Bulgarian** NECP mentions heat pumps as a potential solution for RES heating and growth is expected in the sector (from 98 ktoe in 2020 to 122 ktoe in 2030, 2-3% of heating and cooling energy consumption), but no specific support or policy is mentioned in relation to this technology. In the industry sector, no specific electrification plans are mentioned. Gasification is considered to switch from coal as a source of process heat in industry.

Czechia's National Action Plan for Clean mobility includes 49 measures to support electrification and switching to renewable fuels in transport. Measures include legislative incentives, direct incentives to purchase alternative fuel vehicles and tax incentives as well. Heat pumps are supported via the New Green Savings programme for new buildings. The WAM scenario considers the doubling of heat pump RES generation.

In **Croatia**, a platform for hydrogen technologies will be established, but no actual targets were set. Heat pumps and electrification are mentioned, but energy efficiency investment and other measures are the focus, and no actual goals are set. Electrification in industry is not mentioned as an option for decarbonisation.

In **Germany**, the NECP contains a dedicated chapter for sector coupling. Actual policies include targeting the low-emission mobility by electrification, low-temperature heating network system development with use of high RES share and building modernisation programmes.

In **Hungary**, sector coupling is mentioned as an important tool for decarbonisation, but without any policies or measures. Heat pumps are also considered with some support measures but lack targets. RES district heating stipulates heat pumps replacing natural gas in local heating networks. Hydrogen is mentioned in the transport sector mainly. The blending of hydrogen for existing gas network and deployment of power-to-hydrogen technologies is shown only in the pilot phase. Industry sector plans do not include increased electrification or use of hydrogen or synthetic gases.

The **Romanian** NECP lists heat pumps as an option for RES heating in the WAM scenario, accounting for 3% of heating and cooling needs in 2030. However, no policies or funds are allocated for heat pump deployment. Hydrogen is considered as a potential new technology, but only at R&D and pilot project level. Industrial use of blending green hydrogen is mentioned in the 2025-2030 timeframe but no specific policies are targeted.

Slovenia has a 2030 indicative target for 10% renewable methane or hydrogen in the gas network. The hydrogen is to be produced from renewable sources via electrolysis (i.e., sector coupling). Policy support and plans for reaching this goal are not articulated, but according to the NECP this is already at policy formulation level. Heat pump installation is expected to grow in district heating from 1.1 ktoe in 2020 to 6.3 ktoe in 2030. The plan mentions heat pumps as an important part of the NECP, but no dedicated measure or support is mentioned for the development of capacities. For the industry sector, increased use of synthetic gases is envisaged: the WAM scenario anticipates the use of synthetic gas as early as 2030, a 10% share in 2030 and a 25% share in 2040. Current policies are not linked to this target. In

Slovakia, investment aid for households to install heat pumps and other RES solutions already exists. Heat generation from heat pumps is expected to grow from 35 ktoe in 2020 to 94 ktoe in 2030. Hydrogen production is considered an important option for decarbonisation, but this is limited by the high share of gas. Blending for existing networks is an option, but specific targets were not set. No specific policies for electrification or increased hydrogen use were set out in industry sectors.

3.11.2. NON-EU COUNTRIES

In the strategic documents of non-EU DR countries, no specific targets or measures were mentioned for sector coupling. Heat pump and geothermal technology is not a priority for these countries. Electrification in transport loosely follows the European guidelines with some lag, but no targets or measures are set.

TABLE 49: MEASURES RELATED TO SECTOR COUPLING IN NON-EU DANUBE REGION COUNTRIES

Infrastructure investments	BA	MD	ME	RS	UA
Electrification of transport					
Buildings: Heat pump					
Power-to-X, Hydrogen					
Electrification in industry					

Not in target / No information | Proposed, but no targets, measures | Under policy formulation / decision making | Implemented measure

Bosnia and Herzegovina considers heat pumps for upgrading local heating networks, but no concrete support or policy is mentioned. RES heating and cooling is mainly based on biomass (95-98%), while PV and geothermal solutions remain below 2-5% by 2035.[100] Electrification of the transport sector is expected to follow European trends, reaching 5-15% of RES-T by 2035 (currently it is 0%). Hydrogen and power-to-gas solutions were not mentioned in the document.

The latest energy strategy of **Moldova**[101] dating from 2013 does not mention sector coupling. The updated NECP will be finalized in 2021. For this reason, it can be said that no policies exist in Moldova regarding sector coupling. The latest energy strategy of **Montenegro**[102] dates back to 2015. There is no indication for sector coupling, e-mobility or hydrogen. In the building sector, support is provided for the assessment of heat pump potential, but no further measures are in place related to sector coupling in the building sector. No support for electric vehicles or other programmes in e-mobility were mentioned.

The Energy Strategy of **Serbia**[103] dates back to 2016, NECP is being drafted. No indication for sector coupling, electrification plans, or hydrogen has been yet included. For **Ukraine**,[104] the 2035 energy strategy does not contain any provisions for heat pumps, electrification or sector coupling.

[100] Framework energy strategy of the Republic of Bosnia and Herzegovina, p 114
[101] ENERGY STRATEGY of the Republic of Moldova until 2030. Approved by Government Decision 2013.
[102] Energy Development Strategy of Montenegro by 2030.
[103] Energy Sector Development Strategy of the Republic of Serbia for the period by 2025 with projections by 2030
[104] Energy Strategy of Ukraine by 2035

4. COOPERATION IN THE FIELD OF CLIMATE AND ENERGY IN THE DANUBE REGION

The mandatory NECP template outlined in the governance regulation includes several sections requiring member states to collaborate with other EU countries. Under the course of elaborating NECPs, the DR countries have all organised meetings with their neighbours to inform and discuss the content and possible impacts.

Dedicated sections of the NECPs ask governments to assess possibilities for regional cooperation in the fields of climate and energy. As far as renewable electricity production is concerned, regional cooperation possibilities cover the **opening of support schemes** to other EU member state countries (as described in Article 5 of the recast renewable energy directive), cooperation mechanisms (as described in Article 8-12 of RED2), **joint infrastructure projects** funded by the Connecting Europe Facility (CEF) (including PCI projects) and projects financed by the EU renewable energy financing mechanism (introduced by the Governance Regulation[105]).

Several governments mention **statistical transfers** (AT, BG, CZ, DE, HR, RO, SI, SK) and joint projects (AT, BG, DE) as a way to fulfil the 2030 renewable energy targets. Regional cooperation on cross-border projects related to the use of energy from renewable sources with CEF financing is also envisaged by almost all countries (except for HR) in the NECPs. Bulgaria and Germany have already received funding through the CEF Facility for PCI projects, including the Danube InGrid smart grid project between Slovakia and Hungary appearing on the 4th list of PCI projects. Opening support schemes to other member states and **organising cross-border auctions** is mentioned by Austria and Germany among the Pentalateral Energy Forum (PENTA) countries. Even though the Hungarian and Romanian state aid approval contain an obligation to open the operating support schemes to other countries, the NECPs do not refer to these obligations.

Other EU initiatives mentioned include INTERREG projects (CZ), the Clean Energy Initiative for EU Islands (HR), the Joint Program Initiative Urban Europe (HR) or the Just Transition Fund (RO). Austria and Germany are active members of the Pentalateral Energy Forum (PENTA). As a member of the North Seas Energy Cooperation, Germany also engages in knowledge and experience exchange related to obstacles and the use of offshore wind energy and market integration.

The non-EU countries of the Danube Region also communicate intentions for regional cooperation. More precisely Montenegro aims to reach an agreement with neighbouring countries in relation to the **optimal utilisation of joint hydro-potential and water management** as well as planning and construction of new electric power interconnecting lines.

[105] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action

The majority of countries (BG, CZ, DE, HU, RO) do not mention **regional cooperation in transport**, with the remaining four countries only mentioning 1 to 3 policy goals without elaborating specific measures. This mostly relates to rail transportation, through the development of the international freight transportation (AT, HR, SI) while two NECPs mention public transportation, including rail. Slovenia underlined that establishing regional co-operation could enable transport infrastructure to be used and managed more efficiently, particularly for the freight transport. In relation to public transport, Croatia also mentioned bus transportation and green tourism.

Croatia and Slovenia also refer to knowledge transfer cooperation in the planning and **development of alternative fuel infrastructure**.

The connection of electricity markets is one of the priorities of the Energy Union, facilitated by the targets and measures outlined in the relevant EU regulation.[106] This process requires high level of coordination and cooperation at the national level. The progress achieved in physical connections and market integration, as well as system security are reported in detail in the dedicated sections of the NECPs. Some EU countries participate in **cross border smart system pilot projects** using innovative technology solutions related to smart grids, such as the ACON and the Danube Intelligent grid project. Another cross-border pilot project in the region is the SINCO.GRID between Slovenia and Croatia (see section 3.9.3).

The regional cooperation in gas is dominated by the already established and partly obligatory cooperation on security of supply and infrastructure planning (Gas Coordination Group, ENTSOG, CESEC). The market coupling initiative between Hungary and Croatia will rely on better implementation of EU rules and network codes on the periphery (EU-Energy Community borders).

There are several forums for cooperation in the Central and Eastern European Region, including the CESEC (Central and South Eastern Europe Energy Connectivity) association, aiming at facilitating the diversification of gas supply as well as improving energy efficiency and renewable energy deployment. The Visegrad Group cooperation includes Czechia, Poland, Hungary, and Slovakia, and aims to provide for joint representation in economic, diplomatic and political matters, including collaboration in the field of energy and climate policy.

The varying degree of **GHG reducing obligations** under the Effort Sharing Mechanism and the differences in mitigation costs across the countries might require the **cooperation of countries using the flexibility options** provided by the regulation[107]. Austria and Germany might consider applying flexibility instruments, while DR countries including Romania and Bulgaria could offer annual emission allocation units to other countries.

Many of the DR countries are involved in **joint research and development projects**, including cooperation through the different initiatives of the "Strategic Energy Technology Plan" (SET Plan)

For non-EU Danube countries, the importance of cooperation in the field of **knowledge and technology transfer**, and the provision of financial assistance must be emphasized.

[106] (2019/943/EU)
[107] 2018/842/EU

Austria and Germany stated a desire to **contribute to the achievement of commitments of third countries under the Paris Agreement**. Hungary has created the Western Balkans Green Fund Project, which will support the transformation process, supporting Hungarian companies and providing assistance for meeting the EU accession obligations.

DR countries emphasized **the role of solidarity** in relation to Ukraine and the importance of contributing to its political and economic stability.

The **involvement of non-EU DR countries in the EU Financing Mechanism** could be an opportunity for the financing of renewable energy projects in their territories. Improved electricity system and market connections with neighbouring EU countries would facilitate the integration of renewable plants and the deployment of sustainable energy sources.

The **prospective inclusion of non-EU DR countries under the EU ETS** or the imposition of a carbon-border adjustment mechanism could pose a challenge to non-EU DR economies, making it even more important that they **receive assistance to prepare heavy emitting sectors (industry, energy) for decarbonisation**.

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