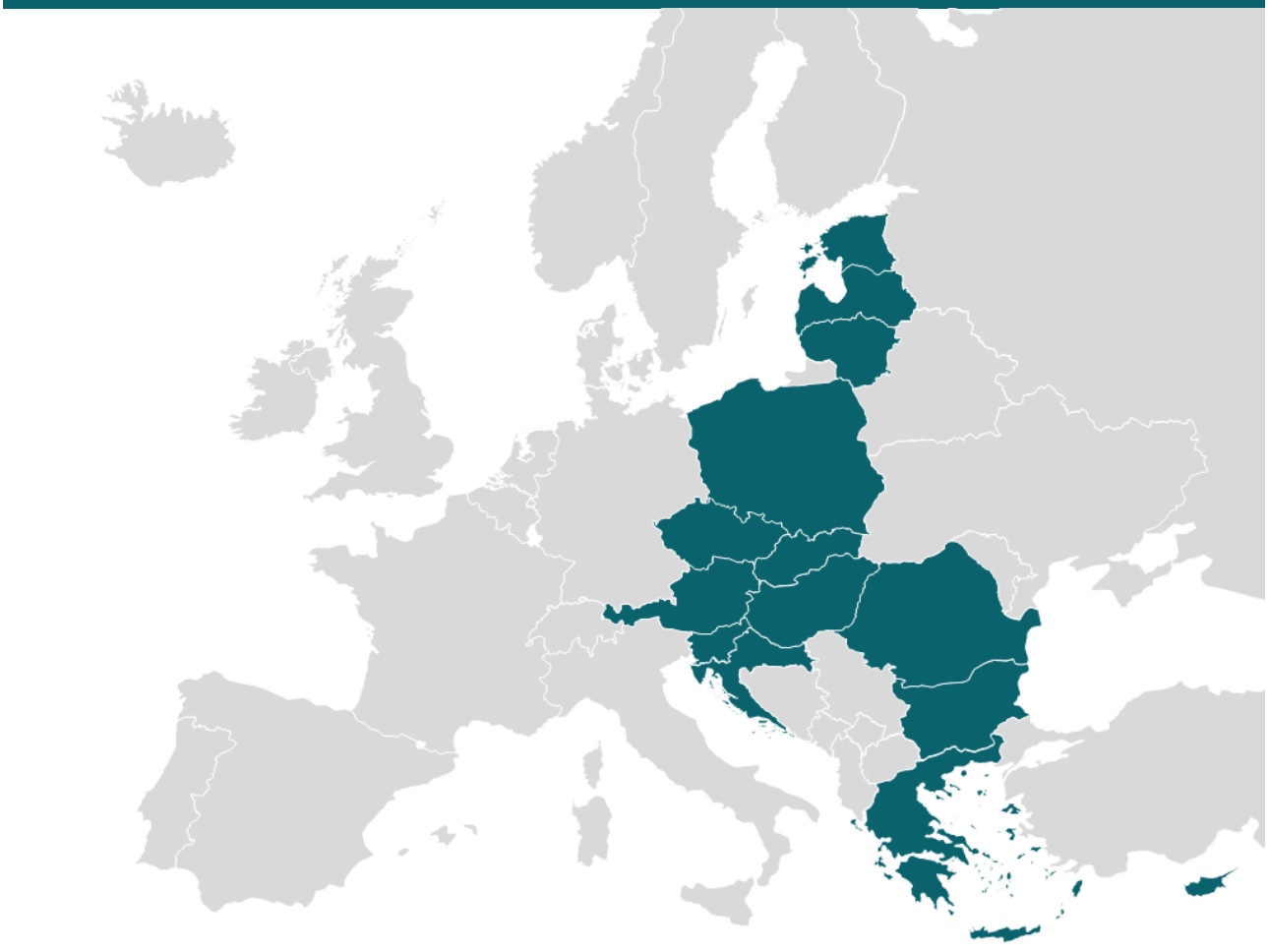
Gas Infrastructure Europe

Deloitte.

CENTRAL & SOUTH-EASTERN EUROPE

DECARBONISATION REPORT 2023

Special Focus: The Impact of Europe's Energy Crisis



Published November 2023

Content

List of Figures

Part I: Introduction

In November 2022, we published a comprehensive Decarbonisation report for Central & South-Eastern Europe. The main aim of the report was to provide you with relevant up-to-date information about the status of the energy markets and the energy transition in this particular region which is underrepresented in other publications. We got very positive feedback from many stakeholders on the report. As a result, we have decided to publish this report on a regular basis to give you up-to-date information about the progress of the decarbonisation efforts of EU member states in Central- and South-Eastern Europe.

The report is comprehensive covering all the 14 member states in the CEE / SEE region (Austria, Bulgaria, Croatia, Czech Republic, Cyprus, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia). Thus, in one report, you are getting:

- a comparative analysis of the national energy markets in the region
- the key energy market figures of each of the 14 member states
- the current emissions and emissions target figures of the member states
- the main decarbonisation challenges and strategies of the member states

The report is divided into two detailed chapters. In Part II, we present a high-level regional comparative analysis of the national energy markets in the CEE/SEE region. In Part III, we present the key energy market figures, the emissions figures, and the decarbonisation strategy for each EU member state in the region. This information is presented in separate country sheets in an easy-to-read format and in alphabetical order. As in last year's report we have also added a section with information regarding the role of natural gas, hydrogen and biomethane. In some of the country sheets, examples of decarbonisation projects using the gas infrastructure have also been listed. The project information is based on publicly available data in national and EU Ten-Year Network Development plans.

In addition to presenting the key figures, this year we have also prepared specific information about the impact of Europe's Energy Crisis in 2022. In Part II, this information is presented in specific boxes covering topics such as the crucial role of gas storages and LNG during the energy crisis as well as the increased focus on green gases as an alternative to Russian fossil fuels.

We hope you will find the information helpful. Enjoy reading!

Gas Infrastructure Europe & Deloitte

November 2023

Data collection methodology

All the figures in the report come from publicly available sources. In the analysis, where the data for individual metrics changed significantly since publishing by the source, we have chosen to add the most recent figures published and/or approved by the respective national government or regulatory authority in the analysis.

Data for the key statistics in the *Country analysis* part and comparison graphs in the *Regional analysis* part were drawn from *Eurostat*'s database. At the time of writing, the most recent data in this database covers the year 2021. The category of Solid fossil fuels reported in total consumption, heating, and power generation is a combination of the following fuels: anthracite, coking coal, other bituminous coal, sub/bituminous coal, lignite, brown coal briquettes and coal tar, manufactured gases (which are mostly coke oven and blast furnace gases – produced from solid fossil fuels), non-renewable waste, peat and peat products, where lignite accounts for more than half of the volume. The Oil products category comprises of refinery gases, liquefied petroleum gases, gas oil and diesel oil (excluding biofuel portion), fuel oil, petroleum coke, and other oil products. Finally, the Renewables category includes hydro, geothermal, wind, solar photovoltaic, primary solid biofuels, pure biodiesel, other liquid biofuels, biogases, and renewable municipal waste. In transport, Gaseous fuels include natural gas and liquified petroleum gases. The category Other listed in the consumption of gas by sector includes the sectors: transportation, agriculture and forestry, fishing and other with transportation and agriculture and forestry accounting for most of that category.

In the hydrogen and biomethane part of the *Country analysis*, the information was collected from National Climate and Energy Plans (NECPs), legislative documents of individual countries and other relevant policy documents related to hydrogen or biomethane, including national strategies. In part of the report which analyses the legislative environment, data was also collected from the database of the HyLaw project. For some countries, the drafts of updated NECPs have been published since last year and we use the updated information in this report. These include Austria, Croatia, Cyprus, Estonia, Hungary, Lithuania, Slovakia, and Slovenia. For the remaining countries, we expect the update of the NECPs after the publication of this report. The methodology for assigning individual colors – green, yellow, and red – was based on the evaluation of available information for each country and specific sectors. This methodology aimed to assess the level of engagement and development in various sectors. This color-coded approach provided a clear visual representation of each country's level of commitment and progress in various sectors, facilitating easier analysis and decision-making. Here's how the colors were assigned:

1. Red:
    - Assigned when no official information was available for a specific sector.
    - Given to countries that showed no interest or involvement in the said sector.
2. Yellow:
    - Assigned if there were details available about a planned strategy, legislation, or ongoing efforts related to the sector.
    - Included information from official sources beyond the National Energy and Climate Plan (NECP).
    - Considered the presence of associations or organizations actively promoting sector development.
3. Green:
    - Assigned when there was a specific advanced-level development plan in place.
    - This plan could be approved or is in the approval process.
    - Often accompanied by the active participation of an association dedicated to the respective sector's advancement.

Part II: Regional Analysis

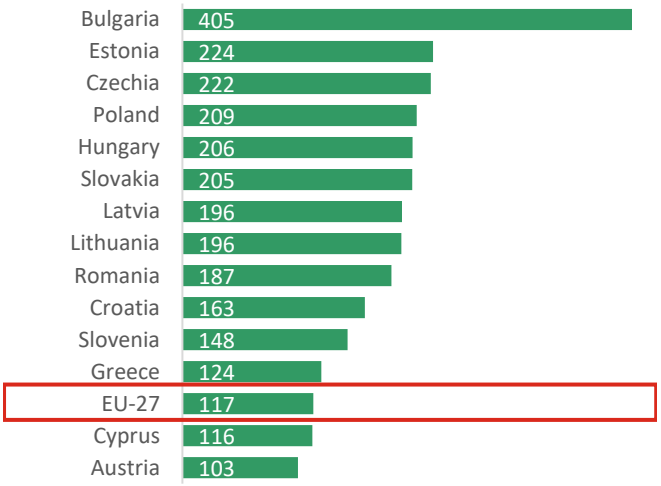
A. General overview

Energy plays a very important role in the economies of the CEE/SEE region

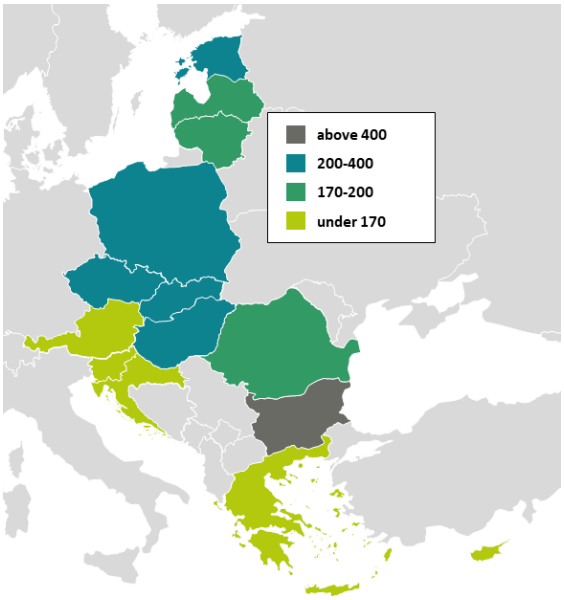
Energy plays a very important role for the economies of many of the EU member states in the CEE/SEE region compared to many less energy-intensive member states in Western Europe. The chart below illustrates that **all countries in the region, except for Austria and Cyprus have an energy intensity higher than the EU-27 average**. Energy intensity is one of the indicators to measure the energy needs of an economy. A high number indicates that the economy utilises a lot of energy to create its products and services.

Many factors influence the level of energy intensity. It reflects the structure of the economy and its cycle, general standards of living, and weather conditions in the reference area. Energy intensity is calculated as units of energy per unit of GDP. **Several countries in the region decreased their energy intensity year-on-year between 2020 and 2021, despite the uptake in economic activity post-Covid 19.** The most significant decrease was seen in Slovakia (7%) and Hungary (5%), while an increase took place in Croatia (4%).

Figure 1: Energy intensity of the GDP (KGOE/1000 Euro)



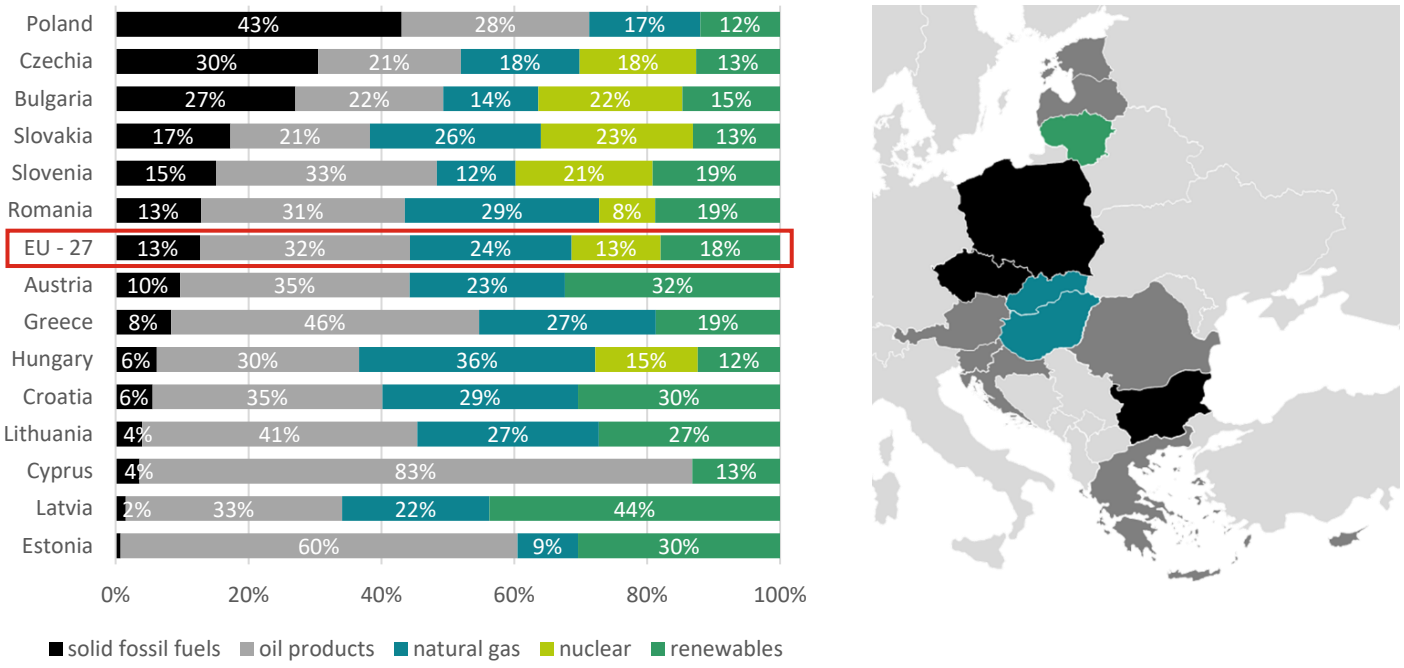
Source: Eurostat 2021



The significant role of coal and oil in the consumption mix

Many EU member states in the CEE/SEE region are burdened by a significant carbon footprint due to the **extensive use of coal and oil** in their total energy consumption. **All the countries currently using brown coal, except for Poland, declared in the last two years its phase out in the short to mid-term horizon**.

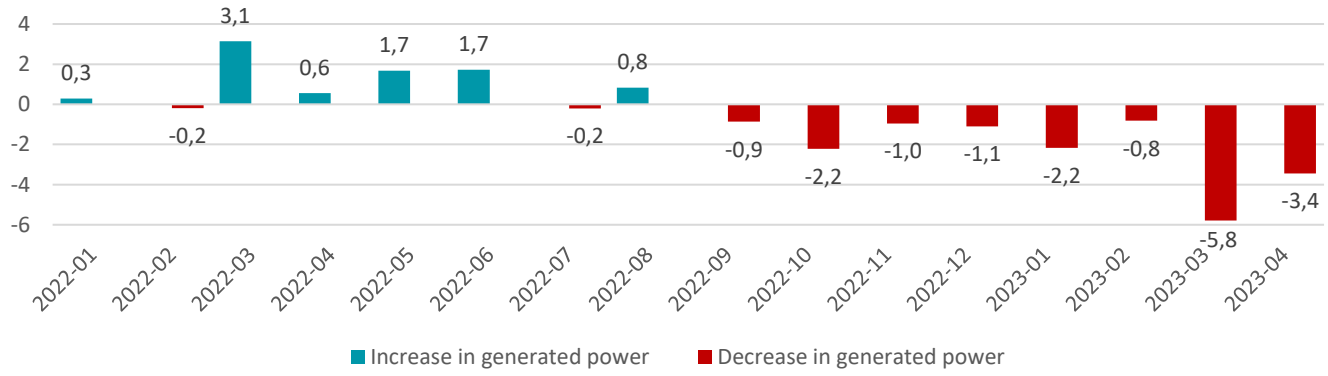
Figure 2: Total energy consumption by fuel (%)



Source: Eurostat 2021

Due to the 2022 energy crisis, the **utilization of solid fossil fuels, of which the majority is coal, in energy generation has experienced a significant uptake in the first months of the year**. A total of 11GW of coal capacity was brought back on emergency standby in 2022.[1] This surge occurred primarily due to elevated prices of natural gas and subsequently its partial substitution in energy production by coal. The increased utilisation of coal power generation has **accelerated the rate of extraction of the remaining accessible coal resources, thereby abbreviating the lifespan of these deposits.** Some coal mining companies have additionally asserted that energy production from solid fossil fuels might become unprofitable as early as 2025, owing to the escalating costs of CO_2 allowances. **This means that though we have experienced a short-term surge in coal utilization, in the long term we are still on track for the planned coal phase-outs.** It is even plausible that some countries might phase out coal before the scheduled official dates for phase-out are reached.

Figure 3: Year-on-year change in electricity generation from coal and manufactured gases in CEE countries (TWh)



Source: Eurostat

[1] https://www.energymonitor.ai/power/europe-any-fears-of-a-coal-rebound-are-now-dead/

SPECIAL FOCUS: Revised Renewable Energy Directive boosts decarbonisation in the EU

On October 9 2023, the Council approved the revised Renewables Energy Directive and agreed to raise the EU's binding renewable target for 2030 to a minimum of 42.5%, up from the current 32% target and **almost doubling the existing share of renewable energy in the EU.** Negotiators also agreed that the EU would aim to reach 45% of renewables by 2030. Through the scaling and speed of the RES rollout, the **EU hopes to achieve a reduction in energy prices and to decrease the EU's dependence on imported fossil fuels.**

The revised Renewable Energy Directive which specifies these goals also introduces easier and **faster permitting procedures**. Member states will put in place **dedicated acceleration areas** for renewables. The agreement includes targets and measures to support the uptake of renewables across various sectors of the economy.

The revised Directive for the first time included a key energy-consuming sector, industry. The agreement establishes indicative targets (a 1.6% annual increase in renewable energy use) as well as **a binding target to reach 42% of renewable hydrogen in total hydrogen consumption in the industry by 2030**. The agreement also **reinforces the regulatory framework for renewable energy use in transport** (14.5% greenhouse gas intensity reduction or 29% share of renewable energy in final energy consumption), including a **combined sub-target of 5.5% for advanced biofuels and renewable fuels of non-biological origin**, including a minimum level of 1% for renewable fuels of non-biological origin. These targets support the EU's ambitions for an accelerated renewable hydrogen roll-out.

Natural gas was heavily impacted by the energy crisis

Following the cutting of Russian gas supplies to Europe in the second half of 2021 and the Russian invasion of Ukraine in February 2022, the EU experienced high natural gas prices and fear of scarcity. Many countries reacted by employing energy savings. **The demand for natural gas in the EU effectively dropped by 13.2% in 2022**, close to the voluntary 15% reduction mark[2] agreed on by the EU member states.[3]

In 2021, the EU relied on natural gas imports for more than 83% of its consumption.[4] Following the Russian invasion of Ukraine, the **EU adopted the REPowerEU Plan that comprises a set of measures to reduce its dependence on imports in the future**. It includes **plans to locally produce 35 bcm of biomethane and 10 bcm of renewable hydrogen.** Further it plans to continue to decrease its natural gas consumption through further energy efficiency measures (to replace 38 bcm of Russian gas), the increased roll-out of heat pumps (to replace 35 bcm of Russian gas), and the construction of additional RES power generation. **For the remaining imports, it plans diversification of the natural gas sources through additional pipeline interconnections, increased LNG import capacity** (-50 bcm of Russian gas) **by 2030 and 10 bcm of renewable hydrogen imports**.[5]

[2] Note: compared to their average consumption in the previous five years

[3] https://www.consilium.europa.eu/en/press/press-releases/2022/07/26/member-states-commit-to-reducing-gas-demand-by-15-next-winter/#:~:text=Saving%20gas%20now%20will%20improve,for%20EU's%20citizens%20and%20industry.&text=Member%20states%20agreed%20to%20reduce,measures%20of%20their%20own%20choice.

[4] https://www.consilium.europa.eu/en/infographics/eu-gas-supply/

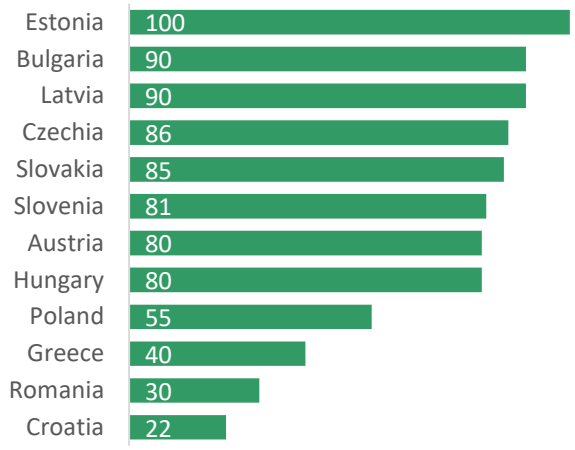
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0230

SPECIAL FOCUS: LNG – the new major source of gas for the region

Since Russia's invasion of Ukraine, pipeline gas imports from Russia to the EU have been significantly reduced. This has mainly been compensated for by a sharp increase in imports of liquified natural gas (LNG). **The change in gas sourcing from Russian pipeline gas to LNG has been dramatic in Central & South-Eastern Europe as prior to 2022, many countries in the CEE/SEE region were predominantly importing gas from the Russian Federation** (see figure 6).

The change of gas supply source has also had a large impact on regional transit gas flows. **Traditional transit countries of Russian gas such as the Czech Republic, Slovakia and Austria have instead become end stations for alternative supplies such as LNG**. As a result, these countries and other landlocked countries in the region are focusing on signing mid- to long-term gas supply agreements with LNG suppliers to ensure future security of gas supply. Also, some new infrastructure projects are planned to strengthen the connection of the landlocked countries with the ports.

Figure 4: Import dependency of Russian natural gas in 2020 (%)



Source: CEE&SEE Decarbonisation Report 2022, Country sheets

While the EU plans to reduce its consumption of natural gas long-term (achieving climate neutrality in the EU by 2050), it will still rely on it in short-term. With the increasing share of renewable sources in the power generation mix and ongoing coal phase-out, power transmission systems will need additional sources of flexibility. **As a result, several countries are planning further development of gas-fired power plants, mainly CCGT.** In the CEE and SEE region, these include Bulgaria (1 GW), Croatia (0.4 GW), Cyprus (0.26 GW in 2023), Czechia (1-1.5GW), Estonia (0.25 GW is likely), Greece (5GW), Hungary (1.65 GW), Poland (5 GW), and Romania (3.56 GW by 2028). **Apart from power generation, gas in the EU is mainly used in household heating and industrial processes, where electrification or substitution with other renewable sources remains problematic.**

In the short-term, securing gas supplies for the winter is a real concern, especially in the CEE and SEE region. As a result, the Council adopted a regulation aiming to ensure that gas storage capacities in the EU are filled before the winter season (for more information, see the Special Focus section below).

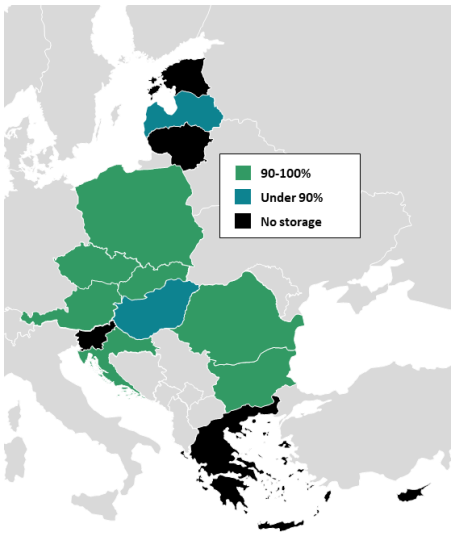
SPECIAL FOCUS: Gas Storages played a crucial role during Europe's Energy Crisis in 2022

The Council adopted a regulation aiming to ensure that gas storage capacities in the EU are filled before the winter season. Underground gas storage on member states' territory should be filled to at least 80% of their capacity by November 1st 2022*. This collective target was later further increased to 90%.

Due to the remarkable efforts of Member States and Storage System Operators (SSOs) the target was achieved. **According to GIE's AGSI Transparency platform, EU's underground gas storages reached 95% in terms of filling level, equivalent to 1,060 TWh on 1 November 2022**. Latvia was even breaking new ground and implemented for the first time a two-way natural gas flow, allowing it to juggle between storage injection and withdrawal modes.

* The filling obligation would be limited to a volume of 35% of the annual gas consumption of member states over the past five years

Figure 5: Storage level on 1 Nov 2022



Source: GIE, AGSI Transparency Platform

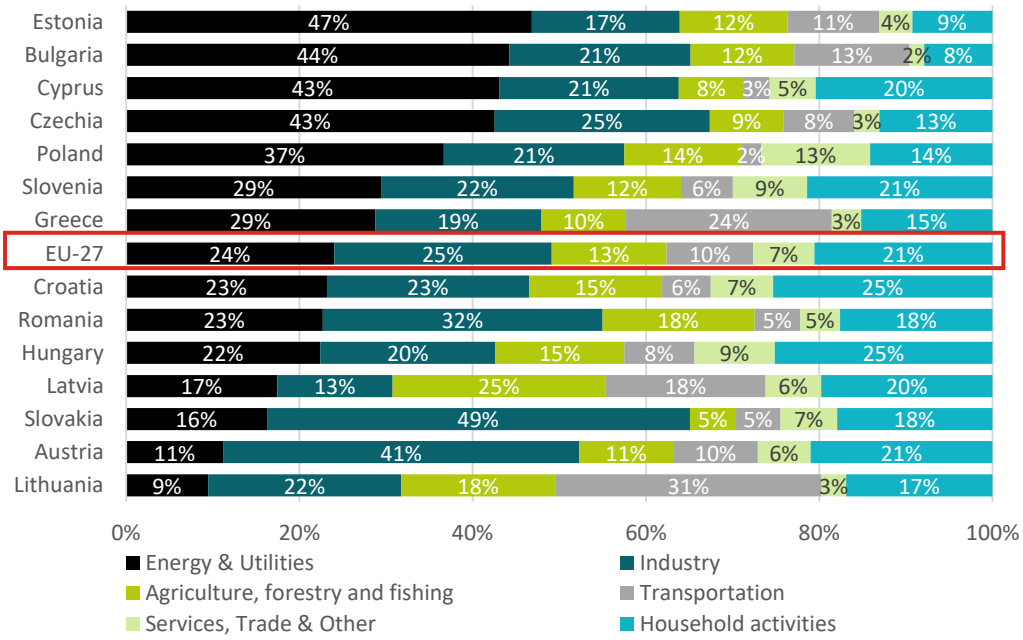
B. Sector analysis

The Energy sector and Industries generate the most emissions

When evaluating the progress of decarbonisation, it is crucial to assess each sector individually. The reason is their largely different decarbonisation potential. Transport, agriculture, and buildings (under the 'other emissions' category) are the three sectors with the slowest emissions reduction progress, as monitored by the EU.

As in the rest of the EU, the 'Energy & Utilities' and 'Industry' are the most emissions-heavy sectors also in the CEE/SEE region. Estonia, Bulgaria, Cyprus, Czechia, Poland, Slovenia, Greece, and Hungary pollute more in the former, while Slovakia, Austria, Romania, Lithuania, and Latvia need to lean in heavily on the latter in their decarbonisation efforts. Croatia and Hungary also struggle with higher pollution than the EU-27 average in Households.

Figure 6: Total GHG by sector (MtCO2e)

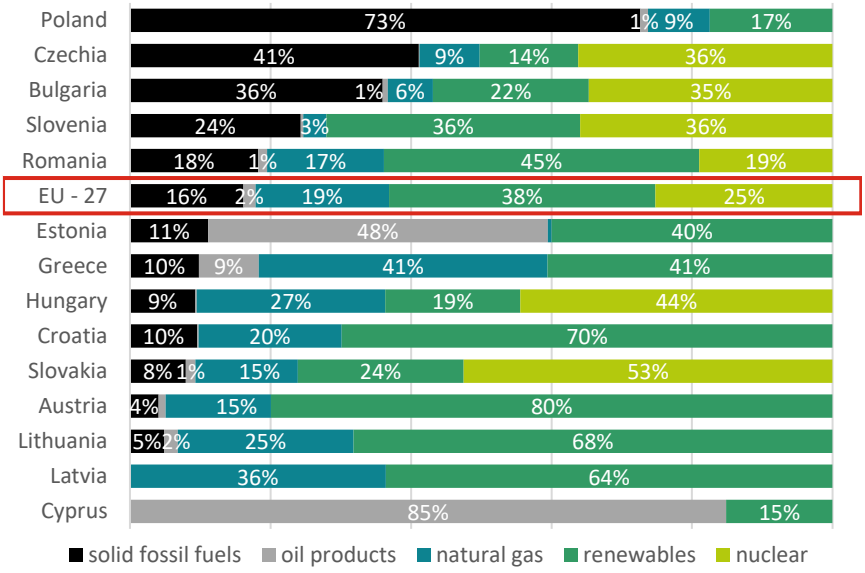


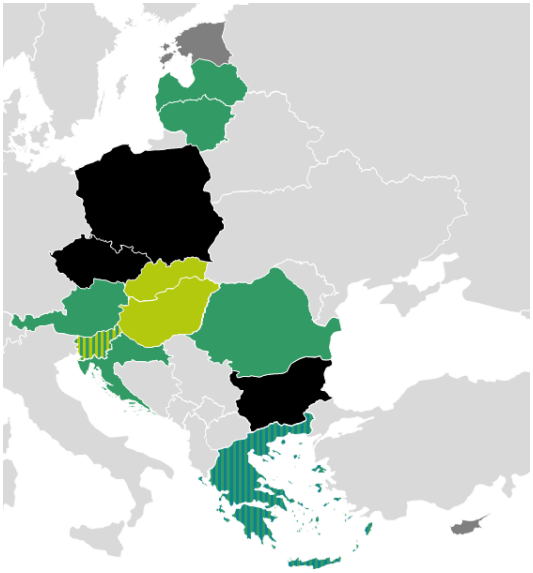
Source: Eurostat, 2021

Decarbonisation is the most advanced in Power generation

As with the European Union in general, the most noticeable progress in the regional decarbonisation can be found in the power generation sector. However, **to reach EU's climate neutrality target, the use of coal in the electricity sector must be phased out completely**. As you can see from the graph, the share of solid fossil fuels in power generation, from which 80 - 90% is coal, remained significantly above the EU average of 16% in Poland, Czechia, and Bulgaria and slightly over in Romania, and Slovenia in 2021.

Figure 7: Power Generation by fuel (%)





Source: Eurostat, 2021

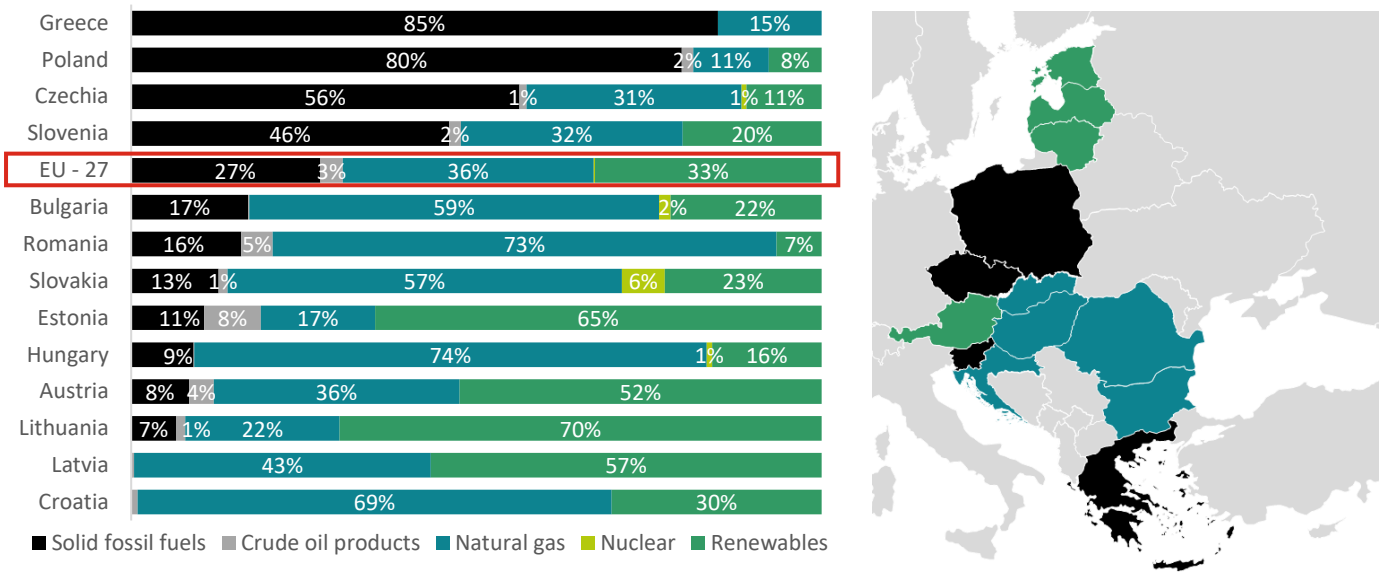
Decarbonisation of the Heating and cooling sector is making some progress

The process of replacing fossil fuels with renewable energy sources and other zero-carbon solutions **in the heating and cooling sector has so far been slower than in the power generation sector**. The average EU-27 consumption of coal and natural gas has increased year-on-year from 15% and 20% to 27% and 36% respectively in 2021. As in the EU average, Bulgaria, Croatia, Romania, Slovakia, and Hungary rely on natural gas heating, while the Baltics and Austria source most of the heat from renewables.

While most EU countries produce heat from other fossil fuels (natural gas, oil/oil products) or renewable sources, a few CEE/SEE states rely heavily on coal and other solid fossil fuels. Notably, Greece, Poland, Czechia, and Slovenia produce more than 40% of their heat from solid fossil fuels.

In 2023 the picture drastically changes for Slovenia, where the biggest district heating utility (in the capital city of Ljubljana), the company TETOL, will shut down two coal fired units. They will replace coal with natural gas in a new CCGT unit (with two gas turbines 57,5 MWel each plus one steam turbine 34 MWel). Thus, the usage of coal will be decreased by 70 %, importantly decreasing the emissions of CO2 and other pollutants (ash etc.). As this is by far the largest district heating utility in the country, the investment will dramatically improve the result of the whole heating and cooling sector on the national level.

Figure 8: Heating by fuel (%)

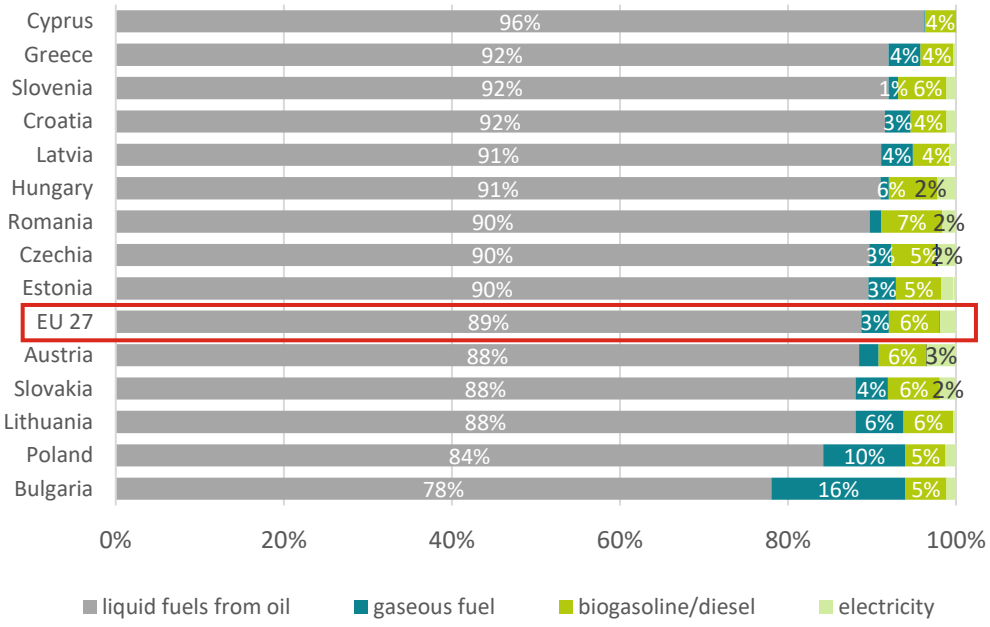


Source: Eurostat 2021, Eurostat does not report any heating consumption data for Cyprus

Decarbonisation in Transportation has just started

For most countries in the CEE/SEE region, transport is the 1st or the 2nd largest contributor to GHG emissions. The share of alternative fuels to the traditional liquid fuels from oil (mainly gaseous fuels and biogasoline/diesel) is so far larger than 20% only in one country, Bulgaria, as shown in the graph below. The largest share of electricity among the countries in the region is in Austria, but even the share was only 3% in 2021.

Figure 9: Transportation by fuel (%)

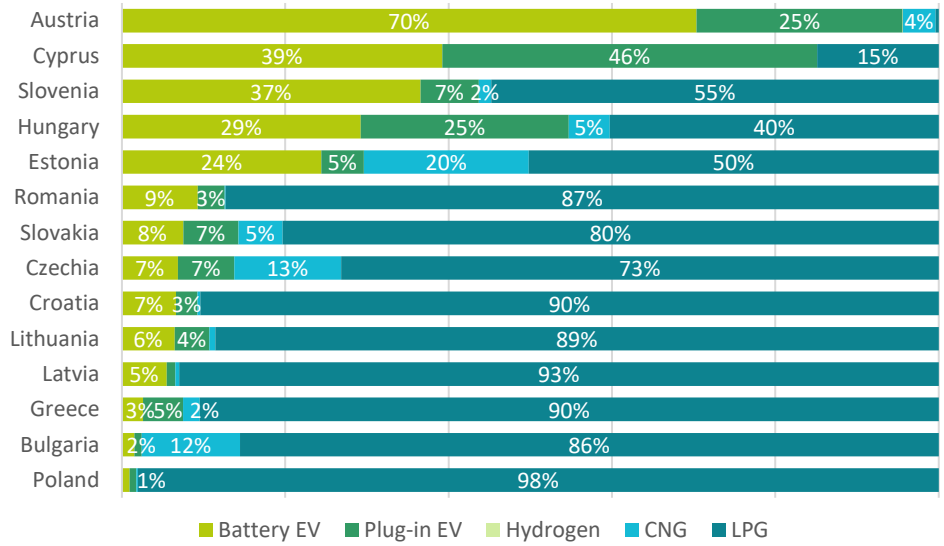


Source: Eurostat 2021

In the graphs below, you can see the employment of alternative fuels, in other words fuels or sources which serve, at least partly, as a substitute for fossil oil source in the transport sector. **These sources require installation of alternative infrastructure that is not interchangeable.** The below displayed sources are recognized as alternatives by the Directive 2014/94/EU.[6]

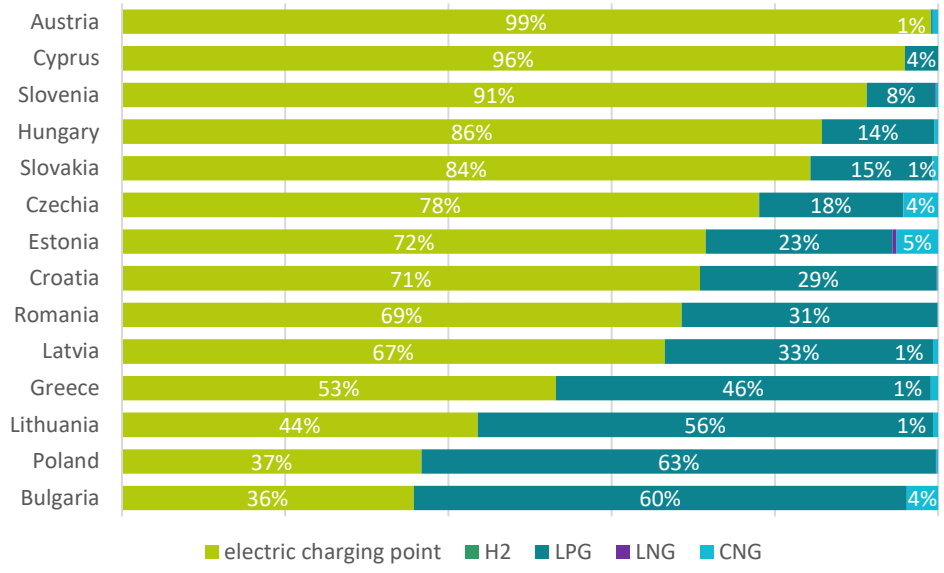
According to the European Alternative Fuels Observatory[7], which collects and regularly updates data for all EU countries, liquified petroleum gas (LPG) dominates the alternative fuel mix for most of the countries in the region. The data showing the installations at the end of 2022 reveal that **only Austria, Cyprus, and Hungary have a cumulative share of electric (battery electric vehicle, BEV) and hybrid vehicles (plug-in hybrid electric vehicles, PHEV) of 50% or more of the total alternative fuel vehicles.** Only Poland (115), Austria (62), Czechia (12), Slovakia (3), Estonia (2), and Lithuania (1) **have registered hydrogen passenger vehicles**.

Figure 10: Alternative fuel passenger vehicles, share by type (%)



Source: European Commission, European Alternative Fuels Observatory, July 2023

Figure 11: Alternative infrastructure points, share by type (%)



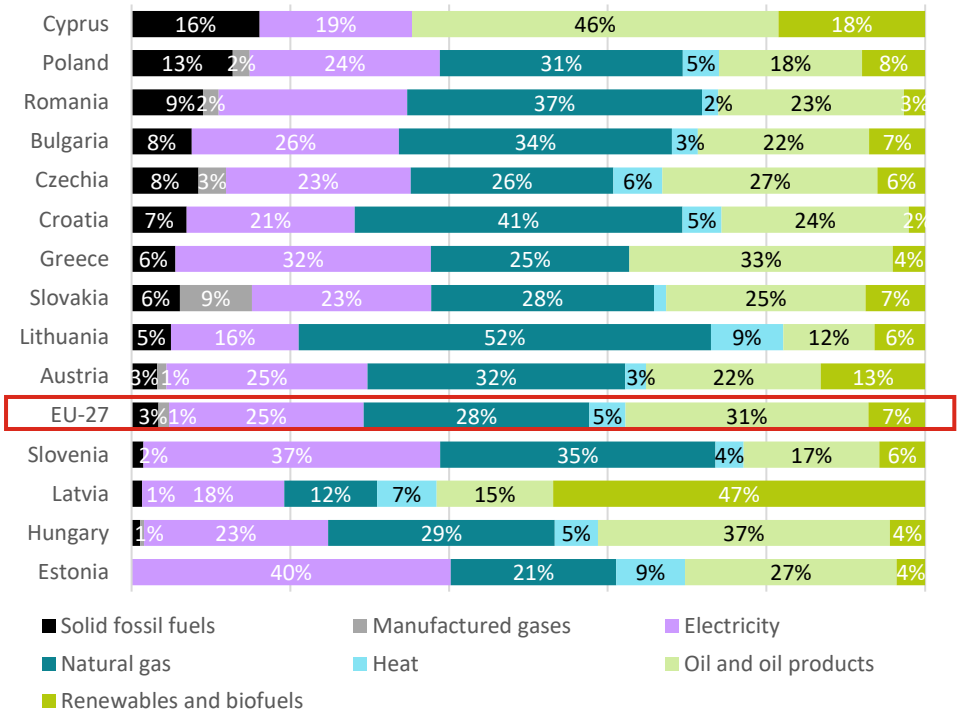
Source: European Commission, European Alternative Fuels Observatory, July 2023

[6] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0094
[7] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road

Decarbonisation in the Industrial sector is challenging [8]

In industry, decarbonisation proves to be very difficult as it demands reimagining production processes and redesigning existing sites with costly rebuilds and retrofits. For companies adopting low-emission production this means a short-to mid-term cost increase, putting them at a disadvantage. According to Eurostat in 2022, the Czech Republic (27%), Slovenia (26%), Poland (28%), Slovakia (25%), Hungary (24%), Romania (25%), Austria (22%), and Lithuania (23%) had a share of industry (except construction) larger than the EU-27 average of 21%, making their economies more vulnerable when implementing structural changes. Further, the regional industry and manufacturing sector (except construction) employs around half of the labour force in some CEE/SEE countries, with the most notable example being Czechia and Slovakia (45%), Slovenia (37%), Poland (42%) and Latvia (53%). The impact of decarbonisation on employment must therefore also be considered by these member states. The chart below illustrates the dependency of regional industries on the emission-intensive fuels.

Figure 12: Final energy consumption in the industry by type of fuel



Source: Eurostat 2021

Decarbonisation in Services is set to increase in upcoming years[9]

In the Services sector, the region overall follows the EU-27 progress and approaches decarbonisation using the same tools of energy efficiency measures and targeting the same emission sources, mainly buildings. Outliers are Poland, Slovakia, and to lesser degree Lithuania, which still utilize solid fossil fuels in the final energy consumption of this sector as presented in the graph below.

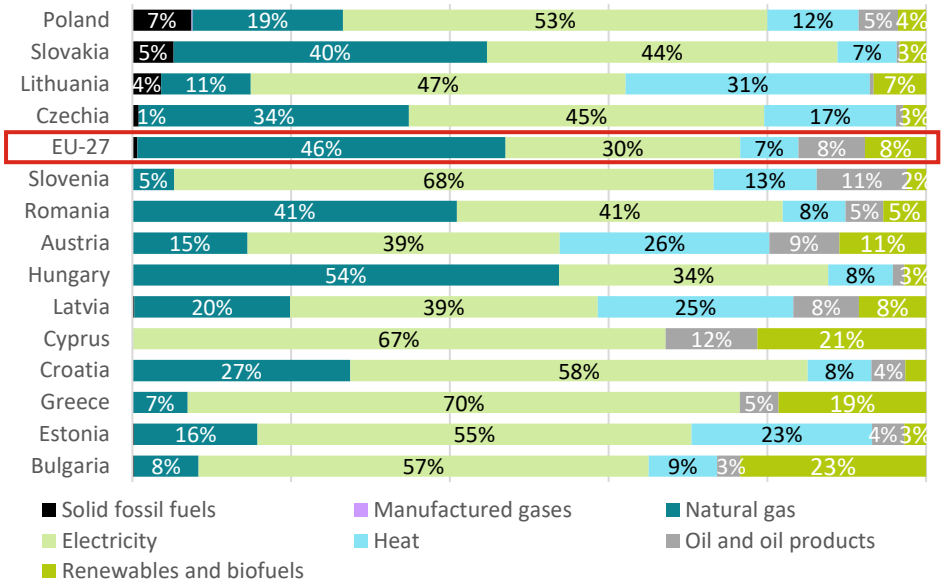
Decarbonisation efforts in this sector could speed up given the increasing energy efficiency measures propelled both by the energy crisis and new EU legislation. Further, the EU emission trading scheme (the EU ETS II) has been extended to the transportation and buildings sectors.[10] This step will slowly impose additional costs on fossil fuel utilization in these industries, sparking further decarbonisation efforts.

[8] Note Final energy consumption in industry covers the energy consumption of the NACE divisions: 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 41, 42 and 43. For NACE divisions 7, 8 and 9, only mining and quarrying of non-energy products is included. Quantities of energies transformed into another energy product are excluded from the industry sector and reported in the transformation sector (for example: electricity generation, coke ovens, blast furnaces, oil refineries)

[9] Final energy consumption in services covers the energy consumption of public and private entities in the NACE divisions 33, 36, 37, 38, 39, 45, 46, 47, 52, 53, 55, 56, 58, 59, 60, 61, 62, 63, 64, 65, 66, 68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 79, 80, 81, 82, 84 (excluding Class 8422), 85, 86, 87, 88, 90, 91, 92, 93, 94, 95, 96 and 99. Also includes fuel used by all non-transport activities of NACE Divisions 49, 50 and 51 (such as heating and lighting of buildings).

[10] https://www.europarl.europa.eu/legislative-train/package-fit-for-55/file-revision-of-the-eu-emission-trading-system-(ets)

Figure 13: Final energy consumption in services by type of fuel (%)



Source: Eurostat 2021

SPECIAL FOCUS: GREEN GASES

New political and economic incentives for the European green hydrogen economy

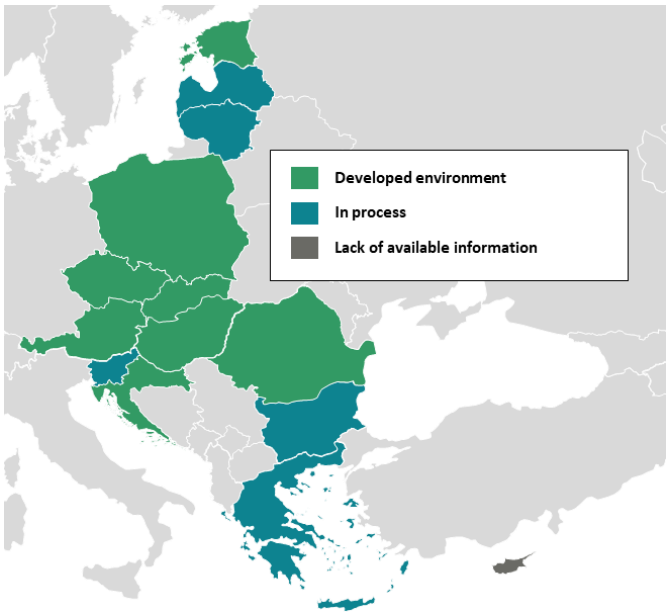
The European Commission (EC) has already proposed a fully-fledged legislative framework for the production, consumption, infrastructure development and market design for hydrogen in 2022. It believes that **hydrogen can make a major contribution to the EU's ambitions to end imports of Russian fossil fuels and achieve climate neutrality by 2050.** More recently, the Commission also set out rules defining what renewable hydrogen is for the EU in two delegated acts.

The most recent move to stimulate and support investment in sustainable hydrogen production and utilization is the **establishment of the European Hydrogen Bank**. The EC outlined four pillars of the Bank, which should be operational by the end of 2023. Two of them are financing mechanisms - for creating the EU domestic market, and for international imports into the EU. The third pillar is linked to transparency and coordination – assessing demand, infrastructure needs, hydrogen flows, and cost data. The final element is streamlining existing financial instruments - coordinating and blending these with new public and private funding, both in the EU and internationally.

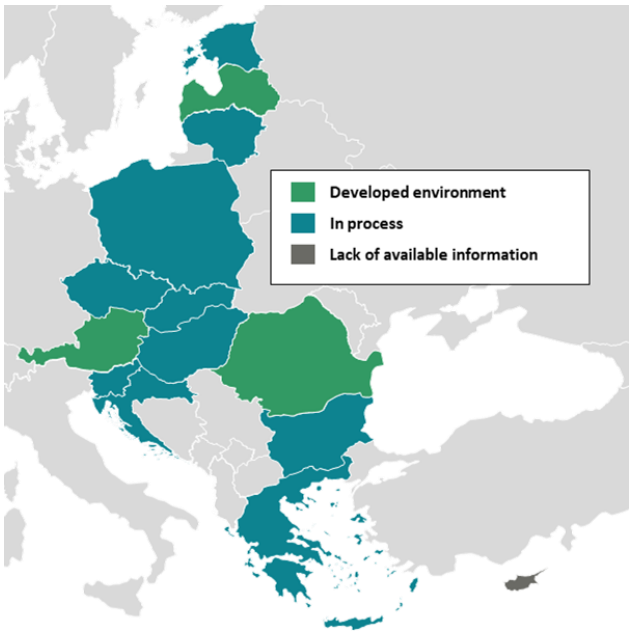
The Commission is intending for the B**ank to cover and lower the cost gap between renewable hydrogen and fossil fuels for early projects.** As the first final investment decisions were only taken last year and most projects are still in the planning stage, the Bank will help address the initial financial challenges to create an emerging renewable hydrogen market. The first pilot auction is currently being designed and is expected to open on 23 November 2023, backed by €800 million from the Innovation Fund. **Bank will also have an international dimension to facilitate renewable hydrogen imports to the EU.**

T**he maps below show the level of readiness for the green gas investments in each country**, assessing the political and legislative environment. More detail on the developments in each country can be found in the Country analysis part of the report.

Hydrogen: political environment



Hydrogen: legislative environment



Source: Various national sources compiled by Deloitte

Companies are working to develop a hydrogen value chain in Central & South-Eastern Europe

Several hydrogen projects have been developed in the CEE/SEE region that aim to establish a hydrogen value chain covering production, transportation and storage to end customers. Below are some specific gas infrastructure initiatives/projects in the region. All relevant hydrogen infrastructure in Europe are comprised in the interactive Hydrogen Infrastructure map that brings together the hydrogen perspective and projects of Transmission System Operators (TSOs) of gas, Distribution System Operators (DSOs), Storage System Operators (SSOs) and LNG System Operators (LSOs), as well as third party promoters developing projects in consortia along the whole value-chain.

Regional Hydrogen Corridors:

Central European Hydrogen Corridor

The Central European Hydrogen Corridor (CEHC) project aims to **create a hydrogen import "highway" from Ukraine via Slovakia and the Czech Republic to large hydrogen demand areas in Germany and the EU by 2030**. The hydrogen corridor will also enable the transportation of hydrogen between hydrogen production facilities and hydrogen consumers in the Czech Republic and Slovakia.

CEH2C Central European Hydrogen Corridor

The first preliminary results of the pre-feasibility study confirm that most of the relevant natural gas infrastructure can be repurposed to carry 100% hydrogen.

Participating companies include EUSTREAM (the Slovak gas TSO), GTSOU (Gas TSO of Ukraine), NET4GAS (the Czech gas TSO) and OGE (a leading German gas TSO).

The project is on the list of candidates for PCI status.

More information at www.cehc.eu.

South Eastern Europe H2 corridor

The major driver behind the development of this hydrogen corridor is the need to decarbonise industry, transport and power across the CEE/SEE region. This is specifically relevant for new green steel projects and existing industry in Greece, Bulgaria, Romania, Hungary, Slovakia, Croatia, Slovenia, Austria, Czechia towards Germany.

Due to the vicinity to North Africa and Middle East, the corridor could in the future facilitate hydrogen imports from the neighboring countries via shipping or subsea pipeline transportation. The area offers abundant renewables potential, due to land availability and high-capacity factors for solar and onshore wind. Depleted gas fields in Greece, Czechia, Slovakia, Austria, and salt caverns Germany will be used to provide a cost-effective hydrogen storage solution.

For more details, please consult the Learnbook on hydrogen supply corridors, published by European Clean Hydrogen Alliance.

Nordic-Baltic Hydrogen Corridor

The Nordic-Baltic Hydrogen Corridor aims to serve growing capacities of the green hydrogen production in the Baltic Sea. The project enables bidirectional cross-border connection of regional H_2 supply, demand, and storage from Finland to Germany through the Baltics and Poland.

The project initiative includes 6 gas transmission system operators (TSOs): Gasgrid Finland Oy (FI), Elering AS (EE), Conexus Baltic Grid, JSC (LV), AB Amber Grid (LT), GAZ-SYSTEM S.A. (PL), ONTRAS GmbH (DE).

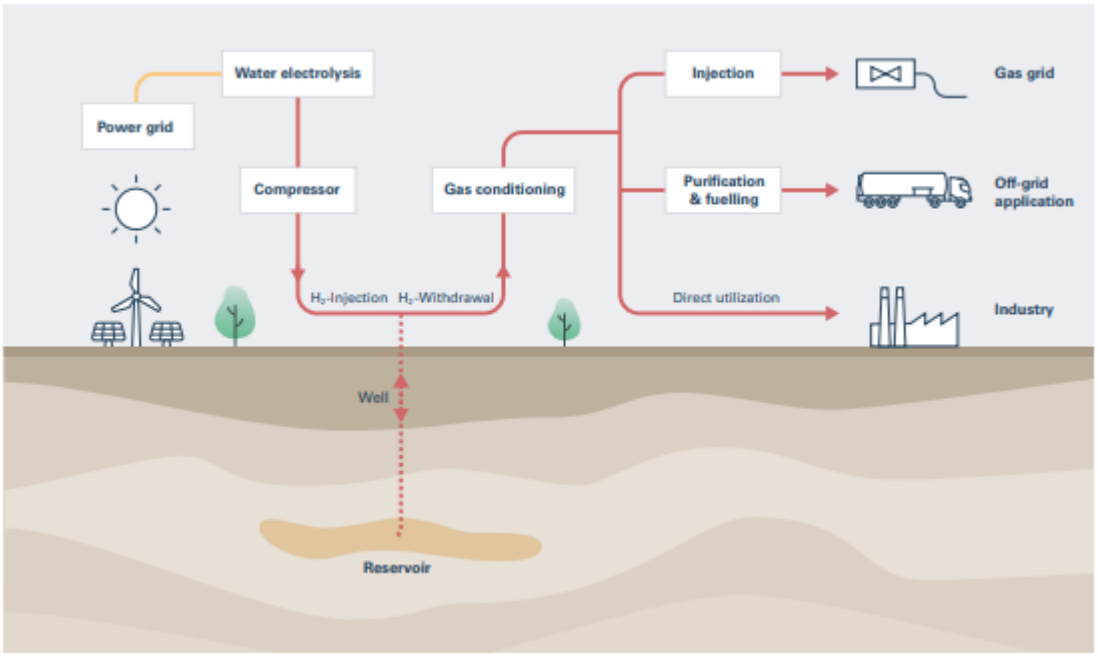
The Nordic-Baltic Hydrogen Corridor will especially unlock the potential for production and use of hydrogen in the Nordic and Baltic Sea region. It expects production of approx. 7-11 Mt of H2 meeting the 10 Mt REPower EU hydrogen production target by 2030, cost competitiveness is estimated to be around 2.4 €/kg for 2030 and around 1.8 €/kg for 2040.

The project also aims to integrate the Nordic, Baltic, Polish and German hydrogen infrastructure and to trigger further infrastructure developments to connect additional hydrogen suppliers and consumers (demand centres) in the concerned countries.

HYDROGEN STORAGE: Underground Sun Storage 2030

In this pilot project, the only one of its kind in the world, renewable solar energy is converted into green hydrogen in a climate-neutral way by means of electrolysis and stored in a pure form in depleted natural gas reservoirs. Until 2025, interdisciplinary technical-scientific investigations for the energy future will be carried out under real conditions in a small former natural gas reservoir in the municipality of Gampern (Upper Austria) under the leadership of RAG Austria AG together with several notable project partners.

The project started its operation in April 2023 with a hydrogen storage capacity of ~4500 MWh that are injected in the form of pure hydrogen into a porous subsurface reservoir. The plant will achieve TRL 6 level and will be scaled up to reach TRL 8 during a follow up project. The project USS 2030 is already based on 10 years of research and two prior projects to reach TRL 6. Transferability and scalability to larger reservoirs is given.



More information at: https://www.uss-2030.at/

Biomethane development is lagging behind its potential

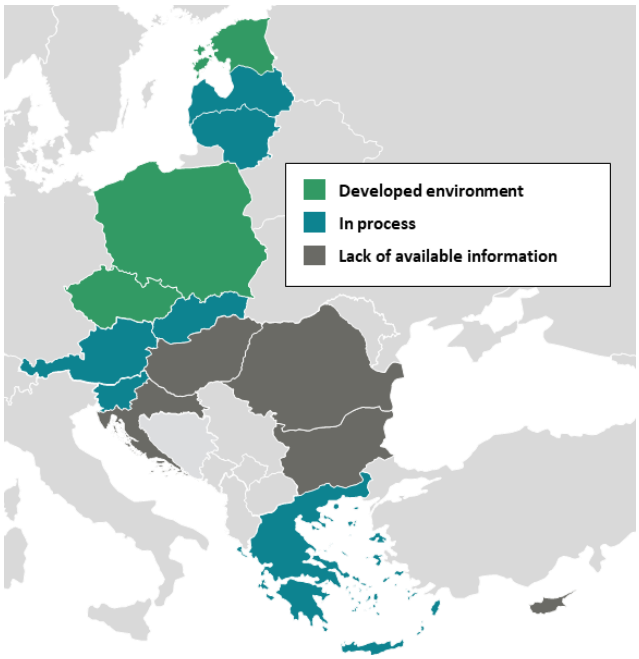
Biomethane has received significant attention within the recent EU initiatives and legislative actions. **The RePowerEU plan has established a 2030 target of 35 bcm for biomethane production. Furthermore, the revised Renewable Energy Directive broadens the scope of the fuel supply obligation to cover all uses of biomethane. Finally, the Commission's recommendation on permitting for renewable energy projects should also accelerate new biogas and biomethane investments.**

To achieve the specified biomethane targets**, the Biomethane Industrial Partnership (BIP) was established on September 28, 2022**, promoting an active engagement between the Commission, EU countries, industry representatives, feedstock producers, academics and NGOs.

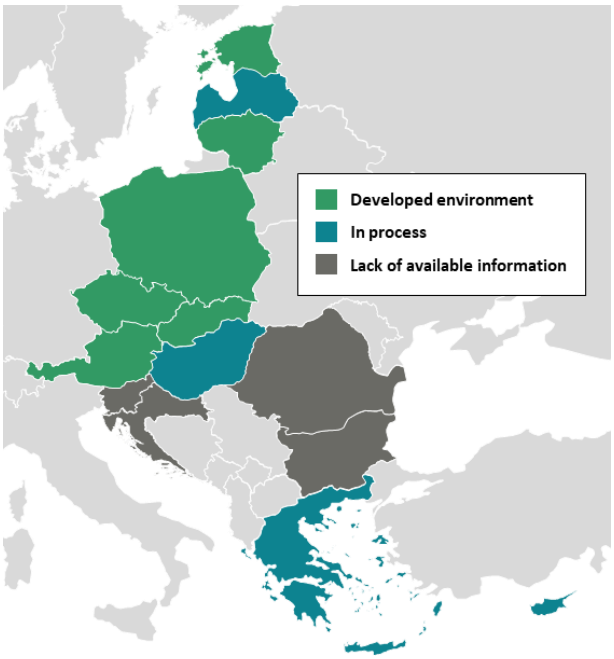
Despite the readiness of the infrastructure for biomethane transportation without any need for further investments in most of the member states in the CEE/SEE region are falling behind their biomethane potential. To address this gap, it is crucial to create clear national-level roadmaps through updates to the National Energy and Climate Plans and to identify their key milestones. A clear and supportive legislative and regulatory environment is also necessary for the market uptake of biomethane in the region.

The maps below show the level of readiness for the green gas investments in each country, assessing the political and legislative environment. More detail on the developments in each country can be found in the Country analysis.

Biomethane: political environment



Biomethane: legislative environment



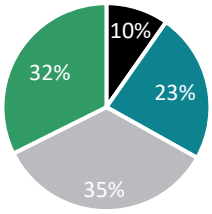
Source: Various national sources compiled by Deloitte

Part III: Country Analysis

Austria

has one of the largest shares of renewable energy in the total energy consumption, taking advantage of the country's high renewable energy potential, especially in biomass and hydropower.

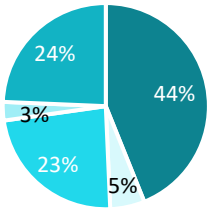
Total energy consumption by fuel



solid fossil fuels ■ natural gas ■ oil products ■ renewables

Source: Eurostat 2021

Consumption of gas by sector



industry ■ services ■ households ■ other ■ energy production

Source: Eurostat 2021

Renewables and crude oil products play the main role in Austrian energy consumption. In 2021, they constituted 32% and 35% of the energy consumption respectively. Austria has a geographically advantageous location which gives it a **high energy potential primarily from hydro and in addition from wind, and PV**. Further, the government allocated additional subsidies for small-scale solar photovoltaic (PV) generation in 2023**.** While natural gas which accounts for 23% of the overall energy mix still plays a key supporting and balancing role for the whole energy system, Austria intends to move to renewable gases, biomethane and hydrogen, in the next decade.

On average, around 10 TWh of Austria's gas were obtained annually through domestic natural gas extraction over the last five years. Domestically produced amounts of biomethane have so far been negligible (0.14 TWh). **The remainder of the natural gas used is imported (79 TWh).** Austria's storage capacity increased by 2% to 98 TWh between year-on-year, which means it could store more than its annual gas consumption. Austria established two new gas transfer points on the borders with Germany and Italy allowing it to import more LNG and natural gas from varied sources.

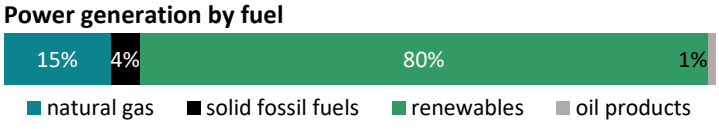
80 %

of natural gas is imported from the Russian Federation

Heating sector by fuel

natural gas ■ solid fossil fuels ■ renewables ■ oil products

Power generation by fuel



natural gas ■ solid fossil fuels ■ renewables ■ oil products

Transportation by fuel

liquid fuels from oil ■ gaseous fuel ■ biogasoline/diesel ■ electricity

Source: Eurostat 2021

Austria's heating sector is quite decentralized with approximately 70% of main residences having their own heating sources. Austria planned to ban fossil-based heating systems until 2040 and gas boilers in new buildings as of 2023 but decided to follow the example of Germany with less strict rules. In addition, there are massively increased financial incentives to switch to renewable heating.

Austrian power comes mostly from RES, where the intermittency of solar PV and wind is compensated by large hydropower plants.

Austria further aims to utilize its RES potential to decarbonise the transportation sector. The country has the most developed EV infrastructure out of all CEE/SEE countries (approx. 18 000 chargers in 2022, double the number reported for 2020).

72 $MtCO_2e$

Total GHG emissions

Austria generates 2% of the EU's total greenhouse gas (GHG) emissions and its carbon intensity is lower than the EU average. Austria's target for emission reduction was set for 2030 at around 36.4 Mt CO2eq. The main contributor to Austria's emissions in 2021 was industry which accounted for 41% of the total emissions. The Energy and Transportation sectors accounted only for 11% and 10% of Austria's total emissions in 2021 respectively. The country is aiming to reach carbon neutrality by 2040.

SPECIAL FOCUS: The role of gases in the decarbonisation of Austria[11]

Natural gas

57 TWh
Planned consumption in 2030

According to a draft of the NECP from July 2023 the consumption of natural gas by 2030 in the scenario with additional measures (WAM) should be around 57 TWh. The first estimates after the conflict in Ukraine started spoke about 36 TWh of gas from other suppliers that Austria will need in 2030 to diversify from Russian imports. In the draft of the new NECP Austria focuses on replacing natural gas mainly with biomass and RES with between 89 TWh and 138 TWh (67-75 TWh of that for hydrogen) alternative sources by 2040.[12]

Biomethane

According to the draft NECP, Austria plans on turning biogas into biomethane and producing 5 TWh of electricity from these sources in 2030 in the WAM scenario. The **NECP predicts that 13 PJ (0.37 bcm) of biogas and biomethane will be consumed in the country annually by 2030. The legislative draft of the Renewable Gas Act (EGG)** plans to help with the deployment of local renewable gases like biogas, and green hydrogen. The draft of the EGG states that 7.5 TWh of domestic green gas should be produced by 2030 and fed into the gas network. The law is still under negotiation.

Biomethane and biogas application areas mentioned in the NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment
There is an active association[13] focused on the sustainable development of biogas and biomethane production and consumption. Biomethane is also covered by the NECP, however, there are no specific strategies for biomethane.

Legislative environment
With the adoption of the EGG, Austria will create a good environment for the development of renewable gases. According to the draft of the EGG suppliers will be given quotas for the volumes of green gases, and if they do not comply with them, they must pay fines.

Hydrogen

Austria has high ambitions to develop an advanced hydrogen economy. According to the draft NECP, **hydrogen will be one of the key technologies for sector coupling and integration**. Measures aim to develop the entire H_2 supply chain. According to the Austrian H_2 strategy, the **country set a target of having 1 GW of installed capacity of electrolysers by 2030. This capacity aims to annually generate up to 4 TWh H_2**, with a total of 80 % of the volume to be carbon neutral by 2040. Thanks to the "Hydrogen Partnership Austria" the development of H_2 should be ensured. Austria also wants imports of green H_2, therefore, they are internationally active in building new corridors (e.g. SunsHyne and SoutH2 for H_2 from North Africa, H2EU+Store from Ukraine).

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment
In Austria, there are several hydrogen associations and platforms[14] that promote hydrogen solutions and connect stakeholders from government, industry, and research. **Austria also has its hydrogen strategy[15] with specific goals** for individual sectors and **includes hydrogen in national plans for the deployment of alternative fuels infrastructure**.

Legislative environment
Minor specific tax incentives for hydrogen are already implemented and **Austria is part of the HyLaw project**, which aims to identify the status and legislative barriers to hydrogen development.

[11] Planned gas consumption in 2030 source: https://www.energyagency.at/fileadmin/1_energyagency/presseaussendungen/allg._pa/2022/04_independence_from_russian_gas_analysis_aea_bmk_2022.pdf, page 4
[12] https://www.energyagency.at/fileadmin/1_energyagency/presseaussendungen/allg._pa/2021/06_erneuerbares_gas_2040_final_barrierefrei_juni21.pdf
[13] https://www.kompost-biogas.info/
[14] WIVA P&G Energy Model Region: https://www.wiva.at/;; HyCentA (Hydrogen Center Austria): http://www.hycenta.at/
[15] https://www.bmk.gv.at/themen/energie/energieversorgung/wasserstoff/strategie.html

Example of hydrogen project:

WAG Loop: For Austria's gas supply and the energy transition

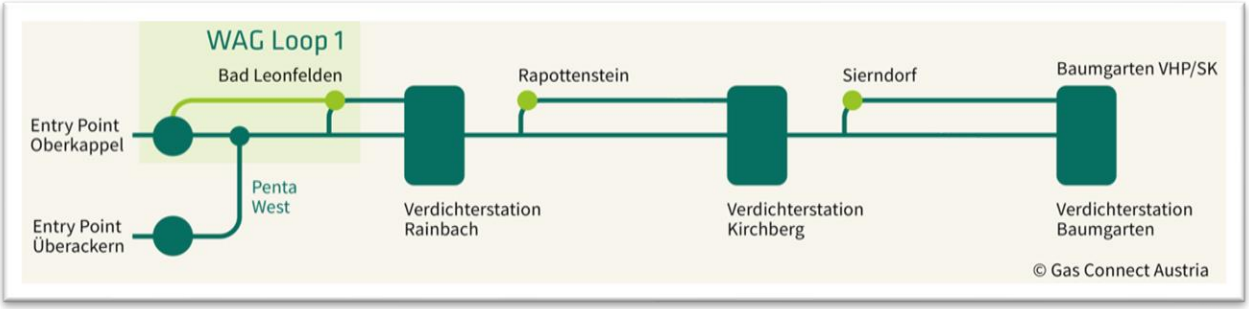
West-Austria-Gasleitung (WAG) is one of the most important gas transmission systems in Austria. It runs for 245 kilometres between the Baumgarten gas hub on the Slovak border to the German border in Oberkappel.

Timeline of the project
Pre-feasibility as per 10/2023

Due to the current geopolitical situation and in view of the imminent expiry of the transport contracts between Russia and Ukraine at the end of 2024, there is a risk of a gas shortage for the Eastern European region (see graph). The urgent expansion of the West-East route is therefore particularly important. It provides access to gas sources from North-West Europe, e.g. Norway, and to LNG delivered along the coast in Germany, Belgium, Holland and France. This will secure Austria's supply.

Step-by-step expansion: WAG LOOP 1

The first phase, known as WAG Loop 1, will focus on security of supply in Austria. Further expansion steps can be taken if necessary. In the first part of the loop, the approximately 40-kilometre section from Oberkappel to Bad Leonfelden is to be extended with a parallel line, in addition to the existing line. This additional, parallel transport line would increase the transport capacity from Germany by around 30 percent, or 27 TWh per year. In addition, this capacity increase will allow more flexibility in the injection and withdrawal of gas into and from the Haidach and 7Fields gas storage facilities in Upper Austria.



Project status: Pre-feasibility phase is underway and shall end in 2024. Next steps to be determined after the feasibility studies.

Project promoters: GAS CONNECT AUSTRIA GMBH

The project for the energy transition

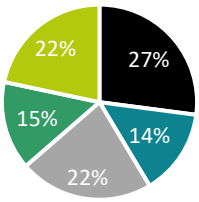
The implementation of the WAG Loop also paves the way for the transport of green hydrogen in larger quantities in the future. In the future, natural gas and hydrogen could be transported simultaneously in the network via the then parallel pipeline system. Embedded in the planning of a European hydrogen network, it creates the basis for transport corridors envisaged in the European Hydrogen Backbone.

More information on: https://www.gasconnect.at/en/recent/news/detail/wag-loop-1

Bulgaria

has large coal reserves, with large shares of the oil and natural gas imported. To decarbonise and increase energy security Bulgaria needs to reduce dependency on all three.

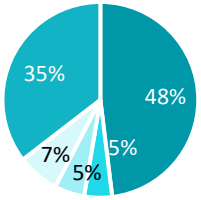
Total energy consumption by fuel



■ solid fossil fuels ■ natural gas ■ oil products ■ renewables ■ nuclear

Source: Eurostat 2021

Consumption of gas by sector



■ industry ■ services ■ households ■ other ■ energy production

Source: Eurostat 2021

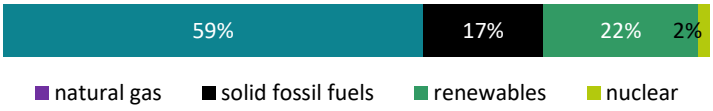
Crude oil products together with solid fossil fuels and nuclear energy play the main role in the Bulgarian fuel mix. The Bulgarian electricity market is currently undergoing privatization and liberalization. **Nuclear power is expected to remain dominant with construction of new nuclear blocks being accelerated in 2023. The government is slowly decreasing its coal power capacity to gradually replace it with RES.** A considerable share of Bulgarian RES comes from hydropower. However, Bulgaria has due to its location favourable conditions for PV plants. Its access to the Black Sea also opens opportunities for 116 GW of installed offshore wind capacity.

Bulgaria consumes about 27 TWh of gas per year, about 99 % of which are imports. Most of the gas is consumed by the Bulgarian industry, which comprises metallurgy and machinery production and other energy-heavy industries. In July 2022, Bulgaria completed an interconnector with Greece with an initial capacity of 3 bcm and a potential to raise it to 5 bcm. Located by the Black Sea, Bulgaria can explore the LNG options. Bulgaria began construction of natural gas pipeline link with Serbia that will make Bulgaria a transit country for gas from Croatia to Serbia, due for completion by 2024. Onshore exploration opportunities exist in the Western and Northern parts of the country. A project increasing Bulgaria's gas storage capacity from 0,55 bcm to 1 bcm is due to be completed by the end of 2024.

80 %

of natural gas is still imported from Russian Federation

Heating sector by fuel



■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear

Power generation by fuel

■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear ■ oil products

Transportation by fuel

■ liquid fuels from oil ■ gaseous fuel ■ biogasoline/diesel ■ electricity

Source: Eurostat 2021

The Bulgarian heating sector is highly dependent on natural gas. As there is large share of electricity produced from nuclear sources, there is **potential for better management of waste heat from the nuclear power** which could be used to partially substitute heat produced from natural gas.

Nuclear energy accounted for 35% of the power generation in 2021. Bulgaria has large PV and onshore and offshore wind potential for additional capacities to be developed which could replace solid fossil fuels.

The Bulgarian **transportation sector is highly dependent on liquid fuels from oil**. With 1 118 EV chargers, its infrastructure for electric vehicles is steadily growing.

56.1 $MtCO_2e$

Total GHG emissions

Bulgaria is the most GHG-intensive economy in the European Union. The energy sector remains the main source of these emissions due to the utilization of coal. Bulgaria's 2030 target for greenhouse gas emissions not covered by the EU Emissions Trading System (non-ETS) is 0% compared to 2005. The Renewable share is set at 27% of the gross final consumption of energy by 2030.

SPECIAL FOCUS: The role of gases in the decarbonisation of Bulgaria[16]

Natural gas

45.5 TWh
Planned gas consumption in 2030

The utilization of natural gas in 2030 is predicted to remain at 3 bcm/year and the remaining volume should come from renewable gases. Bulgaria will import some 1 bcm of natural gas annually from Azerbaijan for a period of 25 years under a contract with SOCAR and talks to increase the volume are underway. The remaining natural gas is expected to come from LNG through the IGB interconnector. Despite natural gas savings in 2022, Bulgaria expects to almost double consumption in 2030.

Biomethane

Bulgaria's NECP does not primarily mention the use and development of biomethane. According to the projections of the report, **biogas and off-gases could reach up to 680 GWh in 2030**. Projection of the development in the renewable transport technology shows no use of biogas and consequently no biomethane. According to the National Energy strategy[17] **published in 2020, biogas has the technical potential to cover a 6 % share of RES** in the country.

Biomethane and biogas application areas mentioned in the NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

The technical potential of biogas is mentioned in the National Energy Strategy of 2020. **Biomethane is not explicitly mentioned in this document or other relevant national strategies**. In Bulgaria, there is Biogas Association, which was established in 2017 with no significant activity yet.

Legislative environment

Specific tax incentives to encourage the use of biomethane are not currently implemented. However, one of the targets of the National Energy Strategy published in 2020 is the creation of an appropriate legislative framework that will enable biogas producers to subsequently produce biomethane and push it into the gas transportation network.

Hydrogen

According to the NECP[18], Bulgaria intends to enable the integration of hydrogen in its energy and transport up to 10 %. The country **expects an annual final H_2 consumption of 32 GWh in the transport sector by 2030**, facilitated by the planned deployment of **H_2** refuelling stations. **According to NECP a pilot project for H_2 production with an installed capacity of 20 MW is planned.** According to Bulgaria's Sustainable Energy Development Strategy[19], the **country intends to prepare key gas infrastructure for H_2 transport by 2030**. Based on Recovery and resilience plan (RRP) Bulgaria plans on creating its H_2 strategy and through legislative amendments, it wants to create a suitable environment for H_2 development. Thanks to the planned projects, Bulgaria is supposed to build electrolysers with a 55 MW installed capacity and produce 7 800t of green H_2 annually by 2030.

Hydrogen application areas mentioned in the NECP

Energy	Heating*	Industry*	Transportation*

*Bulgaria sets policy goals for hydrogen in these sectors in other relevant strategic documents.

Political environment

In Bulgaria, **there is an active** hydrogen association [20] bringing together approximately 10 stakeholders. **Bulgaria does not have its hydrogen strategy**, but hydrogen is mentioned in other strategic documents and road maps focusing on innovation and sustainable development. **Bulgaria includes hydrogen in national plans for the deployment of alternative fuels infrastructure** (2014/94/EU).

Legislative environment

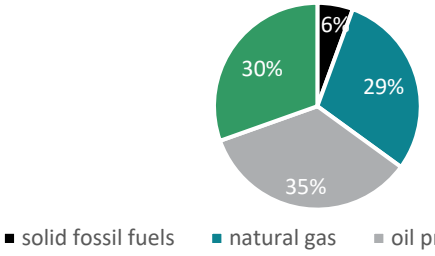
Specific tax incentives to encourage the use of renewable or low-carbon hydrogen or other legislation are not currently implemented. Nevertheless, **Bulgaria is part of the** HyLaw[21] **project**, which aims to identify the status and legislative barriers to hydrogen development.

[16] 2030 planned gas consumption source: ДЕ С ЕТ ГОДИШЕН ПЛАН ЗА РАЗВИТИЕ НА МРЕЖИТ Е НА „БУЛГАРТ РАНСГАЗ" ЕАД ЗА ПЕ РИОДА 2022– 2030г ., Bulgartransgaz, 2022, page 40
[17] http://www.seea.government.bg/documents/EnegyStrategyEN.PDF
[18] https://energy.ec.europa.eu/system/files/2020-06/bg_final_necp_main_en_0.pdf
[19] https://www.moew.government.bg/bg/strategiya-za-ustojchivo-energijno-razvitie-na-republika-bulgariya-do-2030-g-s-horizont-do-2050-g-i-proekt-na-integriran-nacionalen-plan-v-oblastta-na-energetikata-i-klimata-inpek-na-republika-bulgariya-do-2030-g/
[20] https://bgh2a.bg/
[21] https://www.hylaw.eu/

Croatia

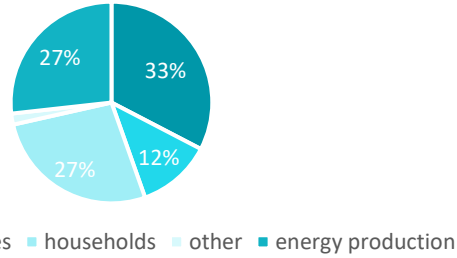
plays a role in the region's energy security as it operates an LNG terminal, the first one to serve the Balkans directly.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



Source: Eurostat 2021

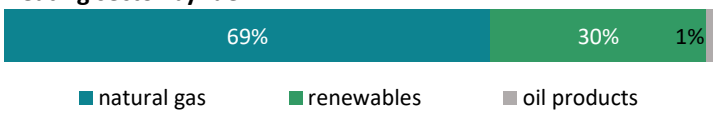
Croatia, unlike most of its Western Balkan neighbours, no longer has its own coal reserves. A full coal phase-out is expected to follow before 2030. **Croatia is somewhat dependent on electricity imports, depending on hydrological conditions as almost half of its electricity came from hydropower in 2021.** Croatia has a **higher use of natural gas in services than other countries in the region.** Its **industry is more dependent on gas compared to other countries in CEE/SEE.** The most prominent subsections in the Croatian industry contributing to gas consumption are manufacturing and chemical products.

Croatia consumes around 3 bcm (30 TWh) of gas annually, of which some 65% comes from imports. Croatia has its own natural gas production with 0.78 bcm produced in 2022. New plans to increase the gas output by 0,29 bcm mean that **domestic production could cover 40% of the country's demand in 2023.** In 2021 Croatia opened its first **LNG terminal with a current annual capacity of 2.9 bcm, through which around 57% of the total natural gas supply was imported**. The works to double the capacity of the LNG terminal have begun and are due to be completed in mid-2025. Croatia can only store 4.7 TWh or 15% of its gas consumption.

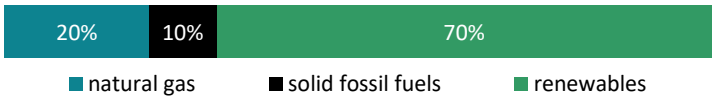
22 %

of natural gas used to be imported from Russian Federation

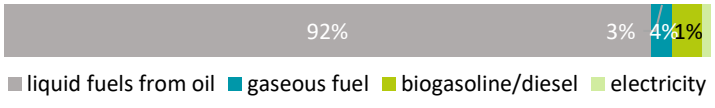
Heating sector by fuel



Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

The Croatian heating sector is highly dependent on natural gas. However, **the volume used for heating is relatively low** due to the favourable climate.

While there is a high share of RES in power generation, **Croatia still relies on power from natural gas and solid fossil fuels.** Croatia also technically produces electricity from nuclear power as it owns 50% of a nuclear power plant in Slovenia, from which electricity is imported. There are talks of building a new block in this power plant.

The intent to decarbonise transportation is slowly showing through the continuous absorption of EU funding. For instance, in July 2022, the Croatian Ministry of the Sea, Transport and Infrastructure expanded on cooperation with EIB for the development and financing of transport.

23.4 $MtCO_2e$

Total GHG emissions

Croatia generates 0.6% of the EU's total greenhouse gas (GHG) emissions and has reduced emissions at a slower pace than the EU average since 2005. The Energy & utilities, Industry and Household activity sectors each accounted for approximately a quarter of Croatia's total emissions in 2021.

SPECIAL FOCUS: The role of gases in the decarbonisation of Croatia[22]

Natural gas

25.2 TWh
Planned gas consumption in 2030

In the new NECP from June 2023 there is no specific information on natural gas consumption in 2030, but in *scenario with existing measures* which reflects existing policies and measures taken, the expected consumption of natural gas is 107.3 PJ (3.05 bcm) in 2030 which is roughly 29.8 TWh, more than the volume indicated in the national energy strategy in 2020.

Biomethane

Although the NECP does not mention the use of biomethane in more detail, the **report mentions the intention of injecting biomethane into the gas network and the use of biogas for biomethane production in general. Gas network should be in the next 10-15 years ready for transportation of 100 % of decarbonised gases**. In the report from IEA called *Implementation of bioenergy in Croatia* from 2021, there are brief mentions about biomethane in transport sector and that the domestic production should be stimulated together with development of the RES, without specifics.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

In Croatia, there is no association focused on biomethane. **Biomethane as a separate component is also not covered by any subsidy scheme and the government have not introduced any strategy or roadmap for developing biomethane or biogas.** The association OIE Hrvatska[23] focuses on RES in general. Situation remained the same in 2023, there is only a possibility of feed in tariffs for electricity produced from biogas.

Legislative environment

Specific tax incentives to encourage the use of biomethane are not currently implemented.

Hydrogen

According to the NECP Croatia intends to cooperate on research of hydrogen-based decarbonisation solutions and adopt a hydrogen strategy encouraging the development of science, research, and development of hydrogen technologies on all sectors. **NECP estimates the gross final consumption of hydrogen from RES to 39.2 ktoe (0.04 bcm) in 2030.** To further develop the inland market, the higher usage of hydrogen in industry should be supported. Higher usage of hydrogen is expected in 2050.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

In March 2022, **Croatia adopted hydrogen strategy for 2050, which is setting goals for production and consumption of H_2. Croatia plans installation of electrolysers with a capacity of 70 MW by 2030 and 2 750 MW by 2050.** Strategy even recognised that in the case of faster development of hydrogen-based economy there is potential for electrolysers with a capacity of 1.3 GW MW by 2030 and 7.3 GW by 2050. **There is also an active** National Hydrogen Association[24], which is gradually developing cooperation between industry and research in the field. Further, according to NECP, new technology platform will be established to connect national stakeholders in hydrogen research and application. It will monitor global hydrogen technology advancements, serve as a bridge between national, EU, and international levels, and propose development areas and project support.

Legislative environment

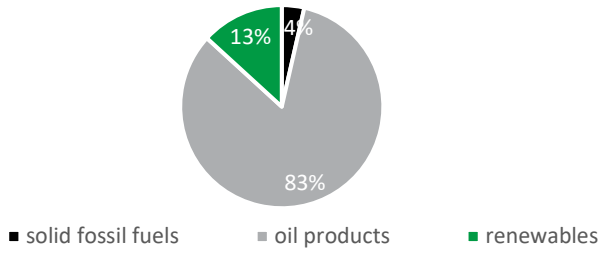
Additionally, a suitable legislative framework is needed to integrate hydrogen into the energy system, such framework should be implemented by the end of 2025. Specific tax incentives to encourage the use of renewable or low-carbon hydrogen or other legislation are not currently implemented. Croatia also is not part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development.

[22] Planned gas consumption in 2030 source: Strategija energetskog razvoja Republike Hrvatske do 2030. s pogledom na 2050. godinu, Ministarstvo zaštite okoliša i energetike, 2020, page 19
[23] https://oie.hr/
[24] http://croh2.fesb.unist.hr/

Cyprus

is an outlier country in the CEE/SEE region. Its energy consumption is rather unique due to its climate and economic activities. However, Cyprus can play a role in the natural gas market due to its five large gas fields discovered between 2011 and 2022.

Total energy consumption by fuel



Source: Eurostat 2021

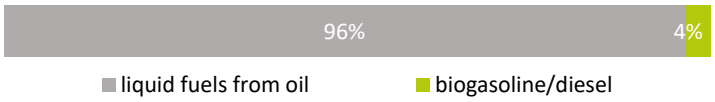
Almost 90% of Cyprus's GDP comes from services and only very little from industry including cement plant and a small number of brick and tile factories. **Cyprus does not consume any natural gas** and all its energy needs are met from crude oil products and renewables. Oil and solid fossil fuels cover around 90% of the country's energy needs and therefore, further development of RES is needed to decarbonise. **All oil products are imported with around half of them used to produce electricity and about a third going to the transport sector.** A higher penetration of RES, primarily photovoltaics, would also reduce the island's electricity costs.

Although Cyprus does not consume any natural gas, it might become its producer due to discoveries of Aphrodite (4.5 tcf), Calypso (1-2 tcf), Glaucus (5-8 tcf), Cronos (2.5 tcf), and Zeus (2-3 tcf). Several appraisal wells were already drilled, establishing that the geology in the location is complex which is likely to add development costs and uncertainty in the commercialization of discovered gas fields. There are ongoing negotiations on building a gas pipeline between Cyprus and Egypt. Gas exploration is also continuing in other Cypriot offshore blocks.

Residential energy continues to increase mostly due to the growing demand for space cooling. The widespread adoption of solar water heating systems is currently the main technology option contributing to the relatively high RES share in the cooling sector. The energy consumed for cooling is unfortunately not captured by the Eurostat data.

Power generation by fuel

Transportation by fuel



Source: Eurostat 2021

Oil-fired generation contributed to 85% of the total generation mix in 2021 and the remainder was supplied by renewable energy sources (mainly wind and solar photovoltaics).

Mobility is largely dependent on motor vehicles for the transport of both passengers and goods. **There are no railways, and public transport modes account for about 2% of total passenger mobility.** The share of electric vehicles is very low (some 566 registered BEVs and 662 PHEVs) and there are also few public charging stations (around 188).

8.6 $MtCO_2e$

Total GHG emissions

Total GHG emissions have decreased 4% between 2019 and 2021. Cyprus' NECP aims to reduce GHG emissions by 24% by 2030 compared to 2005, including -24.9% in ETS sectors and -20.9% in non-ETS sectors (including industry, waste, and agriculture). The NECP sets a target of 31-34% of renewables in gross final energy consumption by 2030, including at least 29% in transport.

SPECIAL FOCUS: The role of gases in the decarbonisation of Cyprus[25]

Natural gas

10.3 TWh
Planned gas consumption in 2030

The planned consumption of natural gas remains unchanged, however in the business-as-usual scenario in NECP the planned consumption in 2030 is 9,7 TWh, which was increased to 10,3 TWh in the national energy strategy in 2030. The updated NECP in 2023 is not yet public.

Biomethane

NECP of Cyprus reports on the possible development of biogas technologies. Higher input of renewable fuels is expected after 2030. **The current output of biogas units in electricity sector is 12.12 MW and in 2030 the capacity should be 27 MW**. NECP mentions biogas especially biogas from waste, specifically project Marathunta landfill. Report does not provide more detailed references to biomethane.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment
In Cyprus, there are no active associations involved in the development of biogas and biomethane. The **Government also has not prepared a strategy for biomethane development**.

Legislative environment
Cyprus plans to introduce a policy framework and support scheme for the use of alternative fuels in transport to achieve sustainable mobility, but no other tax incentives or other legislation framework is implemented.

Hydrogen

NECP mentions usage of hydrogen in transportation and industry, but there will be no use of hydrogen in the domestic industry by 2030. EastMed Pipeline should be prepared for transportation of hydrogen by 2036, Cyprus also agreed to examine the possibility of building gas/hydrogen pipeline from Israel. Also, the possibility of offshore renewable power generation together with production of hydrogen should be examined according to NECP.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment
There is currently no strategy for hydrogen and no government plans to develop a roadmap in the nearest future. There is Hydrogen Association, but no further information or website could be found. Policy research working paper of Energy Fiviion at the Cyprus Institute - *Hydrogen coming of age? A policy framework for Cyprus*. Suggest possible solutions, recommendations for policymakers for creating a hydrogen friendly environment, however it is not a government/official document.

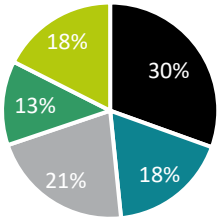
Legislative environment
Specific tax incentives to encourage the use of renewable or low-carbon hydrogen or other legislation are not currently implemented. Cyprus also is not part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development.

[25] Planned gas consumption in 2030 source: Εθνικό Σχέδιο της Κύπρου για την Ενέργεια και το Κλίμα, Theodoulos Mesimeris, ministry of the environment / Nicoletta Kythraiotou, ministry of the environment, 2020, page 217

Czech Republic

has large brown coal reserves, which play a significant role in both power generation and heating. Natural gas, which is a key source for the Czech industry, is almost entirely imported.

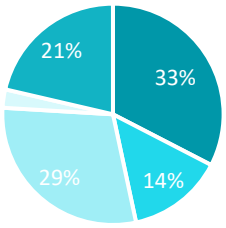
Total energy consumption by fuel



■ solid fossil fuels ■ natural gas ■ oil products ■ renewables ■ nuclear

Source: Eurostat 2021

Consumption of gas by sector



■ industry ■ services ■ households ■ other ■ energy production

Source: Eurostat 2021

The Czech Republic's energy mix is largely based on solid fossil fuels and nuclear. Due to high costs of CO_2 allowance, it is likely that coal will become uneconomical before the planned phase-out in 2030s. The national decarbonisation plans counted on natural gas as a replacement for solid fossil fuels, especially in heating. The country relies predominantly on old coal power plants and no new large-capacity sources were commissioned in the last decade.

The Czech Republic consumed 9.3 bcm (91 TWh) of natural gas in 2021 with the largest shares going into industrial production, households, and the energy sector, same as in 2020. **Czechia imports 95% of its gas consumption**. In the first half of 2023, no natural gas was imported from Russia. The country's storage capacity is 43.7 TWh, covering almost half of the natural gas consumption.

0 %

of natural gas is imported from Russian Federation

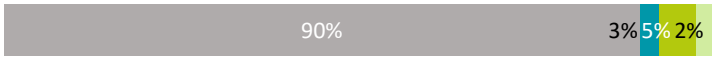
Heating sector by fuel

■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear ■ oil products

Power generation by fuel

■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear

Transportation by fuel



■ liquid fuels from oil ■ gaseous fuel ■ biogasoline/diesel ■ electricity

Source: Eurostat 2021

The heating sector is heavily dependent on coal (56% in 2021) and natural gas (31%). Large structural change is necessary to decarbonise the sector. **A large part of the heat is supplied via a centralized network.** Thus, Czechia aims to increase utilization of the nuclear waste heat in heating to decarbonise. In local heating, the installation of heat pumps and biomass boilers received substantial funding in 2022.

Power generation also heavily utilizes coal (41%). Czechia's RES development is expected to continue as new legislative changes in 2022 and available EU funding provide needed stimulus.

The transport sector is highly dependent on fossil fuels as well. **Alternative fuels play a minor role in national transportation.** The Czech Republic has a noticeable charging infrastructure. Together with Poland and Hungary, it is the second largest in the CEE/SEE countries amounting to over 4 000 points.

109 $MtCO_2e$

Total GHG emissions

Czechia generated 3% of the EU's total greenhouse gas (GHG) emissions in 2021. Energy, utilities, and Industry sectors account for 67% of Czechia's total emissions. Decarbonisation action mainly focuses on increasing shares of renewable energy and energy efficiency.

SPECIAL FOCUS: The role gases in the decarbonisation of the Czech Republic[26]

Natural gas

117.7 TWh
Planned gas consumption in 2030

Czech Republic has not altered its official 2030 target yet since the Russian invasion of Ukraine and assumes that gas will still play an important role in its energy transition away from coal. However, in 2022, the government communicated a commitment to completely withdraw from dependence on the supply of energy raw materials (mainly natural gas) from the Russian Federation within a five-year horizon. The goal is to increase the share of RES instead of natural gas.

Biomethane

According to the NECP, Czechia plans to support the development of production and use of biomethane, especially in transport and heating. **It plans investment and operational support for biomethane.** The production of biomethane, its injection into the gas network, and other projects for the use of biomethane are already underway. **According to the NECP, biomethane production in the country should reach 500 mcm in 2030. Distribution system operators estimate that up to 223 biomethane plants could be connected by 2032, with a total annual production capacity of approx. 3 690 GWh/year.**

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

Plans for biomethane are extensively described in NECP and National Plan for Clean Mobility[27]. In the National Energy Strategy[28], biomethane is not directly mentioned, however, the document provides for the production and use of biological gases. **There is an active biogas** association[29] **in the Czech Republic**, with more than 100 members.

Legislative environment

Tax incentives for biomethane are included in financial support for other RES. The legislative framework further enables the **tax incentives for biomethane and other biological gases in transport and does not pose fundamental obstacles to injection** into the gas system. Biomethane market development is also limited by the absence of national registry for biomethane guarantees of origin and its harmonisation with the EU registries.

Hydrogen

Czechia has ambitious goals to use H_2 in transport, industry, and energy industries. It sets specific goals for its development in the NECP[30] and further develops them in the national hydrogen strategy. The strategy lays out detailed scenarios for the development of hydrogen in individual sectors. **The transport sector and heavy industry should become the largest consumers of hydrogen**. Czechia is also internationally active in building new corridors: Central European Hydrogen Corridor from Ukraine, SunsHyne from North Africa, and Czech German Hydrogen Interconnector from Northern Germany & Baltics.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry*	Transportation

*Industry is not mentioned in NECP but already figures in Czechia's hydrogen strategy

Political environment

In Czechia exists, an active hydrogen association[31] **that** promotes hydrogen solutions and connects many stakeholders from government, industry, and research. Czechia also **has its** hydrogen strategy[32] **with specific goals and includes hydrogen in national plans for the deployment of alternative fuel infrastructure** (2014/94/EU).

Legislative environment

Specific tax incentives to encourage the use of renewable or low-carbon hydrogen or other legislation are not currently implemented. Czechia also is not part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development. Hydrogen is mentioned in legislation connected with alternative fuels in transport and an amendment to the energy law that establishes hydrogen for regular usage in economy is expected.

[26] Planned gas consumption for2030 source: Czech Ten-Year Network Development Plan 2023 - 2032, NET4GAS, 2022
[27] https://www.mpo.cz/en/industry/manufacturing-industry/automotive-industry/national-action-plan-for-clean-mobility--179151/
[28] https://www.mpo.cz/dokument161030.html
[29] https://www.czba.cz/en.html
[30] https://energy.ec.europa.eu/system/files/2020-03/cs_final_necp_main_en_0.pdf
[31] https://www.hytep.cz/en/
[32] https://www.mpo.cz/assets/cz/prumysl/strategicke-projekty/2021/9/Hydrogen-Strategy_CZ_2021-09-09.pdf

Example of hydrogen project:

Czech German Hydrogen Interconnector

The Czech-German Hydrogen Interconnector (CGHI) initiative has been launched in 2022 to create a hydrogen interconnector to connect high potential hydrogen supply areas in Northern Germany and Baltics with expected high demand clusters in the EU (predominantly in South Germany and North Bohemia). It will also enable connection of local suppliers and consumers along the corridor in the Czech Republic and Germany.

Timeline of the project
Operation start by 2030

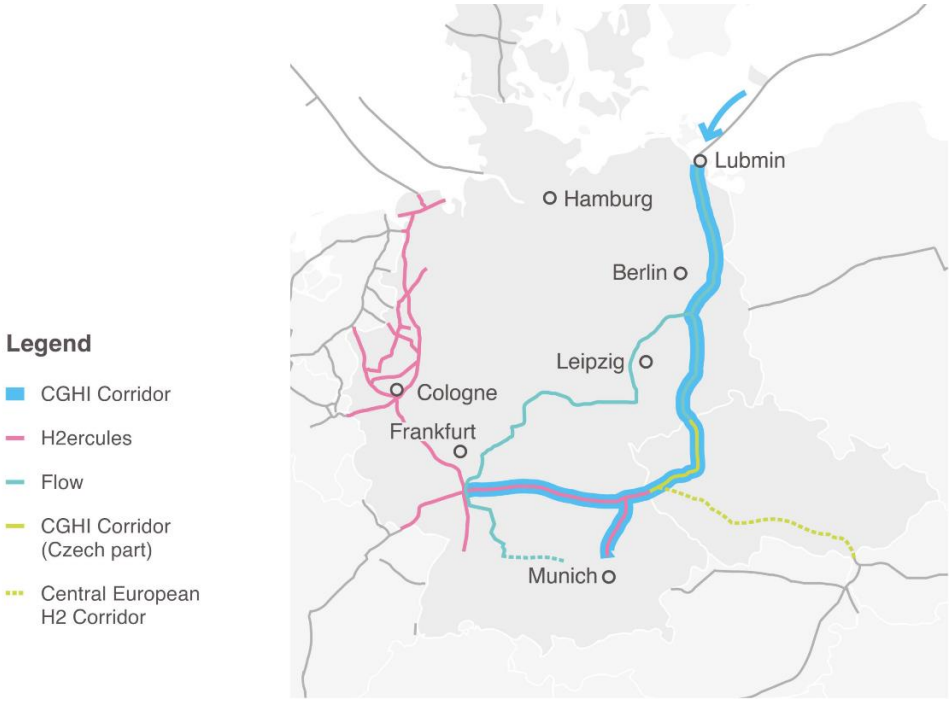
The project is promoted by three gas TSOs - NET4GAS (Czech gas TSO), GASCADE (German gas TSO) and OGE (German gas TSO). These TSOs have submitted separate applications for Project of Common Interest (PCI) status of the CGHI initiative through an open call for applications, launched by the European Commission on 17 October 2022 and at the time of publishing of this report the project is on the list of candidates for the PCI status.

The currently ongoing pre-feasibility study indicates that the whole pipeline stretch of 1,068 km can be repurposed for transmission of 100% hydrogen. The project aims to be operational by 2030, with later target transport capacity of up to 144GWh of hydrogen per day or 1.5 million tonnes per year.

The initiative could make a significant contribution to REPowerEU's target of importing 10 million tonnes of green hydrogen into the EU by 2030 and is open for cooperation with hydrogen producers, large hydrogen consumers and other gas infrastructure companies to help facilitate the production and consumption of hydrogen in Central Europe.

Project status: Planned, pre-feasibility study in process.

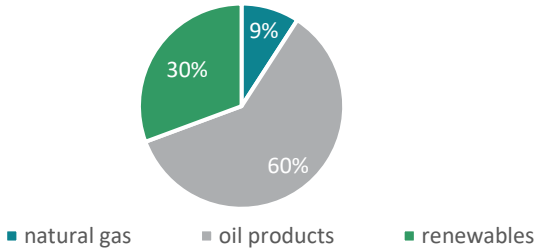
Project promoters: NET4GAS, s.r.o., GASCADE Gastransport GmbH, OGE



Estonia

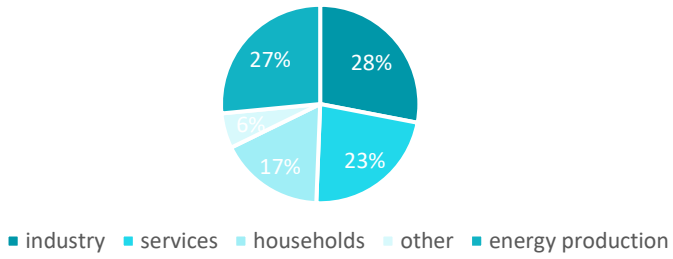
Estonia still relies on locally produced and highly polluting oil shale as its primary source of energy but is gradually moving to RES, mainly solid biomass.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



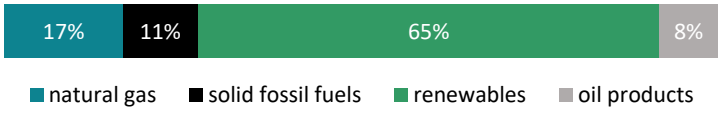
Source: Eurostat 2021

Estonia has a unique energy mix, where the energy supply is dominated by domestically produced oil shale, some 60% of the final energy consumption of around 30 TWh. This gives the country a high degree of energy independence but also makes it one of the most carbon-intensive in the region. In early 2021, the Estonian government announced plans to reach carbon neutrality by 2050. The share of RES in the gross final energy consumption reached 30% in 2021. Around 86% of renewable energy is from biomass. More than half of the Estonian territory is covered with forest and the role of forestry and wood industries in the Estonian economy is substantial. Gas consumption across the Baltic states is quite small, accounting for some 9% of total energy consumption in Estonia. District heating is the main natural gas consumer in Estonia. Nearly a third of the gas is consumed by the residential-tertiary-agriculture sector (including 19% for services and 15% for households) and 26% by industry.

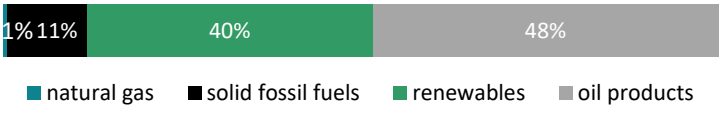
Estonia's gas consumption has remained stable since 2015 at around 0.5 bcm (5 TWh). Estonia imports 100% of its natural gas consumption. Estonia banned import of Russian gas replacing it with LNG from 2023. The capacity of LNG terminals in Finland and Lithuania was said to be sufficient to meet the needs of the Finish and Baltic market even if the demand were to recover to pre/war levels.

0 %
of natural gas is imported from Russian Federation

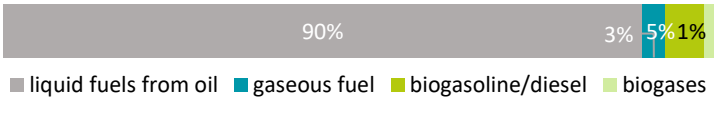
Heating sector by fuel



Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

District heating takes up around 60% of heating in Estonia and its continuous growth is supported by the government. 50% of heating is covered by biomass, the second largest is the consumption of natural gas. However, in 2022 the district heating sector increased its consumption of shale oil due to natural gas shortages.

Electricity production from oil shale was radically reduced in 2019 (by 50%), temporarily increasing last year due to the energy crisis. **The electricity generated from RES is dominated by biomass,** but solar and wind capacity is projected to quadruple in the next decade. Estonia declared a target to completely decouple from Russian power grid in early 2025.

The final energy consumption in transport is slightly increasing, with renewable energy fuels showing an upward trend in the past years. **In 2021 renewable energy in transport was around 7%**, mostly through biofuels.

13.3 $MtCO_2e$
Total GHG emissions

Estonia generated 0.4% of the EU's total greenhouse gas (GHG) emissions. The extraction and processing of oil shale, the main raw material used for electricity generation and production of liquid diesel fuel, is highly energy intensive and generates a significant amount of CO_2. **The government aims to phase out shale in electricity production by 2035 and in the entire economy by 2040.**

SPECIAL FOCUS: The role of gases in the decarbonisation of Estonia[33]

Natural gas

4.85 TWh
Planned gas consumption in 2030

Estonia assumes relatively small natural gas consumption in 2030. According to *The Estonian Energy Policy Development Plan* (ENMAK) natural gas consumption for heating sector which has the highest consumption should be 4,3 TWh. The country's decarbonisation efforts focus on the phase out of oil shale. Decarbonisation of the hard-to-abate sectors will be achieved with higher production of low emission gases. With potential biomethane production of 450 mcm/year (4,4 TWh).

Biomethane

One of Estonia's targets in the NECP is to increase the share of renewable transport fuels to 14 %. The target should be met primarily by increasing domestic biomethane production to 380 GWh per year by 2030 compared to 168 GWh in 2022. Biomethane should be primarily used in transportation. Renewable energy's share in final energy consumption is projected to rise from 42% in 2021 to 65% by 2030.

Developed environment | In process | Lack of available informations

Biomethane and biogas application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

There is an **active** biomethane association[34] **in Estonia**. According to their knowledge, no investment decisions concerning gasification and power-to-methane production have been made yet. There is no specific biomethane strategy, however, plans for biomethane are part of the ENMAK.

Legislative environment

To develop biogas and biomethane, The Ministry of Economic Affairs and Transportation of Estonia introduced a **new regulation to support biomethane producers with feed-in premium** to cover the price gap between biomethane and natural gas, for now **until 2023**. It is expected that this support and regulation will be extended for a further period and the level of support increased.

Hydrogen

Estonia aims to establish **a complete hydrogen supply chain for transportation, heating, and electricity generation**. According to the NECP[35] Estonia gave over 67 mil. EUR to industrial research and initial recovery of electrolysers and fuel cells until 2026**. By 2030 Estonia estimates that 1095 tonnes of green hydrogen will be needed annually.** Estonia is also supporting IPCEI projects with hydrogen and European Hydrogen Backbone. In 2022, Estonia received 23 applications worth 1.5 billion euros for hydrogen projects under IPCEI, intending to integrate hydrogen into existing infrastructure and develop new infrastructure dedicated to hydrogen.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

There is currently no official strategy for hydrogen, but government institutions are developing plans for hydrogen in various sectors. Estonia also **includes hydrogen in national plans for the deployment of alternative fuels infrastructure** (2014/94/EU). In 2016, the Estonian Association of Hydrogen Technologies[36] was established. Agreement to establish Hydrogen Valley Estonia which should create a complete ecosystem and a hub for hydrogen technologies in the region. In 2023 Estonian Hydrogen Roadmap was published.

Legislative environment

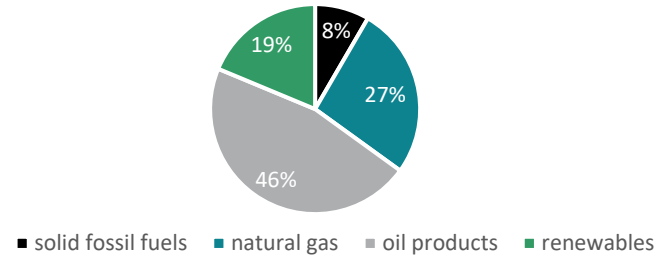
Specific tax incentives to encourage the use of renewable or low-carbon hydrogen in the transport sector are currently implemented, but Estonia is not part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development. Estonia supports legislation coming from EU that supports hydrogen and the creation of a pan-European hydrogen infrastructure.

[33] Planned gas consumption in 2030 source: EESTI GAASIÜLEKANDEVÕRGU ARENGUKAVA 2021-2030, Elering, 2021, page 13
[34] http://eestibiogaas.ee/
[35] https://commission.europa.eu/system/files/2023-08/Estonia_Draft_Updated_NECP_2021-2030_en_1.pdf
[36] http://h2est.ee/eng/

Greece

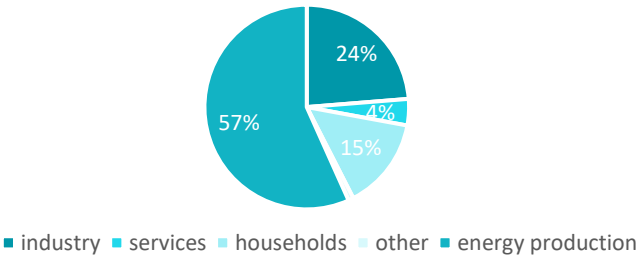
has an LNG terminal, making it strategically important in European energy security. It also has coal reserves which still impact its emissions.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



Source: Eurostat 2021

Greece experienced a significant increase in the share of renewable energy in the total energy consumption between 2020-2021. **Greece has announced the complete phase-out of lignite from energy production by 2028 and the aim to decrease dependency on Russian oil.** All but one lignite powerplants were supposed to be shut down by the end of 2023 but this has been extended due to the energy crisis. Additional major energy sources are oil products and natural gas.

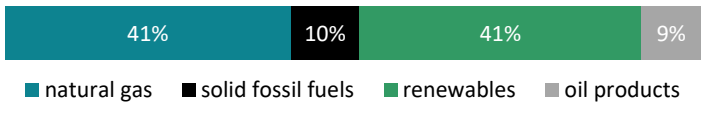
Greece consumed approximately 7 bcm (69,96 TWh) of gas in 2021. Greece imports 100% of its natural gas. The country managed to reduce its dependence on Russian gas from 2021 to 2022 by 16,3%, mainly by increasing LNG by 54,2%. **Greece aims to build new LNG terminals with a combined capacity of 18,7 bcm/year,** which would raise Greek importance in gas supply at the regional level. The Alexandroupolis LNG terminal, with a regasification capacity of 5.5 billion cubic meters (bcm) per year, is expected to become operational by the end of 2023. The terminal will be 20% owned by Bulgaria.

34,36 %

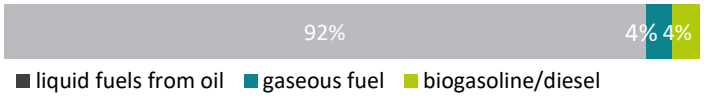
of natural gas is imported from IP Kulata-Sidirokastro

Heating sector by fuel

Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

Greece has a very **low need for heating due to its climatic conditions**. However, the energy needs of cooling are likely to substantially increase in the coming years.

Natural gas is the greatest source of energy used for electricity production in Greece but is **closely followed by RES**. About 20% or 9.5GW of newly installed RES capacity seems to be the realistic outcome by 2030.

Greece uses biofuels in transportation and has a growing share of electromobility with an approximately 85% increase in the number of BEVs and PHEVs in 2022. In 2022, Greece had approximately 1 300 EV charging points. **Greece passed legislation stating that at least 14% of the energy used in transportation will be renewable by 2030.**

86 $MtCO_2e$

Total GHG emissions

Greece accounts for 2.5% of total EU GHG emissions and has reduced its emissions at a higher pace than the EU average since 2005. With a 29% share of the total, Energy & utilities industries accounted for the largest share of Greece's GHG emissions. Reductions in Energy & Utilities emissions are expected as the country proceeds with phasing out lignite-fired power plants and an increase in the share of RES in energy.

SPECIAL FOCUS: The role of gases in the decarbonisation of Greece[37]

Natural gas

36 TWh
Planned gas consumption in 2030

Gas consumption is to drop by almost half compared to the current consumption of 70 TWh, natural gas will continue to play a key role in heating. Greece wants to achieve this savings through greater electrification and the development of renewable sources, when photovoltaics target for 2030 is determined at 14.1 G (from 5 GW today), and for onshore wind at 7 GW (from 5 GW). The decarbonisation focus will remain on the more polluting lignite plants. In addition, Greece is expected to be a net hydrogen exporter by 2045 (8.6 TWh or 2.4 bcm H_2), while in 2050 the net exported volumes are anticipated to be even larger (20.2 TWh or 5.7 bcm H_2).

Biomethane

In the NECP, Greece plans the gradual blending of biomethane into the gas network and its use in heating, transport, and energy sectors. Greece plans **to create a new regulatory framework that will enable the development of biomethane production and its use in gas transmission and transportation network**. The proposed goal of the new NECP is biomethane production of 1.5 to 1.7 TWh by 2030 with potential up to 11 TWh / year.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

The use of biomethane is outlined in the NECP, but the government is yet to present a more detailed biomethane strategy. There is a national association[38] uniting biogas producers, with an active role.

Legislative environment

According to the NECP Greece intends to provide regulatory support for biomethane in the gas network, the goal is an increase of RES for heating-cooling. **Biogases support is part of the regulatory framework for the support of renewable sources.** However, for example the absence of the required institutional framework for the introduction of the produced biomethane in the natural gas network and fuel stations limits its full utilization.

Hydrogen

Greece declares in the NECP[39] that it is necessary to consider the production of hydrogen in connection with the construction of RES. According to government institutions, **Greece must participate in relevant programs that deal in more detail with the application of hydrogen in individual sectors**. At the beginning of 2023, Greece proposed a hydrogen strategy. **According to the strategy 750 MW installed electrolysis capacity should be operational by 2030.** Greece wants to build a hydrogen pipeline to Bulgaria as a part of a southeastern corridor which is supposed to be a part of the European projects of common interest. Projects with private financing are starting to increase, such as the construction of a 100 MW hydrogen production facility, the Hydrogen Valley in Crete.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

Government supports the development of the hydrogen economy, there is currently **proposed national strategy for hydrogen that needs to be finalized**. Greece also does not include hydrogen in its national plans for the deployment of alternative fuel infrastructure until today (2014/94/EU). There is no hydrogen association.

Legislative environment

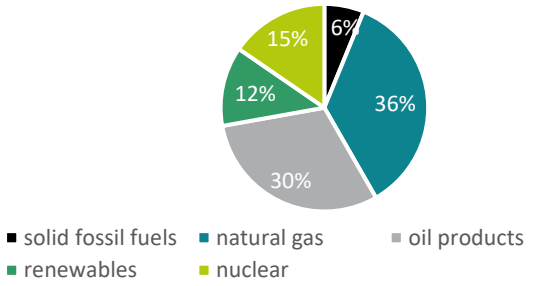
Specific tax incentives to encourage the use of renewable or low-carbon hydrogen exist in transportation together with plans on building fuelling infrastructure. Other hydrogen focused legislation is not currently implemented. Greece is also not part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development.

[37] Planned gas consumption for 2030 source: https://radar.gr/article/xanagrafoume-to-ethniko-schedio-gia-tin-energeia-kai-to-klima-esek
[38] https://habio.gr/en/?lang=en
[39] https://energy.ec.europa.eu/system/files/2020-03/el_final_necp_main_en_0.pdf

Hungary

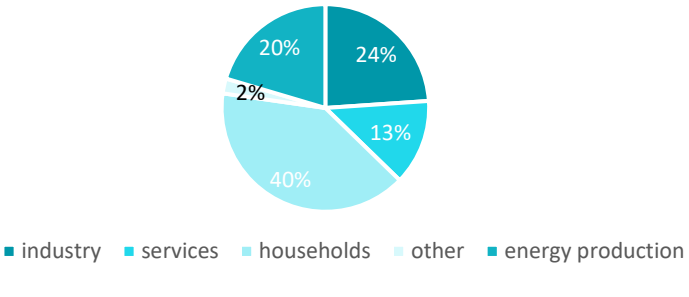
is highly dependent on Russian gas. Natural gas is the main heating fuel and assumes second place in the country's power generation.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



Source: Eurostat 2021

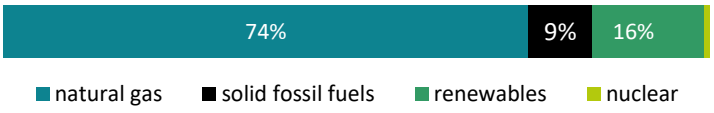
Natural gas is the main source of energy in Hungary. Gas consumption has increased since 2014, by 4%/year on average. Half of the gas is consumed by households and services (53% in 2021), mainly for heating. The share of industry in gas consumption amounted to 24% in 2021, surpassing that of the energy sector (20%). Gas is supplemented by nuclear energy and renewables, which were in the national decarbonisation strategy identified as the key drivers toward Hungary's net-zero emission target by 2050. The share of RES in final consumption in 2021 was slightly over 12%. Hungary also produces around 7 Mt/year of lignite, from which around 86% is used in the power sector by the only remaining coal power plant. Hungary's coal phase-out is planned for 2025. In 2023, the European Commission approved Hungarian scheme that will support investments towards a net-zero economy. The scheme is open to strategic sectors producing batteries, solar panels, wind turbines, heat-pumps, electrolysers, equipment for carbon capture usage and storage and key components for such equipment.

Hungary consumes around 11 bcm (110 TWh) of gas annually. In 2021, approximately 13% of natural gas was extracted domestically. **The country imports around 87% of its gas** and most of it comes from Russia. Hungary's gas storage capacity is 67.7 TWh.

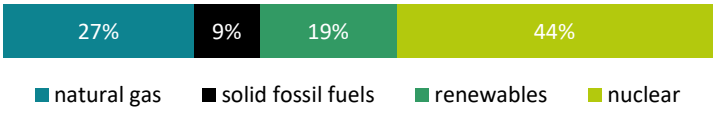
85 %

of natural gas is imported from Russian Federation

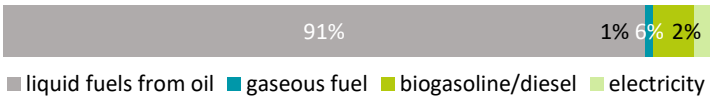
Heating sector by fuel



Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

Hungary is amongst the most dependent on (Russian) gas for heating in CEE/SEE region. However, due to the large share of nuclear power, there is considerable potential for the substitution of natural gas with nuclear waste heat in heating.

Hungary aims to increase its nuclear capacities through the Paks II project, where Russian Rosatom begun preparatory construction works on two new nuclear units of 1.2GW each.

Hungary ranks 4th in the region in the share of battery EV and plug-in EV vehicles among its alternative fuels fleet (over 50%). There are mechanisms in place to boost electromobility by 2030 with existing subsidies and tax incentives.

52 $MtCO_2e$

Total GHG emissions

Hungary accounts for 1.9% of total EU GHG emissions. Each with 20-25% share of the total, the Energy & Utilities, Industry, and Household activities sectors accounted for majority of Hungary's GHG emissions in 2021. An increasing trend of GHG emission since 2005 was observed in agriculture, manufacturing, and construction.

SPECIAL FOCUS: The role of gases in the decarbonisation of Hungary[40]

Natural gas

94 TWh
Planned gas consumption in 2030

Natural gas remains to be the main source of energy still in 2030, the dependence on natural gas not domestically produced should be 80 % by that time. Besides the current main supplier, Russia, LNG, and alternative sources are being explored together with addition expansion of cross border infrastructure. Hungary also plans more gas power generation to counter the effects of increased production from intermittent RES. In district heating the share of natural gas should by reduce by 50 % in 2030, however the consumption of natural gas will increase by 4.5 % over the period 2019-2030.

Biomethane

According to the NECP, the **share of biogas in the total gas consumption is expected to be 1 % in Hungary in 2030**, **which is approximately 85 mcm/year.** NECP mentions the **possibility to blend biomethane into the gas network or use it as an alternative fuel.** Hungary's National Energy Strategy[41] lists the **annual potential of biogas at 25 PJ (0.71 bcm)**, and the electricity production capacity from biogas should be 124MW based on NECP. Hungary seems to pay more attention to biomass in general rather than biogas with biomethane.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

Hungary seems to not have biogas or biomethane association. The future role of **biomethane is not explicitly mentioned in the National Energy strategy or NECP**, these documents, however, bring up the potential of biogas, which has a direct impact on biomethane production.

Legislative environment

Hungary intends to encourage biogas/biomethane production through the **establishment of new subsidy schemes.** Refundable aids in the 2021-2027 period aim to support biogas plants processing agricultural waste.

Hydrogen

Hungary expects development of hydrogen and other alternative fuels mainly in connection with the increase in domestic production of natural gas. According to the NECP[42], **Hungary plans to implement hydrogen in transport, industry, heating and intends to further develop plans to transport hydrogen through the existing gas system together with European hydrogen backbone**. The development of hydrogen will be supported by the new regulation that will cover the entire supply chain together with higher share of RES in final energy consumption which should by 29 % by 2030. **The country sets a target of consuming 593 GWh of hydrogen produced through electricity from RES in 2030**. Hungary specifies the plans for the hydrogen economy in hydrogen strategy, Hungary sets itself **the goal of installing 240 MW of electrolysers by 2030**. According to the strategy, hydrogen solutions should be implemented by 2026, which will ensure the readiness of the infrastructure for further development.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

In Hungary, an active hydrogen association [43]that promotes hydrogen solutions connects many stakeholders from government, industry, and research **already exists. Hungary also has its** hydrogen strategy [44]with specific goals and **includes hydrogen in national plans for the deployment of alternative fuels infrastructure** (2014/94/EU).

Legislative environment

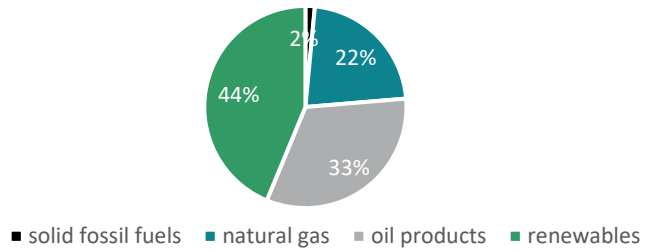
Specific tax incentives to encourage the use of renewable or low-carbon hydrogen or other legislation are not currently implemented. Nevertheless, Hungary is part of the HyLaw[45] project, which aims to identify the status and legislative barriers to hydrogen development.

[40] Planned gas consumption for 2030 source: NECP Draft, page 188, figure 48.
[41] https://2010-2014.kormany.hu/download/7/d7/70000/Hungarian%20Energy%20Strategy%202030.pdf
[42] https://commission.europa.eu/publications/hungary-draft-updated-necp-2021-2030_en
[43] https://p2g.hu/
[44] https://www.iea.org/policies/13928-national-hydrogen-strategy-nhs
[45] https://www.hylaw.eu/

Latvia

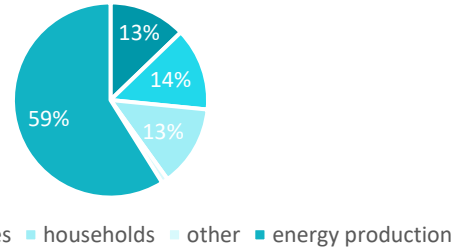
aims to create new LNG terminals which would significantly increase its energy security. It has a well-developed share of renewable energy sources.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



Source: Eurostat 2021

Latvia achieved a 44% share of RES in the final energy consumption in 2021 and aims to reach 50% by 2030. The most common renewable source is wood fuel, followed by biogas and solid biomass in the production of electricity and heating and cooling. **The main driver of gas demand is the energy sector responsible for the consumption of 59% of natural gas**. The Latvian Industry consumes very little gas.

In 2021, Latvia consumed some 1.2 bcm (12,5 TWh) of gas. All Latvian natural gas is imported with the majority historically coming from Russia. Latvian lawmakers have passed a legislative amendment banning imports of Russian gas into the country starting January 2023 with all future gas supply coming via LNG terminals. The capacity of LNG terminals in Finland and Lithuania was said to be sufficient to meet needs of the Finish and Baltic market even if the demand were to recover to pre/war levels.

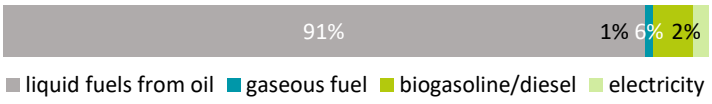
0 %

of natural gas is imported from Russian Federation

Heating sector by fuel

Power generation by fuel

Transportation by fuel



Source: Eurostat 2021

Compared to 2020, in 2021 the amount of heat produced in **CHP plants** grew by 13%, reaching 5.6 TWh or **66% of the total amount of heat produced in Latvia** (8.6 TWh).

The **electricity produced by CHP plants has constituted more than half of the total electricity** produced in the country for the past ten years. Most of the fuel used in the CHPs was fossil, not renewable fuel. **Almost half of the electricity used in the country is provided by RES.** The main renewable resource is hydroelectric power. CHPs account for 23% of electricity produced (15% in biomass CHP plants and 8% in biogas CHP plants).

The transport sector is the second-largest consumer of energy and the biggest polluter. Latvia's alternative fuel vehicles are by 93% comprised of LPG vehicles. During the covid-19 pandemic, Latvia began experiencing a sudden spike in EV sales. However, the share of BEV is only 5% of the alternatives.

12.9 MtCO2e

Total GHG emissions

Latvia accounts for 0.3% of total EU GHG emissions. Agriculture represents 25%, followed by Household activities with 20%. Energy industries account for 17%. The Transportation and storage sector accounts for 18%. Industries accounts for 13% and trade, Services & other account for around 6%.

SPECIAL FOCUS: The role of gases in the decarbonisation of Latvia[46]

Natural gas

11.8 TWh
Planned gas consumption in 2030

Disconnecting the Baltic power grid from BRELL[47] (connection to Russia and Belarus) and aligning it with Continental Europe will notably affect the natural gas market. Upon entering the new synchronization zone, Latvian electricity producers must ensure their own generation capacities, with natural gas mainly ensuring stable power supply as RES power generation increases. Moreover, according to the NECP, natural gas is potentially seen as alternative fuel (CNG, LNG) to gradually decarbonise transport sector.

Biomethane

Latvia mentions the use of biomethane in the field of transport (alternative fuel), NECP also mentions regional cooperation in the transport sector between the Baltic States, but there are no more details about biomethane development in Latvia. Lithuania supports projects that should lead to the development of biomethane and biogas.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

In Latvia, there is an active association[48] operating in the field of biomethane. The Latvian Biogas Association connects 44 members from the industry, government, and academic spheres. Latvia Ministry of Environment **also published a document focusing on the development of biogas.**

Legislative environment

According to a governmental statement, the **increase in biomethane production and its use in transport should be supported by the obligation of fuel suppliers to sell energy obtained from RES**. Neither NECP nor other strategic documents mention the planned biomethane support in more detail.

Hydrogen

According to the NECP[49], Latvia focuses on the application of hydrogen as an alternative fuel for transport. However, the **plan does not include specific goals for the application of hydrogen and presents a more long-term vision for hydrogen development.** Latvia's hydrogen regulations are lacking, despite its inclusion as an alternative fuel in the directive. **Currently, the main activities related to hydrogen in Latvia are taking place in the academic sphere**. Conexus, the gas TSO, actively researches H_2 with Estonia, Finland, and Lithuania. They are prepping an R&D study on hydrogen injection and transport in the grid. Conexus began phase 1 of assessing 100% hydrogen injection in Inčukalns UGS. They also contribute to the European Hydrogen Backbone infrastructure vision.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

There is Latvian Hydrogen Association which is supposed to develop hydrogen strategy by the end of 2023 with the governmental support. A consortium of companies to help with the creation of the national hydrogen strategy was founded at the beginning of 2023, they signed Memorandum of Understanding (MoU) on the development of hydrogen technology. Latvia does not include hydrogen in national plans for the deployment of alternative fuels infrastructure (2014/94/EU).

Legislative environment

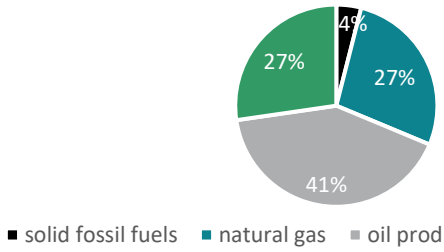
Specific tax incentives to encourage the use of renewable or low-carbon hydrogen in the transport sector are currently being implemented. Latvia is also part of the HyLaw[50] project, which aims to identify the status and legislative barriers to hydrogen development.

[46] Planned gas consumption for 2030 source: Dabasgāzes pārvades sistēmas operatora, Conexus Baltic Grid, 2021, page 13
[47] Signed agreement among Belarus, Russia, Estonia, Latvia, and Lithuania on synchronization of mutual electricity networks of the states
[48] http://www.latvijasbiogaze.lv/
[49] https://energy.ec.europa.eu/system/files/2020-04/lv_final_necp_main_en_0.pdf
[50] https://www.hylaw.eu/

Lithuania

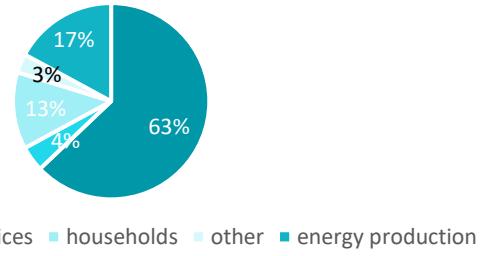
has by international comparison a fossil-fuel intensive energy mix due to large utilization of oil products, but a high share of bioenergy, like its Nordic and Baltic neighbours and Austria.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



Source: Eurostat 2021

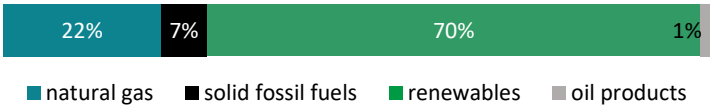
Since the end of domestic nuclear production in 2010, **Lithuania strongly depends on imports of energy. Lithuania's own energy production which accounts for a quarter of the consumption consists mostly of bioenergy and waste (90%),** a minimum of other renewables such as wind, solar, hydro, geothermal, and negligible oil production. All other consumed oil, coal and natural gas must be imported. Dominant sources in the country's total energy consumption are oil and natural gas, which increases the country's need for decarbonisation. The sectors accounting for almost two-thirds of the final energy consumption are transport and industry (which includes agriculture). **Natural gas plays an important role in the industry, satisfying 63% the sector's fuel consumption.**

Lithuania's natural gas consumption in 2021 was 2.3 bcm (23 TWh). Lithuania imports all its gas. In April 2022, it stopped all imports of Russian gas (as well as all energy sources), utilizing The Independence floating storage and regasification unit. Lithuania is one of the few countries in the region without underground gas storage.

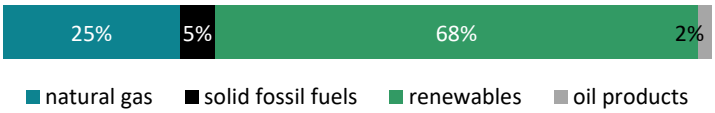
0 %

of natural gas is imported from Russian Federation

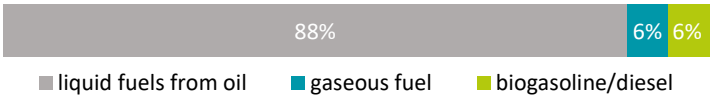
Heating sector by fuel



Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

Lithuania has more than 50% of households connected to district heating. Most of the fuel used is secondary biomass, a by-product of the lumber industry. **State support for biomass is now cancelled and new subsidies should become available for solar and heat pumps.**

In the next phase of the transition of the energy industries, the **country will invest in CHP plants to replace simple biomass boilers**. By 2030, **Lithuania wants to reduce its electricity imports and cover 70% of its electricity consumption with domestic RES**. It plans to complete its synchronization with the continental European power system by 2025.

Lithuania has one of the OECD's lowest excise duties on petrol and diesel and a much lower tax rate on diesel than petrol. Starting from 2023, the excise tax rates will be consistently increased. The EVs are receiving political and investment support to be a dominant replacement. Currently, there are over 7 500 BEVs and 4 900 PHEVs registered.

20.6 MtCO2e

Total GHG emissions

Lithuania generates 0.8% of the EU's total GHG emissions. In 2021, Transportation and storage accounted for the largest share (31%) of total emissions in Lithuania, followed by Industry with 22%. With Lithuania's low population density and dispersed towns making road transport the dominant mode of travel for passengers and freight, transport emissions are projected to rise steeply until at least 2024 without additional measures. As a highly agrarian country, Agriculture was responsible for 18% of total emissions, compared to the EU average of 13%. Energy & utilities account for only 9% of emissions (third the EU average).

SPECIAL FOCUS: The role of gases in the decarbonisation of Lithuania[51]

Natural gas

20 TWh
Planned gas consumption 2030

Lithuania is planning to replace natural gas consumption in most sectors with alternative gaseous fuels. The consumption of natural gas in heating should get from 6.7 TWh in 2020 to 0.6 TWh by 2050. The injection of hydrogen and methane blends will be available in Lithuania. The domestic gas demand will remain at the level of 20 TWh. This number can change if the energy savings will continue as the natural gas consumption was reduced by 35.5 % in 2022, from 24 TWh in 2021 compared to 2022 with 15.5 TWh. The existing natural gas grid infrastructure should be ready to transport hydrogen and biogas by 2024. For transport sector, biomethane and green hydrogen consumption should account for least 5.2 % of the final consumption by 2030. Further, the establishment of public and private hydrogen and biogas refuelling point is one of the priorities.

Biomethane

Lithuania mentions the use of biomethane in the field of transport as an alternative fuel. According to NECP, entities supplying natural gas for direct consumption in the transport sector shall be obliged to supply a specified and gradually increasing amount of gas from renewable energy sources. The **additional 950 GWh of production capacity of biomethane should be built by 2030**.[52] To cover such a volume of demand, it will be necessary to build new production capacities. **Lithuanian government sets a goal of supporting new production capacities in the NECP and planning on building several facilities**. One of the measures to increase biomethane production is to support the reorientation of biogas stations to biomethane production.

Biomethane application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment
There is an association for biogas in Lithuania (Lithuanian Biogas Association[53]), the association does not seem very active. However, in the NECP biomethane together with biogas are given a lot of space and political attention.

Legislative environment
In 2022, Lithuania's Ministry of Energy announced plans to allocate 22.2 million euros to support the production of biomethane and in March 2023, Lithuania approved it into the law.

Hydrogen

In its NECP[54], **Lithuania perceives hydrogen technologies as promising for the industry, transport, and energy. It is dedicated to supporting research and first projects of companies in the field of hydrogen**. Assessment of adapting gas network for green hydrogen transport is underway. The amount of hydrogen produced in the transportation sector by 2030 is supposed to be 1.7 bcm. Lithuania's Hydrogen Platform was established in 2020 at the initiative of the Ministry of Energy.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment
In July 2023, the government approved guidelines for the creation of a hydrogen strategy. Based on these guidelines, there should be at least a 350 MW electrolysis capacity and a production of 34 000 tons of green hydrogen in 2030. After 2030, a large increase in the use of hydrogen throughout the economy is expected. The existing natural gas infrastructure can be adapted to transport a mixture of hydrogen and methane by 2030.

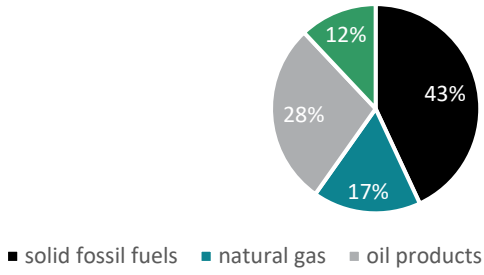
Legislative environment
Specific tax incentives for hydrogen are currently being implemented. One of the NECP priorities is to establish provisions related to the development of the hydrogen market and infrastructure in the Lithuanian legal framework. Lithuania does not participate in the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development.

[51] Planned gas consumption in 2030 source: https://www.ambergrid.lt/uploads/structure/docs/220_98ea7a3edc477637d38bc3279c1c069a.pdf
[52] https://am.lrv.lt/uploads/am/documents/files/KLIMATO%20KAITA/Integruotas%20planas/Final%20NECP.pdf, page 60
[53] http://www.lbda.lt/en/home
[54] https://commission.europa.eu/system/files/2023-07/LITHUANIA%20DRAFT%20UPDATED%20NECP%20EN.pdf

Poland

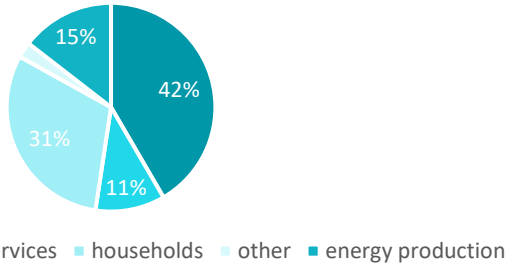
is still largely dependent on its coal production and utilization. In gas, it plays an increasingly more important regional role with its existing LNG terminal and planned new infrastructure.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



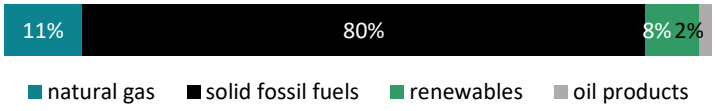
Source: Eurostat 2021

In 2021, solid fossil fuels accounted for 43% of Poland's total energy supply. In 2021, 73% of Poland's electricity came from coal and it is estimated that in 2022 it remained approximately the same. While the share of coal in Poland's energy system has been gradually declining, the replacement was found mostly in natural gas, to a lesser extent in RES. **Poland aims to introduce nuclear power to its energy mix.** The first six nuclear power blocks with 6-9 GW of total capacity should become operational by 2040. The target for powering up the first of the six nuclear reactors is 2033. This target is unlikely to be met due to technical obstacles. Poland also signed an agreement with EDF for the deployment of multiple small modular reactors.

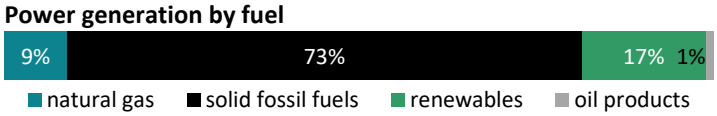
Poland consumes around 19 bcm (around 190 TWh) of gas annually. Poland's own gas production has been around 3-4 bcm for the past few years. In 2021, natural gas imports totalled 17.4 bcm (87%) with more than half from Russia. Starting on 27th April 2022 Gazprom terminated gas flows to Poland. LNG imports accounted for 22% (3.8 bcm after regasification) of all imported gas fuel. The existing LNG terminal in Świnoujście operates at an increased capacity of 6.2 bcm/year and it will extend its capacity up to 8.3 bcm from the beginning of 2024. **Gas started flowing to Poland through the new project Baltic Pipe pipeline in October 2022 with a 10 bcm capacity from Norway via Denmark and the Baltic Sea**. In addition, Poland is planning to build a 6.1 bcm Floating Storage Regasification Unit (FSRU) in Gdansk by the end of 2027. Poland also considers to add a second FSRU in Gdansk (with a capacity of 4.5 bcm) and as a result the LNG storage and regasification terminal in Gdansk, **would have a total capacity of 10.6 bcm, such increase depends on the market interest confirmed in the binding open season.**

55 %
of natural gas used to be imported from Russian

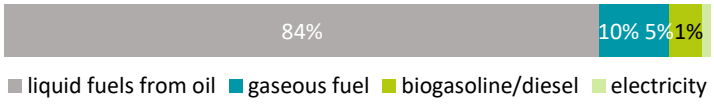
Heating sector by fuel



Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

As much as 76% of heat is generated in local heating installations (households 49%, industry and construction 20%, trade, services, and others 7%). The remaining 24% is produced in district heating systems.

Polish power generation is still heavily reliant on fossil fuels. In 2022, Poland experienced an unprecedented boom in residential solar development with approximately a 60% year-on-year increase in installed capacity.

Poland's demand for EVs is outpacing the European average by a considerable margin. Poland has already over 33 200 BEVs and 30 300 PHEVs registered. To keep up, Poland will need to expand its infrastructure, currently at 4 300 charging points.

400+ MtCO2e
Total GHG emissions

Poland is responsible for generating 11.6% of the EU's total GHG emissions. The energy sector, heavily reliant on coal, is the country's largest GHG emitter, with 37% of total emissions. The second place in emissions (21%) belongs to the industry sector, which comprises primarily heavy industry. Agriculture, forestry, and fishing; Services, trade and other; Household activities sectors have similar shares of 13-14% each.

SPECIAL FOCUS: The role of gases in the decarbonisation of Poland

Natural gas

263.7 TWh
Planned gas consumption 2035

Poland still sees gas as a transition fuel due to their huge dependence on coal. However, after latest events in Ukraine the Polish gas operator Gas-System modified its forecast for 2035 to 27 bcm. In the future a further RES development, energy savings and increasing energy efficiency should help the decarbonisation efforts. A big role is also to be played by the new nuclear power plants in Poland, which should be commissioned after 2033.

Biomethane

The NECP expects **the production of agricultural biogas to exceed 7.8 bcm annually but mentions no specific use of biomethane**. According to the National Energy Policy[55], the biomethane and other biogas markets should reach a 14 % share of the total renewable energy consumption in transport by 2030. Poland can have 1 GW installed capacity by 2025 in biomethane power plants.

Biomethane and biogas application areas mentioned in the NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation*

*Use of biomethane in transport also figures in Poland's national Energy policy.

Political environment

Several associations[56] are active in the field of biogas and biomethane in Poland and a magazine about the state of biomethane and biogas sector is published every year. The Polish government supports the biogas and biomethane sector and perceives it as an important part of decarbonisation and energy security plans.

Legislative environment

Poland introduced a zero-excise tax for CNG, LNG, biomethane, biogas, and hydrogen. Low-Carbon Transport Fund will support the development of alternative fuel infrastructure, including biomethane, over 10 years and represents another catalyst regarding biomethane development. Another discussed support scheme is primarily concerned with biomethane from anaerobic digestion.

Hydrogen

In the NECP[57], Poland emphasizes the potential of hydrogen in the energy, transport, and gas sectors and sees hydrogen as one alternative that will help strengthen the country's energy security. **Specific goals for hydrogen development are set out in the Polish Hydrogen Strategy[58], which focuses on the entire supply chain of the hydrogen economy. According to this strategy, five hydrogen valleys and 2 GW of capacity to produce low-carbon and green hydrogen should be developed by 2030**. In the initial stage, the distribution of hydrogen will be ensured by train transport, and afterward with the already existing gas infrastructures. Several fuelling stations are planned, among the largest capacity from PKN ORLEN (54 fuelling stations by 2030).

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry*	Transportation

*Industry is not mentioned in NECP but already figures in Poland's hydrogen strategy.

Political environment

In Poland, an active hydrogen association[59], which promotes hydrogen solutions and connects many stakeholders from government, industry, and research **already exists**. Poland also **has its hydrogen strategy with specific goals but does not include specific goals for hydrogen in its national plans for the deployment of alternative fuels infrastructure** (2014/94/EU).

Legislative environment

Poland has set up a CO_2 pricing mechanism, which supports the use of hydrogen in transport. Poland is also part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development. HyLaw already identified high regulatory and legislative barriers to hydrogen development in Poland. Poland is now producing great amount of grey hydrogen and constantly working on development of green hydrogen chain.

[55] https://www.gov.pl/web/climate/energy-policy-of-poland-until-2040-epp2040
[56] https://biometan.org.pl/en/kontakt-en, http://www.pspbr.org/, http://www.upebi.pl/
[57] https://energy.ec.europa.eu/system/files/2020-01/pl_final_necp_summary_en_0.pdf
[58] https://www.gov.pl/web/klimat/polska-strategia-wodorowa-do-roku-2030
[59] http://www.hydrogen.edu.pl/index_en.php

Example of hydrogen project:

Damasławek Hydrogen Storage - enabling the storage of pure hydrogen

Timeline of the project
31/03/2021 Pre-feasibilitv

The project involves the construction of an underground storage facility for pure H2 (2 caverns with the capacity of approx. 40 mcm each) and H2-ready caverns for CH4 that may be converted to H2 (up to 36 caverns with the capacity of approx. 40 mcm each). The project is planned to be in the Damasławek salt deposit (central Poland). Integral parts of the investment are the underground and aboveground infrastructure of the storage facility, the leaching plant, brine, water, and high-pressure pipelines for H2 and CH4. The project foresees the construction of a tankless underground hydrogen storage facility that will offer the possibility to store renewable energy, to increase energy efficiency and to foster environmental sustainability including through the reduction of greenhouse gas emissions by decarbonising the economy in a socially equitable manner.

The project will store hydrogen that will be distributed via the Polish Hydrogen Backbone Infrastructure, thus balancing supply and demand for hydrogen. It will be supplied with renewable hydrogen (e.g., onshore, and offshore wind, solar PV) and low-carbon hydrogen in line with application EU and national regulatory framework. The project will contribute to the integration of renewable and low carbon gases into the gas network, greenhouse gas emission reductions, as well as flexibility and seasonal storage options for renewable electricity generation. It will provide efficient and safe storage of hydrogen with aim to support use of hydrogen as an alternative fuel in transport, decarbonisation of industry and reduction of greenhouse gas emissions of the whole economy, especially in hard-to-abate sectors (e.g. heavy industry), as well as utilisation of hydrogen technologies in the energy sector to reduce the emissions and diversify the energy generation structure, to limit the use of fossil fuels and to reduce the state's dependence on fuel imports.

The project is the dedicated facility to serve relevant storage capacities in terms of the Bi-directional, cross-border dedicated hydrogen pipeline infrastructure project from Finland to Germany through the Baltics and Poland so called Nordic-Baltic Hydrogen Corridor.

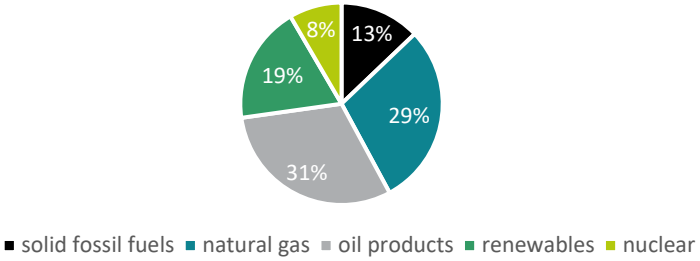
Project status: Planned. Pre-feasibility phase is underway since 2021 and shall end in 2024. Next steps to be determined after the feasibility studies.

Project promoters: GAZ-SYSTEM S.A.

Romania

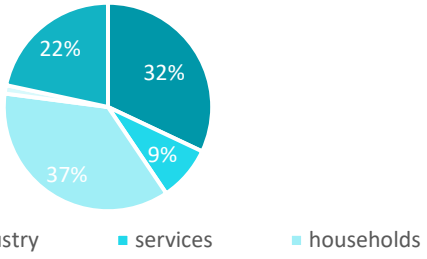
is the second largest producer of natural gas in the EU with the ability to grow. It has potential to also become a major European LNG supplier and transport hub.

Total energy consumption by fuel



Source: Eurostat 2021

Consumption of gas by sector



Source: Eurostat 2021

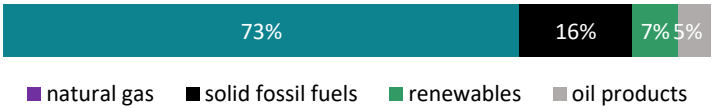
Romania relies to a great extent on fossil fuels. Romania is the second largest gas producer in the EU with currently estimated 200 bcm **of reserves. This means that Romania has the lowest reliance on gas imports in the region.** Natural gas accounts for almost 75% of Romania's heating and plays a supporting role in power generation. Romania still produces and uses coal, operating a 4.9 GW coal capacity. **The country committed to a coal phase-out by 2032 but, in the light of the energy crisis, decided to keep the power plants in reserve instead of decommissioning them.** Renewables, along with nuclear energy, but also gas are seen as essential to the transition process. Romania achieved a 19% share of RES in total energy consumption in 2021. The two existing nuclear reactors play crucial role in the energy mix, supplying around 20% of the country's power and two additional units should come online by 2030 and 2031 respectively.

Romania produces 80% of its natural gas consumption domestically. That makes it less dependent on imported gas. Over the last few years, the percentage of imports in Romania's gas consumption increased as quantities extracted from mature fields declined, while the development of offshore projects was delayed by legislation changes. Romania's dependence on Russian gas is less severe, but not insignificant. So far Romania has no LNG terminal.

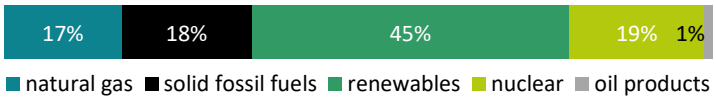
29.5 %

of natural gas was imported from Russian Federation in 2021

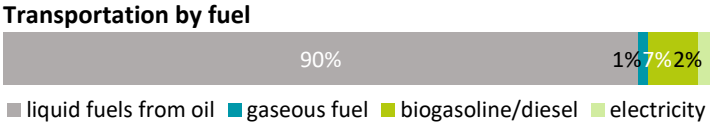
Heating sector by fuel



Power generation by fuel



Transportation by fuel



Source: Eurostat 2021

The existing district heating systems generate heat predominantly from coal and natural gas. A new measure sets to support fuel switch to RES such as biogas, biomass, and geothermal, but the progress is so far slower than planned. Romania has one of the largest potentials for geothermal energy in Europe is taking steps towards utilizing the potential in heating.

Significant portion of Romanian power generation capacity is old and due for modernisation. Despite that it is not planning on renewing its coal power generation plants and is working on plans for phasing out coal by 2032.

In May 2022, European Commission endorsed Romania's recovery and resilience plan with reforms promoting decarbonisation of road transport, green taxation, incentives for zero-emission vehicles, and a modal shift to railways and water transport.

113 MtCO2e

Total GHG emissions

Romania generates 3% of the EU-27's total GHG emissions. Industry sector accounts for the largest share of Romania's GHG emissions (38.7%), followed by Energy & Utilities sector (27%), Agriculture and household activities (both 21%), Transportation and Storage (6.4%), and Services, Trade & Other (5.5%).

SPECIAL FOCUS: The role of gases in the decarbonisation of Romania[60]

Natural gas

103.4 TWh
Planned gas consumption 2030

To ensure national energy security, Romania aims to maintain a diversified energy mix by 2030, where **natural gas accounts for 12 % of the power installed capacity and most of the consumption is covered by local production**. By 2030 the installed capacity of gas power generation sources should be 2.9 GW.

Biomethane

Biogas in general is at a very early stage of development in Romania. The NECP does not mention the specific role of biomethane in transport, heating, or industry. In the NECP, the **country sets general targets for the promotion of biogas research, which will determine the potential for biomethane production. No data is available at the national level,** based on which future potential can be estimated even with Romania's high potential thanks to their agriculture.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

In Romania, operates the Association for biomass and biogas[61] (ARBIO), which represents the shareholders of the bio-industry and actively propose new incentives to promote and support biogas and biomethane potential. They are not **part of the National energy strategy until 2030[62]. ** Biogas and biomethane are dealt together with biomass.

Legislative environment

In Romania, **there is currently no tax or legislative support for upgrading biogas or for injecting biogas/biomethane into the natural gas grid**, also no tax incentive is provided for biomethane usage in transport and other relevant sectors.

Hydrogen

According to the NECP[63], Romania focuses on the implementation of hydrogen projects in economy to achieve the country's decarbonisation goals. **Romania plans to build 2 000 km of new gas infrastructure, which will be fully prepared for hydrogen blending. In 2026, the share of hydrogen should reach 20 % of transported gases via gas infrastructure**.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

New Hydrogen strategy was accepted in 2023 which sets goals for hydrogen chain development and quantity. In a best-case outlook, Romania aims for 3.9 MW electrolyser capacity by 2030, backed by 8 GW renewable energy solely for H_2. **Anticipated H_2 output is 288.8 kt annually by 2030**, to be achieved with a help from five proposed hydrogen valleys. Active hydrogen association[64], which promotes hydrogen solutions and connects stakeholders from government, industry, and research **already exists in Romania.**

Legislative environment

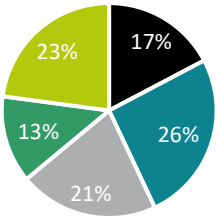
Romania has set up a CO_2 pricing mechanism and introduced carbon-related taxation, which will help with shift to low carbon transportation. The country is also part of the HyLaw[65] project. New Hydrogen Law establishes obligations on fuel suppliers to provide fuels from RES and **sets minimum percentages of H_2 from RES in fuel used in Romania**, not complying will results in fine. It also sets up a reporting obligation for fuel suppliers about the energy value of all fuels supplied for consumption. It generally removes barriers to the production and use of hydrogen.

[60] Planed gas consumption in 2030 source: Strategia Energetică a României 2016-2030, cu perspectiva anului 2050, Ministerul Energiei, 2016, page 64
[61] https://www.arbio.ro/english/#all
[62] http://energie.gov.ro/wp-content/uploads/2016/11/Romanian-Energy-Strategy-2016-2030-executive-summary3.pdf
[63] https://energy.ec.europa.eu/system/files/2020-06/ro_final_necp_main_en_0.pdf
[64] http://www.h2romania.ro/en/index.html
[65] https://www.hylaw.eu/

Slovakia

has a balanced energy mix with notable shares of nuclear and natural gas energy.

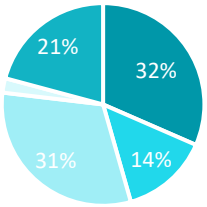
Total energy consumption by fuel



■ solid fossil fuels ■ natural gas ■ oil products ■ renewables ■ nuclear

Source: Eurostat 2021

Consumption of gas by sector



■ industry ■ services ■ households ■ other ■ energy production

Source: Eurostat 2021

Slovakia's total energy consumption depends on crude oil products due to transport, imported natural gas, domestic nuclear energy, and electricity imports. **Unlike other countries, Slovakia confirmed** coal phase-out **for end of 2023 despite the energy crisis.** Two additional nuclear reactors, Mochovce 3 and 4 will help to secure power supply after the coal retirement. Addition of the new blocks would double the nuclear capacity (currently 1 400 MW). The block 3 is running at 75% of its capacity and after final tests the reactor should begin full commercial operation in October/ December 2023. **Domestic energy consumption is driven by the demand for energy from the industrial and commercial sectors.**

Slovakia consumes around 5.2 bcm (52 TWh) of gas annually. The country imports 95% of its natural gas but managed to reduce the amount it imports from Russia to approximately 1/3. To become independent, Slovakia has reserved the capacity in several European LNG terminals and will import gas from Norway via a pipeline. Slovakia completed an interconnector with Poland. Slovakia can cover about 70% of its annual consumption from its underground gas storage, assuming full utilization of their capacity.

30 %

of natural gas used to be imported from Russian Federation

Heating sector by fuel

■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear ■ oil products

Power generation by fuel

■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear ■ oil products

Transportation by fuel

■ liquid fuels from oil ■ gaseous fuel ■ biogasoline/diesel ■ electricity

Source: Eurostat 2021

Slovakia heavily utilizes natural gas and to lesser extent coal in heat production. When the new nuclear blocks become fully operational, further utilization of waste heat from blocks 3 and 4 could boost the decarbonisation of the heating sector.

Most of the electricity comes from nuclear power (53%), followed by RES (24%) and fossil fuels (23%). **Slovakia plans to build additional RES capacity, including 80 MW of solar on the phased-out coal mining sites.**

Slovakia prioritizes the use of engines with compressed natural gas (CNG, currently some 3 000 personal and light commercial vehicles), liquefied propane gas (LPG, 50 000), as well as CNG or LPG supplemented by biomethane for transportation decarbonisation. However, the number of BEVs (some 4 700) and PHEVs (4 200) is also growing as is the charging infrastructure (over 2 100 charging points).

31.6 MtCO2e

Total GHG emissions

Slovakia accounts for 1.1% of the EU's total GHG emissions. The industry is responsible for the largest share of the emissions, with 49%. Household activities and Energy & Utilities sectors follow with 18% and 16% of the emissions respectively.

SPECIAL FOCUS: The role of gases in the decarbonisation of Slovakia[66]

Natural gas

52,6 TWh
Planned gas consumption 2030

The natural gas stays in mid-term an important energy source, mainly due to highly developed and implemented central heating systems for domestic sector and the hard-to decarbonise industry in Slovakia. Slovakia expects decrease in consumption of natural gas in heating sector but expects its rise in power generation and transportation. Faster development of RES sources and alternative fuels together with increasing energy efficiency is expected and can reduce planned consumption.

Biomethane

To achieve its goals in the field of renewable resources, Slovakia plans to increase the production of biogas and biomethane. The **NECP anticipates an increase in biogas and biomethane from the 2021 level of 21 GWh annual production to 1 440 GWh in 2030. Total production of biomethane in 2030 should be 300 mcm/year.** Slovakia intends to use biomethane in several sectors, the NECP mentions an alternative fuel, injected into the gas network, or used in the heating sector.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment

Biogas Association[67] brings together different stakeholders to improve the legislative framework for biogas development. **Slovakia is focusing more on production of biomethane instead of biogas.**

Legislative environment

According to the NECP, **Slovakia intends to introduce several legislative measures to support biomethane** (promoting the transition from biogas to biomethane, support for the recovery of waste from plant and animal production, support for the recovery of waste from the biodegradable part of municipal). For example, by amending Act no. 309/2009 on the support of renewable energy sources is supposed to introduce an obligation to mix biomethane into LNG and CNG, thereby increasing the share of biomethane from 2% to 14% in 2030. National registry for guarantees of origin was established.

Hydrogen

Slovakia perceives hydrogen technologies as a promising option to decarbonise its economy. **According to the NECP, 200 kt of H_2 per year will be consumed in Slovakia by 2030, of which approximately 40% will be renewable or low carbon** (from nuclear power)**. More specific targets were presented in the Slovak Hydrogen Strategy[68], according to which the major development of hydrogen till 2030 should take place in transport**. In addition, Slovakia adopted Action plan for the successful implementation of the National Hydrogen Strategy of the Slovak Republic until 2026 with specific steps and funding. Slovakia also has plans to mix hydrogen into the EUSTREAM gas pipeline and transport it to other countries.

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment

Active association[69] to promote hydrogen solutions and connect many stakeholders from government, industry, and research already exists in Slovakia. Slovakia also **has its hydrogen strategy with specific goals and plans to build fuelling stations.**

Legislative environment

Specific tax incentives to encourage the use of renewable or low-carbon hydrogen or other legislation are not implemented and Slovakia is also not part of the HyLaw project, which aims to identify the status and legislative barriers to hydrogen development.

[66] Planned gas consumption in 2030 source: Plán rozvoja prepravnej siete spoločnosti eustream, a. s., na obdobie 2022 – 2031 EUSTREAM, page 10 (calculated from the table)
[67] https://www.sba-sk.sk/
[68] https://www.slov-lex.sk/legislativne-procesy/-/SK/LP/2021/155
[69] https://nvas.sk/en/

Example of hydrogen project:

Slovak hydrogen backbone

Timeline of the project
To be commisioned 2030

The project aims at repurposing of one of existing natural gas transmission lines, enabling transport of hydrogen. The goal is to create a corridor for H2 transmission from H2 production areas to consumers in Slovakia and other EU countries. The existing pipeline connects border point with Ukraine (Veľké Kapušany) with Slovakia-Austria border at Baumgarten and Slovakia-Czech Republic border at Lanžhot. The repurposed pipeline will have daily transport capacity of hydrogen 144 GWh/d, enabling the transit of hydrogen - the clean fuel of the future, substantially contributing to sustainability goals of the EU. Integral part of the backbone is also hydrogen connection to the Hungary via interconnection point Veľké Zlievce, which could enable further hydrogen imports from the South-East Europe (Black Sea area)

The project forms an integral part of more multilateral projects in the region. It is a part of the Central European Hydrogen Corridor (CEHC) project. The CEHC initiative explores the feasibility of creating a hydrogen highway in Central Europe for transporting hydrogen from major hydrogen supply areas in Ukraine via Slovakia and the Czech Republic to hydrogen demand areas in Germany. It is also part of H2EU+Store project which investigates the repurposing of existing transit route between Ukraine and Germany via Slovak republic and Austria with a special focus of utilizing abundant gas storages in Austria and Slovakia for storage of hydrogen. Thus, the main potential of clean hydrogen – ability to be stored – can be utilized. Part of the Slovak hydrogen backbone could be utilized further for the Sunshyne corridor importing green hydrogen form North Africa via Italy, Austria, Slovakia, and Czech Republic to Germany as well as for the South-East European Hydrogen Corridor from Black See area to the Central Europe.

Successful implementation of the Slovak hydrogen backbone will have significant impact on security of supply as well as sustainability goals of the EU, helping to build and strengthen the EU hydrogen market.

To achieve its goals in the field of renewable resources, Slovakia plans to increase the production of biogas and biomethane. The **NECP anticipates an increase in biogas and biomethane from the 2021 level of 21 GWh annual production to 1 440 GWh in 2030.** Slovakia intends to use biomethane in several sectors, the NECP mentions an alternative fuel, injected into the gas network, or used in the heating sector.

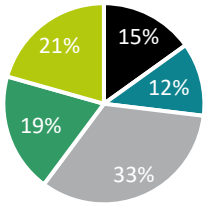
Project status: Planned. Ongoing preparation of the pre-feasibility study.

Project promoters: Eustream

Slovenia

has been traditionally an electricity exporter due to its nuclear and hydropower generation. In its decarbonisation, the country needs to focus on transportation and heating.

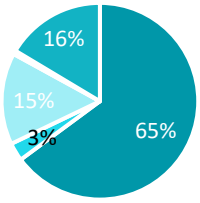
Total energy consumption by fuel



■ solid fossil fuels ■ natural gas ■ oil products ■ renewables ■ nuclear

Source: Eurostat 2021

Consumption of gas by sector



■ industry ■ services ■ households ■ other ■ energy production

Source: Eurostat 2021

Crude oil products (33%) together with nuclear power (21%) play the main role in the Slovenian energy mix. The share of RES was 21%, with majority being hydropower. Solid fossil fuels and natural gas follow with 15% and 12% respectively. Slovenia currently operates one coal-fired 600MW thermal power plant. It announced a phase-out by 2033. Slovenia joined a group of another 10 EU members which issued a joint statement saying that the best way to achieve the EU's independence from Russian fossil fuels is to accelerate the green transition towards climate neutrality by 2050 at the latest.

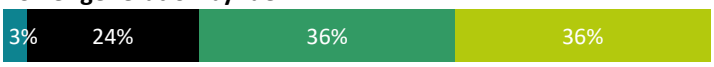
Slovenia uses approximately 0.8 bcm (9 TWh) of natural gas annually (based on 2022 data) and **imports all its natural gas**. After the war in Ukraine, the gas flows have changed, now approximately 30 % of gas comes from Algeria. The country has no LNG import terminals and no underground gas storage, which makes Slovenia mainly dependent on infrastructure in Austria, Italy and Croatia. Slovenia's natural gas infrastructure company Plinovodi plans together with Hungary's FGSZ to construct a new gas interconnector to link Hungary and Slovenia, but the project had to be postponed, because of insufficient funding.

Physical flows were substantially changed after 2022

Heating sector by fuel

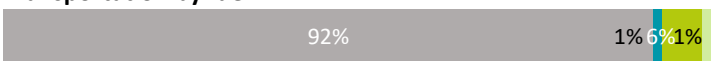
■ natural gas ■ solid fossil fuels ■ renewables ■ oil products

Power generation by fuel



■ natural gas ■ solid fossil fuels ■ renewables ■ nuclear

Transportation by fuel



■ liquid fuels from oil ■ gaseous fuel ■ biogasoline/diesel ■ electricity

Source: Eurostat 2021

Slovenia has a high use of biomass for individual heating, especially in small cities and rural areas. Most district heating is based on large-scale fossil-driven generation. The development of small-scale RES-driven district heating networks is a part of the Slovenian national energy plans and strategies. The picture will change in 2023 (see the remark for Slovenia in the sub-chapter Heating and cooling).

Slovenia's new renewable capacity build-out still largely counts on hydropower (NECP sees a 42% increase). Slovenia's government further accelerated efforts to increase power generation from renewable sources, including solar and wind energy. The last source to boost RES share in Slovenia's power generation is wood biomass.

Due to emissions development in the transport sector, the current decarbonisation measures focus on public transport. Measures include integrated transport planning, mobility management, incentives to use modern management technologies, and subsidies.

15 MtCO2e

Total GHG emissions

Slovenia accounts for 0.4% of total EU GHG emissions. Energy & Utilities accounted for the largest share of Slovenia's GHG emissions in 2021, with 29% of the total. The second largest emitter was the industry sector (21%), followed by Household activities (21%). Agriculture, Transportation & Storage, and Services, Trade & other sectors were all around 10%.

SPECIAL FOCUS: The role of gases in the decarbonisation of Slovenia[70]

Natural gas

9.8 TWh
Planned gas consumption 2030

According to the draft of revised NECP from June 2023 the primary energy consumption of gaseous fuels in 2030 should be 9.8 TWh in scenario with existing measures. This marks a 7% decrease from the previously published NECP. As mentioned, the goal is for all gaseous fuels, and it can be expected that **the consumption of natural gas itself will be even smaller.** By 2030, the country intends to replace between 10 % to 30 % of the gas supply with RES gaseous fuels (hydrogen or other synthetic gases.)

Biomethane

According to the existing NECP, Slovenia expects a total of 34 MW power generation capacity from all types of biogases by 2030 and up to 41MW by 2040. This could generate up to 170 GWh in 2030. The NECP mentions the total biogas potential to be approximately 480 GWh in 2030 and up to 700 GWh in 2040, including biogas produced from sewage treatment plants, waste treatment, landfill gas capture, and agricultural gas production.

Biomethane and biogas application areas mentioned in NECP

Developed environment | In process | Lack of available informations

Energy	Heating	Industry	Transportation

Political environment
There is **no active specialized biomethane association in Slovenia**. However, it is the Chamber of Commerce and Industry of Slovenia[71] (CCIS), which is the largest independent association of companies in Slovenia that covers the development of biogas and biomethane projects. **Slovenia is also part of the European Biogas Association. Slovenia does not currently have a biogas or biomethane strategy.**

Legislative environment
At this moment, **there is no legislative framework for biomethane** support in Slovenia.

Hydrogen

According to the NECP[72], the role of hydrogen should develop with the increasing share of RES in power generation and the current pipeline system should be prepared for new gases. The **annual consumption of hydrogen in transport is predicted to reach 400 GWh in 2030 according to the draft of revised NECP.** Slovenia is also planning on building two-way hydrogen corridors: HU-SI-IT and HR-SI-AT. Slovenia, Croatia and Italy promote ambitious project of the North Adriatic Hydrogen Valley. According to the Long-Term Climate strategy and draft of revised NECP, **Slovenia plans to achieve an approximately 10-30 % share of renewable hydrogen or synthetic gas in the transmission and distribution system by 2030[73].**

Hydrogen application areas mentioned in NECP

Energy	Heating	Industry	Transportation

Political environment
There is currently no separate detailed strategy for hydrogen, however the hydrogen is included in main strategic documents. **There are initiatives to develop hydrogen strategy**. Slovenia also includes hydrogen in its national plans for the deployment of alternative fuel infrastructure (2014/94/EU) to a limited extent. The emphasis on preparation of the existing transmission infrastructure for hydrogen is clear in the NECP.

Legislative environment
Slovenia has set up a CO_2 pricing mechanism and introduced carbon-related taxation, which could nudge the shift to low carbon transportation. Also, the preparation of regulatory and supportive environment for green gases is the key priority in the new NECP. Slovenia is not part of the HyLaw [74] project, which aims to identify the status and legislative barriers to hydrogen development.

[70] NECP, Sankey diagram, page 205 (scenario with ambitious additional actions). Represented are: natural gas + syngas + h2
[71] https://eng.gzs.si/
[72] https://energy.ec.europa.eu/system/files/2020-06/si_final_necp_main_en_0.pdf
[73] EN_SLOVENIA DRAFT UPDATED NECP.pdf (europa.eu), page 71
[74] https://www.hylaw.eu/

Example of hydrogen project:

Slovenian Hydrogen Backbone

Slovenian Hydrogen Backbone will consist of two bidirectional hydrogen corridors: CRO-SI-AT and HU-SI-IT. Both corridors will be built in two phases. In the first phase parts on the parallel existing natural gas pipelines which will be repurposed. In this phase the first Slovenian hydrogen interconnection point with Austria will be established and limited hydrogen flow capacity between Austria and Slovenia will be possible. The first phase will be completed by 2029. In the second phase, repurposed parts of the hydrogen backbone will be upgraded with hydrogen compressor stations and additional new hydrogen pipelines will be built. In this phase new hydrogen interconnection points will be established, and Slovenian hydrogen transmission infrastructure will be connected to all four neighbouring countries. Second phase will be completed by 2035. Slovenian Hydrogen Backbone will be parallel to the existing gas system making uninterrupted gas and hydrogen supply possible.

Timeline of the project
2022-2035

Slovenian hydrogen backbone will make hydrogen production more appealing since potential hydrogen producers will be able to transport their hydrogen to the customers, both domestic and cross border. Functional hydrogen transmission infrastructure will also enable hydrogen market and guarantees of origin (GO) to develop.

Project status: Planned. Ongoing preparation of the pre-feasibility study.

Project promoters: Plinovodi d.o.o.