Gas Infrastructure Europe

Decarbonisation in Central-Eastern and South-Eastern Europe:

How gas infrastructure can contribute to meet EU's long-term decarbonisation objectives

May 2021

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Photo : Inčukalns underground gas storage, Conexus Baltic Grid, Latvia

Photo : gas dehydration station in Mackowice, GAZ-SYSTEM, Poland

I. Introduction

1.1. Rationale behind this report

The members of Gas Infrastructure Europe (GIE) fully support the European Green Deal in reducing emissions and pollution and reaching carbon neutrality by 2050[1]. As an organisation which associates storage, transmission and LNG terminal system operators from all over Europe, GIE considers the role of regions to be pivotal in making the energy transition happen. To achieve this common objective, multiple solutions for region- and country- specific situations must be taken into consideration. More specifically, when it comes to defining the right energy mix of Member States, GIE members are convinced that there is no 'one size fits all' solution. Thus, programs and policies should be tailored to local conditions.

Such a regional aspect is especially visible in Central-Eastern and South-Eastern Europe where reliance on coal is significant. In the next decades, natural gas will play an important role in the region in substituting coal in power generation and providing flexibility in electricity systems. For this part of Europe, the coal-to-gas switch therefore represents the first most reasonable, fast-track and economically viable decarbonisation pathway. Furthermore, building on an already strong and well-developed infrastructure, gas assets will gradually accommodate growing share of renewable and low-carbon gases and play a key role in a fully decarbonised energy system across Europe.

The purpose of this report is to highlight and map out the strengths and opportunities that the gas infrastructure brings for Central-Eastern and South-Eastern European countries vis-à-vis the energy transition under the coal phase-out scenarios illustrated in Figure 1 below. In this context, a dedicated task force consisting of GIE member companies was established to analyse the different decarbonisation pathways of Central-Eastern and South-Eastern European countries. GIE decided to focus on a selected group of countries which expressed their interest in this exercise, namely: Austria, Czech Republic, Germany, Greece, Hungary, Latvia, Poland, Romania, Slovakia, and Slovenia. While there is a broader range of countries in the region, we believe that this sample is already representative in order to visualise the energy challenges met/confronted by Central-Eastern and South-Eastern Europe.

Figure 1 – Coal phase-out scenarios in the ten selected countries

1 GIE (2019) GIE Vision 2050. Available at: https://www.gie.eu/index.php/gie-publications/position-papers/27537-gie-vision-2050/file

1.2. Work on the report

Over the past ten months, different activities were carried out by the dedicated GIE taskforce to examine the opportunities and challenges behind the decarbonisation of Central-Eastern and South-Eastern Europe. The data from the National Energy and Climate Plans (NECPs) presented in this report reflect the status as of June 2020. Other information that were included in this report date back to December 2020."

Questionnaire

To achieve the EU's energy and climate targets for 2030, and in line with the Energy Union Governance Regulation, Member States were required to establish and submit Integrated National Energy and Climate Plans (NECPs). The NECPs were designed to group together in a single document the key elements indicating the direction of national energy policies and their approach to climate issues. Renewable energy sources, development prospects greenhouse gas emissions reduction, infrastructure connection or research and innovation were key information on which Member States focused. Moreover, various dimensions of national energy policy, including energy efficiency, innovation and security of energy supply, were also tackled.

To collect information on the pathways and developments as described in the individual NECPs, a questionnaire was prepared by the GIE task force and distributed among the companies involved, in May 2020.

The questionnaire was split into two parts: the first one was strictly dedicated to data collection to provide relevant comparisons and analysis, while the second one consisted of more open questions to gather information on national decarbonisation pathways. An additional aim of the questionnaire was to verify how consistent the different NECPs are with each other.

Virtual workshop

In July 2020, a virtual workshop was organised on 'Decarbonising the Gas Infrastructure in Central-Eastern and South-Eastern Europe with a Sustainable Recovery[2]'. The webinar brought together speakers from the European Commission, the European Parliament, the Polish Presidency of the Visegrad Group as well as representatives of the energy industry and academics. Most of the participants to the webinar highlighted that the Covid-19 pandemic is a crucial crossroad for the European Union and for its climate commitments, further increasing the importance of choosing the right pathway to achieve carbon neutrality. At the same time, it was emphasised that in Central-Eastern and South-Eastern Europe, energy poverty and heating remain major challenges that need to be solved. In Poland, for example, a major part of heating comes from coal. In order to successfully carry out a just transition in each member state, a clear EU-wide framework to achieve the decarbonisation of the economy accompanied by strong European instruments needs to be established. On the other hand, the risk of support for the gas sector being withdrawn cannot be ignored, especially as it would significantly increase the costs of the energy transition without alleviating energy poverty. Western European countries have achieved a high level of gas infrastructure development. However, in some regions of the EU, investments in natural gas infrastructure are necessary to support the switch from coal to gas, or to manage evolving supply-demand patterns, while preparing at the same time the energy system for the transition to renewable and low-carbon gases. In this context, several Member States stressed that the energy transition should be undertaken at the lowest possible costs. Thus, gas, as a transitional fuel was determined as part of the solution

[2] https://www.gie.eu/index.php/events-diary/workshops/2020-workshops/decarbonising-the-gas-infrastructure-in-central-eastern-and-south-eastern-europe-with-a-sustainable-recovery-1

[3] The EU Clean Energy Package covers as well RED II, Energy Efficiency Directive, Building Directive and Regulation on the governance of the Energy Union.

[4] https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

[5] https://ec.europa.eu/energy/sites/ener/files/energy_system_integration_strategy_.pdf

[6] https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

1.3 Regulatory background - ongoing works at the EU level

The transition of the energy system has become one of the most important issues on the EU agenda since the Paris Agreement in 2016. The Paris Agreement acknowledges the urgency and need for broad cross-sectoral changes to slow down the effects of the greenhouse gas emissions. In the electricity sector, this has led to the publication of paramount legislation such as the Electricity Directive part of the Clean Energy Package[3].

Since December 2019, the European Commission has been developing the European Green Deal that "aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use"[4]. The EU Green Deal is composed of a series of policy and legislative initiatives that would enable the EU to achieve climate neutrality by 2050. The Commission has already published several documents such as the EU's Energy System Integration Strategy[5], the Hydrogen Strategy[6], and the Climate Law. In parallel, as part of the post Covid-19 crisis recovery, in May 2020 the Commission put forward its proposal for a Recovery Plan that provides significant resources for clean and digital investments. During her State of the Union speech on 16th September 2020, Ursula von der Leyen, President of the European Commission, informed that the Commission would propose to increase the emission reduction target for 2030 from 40% to at least 55 %. As Ms Von der Leyen highlighted, this new goal might be too ambitious for some countries and not ambitious enough for others.[7] Subsequently, on 7th October 2020, the European Parliament's plenary voted for a 60% GHG emissions reduction target for 2030. As part of the co-decision legislative procedure, the proposal is now under the scrutiny of the Council. Until December 2020, the negotiations on the proposal will be supervised by the German Presidency of the Council. From January 2021 European Commission will focus on preparations for the implementation of the European Green Deal. In order to fulfil climate and energy legislation which will need to align with the newly proposed target to reduce emissions by at least 55% by 2030, as compared to 1990 levels. This will be brought together in a "Fit for 55 Package" which will cover everything from renewables to energy efficiency first, new gas law, energy taxation, emission trading revision and a wide range of other pieces of legislation.

Consideration should also be given to the fact that recently nine Members States - Bulgaria, Czech Republic, Greece, Hungary, Lithuania, Poland, Romania, Slovakia and Cyprus - co-signed a position paper on the role of natural gas in a climate-neutral Europe[8]. The paper, circulated within the EU institutions, underlines that natural gas can curtail greenhouse gas emissions by emitting 50 to 60 percent less carbon dioxide (CO_2) when combusted in a gas power plant, as compared to a typical new coal plant, but also dusts and other air pollutants such as NOx and SOx (up to 99% less than coal). Last but not least, the positive externalities brought by synthetic methane, bio-methane, and hydrogen thanks to their neutral greenhouse gas emission impact were highlighted.

On the basis of the above-mentioned considerations, the authors pointed out that the gas infrastructure should be acknowledged as a key enabler of sustainable and swift transition towards cleaner heat and electricity generation, transport, industrial processes and residential heating and cooling. Therefore, the principle of technological neutrality and country-specific flexible policy solutions must be acknowledged.

[7] https://ec.europa.eu/info/sites/info/files/soteu_2020_en.pdf

[8] https://www.euractiv.com/wp-content/uploads/sites/2/2020/05/Non-paper-Role-of-gas-in-climate-neutral-Europe-Final.pdf

Photo: Gas Connect Austria (Fejer)

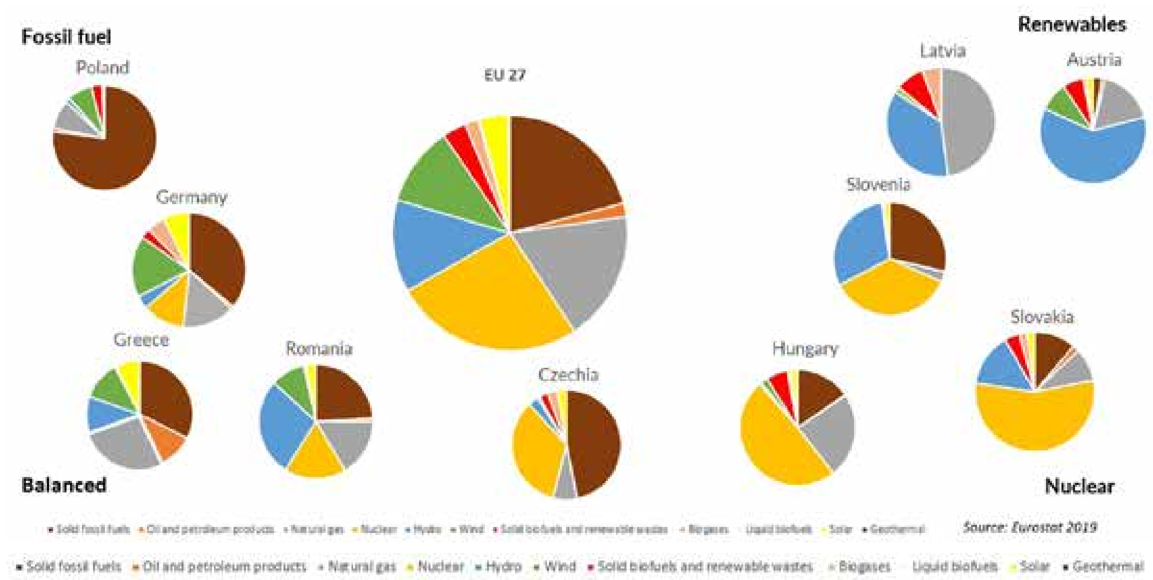
II. Current state of energy markets in Central-Eastern and South-Eastern Europe

In this section we focus on three sectors currently heavily dependent on fossil fuels – power generation, heating and transport while they give the most visible reflection on the possible decrease of the various emissions.

2.1. Gross electricity generation in Central-Eastern and South-Eastern European Member States

In 2018, the total production of electricity in Central-Eastern and South-Eastern Europe amounted to 2941,47 TWh. The energy mix varies within the region. Three main sources of electricity production can be noted in the energy mix of the ten selected countries: fossil fuels, renewables, and nuclear energy. As illustrated in Figure 2 below, some countries such as Greece or Romania have already achieved quite balanced energy mixes.

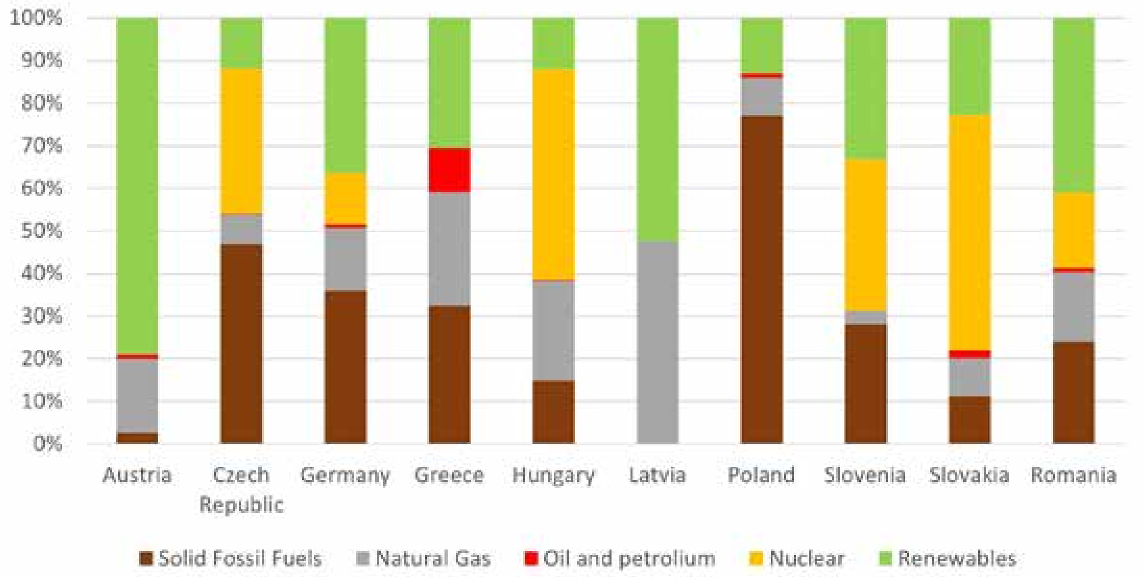
Figure 2 – Gross electricity generation in the selected Central-Eastern and South-Eastern European countries by fuel in TWh



Source: Eurostat 2018

One should notice from the following graph (Figure 3) that electricity generation in many of the Central-Eastern and South-Eastern Europe an Member States is based on solid fossil fuels, nuclear and renewable energy. Some of the analysed countries like Germany already have a plan to phase out nuclear and solid fossil fuels, while others are still in the process of defining it. Others continue to recognise the need to increase nuclear reliance: the Czech Republic, Hungary and Poland. Taking into consideration national gross domestic product (GDP) and the competitiveness of the industry in Central-Eastern and South-Eastern Europe, the switch from coal to gas will contribute towards a fair transition.

Figure 3 – Electricity gross production of the ten selected countries

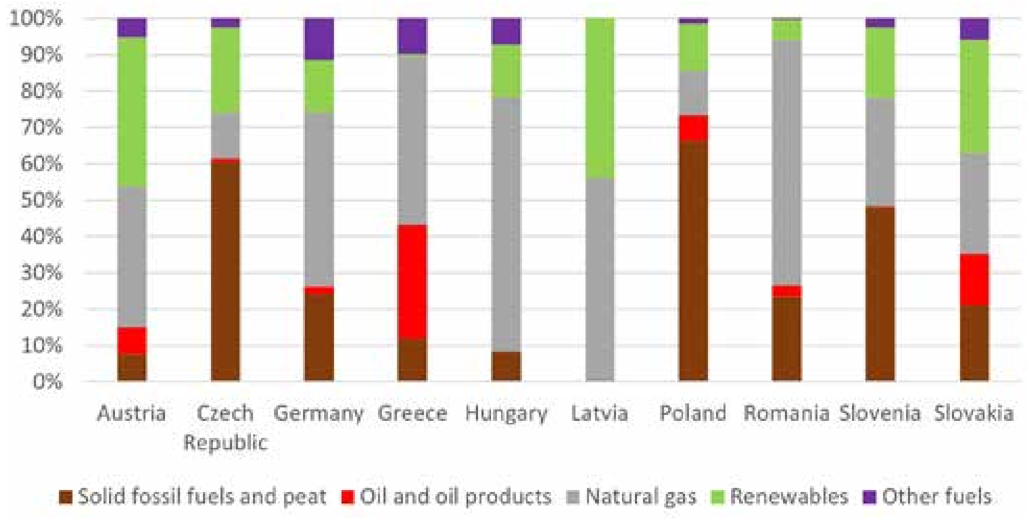


Source: Eurostat 2018

2.2. Heating sector in Central-Eastern and South-Eastern European Member States

The heating sector in Central-Eastern and South-Eastern Europe is highly based on solid fossil fuels. As some of the countries in the region are facing serious issues related to air quality[9], decarbonising the heating sector is one of their main challenges. Several initiatives taken by the countries in the region aim at replacing coal furnaces with natural gas boilers. As a next step, consideration should be given to renewable gases for heat generation. Cleaner gases can be produced through diverse techniques such as methanisation, pyrogasification or from micro-algae cultivation for biomethane; or mainly from water electrolysis for hydrogen. Methanisation is a mature technology mainly producing power and heat through Combined Heat and Power (CHP) engines.

Figure 4 - Heat generation in the ten selected countries



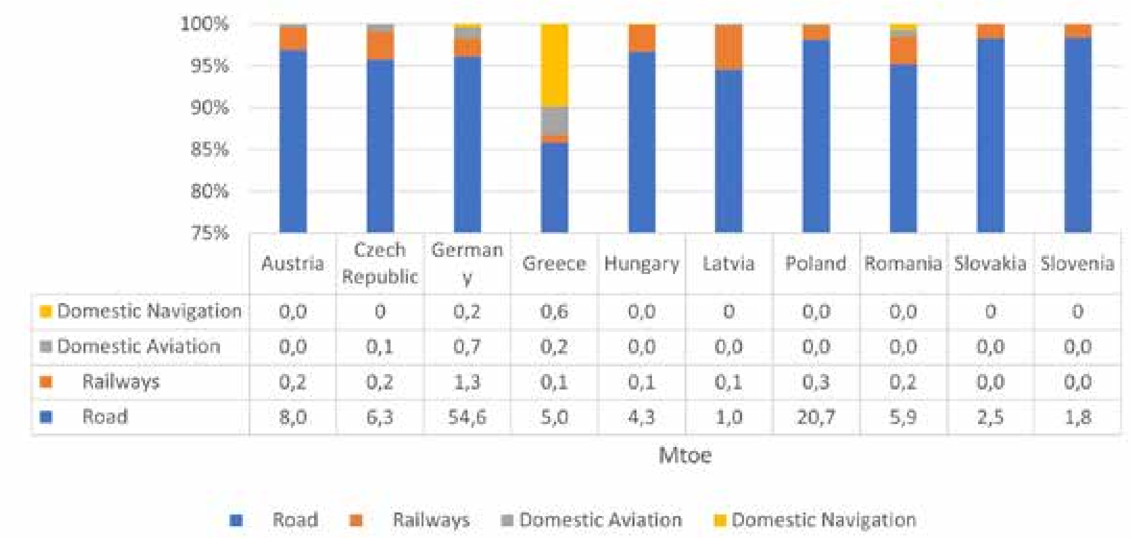
Source: Eurostat 2018

[9] This problem has been reported in the questionnaire (and many times before on a number of occasions) by the Czech Republic, Greece, Poland and Slovakia

2.3 Transport sector in Central-Eastern and South-Eastern European Member States

In Europe, transport represents almost a quarter of greenhouse gas emissions and remains a significant cause of air pollution, especially of particulate matter (PM) and nitrogen dioxide, in cities. Contrary to other sectors, greenhouse gas emissions from transport only started to decrease in 2007 due to the introduction of fuel quality standards and cleaner technologies. Among the different transport modes, Figure 5 shows that road transport is the biggest consumer of energy in all the countries from the region and, as a consequence, is responsible for a large part of the greenhouse gas emissions of this sector. By virtue of its coastal and islander character, Greece has also an important part of its emissions stemming from domestic navigation.

Figure 5 - Final energy consumption by transport mode in the ten selected countries



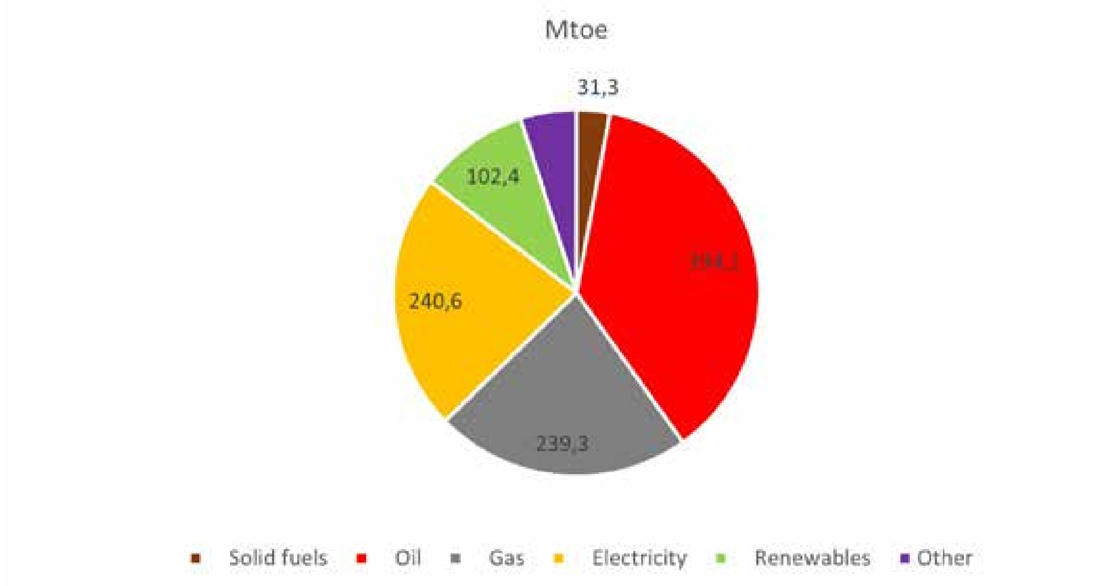
	Austria	Czech Republic	German y	Greece	Hungary	Latvia	Poland	Romania	Slovakia	Slovenia
Domestic Navigation	0,0	0	0,2	0,6	0,0	0	0,0	0,0	0	0
Domestic Aviation	0,0	0,1	0,7	0,2	0,0	0,0	0,0	0,0	0,0	0,0
Railways	0,2	0,2	1,3	0,1	0,1	0,1	0,3	0,2	0,0	0,0
Road	8,0	6,3	54,6	5,0	4,3	1,0	20,7	5,9	2,5	1,8

Source: Eurostat 2017

Photo : gas storage facility,
Magyar Földgáztároló Zrt (FGSZ)., Hungary

Figure 6 presents the final energy consumption in transport in the European Union, by fuel. As oil and solid fossil fuels account for 40% of energy carriers in the transport sector, it would be of crucial importance to switch to lower emissions gaseous fuels. In the heavy-duty transport, this already constitutes a flexible, affordable and efficient solution.

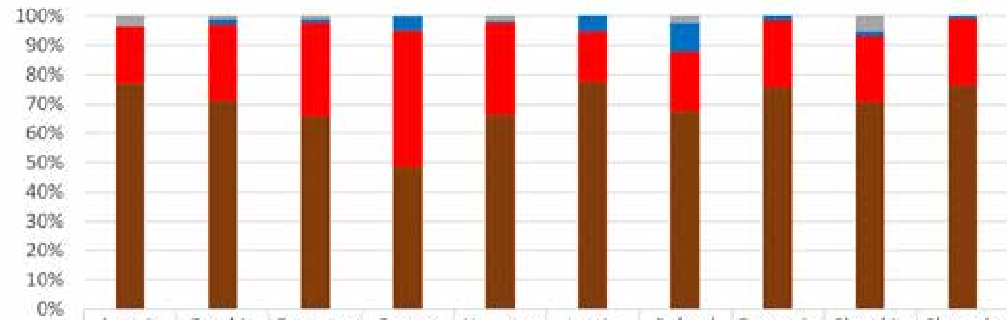
Figure 6 - Final energy consumption in transport by fuel in the European Union



Source: Eurostat 2017

The comparison of the use of different fuels in the transport sector shows that natural gas and LPG account only for 22,5 % of total fuel consumption. Given the lower CO_2 emissions resulting from the use of these gases in the transport sector, their increased use in the Central-Eastern and South-Eastern Europe should be considered.

Figure 7 - Final consumption of petroleum products and natural gas in the ten selected countries



	Austria	Czechia	Germany	Greece	Hungary	Latvia	Poland	Roamnia	Slovakia	Slovenia
Natural gas	269,9	74,8	613,1	15,2	78,3	0,1	488,3	0,2	133,1	3,3
LPG	8,2	96,2	551,4	242,2	23,1	55,2	2039,5	93,7	35,2	14,9
Gas/Diesel oil	1543,1	1601,4	16538,5	2402,9	1417,7	184,0	4385,9	1320,3	570,8	425,5
Motor gasoline	6160,6	4393,2	33623,8	2503,6	2994,0	822,3	14257,5	4446,0	1804,5	1428,0

ktoe

Motor gasoline ■ Gas/Diesel oil ■ LPG ■ Natural gas

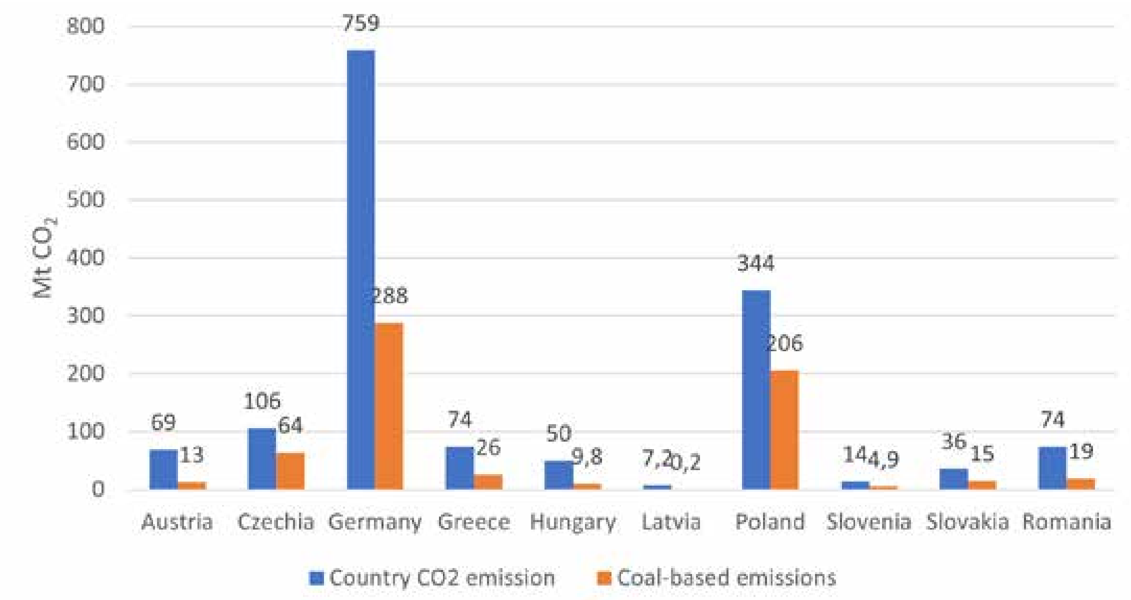
Source: Eurostat 2018

III. Role of coal and gas in Central-Eastern and South-Eastern European Member States

3.1 CO_2 emissions

In 2018, the least energy intensive economies in the EU, i.e. those using the least amount of energy relative to their overall economic size (based on GDP in purchasing power standards), were Ireland, Denmark and Romania, whilst Malta and Estonia appeared as the most energy intensive EU countries[10]. It is worth emphasising here that the economic structure of a country is a significant determinant of the energy intensity of its economy: service-based societies will a priori display relatively low energy intensities, while economies with heavy industries (such as iron and steel production) may have a considerable proportion of their economic activity related to industrial production, thus leading to higher energy intensity. In this perspective, it should be noted that in 2018, the EU27 emitted 3068,9 Mt CO_2 while only coal-based total CO_2 production in the Central-Eastern and South-Eastern Europe an region equalled 645,9 Mt CO_2. This is the equivalent of the overall production in France and Spain, i.e. 656Mt CO_2 . As natural gas is a low-emission energy carrier compared to other fossil fuels, it would be of crucial importance to ensure a smooth switch from coal to gas, especially in the power generation, heating sector and energy intensive industries such as steel production, fertilizers, cement, petrochemicals and many others.

Figure 8 – CO_2 emissions of the ten selected countries



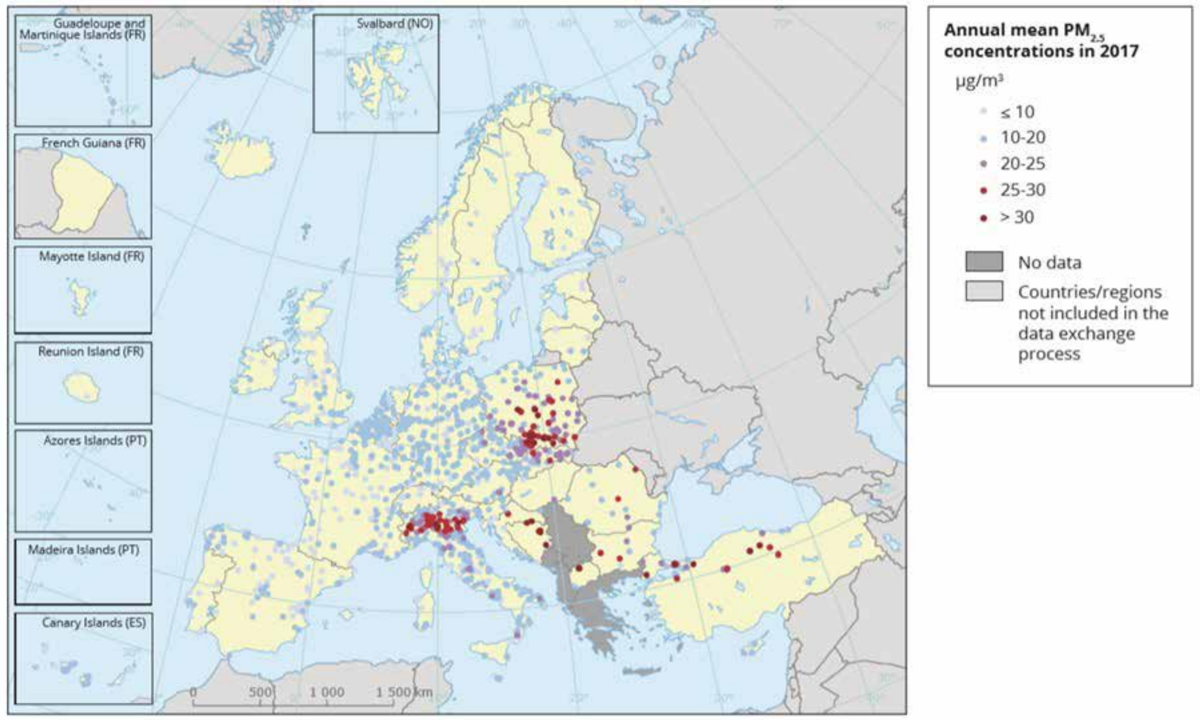
Source: UNFCCC, 2019 http://www.globalcarbonatlas.org/en/CO_2-emissions

10 Eurostat (2018), Infograph How efficient are we in our consumption of energy? Available at: https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-4b.html#:~:text=The%20least%20intensive%20economies%20in,States%20were%20Malta%20and%20Estonia.

3.2 Air quality

Air pollution is caused by the emissions of a mixture of solid particles, liquids and gases which are detrimental for human health and life. Air pollutants derive from a range of both man-made and natural sources. The combustion of fuels in electricity generation, transport, industry and households is the main factor responsible for outdoor pollution. The National Emission Ceilings (NEC) Directive obliges Member States to measure five main air pollutants. Among them, the most impactful and dangerous are nitrogen oxides (NOx), sulphur dioxide (SO2), and fine particulate matter ($PM_{2.5}$).
Aggregated data reported by the European Energy Agency (EEA) prove that the levels of air pollutants – though significantly diminished in the last decade – still exceed EU standards and World Health Organisation guidelines. The figures also indicate disparities among various regions. Concentrations of key pollutants vary depending on the region and urban/rural densities. While Western Europe suffers primarily from NOx, Central-Eastern Europe and Central-South Europe (CSE) struggle with a huge health threat posed by particulate matters.
According to the 2019 Report of IQAir, among the 100 most polluted cities in Europe, a high number of them are located in Central-Eastern and South-Eastern Europe. These are represented in red on the map below.

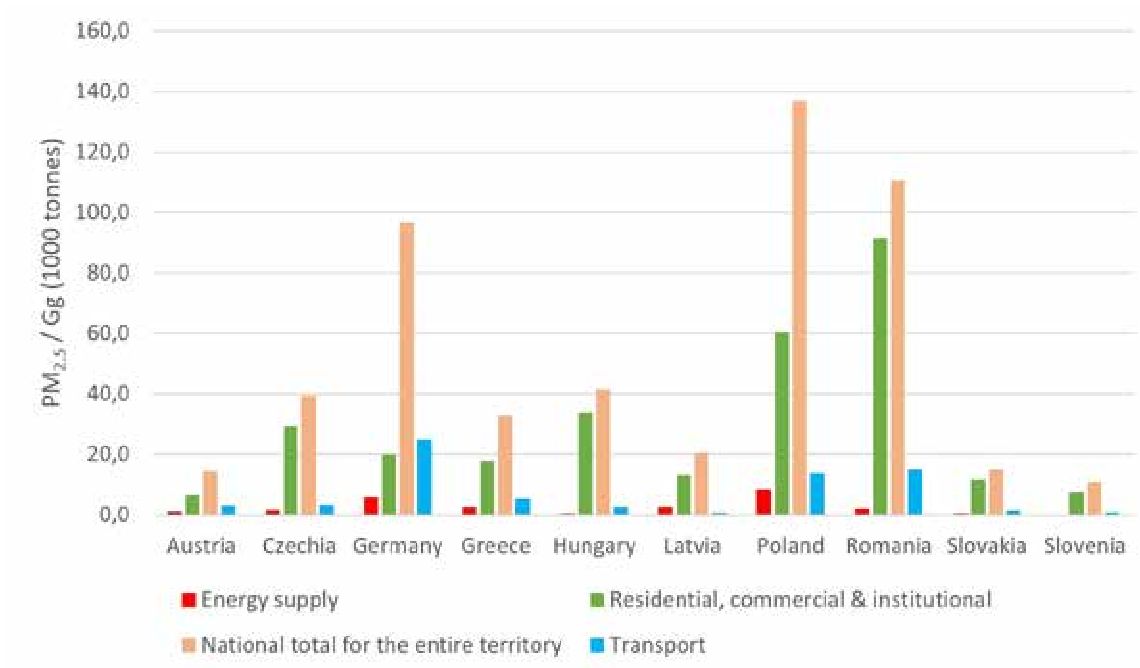
Figure 9 - Concentration of $PM_{2.5}$ annual limit values in Europe



Source: Air quality in Europe — 2019 report, page 30.
Available at: https://www.eea.europa.eu//publications/air-quality-in-europe-2019

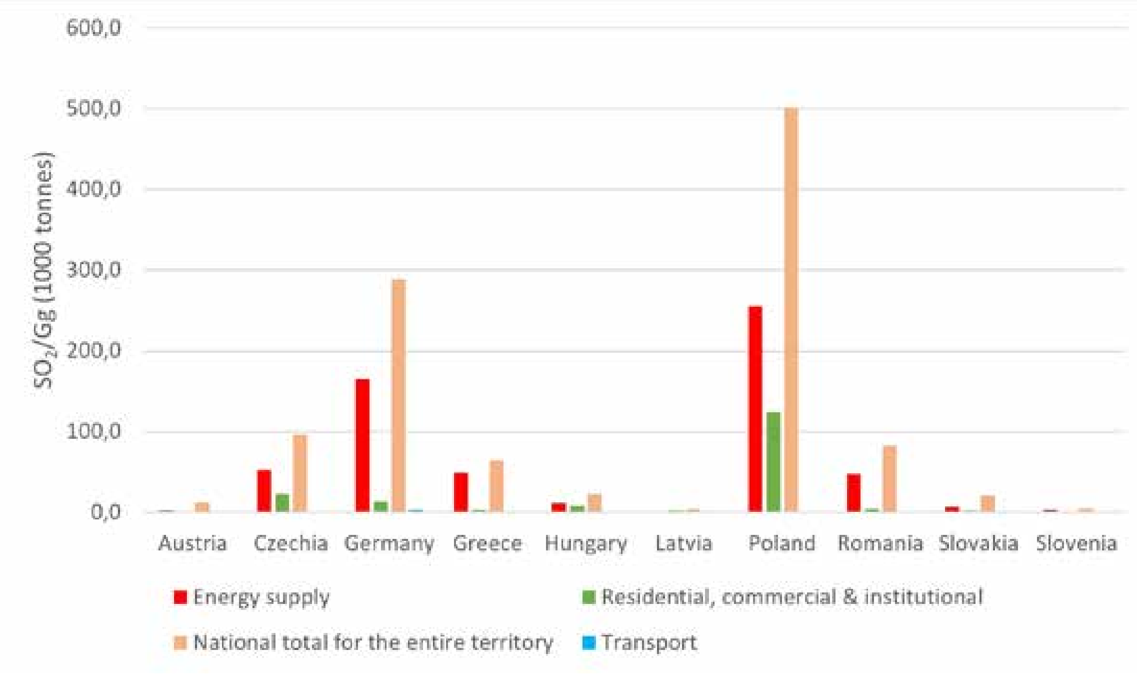
One of the main sources of air pollution are so called low-stack emissions – those caused by burning coal and other solid fuels in single family buildings. Heating is responsible for over 45% of PMs emissions and 84% of Benzo(a) pyrene emissions. A very high level of air pollution affects in particular those regions where energy intensive industries play an important role in national economies.
Emissions of CO_2 caused by natural gas combustion and processing are significantly low when compared to other fossil fuels (ew. Compared to solid fossil fuels).. Moreover, it is a friendly and emissions-neutral energy source in terms of air pollution. Natural gas generates hardly any traces of PM10 and $PM_{2.5}$ – two pollutants known as the most "deadly"; hardly measurable traces of SOx, and very low volumes of NOx and CO.
Due to its features and its accessibility, natural gas is the most prominent energy source to combat toxic air pollution in Central-Eastern and South-Eastern Europe in the mid- and long-term perspective.
Renewable energy sources (RES) have been recognised as crucial to cover, at least partially, the heating and energy production sectors, and meet the climate and air quality targets. Nevertheless, natural gas has a role to play since RES are unstable and the access to them is still difficult. In this context, natural gas can be a back-up source to compensate for the lack of cost-efficient and large scale RES storage technologies.
So far, Central-Eastern and South-Eastern Europe an countries have undertaken initiatives to reduce air pollution and minimise CO_2 emissions. To give an illustration, various actions and programmes on national and local levels have been adopted to reduce the transport impacts on air quality – from upgraded standards for engine emissions (following EU regulations), through construction of beltways bypassing populated areas, to local initiatives reducing access to city centers or other areas. Countries from the region are also working on diversification of fuels for transport by promoting the use of LNG, CNG and electricity.

Figure 10 - $PM_{2.5}$/Gg emissions in the ten selected countries



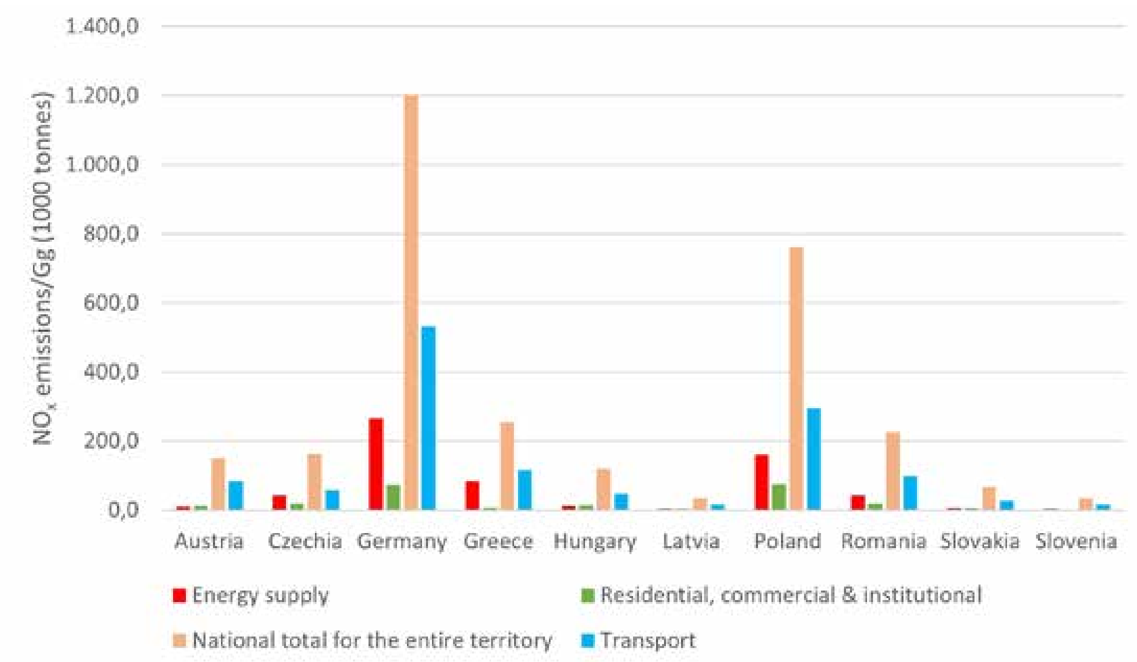
Source: European Environmental Agency, data for 2018.
https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-3

Figure 11 – PM SO2/Gg emissions in the ten selected countries



Source: European Environmental Agency, data for 2018.
https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-3

Figure 12 – NOx/Gg emissions in the ten selected countries

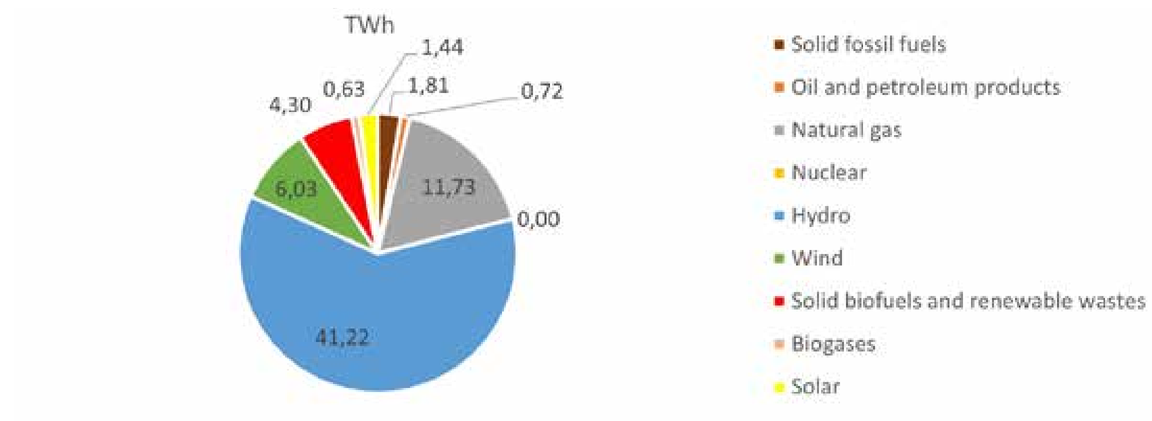


Source: European Environmental Agency, data for 2018.
https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-3

3.3 Austria

Austria can be considered as one of the greenest countries in Central-Eastern Europe. Figure 10 below shows that its energy mix strongly relies on renewable energy sources, especially hydropower. While natural gas still plays a supporting and balancing role for the whole energy system, Austria plans to move to renewable gases - biomethane and hydrogen - in the next decades.

Figure 13 - Gross electricity generation of Austria



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

In 2018, Austria adopted its climate and energy strategy, #mission2030, which aims at reaching the 2030 targets and paving the way to the long-term vision of a carbon-free energy sector by 2050. Subsequently, this document laid the foundations of Austria's National Energy and Climate Plan (NECP). Among the main points of the Austrian NECP, it is important to note that Austria has a very ambitious sectoral objective of a 100% renewable electricity system by 2030 and has committed to the installation of 1 million PV systems by 2030, a substantial increase from the target of "100 000 roof-mounted PV systems" under #mission2030.

Furthermore, Austria intends to reduce its greenhouse gas emissions in non-ETS sectors by 36% by 2030, compared to the 2005 level. According to the Austrian NECP, in 2017, greenhouse gas emissions of the country in the non-ETS sector were approximately 51.7 million tonnes of CO_2 equivalent (mt CO_2eq). The target that has been set for 2030 is around 36.4 mt CO_2eq, which means that Austria must reduce its emissions by around 30% when compared with 2017.

The sensitivity analysis shows that emissions in the heat and electricity generation sector will only fall by around 55,000 additional tonnes of CO_2eq than under the WEM scenario. This also results from the assumption of lower electricity imports against a backdrop of reduced economic growth. It has been assumed that the operation of the only refinery in Austria will not be affected by economic growth, since, as of 2017, more than half of the diesel consumed in Austria is imported. In the case of low GDP growth in 2030, emissions within the industry sector will fall by around 297,000 t CO_2eq when compared with the WEM scenario.

Changes in GDP do not have any significant impact on emissions in the buildings sector. In the event of slow economic growth in 2030, greenhouse gas emissions would exceed the WEM scenario by 126,000 t CO_2eq. Since less money is invested in renovation as a result of the fall in energy prices (the sensitivity scenario assumes a similar slowdown in global growth and therefore in the demand for energy sources), the fuel demand for heating buildings will ultimately increase.

Greenhouse gas emissions in the "with additional measures" scenario (WAM)

The WAM scenario was created to show the model-based effects of the measures set out in NECP.

For sectors that are subject to the EU Effort Sharing Regulation, the models applied show a reduction in greenhouse gas emissions of 41,5 mt CO_2eq by 2030 (27% when compared with the base year 2005). Further reduction efforts will be required to close the shortfall of around 5 mt CO_2eq in the achievement of the objectives by 2030.

A federal government will have to decide whether and to what extent further measures have to be applied to flexibility mechanisms used from 2020 onwards.

The role of gases

According to the Austrian NECP, a large proportion of natural gas will be replaced in the future by renewable gas, namely biomethane, hydrogen and synthetic methane produced from renewable power sources. Within the framework of its decarbonization efforts, Austria plans to introduce tax advantages for sustainable biogas, hydrogen, liquefied natural gas and bio-LNG.

To guarantee the origin of renewable gases in a comprehensible and transparent way, the electricity sector's system of guarantees of origin must be transformed in an evolutionary manner. Not least as a requirement for transposing the Renewable Energy Directive 2018, guarantees of origin must be established not only for electricity and gas but also for heating and cooling.

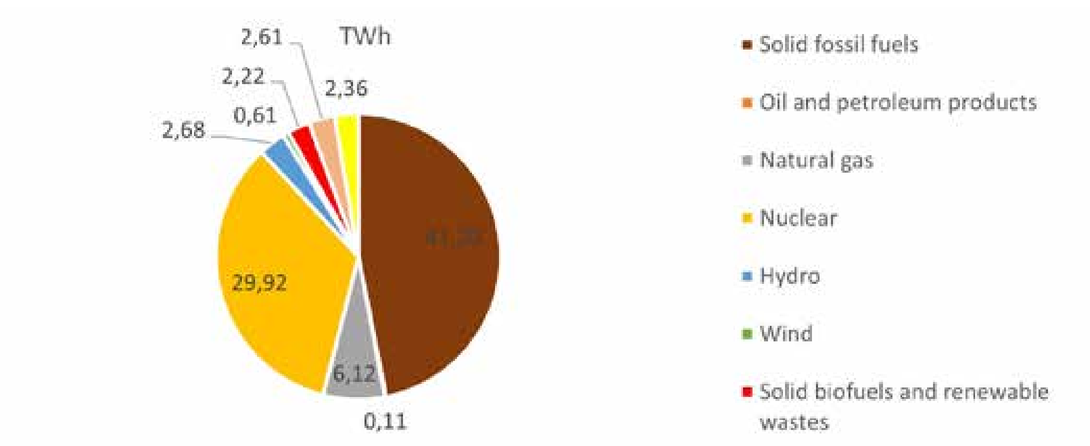
The Renewable Energy Expansion Act will stipulate that gas grid operators will have to take over parts of subsequent investments in renewable gas generation installations. The aim is for renewable gases to be produced locally and be fed directly into the natural gas grid. The sustainability of renewable gases will be governed by guarantees of origin.

As regards hydrogen and renewable gases in general, powers to regulate will be conferred based on the Renewable Energy Expansion Act 2020 which will allow an incorporation rate no greater than the level provided for in the applicable standard of the Austrian Association for the Gas and Water Industries.

3.4 Czech Republic

The Czech Republic's energy mix is largely based on solid fossil fuels and nuclear as shown in Figure 11 below. The Czech Republic is currently working on a plan to phase out solid fossil fuels[11]. In the energy mix, solid fossil fuels will be replaced by natural gas, nuclear energy and renewable energy sources. As previously shown in Figure 9, the Czech Republic is one of the countries in the region with a severe air pollution problem, an issue that could be mitigated via the switch from coal to gas in the heating sector.

Figure 14 - Gross electricity generation in the Czech Republic



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Based on total primary energy sources in the Czech NECP with perspective until 2040, the share of coal is expected to gradually decrease after 2020, and in 2040 it will be less than half compared to the 2020 level. The share of oil is expected to remain stable throughout the years until 2040. Natural gas is expected to slightly decrease after 2020 until 2035, but between 2035 and 2040, it will increase again thanks to the coal to gas switch in heat and power generation. The share of natural gas in primary energy sources in 2040 is predicted to be slightly bigger than in 2020. Renewable sources of energy are predicted to continually grow. Based on planned construction of new nuclear units the share of nuclear energy is expected to increase during years 2035-2040.

In the Czech Republic, some so-called coal limits are currently into force, and restrict access to coal resources. The coal limits were introduced to protect the local environment. The main consequence is the limited accessibility to coal resources, which then results in a limitation in the operationality of specific coal power plants.
Currently, the consumption of natural gas is around 8.1 bcm/y. The biggest consumers of natural gas in the Czech Republic are the industry and households (cooking and heating).

[11] https://bankwatch.org/blog/the-czech-coal-commission-and-its-planned-fossil-fuels-phase-out

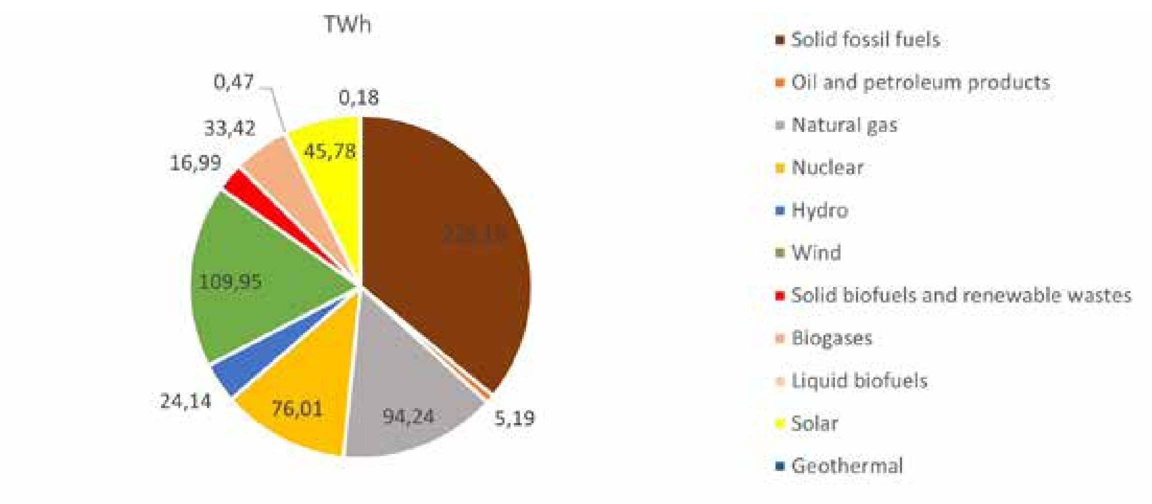
In the heating sector, natural gas is the second most used fuel after coal with a share of around 28 %. The role of natural gas in electricity production is rather small with a share of less than 5 %. In the transport sector, the role of natural gas (CNG vehicles) is small at the moment but according to projections and the state strategy for alternative fuels, it should grow in the coming years, including LNG (natural gas consumption in transport in 2018: 73 mcm, i.e. about 1% of total Czech gas consumption).

There are several benefits of natural gas that are recognized in the NECP, mainly better air quality when switching from solid fuels to natural gas, and lower emissions from transport. Also, switching from solid fuels to natural gas is an easy and cost-effective way to increase energy efficiency in the residential sector.

In local heating, a switch from coal to natural gas brings down health risk caused by constantly exceeded pollution limits, especially for particulate matter, NOx and sulphur dioxide. There is an ongoing subsidy programme focused on air quality where citizens can apply for financial support to exchange an old coal boiler for a new gas one (they can also opt for a biomass boiler or a heat pump). Local heating is by far the greatest source of particulate matter pollution in the Czech Republic: solid fuels are used in for heating 15% of households, yet they are responsible for over 40% of particulate matter emissions, 47% of volatile organic compounds pollution and 98% of benzo(a)pyrene emissions[12]. Thus, switching to natural gas helps to achieve the air quality targets set in the EU Directive 2016/2284. Further, in transport, the National Action Plan on Clean Mobility recognizes CNG and LNG to be among priority fuels according to the EU Directive 2014/94 on alternative fuels. As a result, construction of a number of LNG and CNGs filling stations is financially supported by the state. Also, the state signed a memorandum pledging to keep the current excise tax level for gas in transport until 2025 (it corresponds to the minimum tax level set in the EU Energy Taxation Directive).

3.5 Germany

Figure 15 - Gross electricity generation in Germany



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

The above chart shows that power generation in Germany is mainly based on fossil fuels with 228 TWh fuelled by coal production. Renewables, with more than 109 TWh, generate more energy than natural gas. Additional investments are required to decrease the usage of fossil fuels. Germany's current energy supply is heavily dependent on the consumption of fossil energy sources. In 2018, petroleum, gases and coal accounted for around 80% of primary energy consumption. Most of the remainder was accounted for by renewables (14%), nuclear energy (6%). Germany plans to phase out coal by 2038 at the latest. The process will be carried out in four stages:

- 15 gigawatt (GW) hard coal and 15 GW lignite capacity by the end of 2022 (from 22.8 GW hard coal and 21.1 GW lignite in 2019)
- 8 GW hard coal and about 9 GW lignite capacity to remain by 2030
- By the end of 2038 at the latest, there will be no coal-fired power generation left as the phase-out is completed
- Three reviews in 2026, 2029 and 2032 are scheduled to decide whether the phase-out can already be completed by 2035[13]

[12] Czech Ministry of the Environment: Report on the Environment of the Czech Republic 2017 (in English) and 2018 (in Czech only)

Germany also plans to phase out nuclear energy (from 2023 onwards). Phased out capacity is to be replaced by renewables (with a significant role of hydrogen).

Currently Germany produces all the lignite it uses, and some minor quantities are even exported. Subsidies for sales of domestic hard coal ended in 2018. The share of imported hard coal has therefore risen to 100% since 2019. Given the high liquidity of global markets and international supply structures, the security of supply for imported hard coal is considered high.

Gas consumption dropped by around 100 PJ between 2010 and 2018, but domestic gas production almost halved during the same period. The share of gas which is imported therefore rose significantly. Germany imports almost all the petroleum it uses. By way of contrast, it produces almost all its renewable energy and nuclear energy on a domestic basis. Germany has great willingness and plans to make great changes within its national process of generating energy carriers. RES are a key factor to be further deployed and this sector has been seeing significant investments.

In the baseline projection, primary energy consumption will drop by almost 1,400 PJ between 2021 and 2030. The drop in primary energy consumption for fossil fuels will mainly be driven by the increasing use of renewable energies in the buildings and power sectors, and the drop in coal and petroleum consumption. The share of hard coal and lignite in electricity generation will see a particularly marked drop, while generation based on natural gas will initially increase before falling slightly. This development will essentially be driven by the long-term increase of carbon prices under the ETS. By 2030, the use of renewables will increase by 13% compared to 2021. Consumption of renewables will only increase slightly between 2030 and 2040. This can be traced back to developments in the energy sector, where not all the existing plants at the end of their lifespan will be replaced with new ones. (particularly in the case of photovoltaics and biomass plants).

GHG emissions

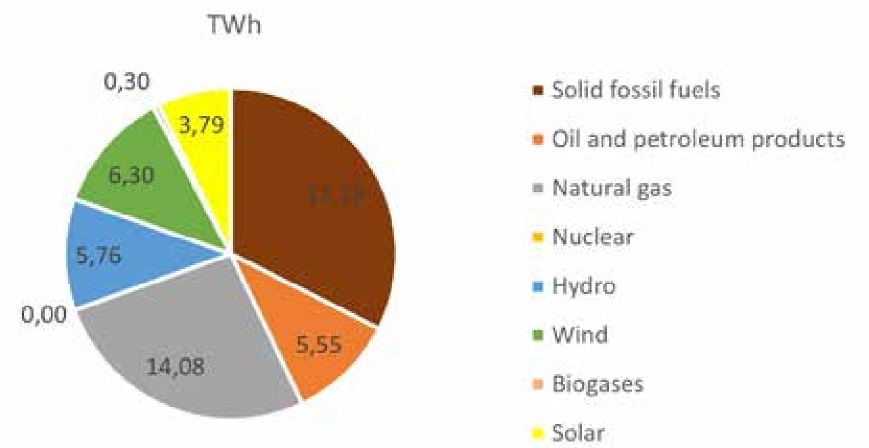
The country emitted some 805 million tons of greenhouse gases in 2019, which was roughly 54 million tons or 6,3% less than in 2018

Except for the 2009 global economic crisis, Germany's emissions reduction in 2019 was the country's largest annual decline since 1990. Compared to then, Germany has already reduced its emissions by 35,7%. The German government has pledged an emissions reduction of at least 55% by 2030.

This change can be attributed to the successful reform of the European emissions trading system, the low price of gas, the expansion of wind and solar energy, and the shutdown of the first coal-fired power plant units.
Most of the reductions have been observed in Germany's power sector, which saw a reduction of 51 million tonnes of CO_2. That represents a 16.5% drop in emissions on the previous year. A key factor is the use of gas-fired instead of coal-fired power plants[14].

3.6 Greece

Figure 16 - Gross electricity generation in Greece



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Greece energy mix is mainly based on solid fossil fuels and natural gas. The role of natural gas in the country's energy mix is forecasted to grow (especially in the medium/transitional term).

The production of electricity accounts for the largest share of natural gas consumption (65% in year 2019). In recent years, following the end of the recession in Greece, the role of natural gas in the energy mix has been growing. It should be noted that in 2019 the share of natural gas in power production exceeded the share of lignite (~30% vs ~20% accordingly), reversing the picture of the electricity production that had prevailed until then.

Also, an increase in natural gas consumption is observed in the industrial sector. The consumption of natural gas in the residential/ commercial sector has already exceeded the peeking consumption levels observed in the years prior to the crisis. Having said that and taking into account the expected expansion of the network in more regions of Greece, the market is expected to be dynamically developed in all sectors in the future to come.

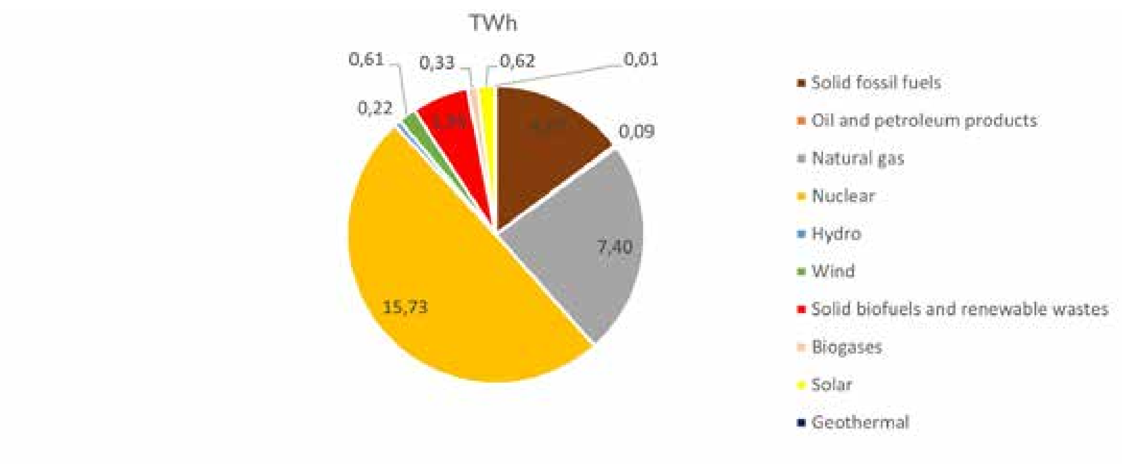
Natural gas is expected to be the intermediate fuel for the transition to low level of GHG emissions, while at the same time it can lead to both improved energy efficiency and lower energy efficiency costs compared to other conventional technologies. However, with the energy efficiency considered (if achieved) together with the development of RES, the result will be a marginal drop in the gas demand projected for year 2030.
Based on the current situation, there are areas in Greece where heating – for several days a year – depends on district heating connected to lignite plants. Following the withdrawal plan of lignite fuelled plants, natural gas will ensure the operability of the district heating of such areas.

[13] https://www.cleanenergywire.org/factsheets/spelling-out-coal-phase-out-germanys-exit-law-draft

[14] https://www.dw.com/en/climate-change-germany-cuts-carbon-emissions-by-63-in-2019/a-52791753

3.6 Hungary

Figure 17 - Gross electricity generation in Hungary



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Hungarian energy mix is mainly based on nuclear power with a significant share of natural gas.

Hydrocarbons accounted for a significant share in 2018. Natural gas – Hungary's key source of energy – had a 32 % share (significantly less in comparison to 45 % share in 2003), while oil accounted for 28,5 % of total Hungarian primary energy consumption. The share of coal/lignite (the Hungarian structure of coal use is primarily based on lignite), however, significantly declined from 21 % to 8 % – subject to minor fluctuations – with the phasing out of deep mining in Hungary between 1990 and 2017. In parallel with the above trends, the role of renewable sources of energy is gaining relevance in Hungary's energy consumption: the share of renewables doubled between 1990 and 2005, and between 2005 and 2017 (1990 = 2.6 %, 2001 = 5.9 %, 2017 = 11 %).

Natural gas contributes 24 % of the total energy supply and consumption. Domestic production has been continuously declining and therefore import dependency remains high. A significant amount of natural gas consumed in the country comes from Russia. Regarding gas supply, the uncertainties about the availability of Russian transit routes from 1st January 2020 forced Central and Eastern European market players to import and store more intensely in the 2019 summer season than in previous years. Imports from Russia continue to dominate since extension of the long-term contract between the two countries in 2019. To improve diversity and security of supply, Hungary has developed gas transit interconnections with its neighbouring countries.

Demand for natural gas has declined in both heat and power generation and in the residential sectors, while industrial demand has improved slightly. The overall trend, however, is a decline in natural gas consumption over the last decade.

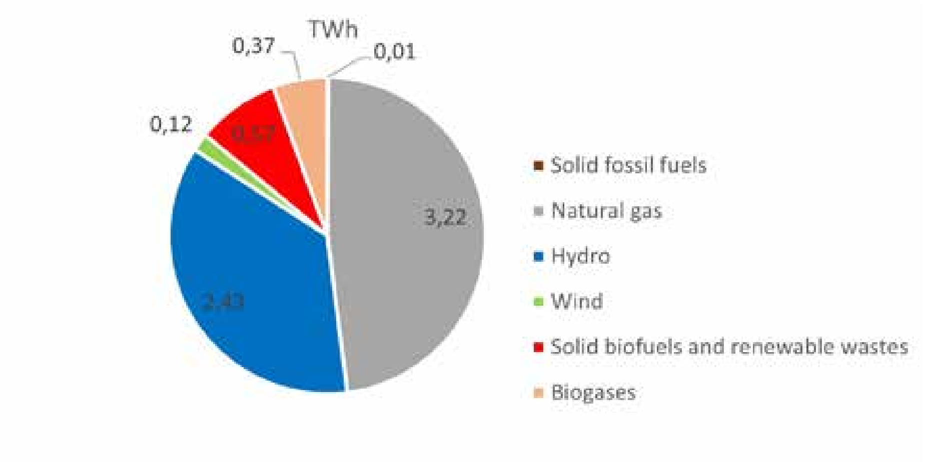
The residential sector is the largest user, accounting for one third of total consumption. Households mainly use natural gas for heating purposes, and therefore this segment's consumption has the highest seasonal fluctuation. The latest consumption data show that 45% of consumption in winter months comes from households with their share dropping to mere 11-13% in summer months.

The share of power plant gas consumption within total gas consumption in the last three years ranged from 16 to 18%. It is worth dividing the power plant category into the subcategory of large power plants and that of small power plants, since plants in those two categories operate according to different consumption logic. The production (and thus the natural gas consumption) of large power plants, which accounts for 2/3 of power plant gas consumption, depends mainly on trends in the electricity wholesale market and, to a lesser extent, on heat demand. Gas consumption by small power plants mainly includes units concerned with industrial production, therefore, additionally to heat demand, natural gas consumption in this segment is driven by industry and general economic trends.

Industry sector consumption is responsible for about 25 % of total demand. The three largest gas-consuming industry sectors (food and tobacco, chemicals and petrochemicals, and non-metallic minerals) account for over half total industry demand.

3.8 Latvia

Figure 18 - Gross electricity generation in Latvia



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Latvia is one of the countries in the Central-Eastern and South-Eastern Europe region with one of the most balanced energy mixes. Natural gas plays a crucial role in it (and its role is forecasted to be significant at least until 2030).

Latvia's natural gas consumption is about 1.4 bcm, even if a reduction in consumption has been observed in the last ten years (1.66 bcm in 2008). The declining gas consumption has been the result of a number of objectives and positive developments such as different energy efficiency measures, including modernisation of boiler houses and reduced losses in energy supply, especially heating, as well as diversification of energy sources, namely, successful use of local RES (for example, an increase in the share of woodchips), for example, in heating. This reduction also enhances Latvia's energy security, making it less dependent on energy imports. The potential benefit of a regional market for Latvia is its geographic location, which creates opportunities for natural gas transit from south to north, as well as the technical capacity of Incukalns UGSF is used as a market instrument.

The electricity consumption in Latvia is 7.4 TWh. In recent years there have been changes in the overall mixed structure of total energy sources consumption - as the consumption of natural gas has decreased in the processing sector, the share of RES in total energy sources consumption has increased due to the increase of electricity production in hydro and wind power plants. At the same time, the amount of electricity from RES varies depending on external factors. High rainfall and resulting high water inflow to the Daugava River in 2017 contributed to the increase of RES consumption by 5.6% in 2017. On the contrary, under filled reservoirs and low water levels in water bodies, including the Daugava River, due to an extremely dry and hot summer in 2018, this led to a 43.6% decrease in HEP production. Latvia mainly uses natural gas to produce thermal energy and electricity in the transformation sector (cogeneration units and boiler houses): 81% in 2010, 53.7% in 2017, and 59% in 2018. The share of RES consumed by the transportation sector increased by 5.4 percentage points in five years and reached 40.5 % in 2017. This is an important indicator considering that RES used in the transportation sector are local energy sources: wood fuel, biogas and other types of biomass. The final consumption of energy sources was 174.55 PJ in 2018, which is 9.1 % higher than in 2016. The largest consumers of energy sources in 2018 were the transport sector (31%), households (28.8%) and industry (22.8%). Compared to 2017, in 2018 an increase in the final consumption of energy sources was observed in transport (+3.3%), industry (+13.3%) and households (+2.9%), while a lower consumption of energy sources was observed in agriculture and forestry (-3.6%) and business and public sector (-2.7%). The structure of consumption of energy sources in households has not changed substantially in the recent years — wood fuel and natural gas have been used predominantly. The consumption of natural gas has increased significantly (+9.3%) and the consumption of coal has decreased (-32.7 %) in comparison to 2017. An increase in the share of consumption of liquefied petroleum gas (LPG) has been observed in transport in recent years, though the share of LPG consumption in the total energy mix has fallen by 5.2% .

The main part of the natural gas supply is used for the production of heat and electricity in Latvia (together they account for about 75% of natural gas consumption), so demand is closely linked to fluctuations in ambient temperature and changes in the consumption of natural gas for electricity production (for example, the low capacity of hydroelectric power plants and the price of gas affect electricity production and the development of energy prices themselves). According to Latvia NECP, natural gas along with oil products will continue taking up the biggest share in the overall primary consumption of energy resources in Latvia. Also, the plan indicates the promotion of the production of biogas and biomethane and a forthcoming study on the decarbonisation of the gas network as the main instruments to adapt the natural gas transmission system to the input of RES hydrogen.

In the future, natural gas and the existing infrastructure in Latvia will play a major role in achieving decarbonisation targets at a minimum cost. In the last year, the development of transport gas infrastructure began, and according to the Latvian NECP data, the share of natural gas in the overall final consumption of energy will rise due to the replacement of oil products with gas in road vehicles.

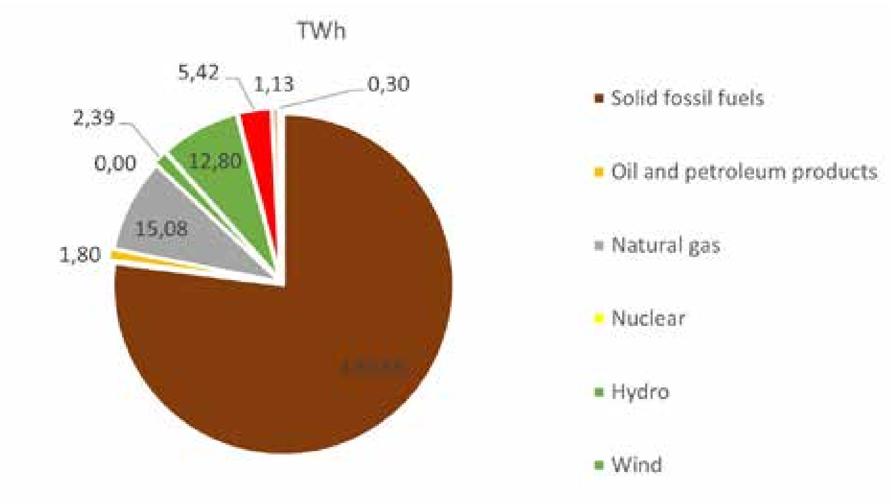
Increasing progress in the use of renewable sources in the electricity sector will require the flexibility that natural gas and Inčukalns UGS can provide. The results of the 2019 Artelys study, 'Value of the gas storage infrastructure for the electricity system', commissioned by GIE, which were presented by the European Commission and the European Association of Gas Market Participants during the 33rd Madrid Forum, show that in the view of the reduction in the capacity of European storage facilities by more than 10% substantial investments in the electric power sector are required; for example, if the capacity of European storage facilities fell by 30%, this would lead to 55 billion euros required in investments and 8 billion a year in operational costs.

"New gases"[15] production using Power-to-X technologies, blending them with natural gas and transport via a Guarantee of Origin certificate will be supported by the existing gas transmission and storage system. According to the NECP, a study concerning the decarbonisation of the gas transmission system, including the viability of adapting the natural gas transmission system to the input of RES hydrogen and other gaseous fuels, must be completed by the end of 2023.

[15] In the absence of common terminology, we use the term "new gases" to define renewable and low-carbon gases.

3.9 Poland

Figure 19 - Gross electricity generation in Poland



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Poland's energy mix is mainly based on solid fossil fuels. Poland is also one of the countries in the region facing the challenge of high air pollution.

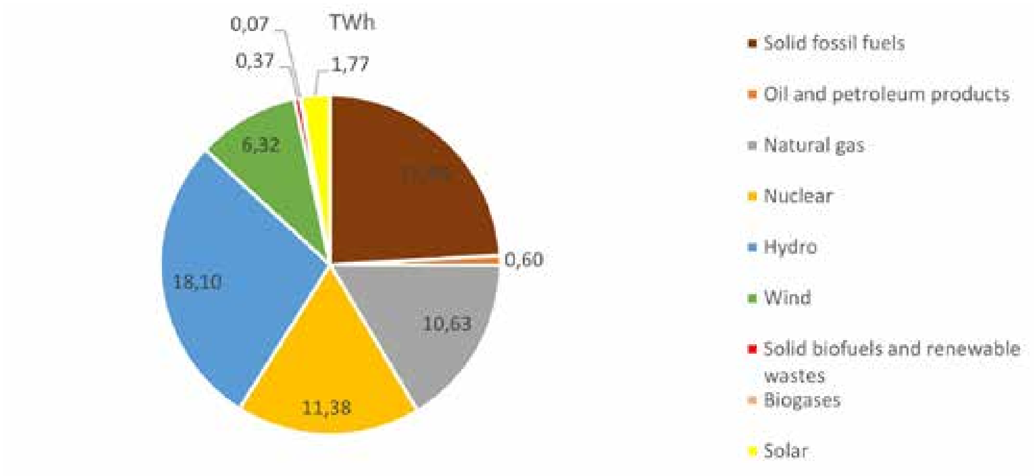
The Polish energy system is one of the largest within the European Union. It ranks in the top ten in terms of main macro-energy indicators. Poland is the biggest producer of electricity based on coal: more than 130 TWh. Poland is aware of the upcoming challenges to be faced by its energy sector and therefore plans to decrease coal-based electricity from the current 76% to 11% in 2040. In this context, the Polish government recently announced a proposal for the closure of coal mines by 2049. Poland's power generation will be based on the most flexible energy carrier: natural gas. Nevertheless, the Polish NECP set a target of 21-23% RES share in 2030, while reaching 23% will be possible if Poland is granted additional EU funds, including those allocated to a fair transition. The emission trends in the key economy sectors and actual emission levels in the period 2021-2030 will determine the final total emission level in the non-ETS area. The share of coal-based units in the generation structure is expected to decrease from approximately 80% in 2015 to around 69% in 2030 and 31% in 2040. Therefore, between 2030 and 2040, the share of coal-fired units in total electricity generation will rapidly decrease. This process will be mainly driven by the decommissioning of coal-fired units (determined on the basis of declarations of electricity undertakings) and the decreasing operating time of coal-fired units, amongst others, as a result of an expected increase in the popularity of low-carbon sources over the period.

GHG emissions

Poland has considerably reduced total GHG emissions compared with 1988 levels. Notably, a profound reduction took place before 2005: from 1988 to 2005, the decrease reached around 30%, and from 1990 to 2005 it amounted to approximatively 15%. Given the above-described trends, the reduction of GHG emissions in the non-EU ETS sectors covered by the Effort Sharing Regulation (ESR) by -7% until 2030 as compared with 2005 will be an ambitious challenge for Poland. An analysis of the current 2030 GHG emission forecast shows that aggregate emissions in the ESR sectors will decrease. The following non-EU ETS sectors have the largest shares in the GHG emission structure: households, i.e. municipal and domestic sector (ca. 30%), transport sector (ca. 27%), agricultural sector (ca. 15%). From the point of view of meeting the ESR target, the following sectors will be crucial for the level of GHG emissions: transport, agriculture, construction and non- EU ETS industry (which accounts for ca. 8% of GHG emissions in the non-EU ETS sectors).

3.10. Romania

Figure 20 - Gross electricity generation in Romania



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Romania's energy mix is quite balanced with a high share of solid fossil fuels, hydro, natural gas and nuclear power. Romania has significant resources of natural gas which can contribute to the security of supply of this country.

The natural gas market features a rather high level of concentration with the two main large producers, i.e. OMV Petrom and SNGN Romgaz, holding together a market share of over 90 % of the natural gas production. As for the market shares of main suppliers, there is a slight differentiation between the free market and the regulated market, the latter featuring a higher level of concentration.

Having a look at the projected trend in the natural gas-fired capacity, we see that the Development and Decarbonisation Plan for CE Oltenia 2020-2030 provides for an additional natural gas-fired capacity of 1 400 MW as from 2024. Considering the age of the current natural gas-fired units, it has been estimated that the decrease due to their decommissioning will exceed the increase resulting from the new capacity. Nevertheless, the gross energy production from natural gas will increase (due to increased efficiency of new capacity and increased utilisation rate of existing ones).

The level of ambition regarding the share of renewable energy was revised compared to the initially proposed share of 27.9 % to 30.7 %. The new target was mainly calculated based on the Commission's recommendation to align the national macroeconomic projections to those in the "Ageing Report: economic and budgetary projections for the EU-27 Member States (2016-2070)", correlatively decommissioning the coal-based units.

In order to reach the ambition level regarding the share of renewable energy of 30.7 % in 2030, Romania will thus develop additional RES capacity of approximately 6.9 GW compared to 2015. To achieve this target, appropriate funding from the EU is needed to invest in the adequacy of electricity grids and flexibility in the production of RES-E. This goal will be achieved by deploying backup gas capacity and storage capacity, and by using smart electricity grid management techniques.

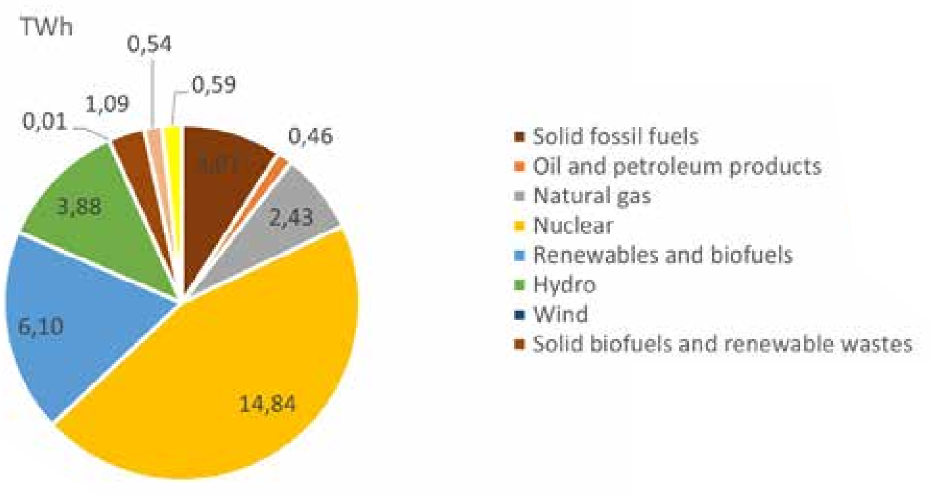
Romania has chosen to adopt a prudent approach to the level of ambition, taking into account the national particularities and the RES investment demand for both replacement of units that have reached the maximum operation period and new ones in order to achieve the targets of the NECP

The replacement of existing conventional power generation capacity with low carbon capacity will also result in the further promotion of renewable resources in the production of energy (e.g. wind or solar energy), including for heating in SACET type district heating systems, energy transit through the National Energy System (NES), and the use of heat pumps at source level, as well as using the energy market mechanisms. The replacement of the existing power and heat generation capacity will also result in the reduction of own consumption for process purposes, in particular as a result of investments in the refurbishment and development of high-efficiency cogeneration units (including methane gas-fired ones). Projections for 2030 show an increase of up to 5,255 MW in the wind capacity and of approximately 5,054 MW in the photovoltaic capacity.

Romania plans to make a fair contribution to the achievement of the decarbonisation target of the EU, and will follow the best environmental protection practices. The application of the EU ETS scheme and compliance with the annual emissions targets for the non-ETS sectors are the main commitments to achieve the goal. For the sectors covered by the EU-ETS scheme, the overall emissions reduction target of Romania reaches approximately 44 % by 2030 compared to 2005

3.11. Slovakia

Figure 21 - Gross electricity generation in Slovakia



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

The Slovakia's energy mix is strongly based on nuclear. Slovakia, being one of the biggest natural gas transit countries, has significant gas infrastructure. Next to Poland and the Czech Republic, Slovakia is one of the countries dealing with a serious air pollution problem.

The Slovak natural gas market has changed significantly in recent years. Reverse flows have been introduced, sources and routes of gas supply have been diversified, the market has been liberalised, and the country's gasification rate has been increased to as much as 90%. On the infrastructure side, it can be said that Slovakia has made a huge step forward in the field of gas storage. Since 2010, storage capacity has been increased to a level that allows the amount of gas needed for the annual demand of the whole country to be accumulated. Currently, the Slovak gas market is characterised by a highly developed gas infrastructure. Slovakia is an important transit country on the way from Russia to Western Europe. What distinguishes Slovakia is the high share of natural gas in district heating and the visible trend of coal replacement with gas in this area. This means that it can be said that natural gas in Slovakia has strongly contributed to the reduction of CO_2 emissions in relation to 1990.

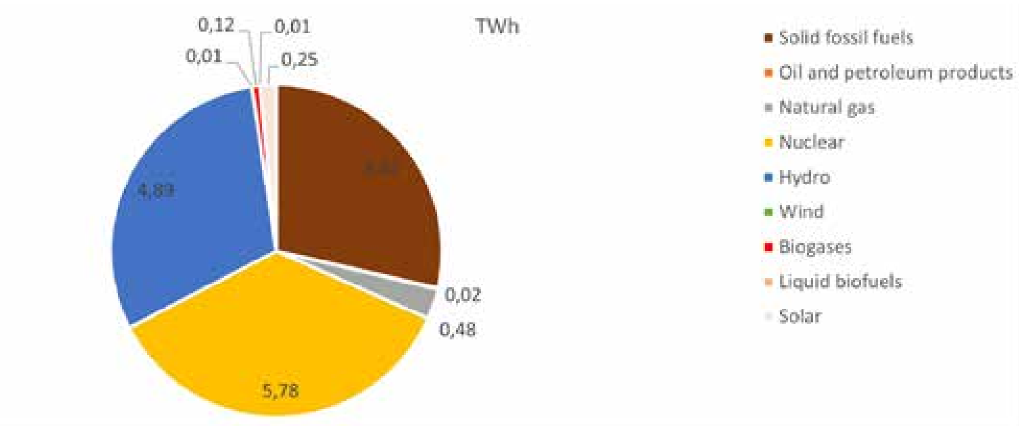
The trend in emissions has remained relatively stable since 1999. The most significant reduction in emissions from agriculture was achieved in the early 1990s as a result of a reduction in livestock breeding combined with reduced use of fertilizers. In 2016, the waste sector contributed 4% of total greenhouse gas emissions. The application of a more accurate methodology for assessing methane emissions from solid waste in landfills and the inclusion of the older layer in the calculation resulted in a continuous increase in emissions of over 100% compared to the 1990 base year. A similar trend is anticipated in the coming years, although this increase should not be as significant as before. The amounts of emissions from landfills depend largely on the applied methodology for landfill assessment, as well as on the extent to which landfill site operators use energy recovery from landfill gases.

Given current technology and price levels, the extensive use of geothermal energy in the 2020-2022 period is unlikely. The costs involved in the accelerated construction of geothermal equipment would lead to a significant increase in prices for heat consumers. It is unlikely that the significant input investments required for a large number of geothermal sources could be covered from public and private financing in such a short time period. Greater use of geothermal energy is more likely at a later date. The planned RES target for 2030 in the NECP is 19.2%. The Ministry of Economy will take all possible steps to further accelerate RES development between 2021 and 2030, in particular in heat generation, to ensure that Slovakia is able to achieve a higher RES share in 2030. Based on EUStream's own calculations and expert estimates it can be concluded that achieving the target of 24% RES in 2030 is rather difficult to achieve..

The regulation itself anticipates that this value will be modified to take national specifics into account. From the perspective of Slovakia, account needs to be taken of the fact that after the unfinished power blocks at the Mochovce nuclear power plant are put into operation, it will be difficult, even impossible, to increase the RES share above the proposed RES target in the electricity generation sector. Maintaining the reliability of the Slovak electricity system will require a sufficient level of flexible sources, even if the level of cross-border connections with neighbouring countries is higher than the EU average.

3.12. Slovenia

Figure 22 - Gross electricity generation in Slovenia



Source: ENERGY STATISTICS, Energy datasheets: EU countries version 20 July 2020, EU Commission, DG Energy, Unit

Slovenia energy mix is based on three main components: nuclear energy, hydro and solid fossil fuels.

Energy supply in 2017 was dominated by liquid fuels representing a 34% share, with RES and waste at 15%, nuclear energy at 13%, gaseous fuels at 10%, electricity and solid fuels at 9%and hydroelectric power at 8%, while and other fuels with share below 1%.

The goal of Slovenia's energy and climate policy is to ensure a reliable, secure and competitive energy supply in a sustainable way to ensure the transition to a climate-neutral society and achieve sustainable development goals by, among other things, establishing an environment that stimulates economic development, and creating jobs with high added value, improving the quality of life, increasing environmental responsibility and providing acceptable energy services for Slovenia's population and economy.

The objective of reducing GHG emissions is reflected in setting an ambitious and development-oriented share of RES in the final consumption mix. The NECP reaffirms the national target of at least a 27% share of RES by 2030 set by the SRS 2030, and actively seeks to create an appropriate structural environment and to stimulate the necessary changes that will enable Slovenia when updating the NEPN (2023 and 2024) to set a more ambitious target for the share of renewables by 2030. In the area of transport and transport infrastructure up to 2030, the fundamental document in Slovenia is the Transport Development Strategy.

Increasing energy efficiency (and hence reducing consumption) is Slovenia's first key measure for the transition to a climate-neutral society. Security of supply is one of the three fundamental pillars of energy policy and is inextricably linked to climate sustainability and competitiveness of the energy supply. To create a secure energy supply, Slovenia will, in a well-founded sustainable and economical fashion, ensure a sufficient supply of energy resources and sufficient capacity and diversification of supply routes, sufficiently powerful and regularly maintained networks, appropriate cross-border connections, operationally reliable and efficient cooperation between energy systems, and diverse sources of electricity and energy storage.

Considering the size of Slovenia and EU energy policy, the integration of supply routes and resources in the region is fundamental. Having regard to climate change, maintaining the security of supply will be crucial in the electricity system. To achieve its ambitious energy and climate policy targets, Slovenia will ensure better conditions for accelerated development of the electricity distribution network, conferring greater intensity, resistance to disruption, future development potential and exploitation of the flexibility of resources and loads. The network represents a cornerstone of the future transition to a climate-neutral society, which alone will enable accelerated connection of heat pumps and the fulfilment of requirements related to accelerated deployment of e-mobility and accelerated integration of renewable energy generation facilities.

Slovenia will endeavour, as far as possible, to reduce the use and importof fossil energy sources by phasing out fossil energy sources while focusing on increasing energy efficiency and a greater use of renewable and low-carbon sources. In accordance with the decarbonisation projections, the share of renewables in the energy mix will increase. Slovenia's electricity connectivity was 83.6% in 2017, well above the 10% target for 2020 and the 15% target for 2030. Slovenia has several projects of common interest in the area of electricity and natural gas transmission. The most significant natural gas transmission project is a transmission pipeline between Slovenia and Hungary, which will create the missing link between the two systems and enable the transfer of gas from Hungary via Slovenia to Italy and vice versa, affording access to LNG terminals and underground storage facilities. A second project is to increase the bilateral capacity of the transmission link between the Slovenian-Croatian and Slovenian-Austrian interconnection for access to LNG terminals. In the area of research and innovation, in 2010 the Slovenian Government adopted the target of achieving by 2020 joint public-private investment in R&D amounting to 3% of GDP (with a target of 1% of GDP for the public investment).

The projections for both the existing measures (EM) scenario and the WAM scenario for 2030 and 2040 show that liquid fuels dominate throughout the whole period, but consumption of these is already discernibly reduced by 2030, in particular in the WAM scenario thanks to the intensive electrification of transport. In the EM scenario, final energy consumption will increase by 2030, in particular on account of transport. In addition to transport, energy consumption increases in industry as well as in other uses on account of economic growth in these sectors. The only sector where energy consumption is reduced is households.

Photo : provided by Plinovodi d.o.o.

IV. Future energy scenarios for the region

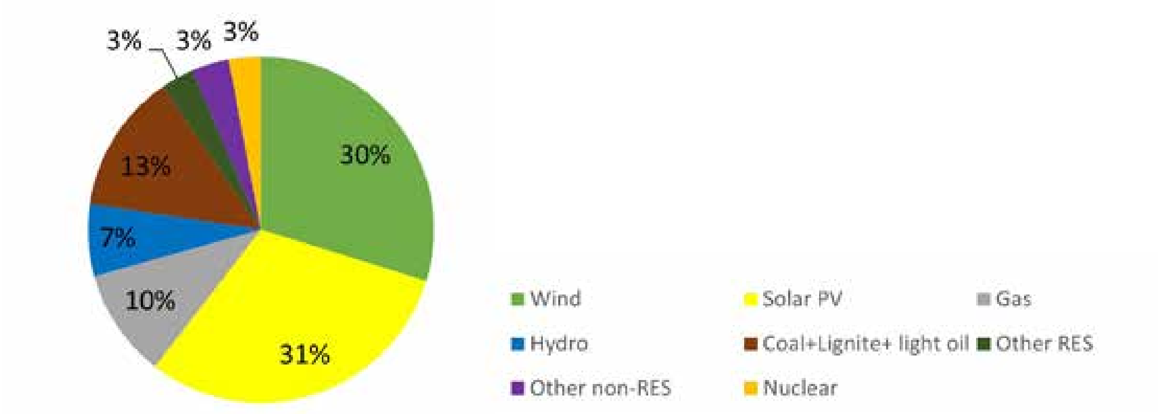
The European Commission's requirements regarding the reduction of the GHG emissions resulted in a switch from fossil fuels to renewable and low-carbon energy sources in the analysed Member States. Similar conclusions can be drawn from data from the National Trends Scenario (appendix to TYNDP 2020). These data were obtained from Electricity and Gas Transmission System Operators and were based on the NECPs (final versions and drafts). The charts below present the share of individual technologies in the energy mix.

Figure 23 - Global installed generation capacity in the analysed countries in 2025

Source: ENTSOG, TYNDP 2020, National Trends Scenario,

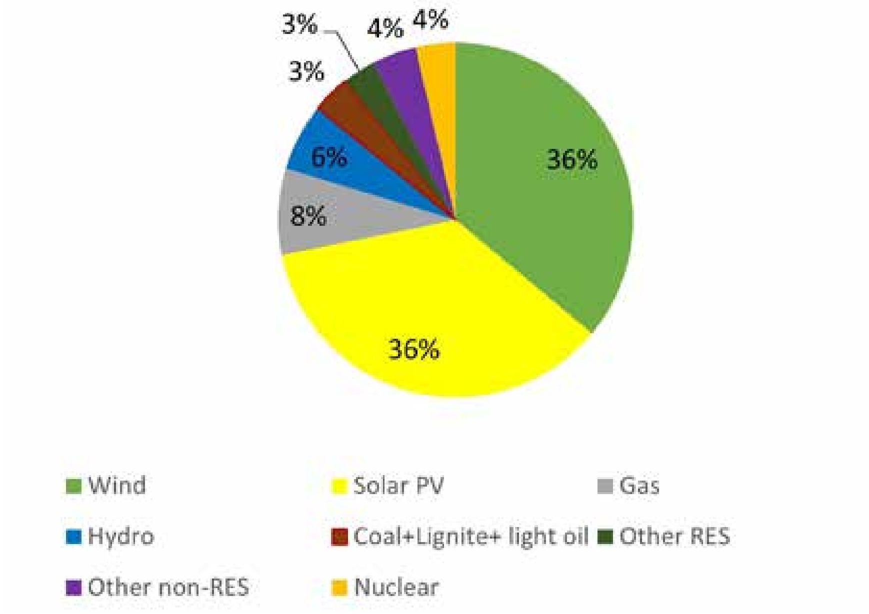
In 2025, the installed capacity of wind and solar accounts for 65% of the total installed capacity in the Central-Eastern and South-Eastern Europe region. 75% of other renewable sources (biomass, biogas, waste) and water engineering, are taken into account. Installed capacity of coal, lignite and heating oil power plants as well as other facilities based on fossil fuels amount to 21%. The share of natural gas will amount to 11

Figure 24 - Global installed generation capacity in the analysed countries in 2030



Source: ENTSOG, TYNDP 2020, National Trends Scenario, In 2030, the installed capacity of renewable energy sources is forecasted to amount to 71%. What should be highlighted is that this forecast requires more comprehensive investment plan because only some minor changes in installed RES capacity are observable yet.

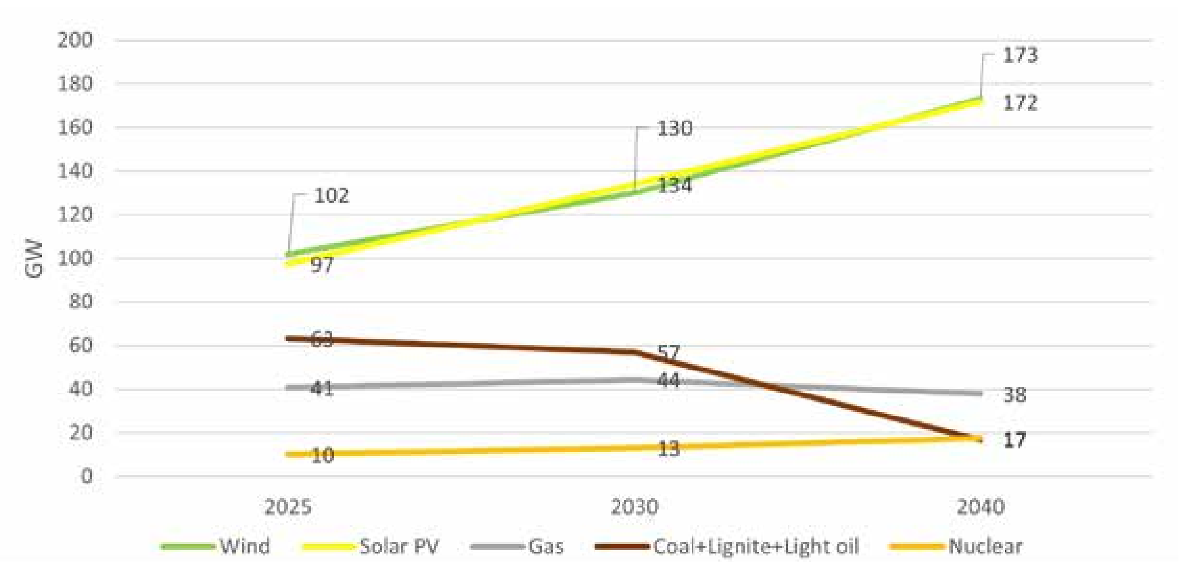
Figure 25 - Global installed generation capacity in the analysed countries in 2040



Source: ENTSOG, TYNDP 2020, National Trends Scenario,

In 2040, RES are foreseen to account for 81% of the installed capacity in the region, while the installed capacity of solid fossil fuel power plants is 7%.
The share of natural gas in the energy mix will decrease, but even in 2040 it will play a significant role. Natural gas will be mainly a back-up source of power in case of low generation from renewable energy sources.

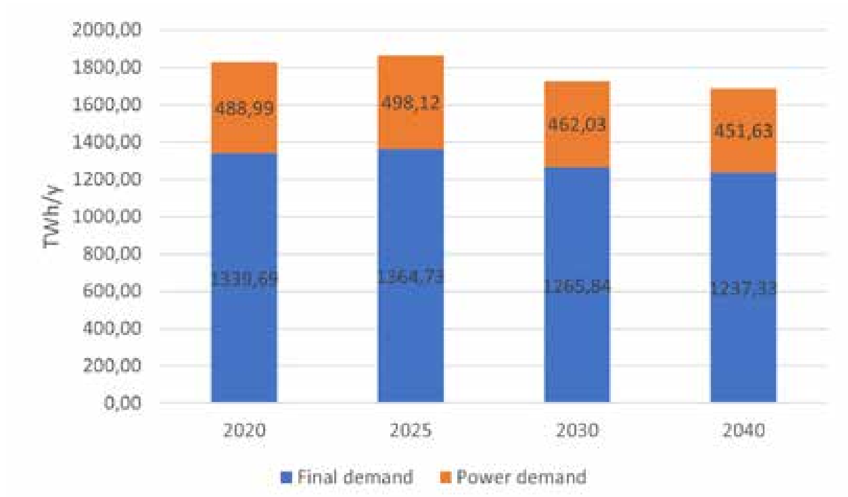
Figure 26 - Global installed generation capacity in the analysed countries from 2025 to 2040



Source: ENTSOG, TYNDP 2020, National Trends Scenario,

This graphic summarizes the development of the installed capacity for different energy sources over time. Renewable energy will be replacing fossil fuel-based energy sources. Installed capacity of gas-fired power plants will remain relatively constant (around 40 GW), while the share of nuclear energy will increase.

Figure 27 – Total gas demand in the European Union in ENTSOs scenarios

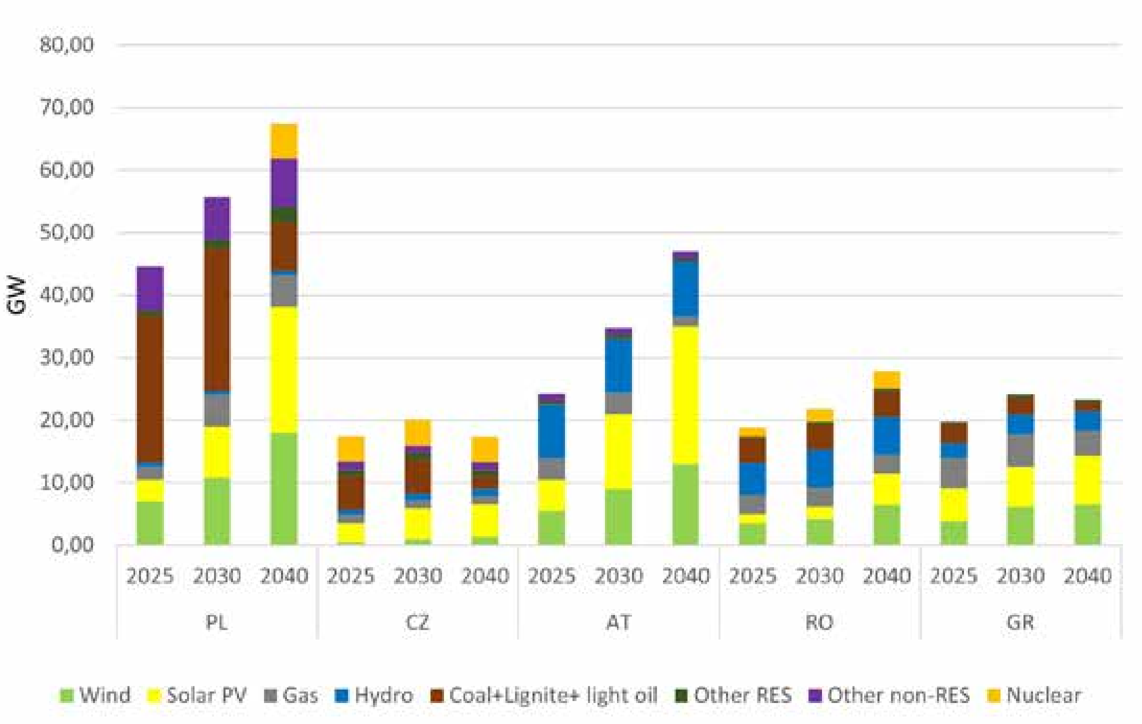


Source: ENTSOG, TYNDP 2020, National Trends Scenario,

On the graph above gas demand is presented as two values - "final demand" (blue) and "power demand" (orange). The "final demand" volume covers gas demand in transport, industry, domestic and commercial use of gas. The "Power demand" takes into account the demand for gas for power and CHP plants.
Considering the above data, natural gas will play a significant role in decarbonising the EU economy, ensuring a stable source of electricity production, especially in case of low production from renewable sources. Nonetheless, it should be noted that natural gas will slowly be replaced by zero-emission gases such as hydrogen or synthetic methane and agricultural biogas.

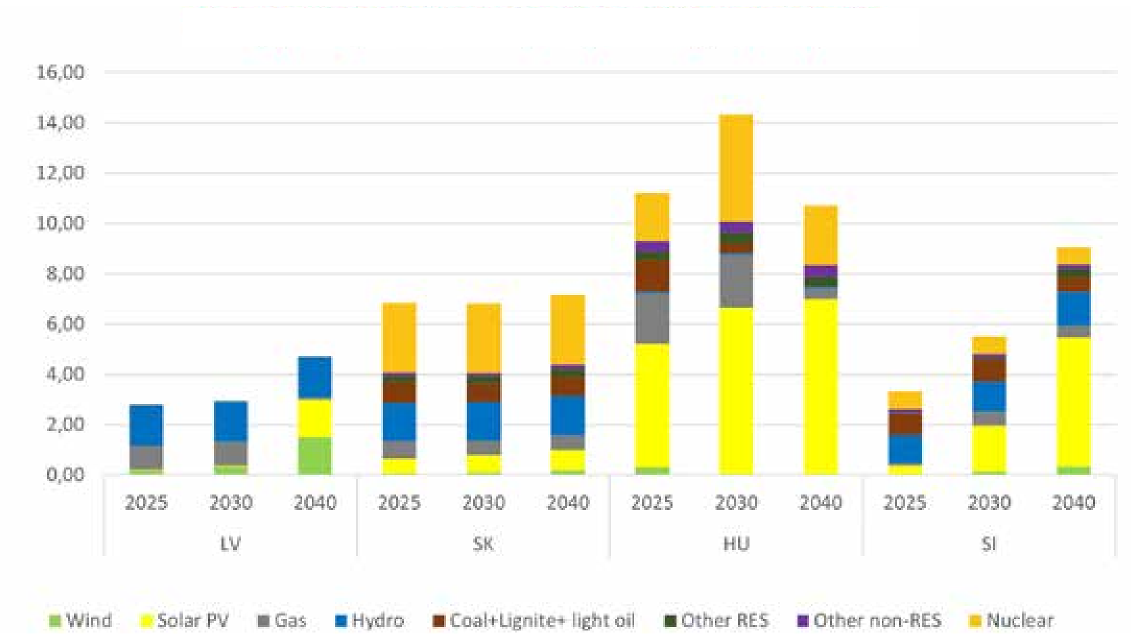
Based on data from ENTSOG, TYNDP 2020, National Trends Scenario, the forecasted energy mix of the Central-Eastern and South-Eastern Europe countries is presented below. Analysis is made for the following years: 2025, 2030 and 2040. What can be taken from the analysis is that natural gas as a transition fuel will play a significant role by 2040, in the energy mix of many countries in the region. In some countries (e.g. Slovenia or Poland) the increase of the natural gas share in the energy mix will be significant

Figure 28 - Installed generation capacity by energy source in Poland, Czech Republic, Romania, Austria and Greece



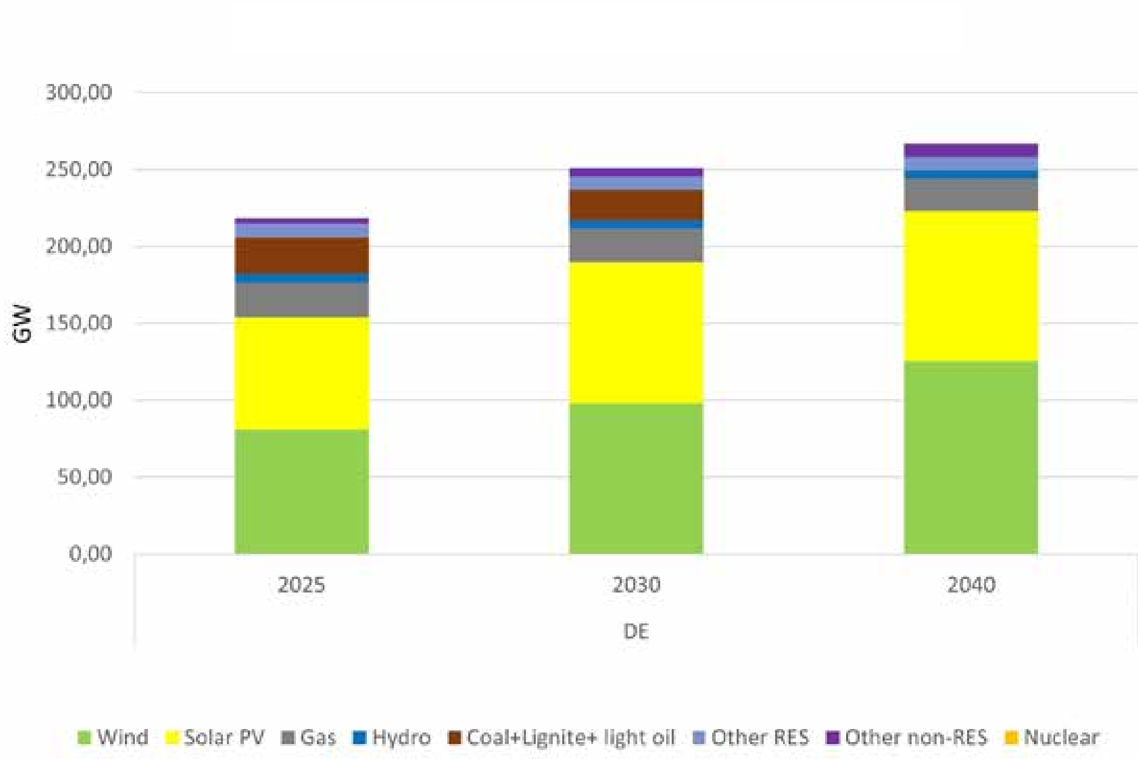
Source: ENTSOG, TYNDP 2020, National Trends Scenario

Figure 29 - Installed generation capacity by energy source in Latvia, Slovakia, Hungary and Slovenia



Source: ENTSOG, TYNDP 2020, National Trends Scenario,

Figure 30 - Installed generation capacity by energy source in Germany



Source: ENTSOG, TYNDP 2020, National Trends Scenario

4.1 New gases in the future scenario of national trends.

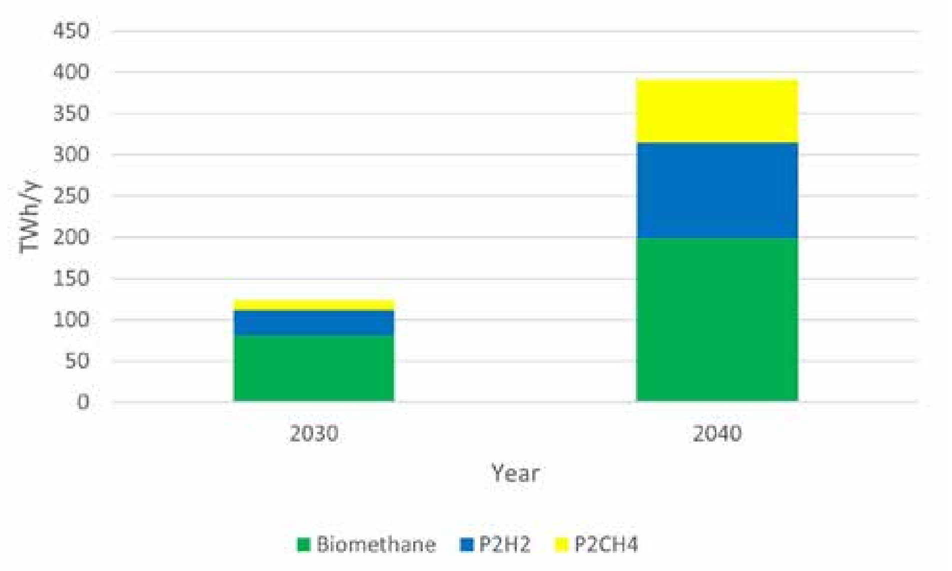
In order to demonstrate how the market for hydrogen, synthetic methane and biomethane can develop, it is worth to give special attention to the ENTSOG's "top down" scenarios: "Distributed Energy" and "Global Ambition". These scenarios present different approaches in achieving climate neutrality in line with the Paris Agreement. According to the definitions given by ENTSOG:

- Distributed Energy scenario is compliant with the 1.5°C target of the Paris Agreement. It embraces a de-centralized approach to the energy transition. A key feature of the scenario is the role of the energy consumer who actively participates in the energy market and helps to drive the system's decarbonization by investing in small-scale solutions and circular approaches.

- Global Ambition: scenario is compliant with the 1.5°C target of the Paris Agreement. It looks at a future that is led by economic development in centralized generation. Economies of scale lead to significant cost reductions in emerging technologies such as offshore wind and Power-to-X, but also imports of energy from cheaper sources are considered as a viable option.

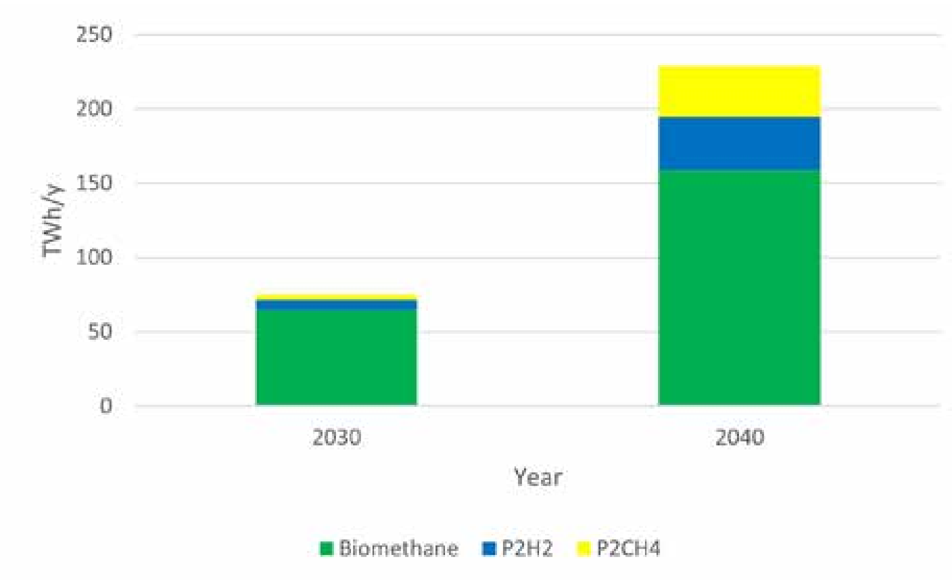
The two scenarios show how, depending on the direction of the energy market development, low and zero emission gas technologies will develop. These data may constitute a range of possible pathways of "new gases" production[16] in individual countries. The graphs below present the assumed production of hydrogen, synthetic methane and biomethane under the two scenarios.

Figure 31 – Production of renewable gases in ENTSOs' Distributed Energy scenario



Source: ENTSOG, TYNDP 2020, Distributed Energy Scenario

Figure 32 – Production of renewable gases in ENTSOs' Global Ambition scenario



Source: ENTSOG, TYNDP 2020, Global Ambition Scenario

For both scenarios, the growth of biomethane production in 2030 and 2040 was taken into consideration. The German scenario assumes greater production of hydrogen and synthetic methane than in the Global Ambition (GA) scenario. This results, inter alia, from the models of energy market development adopted for these scenarios. In the German scenario, the production of renewable gases in 2040 is 391 TWh, while for GA it is 229 TWh. Common hydrogen area gives a technical potential of green hydrogen production by means of electricity from RES in all analysed countries. Blue hydrogen may well play an important role in the energy carriers switch in the mid-term perspective and enable green hydrogen to become a long term solution. It is an important part of the value chain and market uptake of clean hydrogen in order to make it technologically mature and competitive with fossil-based and low-carbon hydrogen. The technical potential will be crucial here and will depend very much on the financing possibilities. Hydrogen can cover short-term and seasonal needs for flexibility in the energy system of individual countries. Flexibility of the power system can be one of the main drivers and an important pillar of support for funding programmes.

The existing methane infrastructure is a step on the way to introducing hydrogen (as admixtures or in special networks). The hydrogen programmes and the development of CCS and CCU technologies will be crucial. Significant opportunities exist to meet demand in complex industrial processes and heavy transport. The widespread use of hydrogen powered vehicles will be of particular importance.

Hydrogen is an important component in the integration of the electricity and gas sectors, especially with regard to storage capacity. EU hydrogen strategy predicts hydrogen share of 12-14 % of the energy mix by 2050, and this perfectly reflects the mission of the hydrogen in long term, which is to decarbonise industry and heavy-duty vehicles.

[16] New gases stands for the definition of biomethane, hydrogen, biogas, synthetic gas etc.

Building of a competitive hydrogen market that contributes in a cost and time-efficient manner to the objectives of decarbonisation, requires well developed transmission infrastructure to distribute efficiently hydrogen from production sites to consumption areas across the European Union. This may be achieved based on repurposing of existing gas grids and building dedicated hydrogen transmission infrastructure creating EU-wide hydrogen backbone.

Estimated upper bounds for annual emission reductions in Europe give a great potential for CCS/CCU technologies to replace solid fossil fuels. Growing energy demand in the Central-Eastern and South-Eastern Europe region creates a number of opportunities for energy demand in different sectors to be covered by natural gas. On top of that, natural gas storage and distribution system can be used as well for CO_2 transportation and storage. Production from natural gas using CCS could be integrated into industrial clusters. Then, thanks to the CCS and CCU potential, CO_2 could be transported to the storage location. A future study should investigate the sensitivity of the estimated costs compared to the expected consumption costs for natural gas, biomass and electricity.

There is potential for production of large volumes of hydrogen based upon renewable sources in the long-term but hydrogen from natural gas with CCS is an interesting option for industrial clusters. Currently, gasification of unconventional biomass is still on a pilot project scale. Further, due to increasing renewable power generation, hydrogen production from renewable power sources through electrolysis is as well an option (having in mind limitations connected to the available production capacity). Hence, until the cost of these technologies is reduced, clean hydrogen can be produced from natural gas with CCS in sufficient quantities to supply a European hydrogen market and gradually replace existing energy intensive carriers.

An analysis of the NECPs allows to draw fairly general conclusions about the future use of "green gases" in the countries of the Central-Eastern and South-Eastern Europe region: in the long-term, most of the countries recognize a significant role of hydrogen in their energy mix. However, for some countries, biomethane is more likely to be the green gas of the future. What is interesting is the perception that the countries of the region have of hydrogen: as mentioned in various parts in the NECPs, hydrogen is a kind of synonym for progress, having multiple meanings - as a fuel, a direction of development and transformation, and a mean for decarbonization or energy storage.

The simplest conclusions that can be drawn from NECP's are the following:

Almost all NECPs clearly refer to hydrogen but effective coverage varies considerably – interest and awareness of countries needs to be increased.

When the NECPs were established, the lack of a EU's uniform vision on "new gases" was significant. This situation began to change with the publication of "A hydrogen strategy for a climate-neutral Europe" in July 2019. In the near future, it is also expected that the countries´ internal plans for "new gases" will be more detailed and adjusted to EU regulations and frameworks. The vast majority of NECPs provide for a variety of technical approaches to hydrogen production, CO_2 capture - which may also result from the subsequent emergence of frameworks and expectations from the EU, but also indicate a pragmatic willingness to exploit the existing potential of Member States.

In general, countries in the region consider hydrogen to be a medium to long-term option. NECPs focus is on preparatory activities.

The hydrogen discussion so far has revolved around projects for the production and supply of hydrogen from renewable energy sources, the development of a European hydrogen infrastructure with a network of filling stations, and the decarbonization of the supply and transport of heavy goods by means of hydrogen-powered trucks and transporters. As already mentioned, hydrogen is now a kind of synonym for the future of the energy model and the search for solutions to support energy neutrality.

The main benefits of the "green gases" listed in the NECPs are the facilitation of growth and stabilization of electricity from RES - reduction of greenhouse gas emissions by replacing fossil fuels

"Green gases" are currently an important part of the plans to support RES, GHG reduction and energy storage. They can be a major step in strengthening the move away from fossil fuels, and especially the phase-out of coal.

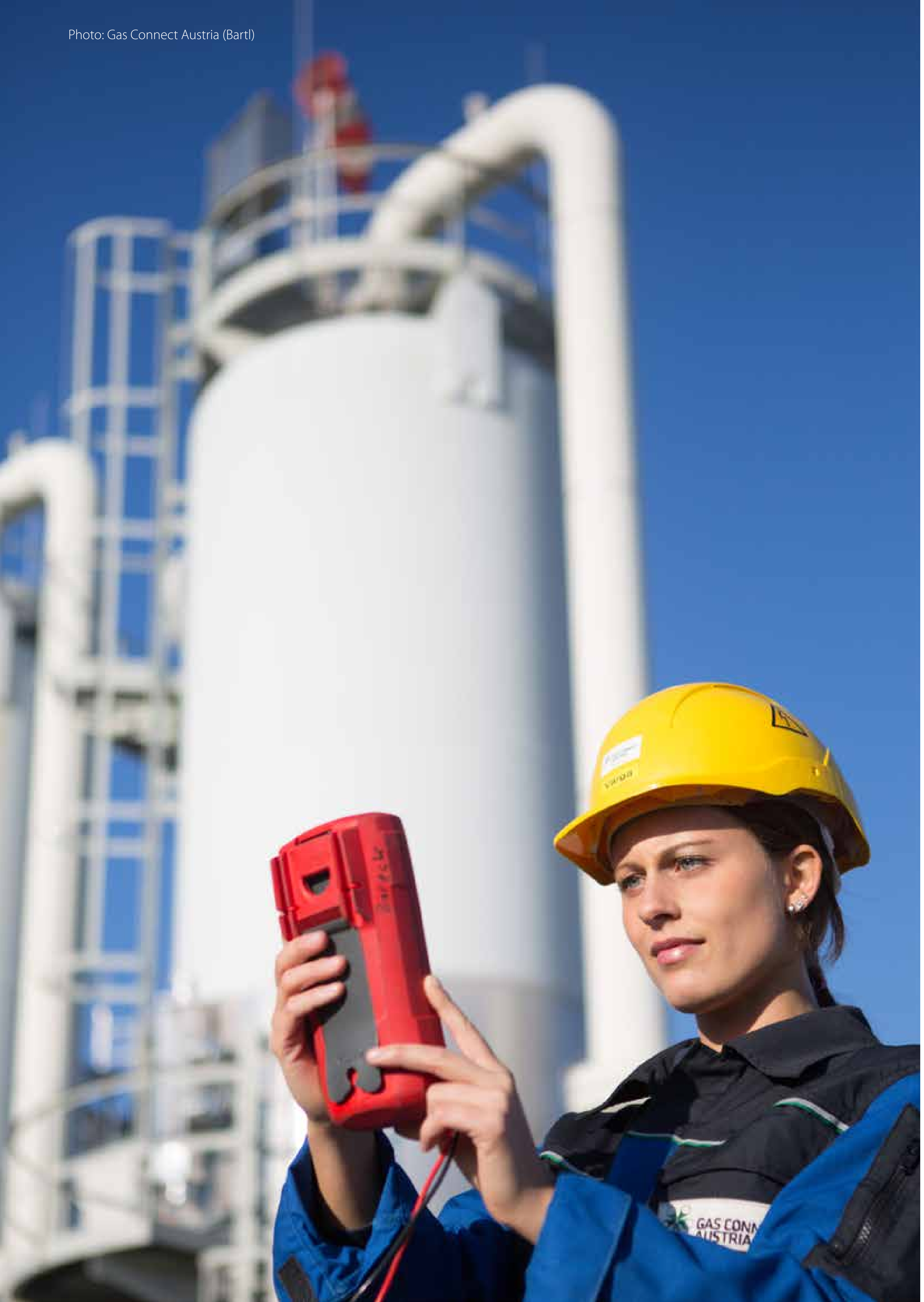


Photo: Gas Connect Austria (Bartl)

V. The role of the gas infrastructure in Central-Eastern and South-Eastern Europe

The gas infrastructure has been historically built and optimised in Central and South-Eastern Europe along the east-west axis to supply domestic markets with gas originating from the Eastern direction. In addition, the major transit corridors, such as the Yamal and Brotherhood pipelines, were designed to deliver substantial volumes of methane towards downstream markets in Western Europe. As a result, the concerned markets were entirely or largely dependent on imports from Russia while the possibility of supplies from alternative sources and directions was very limited.

The threats resulting from limited infrastructure development have become clear during the gas supply crises which occurred in recent years (i.e. 2006, 2009, 2010, 2012, 2014/2015). The supply crises gave an impetus to take remedial actions in the field of both regulatory set-up and infrastructure development.

Over the last 10 years, gas infrastructure operators have successfully implemented a number of investments to enhance security of supply and foster market integration. These investments concern already-commissioned projects that:

- Enabled imports of LNG by means of expanded Revithoussa LNG terminal in Greece, as well as newly built Klaipeda LNG terminal in Lithuania and Świnoujście LNG terminal in Poland Poland and Krk LNG terminal in Croatia;
- Improved cross-border interconnections between a number of the CEE and SEE countries, and stronger integration of the two regions with adjacent markets, among others, Western Europe;
- Upgraded UGS facilities across the CEE and SEE regions;
- Reinforced domestic networks and new customers connected to the grids;
- Diversified pipeline routes – new pipelines transporting gas from Norway and the Southern gas corridor from the Black Sea and Caucasus region emerged.

In parallel to project developments in Central and South-Eastern Europe, the rules governing the functioning of gas grids have been changing. Increasingly, the capacities are booked under network codes that harmonise and make more transparent capacity allocation, congestion management, balancing, tariff setting and interoperability. With the implementation of the EU rules and the adaptation of national solutions, the access to infrastructures in the CEE and SEE regions became simpler, more transparent, and competitive. It is especially visible in the western markets where developed infrastructure had an impact on the gas price convergence.

Enhanced optionality created by the commissioning of gas infrastructure projects together with market-oriented regulatory frameworks, new services, products and tools offered by network operators increased competition between market players and improved accessibility to gas infrastructure in the CEE and SEE regions. This is visible considering, for instance, new flow patterns in the region with more and more gas flows coming from the west to the east and along the north-south axis, as well as a growing tendency to book capacity in the short-term perspective.

Despite the progress made, the NECPs indicate the need for further infrastructure developments. Natural gas projects considered in the NECPs are mostly aimed at guaranteeing physical diversification of supply by creating or enhancing the access to LNG and gas fields located in Norway, the Black Sea and the southern gas corridor region. Furthermore, the NECPs call for investments to foster integration between national gas infrastructure, to debottleneck domestic grids, to connect new customers that are increasingly interested in replacing solid fossil fuels with natural gas , to produce electricity, heat, and as a feedstock in various industries. At the same time, the roll-out of variable renewables strengthens the need for adequate transmission and storage capacities that are required to ensure security of supplies and meet customer demand for electricity and heat. Finally, the NECPs anticipate LNG projects to meet stricter environmental regulations and satisfy demand for LNG in various industries and off-grid locations.

An overview of natural gas projects foreseen in the NECPs is illustrated on the table below.

	Diversification & cross-border projects	Domestic projects
Austria	AT-SI interconnection	
Czechia	CZ-PL and CZ-AT interconnections, Capacity4Gas project	Upgrade of domestic infrastructure (Moravia region) Connection of new gas customers to the transmission and distribution systems (power and heating plants, industry facilities)
Greece	TAP project Alexandroupolis LNG terminal East Med pipeline GR-BG and GR-MK interconnections	Extension of the gas grid and connection of new customers (e.g. power plants, industry), in particular in regions that are currently supplied with lignite UGS South Kavala Small scale LNG projects (e.g. ship bunkering, gasification of off-grid areas)
Hungary	CR-HU interconnection, reverse flow at RO-HU interconnection Turk Stream – HU section	
Latvia	Enhancement of Inčukalns UGS Enhancement of LV-LT interconnection	
Germany		Enforcement of gas grids (new pipelines and compressor stations)
Poland	Baltic Pipe, extension of Świnoujście LNG terminal, FSRU Gdańsk GIPL project, PL-SK interconnection and possibly PL-CZ interconnection (incremental project) and PL-UA interconnection	Extension of transmission system across the country to satisfy domestic and cross-border needs; Connection of new customers to the transmission and distribution grids (power & heating plants, industry); Gasification of areas not connected to the distribution grids; Construction of Damasławek UGS, expansion of UGS facilities (Kosakowo, Wierzchowice, Mogilno) Small scale LNG projects (bunkering)
Romania		Upgrade of domestic transmission infrastructure Enhancement of Sarmasel UGS
Slovakia	PL-SK interconnection Eastring pipeline	Veľké Kapušany UGS
Slovenia	SI-HU interconnection Upgrade of AT-SI and SI-CRO interconnectors	Connection of new customers to the grids (power & heating plants) Regional connections to the regions which are not gasified at the moment

Source: National Energy and Climate Plans

An overview of projects and initiatives aimed at developing renewable, decarbonised and low carbon gases, as foreseen in the NECPs, is illustrated in the table below.

Austria	Adaptation of grids to accommodate growing volumes of renewable gases Identification of locations for the construction of biogas plants with suitable framework conditions (suitable livestock or raw material supply, short distances, possibility of feeding into the gas grid)
Czechia	Connection of biomethane production plants to the grids Injection of growing volumes of biomethane (7% target by 2030) Pilot projects in the area of P2G
Greece	Assessment of H2 readiness for the existing gas assets Refurbishment of gas transmission infrastructure for the purpose of hydrogen
Hungary	Adaptation of networks and UGS facilities to enable injection of hydrogen Optimisation of existing infrastructure, decommissioning of distribution pipelines with a low utilisation rate (below 10%) P2G projects (PEM electrolysis)
Latvia	Study on decarbonisation of the gas network (incl. possibilities to adapt the natural gas transmission system to the input of RES hydrogen) Biomethane production and market development
Germany	Conversion of natural gas pipelines into hydrogen pipelines and construction of dedicated hydrogen infrastructure (hydrogen backbone)
Poland	Assessment of H2 readiness for the existing gas assets Where needed, refurbishment of gas transmission infrastructure for the purpose of hydrogen Hydrogen storage at Damasławek UGS Connection of hydrogen, biomethane and synthetic methane production plants to the gas transmission and distribution systems Pilot projects in the area of P2G and CCS
Romania	
Slovakia	Storage of hydrogen admixtures at Veľké Kapušany UGS Connection of biomethane production plants to the grids
Slovenia	Assessment of H2 readiness for the existing gas assets Adaptation of grids to accommodate growing volumes of renewable gases (10% target by 2030) Connection of hydrogen, biomethane and synthetic methane production plants Construction of pilot power-to-gas plant

Source: National Energy and Climate Plans

In July 2020, a group of eleven Transmission System Operators (TSOs), that are all also members of GIE, published the European Hydrogen Backbone. The initiative presents a vision to connect supply and demand of hydrogen by a pan-European network, consisting of 75% converted natural gas pipelines and 25% new pipelines. It shows a concrete pathway of gradually developing a dedicated hydrogen backbone with a length of almost 23.000 km by 2040. Furthermore, it gives a clear cost analysis which proves that the development of a hydrogen backbone is possible at socially acceptable costs. The Hydrogen Backbone Initiative is open to stakeholders who want to contribute to the extension of a pan-European Hydrogen Backbone, both geographically and along all stages of the hydrogen supply chain.

Storage facility, Hungarian Gas Storage

The NECPs drafted by the member states in Central and South-Eastern Europe focus not only on natural gas initiatives but they also recognise opportunities offered by green gases in the decarbonisation process. To this end, several NECPs expect the network operators to analyse and determine the maximum permissible hydrogen content in gas systems. In appropriate cases, refurbishment of existing infrastructure and construction of dedicated assets is foreseen to gradually replace fossil methane with alternative gases and hence strengthen the climate and environmental effects achieved with a wider use of natural gas in short-term perspective.

To foster the gradual development of the hydrogen network, a step-by-step process is often foreseen. The NECPs envisage pilot projects to confirm technical viability and to commercialise technologies related to hydrogen production and utilisation. Emerging hydrogen networks connecting production and consumption points, are also foreseen in several NECPs (starting from local grids through regional systems up to a national-wide hydrogen backbone).

Decarbonisation of gas infrastructure with the use of biomethane and synthetic methane is also on the agenda of the NECPs. The plans foresee connections of new biomethane production plants and facilities generating synthetic methane from hydrogen produced by electrolysis as well as coking coal and carbon dioxide from sources such as water treatment, anaerobic digestion and industrial processes.

The NECPs draw attention to the integration of various energy sectors, in particular the coupling of the electricity, gas and district heating and cooling sectors, which will be crucial for the successful achievement of energy and climate objectives. To this end, the NECPs consider the development of appropriate technical capacities for the conversion of renewable electricity into renewable gases (i.e. hydrogen or synthetic methane) and heat (power-to-gas and power-to-heat).

The NECPs also draw attention to technical and safety aspects. Hydrogen, synthetic methane and biomethane have different effects on transmission, storage, and LNG infrastructure due to their different composition and chemical and physical properties. Therefore, the NECPs call for R&D actions to ensure safe injection and transport of renewable and decarbonized gases.

In some NECPs, the national authorities call for NRAs to provide support and regulatory environment for the integration of renewable and decarbonised gases into the natural gas network.

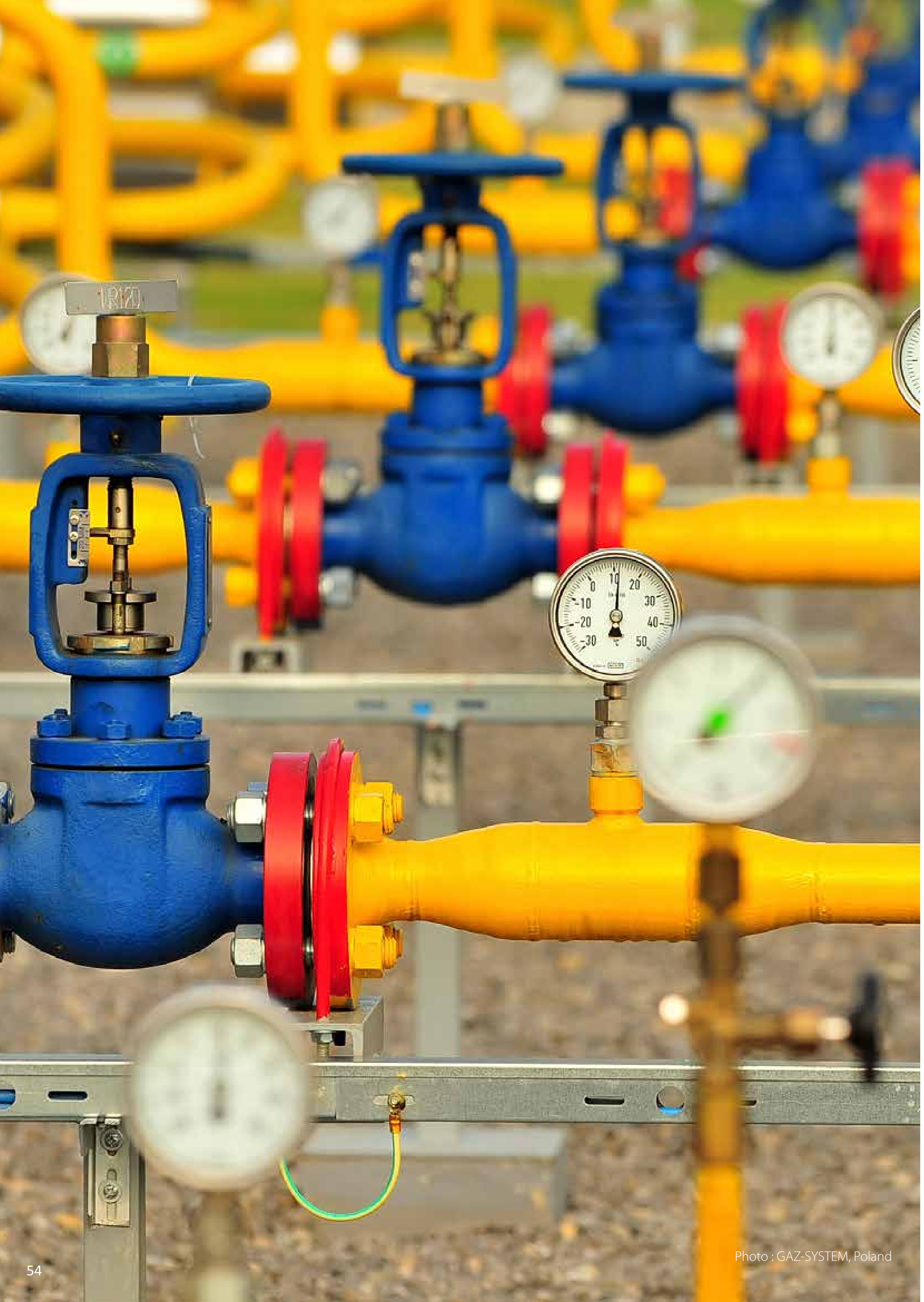


Photo : GAZ-SYSTEM, Poland

VI. Contribution of gases in the Central-Eastern and South-Eastern Europe regions to meet EU's long-term decarbonisation objectives

Economies in Central and South-Eastern Europe have recorded a high and stable pace of economic development in recent years. Maintaining this trend in the future will require ensuring energy supplies at competitive prices. In this context, the implementation of diversification and market integration investments is considered crucial, as they will ensure appropriate conditions for the further development of enterprises in the region, with a particular emphasis on the energy intensive industries, the electricity and heating sectors, and other industries.

6.1. Austria

Austria occupies an important position in Europe as a gas transit country. The Baumgarten gas transfer facility in Lower Austria is one of the most important gas hubs in Europe. Standing at 38 bcm in 2020, the volume of natural gas transported through Austria is significantly higher than domestic consumption (8.4 bcm in 2020). Three companies (OMV Austria Exploration & Production GmbH, RAG Austria AG and RAG Exploration & Production GmbH) extract natural gas in Austria. Since the beginning of the decade, natural gas storage capacity in Austria has risen from 4 bcm to the current capacity of 8.3 bcm provided by the five natural gas storage companies operating in Austria. Imports based on long-term contracts, which Austrian importers have concluded with suppliers in Norway and Russia, form a cornerstone of the supply of gas. In 2020, a total of 6.1 bcm of natural gas was imported into Austria. (Energie-Control Austria) Due to the ongoing liberalisation of the natural gas market, spot purchases of natural gas have gained significance comparing to the natural gas exchange.

In the long term, natural gas will be replaced by renewable gases in the gas network. The competitiveness of gas from renewable sources is to be supported by tax incentives, which were implemented by the Tax Reform Act of 2020[17]. "Greening the gas" through biomethane from biogenic residues and waste, through hydrogen and synthetic methane from renewable electricity sources on the basis of a significantly improved system of guarantees of origin are key components for the sustainable further development of the energy system.

The Austrian NECP foresees an increasing role for renewable gases and their contribution to energy storage and processing - Power-to-Gas, Power-to-Heat, Wind-to-Hydrogen, Power-to-Liquids. For this reason, the Renewable Expansion Act is intended to promote the feed-in of renewable gas into the natural gas distribution system, for example by means of a quota system - potentially also in stages.

The transition to new gases will require not only legislative but also investment changes. Austria is planning not only specific programs related to green gases, but also real and quite substantial investments[18].

[17] Tax Reform Act 2020:

- Tax relief for biogas and hydrogen
- More favourable taxation due to the allocation of hydrogen and biogas to the Natural Gas Levy Act
- Tax exemption for sustainable biogas
- Tax exemption for sustainable hydrogen
- Tax concession for liquefied natural gas
- Exemption from the auto diesel levy
- Tax exemption of self-produced and consumed electricity if it was generated by a photovoltaic system.

[18] Investments until 2030

- Energy system (electricity, gas, district heating) total between 31,547 million and 38,547 million euro;
- Biogas (production, processing, feed-in/connection to networks) 1,800 million euro;

6.2 Czech Republic

The Czech Republic is an important transit country for natural gas so there is big diversification of sources and supply routes, which significantly contributes to high security of supply for the Czech consumers.

Currently, the consumption of natural gas in the Czech Republic is around 8.1 bcm/y. The biggest consumers of natural gas are the industry and households (cooking and heating).

In the heating sector, natural gas is the second most used fuel after coal with a share around 28 %. The role of natural gas in electricity production is rather small with share of less than 5 %. In transport sector the role of natural gas (CNG vehicles) is small at the moment but according to projections and the state strategy for alternative fuels, it should grow in the upcoming years, incl. LNG (natural gas consumption in transport in 2018: 73 mcm, i.e. about 1% of total Czech gas consumption).

The share of natural gas in total primary energy supply is expected to slightly decrease after 2020 until 2035, but between 2035 and 2040 there is an expected increase owing mainly to coal to gas switch in heat and power generation. The share of natural gas in primary energy sources in 2040 is predicted to be slightly bigger than in 2020.

There is not much detailed and quantified information on hydrogen in the Czech NECP because the plan was written with a perspective until 2030, when no significant development of hydrogen is expected. The only sector where the role of hydrogen is developed in more detail is transport. Since hydrogen (both green and blue) can contribute to climate and energy goals, it is expected to be used more, but after 2030, when further research will be needed. However, the Plan explicitly mentions financial support to biogas stations being converted into biomethane production facilities, building of new biomethane production facilities as well as facilities to produce synthetic gases and hydrogen. Also, the existing gas infrastructure should be kept and prepared for future utilization for both natural gas and new types of gases.

The Czech Republic aims to allocate as much as possible of “advanced” biomethane[19] (produced from non-food biomass and waste). The NECP sets a biomethane target of 819 mcm in 2030, corresponding to ca. 7% share of gas consumption. It is expected to be produced mainly from biogas power plants refurbished to generate biomethane, from and new biomethane production facilities. Production of biomethane is important for reaching the national renewable energy target in the transport sector corresponding to 14% by 2030. Therefore, biogas purification technology and the construction of CNG and LNG filling stations are eligible for investment aid from national programmes backed by EU funds.

The main goal with green gases is currently to test new technologies and explore all options available. The focus is on P2G facilities with metering of hydrogen and its injection into the gas system.

One of the key targets within the field of Czech gas industry is financial and institutional aid/ support for the transformation of current biogas sites into biomethane production sites and the construction of new biomethane sites.

6.3. Germany

The role of gas as a fuel that ensures system stability will grow over time and will be enhanced by the departure from coal and nuclear energy. The importance of natural gas in the German energy mix should be considered significant. Currently, production of electricity accounts for around 12% of the total gas consumption. In the heating sector, almost 50% of the buildings use gas as energy source. The use of gas in the industry sector has increased from 33% of the gas consumption in 2009 to 38% in 2019.

As part of the Gas NDP 2020, the processes established for the development of the natural gas infrastructure were also used for hydrogen for the first time. This, together with the use of existing natural gas pipelines, makes it possible to rapidly advance the development of hydrogen infrastructure. Investments of around €290 million are expected to be needed by the end of 2025 to build the H2 starter network, and a total of some €660 million by the end of 2030, resulting in a moderate increase in transmission system tariffs of less than 1% in 2031. The German Gas TSOs have presented their vision of a dedicated hydrogen network, largely based on their well-developed existing infrastructure. The German Hydrogen strategy, published in June 2020, sees hydrogen as a multi-purpose energy carrier that can be used in fuel cells to power hydrogen-based mobility, in industrial processes as feedstock for synthetic fuels, but also as a medium to store renewable energies. “Hydrogen is an essential element of sector coupling. In those areas where electricity cannot be used directly from renewable energies, green hydrogen and its downstream products (Power-to-X) open new paths to decarbonization.” The strategy adds that hydrogen can also be used as a raw material for industry production processes without current alternatives for deep emission cuts, citing steel and cement making as examples.

The Federal Government foresees a hydrogen demand of about 90 to 110 TWh until 2030. In order to cover part of this demand, generation plants with a total capacity of up to 5 GW, including the necessary offshore and onshore energy generation, are to be built in Germany by 2030. This corresponds to a green hydrogen production of up to 14 TWh and a required renewable electricity quantity of up to 20 TWh. It must be ensured that the demand for electricity induced by the electrolysis plants does not result in an increase in CO_2 emissions. For the period up to 2035, a further 5 GW will be added if possible, by 2040 at the latest.

[19] Share of biomethane in total gas production in 2030 is estimated at 45 % (NECP – expected annual conventional natural gas production in 2030 is 2,45 TWh) It is expected that biomethane will be produced from biogas. i.e. the share of biomethane is calculated from total production of natural gas + biogas. Ca. 10% of gas consumption in CZ (819 million m3)

6.4. Greece

Until now, the largest proportion of natural gas was used mainly for electricity generation (65% in 2019). After the end of the recession, the role of natural gas in the energy mix has been increasing. It should be noted that until 2019, for example, the share in electricity production exceeds the share of lignite (~30% vs. ~20% respectively), reversing the picture of electricity production, which has been dominant until now.

Moreover, Greece's consumption of natural gas in the industrial sector is increasing, and also the consumption of natural gas in the residential & commercial sector has already exceeded the peak levels observed in the years preceding the crisis. Therefore, and given the network expansion plans in further regions of Greece, the market is expected to develop dynamically in all sectors in the future.

The scenarios for new energy carriers suggest that appropriate policies at the European level will ensure the gradual development of hydrogen, biogas and synthetic methane technologies and production methods with climate-neutral specifications, and will help achieving a drastic reduction of the carbon footprint of the gas distributed. These scenarios envisage that by 2050, new gases will play a major role and that natural gas can only be used in combination with CCS technologies.

Natural gas is expected to be an intermediate fuel in the transition to low-carbon GHG emissions and at the same time can lead to both improved energy efficiency and lower energy efficiency costs compared to other conventional technologies.

However, if energy efficiency is considered (if it is achieved) along with the development of renewable energy sources, the result will be a marginal decrease in demand for gas in 2030.

Indeed, the fact that Greece will move to this energy transformation has led to the need to supply gas to new areas of the country, especially those that use district heating produced from coal-fired power plants.

These are new projects that have already emerged and are included in future DESFA investment plans (new M/R stations, extension of pipelines, etc.).
In addition to the projects already mentioned, the vast majority of DESFA's investment strategy relates to the development of projects necessary for the operation of the system (i.e. CS for the removal of bottlenecks in the system, as well as Booster CS for enabling the return flow of gas to the TAP pipeline).

Greece is looking forward to a future where green gases will be produced. In this area, investments will be needed to ensure that the pipelines are ready to transport such gases and that end users are ready for such consumption.

In recent years, DESFA has carried out many projects that have contributed to several positive externalities. The modernization of the Terminal in Revithoussa has increased the security of supply benefits attributed to LNG facilities both in the Greek market and in the neighbouring countries. In this context, the third LNG storage tank, together with the upgrading of the terminal's shipping speed combined with low LNG prices, has given a boost to cross-border flows and international trade.

The upcoming construction of a Boil-off gas compressor in Revithoussa is also a project that, in addition to the benefits for LNG facility users resulting from lower LNG losses, will contribute to the C02 reduction.

Based on the current situation, there are areas in Greece whose heating - for several days of the year - depends on local heating connected to a lignite plant. According to the plan to decommission lignite-fuelled power plants, natural gas will ensure the operation of heating systems in these areas.

6.5. Hungary

Natural gas with the overall trend declines within the last 10 years perspective. Households are the biggest consumer of natural gas especially for space heating.

Hungary does not foresee a significant role for renewable gases before 2040. These new gases will be mostly used for storing the surplus energy, which will be generated from the PVs. For this reason, a P2G project is planned in the Hungarian gas storage facility. It will use the surplus renewable energy to create hydrogen via PEM electrolysis, which can be used for numerous purposes. For example, it can be stored in the underground gas storage sites or could be sold to industrial consumers making the industry greener and sustainable.

6.6. Latvia

Natural gas along with oil products will continue taking up the biggest share in the overall primary consumption of energy resources in Latvia. The NECP placed special emphasis on energy efficiency and the use of renewable energy. Also, the plan indicates the promotion of the production of biogas and biomethane and the launch of a study on decarbonisation of the gas network – which will include possibilities to adapt the natural gas transmission system to the input of RES hydrogen.

According to Latvia's NECP, renewable energy is preferred in the perspective of 2030 and beyond, specifically the promotion of the production of biogas/ biomethane and construction of wind farms. Conexus sees the potential of biomethane and hydrogen (up to 2%) injection into the gas transmission system. Concerning the development of hydrogen production, it is also possible to consider the development of a separate hydrogen infrastructure.

In 2019, a project concerning the production of biogas and biomethane in Latvia was launched together with the Latvian Biogas Association and the University of Latvia. Preliminary data show that the cost of a single unit of biomethane in Latvia is lower than elsewhere in Europe. And therefore, Conexus sees potential in developing Power-to-Methane technology that can strengthen biomethane production and, by implementing new technology, see a resulting improvement in energy affordability. The development of the use of new gases will take place at the expense of natural gas, whose consumption will decrease.

6.7. Poland

According to the updated Polish Energy Policy to 2040 (PEP2040) document, Poland's energy policy until 2040 will be based on three pillars: a just transition, a zero-emission energy system and good air quality. In this country, a growing role for natural gas is being observed, which naturally supports the process of coal phase-out. Both the NECP and other national documents clearly indicate gas as a fuel for the energy transition.

According to the document in 2040, zero emission sources will constitute more than half of the installed generation capacity. The transformation also requires to increase the use of new technologies in heat generation and the use of alternative fuels in transport. These changes will lead to a profound improvement in air quality and a reduction of pollutant emissions.

In individual heating, coal will be phase out by 2030, and outside cities, by 2040. Furthermore, at the end of September 2020, the Polish government and trade union representatives have agreed to phase out coal mining by 2049. The share of coal-based units in the generation structure is expected to decrease from approximatively 80% in 2015 to around 69% in 2030 and 31% in 2040. In this context, natural gas will constitute a bridge fuel in the energy transition.

In Poland, the gradual phase-out of coal, the absence of nuclear power plant and the still small share of renewable energy sources in the energy mix might jeopardise the stability of the system In such a context, the development of the gas infrastructure will provide key solutions. In recent decades, it had already brought several benefits in terms of diversification of the energy supply and the investments underway will result in a significant increase in energy security.

According to the updated Polish Energy Policy to 2040 document (PEP2040), the gas infrastructure will transport 10% of renewable and low-carbon gases by 2030. Furthermore, by the end of 2020, specific precise plans related to the use of hydrogen should also be deployed.

6.8. Romania

The Romanian NECP, in the part referring to the cancellation of new coal units, refers to "the inclusion of natural gas as an interim fuel in the decarbonized energy industry".
The most important argument on the part of Romania is probably the economic one.

The Romanian energy system will need fossil fuels for several more years and there are currently no immediate solutions for its security. Romania must therefore start investments that have been postponed in the last two decades. Considering the costs of storage, energy efficiency and reduced interconnections or unused potential of renewable energy sources, natural gas plants will continue to operate in the near future despite high costs.

Romania plans to place natural gas at the center of the energy system and develop nearly 3 GW of new capacity by 2030.

Romania sees opportunities in the decarbonization context when it comes to hydrogen use. The development and tapping of the technical and economic potential of RES in the NES depends on the expansions of storage capacities and technologies for injection of hydrogen in the form of synthesis gas from RES and the use of hydrogen in industrial processes.

Photo: Gas Connect Austria (Fejer)

6.9. Slovakia

Slovakia boasts a well-developed gas infrastructure. For geographical reasons, it lies on the transit route from Russia to western Europe. As we have already mentioned, this has had a historical impact on the use of this fuel. Currently Slovakia produces only 2% of its annual demand. However, natural gas will be a bridging fuel in Slovakia to move away from coal. Looking back, we can also say that natural gas has had a significant impact on reducing CO_2 emissions (in terms of 1990).

The Slovak NECP foresees the following roles for "new gases" until 2030:

- Full use in central heating systems;
- Coal substitution in combined heat and power generation (CCGT);

Slovakia's NECP aims at a 19.2% share from RES in energy consumption by 2030, with expected investment costs of 4.3 bill. EUR. Biogas/biomethane portion at the electricity production will reach 15% by 2030, 10% in the heat generation sector and approx. 10% in the transportation sector. The share of hydrogen from renewable sources in the transportation sector in 2030 is projected at the level of 1%. There is an ongoing project for hydrogen storage blended with natural gas.

6.10. Slovenia

Natural gas is very well present in the industry. Penetration in households is moderate and below EU average, due partially to low population density. Also usage in power generation and in transportation is low. Usage of natural gas will increase in general, but at the same time, gas will become more and more decarbonized. More gas will be used for power generation. There is a substantial amount of power produced from nuclear. The decision about possible prolongation of this production will be taken at a later stage.

The NECP sets a goal for at least 10% of gas to be renewable by 2030, being hydrogen, biomethane, synthetic methane or biogas. The decarbonisation will speed-up after 2030. By that time Slovenia will need gradual upgrade of the existing infrastructure to enable transport of renewable gases, especially hydrogen. Pilot projects for production of renewable gases should be introduced. However, the favourable/suitable regulatory framework is needed for these projects to take-off, including, inter alia, the financial incentives for the new green technologies.

Photo: Gas Connect Austria

VII.Conclusions and further recommendations

Main conclusions

The analysis of the NECPs of the Member States of the Central-Eastern and South-Eastern Europe region clearly indicates several paths related to the current role of natural gas, its future use and the future role of renewable and low-carbon gases. The following conclusions and directions can be drawn:

1) In most cases, due to their transit character and historical circumstances, countries of the region have natural gas in their energy mixes. For decades, in the vast majority of cases, it has been complementary to the fuel dominating in the national economy such as coal or nuclear energy.

2) Natural gas is expected to be an intermediate fuel in the process of transition to the zero-carbon GHG emission economy, and at the same time, it can lead to both improved energy efficiency and lower energy efficiency costs compared to other conventional technologies.

3) The countries of the region see the need to use new gases, recognizing that their scale-up will vary depending on internal conditions and the different starting points regarding each country's energy mix. Giving the important role that renewable and low-carbon gases will play as energy carriers in a more integrated energy system, new legislation and regulations should be introduced at the European level to create the right conditions for an EU-wide market to be developed."

4) The European Commission, through legislative proposals, should provide for solutions addressing the concerns and challenges raised in this report. The European Commission and National Regulatory Authorities (NRAs), through legislative proposals, should provide for solutions addressing the concerns and challenges raised in this report".

5) The development of hydrogen economies in the individual member states as well as at EU-level underlines the necessity to invest into an EU-wide hydrogen infrastructure

Summary

In an attempt to answer the question "How gas infrastructure can contribute to meet EU's long-term decarbonisation objectives", this report puts forward a series of observations. In the Central-Eastern and South-Eastern Europe region, there is an untapped potential to achieve fast and significant emission reductions with the switch from carbon-intensive fuels, such as coal, lignite and heavy fuel oil, towards low emission natural gas. Natural gas can quickly substitute coal, lignite and oil in the power generation, heating and industrial sectors. Moreover, the gas infrastructure will help accommodate the increasing uptake of renewable energy sources, inter alia via sector coupling, and pave the way towards the use of renewable and low-carbon gases in the medium to long terms. Transitioning to natural gas will have a significant, immediate and sustainable effect on the reduction of emissions in the parts of the EU where dependency on coal, lignite and oil is high, without a significant increase in costs, thus contributing towards efforts focused on ensuring fair transition and acceptance by end users and civil society. In the short term, natural gas can also have an immediate and tangible positive effect on health problems faced by EU citizens: air pollution resulting from burning high-emission fuels (including NOx, SOx and particles) constitutes a serious health problem in many communities. A shift from waste burning, coal, lignite and oil to natural gas in the heating and electricity sector, and from diesel and petrol to LNG and CNG in the transport sector, will significantly reduce the level of air pollution in a timely and cost-efficient manner. This could also result in tens of thousands of lives being saved annually.

In the medium term, an increased use of natural gas in the energy mix can provide the flexibility needed to integrate an increasing share of variable renewable energy sources, such as wind and solar, into the electricity system, whilst guaranteeing secure and resilient access to electricity, storage, heat and mobility for EU consumers. Through power-to-gas and other new technologies, in addition to the optimisation of links between gas and electricity markets, the existing gas infrastructure, with its high flexibility and storage capacity, can support the integration of renewable electricity in Europe and reduce the need for large investments into electricity grids – on both transmission and distribution levels. The ability to store gas and produce electricity from gas in periods of high energy demand can also reduce price volatility and overall end user energy prices, thereby alleviating energy poverty. The gas sector supports the path towards a decarbonised future through innovation in decarbonisation technologies and will continue to do so. Biomethane, hydrogen and synthetic methane as well as carbon capture, storage and utilisation (CCS/CCU) technologies provide a portfolio of solutions which will play a significant role in achieving the 2050 objectives in an efficient way. Besides adapting existing generation methods to biomethane, gas infrastructure operators are already investing in various R&D and pilot projects with the intention of developing further renewable gases, energy conversion and – both on transmission and distribution levels into the grid and storage technologies.

The gas sector will continue to play a substantial role in reducing emissions and increasing economic development and welfare of CEE&SEE region in the short, medium and long term. On the way towards reducing emissions, we need to remember that GHG emissions are more than carbon release. In the short term, emissions can be reduced in energy intensive areas in the regions through a transition from coal, lignite and oil to gas with the added benefit of better air quality, whilst other areas can continue to develop biomethane, and other countries with more developed renewables kick-start a transition with hydrogen. In the medium and long term, natural gas and biomethane can facilitate a more efficient use of variable renewable electricity sources (wind, solar), while other renewable gases ramp up in the long term. Natural gas, renewable and decarbonised gases (hydrogen, biomethane and synthetic methane) will be key in the future hybrid energy mix to achieve the 2050 decarbonisation targets in a cost-efficient way.

Benefits of the "new gases"

The "new gases" are the only possible way to achieve full climate neutrality and decarbonization. With the growing share of RES, renewable gases will grow depending on the geographical perspective. Thus, the decarbonization of the industry can be achieved in a timely and efficient manner. Inclusion of new gases will also have quite significant economic impact. As emphasised in a recent report released by IRENA in September 2020[20], new gases will generate jobs and income, which could stimulate the economy and, at the same time, lead to decarbonization.

Renewable and low-carbon gases, especially hydrogen, will enable the decarbonisation of the gas infrastructures which, within the European Union, are connected to industries and deliver more than 40% of heating in the households. Biomethane will also play a major role but on a more limited scale depending on the feedstock availability. Electrification with heat pumps can replace natural gas to heat new buildings, whereas it requires costly or even impossible retrofits in old buildings, which account for 90% of buildings' CO2 emissions. Furthermore, direct electrification would also lead to major seasonal imbalances in power demand that would, in turn, require a power storage mechanism at large scale. Renewable and low-carbon do not suffer from these shortcomings and can act as complements to heat pumps.

Producers can distribute some hydrogen by blending it into the existing grid without the need for major upgrades, but it is possible to go much further than this. Ultimately, energy suppliers can convert grids to run on pure hydrogen. Alternatively, natural gas can be replaced with synthetic natural gas (SNG) produced from hydrogen and CO_2.

All gas-based heating systems can increase energy efficiency through the use of fuel cell-based combined heat and power (CHP) technology. In transport, in the long term, hydrogen is the most promising decarbonization option for trucks, buses, ships, trains, large cars, and commercial vehicles, where the lower energy density, high initial costs, and slow recharging performance of batteries are major disadvantages.

Legislative recommendations

The transformation of the energy sector requires a solid legislative and investment framework to develop and adjust the gas infrastructure services to the market needs. Therefore, the European Commission should consider the opportunities offered by the existing gas infrastructure and gas in all its forms – natural gas, low-carbon gases and renewable gases – to contribute to the EU's climate targets, especially in the context the "Climate Law" negotiations being currently underway. The legislative framework should underline that integration of the gas sector with the power, transport and heating sectors is a fundamental and inescapable step.

With this report, GIE members show their willingness to continue cooperation with the EU institutions on the role of gas infrastructure in the energy transition and economic recovery.

[20] IRENA (2020) Renewable Energy and Jobs – Annual Review 2020, report available at: https://www.irena.org/publications/2020/Sep/Renewable-Energy-and-Jobs-Annual-Review-2020

List of abbreviations

bio-CNG	Bio Compressed Natural Gas
bio-LNG	Biomethane Liquified Natural Gas
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilisation
CEE	Central-Eastern Europe
CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CO2	Carbon dioxide
CSE	Central-South Europe
EEA	European Energy Agency
ENTSO-E	European Network of Transmission System Operatos for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ENTSOs	European Networks of Transmission System Operators
ESR	Effort Sharing Regulation
ETS	Emissions Trading System
EU	European Union
EUR	Euro
GA	Global Ambition
GDP	Gross Domestic Production
GHG	Greenhouse Gas
GIE	Gas Infrastructure Europe
GW	Gigawatt
H2	Hydrogen
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
MW	Megawatt
NEC	National Emission Ceiling
NECP	National Energy and Climate Plan
NES	National Energy System
NOx	Nitrogen oxide
P2G	Power-to-Gas
PEM	Polymer Electrolyte Membrane
PEP2040	Polish Energy Policy 2040
PJ	Petajoule
PM	Fine Particulate Matter
R&D	Research & Development
RES	Renewable Energy Source
SEE	South-Eastern Europe
SNG	Synthetic Natural Gas
SOx	Sulphur oxide
TSO	Transmission System Operator
TWh	Terawatt hour
TYNDP	Ten-Year Network Development Plan
UGS	Underground Gas Storage
WAM	NECP scenario with additional measures
WEM	NECP scenario with existing measures

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Gas Infrastructure Europe (GIE) is an association representing the infrastructure industry in the gas business, including Transmission System Operators, Storage System Operators and LNG Terminal Operators.

With 69 companies coming from 27 European countries, GIE voices the views of its members vis-à-vis the European institutions, regulators and other key stakeholders. Its mission is to actively contribute to the construction of a single, sustainable and competitive gas market in Europe, underpinned by a stable and predictable regulatory framework as well as by a sound investment climate.

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