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Strategic Roadmap for Germany

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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 the electric power and gas sector. The effective realisation of this project depends strongly on the legal and regulatory framework. During the work within the WP3 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 decarbonization, 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 will be discussed during national stakeholder workshops and individual expert interviews and additional adjustments, based on the interviews, will be incorporated.

Deliverable 3.2.1 serves as a basis for all the above-mentioned objectives. The aim of this Deliverable is therefore to define the needed actions to promote and deploy the sector-coupling hubs in Germany

2. METHOD

The objective of this Deliverable is to present the developed country-specific roadmaps, which are developed based on the conducted legal assessment in every involved country and, especially, taking into account the identified barriers. In the development of the national roadmaps work package the core team met twice to discuss the aims, timeline and needed actions. The roadmaps, which than were developed by the respective project partners were disseminated to the important stakeholders/political/policy representatives in each country 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. It clearly outlines links among tasks and priorities for action in the

near, medium and long term. A roadmap also includes metrics and milestones to allow regular tracking of progress towards the roadmap's ultimate goals. The IEA defines a technology roadmap as *"a dynamic set of technical, policy, legal, financial, market and organizational requirements identified by all stakeholders involved in its development."*[1]

The development of the roadmap in the 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 the analysis of biomass potentials, as well as infrastructural challenges made within the WP 2 are an essential part of the roadmap, showing the existing situation with future scenarios. Evaluated use cases of sector coupling hubs within the WP2, highlighting important findings for potential investors or other interested stakeholders, showing the possibilities and weaknesses of the feasibility of such projects in every country.

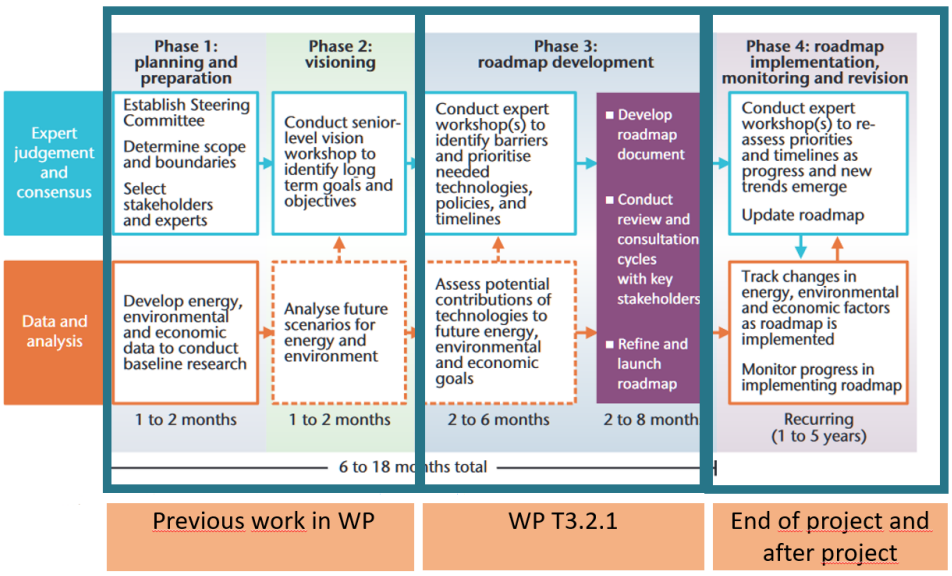

Figure 1- Roadmap process outline (Adjusted from IEA technology Roadmap Guide, 2014)

The analysis of the legal framework and identification of existing 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.

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 Germany 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

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

within Germany. The roadmap focuses foremost on adjustments of legal framework, however overall interdisciplinary barriers and challenges are shown and further steps identified.

5. GERMANY

5.1 NATIONAL (SPECIFIC) GOALS

In the national Climate Protection Act, the German government set the goal to become a climate-neutral country by 2045. This shall be reached in two steps: The preliminary goal for 2030 is set for emission reduction of 65% compared with 1990 levels, the goal for 2040 is the reduction by 88%[2].

The 2022 revision of the Renewable Energy Act states that by 2035, almost all the electricity consumption shall be covered by renewable electricity. Measures to reach this goal include expansion pathways for renewable electricity production via wind and photovoltaics as well as an accerlation of planning and approval processes. Further, the electricity grid shall be expanded and more offshore wind power shall be installed. Municipalities shall be involved more in the expansion of onshore wind and PV production and the frameworks for PV on roofs shall be improved.

Further, the German government has committed to the Paris Agreement and all its contents.

5.2 OVERVIEW OF POWER-TO-GAS RELATED ACTIVITIES

No legal or regulatory framework has been developed in relation to Power-to-Gas. As set in the German Hydrogen Strategy, green hydrogen is one key technology to reach the German climate and energy goals. The German government fosters the usage of hydrogen via financial support for companies and research institutions, so-called »real labs« and through the national innovation program for hydrogen and fuel cell technologies[3].

Biogas is recognized as an important renewable energy carrier that can be used for multiple purposes (CHP, fuel, substitute for fossil natural gas)[4]. However, there is no strategy or goals specifically on biomethane production or usage in the coming years.

5.3 SECTOR-COUPLING POTENTIAL IN GERMANY

The potential of sector-coupling via P2G depends mostly on two variables: the availability of surplus renewable electricity and biomass availability. Further, the economic

[2] https://www.bundesregierung.de/breg-de/themen/klimaschutz/klimaschutzgesetz-2021-1913672
[3] https://www.bundesregierung.de/breg-de/themen/klimaschutz/wasserstoff-technologie-1732248
[4] https://www.bundesregierung.de/breg-de/aktuelles/biogas-614902

feasibility depends mostly on gas prices (and on electricity prices, if no renewable electricity plant is available).

5.3.1 BIOMASS POTENTIAL

At the moment, around 1% of the primary energy demand in Germany is covered by biogenic waste resource utilization[5]. Studies, however, assume that the potentially exploitable biogenic waste resources could cover up to 1,000 PJ of the primary energy demand (around 7%)[6].

According to studies, currently many biogenic waste resource potentials remain unexploited. Logging residues might be exploited more efficiently. However, the exact amount of residues is unknown. A great potential lies in the exploitation of roadside greenery, especially on local level. Data on roadside greenery is not collected centrally, but might be by local municipal authorities. Other potentials are straw, animal manure, harvest residues, municipal biowaste, municipal green waste and waste wood.

In 2015, 67-85% of all biogenic wastes and residues were exploited for material or energetic use. According to experts, 13.9-48.2 million tons dry mass can be mobilised in the future, mainly cereal straw, logging residues, bovine dung and manure and green waste[7].

For the case of Bavaria, the focus of data collection in Germany, it is estimated that out of 4.32 million tons of recyclable material, 1.88 million tons were used for biological exploitation (2019)[8]. 38% of sewage sluged is not processed and could be exploited[9].

Potentials that could not be examined due to the lack of data lie in the production of biogenic waste and residues during industrial and agricultural production processes (e.g. breweris, paper factories). Actors active in those fields, knowing the amount of their idle or not optimally used biogenic residues, are strongly adviced to make use of the Optimization Tool to assess the potential of their biomass to produce hydrogen and renewable natural gas.

5.3.2 DESCRIPTION OF THE GERMAN INFRASTRUCTURE LANDSCAPE

Relevant infrastructure landscape for the P2G sector coupling using bioenergy and surplus renewable energy includes constructed renewable energy power plants, electricity transmission and distribution grid, natural gas transmission and distribution grid, water grid, and transport hubs.

Germany has an installed capacity of 136 GW of renewable electricity (2021), mainly wind (64 GW) and photovoltaic (59 GW)[10]. Up to 50% of the electricity demand can be covered

[5] FNR (2020), p. 7
[6] Brosowski (2021), p. 16
[7] Bringezu et al. (2020), p. 36
[8] Hausmüll in Bayern (2019), p. 86
[9] Hausmüll in Bayern (2019), p. 88
[10] https://www.umweltbundesamt.de/bild/installierte-leistung-zur-stromerzeugung-aus-2

by renewable electricity plants depending on weather conditions (50% in 2020, 45% in 2021)[11]. In 2021, 6.1 TWh remained unused due to lack of grid capacity. This surplus electricity could be used for P2G purposes. Plans for faster expansion of renewable electricity plants will lead to higher necessities to shut off plants if the grid is not expanded at equal pace. Therefore, more possibilities for P2G hubs will emerge in the future.

The state of the grids in Germany is good. The existing gas grid can be used for renewable natural gas. Capacity shortages are not expected. Currently, the addition of up to 5% hydrogen is allowed in the gas grid. Higher percentages without grid upgrades are expected, up to 20%[12]. The electricity grid, as already mentioned, is not equipped for the expansion plans for renewable electricity plants based on fluctuating renewables (foremost wind and PV). Thus, P2G is the solution to intercept these shortcomings. The direct connection of a newly installed renewable electricity plant with a P2G hubs makes sense, since in this case the grid does not get loaded.

Electricity, water and gas grids are located all over Germany. Connection costs for newly installed plants depend on the distance to the nearest connection points and the landscape on which the connection needs to be established. Some numbers for orientation can be found in the Infrastructure Report for Germany.

Biochar is usally produced for agricultural purposes (soil improvement). However, interesting business opportunities might emerge from biochar production for energetic purposes.

5.3.3 USE CASE ANALYSIS

Three use cases were tested using the Optimization Tool developed in the course of this project and the data collected for biogenic resources and infrastructural frameworks in Bavaria, Germany.

Cases:

1) P2G hub at an existing industrial plant
2) P2G hub at an existing renewable electricity plant
3) Greenfield investment

The overall result is that the gas prices are currently too low in Germany. Even after the increase of gas prices, it is still often cheaper to consume gas from the grid than to produce one's one renewable natural gas. Starting at gas prices of ~50ct/kWh, the production of renewable natural gas for feed-in or self consumption becomes economically viable, given that a renewable electricity plant is on-site or electricity prices are low enough.

[11] https://www.ise.fraunhofer.de/de/presse-und-medien/news/2022/nettostromerzeugung-in-deutschland-2021-erneuerbare-energien-witterungsbedingt-schwaecher.html
[12] DVGW 2014, p. 5

The production of hydrogen via electrolysis is feasible in most cases if a renewable electricity plant is on-site or if electricity prices are not too high (35ct/kWh is not suitable). However, the demand for hydrogen needs to be evaluated in certain areas beforehand, in case hydrogen is not needed for on-site usage (e.g. in industrial processes).

More detailed results can be found in the pre-feasibility study for Germany.

5.3.4 EXISTING FUNDING POSSIBILITIES

Germany has a variety of different funding instruments and programs for P2G related projects, ranging from research to demonstration projects and upscaling of existing technologies. Major funding programes are the 7th energy research program funded by the Federal Ministry for Economic Affairs and Climate Action. Several international actions, such as Bioeconomy International, are options for P2G projects in cooperation with European or international partners. A list of funding programs can be found in the DanuP-2-Gas subsidies catalogue.

Further, the law supports renewable energy activities via financial incentives. These include remuneration of network charges, market bonuses and priority grid connections for which the network operator pays 75% of the connection costs. The eligibility of priviliges depend on variables such as the exclusive usage of renewable electricity or the production of biogas as defined in the Renewable Energy Act.

5.4 EXISTING BARRIERS

In the following chapter existing barriers and needed actions for the deployment of P2G projects in Germany are listed. These are based on the findings DT.3.1.2 and barriers identified during stakeholder discussions.

Legal barriers

- Missing or unclear definitions
  - “Power-to-Gas”, “methanation” are not legally defined.
  - The definitions of certain terms, such as “biomethane”, differ in the Renewable Energy Act and the Energy Industry Act.
  - The definition of “green hydrogen” is too narrow. “Green hydrogen” or “renewable hydrogen” is not defined in the Renewable Energy Act or in the Energy Industry Act.
  - “Renewable natural gas” and “synthetic natural gas” are not mentioned in the Renewable Energy Act.
- The definition of storage facilities, electricity production facilities, energy production facilities etc. do not directly include any kind of power-to-gas hubs (with/without methanation, with/without re-electrification). It is unclear as what a P2G hub qualifies. Thus, it is unclear which benefits and legal regulations apply for a certain plant.

- The unclear classification of P2G hubs leads to legal insecurities regarding unbundling regulations.
- The usage of biogenic waste and residuals does not lead to any privileges over the usage of plant biomass.

Socio-technical barriers

- Low awareness of P2G possibilities among the general public.
- Low awareness regarding storage / electricity conversion technologies needed to enable the fast expansion of renewable electricity plants.
- The general public often does not differentiate between "natural gas" and "renewable natural gas", as both gases are methane. "Methane" has quite a negative connotation in the German general public due to its high climate-damaging potential and methane leaking.
- Complex and long permission procedures, also because of the insufficient knowledge level of public authorities involved.

Techno-economic barriers

- Lack of financial support for investors.
- Lack of business cases for successful P2G installation.
- Natural gas prices are still too low to make P2G applications economically viable.
- Financial incentives to replace fossil natural gas with renewable substitutes are not high enough.
- The complex legal framework complicates and prolongs planning and building processes, thus increasing costs.
- Lack of financial incentives to use biogenic waste and residues.
- Lack of data to assess P2G potential.

5.5 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.

Action items needed to overcome legal barriers

- Clear and uniform definition of the following terms:
  - Biomethane / Renewable Natural Gas
  - Synthetic natural gas
  - Biogas
  - Green hydrogen
  - Power-to-Gas
  - Biogenic waste and residual resources

- Clear legal classification of different P2G applications as storage facilities or gas/electricity generators etc. Instructions on how to classify P2G hubs with different characteristics would be helpful. Inclusion of different P2G implementation scenarios and different operation modes in unbundling regulations.
    - Power-to-Gas with methanation
    - Power-to-Gas (electrolysis / green hydrogen production only)
    - Power-to-Gas with / without re-electrification
    - Direct usage / grid consumption of renewable electricity
    - Usage of different biogenic waste resources for gas production
- Uniformization of definitions in different laws and ordinances.
- More privileges for the usage of biogenic waste and residues over plant biomass.
- More privileges for production of green hydrogen and renewable natural gas.

Action items needed to overcome socio-technical barriers

- Better communication on the difference of fossil natural gas and renewable natural gas, on methane leaking mitigation measures, on potentials for BECCS (biomethane pyrolysis), on climate-neutrality of biomethane (communication from science to the general public and to policy makers, communication from politics to the general public)
- Better communication on green hydrogen, risks and benefits.
- More dialogue with the general public to address concerns, perceived risks and costs and to highlight potential benefits.
- Policy support of energy cooperatives owned by the public (e.g. the population of a certain municipality) and share of revenues with the general public to increase acceptance of concrete projects.
- Better communication about the possibilities for publicly owned energy cooperatives to raise awareness of benefits and thus increase acceptance of the installation of concrete plants.
- Financial incentives to the general public to increase the perceived benefits of P2G hubs in order to increase acceptance.
- Inclusion of renewable energy systems and the benefits of green gases in scholar curriculums and general knowledge university courses.

Action items needed to overcome techno-economic barriers

- Financial incentives for the production of renewable natural gas, e.g. reduced tax on electricity consumption from the grid or omission of other levies. Especially financial incentives to make use of biogenic waste and residues (of other or own residues) should be installed.
- Simplification of the tax laws for electricity consumption, gas production and electricity production in P2G hubs in general.
- Faster approval procedures to reduce costs during planning processes. Privileges for renewable energy applications.
- Subsidies on the co-creation of a renewable electricity plant (PV or wind) and a P2G hub.

- Subsidies should not only apply for reconversion of produced gas, but also for the direct usage of renewable natural gas and renewable hydrogen.
- The prices paid for injection of renewable natural gas should be higher than for fossil natural gas.
- An increase of the CO_2 tax might support the economic competitiveness of renewable natural gas in comparison to fossil natural gas.

Further action items and recommendations

- A centralized system for data collection on biogenic waste / residues and surplus renewable electricity potential should be established.
- Better support for investors to find suppliers of biogenic waste and residues (match making coordinated by public bodies).
- Open and transparent communication about the currently valid laws and ordinances to provide the general public with basic understanding of the procedures in the renewable energy sector to foster general acceptance.

LIST OF ABBREVIATIONS

CCS	Carbon Capture and Storage
DSO	Distribution system operator
EU	European Union
GDP	Gross Domestic Product
GHG	Green House Gasses
GW	Gigawatt
GWh	Gigawatt hour
IEA	International Energy Agency
km	kilometer
ktoe	Kilotons of oil equivalent
kV	Kilovolt
LLC	Limited Liability Company
Mtoe	Million tons of oil equivalent
MVA	Mega Volt Ampere
MW	Megawatt
NECP	National Energy and Climate Plan
RES	Renewable Energy Sources
WP	Work Package

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