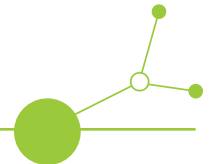


D.2.1.1

Policy framework assessment report



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The following document is developed as a compilation of the analyses of the policy and legal situation by participating countries, which have been made by the respective partners with accompanying support of PP4 EI-JKU in the development of the reports. The EI-JKU assumes no liability for the correctness and completeness of these country-specific analyses.

The contents of this publication do not necessarily reflect the position or opinion of the European Commission.



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A. Introduction

The transition to a sustainable and resilient energy system in Europe requires the coordinated use of a broad range of energy resources and technologies. A successful energy transition cannot rely solely on the expansion of renewable electricity but must instead be based on an integrated approach that leverages all available potentials. In this context, renewable hydrogen plays a central role—particularly in hard-to-electrify industrial sectors—but its production must also be considered from a systemic efficiency perspective.

The operation of electrolyzers for hydrogen production, which requires large volumes of electricity—preferably from renewable sources—also generates significant amounts of waste heat. This thermal energy, if left unutilised, represents a substantial loss of valuable energy. Integrating the recovery and reuse of this waste heat into the broader energy system offers an important opportunity to increase overall efficiency, reduce primary energy demand, and support decarbonisation targets, especially in the heating and industrial sectors.

As electricity generation from renewable sources often does not align with real-time demand, technologies such as renewable hydrogen and the use of waste heat can help balance the grid. While hydrogen production provides a flexible load that can absorb surplus electricity, the associated waste heat can be fed into local heating networks or used in industrial processes, thereby displacing other, often fossil-based, heat sources.

It is therefore essential to design legal and regulatory frameworks that not only support the deployment of renewable hydrogen technologies but also recognise and promote the use of the associated waste heat. Fully exploiting these synergies is crucial for maximising energy system efficiency and achieving the climate and energy goals of the European Union.



B. Country comparison

The comparison table presents responses to six key questions, each of which is answered in binary form (“yes” or “no”). The primary objective of this table is to offer a concise yet structured overview and to enable a preliminary comparison of the policy and legal frameworks across the examined countries. It serves to provide an initial indication of the strategic orientation of each country with regard to hydrogen and/or waste heat. A comprehensive analysis of the respective policy and legal contexts is provided in Chapter 3.

The six questions are listed below, each accompanied by a brief rationale highlighting its relevance to the scope of the project.

- **Does the country have a hydrogen strategy?**
The existence of a national hydrogen strategy—and, more significantly, its substantive content—indicates that the respective state is actively considering the integration of hydrogen into its energy system or has already initiated concrete steps toward the development of a hydrogen economy.
- **Are there national targets (strategic and/or legal) for hydrogen production?**
The definition of strategic or legally binding targets for hydrogen production signifies a clear commitment to the advancement of this specific technology. Moreover, such targets allow for an initial assessment of the intended scale of hydrogen deployment and the specific sectors in which its application may be prioritized.
- **Is there national funding for hydrogen plants and/or hydrogen production?**
The existence of any form of public funding or financial support for hydrogen indicates a further and more concrete step toward the implementation of the technology. By providing such support during its early phase of development and market integration, the state facilitates the establishment and uptake of hydrogen-related solutions. Such support mechanisms not only reflect political will, but also aim to reduce market entry barriers, stimulate private investment, and accelerate the development of a functioning hydrogen economy.
- **Does the country have a heating strategy?**
The presence of a national heating strategy demonstrates that the country has acknowledged the importance of decarbonizing the heating sector and is taking steps to coordinate and guide this transformation. A heating strategy typically reflects overarching policy priorities and may include measures to promote energy efficiency, renewable heat sources, and the modernization of infrastructure
- **Does it include waste heat?**
The explicit inclusion of waste heat within the national heating strategy indicates a



recognition of its potential as a valuable and largely untapped energy source. Integrating waste heat into heating planning highlights the intent to improve overall system efficiency and to reduce dependence on primary energy sources, aligning with broader sustainability and climate objectives.

- **Are there national implementation targets for waste heat?**

The definition of concrete implementation targets for the utilization of waste heat suggests a more advanced level of policy development. Such targets provide orientation for stakeholders, promote the mobilization of investments, and allow for the monitoring of progress



<i>Country</i>	<i>national hydrogen strategy</i>	<i>hydrogen specific targets (strategic and/or legal)</i>	<i>hydrogen fundings</i>	<i>national heating strategy</i>	<i>including waste heat</i>	<i>implementation targets for waste heat</i>
<i>Austria</i>	Yes	Yes	Yes	Yes	Yes	No
<i>Croatia</i>	Yes	Yes	Yes	No	No	
<i>Czechia</i>	Yes	Yes	Yes	No	No	No
<i>Germany</i>	Yes	Yes	Yes	Yes (in form of a legal act)	Yes	Yes
<i>Hungary</i>	Yes	Yes	Yes	No	No	No
<i>Italy</i>	Yes	Yes	Yes	Yes	Yes	No
<i>Poland</i>	Yes	Yes	Yes	No (draft is existing)	No (part of the heating strategy draft)	No
<i>Slovenia</i>	No	Yes	No	Yes	No	No



C. European Legal Framework¹

In recent years, the European Union has undertaken a comprehensive revision of numerous legal regulations in energy and climate matters. This process has been characterised by a notable commitment to the expansion of renewable energies. The legislative change is based on the fact that the implementation of renewable energies into the existing energy system requires a major legal adaptation process to remove legal barriers and obstacles and thus pave the way for the progressive application of renewables.

1. European strategies

The EU initiated this change through a series of strategies that have been further elaborated in subsequent documents. A portion of these strategies has already been integrated into legal norms.

The most significant strategic papers encompass the following:

- **Clean Energy For All Europeans² (2016)**
- **The European Green Deal³ (2019)**
- **A hydrogen strategy for a climate-neutral Europe⁴ (2020)**
- **Sustainable and Smart Mobility Strategy – putting European transport on track for the future⁵ (2020)**
- **'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality⁶ (2021)**

¹ Parts of the elaborations are based on the research project Danube Indeet (Project ID. DRP0200088).

² Communication from the Commission, Clean Energy For All Europeans, COM(2016) 860 final, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0860> (accessed 30.12.2024).

³ Communication from the Commission, The European Green Deal, COM(2019) 640 final, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52019DC0640> (accessed 30.12.2024).

⁴ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A hydrogen strategy for a climate-neutral Europe, COM(2020) 301 final, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0301> (accessed 30.12.2024).

⁵ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Sustainable and Smart Mobility Strategy - putting European transport on track for the future, COM(2020) 789 final, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0789> (accessed 30.12.2024).

⁶ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality, COM(2021) 550 final, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52021DC0550> (accessed 30.12.2024).



2. Hydrogen

The **“European Climate Law” (Regulation (EU) 2021/1119)** should act as a guarantor for progress towards the Paris climate goals and sets a target for the EU to achieve climate neutrality by 2050. On the way to climate neutrality, an interim target has also been set to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

One of the key instruments of European energy and climate policy is the **Renewable Energy Directive (Directive [EU] 2018/2001 – RED III)**. It aims to promote energy from renewable sources and sets overall and specific sectoral targets. It provides a common binding target for Member States to increase the share of renewable energy in the Union's gross energy consumption to 42,5% by 2030, with a view to reaching 45% (2,5% non-binding).

For the industrial sector, the Directive sets a non-binding target for increasing the share of renewable energy sources in final energy and non-energy consumption. Accordingly, there should be an annual increase of 1,6 percentage points, calculated as an annual average for the periods 2021-2025 and 2026-2030. A partial count concerning this target is foreseen for the use of waste heating and cooling. With regard to hydrogen used for the above-mentioned purposes in industry, it is stipulated that at least 42% must be renewable fuels of non-biological origin (e.g. renewable hydrogen) by 2030. This share is to be increased to 60% by 2030.

The **Delegated Regulation (EU) 2023/1184** establishes a harmonised methodology for the EU, introducing rules for the production of renewable fuels of non-biological origin. The method determines the conditions under which electricity utilised in the production process can be classified as renewable, which in turn determines the renewable nature of the produced fuels, particularly hydrogen. Two scenarios are considered: electricity obtained from a direct line or from the public grid. If the electricity is taken from the public grid, the regulation offers several options with corresponding requirements, with different connection points. This ensures that the methods can be chosen according to individual circumstances.

The connection points are as follows:

- more than 90 % average proportion of renewable electricity
- emission intensity of electricity lower than 18 gCO₂eq/MJ
- system useful fuel production
- conditions of additionality, temporal correlation and geographical correlation

The method also regulates the verification requirements for these fuel units. The Delegated Regulation is supplementing Directive (EU) 2018/2001.

Directive (EU) 2019/944 regulates the **European internal electricity market**. Accordingly, it contains provisions on various aspects of the electricity market (such as market roles, unbundling, regulatory authorities, etc.). Of particular relevance is the Directive's definition of



energy storage, which is likely to include electrolyzers. The European Commission confirmed this technology-neutral formulation of the definition in its **Recommendation (2023/C 103/01)** of 14 March 2023. The classification as energy storage is also accompanied by a prohibition for system operators to own, construct, manage or operate such facilities, unless member states define an exemption in accordance with the conditions of the Directive.

The EU directive regulating the internal gas market has recently undergone a revision (**Directive [EU] 2024/1788**) and adoption under the motto 'Decarbonisation of gas markets', accompanied by the corresponding regulation (**Regulation [EU] 2024/1789**). The provisions for hydrogen have been comprehensively novelised. The objective is to establish a hydrogen market, inclusive of the associated infrastructure and network planning. In order to guide the gas industry towards renewable gas, the directive also contains provisions on renewable and low-carbon gases.

3. Waste Heat

The Renewable Energy Directive (RED III⁷) is the central legal act for the definition of waste heat. RED III observes that, despite its wide availability, waste heat remains underutilized, resulting in resource wastage, insufficient energy efficiency in national energy systems, and unnecessarily high energy consumption across the Union.⁸ Building upon this, under the current version of RED III, Member States are allowed to include waste heat up to a specified limit in their national decarbonization measures. Waste heat thereby plays a complementary role to renewable energy sources. The provisions generally stipulate that waste heat can only be partially credited toward meeting the respective targets.

Art 2(9) RED III *waste heat and cold' means unavoidable heat or cold generated as by-product in industrial or power generation installations, or in the tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system, where a cogeneration process has been used or will be used or where cogeneration is not feasible*

Since RED II (and subsequently RED III), in Article 2(9), waste heat has been legally defined as “unavoidable heat [...], generated as a by-product in an industrial installation, in a power generation facility or in the tertiary sector, which would be dissipated unused into the air or water in the absence of access to a district heating system [...], in which a cogeneration process is used, will be used or where cogeneration is not feasible.”

Waste heat is therefore “unavoidable” heat. It refers to heat that inevitably arises in certain processes and cannot be readily avoided. For example, in industrial processes such as steel

⁷ Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, OJ L 2023/77, 1.

⁸ Cf. Recital 70 RED III.



production, cooling processes, chemical reactions, or mechanical operations, heat is generated that cannot be fully integrated into or further utilized by the production process.

The term “unavoidable” implies that, despite existing efficiency measures and technological advances, this form of energy generation is inherently linked to the process.⁹ In light of the Energy Efficiency Directive, “unavoidable” can be interpreted to mean that all other practical energy efficiency measures to reduce waste heat have already been exhausted.¹⁰ Accordingly, a stream of waste heat is considered unavoidable if it cannot be used within the same process or facility.¹¹

Heat generated in industrial, commercial, or power generation processes is classified as a “by-product” because it is not the main objective of those processes. Typically, the intended purpose is to produce a specific product, provide a particular service, or generate electricity. The production of heat is therefore an unintended secondary outcome.¹²

The definition thus refers to the availability of a district heating system. The wording of the definition suggests that without additional structural arrangements (such as setting up access to the district heating system), “waste heat” is not recognized as such.¹³ In this context, the phrase “would be dissipated unused [...] where there is no access to a district heating system [...]” merits closer examination. This phrase targets the waste heat that, in the absence of a district heating system, would remain unused and be discharged into the environment. In other words, if no district heating infrastructure exists to utilize it, this heat would be released into the air or water without being put to use.¹⁴ As a result, the definition only applies to waste heat that is fed into a district heating system. District heating systems are networks transporting heat from a central source to multiple consumers, such as buildings or other industrial facilities. Inevitably, waste heat used internally within the same installation is excluded.

Lastly, the definition places requirements on the district heating system regarding the use of cogeneration. Consequently, within the meaning of the definition, waste heat only exists if a district heating system is in place that uses, will potentially use, or—in exceptional cases—cannot use cogeneration.

⁹ Holzleitner-Senck/Moser/Denk, Waste heat inconsistencies in the EU's energy legislation, Utilities Policy Vol 93, 2025, 10188, 1 (3).

¹⁰ Lyons/Kavvadias/Carlsson/Defining, Defining and accounting for waste heat and cold (2021) 6, 68 <https://op.europa.eu/en/publication-detail/-/publication/b24d337b-4da1-11ec-91ac-01aa75ed71a1/language-en>. Holzleitner/Moser, Renewables vs. Waste heat? Legal provisions on the original energy source, Proceedings of the 2nd NEFI Conference 2022 52 (55), https://pureadmin.unileoben.ac.at/ws/portalfiles/portal/10111449/NEFI_Conference_2022_Proceedings.pdf#page=65.

¹¹ Holzleitner/Moser, Renewables vs. Waste heat? Legal provisions on the original energy source, Proceedings of the 2nd NEFI Conference 2022 52 (55), https://pureadmin.unileoben.ac.at/ws/portalfiles/portal/10111449/NEFI_Conference_2022_Proceedings.pdf#page=65.

¹² Holzleitner-Senck/Moser/Denk, Waste heat inconsistencies in the EU's energy legislation, Utilities Policy Vol 93, 2025, 10188, 1 (3).

¹³ Holzleitner-Senck/Moser/Denk, Waste heat inconsistencies in the EU's energy legislation, Utilities Policy Vol 93, 2025, 10188, 1 (4).

¹⁴ Holzleitner-Senck/Moser/Denk, Waste heat inconsistencies in the EU's energy legislation, Utilities Policy Vol 93, 2025, 10188, 1 (4).



This definition is primarily relevant for the RED III regime; moreover, it is referenced in various legal acts, for instance in the context of European State aid law.

Member States often create incentives for the use of waste heat through investment support instruments, thereby implementing the requirements of the Directive. Under the (strict) Union State aid regime, the definition in Article 2(9) RED III is likewise decisive (Article 2(128c), Article 36(2)(a)–(c), Article 46 of the General Block Exemption Regulation¹⁵). Nationally, for example, the Environmental Promotion Act¹⁶ (*Umweltförderungsgesetz, UFG*) also refers to the RED III definition (pursuant to § 5(1)(1) of the Renewable Expansion Act¹⁷ [*Erneuerbaren-Ausbau-Gesetz – EAG*]).

¹⁵ Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty, OJ L 2014/187, 1.

¹⁶ Bundesgesetz über die Förderung von Maßnahmen in den Bereichen der Wasserwirtschaft, der Umwelt, der Altlastensanierung, des Flächenrecyclings, der Biodiversität und der Kreislaufwirtschaft und zum Schutz der Umwelt im Ausland sowie über das österreichische JI/CDM-Programm für den Klimaschutz (Umweltförderungsgesetz – UFG), BGBl I 185/1993.

¹⁷ Bundesgesetz über den Ausbau von Energie aus erneuerbaren Quellen (Erneuerbaren-Ausbau-Gesetz – EAG), BGBl I 150/2021.



D. National Reports¹⁸

Following the initial overview provided by the comparison table—and after outlining the relevant policy and regulatory framework at the level of the European Union—the subsequent national reports aim to offer a more detailed analysis of the policy and legal situations in the respective countries. For this purpose, the content of relevant national strategies in the areas of hydrogen and waste heat will be examined. This is followed by a closer analysis of the legal instruments governing these sectors.

The national analyses are presented in alphabetical order of the participating countries. The objective is to provide a comprehensive understanding of both the strategic orientation and the legal framework in each case, thereby allowing conclusions to be drawn about the extent to which the respective national systems are prepared to facilitate the integration of hydrogen and waste heat technologies.

1. Austria

1.1. Strategic approach

1.1.1. Hydrogen

The Austrian Hydrogen Strategy¹⁹ provides a strategic framework and was adopted in 2022 with the objective of advancing hydrogen-related developments. Key goals include the establishment of 1 GW of electrolysis capacity by 2030, the creation of a supportive regulatory environment for renewable hydrogen production, the integration of hydrogen as a crucial component of the energy system, and the development of an appropriate hydrogen infrastructure.²⁰

Climate-neutral hydrogen is to be prioritized in sectors that are particularly difficult to decarbonize and lack viable alternatives, such as heavy industry. While hydrogen is already an essential industrial feedstock, it is primarily derived from fossil sources. Shifting to renewable hydrogen could significantly reduce emissions, particularly in sectors like steel production. However, hydrogen will not be used in applications where more efficient and cost-effective decarbonization alternatives exist.²¹

¹⁸ Parts of the elaborations are based on the research project Danube Indeet (Project ID. DRP0200088).

¹⁹ *Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Hydrogen Strategy for Austria* (2020), https://www.bmk.gv.at/dam/jcr:0eb2f307-1e4d-41b1-bfd8-22918816eb1b/BMK_Wasserstoffstrategie_DE_UA_final.pdf (accessed 14.02.2025).

²⁰ Cf. *Federal Ministry for Climate Action, Hydrogen Strategy*, 17, 18.

²¹ Cf. *Federal Ministry for Climate Action, Hydrogen Strategy*, 6.



Priority is given to renewable (green) hydrogen and climate-neutral hydrogen produced via natural gas with carbon capture (blue H₂) or pyrolysis (turquoise H₂) are of primary relevance. The use of hydrogen generated through nuclear energy (pink hydrogen) or blue hydrogen where carbon capture is facilitated by nuclear energy is explicitly excluded.²²

Austria acknowledges that a complete reliance on domestic hydrogen production will not be feasible in the medium to long term. Consequently, the hydrogen strategy is embedded within a European and global context to facilitate the development of import mechanisms and the establishment of European and international partnerships for climate-neutral hydrogen and its derivatives.²³

1.1.2. Waste heat

The use of waste heat is specifically mentioned in the document “Comprehensive Assessment of the Potential for Efficient Heating and Cooling” (*Umfassende Bewertung des Potenzials für eine effiziente Wärme- und Kälteversorgung*) issued by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation, and Technology (*Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie*).²⁴ This document provides a thorough evaluation of Austria’s potential for efficient heating and cooling, based on the European Energy Efficiency Directive 2023/1791/EU.²⁵ In this context, it outlines the possibilities for utilizing waste heat. As part of the comprehensive assessment, the report examines, among other aspects, how industrial waste heat can be harnessed to decarbonize the heating sector.²⁶ According to the analyses in the report (citing Moser & Lassacher 2020), approximately 1.8 TWh of industrial waste heat per year is already fed into district heating networks in Austria, and more recent data indicate a slight increase in this amount.²⁷ In larger cities, waste heat is often used to cover the base load in district heating networks.²⁸ The data are georeferenced and available in the online “Austrian Heatmap,” which provides information on potential sites (e.g., specific industrial facilities).²⁹

The integration of waste heat utilization into strategic frameworks is explicitly mentioned, particularly in the context of Austria’s energy and climate plans. In line with Austria’s goal of

²² Cf. Federal Ministry for Climate Action, Hydrogen Strategy, 5.

²³ Cf. Federal Ministry for Climate Action, Hydrogen Strategy, 26.

²⁴ BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024), <https://www.bmk.gv.at/themen/energie/effizienz/hocheffizient.html>.

²⁵ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 3.

²⁶ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 4.

²⁷ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 18.

²⁸ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 26.

²⁹ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 36.



achieving climate neutrality by 2040, future heating and cooling supply should rely exclusively on renewable energy sources and waste heat.³⁰

The report highlights the Integrated National Energy and Climate Plan (NEKP) for 2021-2030 as the key strategic document promoting waste heat utilization.³¹ Current funding schemes under the Heat and Cooling Pipeline Expansion Act (WKLG) and the Environmental Support Act (UFG) require a decarbonization plan to be submitted, ensuring that by 2035, at least 80% of heating and cooling energy comes from renewable sources and waste heat. Achieving a 100% share in district heating and cooling will require additional strategies and measures.³²

Key sectors identified for waste heat utilization include **waste incineration plants³³ and industrial facilities.**³⁴ The long-term objective is to achieve **100% reliance on renewable energy and waste heat** in district heating and cooling.³⁵

1.2. Legal status quo

1.2.1. Hydrogen

The legal framework governing hydrogen in Austria is multifaceted, encompassing various regulations that address different aspects. In general, the following key legislative areas can be identified:

- **Electricity Act 2010 (Elektrizitätswirtschafts- und -organisationsgesetz 2010, EIWOG 2010)**
- **Revised Electricity Act (Elektrizitätswirtschaftsgesetz, EIWG)**
- **Renewables Energy Expansion Act (Erneuerbaren-Ausbau-Gesetz, EAG)**
- **Hydrogen Promotion Act (Wasserstoffförderungsgesetz, WFöG)**
- **Gas Act 2011 (Gaswirtschaftsgesetz 2011, GWG 2011)**
- **Renewable Gases Act (Erneuerbares-Gas-Gesetz, EGG)**
- **Gas Labelling Ordinance (Gaskennzeichnungsverordnung, G-KenV)**

As electricity is required to generate renewable hydrogen, the **Electricity Act 2010** (Elektrizitätswirtschafts- und -organisationsgesetz 2010), as the central regulation for the electricity sector, is also an important source in this application. It regulates a wide range of topics from electricity generation and supply, the operation of grids and unbundling, to system

³⁰ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 103.

³¹ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 103.

³² Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 103.

³³ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 37.

³⁴ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 26-27.

³⁵ Cf. BMK, Potenziale für eine effiziente Wärme- und Kälteversorgung in Österreich (2024) 103.



utilisation fees and customer rights. With regard to the production of hydrogen, the classification of the electrolyser as a market participant under electricity law and the corresponding rights and obligations (e.g. payment of system usage fees) are relevant in this context.

The Electricity Act 2010 is to be significantly revised in order to, among other things, meet the requirements of European legislation. To this end, the draft of the **revised Electricity Act** (Elektrizitätswirtschaftsgesetz) was presented by the federal government at the beginning of 2024 and was not passed yet. According to the draft, the provisions relating to energy storage (which includes electrolysers) would be relevant to hydrogen. In addition, changes are also planned to the facilitations for system utilisation fees, which in future should be linked to the condition of system usefulness.

The **Renewables Energy Expansion Act** (Erneuerbaren-Ausbau-Gesetz) implements with its provisions the RED II as well as the internal electricity market legislation. Specifically, it sets the goal of increasing the share of nationally produced renewable gas to 5 TWh by 2030. The REEA also sets a target for domestic renewable electricity generation to be equal to total domestic electricity consumption by 2030. Furthermore, guarantees of origin for renewable energy are also regulated, as are investment subsidies for renewable gases. Specifically, regarding electrolysers, there are also regulations on investment subsidies for plants that convert electricity into hydrogen or synthetic gas.

The **Hydrogen Promotion Act** (Wasserstoffförderungsgesetz) just entered into force recently in July 2024. Its aim is to increase the production of renewable hydrogen of non-biological origin by creating a legal basis for promoting the construction and operation of plants for the production of such gases. Funding will be provided through competitive auctions for the period of 2024 till 2026. A total of up to €820 million in federal funds will be made available for the promotion, although only newly constructed facilities for the production of renewable hydrogen from non-biogenic origin are eligible.

If hydrogen is fed into the public gas grid after production, the **Gas Act 2011** (Gaswirtschaftsgesetz 2011) serves as the primary legal framework governing this process. Similar to the Electricity Act 2010, which regulates the electricity market, the Gas Act provides the central regulatory structure for the gas market. However, direct injection of hydrogen into the public gas grid is not permitted in Austria unless methanation takes place. As a result, natural gas must first be extracted from the grid, blended with the renewable hydrogen produced, and then reinjected as a natural gas-hydrogen mixture. The Gas Act 2011 establishes provisions related to system utilization fees, including exemptions for hydrogen injection. In



light of the evolving EU regulatory framework for the gas sector, a revision of the Gas Act 2011 is anticipated in the near future to align with new legislative requirements.

The **Renewable Gases Act** (Erneuerbares-Gas-Gesetz), which aims to increase sales of renewable gases on the Austrian gas market to 7.5 TWh by 2030, is also currently being developed and was not passed yet. Alongside this, domestic consumption of fossil natural gas is to be reduced and a supply of nationally produced renewable gas is to be ensured by 2040. The draft provides mandatory green gas quotas that must be met by gas suppliers in order to substitute fossil gas volumes with renewable gases.³⁶

The **Gas Labelling Ordinance** (Gaskennzeichnungsverordnung) regulates the labelling of the origin and environmental impact of gases that are fed into or withdrawn from the public gas grid. The provisions include the labelling of primary energy sources, conversion and storage as well as international trade.

The definitions of hydrogen and gas vary depending on the applicable law. It has to be outlined that the definitions only apply within the framework of the respective law. The following table is intended to provide a clearer overview of these definitions.

Term	Definition	Law
renewable hydrogen of non-biological origin	hydrogen whose energy value is derived from renewable energy sources, excluding biomass	§ 2(1) Hydrogen Promotion Act
renewable hydrogen	hydrogen exclusively produced from renewable energy sources	§ 7(1)(16a) Gas Act 2011
renewable gas	either renewable hydrogen or gas derived from biological or thermo-chemical conversion, provided that it is produced solely from renewable energy	§ 7(1)(16b) Gas Act 2011
synthetic gas	gas derived from renewable hydrogen	§ 7(1)(61a) Gas Act 2011

³⁶ <https://www.parlament.gv.at/gegenstand/XXVII/ME/251> (accessed 30.12.2024).



decarbonised gas	hydrogen, for which the § 2(1)(3) Gas Labelling production process has Ordinance permanently prevented carbon dioxide emissions, as far as technically possible
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1.2.2. Waste heat

Definition

§ 5(1)(1) EAG	<i>"waste heat and cold" means unavoidable heat or cold generated as by-product in industrial or power generation installations, or in the tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system, where a cogeneration process has been used or will be used or where cogeneration is not feasible"</i>
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As previously mentioned, the EAG (Renewable Expansion Act [*Erneuerbaren-Ausbau-Gesetz*]) contains a definition identical in substance to that found in Article 2(9) RED III. For details on the substance of the EAG, see section 2.1.

With regard to waste heat, § 88 EAG stipulates that operators of district heating or district cooling installations exceeding 250 customers or supplying more than 3 GWh of heat per year in each contiguous network must, at the end of each financial year, publish a breakdown on their website. This breakdown should identify the types of fuels they use in their heating and cogeneration plants, as well as indicate the share of waste heat or cold fed into the network. At a minimum, this information should be set out as a percentage breakdown of the primary energy sources, distinguishing between renewable energy, waste heat or cold, fossil energy, and other energy sources.

Regulation

- **Energieeffizienzgesetz – EeffG**
- **Standardisierte-Kurzberichte-Verordnung - EEff-SKV**

In Austria, the concrete regulations on waste heat largely consist of information obligations. As part of its implementation of EED III³⁷, the Federal Energy Efficiency Act (*Bundes-Energieeffizienzgesetz – EEffG*) imposes corresponding reporting requirements, particularly for data centers. According to § 72a EEffG, owners and operators of data centers with an installed

³⁷ Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955, OJ L 2023/231, 1.



rated power for IT of at least 500 kW must annually publish certain minimum information about their operations. These obligations take effect on May 15, 2024, and are intended to increase transparency regarding energy consumption and efficiency in data centers. Among the details that must be disclosed are basic facts such as the name of the data center, its owner or operator, the date when it became operational, and the municipality in which it is located. Additional information includes the total area of the data center, the installed power, annual incoming and outgoing data traffic, as well as the volume of data stored and processed. Furthermore, the key efficiency indicators of the data center for the most recently completed calendar year must be made public. These indicators comprise essential performance metrics, including overall energy consumption, power usage, setpoint temperatures, utilization of waste heat, water consumption, and the share of renewable energy. Finally, further information must be provided in line with Delegated Regulation (EU) 2024/1364. This obligation entails making the information available on the data center's website, with regular updates required (§ 72a(3) EEffG). In addition, notification of compliance must be submitted to the national Energy Regulatory Authority "E-Control" (§ 60(5) EEffG), including the publication of the minimum information under § 72a(1) and the subsequent transfer of these published data in accordance with § 72a(3). According to § 60(6) EEffG, reporting requirements also extend to the European Database for data centers as specified by Delegated Regulation (EU) 2024/1364.

The Standardized Short Reports Regulation (*Standardisierte-Kurzberichte-Verordnung - EEff-SKV*) introduces additional reporting obligations. Specifically, it requires reporting on waste heat potentials from technical installations in companies as part of the standardized short report in accordance with § 43 EEffG. Under § 5 EEff-SKV, the relevant data must be indicated both as thermal output (in kW) and full-load hours per year, categorized according to the following temperature ranges:

- **Temperatures below 0 °C (cold),**
- **Low temperatures between 0 °C and 50 °C,**
- **Medium temperatures between 50 °C and 200 °C, and**
- **High temperatures from 200 °C and above.**

According to paragraph 2 of § 5 EEff-SKV, the possible uses of the identified available heat quantities must also be specified in annual energy units (kWh per year), based on the temperature levels described above.

1.3. Subsidies, funding, incentives

This section should include any kind of subsidies, funding, incentives, etc. that is granted for hydrogen and waste heat (separate elaboration). Those can be of a financial or non-financial



nature. Those can be provided for production, use, infrastructure, construction, system utilisation fees, etc.

1.3.1. Hydrogen

As previously mentioned, the **Hydrogen Promotion Act** is one of the key support instruments that has been formalized into legislation. Its aim is to expand renewable hydrogen production of non-biological origin by providing a legal framework for supporting new facilities. Up to €820³⁸ million in federal funding will be allocated through competitive auctions from 2024 to 2026,³⁹ exclusively for newly constructed plants⁴⁰.

The **Renewables Expansion Act** also includes provisions for investment grants for the construction of facilities that convert electricity into hydrogen or synthetic gas. A minimum capacity of 1 MW is required, and the facility must be exclusively used for the production of renewable gases, sourcing electricity solely from renewable sources. Furthermore, facilities that blend hydrogen into natural gas in the public gas grid are excluded from this funding. The annual funding volume is expected to amount to €40 million. A maximum of 45% of the costs directly associated with the construction of the facility will be covered. For facilities with a capacity between 0.5 and 1 MW, the maximum funding rate is reduced to 20%. The funded facility must be operational within 36 months after the conclusion of the funding agreement. The Federal Minister for Climate Protection, Environment, Energy, Mobility, Innovation, and Technology is tasked with issuing an outlining the detailed provisions for the implementation and administration of the investment grants.⁴¹

Therefore, a draft of the **EAG Investment Grant Ordinance – Hydrogen** (EAG-Investitionszuschüsseverordnung-Wasserstoff) was already submitted for review in late June 2024, but the Ordinance has yet to be enacted, thus preventing the application of this funding.

The **Electricity Act** grants specific privileges to electrolyzers, particularly with regard to network fees. For installations converting electricity into hydrogen or synthetic gas with a minimum capacity of 1 MW, no network access charge shall be imposed up to a network connection ratio of 200 linear meters per megawatt of agreed capacity (200 lfm/MW_{el}), provided that the facility is exclusively supplied with renewable electricity and does not inject gas into the natural gas grid. If the network connection ratio exceeds the threshold of 200 lfm/MW_{el}, the operator of

³⁸ Cf. § 4(1) WFöG.

³⁹ Cf. § 8(1) WFöG.

⁴⁰ Cf. § 6(3) WFöG.

⁴¹ Cf. § 62 EAG.



the installation is required to bear 50% of the costs associated with the additional connection length beyond this limit.⁴²

Electrolyser operators are also exempt from the payment of the network provision charge, provided that the installation meets the following conditions: it has a minimum capacity of 1 MW, is supplied exclusively with renewable electricity, and does not inject gas into the natural gas grid.⁴³ Furthermore, electrolyzers with a minimum capacity of 1 MW are exempt from network usage charges⁴⁴ and charges for grid losses⁴⁵ associated with the procurement of renewable electricity for a period of 15 years from the date of commissioning.⁴⁶

The **Gas Act 2011** stipulates that for newly constructed facilities for the production and processing of renewable gas, including renewable hydrogen according to the definition of renewable gas in this act, under certain conditions, costs related to grid access for the injection of renewable gases, volume measurement, quality testing, potential odorization, and compressor stations or pipelines necessary for continuous injection must be borne by the network operators. In this way, this provision also serves as a form of financial support.⁴⁷

Furthermore, the Gas Act provides for additional facilitations with regard to hydrogen, particularly in cases where it is intended to be injected into the natural gas grid. In Austria, direct injection of pure hydrogen is not permitted. Instead, natural gas must first be obtained for the purpose of blending, after which the resulting mixture may be fed into the network. For this specific form of injection, no network usage charges are levied.⁴⁸

1.3.2. Waste Heat

In Austria, there are a number of subsidies relevant to waste heat utilization, most of which are based on the Federal Environmental Promotion Act (*Umweltförderungsgesetz, UFG*).

The specific funding conditions are set out in the funding guidelines issued by Kommunalkredit Public Consulting GmbH (KPC). Below is an overview of two selected funding frameworks.

⁴² Cf. § 54(6) ElWOG 2010.

⁴³ Cf. § 55(10) ElWOG 2010.

⁴⁴ Cf. § 52 ElWOG 2010.

⁴⁵ Cf. § 53 ElWOG 2010.

⁴⁶ Cf. § 111(3) ElWOG 2010.

⁴⁷ Cf. § 75(4) GWG 2011.

⁴⁸ Cf. § 73(8) GWG 2011.



Saving energy in companies (Energiesparen in Betrieben)⁴⁹

Within the scope of these funding programs, measures aimed at improving energy efficiency in commercial and industrial facilities and processes used primarily for business purposes are eligible for subsidies. Any company, entrepreneurial organization, association, or religious institution may submit an application. Please note that the timing of an application for heat recovery measures depends on the specific nature and capacity of the system in question.

Potentially eligible measures include heat recovery (or the use of previously unused heat flows, such as from compressed air compressors, industrial processes, or waste water) and heat pumps for harnessing low-temperature waste heat.

Examples of eligible equipment or components are:

- Heat exchangers
- Heat pumps for utilizing waste heat

Internal energy centres (Innerbetriebliche Energiezentralen)⁵⁰

Funding is provided for efficient “energy centers” designed for in-house heating and cooling supply that incorporate a combination of particularly innovative and energy-efficient measures. This involves a suite of efficient heat and cooling production and distribution systems in the form of an energy center for supplying heating, hot water, and process heat/cooling. A mandatory component of these projects is the installation of a renewable heat generation system or a climate-friendly cooling system (e.g., heat pump, biomass boiler, connection to district heating, climate-friendly cooling installations, waste heat utilization, solar thermal power).

Examples of eligible systems or components include: •

- Heat pumps
- Connection to high-efficiency district heating
- Heat recovery systems
- In-house primary distribution networks • Heat and cold storage units

⁴⁹ Cf. KPC, Informationsblatt **Energiesparen**
https://www.umweltfoerderung.at/fileadmin/user_upload/umweltfoerderung/betriebe/Energiesparen_in_Betrieben/UFI_Standardfall_Infoblatt_ENERGSPA.pdf

⁵⁰ Cf. KPC, Informationsblatt **Energiezentralen** zur innerbetr. Wärme- und Kältebereitstellung
https://www.umweltfoerderung.at/fileadmin/user_upload/umweltfoerderung/betriebe/Energiezentralen/UFI_Standardfall_Infoblatt_ENERZEN.pdf



1.4. Identified Barriers and Obstacles

1.4.1. Hydrogen

There is currently a lack of a clear legal definition for energy storage facilities, a category that includes electrolyzers. This definitional ambiguity contributes to legal uncertainty, which is further compounded by the pending adoption of the new Electricity Act. In addition, uncertainty persists regarding financial incentives, particularly with respect to system usage charges for energy storage facilities. The funding structures for large-scale industrial projects are also complex, as securing full financing often requires multiple applications due to the existence of individual funding thresholds.

1.4.2. Waste Heat

The barriers related to waste heat primarily stem from the use of the definition provided in RED III for purposes for which it is not well suited. As previously mentioned, the definition in Article 2(9) of RED III is linked to the injection of waste heat into district heating networks and its use in combined heat and power systems within these networks. This definition has been partially adopted into Austrian funding legislation, which creates legal uncertainty and, in some cases, leads to ineligibility for funding when no connection to a district heating network exists.



2. Croatia

2.1. Strategic approach

2.1.1. Hydrogen

In 2022, the Republic of Croatia adopted the **Croatian Hydrogen Strategy until 2050 (OG No. 40/2022)**⁵¹. This strategy establishes a national hydrogen production and use framework, focusing primarily on renewable and low-carbon hydrogen as an alternative to fossil fuels. It aims to enhance the stability of a power system based on renewable energy sources (RES), promoting energy self-sufficiency, clean energy transitions, and sustainable mobility. The Strategy recognizes hydrogen and a hydrogen-based economy as key contributors to the transition toward green energy, achieving clean energy goals, and reducing greenhouse gas emissions. Furthermore, hydrogen is considered essential for the decarbonization of sectors where electrification is not economically viable or where alternative technologies face limitations.

The Strategy outlines opportunities for clean hydrogen utilization within four strategic goals and defines performance indicators for these goals. The key strategic goals for hydrogen production in Croatia by 2050 are as follows:

- **Increasing renewable hydrogen production:** The aim is to scale up hydrogen production from renewable energy sources, reducing dependence on fossil fuels and improving energy self-sufficiency. By 2030, 70 MW of electrolyser capacity is planned, which is expected to rise to 2,750 MW by 2050.
- **Maximizing the potential of renewable energy sources for hydrogen production:** The Strategy seeks to maximize hydrogen's share in total energy consumption, contributing to the stability of the power system. By 2030, hydrogen is projected to account for 0.2% of total energy consumption, increasing to 11% by 2050.
- **Increasing the use of hydrogen:** The Strategy promotes hydrogen adoption across various sectors, including industry, transport, and energy, to reduce CO₂ emissions and support economic decarbonization. By 2030, 15 hydrogen fuel stations are planned, with the number increasing to 100 by 2050.
- **Encouraging the Development of Science and Research in Hydrogen Technologies:** The Strategy emphasizes the importance of advancing science, research, and innovation in hydrogen technologies. By 2030, the goal is to achieve five patents related to the hydrogen-based economy, increasing this number to 50 by 2050.

⁵¹ https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_40_492.html

<https://mingo.gov.hr/UserDocImages/UPRAVA%20ZA%20ENERGETIKU/Croatian%20Hydrogen%20Strategy%20ENG%20FIN%2022%208.pdf>.



The strategic goals and performance indicators are aligned with the climate neutrality scenario, which was developed based on scenarios outlined in the **Energy Strategy of the Republic of Croatia**.⁵²

The required electrolyzer capacities mentioned above (70 MW by 2030 and 2,750 MW by 2050) that draw electricity from the grid for hydrogen production reflect the current situation regarding available resources. However, given the growing potential of the hydrogen-based economy within the EU and Croatia's demonstrated capacity in renewable energy sources (RES), these targets could be further increased under an accelerated development scenario. This scenario envisions electrolyzer capacities that source electricity exclusively from RES, ensuring renewable hydrogen production. In this case, capacities are projected to reach 1,274 MW by 2030 and 7,329 MW by 2050.

The Croatian Hydrogen Strategy until 2050 stipulates that the development of a hydrogen-based economy will be financed through EU funds and national programs.

The Croatian Hydrogen Strategy until 2050 explicitly prioritizes the production and utilization of renewable hydrogen, defined as hydrogen generated through water electrolysis powered by electricity from renewable energy sources (RES), primarily solar and wind.

A central objective of the strategy is to significantly increase the share of renewable hydrogen in total hydrogen production, as part of broader efforts to reduce greenhouse gas emissions and achieve climate neutrality. To this end, the strategy promotes the advancement of technologies related to renewable hydrogen production and their integration into the national energy system.

While the strategy's primary emphasis is on scaling up domestic renewable hydrogen production, it also recognizes the potential need for hydrogen imports, particularly during the early phases of hydrogen economy development. Importation is viewed as a transitional measure to ensure supply security and meet initial demand while domestic infrastructure and production capacity are being established.

Furthermore, strategic imports may serve to bridge shortfalls in domestic production and support the gradual integration of hydrogen into key sectors such as industry, transportation, and energy.

Hydrogen will play a significant role in several key sectors, including:

- Industry: Hydrogen will be used as a raw material in industrial processes, especially in the chemical industry, refineries, and steel production.
- Energy: Hydrogen will be used to store surplus renewable energy and as fuel for power generation in peak power plants.

⁵² Strategija energetskeg razvoja Republike Hrvatske do 2030. s pogledom na 2050. Godinu (OG no. 25/2020)



- Transport: The plan includes using hydrogen as a fuel for fuel cell vehicles, including buses, trucks, and trains.
- Other sectors (including residential and commercial): Hydrogen will replace natural gas in heating systems, particularly in buildings and industrial plants.

Development Plan and Study Implementation:

In 2024, the **Study of the Development Plan and Implementation of the Croatian Hydrogen Strategy until 2050**⁵³ was finalized. The study was commissioned by the Croatian Hydrocarbons Agency (CHA) and serves as a foundational document for the strategic rollout of hydrogen initiatives. The study outlines a detailed roadmap for integrating hydrogen into Croatia's energy system. The Study proposes the hydrogen coordination role of the Croatian Hydrocarbon Agency (CHA) to be expanded to cover all renewable fuels in transport. As part of technical support, CHA will assist in achieving renewable energy (RES) targets in transport, enhance support for hydrogen value chain projects, and could support the sustainability certification process for renewable hydrogen.

Another important document shaping the development of hydrogen in Croatia is the updated **National Energy and Climate Plan (NECP)**⁵⁴. The updated version of the NECP, originally adopted in 2019, is currently undergoing public consultations.

The NECP outlines several measures directly aimed at advancing hydrogen development, including:

- Legal adjustments and technical preparations for integrating hydrogen into the energy system.
- Upgrading the gas transmission system to enable the future transport of up to 100% hydrogen.

Additional hydrogen-related actions highlighted in the NECP include certification of green hydrogen, increasing the number of hydrogen stations, procurement of new hydrogen-powered vehicles, building hydrogen supply stations for maritime, rail, air, and road transport.

The NECP envisions an investment of €191 million by 2030 and an additional €732 million from 2031 to 2050 to support hydrogen-related initiatives.

The NECP also defines estimated trajectories for renewable energy technologies to meet sectoral and total renewable energy targets from 2021 to 2030. The estimated contribution of hydrogen by 2030 is:

⁵³ https://www.azu.hr/media/201nx0by/hr-h2-strategy-implementation_summary-study_final.pdf.

⁵⁴ <https://mingo.gov.hr/azurirani-integrirani-nacionalni-energetski-i-klimatski-plan-republike-hrvatske-za-razdoblje-od-2021-2030-necp/9220>.



- 39.3 kilotons of oil equivalent (ktoe), representing 1.32% of gross final RES consumption.
- 53.1 ktoe, or 3.8% of gross final RES consumption for heating and cooling.

The National Recovery and Resilience Plan 2021-2026⁵⁵ (RRP) is another key framework document for implementing hydrogen technologies in Croatia. It focuses on the production of clean hydrogen from renewable energy sources and its application in mobility.

The RRP outlines plans to financially support 10 MW electrolyser plant to be established by 2026, capable of producing 4,000 tons of hydrogen per day. Additionally, the plan envisions expanding electrolyser capacity by an additional 20 MW in subsequent years.

The refuelling stations and buses for public transport will be supported financially by the Ministry of Economy and the Ministry of the Sea, Transport, and Infrastructure. The Ministry will financially contribute to support:

- Establishment of construction of at least six hydrogen refueling stations (HRS) by 2026 (planned capacity: 100 kg hydrogen per day for buses, cars, and heavy-duty vehicles) on the TEN-T corridor and aligned with standards and rules set up within Alternative Fuel Infrastructure Regulation (AFIR);
- Deployment of hydrogen-powered vehicles on the road by 2026 (hydrogen buses supported within the planned 70 alternative fuels vehicles) and
- Development and deployment of a hydrogen-powered locomotive (HERMES project).
- Additionally, the RRP plans to establish a “hydrogen coordinating body,” which designated the Croatian Hydrocarbon Agency as the relevant national body in charge of all hydrogen-related activities.
- Moreover, following the RRP amendment, an additional 13,500,000.00 EUR is dedicated in Q2 2026 for co-financing of renewable hydrogen production in the context of the North Adriatic Hydrogen Valley (NAHV) project, gathering expert companies in the hydrogen field and their research projects.

Regarding the use of hydrogen in transport, an important planning document is the **National Policy Framework (NPF)⁵⁶**, which is adopted by the Government of the Republic of Croatia based on the Act on the Deployment of Alternative Fuels Infrastructure (OG No. 120/16 and 33/22). The development of a new NPF is underway, following the Alternative Fuels Infrastructure Regulation (AFIR)⁵⁷ requirements concerning hydrogen refuelling infrastructure.

⁵⁵ <https://planoporavka.gov.hr/UserDocImages//dokumenti/Plan%20oporavka%20i%20otpornosti,%20srpanj%202021..pdf>.

⁵⁶ https://narodne-novine.nn.hr/clanci/sluzbeni/2017_04_34_748.html

⁵⁷ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1804>



The Croatian Hydrogen Strategy until 2050 is fully aligned with the other national strategies, including:

- **National Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG No. 13/2021)⁵⁸**
Hydrogen is included as part of the decarbonization segment, emphasizing research and innovation in the industry's decarbonization process. It is expected to replace fossil fuels in hard-to-abate sectors alongside electrification, supported by advancements in alternative fuel technologies.
- **Strategy for Low-Carbon Development of the Republic of Croatia until 2030 with a view to 2050 (OG No. 63/2021)⁵⁹**
Hydrogen plays a pivotal role in the energy sector, particularly as a replacement for natural gas in the gas grid and for grid balancing with clean hydrogen. It also has a significant role in mobility, replacing fossil fuels with alternative fuels, biofuels, and electricity. This transition is critical for ensuring the sustainability and economic viability of refineries currently focused on fossil fuel production for mobility and the petrochemical industry.
- **Energy Development Strategy of the Republic of Croatia until 2030 (OG No. 25/2020)⁶⁰**
Hydrogen is highlighted primarily within the transport sector, where it has the greatest potential for implementation, particularly in public transport. It is also mentioned in the energy sector as a substitute for fossil fuels in hard-to-abate industries such as petrochemicals and cement production. However, most hydrogen production is expected to come from renewable energy sources, which are prioritized for grid decarbonization. The strategy acknowledges the limited availability of renewable resources for hydrogen production and the need to explore additional sources.
- **Smart Specialisation Strategy (S3) until 2029⁶¹**
Hydrogen is integrated into the overall approach of this strategy, aligning closely with the National Hydrogen Strategy. It supports hydrogen applications in mobility and identifies the North Adriatic Hydrogen Valley (NAHV) as a primary national project. The NAHV project is expected to encourage additional national, regional, and international hydrogen initiatives, particularly by Croatian stakeholders. Furthermore, the strategy mentions the potential for hydrogen production

⁵⁸ https://narodne-novine.nn.hr/clanci/sluzbeni/2021_02_13_230.html.

⁵⁹ https://narodne-novine.nn.hr/clanci/sluzbeni/2021_06_63_1205.html.

⁶⁰ https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_25_602.html.

⁶¹ <https://mingo.gov.hr/UserDocsImages/slike/Vijesti/2022/S3%20do%202029%20Tekst%20VRH%202023%2012%2013.pdf>.



through waste-to-hydrogen (WtH) technologies, which are already being utilized within the NAHV project.

2.1.2. Waste Heat

The National Energy and Climate Plan for the Republic of Croatia until 2030 aims to achieve energy security by diversifying energy sources. By increasing energy storage capacities and diversifying energy sources, the RES plan is being used to ensure a safe and quality energy supply. Although the plan is to replace fossil fuels with biomass boilers, heat pumps, or waste heat technologies by 2030 and to reduce primary energy consumption by 833,18 GWh, there are no specific targets for waste heat utilization.

The same applies to the Energy Development Strategy and Energy Efficiency Program for Decarbonisation of the Energy Sector, which, in the long term, aims to bring the fourth generation of district heating systems characterized by the development and implementation of thermal energy storage and heat pumps and a significant increase in the use of waste heat, but gives no specific targets.

2.2. Legal status quo

2.2.1. Hydrogen

The legislative framework entails ensuring the transfer of EU legislation into national legislation in accordance with the goals set at the EU level related to the decarbonization of the economy and the reduction of CO₂ emissions.

In accordance with the above, the following laws of the Republic of Croatia regulate the possibilities of using hydrogen:

Law on Biofuels for Transport (OG, No. /09, 145/10, 26/11, 144/12, 14/14, 94/18 and 52/21)

– by the amendments from 2021 introduction of the hydrogen on the Croatian market is foreseen. In accordance with this Law, the person liable for placing biofuels or renewable energy in transport on the market, is obligated to prepare a Program (for three years) and a Plan (for one year) that includes the projected quantities of hydrogen from renewable sources for transport purposes that it intends to place on the market as well as report on the use of hydrogen as an alternative fuel on the market.

The standard quality of gas at the entry point to the gas transmission system is defined by the General Conditions of Gas Supply. Currently, the legislative and technical framework does not allow for the injection of hydrogen or gas mixtures into the transmission system.

The Croatian gas transmission system operator has outlined plans to gradually adapt the existing natural gas infrastructure to enable the future transport of hydrogen. This will involve



the repurposing of existing pipelines as well as the construction of new, hydrogen-compatible infrastructure.

All newly constructed gas pipelines will be designed to be hydrogen-ready. Additionally, over the next 10 to 15 years, the operator will undertake the reconstruction of gas nodes and the upgrade of safety and metering equipment to facilitate the reception and blending of decarbonized gases within the transmission network.

Between 2030 and 2040, existing cross-border interconnections with Hungary and Slovenia are planned to be converted for hydrogen transport. Furthermore, from 2030 to 2050, the 75-bar transmission system, along with the 50-bar branches towards Varaždin and Osijek—and potentially also towards Vukovar and Virovitica—will be repurposed for hydrogen transmission.

In light of the planned phaseout of natural gas after 2050, Plinacro's mid-term strategic focus is on enabling the transport of gas blends. Accordingly, it is anticipated that from 2050 onwards, the transmission system will be capable of transporting 100% renewable (green) hydrogen.

The conversion of existing infrastructure for the transmission of pure hydrogen is considered most feasible in northern Croatia, where parallel pipeline routes exist. This configuration provides the potential for dedicating one pipeline to hydrogen transport.

In principle, all existing pipelines can be technically adapted for hydrogen transport. Notably, older pipelines in the Republic of Croatia may be particularly suitable due to their low-carbon steel composition; however, such conversions would require a reduction in operating pressure.

The Electricity Market Act (OG No. 111/21, 83/23 and 17/25) recognizes electrolyzers with hydrogen storage as a form of electricity storage, whereby electrical energy is converted into another form of energy and can subsequently be reintroduced into the transmission or distribution network. This legal provision enables the user to participate in the electricity market and grants them rights and obligations in accordance with the applicable regulatory framework.

While hydrogen technologies are not granted preferential treatment over other electricity storage solutions under the Act, they are considered equivalent in terms of legal status and eligibility. As such, hydrogen-based storage systems, like other forms of energy storage, contribute to a higher evaluation score in public tenders for the issuance of energy approvals.

Specifically, if a tender participant includes an energy storage facility—such as hydrogen storage—in the conceptual design and feasibility study accompanying the generation facility proposed in a public tender, additional points may be awarded under the competitiveness criterion of the generation facility. This incentivizes the integration of storage technologies, including hydrogen, as part of a broader strategy to enhance system flexibility and security of supply.

As the national coordinating body for hydrogen, the Renewable Energy Sources and High-Efficiency Cogeneration Act (**OG No. 138/21 and 83/23**) has designated the Croatian



Hydrocarbons Agency (CHA). Apart from the aforementioned reference in one article, hydrogen is not mentioned elsewhere in the Renewable Energy Sources and High-Efficiency Cogeneration Act.

Within the regulatory framework of the Republic of Croatia, there is currently no definition of green hydrogen, nor is hydrogen mentioned as a transformed form of energy in existing definitions. Consequently, there are no legally prescribed obligations or targets for hydrogen production in Croatia.

Therefore, it is necessary to revise the current legislative framework to ensure that hydrogen produced from renewable energy sources is officially recognized and to establish a clear procedure for obtaining permits for renewable hydrogen production. Hydrogen should also be recognized in the industrial sector as a renewable fuel of non-biological origin. Additionally, an incentive system must be established to support the transition to low-carbon energy sources.

The technical rules governing the existing gas infrastructure need to be revised to enable its adaptation for hydrogen use. Furthermore, the regulatory framework should be updated to incorporate hydrogen use within the industrial and energy sectors, including the production of thermal energy.

Regarding the current regulatory framework for the construction of hydrogen refueling stations, Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure should be adopted. This regulation outlines general guidelines for the revision of the existing regulatory framework to enable the implementation of the hydrogen value chain, with a particular emphasis on the use of renewable hydrogen in the transport and industrial sectors. It is crucial that the content of the directives from the "Fit for 55" package is adequately transposed into national legislation. Legislation from this package that has not yet been fully incorporated into national law must be adopted through the enactment of implementing acts. This particularly applies to Regulation (EU) 2023/1805 on the use of renewable and low-carbon fuels in maritime transport and Regulation (EU) 2023/2405 on ensuring a level playing field for sustainable air transport.

The Republic of Croatia must transpose the provisions of the RED III Directive into its regulatory framework. This includes Article 15b of the RED III Directive, which requires coordinated spatial mapping to identify areas necessary for the implementation of renewable energy projects. This process must take into account the availability of renewable energy sources, projected energy demand, relevant energy infrastructure, and give priority to multiple land-use planning. It is also necessary to identify areas for accelerated development of renewable energy, focusing on regions where the use of renewable energy is not expected to have significant environmental impacts. Areas along the Core Trans-European Transport Network (TEN-T) designated for hydrogen production for transport purposes could reduce the need for hydrogen distribution.



Naturally, one of the priority actions should also include the construction of hydrogen refueling stations, but this must be carried out in coordination with the defined demand in specific areas to ensure the investment is utilized effectively and provides valuable experience for the further development of the hydrogen value chain in Croatia.

2.2.2. Waste Heat

Definitions

The Renewable Energy Sources and High-Efficiency Cogeneration Act defines waste heat as:

Waste heat and cold refers to unavoidable heating or cooling produced as a by-product in industrial facilities, power generation plants, or in the service sector, which—without access to a district heating or cooling system—would otherwise be released into the air or water, provided that cogeneration has been or will be implemented, or if cogeneration is not feasible

Regulation

Waste heat is recognized in the national legislation and is mentioned in the laws related to renewable energy sources and energy efficiency. However, no law transfers the definition of waste heat from EU directives.

The Energy Efficiency Act recognizes efficient centralized heating and cooling as centralized heating or cooling that uses at least 50% waste heat (not limited to waste heat).

The Renewable Energy Sources and High-Efficiency Cogeneration Act obliges the Ministry responsible for spatial planning and construction to incorporate the utilisation of unavoidable waste heat and cold into the processes of planning, design, construction, and renovation of infrastructure. The Act also mandates the assessment of the potential for the use of waste heat and cold in the heating and cooling sector.

Furthermore, the Act sets out the objective of the Republic of Croatia to increase the share of renewable energy in the heating and cooling sector by an average of approximately 1.1 percentage points annually. One of the measures identified to achieve this objective includes the integration of unavoidable waste heat and cold into the supply of energy and energy fuels used for heating and cooling purposes.

To ensure that progress toward these targets is measurable and verifiable, the Ministry is required to establish and publicly disclose a list of measures, as well as a list of obligated parties—such as fuel suppliers and relevant public or professional bodies—who must submit annual reports. These reports must detail the amount of waste heat and cold delivered for heating and cooling, and the corresponding share of waste heat and cold in the total energy supplied for such purposes.

In addition, waste heat is not addressed anywhere in the national regulatory framework.



2.3. Subsidies, funding, incentives

2.3.1. Hydrogen

To meet the objectives stated in the National Recovery and Resilience Plan 2021-2026 (NRRP) and National Programme for Cohesion and Coherence (NPCC) envelope from 2021 to 2027, the Ministry of Economy decided to subsidize the construction of filling stations (CAPEX subsidy) for hydrogen vehicles with a non-reimbursable EUR 23 million (EUR 15 million in 2024 and EUR 8 million in 2026). The highest amount of support per HRS station is EUR 2 million for passenger cars, and EUR 3.5 million for buses and heavy vehicles. Beneficiaries of grants in accordance with this Program can be micro, small, medium, and large enterprises.



3. Czech Republic

3.1. Strategic approach

3.1.1. Hydrogen

Hydrogen strategy of the Czech Republic (original title: *Vodíková strategie České republiky*⁶²), created in 2021 and updated in 2024, is a key strategic document for the development of hydrogen technologies in the Czech Republic, operating on the national level. There is no H₂ strategy on the regional or municipal levels. The national H₂ strategy is part of a broader framework aimed at achieving climate goals and transitioning to a low-carbon economy. Following the European Hydrogen Strategy and the goals of the European Green Deal, this strategy focuses on the period from 2021 to 2050.

In regards to the H₂ production, targets are to build at least 400 MWe of electrolyser capacities to be able to produce 40 000 tons of H₂ annually until 2030.

The produced hydrogen should be used mainly to help with decarbonisation of industry, specifically in iron production, chemical and petrochemical industry or other industries that are currently relying on natural gas (e.g.: glass production). Second important segment is transportation, especially freight transport, buses or trains. Third segment is the storage of electricity generated by surpluses of renewables.

The priority of the Strategy is of course production of RFNBO hydrogen, but it also takes into consideration the low-carbon hydrogen produced from nuclear energy.

The Czech Republic is planning on importing hydrogen due to the limited capacities of renewable energy production (and thus limited usage of such surpluses) and prices of electricity. As the price of renewable and low-carbon hydrogen decreases over time and the price of fossil fuels and emission allowances increases, the opportunities for economic use of hydrogen will gradually expand. Czechia will focus on 'local islands' that will produce hydrogen domestically, but especially in the early stages of the Strategy implementation, also on 'global bridges' that foresee hydrogen imports from abroad.

The national hydrogen infrastructure is expected to be connected to three main entry points for hydrogen import, with a projected total capacity of up to 4.5 million tonnes per year (1.5 million tonnes per entry point). This would allow not only for meeting domestic demand—estimated at 1 million tonnes (by 2040, but also for serving international transit routes.

⁶² <https://mpo.gov.cz/cz/prumysl/strategicke-projekty/vodikova-strategie-cr-aktualizace-2024-schvalena-vladou--282165/>.



3.1.2. Waste Heat

The strategy of the Czech Republic (original title: *Vodíková strategie České republiky*⁶³), created in 2021 and updated in 2024, is a key strategic document for the development of hydrogen technologies in the Czech Republic, operating on the national level. There is no H₂ strategy on the regional or municipal levels. The national H₂ strategy is part of a broader framework aimed at achieving climate goals and transitioning to a low-carbon economy. Following the European Hydrogen Strategy and the goals of the European Green Deal, this strategy focuses on the period from 2021 to 2050.

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3.2. Legal status quo

3.2.1. Hydrogen

Hydrogen has been enshrined in Czech legislation as an energy gas since 2024. The amendment to the Energy Act, effective from January 1st of 2024, has classified hydrogen among the gases that can be distributed to consumers via the public gas network. Hydrogen

⁶³ <https://mpo.gov.cz/cz/prumysl/strategicke-projekty/vodikova-strategie-cr-aktualizace-2024-schvalena-vladou--282165/>.



is now placed within the same legal framework as natural gas. Hydrogen production and its storage have to comply with the same regulation; thus, it is regulated by the Energy Act, Air Protection Act or for example the Fire Protection Act.

These acts apply to renewable hydrogen as they regulate key aspects of its production, environmental impact and safety. The Energy Act classifies hydrogen as an energy gas and sets rules for its production, storage and access to infrastructure. The air Protection Act governs emissions from hydrogen production and use, ensuring compliance with air quality standards. The Fire Protection Act addresses hydrogen flammability by requiring strict safety measures for its handling and storage. Together, these laws ensure the safe and responsible integration of renewable hydrogen into the energy system.

Definitions

- renewable gas: gas produced from renewable sources including biomethane or hydrogen produced through electrolysis while using renewable energy;
- renewable hydrogen: hydrogen produced through the electrolysis of water where the electricity used comes exclusively from renewable energy sources;
- green hydrogen: same as renewable hydrogen;
- low carbon gases and/or hydrogen: hydrogen derived from non-renewable sources, which meets a greenhouse gas emission reduction threshold of 70%.

These definitions reflect terminology used in the updated Czech Hydrogen Strategy (2024) ⁶⁴ and are aligned with European legal acts, particularly:

- Directive (EU) 2018/2001 (RED II) and 2023/2024 (RED III)⁶⁵
- Delegated Regulation (EU) 2023/1184 (on RFNBO)⁶⁶
- Delegated Regulation (EU) 2023/1185 (on GHG emission methodology)⁶⁷

Czechia aims to have an electrolysis capacity of 400 MWe in 2030, as stipulated in the updated National Hydrogen Strategy (2024), approved by the government of the Czech Republic. There are no legally binding obligations on integration of renewable gases and/or hydrogen.

⁶⁴ <https://mpo.gov.cz/cz/prumysl/strategicke-projekty/vodikova-strategie-cr-aktualizace-2024-schvalena-vladou--282165/>.

⁶⁵ https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en.

⁶⁶ https://eur-lex.europa.eu/eli/reg_del/2023/1184/oj/eng.

⁶⁷ https://eur-lex.europa.eu/eli/reg_del/2023/1185/oj/eng.



3.2.2. Waste Heat

No production or use targets for waste heat are currently set in any national legislation or strategic documents in Czech Republic.

3.3. Subsidies, funding, incentives

3.3.1. Hydrogen

- **Modernisation Fund** is one of the main supportive programmes for energy transition, uses financial resources gained through emission permits. **RES+** sub-programme focuses on licenced energy providers and support development of photovoltaics including energy accumulators such as electrolyzers and H₂ storage solutions. **ENERG ETS** sub-programme focuses on decrease of emissions in industries including replacement of fossil fuels with renewable hydrogen. **TRANSCoM** sub-programme focuses on purchase of emission-free vehicles, including H₂-powered vehicles. **TRANSGov** sub-programme focuses on public entities and their transportation services, specifically on purchase of emission-free vehicles. **GREENGAS** sub-programmes supports private companies in production and storage of renewable energy in selected industries. This sub-programme can also support repurposing of gas transmission systems or creation of hydrogen valleys. **I+** sub-programme focuses on individual complex innovation solutions reaching beyond the Modernisation fund and are subject of evaluation in EIB.
- **Innovation fund** strengthens innovative potential of companies in energy transition.
- **Operational Programme Just Transformation** aims at three past-coal regions in the Czech Republic, offering several axes, where energy transition is the biggest one.
- **Recovery and Resilience Facility** supports clean mobility and decreasing the dependency on fossil fuels. Key component is decarbonisation of road transportation.
- **Operational Programme Transportation** supports creation of H₂ filling stations. In the future the programme aims to support development of H₂ linear infrastructure.
- **Integrated Regional Development Programmes** focuses on transformation of multimodal urban mobility with purchase of vehicles or creation of filling stations for public transportation.

In addition to direct subsidy programmes to support the development of hydrogen technologies, the financing of projects by banks is also important. For new investments, channelling capital into sustainable projects is key and the EU taxonomy plays a crucial role in



this process for hydrogen projects. However, there are currently no additional fiscal incentives for hydrogen, such as tax exemptions, VAT reduction or discounts on system utilisation fees.

3.3.2. Waste Heat

Even though there is no legal framework for waste heat in Czechia, the state recognises waste heat as an important attribute in lowering the energy dependency and energy consumption and thus offers its support – though **zero-interest loans** and through **subsidies**.

Zero-interest loans are offered by the National Development Bank to entrepreneurs through programmes 'Energy savings' and 'ENERG' and offer zero-interest loans with co-financing of 70-90%. The remaining financing must be covered by a commercial loan. The loan is targeting usage of waste heat from industrial processes.

Subsidies are provided through several operational programmes co-financed by the EU:

- **Operational Program Technologies and Application for Competitiveness** supports usage of waste energy in general.
- **Operational Programme Just Transformation** supports investments in the reconstruction and modernization of district heating networks with the aim of improving the energy efficiency of district heating systems and investments in heat production, if they are based exclusively on renewable energy sources.
- **Modernisation Fund** with its sub-programmes **ENERG ETS** and **ENERG** supports general improvements in energy efficiency, including usage of waste heat and waste energy. Sub-programme **HEAT** supports modernization of thermal energy supply systems including those focusing on waste heat.
- **New Green Savings Programme** focuses on residential living and its improvements though installation of heat pumps, controlled ventilation with heat recovery or utilization of heat from wastewater.

3.4. Identified Barriers and Obstacles

3.4.1. Hydrogen

The main barriers to hydrogen development in Czech Republic include:

- Lack of binding targets and legal obligations for integrating hydrogen into the energy system.
- Regulatory gaps in transmission tariffs, certification system (low-carbon vs. renewable) and access to infrastructure.



- Complex permitting procedures, including EIA requirements for electrolyzers
- No fiscal incentives such as tax exemptions or system fee reductions
- Slow transportation of EU legislation (RED II/III)

3.4.2. Waste heat

Waste heat utilisation is limited by:

- Absence of unified legal definition and framework
- No national targets for recovery or integration
- Lack of dedicated support schemes and no fiscal incentives
- Low awareness and prioritisation by stakeholders

These barriers significantly delay the deployment of hydrogen and waste heat technologies in Czech Republic. Addressing regulatory gaps, simplifying procedures and introducing targeted incentives both financial and non-financial will be essential to accelerate deployment and integration into the national framework for the energy transition.



4. Germany

4.1. Strategic Approach

4.1.1. Hydrogen

Germany's National Hydrogen Strategy, introduced in June 2020, outlines an ambitious roadmap for hydrogen production, infrastructure development, and sectoral integration. The primary objective is to position Germany as a global leader in hydrogen technologies, fostering a robust domestic market for green hydrogen and supporting international collaborations. To achieve this, Germany targets an electrolysis capacity of **5 GW by 2030**, with a further expansion to **10 GW by 2040**⁶⁸.

Hydrogen is central to Germany's decarbonization strategy (Climate Action Programme 2030 & Klimaschutzgesetz), particularly for sectors that are challenging to electrify. The strategy prioritizes renewable hydrogen, produced via electrolysis powered by renewable energy sources such as wind and solar. This green hydrogen is earmarked for use in **heavy industries** like steel and chemical manufacturing, **transportation** (including heavy-duty vehicles, aviation, and shipping), and **energy storage** to support grid balancing. Hydrogen's role in **district heating** and **industrial heating** is recognized but less emphasized. While **blue hydrogen** (produced using natural gas with carbon capture and storage - CCS) is considered a transitional solution, **grey hydrogen** (produced from fossil fuels without CCS) is discouraged⁶⁹.

Germany acknowledges that domestic hydrogen production will not suffice to meet the anticipated demand. As a result, the strategy includes plans to **import hydrogen** from regions and countries with abundant renewable resources, such as **North Africa**, the **Middle East**, and **Australia**. To facilitate this, Germany is investing in international hydrogen partnerships and developing the necessary infrastructure, including pipelines, liquefied hydrogen terminals, and certification systems to ensure sustainability standards are met⁷⁰.

4.1.2. Waste Heat

Waste heat utilization is an integral part of Germany's energy efficiency and climate strategy, as outlined in the **Integrated National Energy and Climate Plan (NECP)** and the **Energy Efficiency Act**⁷¹. The government recognizes waste heat as a valuable resource to reduce primary energy consumption and greenhouse gas emissions.

Waste heat recovery is particularly emphasized in **industrial processes** and its integration into **district heating networks**. The **Combined Heat and Power (CHP)** systems are actively

⁶⁸ <https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/die-nationale-wasserstoffstrategie.html>

⁶⁹ <https://www.bmwk.de/Redaktion/DE/Dossier/wasserstoff.html>

⁷⁰ <https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/importstrategie-wasserstoff.html>

⁷¹ https://commission.europa.eu/publications/germany-final-updated-necp-2021-2030-submitted-2024_en



promoted to maximize the efficient use of waste heat. The **Federal Ministry for Economic Affairs and Climate Action (BMWK)** supports initiatives aimed at modernizing district heating systems to incorporate waste heat, thereby reducing dependency on fossil fuels⁷².

While the strategy does not specify **quantitative targets** for waste heat utilization, it includes a range of policy measures and incentives to promote its adoption. For example, large industrial facilities are encouraged to conduct energy audits to identify waste heat recovery opportunities, and urban planning policies support integrating waste heat into heating networks. The focus sectors include **manufacturing, urban heating, and data centers**, where significant waste heat potentials exist.

4.2. Legal Status Quo

4.2.1. Hydrogen

Germany has established a robust legal framework to regulate hydrogen production, infrastructure, and integration into the energy system. The primary legislative acts consider:

The **Renewable Energy Act** defines renewable hydrogen as hydrogen produced via electrolysis using **100% renewable electricity**. Low-carbon gases include **blue hydrogen** (natural gas with CCS) and **grey hydrogen** (natural gas without CCS). Green hydrogen is strictly limited to electrolysis-based hydrogen. The RE Act also provides financial incentives for its production. Under this act, green hydrogen producers benefit from **priority grid access** and more competitive **feed-in tariffs**. **In addition**, specific quotas for renewable hydrogen consumption are mandated for certain industries, particularly in **steel** and **chemical** sectors.⁷³

The German Energy Industry Act (Energiewirtschaftsgesetz, EnWG) regulates hydrogen infrastructure, including pipelines, storage, and its integration into the national energy grid. Recent amendments have aligned the EnWG with the EU's Hydrogen and Decarbonised Gas Market Package (May 2024), introducing a dedicated regulatory framework for hydrogen networks. This includes voluntary regulation for network operators, with obligations such as network planning and separate accounting, in exchange for incentives like higher returns on equity.⁷⁴

While there are **no legally binding production targets**, the policy framework aims to achieve **10 GW** of electrolysis capacity by 2030. The Renewable Energy Act mandates that at least **80%** of the electricity used for hydrogen production must come from renewable

⁷² <https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2022/09/20220915-boost-for-green-district-heating-federal-funding-for-efficient-heat-networks-bew-begins.html>.

⁷³ https://www.gesetze-im-internet.de/eeg_2014/.

⁷⁴ https://www.gesetze-im-internet.de/enwg_2005/BJNR197010005.html.



sources, and hydrogen production is capped at **5,000 full-use hours** per year to maintain grid stability⁷⁵.

The **Federal Immission Control Act** sets environmental permitting requirements for hydrogen production facilities, ensuring compliance with emission standards⁷⁶.

The **Hydrogen Acceleration Act** was introduced to streamline the approval processes for hydrogen projects, reducing bureaucratic delays and encouraging investment⁷⁷.

The **Hydrogen Network Tariff Ordinance** governs the transport and distribution tariffs for hydrogen, ensuring fair access and pricing⁷⁸.

The **Guarantee of Origin Register Ordinance** establishes a certification system for green hydrogen, ensuring transparency and traceability in the hydrogen supply chain⁷⁹.

4.2.2. Waste Heat

Germany's legal framework for waste heat utilization is designed to promote energy efficiency and the integration of waste heat into existing energy systems.

Germany's legal framework for waste heat utilization aims to enhance energy efficiency and integrate waste heat (WH) into existing energy systems. Key legislative acts include the Energy Efficiency Act⁸⁰, the Renewable Energy Act⁸¹, and the Energy Saving Ordinance⁸². The Energy Efficiency Act establishes obligations for industrial energy efficiency and mandates the recovery and the reuse of waste heat wherever it is economically and technically feasible. A notable provision is the mandatory use of WH from data centres to supply nearby buildings or heating grids, positioning Germany as a potential European Role model in WH valorization.

The Renewable Energy Act offers incentives for integrating waste heat into district heating networks, particularly through the use of combined heat and power (CHP) systems. The Energy Saving Ordinance sets energy efficiency standards for buildings, indirectly encouraging the use of waste heat for heating and cooling purposes.

Germany's approach to waste heat management is aligned with the European Union's Renewable Energy Directive (RED III – Directive [EU] 2018/2001, as amended), particularly

⁷⁵ https://www.gesetze-im-internet.de/eeg_2014/.

⁷⁶ <https://www.gesetze-im-internet.de/bimsgb/>.

⁷⁷ <https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2024/05/20240529-bundesregierung-stellt-weichen-fuer-den-beschleunigten-ausbau-von-wasserstoffprojekten.html>.

⁷⁸ <https://www.gesetze-im-internet.de/wasserstoffnef/BjNR495510021.html>.

⁷⁹ https://www.clean-hydrogen.europa.eu/get-involved/hydrogen-certification_en.

⁸⁰ <https://www.gesetze-im-internet.de/eneffg/EnEfG.pdf>.

⁸¹ https://www.gesetze-im-internet.de/eeg_2014/.

⁸² <https://www.bmwk.de/Redaktion/DE/Gesetze/Energie/EnEV.html>.



Article 2(9)⁸³, which defines waste heat and cold as “unavoidable heat or cold generated as a by-product in industrial or power generation installations, or in the tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system.” While the German Energy Efficiency Act (EnEfG) does not reproduce this definition verbatim, it adopts the directive’s principles by mandating the avoidance and reuse of waste heat wherever technically and economically feasible (Section 16 EnEfG). In doing so, German legislation operationalizes the EU framework, translating definitional clarity into enforceable obligations. This alignment ensures consistency with EU targets and reinforces Germany’s commitment to integrating waste heat into sustainable energy systems.

The German Energy Efficiency Law (EnEfG) also imposes obligations for the use of waste heat in energy-intensive industries. Companies are required to perform cost-benefit analyses to assess the potential for waste heat recovery, in accordance with Article 26(7)(d) of EED III (Directive [EU] 2023/1791). These analyses are mandatory for large industrial facilities, and the results must be submitted to regulatory authorities⁸⁴.

4.3. Subsidies, Funding, and Incentives

4.3.1. Hydrogen

Germany provides a broad array of subsidies, funding programs, and incentives to support hydrogen production, infrastructure, and research. The state-owned development bank KfW offers low-interest loans and grants for hydrogen projects, with a particular focus on green hydrogen production and infrastructure development⁸⁵.

The Greenhouse Gas Reduction Quota (THG-Quote) system incentivizes the use of green hydrogen in the transport sector by offering a three-euro bonus per kilogram of hydrogen used, encouraging the shift towards renewable fuels⁸⁶. As part of the Important Projects of Common European Interest (IPCEI), Germany also supports large-scale hydrogen infrastructure projects and research initiatives with substantial funding, promoting cross-border collaboration⁸⁷. Additionally, non-financial incentives include fast-tracking approval processes under the Hydrogen Acceleration Act and granting priority grid access to green hydrogen producers.

⁸³ <https://eur-lex.europa.eu/eli/dir/2018/2001/oj/eng>.

⁸⁴ <https://www.bfee-online.de/BfEE/DE/Effizienzpolitik/EuropaeischeEnergieeffizienzpolitik/europaeischeenergieeffizienzpolitik.html>.

⁸⁵ <https://www.kfw.de/International-financing/Briefing-Green-Hydrogen/>.

⁸⁶ <https://energynews.pro/en/germany-approves-three-certification-systems-for-green-hydrogen-with-a-3-euro-bonus-per-kilo/>.

⁸⁷ <https://bmdv.bund.de/SharedDocs/EN/PressRelease/2022/052-41-large-scale-hydrogen-projects.html>.



4.3.2. Waste Heat

Waste heat projects benefit from both financial support and regulatory incentives aimed at promoting energy efficiency.

The Energy Financing Act⁸⁸ provides subsidies for waste heat recovery projects, particularly in industries where significant heat losses occur.

Furthermore, the Energy Efficiency Act imposes obligations for the integration of waste heat in industrial processes. Support is also provided for combined heat and power (CHP) systems that effectively utilize waste heat, with financial incentives to enhance their efficiency.

4.4. Conclusion

Germany's legal and policy framework for hydrogen and waste heat reflects a strong commitment to **climate neutrality** and advancing the **energy transition**. The strategic focus on green hydrogen and waste heat recovery demonstrates an integrated approach to reducing greenhouse gas emissions and improving energy efficiency.

While substantial progress has been made, further **regulatory clarity** and expanded **incentives** will be essential to overcome existing barriers, such as:

- **Uncertainty in Long-Term Markets:** While Germany has set ambitious hydrogen capacity targets (e.g. 10 GW electrolysis by 2030), long-term price signals and demand-side incentives remain insufficiently predictable. Regulatory uncertainties, such as ongoing discussions around Guarantees of Origin, EU hydrogen imports, and carbon pricing, create a cautious and conservative investment climate.
- **Skills Shortages and Knowledge Gaps:** Municipalities, small utilities, and local industry actors often lack the in-house expertise to assess, plan, and execute complex hydrogen or waste heat projects. This creates dependence on external consultants and may result in lower implementation rates or missed opportunities.
- **Regulatory Fragmentation:** The regulatory framework for hydrogen and waste heat remains fragmented across multiple legal instruments (e.g. EnWG, EEG, EnEFG). The coexistence of overlapping provisions and diverging administrative requirements often creates confusion for project developers and public authorities.

By addressing these current challenges, enhancing regulatory coherence, clearer long-term market stability and building local expertise, Germany could be well positioned to accelerate its efforts in the energy transitions and lead the way towards a climate-neutral future.

⁸⁸ <https://www.gesetze-im-internet.de/enfg/BJNR127200022.html>





5. Hungary

5.1. Strategic approach

Regarding hydrogen economy development, the Hungarian Government adopted several strategic documents and plans. The main aim of these plans is to have strategic level documents and strategic plans to advance the hydrogen economy.

The most relevant strategic plans and the highlights are:

- **National Energy Strategy 2030 of 2020⁸⁹:**

It emphasizes the importance of incentives to use non-natural gas origin hydrogen to reduce natural gas consumption. The strategic approach is to support the decarbonisation of industrial production by implementing pilot projects to promote the use of "green" hydrogen (electricity produced from renewable sources).

In addition to biomethane, hydrogen from renewable energy sources is seen as an alternative: blending hydrogen with natural gas produced from electricity from carbon-requirements, which is also relevant to meeting renewable and decarbonisation targets.

- **The National Hydrogen Strategy of 2021⁹⁰:**

The National Hydrogen Strategy is the cross-sectoral national hydrogen strategy document; it sets strategies for industrial, transportational and energy application of hydrogen. The strategy focuses on green hydrogen, but in addition to hydrogen based on electricity from renewable sources, mainly solar energy, Hungary does not ignore the potential of hydrogen production based on carbon-free electricity from nuclear or grid electricity.

- **The REPowerEU Plan of Hungary of 2023⁹¹**

- **The updated National Energy and Climate Plan (NECP) of 2024⁹²**

While waste heat is considered within Hungary's broader energy efficiency and district heating goals, there is no dedicated national strategy solely focused on waste heat utilization. Waste heat utilization is mentioned as part of the National Energy Strategy 2030 of 2020, the updated National Energy and Climate Plan (NECP) of 2024 and very briefly in the REPowerEU Plan of Hungary of 2023. However, the approach towards waste heat recover is not strategic. As an example, the National Energy Strategy 2030 only repeats the district heating directive's definition of efficient district heating -it works with at least 50% renewable energy, 50% waste

⁸⁹ Innovációs és Technológiai Minisztérium, „Nemzeti Energiastratégia 2030, kitekintéssel 2040-ig,” Innovációs és Technológiai Minisztérium, 2020.

⁹⁰ Magyarország Kormánya, „MAGYARORSZÁG NEMZETI HIDROGÉNSTRATÉGIÁJA,” Magyarország Kormánya, 2021.

⁹¹ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.

⁹² Magyarország Kormánya, „Nemzeti Energia- és Klímaterv,” Magyarország Kormánya, 2024.



heat and 75% heat from cogeneration, or 50% from such energy sources a combination of these energy sources.

5.1.1. Hydrogen

The hydrogen used and produced by industry in Hungary is currently mainly high-carbon "grey" hydrogen, produced from natural gas. The National Hydrogen Strategy 2021 aims to meet the energy needs of industry mainly with low-carbon "blue"/"turquoise" hydrogen and partly with carbon-free "green" hydrogen by 2030. The strategy's priority actions are to encourage the development of centralised large-scale production of low-carbon hydrogen to meet local industrial demand, while also supporting the development of decentralised, decarbonised, electrolysis-based hydrogen production to meet smaller-scale demand. According to the strategy, decarbonized hydrogen production is the long-term goal, but in the short term, large-scale production of low-carbon hydrogen is more cost-effective.

The strategy sets the following targets for hydrogen production by 2030⁹³

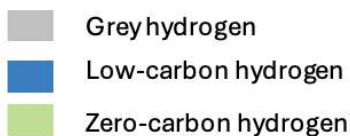
- 20 0000 t/year of low carbon hydrogen
- 16 000 t/year of "green" and other low-carbon hydrogen
- 240 MW of electrolysis capacity

The 2021 National Hydrogen Strategy forecasts industrial hydrogen production and use as follows:

⁹³ Magyarország Kormánya, „MAGYARORSZÁG NEMZETI HIDROGÉNSTRATÉGIÁJA,” Magyarország Kormánya, 2021.



H₂ production



Use of H₂

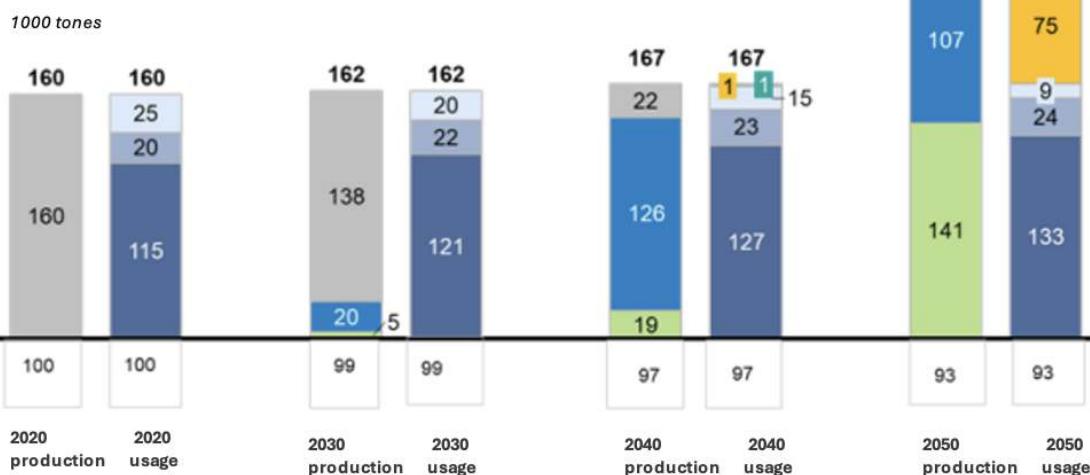


Figure 1: Projected trends in domestic industrial hydrogen production and use in Hungary⁹⁴

However, the National Energy and Climate Plan has already considered the latest EU regulatory requirements. The draft Renewable Energy Directive (REDIII) foresees a much higher demand for so-called non-biological renewable fuels (RFNBO) by 2030. According to RED III, 42% of the hydrogen used as industrial feedstock will have to be replaced by RFNBO by 2030 and 60% by 2035. The NECP recognizes this rule and therefore already states that there will be a significant need for imports to meet the demand for hydrogen, the supply chain of which needs to be developed as soon as possible, considering cost effective modes of transport in the long term. On the demand side, the NECP focuses on the same decarbonization segments - industry and transport - as the Hydrogen Strategy. To reduce GHG emissions from the transport sector, the target is to have 4,800 fuel cell vehicles - mainly buses and trucks - on the domestic road network by 2030. The development of road charging infrastructure is also planned to support hydrogen supply.

Regarding the development of hydrogen ecosystems and hydrogen production, the NECP also follows the same direction as the 2021 Hydrogen Strategy, promoting the diffusion of low-carbon hydrogen for large-scale industrial demand and decentralized green hydrogen production for smaller-scale demand. The NECP plans to support the production and use of green hydrogen through research into means other than electrolysis, such as biological

⁹⁴ Magyarország Kormánya, „MAGYARORSZÁG NEMZETI HIDROGÉNSTRATÉGIÁJA,” Magyarország Kormánya, 2021.



production. In addition, according to the NECP, the production of hydrogen from industrial feedstocks needs to be gradually converted to renewable and nuclear production.⁹⁵

It is important to mention the National Energy Strategy 2020 which highlighted two main pathways for hydrogen: the decarbonization of industrial production using green hydrogen and the blending of hydrogen produced from carbon-free electricity sources with natural gas. However, this strategy has not yet set specific targets for hydrogen.⁹⁶

Hungary's REPowerEU plan identifies several investments and reforms that are in line with Hungary's National Hydrogen Strategy, as the measures outlined support the greening of both transport and industry. It includes, among others, a reform to ensure the legal framework for hydrogen, which will encourage and support the development of a renewable hydrogen ecosystem in Hungary. The reform therefore focuses on identifying and removing legal and administrative barriers related to hydrogen and fuel cell technologies (HTC). The expected outcome of the plan is amended legislation with an implementation deadline of Q1 2024, but the promised amendments have not yet been made.⁹⁷

5.1.2. Waste Heat

In Hungary, we do not have specific law applicable to waste heat in general. In the Energy Efficiency Law (2015/LVII Act on Energy Efficiency) there are specific regulation for district heating where waste heat as a requirement is defined. We summarize the legislation and further national policy documents below.

The goal of the National Energy Strategy is that in the long term all district heating in Hungary, and in the medium term at least the district heating systems of those municipalities where the amount of district heating supplied to the network at the municipal level reaches 100,000 GJ, should be classified as "efficient district heating/district cooling" according to the relevant EU Directive⁹⁸. Efficiency in the sense of the Directive means district heating/cooling using at least 50% renewable energy, 50% waste heat, 75% heat from cogeneration or a combination of these energy sources⁹⁹. The 2015/LVII Act on Energy Efficiency defines efficient district heating as the above mentioned requirement: 'waste heat' content shall be 50% or a combination of the mentioned energy sources. Waste heat in itself is not defined in the law. The policy documents did not detail the meaning of waste heat as well.

⁹⁵ Magyarország Kormánya, „Nemzeti Energia- és Klímaterv,” Magyarország Kormánya, 2024.

⁹⁶ Innovációs és Technológiai Minisztérium, „Nemzeti Energiastratégia 2030, kitekintéssel 2040-ig,” Innovációs és Technológiai Minisztérium, 2020.

⁹⁷ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.

⁹⁸ Energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and Directives 2004/8/EC and 2006/32/EC Directive 2012/27/EU repealing Directives.

⁹⁹ Innovációs és Technológiai Minisztérium, „Nemzeti Energiastratégia 2030, kitekintéssel 2040-ig,” Innovációs és Technológiai Minisztérium, 2020.



The NECP goes beyond the National Energy Strategy in terms of targets. It states that in the heating and cooling sector, in line with RED III, the share of renewable energy (RES-H/C) should be increased by 1% between 2021 and 2025 and by at least 1.3% per year between 2026 and 2030, by increasing the amount and share of biomass and geothermal energy, including waste heat and renewable electricity. Within the sector, specifically for district heating, the NECP expects to increase the share of renewable energy, including renewable electricity, and waste heat and waste cooling (RES-DH) by an average of 2.2% per year.

According to the NECP, incentives for the use of these resources will be developed for each district heating district based on a detailed analysis of local conditions, which will ultimately allow the creation of 5th generation district heating systems.¹⁰⁰

Hungary's REPowerEU plan also mentions waste heat utilization as part of a planned investment, which is described in Part 3.¹⁰¹

5.2. Legal status quo

5.2.1. Hydrogen

In Hungary, the Act XL of 2008 on the Supply of Natural Gas contains various types of definitions relating to hydrogen, and this Act applies to the licensing of installations for the production, use and storage of hydrogen, as well as to pipelines transporting hydrogen. These definitions already refer to the relevant EU legislation:

§ 3 1e. Low-carbon gas	§ 3 1f. Low-carbon hydrogen	§ 3 49k. Renewable gas
<i>means a gaseous fuel as defined in Article 2, Article 35 of Directive (EU) 2018/2001. of Directive (EU) 2018/2001, low-carbon hydrogen and synthetic gaseous fuels, the energy content of which is derived from low-carbon hydrogen and which reaches the 70% greenhouse gas emission reduction threshold compared to the 70% greenhouse gas</i>	<i>means a gaseous fuel as defined in Article 2, Article 35 of Directive (EU) 2018/2001. of Directive (EU) 2018/2001, low-carbon hydrogen and synthetic gaseous fuels, the energy content of which is derived from low-carbon hydrogen and which reaches the 70% greenhouse gas emission reduction threshold compared to the 70% greenhouse gas</i>	<i>gas produced from renewable energy sources, including gaseous renewable fuels of non-biological origin.</i>

¹⁰⁰ Magyarország Kormánya, „Nemzeti Energia- és Klímaterv,” Magyarország Kormánya, 2024.

¹⁰¹ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.



<i>emission reduction threshold in accordance with Article 29a. of Article 29(3) of Regulation (EU) No 2018/2001.</i>	<i>emission reduction threshold in accordance with Article 29a. of Article 29(3) of Regulation (EU) No 2018/2001.</i>	
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The Act also includes a section on the guarantee of the origin of renewable gases and the manner in which they are issued, for which a separate government decree has been issued. However, legally binding targets for the production and integration of green hydrogen have not yet been set.¹⁰²

There are a few other laws that affect hydrogen production, but these laws treat hydrogen production as traditional chemical facilities and do not distinguish between the production methods used. These laws are as follows:

- Government Decree 219/2011 (X. 20.) on the protection against major accidents involving dangerous substances
- 31/2014 (II. 12.) of the Government Decree on the rules of the building authority procedures for certain specific industrial constructions
- Government Decree 314/2012 (XI. 8.) on the settlement development concept, the integrated settlement development strategy and settlement planning instruments, as well as on certain specific legal measures for settlement planning
- Government Decree 314/2005 (XII. 25.) on the environmental impact assessment and the uniform environmental use permit procedure
- 253/1997 (XII. 20.) Government Decree on the national settlement planning and building requirements
- 54/2014 (XII. 5.) BM Decree on the National Fire Safety Regulations
- 35/2016 (IX. 27.) NGM Decree on the testing and certification of equipment and protective systems intended for use in potentially explosive atmosphere¹⁰³

The regulatory and policy framework for hydrogen is underdeveloped and lacks the clarity and incentives necessary to support the growth of a hydrogen economy, which is a major barrier. The lack of clear rules for hydrogen production, storage, transport and injection into existing gas networks creates uncertainty for investors and project developers. In addition, there are no targeted financial incentives or support mechanisms to de-risk investments or facilitate market uptake, particularly in hard-to-abate sectors such as industry and heavy transport. The

¹⁰² „2008. évi XL. törvény a földgázellátásról,” [Online]. Available: <https://net.jogtar.hu/jogszabaly?docid=a0800040.tv>.

¹⁰³ „2008. évi XL. törvény a földgázellátásról,” [Online]. Available: <https://net.jogtar.hu/jogszabaly?docid=a0800040.tv>.



integration of hydrogen into national energy planning and infrastructure development is also limited, and coordination between stakeholders remains fragmented. Without a coherent policy framework and harmonisation with relevant EU legislation such as the Hydrogen and Decarbonised Gas Market Package and RED III, Hungary risks falling behind in the development of a competitive hydrogen market.

5.2.2. Waste Heat

While Hungarian legislation acknowledges the concept of waste heat, it does not provide a detailed definition within the national legal framework.

The Act No. LVII of 2015 concerning energy efficiency defines efficient district heating the same way as it is defined in the National Energy Strategy (and in the EU Directive):

„Efficient district heating: a district heating system that uses at least 50% renewable energy, 50% waste heat, 75% heat from cogeneration or 50% a combination of these;“

Chapter VI of the Act deals with the efficient operation of various facilities, thermal energy supply networks and industrial plants that generate waste heat. A cost-benefit analysis for industrial waste heat recovery must be submitted for approval in the following cases, as defined by the Act:

“7. § f)

(fa) for new electricity generating installations with a total rated thermal input exceeding 20 MW, by operating as a high-efficiency cogeneration unit,

(fb) in the case of significant upgrading of electricity generating installations with a total rated thermal input exceeding 20 MW, by conversion to high-efficiency cogeneration

(fc) in the case of the construction or substantial upgrading of industrial waste heat production installations with a total rated thermal input exceeding 20 MW and producing waste heat at a useful temperature, by connection to the heat distribution network or by using the waste heat to satisfy an economically justified demand, including cogeneration; and

(fd) the assessment of the costs and benefits of using waste heat from nearby industrial installations when designing a heat transmission network or when constructing or substantially upgrading an existing energy production installation with a total rated thermal input exceeding 20 MW into the existing heat transmission network.”¹⁰⁴

The primary barrier to the utilization of waste heat in Hungary lies in the absence of a comprehensive regulatory framework. As highlighted by the Ministry of Energy, the current legislation does not adequately address key aspects necessary for integrating waste heat into the district heating system. Essential components still missing include a clear definition of waste

¹⁰⁴ „2015. évi LVII. törvény az energiahatékonyságról,“
<https://net.jogtar.hu/jogszabaly?docid=a1500057.tv>.

az [Online]. Available:



heat, a distinction between cogeneration and waste heat recovery, and the introduction of motivational pricing that encourages market entry without disadvantaging renewable sources. Additionally, there is a need for a simplified permitting process tailored to sources where heat generation is not the primary activity, as well as financial support mechanisms for connecting waste heat to existing district heating networks. The lack of regulatory alignment with EU directives—such as the Renewable Energy Directive (RED III), the Energy Efficiency Directive, and the Efficient District Heating Directive—further delays progress. Without these foundational elements, Hungary cannot fully capitalize on the potential of waste heat to enhance energy efficiency and reduce emissions in its heating sector.¹⁰⁵

5.3. Subsidies, funding, incentives

5.3.1. Hydrogen

1. Implementation of developments for the conversion of carbon-free, surplus electricity into gas energy (hydrogen, biomethane) through innovative technologies (2020-3.1.2-ZFR-KVG):

- Published in 2020
- Number of funded projects: 5
- Objective: The objective of the call was to support the development of power-to-gas technologies (hydrogen or bio-methane production) using the surplus production of renewable energy sources. The call focused on seasonal energy storage solutions to reduce the need for imports during the winter peak period of natural gas consumption. Such projects increase the flexibility to integrate renewables into the system.¹⁰⁶

2. Green Bus Programme (ongoing government programme)

- Objective: The Green Bus Programme for greening local transport will increase the number of environmentally friendly buses serving local public transport by 2030. Under the Green Bus Programme, around 300 environmentally friendly, electric and hydrogen powered local buses are expected to be in service by 2025. In the longer term, more than 2 000 zero-emission buses are planned to be put into service.¹⁰⁷

¹⁰⁵ Energiaügyi Minisztérium, „A távhő jövője - csendes építkezés,” 11 11 2024. [Online]. Available: https://tavho.org/uploads/rendezvenyeink/2024%20Konfi/EI%C5%91ad%C3%A1sok/05_MaT%C3%A1SzSz_2024_HorvathViktor.pdf.

¹⁰⁶ Energiaügyi Minisztérium, „A távhő jövője - csendes építkezés,” 11 11 2024. [Online]. Available: https://tavho.org/uploads/rendezvenyeink/2024%20Konfi/EI%C5%91ad%C3%A1sok/05_MaT%C3%A1SzSz_2024_HorvathViktor.pdf.

¹⁰⁷ Magyarország Kormánya, „Nemzeti Energia- és Klímaterv,” Magyarország Kormánya, 2024.



3. Green Truck Programme (ongoing government programme)

- Objective: The Green Truck Programme aims to promote the decarbonisation of transport-related vehicle traffic. KEHOP Plus and RRF funds may also help to implement the planned investments. Support can be given to hydrogen production, the purchase of hydrogen vehicles and the construction of hydrogen refuelling infrastructure.¹⁰⁸

4. REPowerEU Plan – Investment 4: Building green economic manufacturing capacity

- Planned investment, expected to be published in 2025
- Objective: Manufacturing capacity development and service expansion (e.g. switching from gas appliance installation to heat pump installation and maintenance) that results in a product or service that contributes to the green transition may be eligible. For example: (1) the installation and capacity expansion of technologies that ensure the production of energy transition devices and the provision of services (typically, but not exclusively, the production of devices that use renewable energy or support energy modernisation), (2) the production of raw materials with improved energy performance, or (3) the development of back-up services related to the green transition (e.g. maintenance and servicing of devices). Support can only be granted for the production of equipment, components, sub-assemblies, materials and products, or for the provision of related services, including equipment for the production and use of renewable hydrogen and its derivatives.¹⁰⁹

5. REPowerEU Plan – Investment 5: Use of green technologies

- Planned investment, expected to be published in 2025
- Objective: The investment aims to reduce greenhouse gas and air pollutant emissions from existing industrial processes, thus contributing to the GHG reduction target set in the National Energy and Climate Plan and the objectives of the National Air Pollution Reduction Programme. The investment would focus on the introduction of GHG emission reduction technologies and fuels (e.g. under REPowerEU eligible carbon capture, use of alternative gases such as hydrogen, biogas/biomethane biomass and biogas, electrification replacing fossil solutions. Where aid is granted for investment in industrial decarbonisation using renewable hydrogen, it shall be ensured that the hydrogen used is produced from renewable energy sources in accordance with the methodology for non-biological liquid or

¹⁰⁸ Magyarország Kormánya, „Nemzeti Energia- és Klímaterv,” Magyarország Kormánya, 2024.

¹⁰⁹ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.



gaseous renewable transport fuels set out in Directive (EU) 2018/2001 and its implementing or delegated acts.¹¹⁰

6. REPowerEU Plan – Investment 8: Hydrogen investments

- Planned investment, expected to be published in 2025
- Objective: The investment is intended to help lay the foundations for a hydrogen economy. The two interdependent pillars of the investment: 1) Hydrogen production: The project will provide 30 MW of electrolysis capacity for the production of renewable hydrogen, contributing to the development of renewable hydrogen production capacity and the deployment of renewable hydrogen as targeted by the national and EU hydrogen strategy. 2) Hydrogen for mobility: The investment will cover buses and goods vehicles, in line with the objectives of the National Hydrogen Strategy, which foresees the introduction of at least 4,800 hydrogen fuel cell vehicles and 20 charging stations by 2030. The investment will provide support for the purchase of hydrogen fuel cell buses and goods vehicles and for the installation of hydrogen refuelling stations.¹¹¹

5.3.2. Waste Heat

1. Developing waste heat recovery, storage or market-based use through innovative heat storage or conversion technology (2021-2.1.2-HŐ):

- Published in 2021
- Number of funded projects: 5
- Objective: The aim is to support demonstration projects that lay the foundations - from both a technical and an environmental point of view - for the market introduction of viable heat storage, heat transport, power-to-heat and heat-to-power technologies.¹¹²

2. Renewable energy production in energy intensive corporations (not yet published)

- Planned funding programme, expected to be published in 2025 Q1
- Objective: The Call aims to provide targeted investment support to large energy-consuming companies for the installation of energy storage facilities and associated

¹¹⁰ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.

¹¹¹ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.

¹¹² Energiaügyi Minisztérium, „A távhő jövője - csendes építkezés,” 11. 11. 2024. [Online]. Available: https://tavho.org/uploads/rendezvenyeink/2024%20Konfi/El%C5%91ad%C3%A1sok/05_MaT%C3%A1SzSz_2024_HorvathViktor.pdf.



renewable energy production. This is expected to replace the electricity demand of companies from the grid and indirectly reduce Hungary's dependence on imports.

3. REPowerEU Plan – Investment 6: Energy efficiency improvements in businesses

- Planned investment, expected to be published in 2025
- Objective: The investment serves the need to increase energy efficiency and energy saving, to strengthen the competitiveness of the economy in an environmentally conscious way, and thus to reduce the amount of primary energy used, which will also reduce the environmental impact. Eligible categories of activities: A) Energy in buildings - possible activities include (but are not limited to): 1) Modernisation of heating/cooling systems (modernisation based on fossil fuels is not eligible). B) Energy efficient modernisation of water supply, wastewater collection and treatment -possible activities include (but are not limited to): 1) Use of lower energy consuming machinery and equipment (including pumps and other equipment), 2) Recovery of residual heat/waste heat (use of residual heat/waste heat from own or other installations).¹¹³

¹¹³ Magyarország Kormánya, „REPowerEU Terv,” Magyarország Kormánya, 2023.



6. Italy

6.1. Strategic approach

Italy's energy and climate strategy, aligned with the European Green Deal, aims for carbon neutrality by 2050. Key national documents such as the National Hydrogen Strategy and the Integrated National Energy and Climate Plan (PNIEC)¹¹⁴ outline the country's dual focus: the promotion of renewable hydrogen as a decarbonization tool, particularly for hard-to-abate sectors, and the enhancement of energy efficiency through the recovery and reuse of waste heat. Regional strategies complement this national vision through localized pilot projects, particularly in the industrial and urban sectors. Despite progress, Italy still faces significant barriers in both sectors, such as regulatory gaps, financial uncertainty, and fragmented planning frameworks, which slow down deployment and investment.

6.1.1. Hydrogen

Italy's hydrogen strategy sets the goal of installing 5 GW of electrolysis capacity by 2030 to produce up to 1 million tons of renewable hydrogen annually. Green hydrogen is expected to play a central role in decarbonizing sectors such as heavy industry (e.g., green steel), transport (rail, maritime, heavy road freight), energy storage (via power-to-gas), and high-temperature industrial heating. While the focus is on hydrogen from renewables, the strategy also considers a transitional role for blue hydrogen (with CCS), and positions Italy as a future Mediterranean hydrogen hub through imports and exports.

However, the hydrogen sector faces substantial barriers. These include the absence of a unified regulatory framework, particularly for low-carbon hydrogen and blended production methods, resulting in legal and market uncertainty. Infrastructure development is hindered by long permitting processes, unclear incentives, and the lack of a certification system to track hydrogen origin and sustainability. The market is further limited by underdeveloped distribution networks (pipelines, refueling stations) and a lack of robust financing schemes or viable business models. As a result, while policy ambition is high, practical implementation remains slow and fragmented.

6.1.2. Waste Heat

The PNIEC identifies waste heat recovery as a key measure to improve energy efficiency and reduce emissions. It highlights the role of industrial processes, waste treatment plants, and power generation in supplying residual heat to district heating networks and urban systems. Priority sectors include manufacturing, district heating infrastructure, and residential or

¹¹⁴ Official Italian document: PNIEC_2024_revfin_01072024 errata corrige pulito.pdf.



commercial buildings using heat pumps. However, the PNIEC does not set explicit national targets for waste heat recovery, relying instead on regional action plans and project-based implementation.

A notable example of regional leadership is the Veneto Region, which included waste heat recovery in its 2017 Regional Energy Plan (PER)¹¹⁵, setting a target to meet 6.5% of total thermal demand through district heating—largely from renewable and residual heat—by 2030. This commitment was reinforced in the New Regional Energy Plan (NPER)¹¹⁶, adopted in 2025, which aims to cut energy consumption by 10% and reduce CO₂ emissions by 15 million tons by 2030. Concrete actions include projects in Verona and Padova using heat from incinerators to power urban heating networks.

Despite these advancements, several barriers persist. National legislation does not classify waste heat as a renewable-equivalent source, limiting eligibility for incentives. Many district heating systems lack the flexibility to integrate external heat sources due to technical or contractual constraints. Investment remains low due to unclear return models, high upfront costs, and long payback periods. Local planning is hampered by a lack of data, such as detailed heat mapping, and lengthy authorization processes. Coordinated planning between municipalities and industry is often absent, limiting synergies.

6.2. Legal status quo

6.2.1. Hydrogen

In Italy, the production of hydrogen via electrolysis is primarily governed by the general regulatory framework applicable to industrial and chemical plants. Specifically, such activities fall under the Integrated Pollution Prevention and Control (IPPC) regime, as outlined in Annex VIII to Part II of Legislative Decree No. 152/2006 (the "Environmental Code"). This classification requires hydrogen production and storage facilities to comply with stringent environmental and safety standards, including obtaining permits from the competent authorities, such as the Fire Department, since hydrogen is classified as a flammable gas.

From an energy perspective, hydrogen production via electrolysis is indirectly affected by electricity market regulations, as electrolyzers are high electricity consumers. These activities must therefore comply with the general provisions of the Italian Electricity Code and with the relevant resolutions issued by ARERA (Regulatory Authority for Energy, Networks and Environment) regarding grid access, energy supply contracts, and potential exemptions or

¹¹⁵ Regional Energy Plan (PER) - 2017: Approved with Regional Council Resolution No. 6 of February 9, 2017. The plan, known as "PERFER," focuses on renewable energy sources, energy savings, and energy efficiency. Source: <https://italiaius.it/ambiente-e-inquinamento/piano-energetico-regionale-del-veneto>

¹¹⁶ New Regional Energy Plan (NPER) - 2025: Adopted with Regional Council Resolution No. 20 of March 18, 2025. The plan outlines the region's strategic objectives for energy transition, including increasing the share of renewable energy and improving energy efficiency. Source: <https://bur.regione.veneto.it/BurVServices/pubblica/DettaglioDcr.aspx?id=553012>.



incentives for energy-intensive users. To date, there is no dedicated energy law specifically addressing hydrogen, although regulatory developments are underway at both national and EU levels.

As for hydrogen injection into the gas grid, current Italian legislation allows the blending of hydrogen with natural gas into the existing infrastructure, under strict technical and safety conditions. Full-scale injection of pure hydrogen is not yet permitted, pending the definition of technical standards and regulatory pathways by ARERA and the national transmission system operator, Snam.

Definitions:

Currently, Italian legislation does not provide official definitions for terms such as *renewable gas*, *renewable hydrogen*, *green hydrogen*, or *low-carbon gas/hydrogen*. However, Italy adopts and applies definitions established at the European level, incorporating them into its regulatory framework through strategic plans and implementing legislation:

- Renewable hydrogen: According to Delegated Regulation (EU) 2023/1184, this refers to hydrogen produced through the electrolysis of water using electricity from renewable sources, in compliance with criteria of additionality, temporal and geographical correlation, and ensuring at least a 70% reduction in greenhouse gas emissions compared to fossil fuels (mase.gov.it).
- Low-carbon hydrogen: Defined as hydrogen derived from non-renewable sources that achieves at least a 70% reduction in life-cycle greenhouse gas emissions compared to fossil fuels (https://www.eca.europa.eu/ECAPublications/SR-2024-11/SR-2024-11_IT.pdf).
- Renewable gases: This category includes biogas, biomethane, and hydrogen produced from renewable sources, as outlined in Directive (EU) 2018/2001 (RED II).

Application in the Italian Context

Italy, through strategic documents such as the *National Hydrogen Strategy* and the *Integrated National Energy and Climate Plan (PNIEC)*, promotes the development and use of hydrogen from renewable sources, in line with EU decarbonization goals. While national legislation does not currently provide formal definitions for these terms, Italian policies align with and implement the definitions and criteria set by the European Union.

In summary, although Italian law lacks official national definitions for the above terms, it follows and incorporates the relevant EU definitions into its regulatory and strategic frameworks.



Legal targets for (renewable) hydrogen production:

Italy has set ambitious targets for renewable hydrogen production. The National Integrated Plan for Energy and Climate (PNIEC) aims to install approximately 5 GW of electrolysis capacity by 2030. Additionally, the draft Ministerial Decree (DM Opex) under consultation proposes measures to promote investments in renewable hydrogen, particularly in hard-to-abate industrial sectors and transportation. The DM Opex outlines an incentive scheme to achieve an annual renewable hydrogen production capacity of 250,000 tonnes by 2027.

Special rules regulating renewable hydrogen production:

While Italy currently lacks a comprehensive regulatory framework specifically for green hydrogen production, efforts are underway to establish clearer guidelines. The draft DM Opex seeks to define "renewable hydrogen" and establish specific operating incentives to accelerate its production. The proposed incentive scheme mandates that hydrogen be produced through electrolytic processes powered by renewable energy sources, aligning with methodologies established for renewable liquid and gaseous fuels of non-biological origin for transport. This initiative aims to provide clarity and support for renewable hydrogen production within the Italian context.

Legally binding obligations on integration of renewable gas and/or hydrogen:

As of now, Italy does not have legally binding obligations, such as green gas quotas, mandating the integration of renewable gas or hydrogen into its energy mix. However, the country is actively exploring strategies to incorporate renewable hydrogen, particularly in sectors like transportation and industry, to meet decarbonization goals. The development of incentive schemes and potential future regulations may introduce binding obligations to promote the integration of renewable gases.

Other hydrogen-specific laws affecting production/use:

In 2016, Italy transposed Directive 2014/94/EU through Legislative Decree no. 257/2016, establishing a framework for the deployment of alternative fuels infrastructure, including hydrogen. This decree facilitates the development of hydrogen refueling stations and supports the adoption of hydrogen as a transportation fuel. Additionally, the Ministerial Decree of 23 October 2018 updated safety regulations for hydrogen distribution facilities, streamlining authorization procedures and reducing barriers for hydrogen infrastructure development.

These legislative measures, along with ongoing consultations and proposed incentives, reflect Italy's commitment to advancing hydrogen production and utilization as part of its broader decarbonization strategy.



6.2.2. Waste Heat

In Italy, the utilization of waste heat is primarily governed by Legislative Decree No. 152/2006, known as the Environmental Code. This comprehensive legislation outlines the country's environmental policies, including those related to energy efficiency and the recovery of waste heat.

Definition

Italian national legislation does not provide a specific definition for "waste heat." Consequently, Italy adheres to the definition outlined in Article 2(9) of the Renewable Energy Directive (Directive [EU] 2018/2001), which defines waste heat and cold as "unavoidable heat or cold generated as by-products in industrial or power generation installations, or in tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system."

Regulation

Italian law does not impose explicit obligations for the utilization of waste heat. However, the Environmental Code encourages energy efficiency measures and the adoption of practices that reduce environmental impact, which can encompass the recovery and use of waste heat.

Regarding cost-benefit analyses, Article 14 of the Energy Efficiency Directive (Directive 2012/27/EU) requires member states to conduct comprehensive assessments of the potential for high-efficiency cogeneration and efficient district heating and cooling. This includes evaluating the utilization of waste heat. While Italy has transposed this directive into national law, specific obligations to perform cost-benefit analyses concerning waste heat potentials are not explicitly detailed in the Environmental Code. Nonetheless, the general principles of promoting energy efficiency and environmental protection imply that such evaluations are encouraged when planning new industrial installations or refurbishing existing ones.

In summary, while Italy does not have specific laws mandating the use of waste heat or explicit requirements for cost-benefit analyses of waste heat potentials, the overarching environmental and energy efficiency policies promote the consideration and implementation of waste heat recovery practices.

6.3. Subsidies, funding, incentives

Italy has implemented a range of financial and non-financial measures to promote hydrogen development and waste heat recovery as part of its broader energy transition and decarbonization strategy. These measures aim to support innovation, infrastructure development, and the adoption of sustainable technologies across industrial, transportation, and energy sectors. Backed by national funding programs like the National Recovery and



Resilience Plan (PNRR) and regional initiatives, these incentives reflect Italy's commitment to achieving climate neutrality by 2050 while boosting economic growth and energy efficiency.

6.3.1. Hydrogen

Italy provides various subsidies, funding mechanisms, and incentives to support hydrogen development, covering production, infrastructure, and use. The key initiatives include:

- **National Recovery and Resilience Plan (PNRR):** Italy has allocated €3.64 billion from its PNRR funds to hydrogen-related projects. This includes €2 billion for green hydrogen production in hard-to-abate sectors such as steel and cement, €530 million for hydrogen refueling infrastructure for transportation, and €450 million for pilot projects involving hydrogen valleys.
- **Hydrogen Valleys:** through regional pilot projects, Italy incentivizes the creation of hydrogen valleys, focusing on localized hydrogen ecosystems that integrate production, storage, and use. These projects are often co-financed by regional and national funds.
- **Production Incentives:** companies investing in renewable hydrogen production facilities can benefit from grants or low-interest loans provided under national funding schemes and EU-backed programs like Horizon Europe.
- **Infrastructure development support:** financial incentives are provided for the construction of hydrogen refueling stations and pipelines, with the aim of integrating hydrogen into the transportation network and industrial processes.
- **Tax incentives and subsidies:** businesses implementing hydrogen technologies may qualify for tax deductions under Italy's energy efficiency and decarbonization programs. For example, the "Industry 4.0" tax credit can be applied to hydrogen-related innovations.
- **Non-financial support:** Italy offers streamlined permitting and regulatory support for hydrogen-related projects to encourage private-sector participation and reduce bureaucratic barriers.

6.3.2. Waste Heat

Subsidies and incentives for waste heat recovery in Italy are aimed at improving energy efficiency and promoting the circular economy. Key measures include:

- **PNRR Funding:** approximately €1 billion is allocated to energy efficiency improvements, including waste heat recovery projects in industry and district



heating networks. Industrial facilities investing in heat recovery technologies can receive grants or subsidies under this funding scheme.

- **Energy Efficiency Certificates (TEE):** also known as white certificates, this mechanism rewards companies that achieve energy savings through measures like waste heat recovery. Eligible projects receive certificates that can be sold on the energy market, providing a financial return for energy-saving investments.
- **Tax incentives:** waste heat recovery investments can qualify for tax deductions under the "Ecobonus" and "Superbonus" schemes, which cover energy efficiency upgrades. Industrial players can also benefit from reduced taxes on equipment used for heat recovery systems.
- **Regional programs:** many regions offer additional financial support for waste heat recovery projects through their energy and climate plans, including co-financing opportunities for local projects.
- **District heating incentives:** funding is available for the expansion and modernization of district heating networks that incorporate waste heat sources, with a focus on urban and industrial areas.
- **Non-financial incentives:** Italy simplifies administrative procedures and accelerates permitting for waste heat recovery systems to reduce costs and encourage adoption.



7. Poland

7.1. Strategic approach

Polish Hydrogen Strategy until 2030 with an outlook until 2040 (PHS) is a strategic document of the Polish Government that sets out the main objectives for the hydrogen economy development in Poland and the actions needed to achieve them

PHS is a part of the global, European and national efforts to achieve a low-carbon economy such as: 1992 UNFCCC Convention, 1997 Kyoto Protocol, Paris Agreement and European Green Deal.

On the national policy landscape, PHS is in line with the objectives of the Strategy for Responsible Development until 2020 (with an outlook until 2030) (SRD), Polish Energy Policy until 2040 (PEP 2040) and the National Energy and Climate Plan (NECP) for 2021-2030. PHS builds on the Polish government's efforts to support hydrogen technologies initiated in the National Policy Framework for the Development of Alternative Fuels Infrastructure.

7.1.1. Hydrogen

The Polish government intends to support only low-carbon hydrogen, i.e. from renewable sources and produced using zero-emission technologies. Obtaining support for the production of hydrogen from fossil fuels will be possible provided that technologies efficiently limiting CO₂ emissions are used (e.g. CCS/CCU).

The PHS, by making support conditional to the level of emissions associated with the production of hydrogen rather than specific technologies, adopts a technology-neutral approach. The Polish government will support research and development of low-emission processes and technologies for obtaining hydrogen, as well as launching such installations with a total power of min. 50 MW. In 2030 the aim is to achieve an installed production capacity of 2 GW from low- and zero-emission sources and processes.

According to PHS, the industrial sector has the potential to become the largest user of low-carbon hydrogen due to the lack of alternative decarbonization options. Sub-sectors requiring very high temperatures (>200 °C), such as steel or chemicals, due to the specifics of their processes, present a significant challenge in the decarbonisation of industry due to the lack or limited potential for large-scale electrification of their processes with renewable energy.

Hydrogen represents an opportunity to reduce emissions from chemical feedstocks and reactants i.e. ammonia, methanol, iron reduction and petrochemical products.

The current strategic documents adopted in 2021 do not cover the issue of imports. Concrete calculations emerged in December 2024, with the completion and publication of the results of



a study entitled Hydrogen Map of Poland, during which 178 projects related to hydrogen production, consumption, distribution and storage in Poland were analysed. A comparison of production and consumption figures showed a potential deficit in domestic production relative to potential demand. This means that it may be advisable to import hydrogen at a level of 0.8 million tonnes in 2030 to 1.4 million tonnes in 2040, or to increase its domestic production to meet the declared demand.

The current state of implementation of the strategy indicates the need for an update to include hydrogen imports and a plan to build infrastructure that is part of the European network. Next year, five years after adoption, a mid-term evaluation would be necessary to help assess the effectiveness of the strategy implementation.

7.1.2. Waste Heat

Waste heat is part of the 'Heat Strategy', which will implement the objectives outlined by the Draft Energy Policy of Poland 2040 and the National Energy and Climate Plan (NEPC). The adoption of the Strategy will be a consequence of the final agreement of the NEPC provisions, which is expected at the end of February 2025.

The Polish district heating sector is divided into two main sub-sectors:

- System district heating - an area regulated by the President of the Energy Regulatory Office that includes companies producing and supplying heat for the needs of other entities.
- Non-system heating - the remaining part of the sector in which the largest group is made up of individual heat sources in households.

According to the diagnosis placed in the strategy, a barrier to the development of district heating is the recognition of a given district heating system as 'efficient' according to the definition in Directive 2012/27/EU. The definition was transposed into the Energy Law and according to its wording: an efficient district heating system is a system in which at least 50 percent of energy from renewable sources is used to produce heat or cold, or 50 percent of waste heat, or 75 percent of heat from cogeneration, or 50 percent of a combination of the above energy and heat is used. A system that does not meet this condition cannot receive public support unless it achieves efficient status as a result of the investment made. Currently, about 10 percent of systems in Poland meet the condition. Proposed solutions in the strategy include the large-scale use of heat from municipal waste and waste heat. Where it is technically feasible and economically viable, waste heat, i.e. heat generated by industrial processes, hitherto unused, should be used. Where necessary and justified by local resources, there will be the development of installations for the thermal conversion of municipal waste in modern installations that meet stringent environmental criteria and produce electricity and heat in cogeneration.



The lack of a governmental strategy is the most important barrier to resource mobilization and development of waste heat utilization projects in Poland. The lack of specific indicators and public policy tools dedicated to their achievement causes a longer waiting period on the part of stakeholders.

7.2. Legal status quo

7.2.1. Hydrogen

Definitions

The Act of 21 November 2024 amending the Energy Law introduced new regulations for the hydrogen sector in Poland and is part of a legislative package referred to as the Constitution for Hydrogen.

As part of the draft amendment, the following changes were introduced:

1. Regarding the entry into force of the legal framework regulating hydrogen infrastructure and the hydrogen market:

- hydrogen has been included in the category of fuels - as a result, legal provisions on fuels, including sales rules, will apply to it; the definitions of sales and supply of heat, electricity and gaseous fuels, as well as the definition of generation, have been extended; the scope of the definition of gaseous fuels has been extended to include the admixture of hydrogen;
- the definition of energy storage relating to a form of energy other than electricity has been clarified - as a result of this change, energy storage will, inter alia, not require to be used in the form of another energy carrier (e.g. stored hydrogen will not necessarily have to be used in the form of electricity or another non-hydrogen carrier);
- introduced definitions of: low carbon hydrogen, renewable hydrogen, non-biological renewable hydrogen, hydrogen transmission network, hydrogen distribution network, geographically limited hydrogen network, hydrogen system, hydrogen system user, hydrogen transmission, hydrogen distribution, hydrogen storage, local hydrogen storage, hydrogen storage facility, small hydrogen storage facility, and hydrogen transmission system operator, hydrogen distribution system operator, hydrogen storage system operator and combined hydrogen system operator - thereby regulating the essential elements of hydrogen market infrastructure and functioning;
- regulates the rights and obligations of hydrogen market participants and the President of the Energy Regulatory Office (ERO) by introducing rules for the



certification and designation of hydrogen system operators, defining the scope of their obligations and rules for ownership unbundling, as well as introducing the obligation for energy companies to provide hydrogen transmission, distribution and storage services.

2. On the cross-sectoral use of hydrogen generation and infrastructure:

- it is made possible for either the hydrogen transmission system operator or the combined hydrogen system operator to act as a single entity together with the gas transmission system operator;
- legal unbundling of hydrogen system operators (hydrogen transmission system operator, hydrogen distribution system operator and hydrogen storage system operator) is constructed in a way that takes into account possible synergies between the gas sector and the hydrogen sector;
- as regards distribution, the possibility is created for owners of gas distribution networks, gas distribution system operators and hydrogen distribution system operators to share assets with other hydrogen distribution system operators within the same group of companies;
- regulated issues relating to hydrogen storage, as well as hydrogen storage facilities, including the entity responsible for the operation of hydrogen storage facilities;
- obligations were introduced: to obtain a licence for hydrogen storage activity, with the exception of local hydrogen storage in small storage facilities; to obtain the designation of hydrogen storage system operator; to obtain registration in the register of hydrogen storage facilities, which was introduced to ensure proper monitoring of market development;
- an obligation to obtain a licence for hydrogen trading activities was introduced (the obligation was excluded when the annual turnover does not exceed the equivalent of EUR 10 million).

3. With regard to the proposed regulation's fulfilment of the 'do no serious harm' (DNSH) principle and ensuring market conditions and conditions for the use of renewable hydrogen are not inferior to those for hydrogen obtained from other sources, as well as supporting the development of renewable hydrogen and renewable hydrogen of non-biological origin - the bill:

- introduced definitions of low-carbon hydrogen, renewable hydrogen and renewable hydrogen of non-biological origin - this enabled the market situation for the different types of hydrogen to be regulated differently;
- a definition of a geographically limited hydrogen network was introduced for which a number of legal facilities were provided; specific rules for the application,



monitoring and withdrawal of the derogation by the President of the ERO were also presented and the characteristics of the network were defined.

In terms of existing regulations, it is difficult at this point to identify significant barriers to the development of the hydrogen economy. The amendment to the regulations, which came into force in January 2025, introduces expected changes to facilitate the operation of hydrogen technologies in Poland. However, the possible need for changes may become necessary only as a consequence of the application of the new regulations. One barrier may be, for example, the need to liberalise the conditions for obtaining a licence, which may hinder the commercialisation process of hydrogen projects.

7.2.2. Waste Heat

Definitions

The legal definition of waste heat did not appear in the Polish legal system until 2023, is contained in the Energy Law of 10 April 1997 and defines waste heat as unavoidable heat generated as a by-product in industrial installations, energy generation installations or in the service sector, which without access to the district heating system would remain unused, dispersing in the air or in water. The definition in force is consistent with the wording set out in Article 2(9) of RED III (Directive [EU] 2018/2001)

Regulation

In Poland, there is no clear nationwide regulation that would directly require the use of waste heat. The Polish Energy Law also does not contain any direct provisions imposing an obligation to analyse the possibilities of using waste heat. However, various legal acts contain provisions promoting or enforcing its management in specific situations, particularly in the context of energy efficiency and environmental protection.

The fundamental barriers to the development of waste heat utilization in Poland are the financial situation and the lack of expected legislative changes that will streamline and in many cases even enable the investment process.

Among the recommended changes, experts indicate, among others, improving the functioning of regulatory mechanisms related to energy efficiency. The system of support for improving energy efficiency based on the formula of energy efficiency certificates, commonly known as white certificates, has not yet brought the expected results. The mechanism should be changed so that it becomes a real motivation to improve energy efficiency and stimulate companies to make investments.

Additionally, it is recommended to adopt regulations to facilitate investments in waste heat. It is postulated to introduce changes that will reward investments that limit the negative impact



of heating on the climate and support the development of energy-efficient systems by providing appropriate incentives and financial resources for the implementation of projects.

7.3. Subsidies, funding, incentives

7.3.1. Hydrogen

The Polish Hydrogen Strategy to 2030 with an Outlook to 2040 envisages the allocation of approximately 11 billion PLN for the development of hydrogen initiatives and technologies. The document divides these investments into two periods: 2021-2025 and 2025-2030. By 2025, the government plans to allocate 983 million PLN for 250 hydrogen buses, the construction of 32 hydrogen refuelling stations and 50 MW of low-emission power. By 2030, on the other hand, there are expected to be 1,000 hydrogen buses and the capacity of these installations is expected to increase to as much as 2 GW. The cost of these investments will be around PLN 10.8 billion. The strategy lists a total of 11 financing mechanisms for these investments, including both national and European funds. According to the document's assumptions, almost all national funding sources will be linked to programmes of the National Fund for Environmental Protection and Water Management. One can also point to such programmes as Green Public Transport, Hydrogenisation of the Economy or the Programme 'Support for electric vehicle charging and hydrogen refuelling infrastructure'. In addition to this, the National Centre for Research and Development has announced the strategic programme 'New Technologies for Energy'. It includes three thematic areas, including 'Technologies for the production and use of hydrogen', with an allocation of PLN 141.2 million. In addition, it is worth highlighting another programme, 'New Energy', which provides funding mainly in the form of loans on preferential terms up to 85 percent of eligible costs, with the possibility of obtaining a premium to reduce the amount of the loan principal to be repaid. It is divided into four project categories: Smart Energy Cities - with a budget of up to PLN 150 million, Multi-fuel units with heat or cold storage - up to PLN 150 million, Stable emission-free energy sources - up to PLN 250 million and Self-sufficient energy clusters - up to PLN 150 million.

A very significant share of the total funds which, according to the assumptions of the document, were to be allocated to the development of green and low-emission hydrogen production capacity, is money from the National Reconstruction Plan. As much as EUR 800 million (nearly PLN 3.8 billion) was earmarked for this purpose, which accounts for as much as 35% of the total funding of the Polish Hydrogen Strategy. In addition to increasing the production potential of hydrogen, these funds were to support its practical use in energy, industry and low- or zero-emission transport, mainly by further developing the NFOŚiGW programmes described above and funding IPCEI (Important Projects of Common European Interest) projects. Unfortunately, funds from the NIP have still not reached Poland due to the lack of agreement between the Government of the Republic of Poland and the European Commission, in particular through the lack of progress in achieving the so-called 'milestones', i.e. the conditions necessary for disbursement. This situation puts the realisation of some of the goals of the Polish Hydrogen Strategy until 2030 under question.



The year 2025 promises to be a breakthrough in the financing of hydrogen-related projects. With the availability of new, broad support programs, investments in the hydrogen economy have a chance for dynamic development. The barrier of lack of financial support for companies planning to invest in hydrogen technologies, production of low-emission hydrogen, as well as development of infrastructure for its storage and distribution has disappeared. The only worrying trend seems to be the government shifting funds originally dedicated to energy transformation and development of the hydrogen economy to other purposes. For example, in March 2025, a decision was made to redirect EUR 200 million that had not been used in hydrogen investment co-financing programs to support the competitiveness of small and medium-sized enterprises - in the form of a national contribution to the EU InvestEU program.

7.3.2. Waste Heat

The Modernisation Fund, funded by the EU Emissions Trading System (EU-ETS), allocates funds for energy transformation in 13 EU countries, including Poland. It is estimated that by 2030, around PLN 60 billion could come to Poland from the Modernisation Fund for projects improving energy efficiency and developing zero-emission transport. As part of the Modernisation Fund, there are:

- the priority programme “District Cogeneration”, which is aimed at companies involved in the generation of heat or electricity in district heating systems. It promotes investments related to the construction and reconstruction of generating units with an installed capacity of at least 1 MW, operating under high-efficiency cogeneration conditions. Support is provided for investments using waste heat, energy from renewable sources, gaseous fuels, gas mixtures, synthetic gas and hydrogen for energy production. The total budget of the programme is PLN 1 billion, and funding can be obtained in the form of grants and loans from the NFOŚiGW
- the priority programme “Cogeneration for Energy and Industry”, dedicated to the achievement of the climate and energy framework objectives set at national level and the long-term goals set out in the Paris Agreement. Under the programme, support was provided for investments concerning the construction and/or reconstruction of generating units with a total installed capacity of not less than 10 MW, operating under conditions of high-efficiency cogeneration (excluding energy generated in a coal-fired cogeneration unit) together with their connection to the transmission network, where energy production uses:



- waste heat,
- energy from renewable sources,
- gaseous fuels, natural gas mixtures, synthetic gas or hydrogen.

Both programmes provide for grants of up to 50% of eligible expenditure and loans for up to 15 years, supplementing the financial assembly of projects up to 100% of investment expenditure.

According to the experts, the key elements for making the necessary investments in the area of waste heat are: improving the bankability of companies, ensuring adequate collateral for loans, streamlining decision-making processes at NFOŚiGW, cooperation with municipalities and including gas as a transitional fuel in support programmes. In addition, the taxonomy p1t is worth considering a legislative solution, e.g. for the transition period - for companies that submit a transition plan - subject to verification and approval. BGK (the Polish State-owned Development Bank) would then provide loans for investments that are part of the transformation, and the guarantee would not burden the debt ratio and would not be written into multi-year financial plans. Provisions need to be clarified to allow access to financing for CHP projects.



8. Slovenia

8.1. Strategic approach

Slovenia decided not to develop a National Hydrogen Strategy as a self-standing and comprehensive document, but has rather inserted the H₂ KPIs, key goals for the introduction of green H₂ technologies and the overall strategy of its adoption in the revised version of the National Energy and Climate Plan (NECP), which was updated in December 2024.

The revised version can be found at the following link (H₂ is mentioned several times throughout the document):

https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/nepn/dokumenti/nepn2024_final_dec2024.pdf

There are also other strategies, where Hydrogen is mentioned several times, but the sector is not strategized as a whole:

- ReNPRP30 - Resolution on the national programme for the development of transport in the republic of Slovenia for the period up to 2030
<https://pisrs.si/pregledPredpisa?id=RESO115>
- Strategy for the development of transport in the Republic of Slovenia until 2030
<https://www.gov.si/assets/ministrstva/MzI/Dokumenti/Strategija-razvoja-prometa-v-Republiki-Sloveniji-do-leta-2030.pdf>
- Market development strategy for the establishment of an adequate infrastructure for alternative fuels in the transport sector in the Republic of Slovenia
<https://www.gov.si/assets/ministrstva/MOPE/TRAJNOSTNA-MOBILNOST-STMP/Alternativna-govirva/Strategija-na-podrocju-razvoja-trga-za-vzpostavitev-ustrezne-infrastrukture-v-zvezi-z-alternativnimi-gorivi-v-prometnem-sektorju-v-Republiki-Sloveniji.pdf>

8.1.1. Hydrogen

Strategic production targets for hydrogen are mentioned in the chapters below.

- In which sectors should the produced renewable hydrogen be used?

The NEPC document emphasizes the usage of hydrogen in:

- Industry (with a special focus on “hard to abate sectors”)
- Mobility



Energy sector (with a focus on green H₂ being used as energy storage)

- Preferences concerning type of hydrogen that the respective country wants to produce (only if this is stated in any official strategic or governmental paper)

The importance of production and usage of Green H₂ is emphasized in NECP document.

- Does the respective country have any plans to import hydrogen?

Yes, the plan is to import and export Hydrogen, via two two-way Hydrogen corridors, Hungary-Slovenia-Italy, and Hungary-Slovenia-Austria.

This is stated in NECP document (the link is above)

8.1.2. Waste Heat

- Is waste heat utilization mentioned in any strategic documents?

YES, but only mentioned. There are no specific objectives or strategic activities mentioned.

- If yes, how is waste heat utilization integrated into national or regional energy and climate plans?

There are no any specific targets for waste heat utilization yet, specified under any specific legal documents, but there are a few mentions of the waste heat utilization in the NECP - COMPREHENSIVE NATIONAL ENERGY AND CLIMATE PLAN. (the link is above)

Decarbonization dimension

Achieve at least a 33% share of renewable energy sources (RES) in final energy consumption by 2030, at least a 30% share of RES (including waste heat) in industry, at least a 2 to 3% annual increase in the share of RES and waste heat and cold in district heating and cooling systems, reaching at least a 25-40% share of this production by 2030.

Other RES objectives

Industry

At least a 1.6% average annual increase in the share of RES in heating and cooling in industry, excluding waste heat in 2025 and the 2026-2030 period

District Heating and Cooling Systems

At least a 2.5% annual increase in the share of RES and waste heat and cold in district heating and cooling systems, reaching at least a 40% share of this production by 2030

- Is it mentioned where (sectors) and how waste heat should be used?

Industry



- At least a 1.6% average annual increase in the share of RES in heating and cooling in industry, excluding waste heat in 2025 and the 2026-2030 period

District Heating and Cooling Systems

- At least a 2.5% annual increase in the share of RES and waste heat and cold in district heating and cooling systems, reaching at least a 40% share of this production by 2030

8.2. Legal status quo

8.2.1. Hydrogen

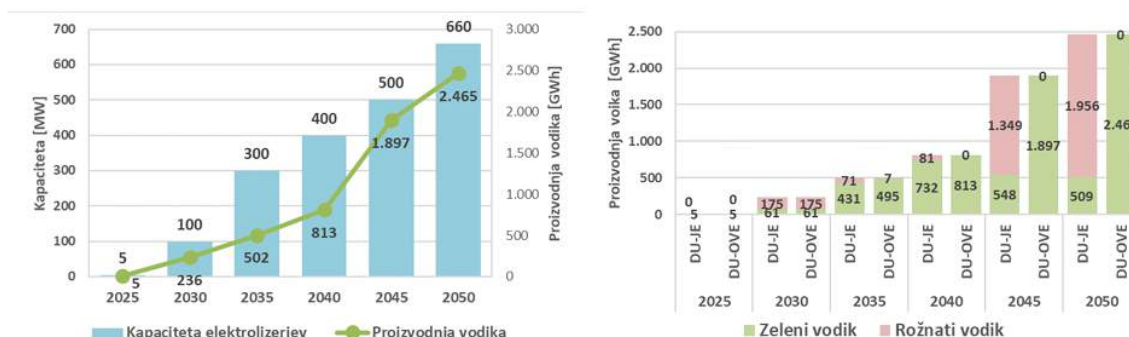
There is no specific legal framework established in Slovenia that would regulate the areas of green hydrogen infrastructure development/hydrogen policy in general. Such acts have not yet been adopted yet in the Republic of Slovenia.

The mentioned area is covered by very different laws and regulations. But we have to emphasize that H₂ is often mentioned several times in these laws, but the legislation does not specifically touch the hydrogen sector:

- ZIAG - Act on infrastructure for alternative fuels and promote the transition to alternative fuels in transport
<https://pisrs.si/pregledPredpisa?id=ZAKO8771>
- Energy law - EZ2
<https://pisrs.si/pregledPredpisa?id=ZAKO8855>
- Electricity supply act
<https://pisrs.si/pregledPredpisa?id=ZAKO8141>
- Energy efficiency act
<https://pisrs.si/pregledPredpisa?id=ZAKO8136>
- Gas supply act
<https://pisrs.si/pregledPredpisa?id=ZAKO8376>
- Act on the promotion of the use of renewable energy sources
<https://pisrs.si/pregledPredpisa?id=ZAKO8236>

There are legal targets for hydrogen production and electrolyzer capacity, which are mentioned in the “Hydrogen sections” under the **NEPN - COMPREHENSIVE NATIONAL ENERGY AND CLIMATE PLAN**.

The plan as can be seen in the image below, is to raise the capacity of the electrolyzers to 100 MW, by 2030, and the production of green hydrogen to 236 GWh (175 GWh of it being the pink hydrogen), by 2030. The next KPI is raising green hydrogen production to 2465 GWh, by 2050 (1956 GWh of it being the pink hydrogen) and the electrolyzer capacity to 660 MW by 2050.



Source: NECP (the link is above)

As described in the NECP document (the link is above), which is a strategic document, Slovenia is considering injecting green hydrogen into its existing gas network, but not more than 10%. The plan is to inject from 2 % to 10% of hydrogen into the existing transmission gas network, which is currently used for natural gas, by 2030. To achieve this, Slovenia intends to develop a market for renewable hydrogen, which will be supported by guarantees of origin scheme. So far, there is no specific legal framework or regulations for hydrogen blending that would control how much % of the blending can really be done in practice. Currently, these actions are under the responsibility of the public company Plinovodi d.o.o, which is the official operator of the transmission network for natural gas deployment of hydrogen in Slovenia. The plan is to inject from 2 % to 10% of hydrogen into the existing transmission gas network, which is currently used for natural gas, by 2030, but no further actions have yet been taken.

8.2.2. Waste Heat

Energy law - EZ2

Article 115 of the Energy Act (EZ-1) provides that investment projects in electricity generation from renewable energy sources, energy storage, sources of flexibility of the electricity system (including hydrogen technologies) and energy utility infrastructure that promotes the connection of these projects do not require an overall return on investment of 4% or more for the assessment of economic viability to be positive. This is the case regardless the public finance regulations governing the uniform methodology for the preparation and treatment of investment documentation and regardless the due diligence required under the Companies Act in companies in which the Republic of Slovenia or local authorities hold, directly or indirectly, a majority stake.

Regulation

Does national law impose obligations for the use of waste heat?



Is there an obligation to undertake cost-benefit analyses regarding waste heat potentials? (e.g. Article 26(7)(d) of EED III (Directive [EU] 2023/1791))

NO

However, there are several regulations that govern the emissions of substances and heat during the discharge of wastewater from various industrial processes in the Republic of Slovenia. These regulations are part of a broader legislative framework aimed at environmental protection and reducing pollution. Key regulations include:

Regulation on emissions from hydrogen peroxide and sodium perborate production: This regulation sets emission limits for wastewater discharge from facilities producing hydrogen peroxide and sodium perborates.

Regulation on emissions from textile fiber production, processing, and treatment: This regulation governs emissions from wastewater discharge in the textile industry.

Regulation on emissions from non-ferrous metal foundries: This regulation applies to emissions from wastewater discharge in non-ferrous metal foundries.

Regulation on emissions from chlor-alkali electrolysis: This regulation covers emissions from wastewater discharge in chlor-alkali electrolysis processes.

Regulation on emissions from pharmaceutical products and active substance manufacturing: This regulation deals with emissions from wastewater discharge in the pharmaceutical industry.

These regulations are part of a broader legislative framework in Slovenia aimed at reducing emissions and protecting the environment. They are not specifically focused on waste heat but rather on managing emissions from various industrial wastewater discharge processes.

8.3. Subsidies, funding, incentives

8.3.1. Hydrogen

Ministry of the Environment, Climate, and Energy - Call for proposals for the co-financing of the purchase of vehicles for the establishment of an emission-free public passenger transport line.

Subsidies for the purchase of EVs – natural persons and private sector

Subsidy up to 7200,00 € for the purchases of new or used (up to 4 years) EVs (including FCEVs)



8.3.2. Waste Heat

ECO-FUND 118FS-PO24 Non-returnable financial incentives for new investments in energy efficiency and renewable energy sources for businesses

- waste heat recovery from processes and/or installations