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Strategic Roadmaps for participating countries

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Short Description
This document include country-specific political roadmaps, which are based on country-specific policy assessments and identified barriers and involves recommendations directed at political actors and energy planers.

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CONTENT

1. INTRODUCTION

The project DanuP-2-Gas aims to advance transnational energy planning by promoting generation and storage strategies for renewables in the Danube Region by coupling power and gas sectors. The effective realisation of this project depends strongly on the legal and regulatory framework. During the work within the WP3 “Policy and Legal Framework” the legal and regulatory status concerning the construction and operation of hubs for coupling the electricity and gas sector was assessed and existing national barriers have been identified.

These assessments are the basis for the development of country specific strategic roadmaps designed to foster energy storage through specific recommendations on different levels - for adjustments of the legal framework, reduce social, technical barriers as well as giving special insights on the potential of the sector coupling hubs in every country. Further, these roadmaps will be combined to a durable strategy to enhance sector coupling in the Danube Region.

In order to obtain valuable results for the roadmaps from the legal analysis and identified barriers, it is imperative to identify which measures and steps are necessary to achieve the EU and national targets for decarbonisation, increasing the share of renewable energies as well as increasing energy security in the region. It must be emphasized that there are some barriers that apply to all countries, however country-specific challenges with corresponding national climate targets will play an important role for the developed roadmaps. The roadmaps have been discussed during national stakeholder workshops and individual expert interviews and additional adjustments, based on the interviews, are incorporated.

Deliverable D.T3.2.1 “Strategic roadmaps for participating countries” serves as a basis for all the above-mentioned objectives. The aim of this Deliverable is therefore to show identified potentials for sector coupling hubs in terms of available renewable energy sources and existing and future demand for PtG products and to define the needed actions to promote and deploy the sector-coupling hubs in Danube Region countries.

2. METHOD

The objective of this Deliverable is to present country-specific roadmaps, which are developed based on the conducted legal assessment in every involved country and, especially, taking into account the identified barriers. The development of the national roadmaps started with discussion in a core team, where aim, timeline and needed actions have been discussed. The roadmaps, which than were developed by the respective project partners were disseminated to the national stakeholders directly or via workshop discussion and gained feedback was incorporated into the roadmaps.

3. GENERAL APPROACH

A roadmap is a strategic plan that describes the steps needed to take to achieve stated outcomes and goals. The IEA defines a technology roadmap as *"a dynamic set of technical, policy, legal, financial, market and organisational requirements identified by all stakeholders involved in its development."*[1]

The development of the roadmap in DanuP-2-Gas project relies on the general approach proposed by IEA in "Energy Technology Roadmaps. A guide to development and implementation", see Figure 1.

The results of analysis of biomass potentials, as well as infrastructural challenges made within the WP 2 "Transnational Infrastructure and Biomass Assessment & Pre-feasibility Study" are essential part of the roadmap, showing the existing situation with future potentials. Evaluated use cases of sector coupling hubs within the WP2, highlight important findings for potential investors or other interested stakeholders, showing the possibilities and weaknesses of feasibility of such projects in every country. An overview about current funding possibilities for sector coupling hubs for each country are also part of the respective roadmaps and output of the WP4 "Future projects and funding".

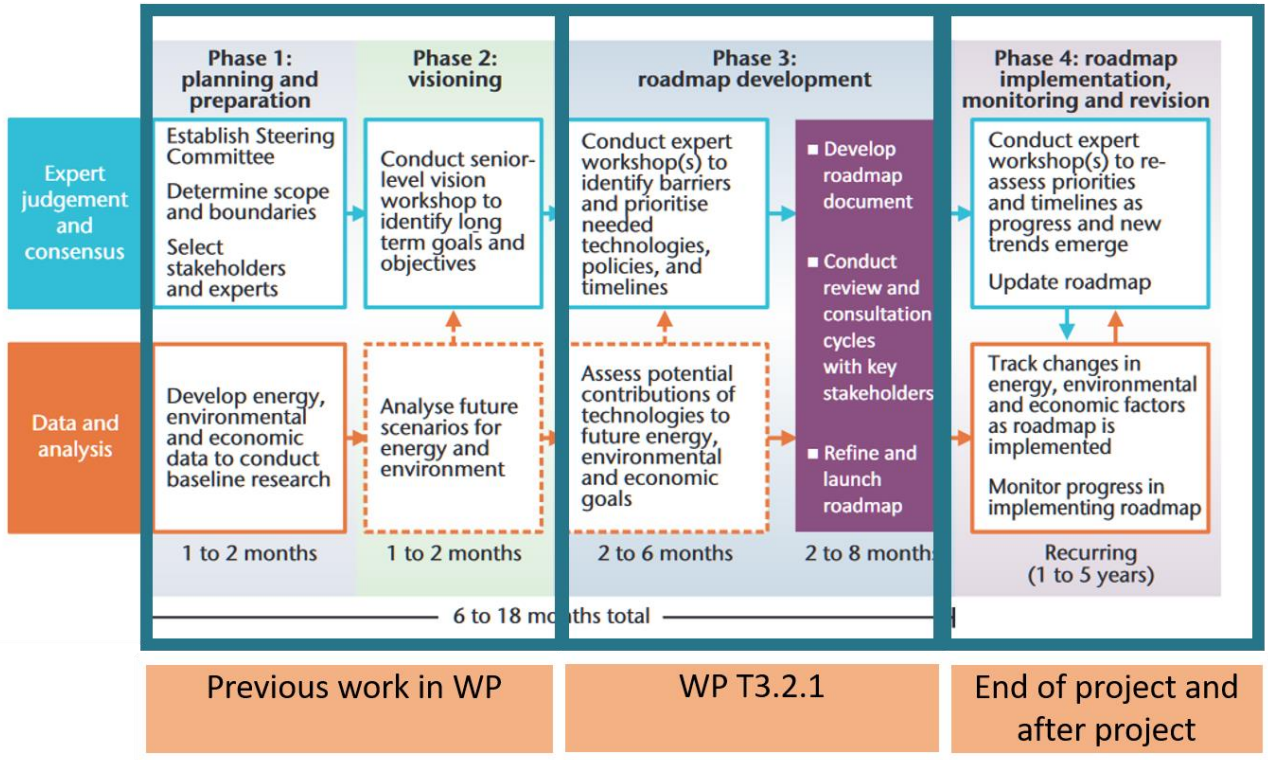

Figure 1. Roadmap process outline (Adjusted from IEA technology Roadmap Guide, 2014)

The analysis of the legal framework and identification of existing transdisciplinary barriers is the core part of this roadmap. The further development of action items and needed steps to overcome the barriers, which are in line with the specific country goals, shows the step-wise plan to achieve the overall targets and aims of the roadmap.

[1] Energy Technology Roadmaps. A guide to development and implementation. IEA, 2014 Edition

4. THEMATIC SCOPE AND GOAL OF THE ROADMAP

The goal of the roadmap is to support the development towards increased energy security and efficiency in the Danube Region via storage of surplus renewable energy in the gas grid and contribute to the EU climate-neutrality by 2050. The roadmap identifies needed actions to overcome existing barriers for wider implementation of sector coupling hubs within the Danube region. The roadmap focuses foremost on adjustments of legal framework, however overall interdisciplinary barriers and challenges are shown and further steps identified.

5. EUROPEAN UNION

Before the national specifics are explained in more detail, the goals and objectives as well as the established procedures of the European Union should be outlined.

Reduction of greenhouse gas emissions – European Climate Law
With the adoption of Regulation 2021/1119[2], the so-called "European Climate Law", the European Union has established a union wide framework for achieving climate neutrality. Article 1 of the Regulation sets out the binding target of climate neutrality by 2050. Article 2 further specifies this target by prescribing the balancing of greenhouse gas emissions regulated by Union law and their removals by 2050 at the latest. This should lead to a net zero reduction of emissions by then. It is also stated that the Union will aim for negative emissions beyond this.

To ensure that climate neutrality is achieved by 2050, the EU has defined the interim target to reduce net greenhouse gas emissions within the EU by 55% by 2030 compared to 1990. Net greenhouse gas emissions are those that remain after subtracting the fraction removed by sinks, whereby a distinction can be made between natural sinks (natural ecosystems that absorb CO_2 such as forests) and technical sinks (technical means by which CO_2 can be absorbed from the atmosphere such as carbon capture and storage). Another goal is to further expand natural sinks and thus counteract the downward trend in the reduction of greenhouse gas emissions. Furthermore, it is to be ensured that sufficient mitigation measures are taken by 2030. As a result, the net reduction of greenhouse gases will be limited to 225 million tonnes CO_2-eq.[3] Under the "Fit for 55-package", the European Union has presented a number of measures which include proposals for revising EU legislation as well as new measures. These are intended to help achieving the climate targets.[4]

Reduction of greenhouse gas emissions – European Emissions Trading System
One measure to reduce greenhouse gas emissions is the EU Emissions Trading System which was established with Directive 2003/87/EC[5]. Here, the goal of reducing emissions in sectors which are covered by the EU ETS

[2] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 Establishing the Framework for Achieving Climate Neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), OJ 2021 L 243/1.
[3] Cf. Article 4 (1) European Climate Law.
[4] Website of the Consilium of the EU, see https://www.consilium.europa.eu/de/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/#package (accessed 28.10.2022).
[5] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, OJ 2003 L 275/32 as amended by 2021 L 305/1.

is 43% by 2030 compared to 2005. This has been set by the European Council and was taken up in recital 2of the Regulation (EU) 2018/841 (hereinafter LULUCF Regulation).[6]

Reduction of greenhouse gas emissions – Effort-Sharing sectors and LULUCF

Regulation (EU) 2018/842[7] (hereinafter Effort Sharing Regulation) plays an important role in the reduction of greenhouse gas emissions. It sets binding national annual targets to be achieved in the period from 2021 to 2030. This is intended to contribute to climate protection and to ensure that the commitments under the Paris Agreement are met.

The regulation sets a target of reducing each Member State's greenhouse gas emissions by 30% in the period 2021-2030 compared to their 2005 levels. It also lays down rules to determine the annual emission allocations for each Member State.[8]

Annex I also contains the specific percentages by which greenhouse gas emissions must be limited in 2030 (compared to 2005).[9] For Austria this means that it should have achieved a reduction of -36% in the burden sharing sectors. For the countries of the partners involved in the project, the targets result in the following table:

COUNTRY	GREENHOUSE GAS EMISSION REDUCTIONS PURSUANT
Austria	-36%
Bulgaria	-0%
Croatia	-7%
Czech Republic	-14%
Germany	-38%
Hungary	-7%
Romania	-2%
Slovenia	-15%
Slovakia	-12%

The second legal basis relevant in this context is the LULUCF Regulation. It regulates the accounting of emissions and removals of GHG in the land use, land use change and forestry sectors.[10] It is an important instrument of climate and energy policy for the second period from 2021 to 2030. A no-debit rule is implemented, according to which Member States must ensure that, taking into account all relevant provisions (Articles 12 and 13 LULUCF Regulation), emissions do not exceed removals in the specific sector in the periods 2021-2025 and 2026-2030.[11]

Renewable Energy

[6] Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU, OJ 2018 L 156/1 as amended by 2021 L 60/21.

[7] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Pa ris Agreement and amending Regulation (EU) No 525/2013, OJ 2018 L156/26.

[8] Cf. Article 1 Effort Sharing Regulation.

[9] Cf. Article 4 (1) Effort Sharing Regulation.

[10] Cf. Article 1 LULUCF Regulation.

[11] Cf. Article 4 LULUCF Regulation.

Directive (EU) 2018/2001[12] (hereinafter RED II) is dedicated exclusively to promoting the use of energy from renewable sources and is intended to create a common framework for this. The binding overall target of the Member States is to have a share of energy from renewable sources of 32% in 2030, measured against gross final energy consumption.[13] The Directive does not specify individual targets for the individual Member States, but leaves it up to them to define these themselves (with a view to achieving the overall target), which are to be incorporated into the national energy and climate plans and submitted to the Commission.[14]

The RED II covers various sectors, including the heating and cooling sector. For this, it is stated that the member states should strive to increase the share of renewable energies in that sector. As an indicative benchmark, 1.3 percentage points compared to the 2020 share are specified. These determinations then serve as an annual average for the periods 2021-2025 and 2026-2030. For those states in which waste heat is not used, the limitation of the increase is set at 1.1 percentage points.[15]

For the transport sector, it is stipulated that Member States must oblige fuel suppliers to bring the share of renewable energy in the sector's energy consumption to a minimum level. This minimum share is to be 14% in 2030. Specific methodologies for the calculation are given in Articles 26 and 27 of RED II.[16]

Energy Efficiency

EU law provides two different relevant standards on the subject of energy efficiency, Directive 2012/27/EU[17] and its amendment by Directive (EU) 2018/2002[18]. The aim is to ensure that the overarching energy efficiency targets are achieved by 2030, which provide a minimum improvement of 32.5%. Furthermore, improvements for the period after 2030 should already be prepared.[19] Here the EU does not specify individual targets, as each Member States has to set an indicative national energy efficiency target, taking into account certain predefined parameters[20] as the maximum energy consumption of 1128 Mtoe of primary energy and/or 846 Mtoe of final energy.[21]

Furthermore, the member states are obliged to make energy savings. They must save cumulatively 0.8% of annual final energy consumption (calculated over the most recent three-year period prior to 01.01.2019) in the period from 2021 to 2030. Annual savings of the same amount are also foreseen for the period after 2030, but the Commission can waive these after reviews if the savings are not necessary to achieve the climate targets for 2050.[22]

[12] 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 2018 L 328/82 as amended by 2022 L 139/1.
[13] Cf. Article 3 (1) RED II.
[14] Cf. Article 3 (2) RED II.
[15] Cf. Article 23 (1) RED II.
[16] Cf. Article 25 (1) RED II.
[17] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, OJ 2012 L 315/1 as amended by 2019 L 158/125.
[18] Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency, OJ 2018 L 328/210.
[19] Cf. Article 1 (1) Directive 2012/27/EU.
[20] Cf. Article 1 (1) Directive 2012/27/EU.
[21] Cf. Article 5 Directive 2012/27/EU.
[22] Cf. Article 7 (1) Directive 2012/27/EU.

6. AUSTRIA

6.1 NATIONAL (SPECIFIC) GOALS

The Austrian government has set the goal of being climate-neutral by 2040 at the latest.[23] Austria aims at building, expanding and repowering plants that produce renewable electricity to the extent that the domestic renewable electricity production equals total domestic electricity consumption from 2030 onwards.[24] In order to achieve that, the annual electricity production from renewable sources should be increased by 27 TWh by 2030. These are to consist of 11 TWh photovoltaics, 10 TWh wind, 5 TWh hydro and 1 TWh biomass.[25] The Renewable Energy Expansion Act (in the following REEA, Erneuerbaren-Ausbau-Gesetz F.L.G. I No. 150/2021 as amended by F.L.G I No. 13/2022) also sets an objective regarding renewable gas, namely to increase the quantity of renewable gas produced in Austria to 5 TWh by 2030.[26]

The National Energy and Climate Plan (hereafter NECP) sets indicative target paths for the share of renewable energy in the gross final energy consumption for 2022, 2025 and 2027 in order to reach 46-50% by 2030. These are specified as follows:

- 2022: 36,2-36,9 %
- 2025: 39,2-40,9 %
- 2027: 41,8-44,4 %.[27]

Furthermore, Austria aims at improving primary energy intensity by 25-30% by 2030 compared to 2015. Over the period 2021-2030, Austria shall achieve cumulative final energy savings of approximately 11,878 ktoe.[28]

6.2 OVERVIEW OF POWER-TO-GAS RELATED ACTIVITIES

In the Austrian NECP, renewable hydrogen is seen 'as a key technology for sector integration and linking' that will make a decisive contribution to the desired restructuring of the energy system.[29] In its government programme 2020-2024, Austria announced that an expansion and support programme for 'green gas' (biomethane, green hydrogen and synthetic gas) will be set up so that 5 TWh will be fed into the gas grid by 2030 (see above the legal implementation). To this end, according to the government programme, support programmes and quotas will be established, as well as a stringent system for guarantees of origin and

[23] *Republic of Austria*, Government Programme 2020-2024 (2020) pp. 72 (available under: https://www.bundeskanzleramt.gv.at/dam/jcr:7b9e6755-2115-440c-b2ec-cbf64a931aa8/RegProgramm-lang.pdf).
[24] § 4 (2) REEA.
[25] § 4 (4) REEA.
[26] § 4 (1) (7) REEA.
[27] *Republic of Austria,* Integrated National Energy and Climate Plan for Austria 2021-2030 (2019) p. 80 (available under: https://ec.europa.eu/energy/sites/default/files/documents/at_final_necp_main_en.pdf).
[28] *BMNT/BMVIT*, #mission2030 - Die österreichische Klima- und Energiestrategie (2018) p. 18 (available under: https://www.bundeskanzleramt.gv.at/dam/jcr:903d5cf5-c3ac-47b6-871c-c83eae34b273/20_18_beilagen_nb.pdf) and *Republic of Austria*, Integrated National Energy and Climate Plan for Austria 2021-2030 (2019) pp. 86.
[29] *Republic of Austria,* Integrated National Energy and Climate Plan for Austria 2021-2030 (2019) p. 155 (available under: https://ec.europa.eu/energy/sites/default/files/documents/at_final_necp_main_en.pdf).

labelling.[30] The Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, together with the Federal Minister for Digital and Economic Affairs have published the Hydrogen Strategy for Austria in 2022. The hydrogen strategy sets out objectives in connection with hydrogen, the contribution of hydrogen to a climate-neutral Austria, and corresponding fields of action. An important contribution of hydrogen to achieving climate neutrality in 2040, according to the strategy, is the decarbonization of so-called hard-to-abate sectors (chemical and steel industries, aviation and shipping). The focus of application should therefore also be on these priority consumption sectors. In this context, it is highlighted, that this contribution can only be achieved with climate-neutral hydrogen. Furthermore, the gas infrastructure should be gradually transformed into a targeted hydrogen infrastructure.[31] The figure below shows the targets of the Hydrogen Strategy Austria.

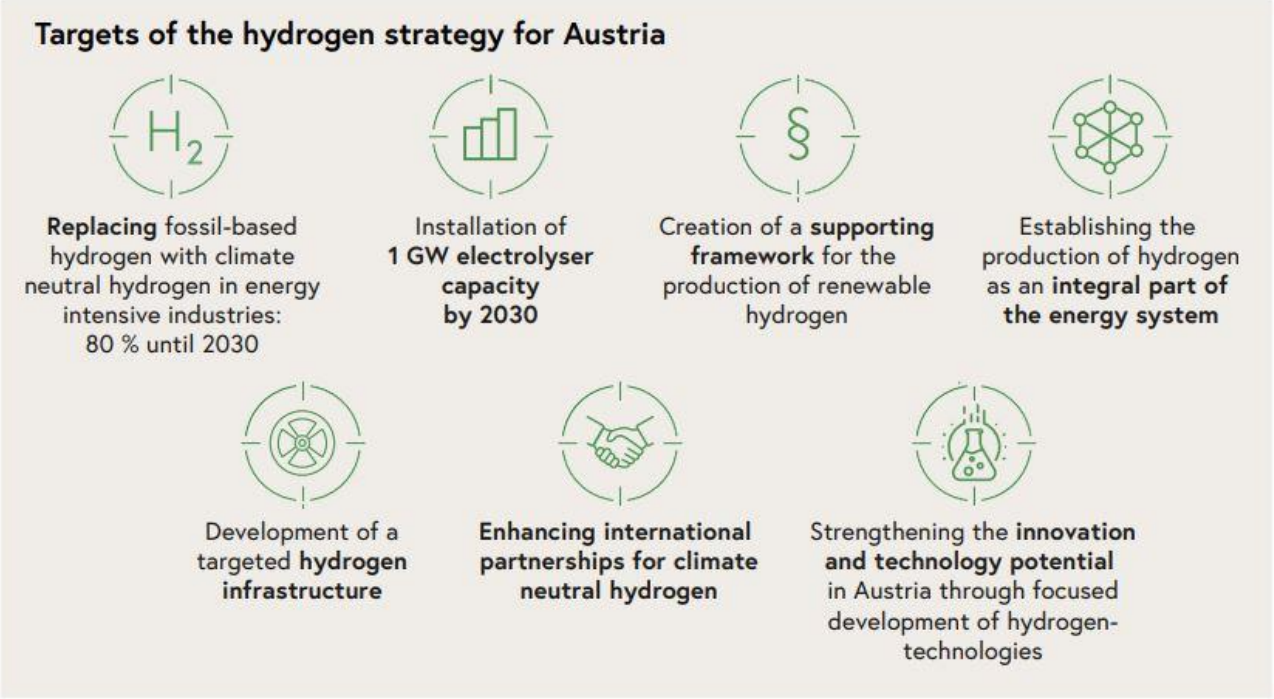

Figure 2: Targets of the hydrogen strategy for Austria. Source: Hydrogen Strategy for Austria BMK/BMAW (2022, p. 1)[32]

For the gas sector, currently, the Natural Gas Sector Act 2011 (Gaswirtschaftsgesetz 2011 F.L.G. I. No. 107/2011 as amended by F.L.G. I. No. 94/2022) is the central legal basis. However, the Austrian legislator has already announced that a 'renewable gas act' will be enacted.

To be highlighted in the context of Power-to-Gas is the association WIVA P&G[33] which aims at the promotion of research and development in the fields of application, grid and storage technologies of hydrogen and

[30] *Republic of Austria*, Government Programme 2020-2024 (2020) p. 79 (available under: https://www.bundeskanzleramt.gv.at/dam/jcr:7b9e6755-2115-440c-b2ec-cbf64a931aa8/RegProgramm-lang.pdf).
[31] *BMK/BMAW,* Hydrogen Strategy for Austria (2022) p. 12 (available under: https://www.bmk.gv.at/dam/jcr:0eb2f307-1e4d-41b1-bfd8-22918816eb1b/BMK_Wasserstoffstrategie_DE_UA_final.pdf).
[32] *BMK/BMAW,* Hydrogen Strategy for Austria Executive Summary (2022) p. 1 (available under https://www.bmk.gv.at/dam/jcr:7788d724-3aed-4a88-a452-37f9df5e1357/bmk_wasserstoff_executive-summary_EN_UA.pdf).
[33] https://www.wiva.at/v2/wiva-pg/.

renewable gases. WIVA P&G has about 20 members, which are well-known companies from all over Austria working in the field of hydrogen. WIVA P&G combines experience of more than 30 completed and ongoing projects in the field of hydrogen, whereby an additional innovation process enables the integration of further projects. WIVA P&G published a position paper in July 2020 in which proposals for amending and clarifying the Austrian legal framework on hydrogen and Power-to-X were elaborated.[34] Also within the framework of WIVA P&G a working group on "Authority Procedures" was established, where issues and possible solutions to these are discussed and elaborated.

Furthermore the project HyLaw (which brings together 23 partners from Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden, Portugal, the Netherlands and United Kingdom) coordinated by Hydrogen Europe, aims at boosting the market uptake of hydrogen and fuel cell technologies providing market developers with a clear view of the applicable regulations whilst calling the attention of policy makers on legal barriers to be removed. Besides an online and publicly available database, national policy papers (including Austria) describing each legal and administrative process, highlighting best practices, legal barriers and policy recommendations are provided.[35]

Austria's industry is also part of newly approved IPCEI (Important Project of Common European Interest) Projects – H2Tech and H2Use, where main R&D aims are development and upscaling of hydrogen technologies and decarbonisation of industry via renewable hydrogen respectively.[36]

6.3 SECTOR-COUPLING POTENTIAL IN AUSTRIA

For Identification of the potential for sector-coupling hubs for the particular country it is important to take into account the following: biomass potentials, availability and suitability of gas and power infrastructure and energy system specification.

The optimization tool, developed during the project was used to evaluate different use cases in all participating countries, the results gives robust overview of techno-economic feasibility of sector-coupling hubs. According to the findings respective recommendations for potential investors are provided.

6.3.1 BIOMASS POTENTIAL

Around 30% of Austria's energy supply comes from renewable sources, while 35% of the overall national consumption is based on renewables (based on 2019 data). Biomass accounts for 55% of renewable energy supply in Austria (as shown in figure 3).

[34] Available under: https://www.wiva.at/v2/wp-content/uploads/2020/07/WIVA_Positionspapier-Recht-2020_FINAL_300720_ohne-Logos_final-1.pdf.
[35] https://www.hylaw.eu/.
[36] https://www.bundeskanzleramt.gv.at/eu-aufbauplan/aktuelles/zweites-ipcei-wasserstoff-grossvorhaben-gestartet.html.

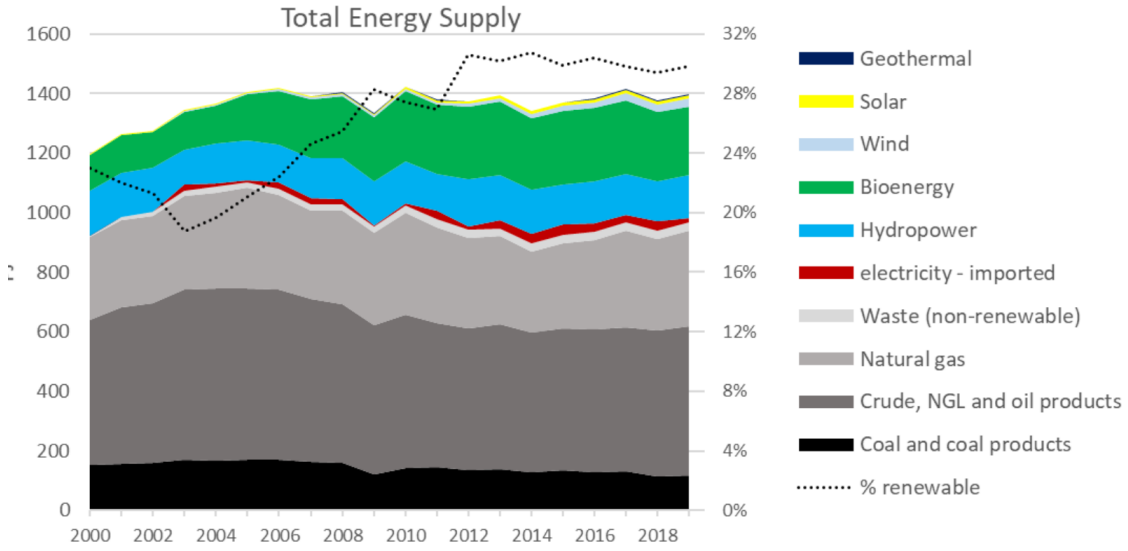

Figure 3: Biomass sources as part of total energy supply in Austria in PJ. Source: IEA Bioenergy (2021: 4).[37]

Biomass sources are used mainly for direct heating including residential heating and industrial applications as well as for district heating. In Austria district heating was traditionally based on bioenergy. Nowadays, it makes up to 50% of the energy supplied through the heat networks.

In 2019, the Total Energy Supply (TES) in Austria reached 1.398 PJ. Around a third of that total energy supply (i.e. 412 PJ) originated from renewable energy sources, 55% thereof were supplied by bioenergy (i.e.213 PJ). Regarding the types of bioenergy, Austria relies to a great extent on solid biofuels, which account for over 80% of the total bioenergy supply, comprising wood fuel, woodchips, wood pellets and bark, as well as sawmill by-products. Supply of solid biofuel is classified in three categories (see Figure 4) (i) energy production (electricity and heat output), (ii) industry and (iii) residential sector. Energy supply of biodiesel, biogas, renewable municipality waste and bioethanol has increased steadily since 2004, reaching currently a share of around 16% of the total bioenergy supply.

[37] IEA Bioenergy (2021) *Implementation of bioenergy in Austria: 2021 update*, Online: https://www.ieabioenergy.com/wp-content/uploads/2021/11/CountryReport2021_Austria_final.pdf

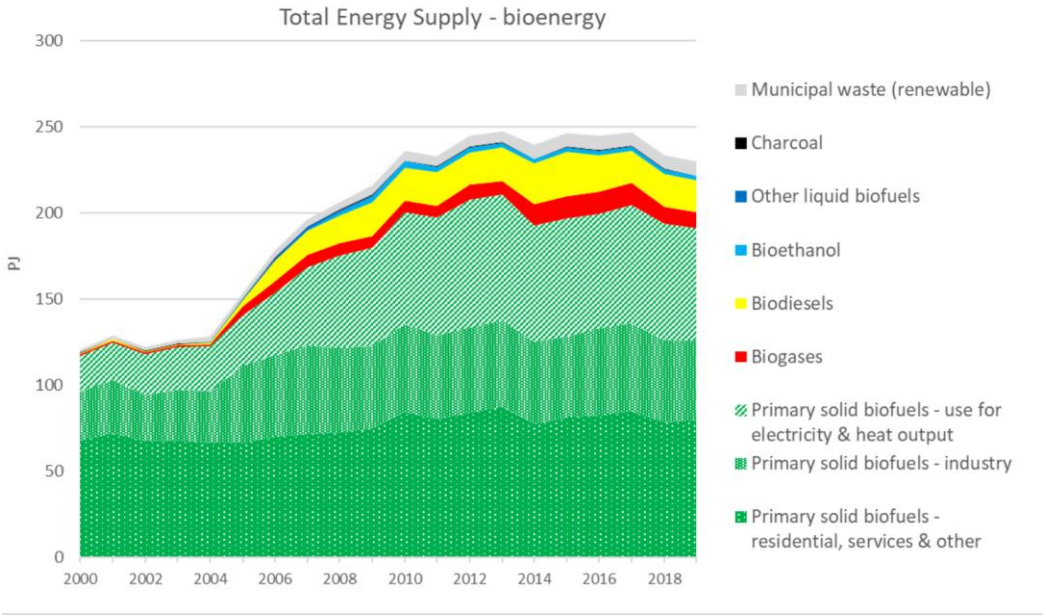

Figure 4: Composition of biomass sources in Austria in PJ. Source: IEA report on bioenergy in Austria (2021: 5).

Data analysed shows a clear trend for wide use of biomass in Austria. Different scenarios prospected by different private and public institutions see bioenergy as the most widespread energy source in a future climate neutral energy system.

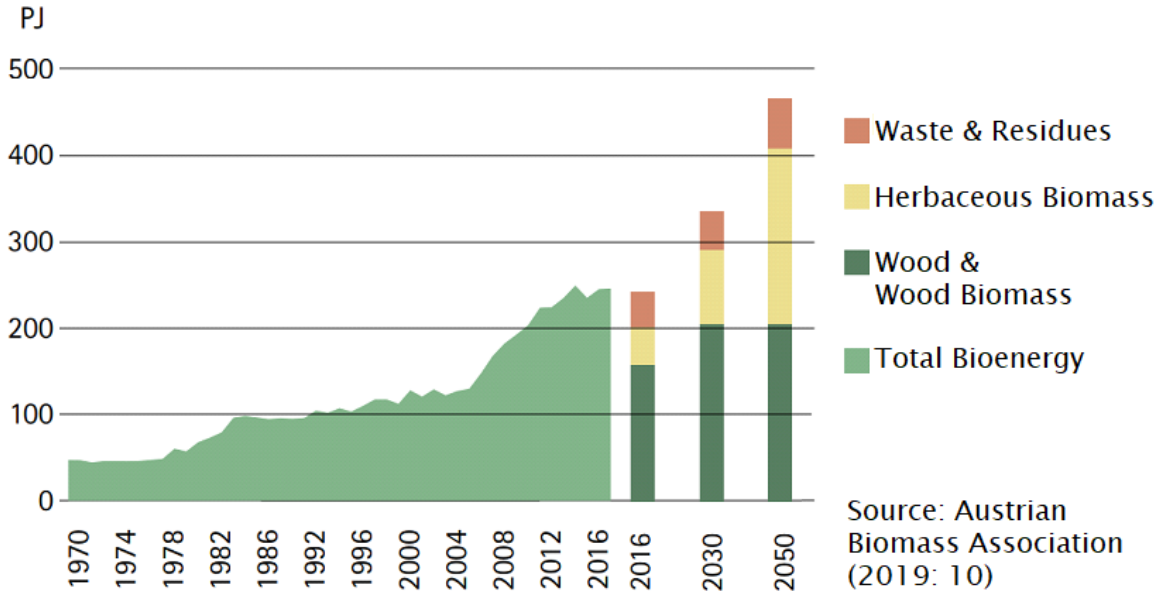

Figure 5: Evolution of gross domestic bioenergy consumption 1970-2016 and estimated unused biomass potential 2030 and 2050 in Austria. Source: Austrian Biomass Association (2019: 10)[38] with own translation.

[38] Austrian Biomass Association(2019) [Ger] *Bioenergie Atlas Österreich*, Online: https://www.biomasseverband-ooe.at/uploads/media/Downloads/Publikationen/Bioenergie_Atlas/Bioenergie-Atlas_Oesterreich_2019_klein.pdf

Figure 5 displays the evolution of the domestic bioenergy consumption between 1970 and 2016 according to national statistics, together with the estimated unused biomass potential for 2030 and 2050. According to the Austrian Biomass Association, the current expansion of biomass utilisation is constrained by energy market receptivity, even though there is still a considerable biomass availability. The unused biomass potential is estimated to be between 25% and 50% of the total biomass available for energetic utilisation. As figure 5 shows, the largest biomass potential is located in the agricultural sector, followed by forestry and woody biomass (Austrian Biomass Association, 2019).

6.3.2 DESCRIPTION OF AUSTRIAN INFRASTRUCTURE LANDSCAPE

Austria produces the majority (approx. 80%) of the electricity using renewable energy sources, and electricity imports account for around a quarter of the total electricity consumption.[39] By 2030, the electricity demand should be completely covered by renewables.[40] For this purpose and also for the electrification of industry, further expansion of the power grid is necessary. The expansion of storage capacities (short-term, seasonal) will also continue to gain more importance. Austria has a well-developed gas network, which can also potentially be used for hydrogen transport in the future and respective gas network developments are planned (European Hydrogen Backbone Initiative), which will allow to further develop hydrogen economy in Austria.[41] Decarbonisation strategies of hard-to-abate industries, which are represented in Austria, such as steel production, chemical, refineries, will be big hydrogen and renewable gases consumer in the future. Thus, several Power-to-gas projects are in operation already, for example, electrolysis plant at Voestalpine Stahl GmbH in Linz (H2FUTURE[42]) or under construction in refinery Schwechat (UpHy[43]), using local renewables potential in Styria (Renewable Gasfield[44]) and at semi-conductor production site in Carinthia (H2Pioneer[45]) only to name just a few.

6.3.3 USE CASE ANALYSIS

Pre-feasibility studies for three typical location cases for a P2G hub investment in Austria have been conducted with the Optimization Tool developed during the project. Maximum allowed return on investment period of 20 years was set for all business cases, however often the optimum economical setup of the investment yields in much shorter return on investment periods. In general, production of renewable hydrogen takes place in all the cases in Austria, however the production of renewable natural gas gets feasible only when the price for selling and injecton is higher as natural gas prices in the baseline scenario. Also, similar tendencies are observed for biochar production. Oxygen as by-product sales are also part of the use cases and should be definitely taken into account when planning future P2G hubs.

[39] https://de.statista.com/statistik/daten/studie/325080/umfrage/stromimport-oesterreichs/
[40] *Republic of Austria*, Government Programme 2020-2024 (2020) p. 79 (available under: https://www.bundeskanzleramt.gv.at/dam/jcr:7b9e6755-2115-440c-b2ec-cbf64a931aa8/RegProgramm-lang.pdf).
[41] European Hydrogen backbone. A European Hydrogen Infrastructure Vision Covering 28 Countries. April 2022 (2022) p.19 (available under: https://ehb.eu/files/downloads/ehb-report-220428-17h00-interactive-1.pdf)
[42] https://www.h2future-project.eu/ (accessed on 10 December)
[43] https://www.wiva.at/project/uphy/ (accessed on 10 December)
[44] https://www.wiva.at/project/renewable-gasfield/ (accessed on 10 December)
[45] https://www.wiva.at/project/h2pioneer/ (accesssed on 10 December)

Generally, P2G projects in Austria are demonstration projects with CAPEX support in terms of national or EU funding projects. According to the Austrian Hydrogen strategy further projects are to be expected in industry, aviation and shipping and for peak-load balancing.

For development of future sector coupling hubs or P2G projects existing funding possibilities, which are described below, should be taken into account.

6.3.4 EXISTING FUNDING POSSIBILITIES

There are several funding possibilities in Austria for the construction of P2G plants and for the operation of P2G hubs, the overview can be found in Subsidies catalogue on the DanuP-2-Gas home-page.[46] There is basic research funding available as well as funding for the construction and operation of demonstration plants, where also additional funding for CAPEX costs is available, as well as there is funding that is anchored in the legal acts. During the project period (2020 – 2022), for example, flagship region project tenders have taken place where, within the flagship region WIVA P&G, project applications could be submitted and in addition to the existing demonstration plants that will be operational in 2023, such as UpHy, Renewable Gasfield and H2Pioneer, other activities in the field of hydrogen and renewable gases could be developed. In addition, WIVA P&G association has published a Position Paper on Research Needs and Challenges for Hydrogen Technologies, where the association estimates the necessary annual funding volume for projects within the hydrogen model region for successful further development of the hydrogen economy in Austria, namely with an annual funding budget of approx. 50-80 Mio.€. [47]

The Renewable Energy Expansion Act (in the following REEA Erneuerbaren-Ausbau-Gesetz F.L.G. I No. 150/2021 as amended by F.L.G I No. 172/2022) introduced investment grants for plants that convert electricity into hydrogen or synthetic gas. The annual funding for such investment grants amounts to 40 million euros.[48] A prerequisite, however, is that the P2G plant has a minimum capacity of 1 MW and is used exclusively for the production of renewable gases and purchases only renewable electricity. Subsidies are not available for plants that are built and operated by network operators or that add hydrogen to natural gas in the public gas network.[49] The investment subsidy is to be determined by ordinance of the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, in agreement with the Federal Minister for Agriculture, Regions and Tourism in subsidy rates of up to 45% of the investment volume directly required for the construction of the plant (excluding land). For installations that contribute to the operational security of the network, a special investment subsidy may be granted in the ordinance.[50] Plants that have a minimum capacity of 0.5 MW and a maximum capacity of less than 1 MW may also receive an investment subsidy. This must, however, be set by ordinance at subsidy rates of up to 20% of the investment volume directly required for the construction of the plant (excluding land).[51]

[46] https://danup2gas.eu/subsidies (accessed 10 December)
[47] https://www.wiva.at/2020/11/24/wiva-pg-position-paper-on-research-needs-and-challenges-for-hydrogen-technologies/ (accessed on 10 December)
[48] Cf. § 62 (2) REEA.
[49] Cf. § 62 (1) REEA.
[50] Cf. § 62 (4) REEA.
[51] Cf. § 62 (5) REEA.

Therefore, different types of investment and R&D funding are available in Austria, however, in order to reach an electrolyser capacity of 1 GW by 2030, as stipulated in the Austrian hydrogen strategy, additional funding may be needed.

6.4 EXISTING BARRIERS

In the following chapter existing barriers and needed actions for the deployment of P2G projects in Austria are listed. These are based on the gained experience with P2G research and demonstration projects in Austria, findings from international projects and feedback received from the stakeholder workshop organised during Q4 2022. For a better overview, the barriers are divided into three subcategories, however all barriers are interconnected.

Legal barriers

- The appropriate legal and regulatory framework including funding possibilities for construction of P2G projects is still in development, which may hinder the faster deployment.

Socio-technical barriers

- A big variety of stakeholders should be involved in the implementation of P2G projects thus higher complexity in achieving sufficient acceptance for construction may occur.
- Low awareness of climate change and knowledge of clean technologies e.g. P2G, concentrated knowledge exist in small group of energy experts and industries.
- Ambivalence in public acceptance of wind farms and decrease of acceptance for construction of new power lines, but higher acceptance for solar farms and P2G compared to options without such technologies.[52]
- Local projects may face resistance from the local community. The general level of acceptance is decreasing when it comes to infrastructure implementation in the neighbourhood.[53]
- Complex and long permission procedures, also because of insufficient knowledge level of public authorities involved.

Techno-economic barriers

- Lack of appropriate infrastructure for hydrogen use in mobility and for injection into the gas grid.
- Readiness of gas infrastructure and appliances for higher shares of hydrogen is not identified; amount of additional investment to overcome this barrier is not identified.
- P2G projects with an aim to produce renewable hydrogen are often non-competitive with conventional fossil hydrogen production via steam reforming of natural gas in terms of costs of produced hydrogen. In

[52] V. Azarova, J. Cohen, C. Friedl and J. Reichl, 'Designing local renewable energy communities to increase social acceptance: Evidence from a choice experiment in Austria, Germany, Italy, and Switzerland' (2019) 132 Energy Policy 1176–1183, available at: https://doi:10.1016/j.enpol.2019.06.067.

[53] A. Veseli et al., 'Interdisciplinary challenges and opportunities for hydrogen projects in Austria and the EU' (2022) #32 European Energy&Climate Journal 60–63, available at: https://doi.org/10.4337/eecj.2022.02.05.

comparison with fossil hydrogen produced at a big scale, renewable hydrogen production costs via electrolysis can be 3 to 5 times higher.

- The P2G process is not yet fully technologically mature, scaling up and R&D activities are still ongoing.
- The use of renewable gases in shipping and aviation is under development, therefore the use of hydrogen in these sectors is still a challenge.

6.5 ACTION ITEMS AND RECOMMENDATIONS

Taking into account the identified existing barriers, a variety of action items and needed steps, which should be taken to overcome these gaps and barriers and to achieve the goals of the roadmap, are summarised in this chapter.

Actions needed to overcome legal barriers

- Consideration of sector coupling technologies such as power-to-gas in the respective energy laws. A legal framework that provides legal certainty and incentives should be further developed. This would promote the implementation of such technologies.
- Increase the current allowable (up to) 10 % mol/mol hydrogen content in the gas network.[54] Pursuant to § 133a Gas Act 2011 (Gaswirtschaftsgesetz 2011 F.L.G. I. No. 107/2011 as amended by F.L.G I. No. 94/2022), the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology, together with the Federal Minister for Digital and Economic Affairs may determine by ordinance the technically maximum permissible proportion of hydrogen in the gas pipelines. An unrestricted feed-in of hydrogen into the existing natural gas grid is currently not possible. However, according to several studies, the feed-in of up to 17 vol-% is possible without causing problems.[55]
- Include energy storage as a market participant into the Austrian energy law framework according to the Electricity Market Directive 2019 (Directive 2019/944 as amended by 2022 L152/45).

Actions needed to overcome socio-technical barriers

- Organization of public engagement events, to increase the acceptance levels of general public and specific stakeholders. The well-prepared information policy to satisfy potential opponents at an early project development stage is essential. Targeted information about system functionality, the general nature of hydrogen, involved benefits and opportunities of direct stakeholder feedback is very important.[56]
- Development of specific funding mechanisms for community-based local projects as the promotion of such projects would raise the awareness and acceptance in the hydrogen technologies, and will allow trying out technically and economically different approaches in real operation as well as will create demand.

[54] ÖVGW (2021). Gasbeschaffenheit Richtlinie G B210.
[55] Haeseldonckx, D., & Dhaeseleer, W. (2007). The use of the natural-gas pipeline infrastructure for hydrogen transport in a changing market structure. International Journal of Hydrogen Energy, 32(10–11), 1381–1386. https://doi.org/10.1016/j.ijhydene.2006.10.018.
[56] A. Veseli et al., 'Interdisciplinary challenges and opportunities for hydrogen projects in Austria and the EU' (2022) #32 European Energy&Climate Journal 60–63, available at: https://doi.org/10.4337/eecj.2022.02.05.

- Guidelines for project developers on permission and admission procedures should be developed.

Actions needed to overcome techno-economic barriers

- Further development of financing mechanisms for demonstration projects and security of long-term funding is essential for achieving long-term decarbonisation goals.
- Intensified funding options for roll-out and commercialization of the respective technologies are needed.
- Further development of hydrogen mobility – construction of hydrogen refuelling stations and funding for hydrogen fuelled busses and heavy-duty trucks should be fostered.
- Readiness of gas infrastructure and appliances for higher shares of hydrogen should be proved as well as the amount of investment needed for adjustments of the infrastructure should be identified.
- As P2G business projects are often non-competitive, but, from the national economy point of view, projects for the generation, distribution and use of green gases as well as the maintenance of existing infrastructure have positive effects on GDP, jobs, import reduction, etc. Therefore, the stronger focus on these positive effects should be used to gain additional/alternative funding, and to increase public acceptance.
- To increase the maturity of the P2G technologies more demonstration and upscaling projects are needed worldwide.
- Constant market observation and targeted networking and experience exchange between demonstration projects owners and interested stakeholders / potential project developers can ensure that the technologies used and use cases implemented remain technologically "up-to-date". Innovations should be anticipated as soon as possible.
- As high investments for the P2G projects are needed, the examination whether projects can be designed in a modular way, so that investments or generation capacities can be adapted to the increasing demand over time, should be made.
- As green gas from local P2G plants would be produced at high costs the system service function (being able to create load balancing in the electricity grid and offering seasonal storage options for wind and PV) should be included in the business case and thus supported via additional financing mechanism to make local P2G more competitive also in comparison with the imported hydrogen and other green gases.

Further action items and recommendations

- The cooperation between investors, governments and public authorities should be intensified in order to foster the development of new projects.

LIST OF ABBREVIATIONS

BMAW Federal Ministry for Labour and Economy

BMK The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

BMNT Federal Ministry for Sustainability and Tourism (now: Federal Ministry for Agriculture, Forestry, Regions and Water Management)

BMVIT Federal Ministry for Mobility, Innovation and Technology (now: The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology)

P2G Power-to-Gas

REFERENCES

Haeseldonckx, D., & Dhaeseleer, W. (2007). The use of the natural-gas pipeline infrastructure for hydrogen transport in a changing market structure. International Journal of Hydrogen Energy, 32(10–11), 1381–1386. https://doi.org/10.1016/j.ijhydene.2006.10.018

ÖVGW (2021). Gasbeschaffenheit Richtlinie G B210.