Interreg
EUROPEAN UNION
Danube Transnational Programme
DanuP-2-Gas

Deliverable number D.T3.2.1

Strategic Roadmaps for participating countries

Activity A.T3.2: Strategy development

September, 2022

Project co-funded by the European Union funds (ERDF, IPA)
www.interreg-danube.eu/danup-2-gas

DOCUMENT CONTROL SHEET

Project reference	
Full title of the project	Innovative model to drive energy security and diversity in the Danube Region via combination of bioenergy with surplus renewable energy
Acronym	DanuP-2-Gas
Programme priority	Priority 3
Programme priority specific objective	SO 3.2 Improve energy security and energy efficiency
Duration	01.07.2020 – 31.12.2022
Project website	www.interreg-danube.eu/danup-2-gas
Project coordinator	TZE

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.

Document Details	
Title of document	Strategic roadmaps for participating countries
Action	WP 3 Policy and Legal Framework
Deliverable	D.T3.2.1
Delivery date	September 2022

Version	Date	Author	Organization	Description
V1	18.05.2022	Darja Markova	EI-JKU	1st version
V2	08.08.2022	Argjenta Veseli, Darja Markova	EI-JKU	2nd version

IMPRINT

This document is issued by the consortium formed for the implementation of the DanuP-2-Gas project by the following partners:

- LP Technology Centre Energy - University of Applied Sciences Landshut (DE)
- ERDF PP1 Energy Agency of Savinjska, Koroška and Šaleška Region (SI)
- ERDF PP2 Tolna County Development Agency Nonprofit Public Ltd.(HU)
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- IPA PP1 Regional Agency for Socio – Economic Development – Banat Ltd (RS)

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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 Danube Region countries.

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 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 are essential part of the roadmap, showing the existing situation with future scenarios. 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.

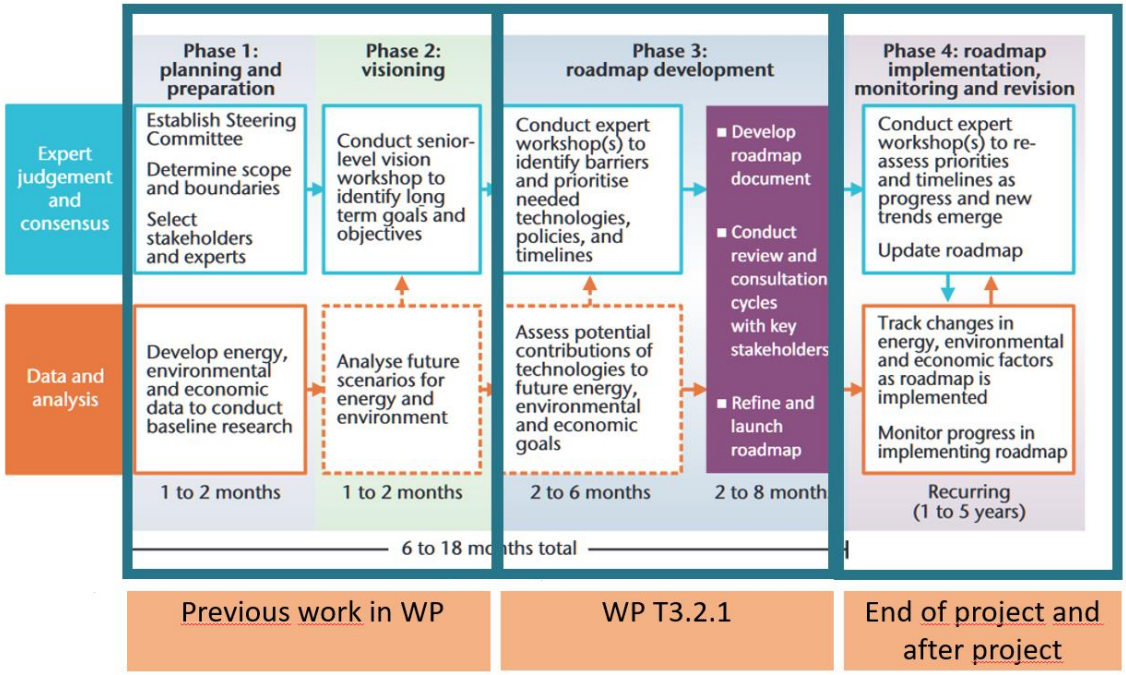


Figure 1. Roadmap process outline (Adjusted from IEA technology Roadmap Guide, 2014)

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 stepwise 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 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-

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

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. SLOVENIA

5.1 NATIONAL (SPECIFIC) GOALS

The key documents in the field of national energy and climate policy of the Republic of Slovenia are represented by two legislative policy instruments, following the EU 2030 and 2050 climate change mitigation goals:

-National Energy and Climate Plan (NECP)
-Resolution on long-term climate strategy of Slovenia until 2050

NATIONAL ENERGY AND CLIMATE PLAN

The instrument was adopted by the Government of the Republic of Slovenia on 27th of February 2020, which in its structure clearly sets out 5 key objectives for the period up to 2030 (with a view to 2040), defining objectives, policies, and measures in the five dimensions of the Energy Union:

1. decarbonisation (GHG emissions and RES),

2. energy efficiency,

3. energy security,

4. the internal market; and

5. research, innovation, and competitiveness.

Among other things, the NECP makes it clear that the objective of Slovenia's energy and climate policy is to ensure a reliable, secure, and competitive energy supply in a sustainable manner by ensuring the much-needed transition to a climate neutral society and achieve the sustainable development objectives by enabling environment for economic development and the creation of jobs with high added value, to improve quality of life and increase environmental responsibility, and provide affordable energy services for citizens and the economy.

The key challenges for Slovenia in the area of energy and climate policy are:

-Progressively reducing energy consumption and increasing energy and material

efficiency in all sectors,

-Accelerated development of the electricity distribution network to increase the intensity and resilience, to enable accelerated exploitation of flexibility of resources and load flexibility, integrating heat pumps, meeting the requirements of the accelerated deployment of e-mobility, and accelerated integration of generation of the electricity from renewable energy sources; financial resources will need to be secured for additional financial resources for additional capital investments by distribution companies and to ensure sustainable grid charging,

-Effective positioning of infrastructure projects contributing the key infrastructure projects that contribute to achieving a climate-neutral society,

-Phasing out fossil fuels in all sectors,

-Sustainable transport management and the transition to alternative fuels,

-Accelerated development of district heating and cooling systems,

-Decarbonisation of natural gas supply and integration of the gas and electricity sectors,

-Maintaining the efficiency and safe operation of nuclear facilities in Slovenia and preparing for providing guidance for a decision on the future use of nuclear energy and the possible construction of a new nuclear power plant,

-Technological development and commercial breakthrough of RES, advanced technologies, and services, including energy storage and energy efficiency,

-Reducing the implementation deficit for all actors and at all levels for a comprehensive and successful management and implementation of measures for the transition to a climate-neutral society.

KEY OBJECTIVES

key objectives in the areas of energy change adaptation, RES implementation and energy efficiency are the following:

i) By 2030, to reduce GHG emissions from sectors not covered by the scheme to a greater extent than the burden-sharing regulation for Slovenia, i.e. by at least 20% relative to the 2005 by meeting sectoral targets: transport 12%, broad use 76%, agriculture 1%, waste management 65%, industry 43%, energy 34%.

ii) Reduce the use of and dependence on fossil energy imports by: phasing out coal use (at least 30% by 2030 and a decision to phase out the use of coal in Slovenia according to the principles of a just transition by 2021), a ban on the sale and installation of new oil-fired boilers by 2023, support for the implementation of pilot projects for the production of synthetic methane and hydrogen (The indicative target is 10% of methane or hydrogen from renewable sources in the transmission and distribution network by 2030).

iii) Ensure that LULUCF sectors do not produce net emissions (after application of accounting rules) by 2030, i.e. emissions in the LULUCF sector do not exceed sinks.

iv) aim for at least 27% renewables in final energy consumption by 2030, i.e. (indicative): At least 2/3 of energy use in buildings from RES by 2030, at least 30% of RES in industry, 43% in the electricity sector, 41% in the heating and cooling sector, 21% in transport (biofuels at least 11%).

v) By 2030, improve energy efficiency by at least 35% compared to the 2007 baseline scenario (in line with the Energy Efficiency Directive).

vi) Ensure that the policies and measures adopted are systematically implemented to ensure that final energy consumption does not exceed 54.9 TWh (4,717 ktoe). Converted to a primary energy level, consumption in 2030 will not exceed 73.9 TWh (6,356 ktoe).

vii) Reduce final energy consumption in buildings by 20% by 2030 compared to 2005; and Ensure that GHG emissions from buildings are reduced by at least 70% by 2030 compared to 2005.

RESOLUTION ON LONG-TERM CLIMATE STRATEGY OF SLOVENIA UNTIL 2050

The National Assembly of the Republic of Slovenia adopted the Resolution on long-term climate strategy of Slovenia until 2050 at its regular session, convened on the 13th of July 2021. The policy instrument itself is a strategic document and does not contain concrete measures. The action plan for the implementation of the "climate strategy until 2030" is the NECP. The two documents were prepared in a coordinated manner and are based on the same expert basis. The orientations in the Resolution on long-term climate strategy of Slovenia until 2050 are based on projections in the expert backgrounds, which analyse possible approaches to achieve the objectives under certain assumptions. The projections take into account the state of the art of technologies, expected developments and information at the time the projections are made. On this basis, projections of economic development, energy prices, technology prices and assumptions on the implementation of measures have been made.

VISION

In 2050, Slovenia will be a climate-neutral and climate-resilient society based on sustainable development. It will manage energy and natural resources efficiently, while maintaining a high level of competitiveness in a low-carbon circular economy. The society will be based on preserved nature, a circular economy, renewable and low-carbon energy sources, sustainable mobility and locally produced healthy food. It will be adapted and resilient to the impacts of climate change. Slovenia will be a society with a high quality of life and security, seizing opportunities in a changing climate. The transition to a climate-neutral society will be inclusive, taking into account the principles of climate justice. The costs and benefits of the transition will be shared equitably, including for the most vulnerable. Mitigation and adaptation measures will be made available to the most vulnerable groups of the population.

MAIN GUIDELINES

The main directive of the policy instrument is to reduce the GHG emissions. Other guidelines, which apply to all sectors, include increasing material efficiency, promoting low-carbon sources, energy efficiency, sustainable spatial development, sustainable construction and promoting digitalisation, and public administration as a role model. Slovenia will not adopt policies and measures or invest resources in a way that would undermine the commitments of the Paris Agreement. One of the cross-cutting themes is the fact that, in addition to the climate crisis, we are also facing a biodiversity crisis, and synergies between the two need to be sought in finding solutions. Any environmental interventions must be carried out with the least possible impact on the environment. To better integrate climate policy into sectoral policies, Slovenia will strengthen the checking of the consistency of documents, policies, regulations and other acts with climate policy, and further strengthen this component in the process of integrated environmental impact assessment or EIA. It will also develop criteria for assessing the consistency of documents with adaptation and mitigation policies.

5.2 OVERVIEW OF POWER-TO-GAS RELATED ACTIVITIES

According to the Integrated National Energy and Climate Plan of the Republic of Slovenia (NEPN) it is planned to decarbonise the natural gas supply in Slovenia by replacing natural gas with renewable gases. To this end, technical, legislative and incentive conditions, facilitating the decarbonisation should be established. The aim is to prepare a regulatory and support environment for alternative gas in the natural gas network. Furthermore, the maximum permissible hydrogen content of the natural gas network should be analysed and determined. Hydrogen (produced by electrolysis of water using excess renewable electricity), synthetic methane (produced by CO2 or CO hydrogen methanation in catalytic or biological methanation reactors, in which hydrogen, CO and CO2 are obtained by means of the gasification of organic materials, using the hydrogen mentioned first and CO2 recovered from pollution sources) and biomethane (methane obtained from the gasification of wood biomass or from biogas produced by the decomposition of organic substances such as slurry, crop residues and plant material, municipal effluent in sewage treatment plants, etc., under anaerobic conditions in fermenters [digesters], since, because of its composition, biogas is not suitable for injection into the pipeline network [it may contain up to 50% of CO2 and, in smaller concentrations, other impurities]) are cited as renewable gases to be used for decarbonisation in the future.

Since the integration of electricity, gas and district heating and cooling sectors is considered crucial for achievement of energy and climate objectives, appropriate technical capacity for the conversion of renewable electricity into renewable gas, hydrogen or synthetic methane and heat (Power-to-Gas and Power-to-Heat) will be ensured. Furthermore, the implementation of pilot projects for the production of synthetic methane and hydrogen should be supported according to the NEPN.

In Slovenia's first green hydrogen project 'SLOP2G' four Slovenian energy firms, the country's major players (Plinovodi, ELES, Holding Slovenske elektrarne and Hidroelektrarne na Spodnji Savi), are brought together in order to convert renewable electricity to green hydrogen and synthetic methane. The produced renewable hydrogen will be distributed through hydrogen pipelines while the synthetic methane can be used in the gas lines. The establishment of a trading platform for renewable gases with certificates of origin is an important part of that project.

5.3 SECTOR-COUPLING POTENTIAL IN SLOVENIA

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 give robust overview of techno-economic feasibility of sector-coupling hubs. According to the findings respective recommendations for potential investors are provided.

5.3.1 BIOMASS POTENTIAL

In the process of data acquisition for the DanuP-2-Gas project, we have identified some obstacles, specificities, and exceptions that we would like to present. The two most potential biomass types in Slovenia, are certainly woody biomass and animal-human waste sludge. Other different potentials, as are Herbaceous biomass and Aquatic biomass are negligible in our country and aren't worth studying. Why? Slovenia has very few stagnant water bodies. There are some big natural alpine lakes, which were formed after the last ice age, but are located in the only existing Slovenian nature park, Triglav national park. Also, much biomass potential cannot be found, in these lakes due to the harsh alpine climate, which highly restricts the formation of different water plants species, algae, plankton etc. Other water bodies are predominantly represented by rivers, streams, bogs, ponds and so on and there is also a lack of biomass potential, or it is highly negligible. Slovenia is also connected to the Adriatic Sea in the southwest, but the length of the Slovenian coast is just over 40 km, and the coast is very densely populated, so there are only few natural accesses to the sea, most of which are used for saltworks or tourist activities. On the other hand, Slovenia is a very agricultural country. People mostly cultivate the plains, in the far east of the country, but there are also a lot of high mountain farms. Most of herbaceous biomass produced privately, is used in the circular process of farming, namely for fertilization, nutrition, fermentation etc. Herbaceous biomass, which is owned by the public authorities (state, municipalities, local communities), such as biomass from green parks in cities and such (types like leaves, mowing residues, small branches etc.), it is however, mostly sold to larger companies, which process it into an organic substrate to be further sold to the end costumers.

We have successfully recognized our country's animal and human waste biomass providers and wood biomass providers, and divided them accordingly to the biomass sub-types, presented in the biomass database.

Wood and woody biomass

Slovenia is one of the most forested countries in Europe, with approximately 60% or just over 1.180.000 ha of forest area, covering more than half of the country. In terms of forest cover, Slovenia is ranked third in EU, just behind Sweden and Finland. The forest stock mainly consists of temperate broadleaf and mixed forests. In some places. Coniferous and deciduous forest can also be found, but the micro picture is constantly changing, due to the excessive and century-old deforestation activities.

The forest ownership in Slovenia is, on the other hand profoundly complicated and very dispersed. A large proportion of the national timber stock is represented by church and state-owned forests, which are rarely properly maintained. Natural disasters such as hurricanes, windstorms, sleet, rime ice, etc., also contribute to the poor condition of these forests. The rest of the forests are very well maintained, but are owned and divided among many big, medium-sized, and small farmers, privateers, civilians, and companies.

The "Strange thing" about our country's wood biomass system is that it is fairly complicated, due to the dispersion of ownership, already mentioned in the previous paragraph. Therefore, the sales process is completely dependent on sole situation, and it is poorly administratively archived. The wood production is mostly, driven by micro farms, with a negligible annual production of wood biomass, which are looking to earn a small profit. Thus, larger private or state-owned companies are hired to cut down the trees, or the trees are cut down by the owners themselves. Mentioned companies are usually hired only for felling, harvesting, and cutting wood, then, the small quantity it is rather sold by the farmer. But sometimes it is different. As already described, it depends on each individual situation. So, the wood is sold directly by the owner or by the intermediate company. This is where the companies that buy from primary producers are next in line and come into play. We are talking about the same story at this stage. These are also smaller self-employed entities or small companies with only one to three and maximum of five employees, which at the state level and from the point of view of our study, are out of the question because their production or sale is certainly less than a ton per day and all their output is already in use and is not idle, to be sold, transported or used in a hub or P-2-G system at all. Even if it would be idle, the daily quantities would still be too low.

Other major deals are struck by bigger and more competing state or private companies, that do not publish wood biomass production data and do not even keep it in the books, because the law is also not so much restrictive for the wood biomass (to be accurately dated and included in the inventory). Nevertheless, it is even more difficult because all the data is presented in the amount called "bulk meters", which weight can significantly vary in the different moisture levels. In terms of our research, this was nothing more than a misleading variable. Besides the amount, the price is also something too often marked as "business secret" or too much dependable on the amount ordered in the deal itself and supposedly also depends on each individual situation.

Animal and human waste biomass

The most potential in the field of animal and human waste biomass was identified by the human waste biomass type, in the form of waste sludge (Dehydrated matter - human faeces and other waste sludge). Other types of animal and human waste biomass are negligible in Slovenia. Why? Municipal and industrial organic waste is mostly purchased by the organic processing companies, that produce various kinds of soil substrates and fertilizers, and is thus not idle. Several companies in Slovenia are engaged in the processing of organic waste into different substrates (E.g., Humko, d.o.o., Koto d.o.o. etc.). However, besides that, there is so little organic municipal and industrial waste available annually, that there is no major potential, that can be identified, or it is just negligible. The remains of animal carcasses, livestock, and other remains of the meat industry are mostly ground into bone meal and are then further used in the process of animal feed production, which is not carried out by any large company in Slovenia. The manure, as a type of biomass, also represents a great potential in Slovenia, but not now, maybe somewhere in the future. Many operating small and mid-sized farms, engaged in livestock farming, can be noticed in Slovenia, but a great majority of this farms, uses the manure, to fertilize their own pastures, meadows, and fields. The use of artificial fertilizers for the fertilization of the just mentioned agricultural areas in Slovenia is only an exception, which is implemented in the absence of manure, thus the manure is also not idle.

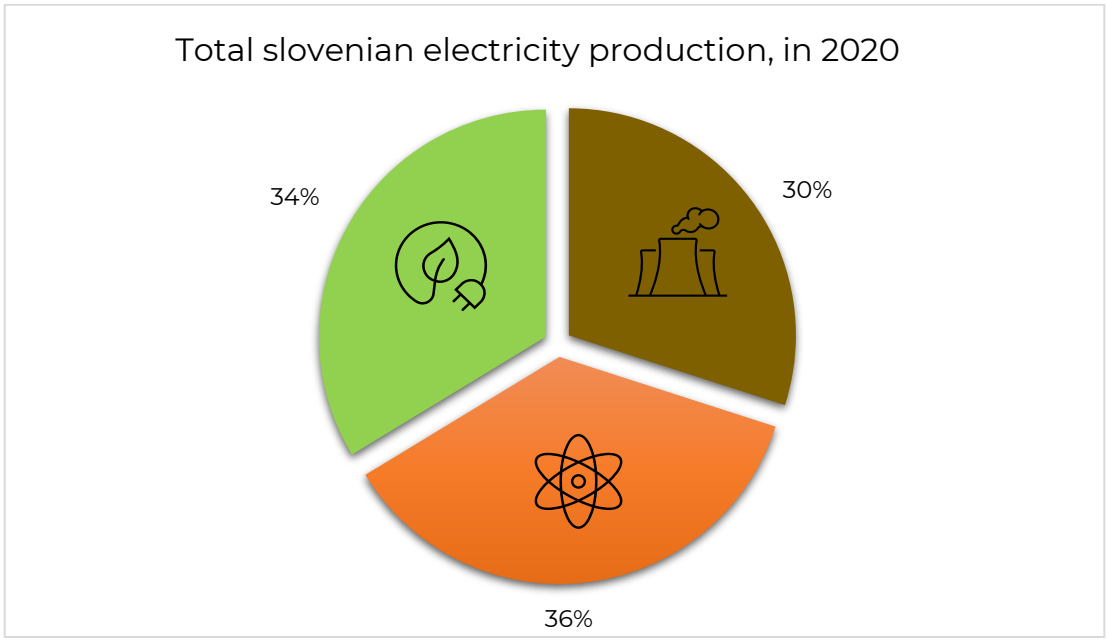
In the light our research, only the potential of biomass obtained from sewage sludge is applicable and idle. The sewage system in Slovenia is developed by the European standards and is maintained by public entities. In Slovenia, Public utility companies are responsible for the operation of public utility network and treatment plants in the most cases (e.g., Public utility company of Velenje). The treatment plants are stationed on the strategic locations. Dehydrated waste sludge is gathered at the final stage of the water treatment process. Mostly private companies in Slovenia are involved in the transport and collection of dehydrated sludge from the treatment plants, e.g. – Koto d.o.o., Saubermacher d.o.o., and public, CeROD d.o.o., etc. The dehydrated sludge has no price of its own, nor it has the transport price. Public utility companies, that collect the sewage sludge in treatment plants have to pay a takeover price to the mentioned transport companies. Before 2019, almost all the waste sludge produced in Slovenia was transported to Hungary, where it was used as an important secondary biomass source. But in the same year, Hungary stopped the import of waste sludge, and all the public utility companies in Slovenia, were left without a solution. Not even the government helped, and the takeover prices increased by 2 to 3 times. Nowadays, three years after, we still do not have a comprehensive solution, so most of the waste sludge, produced in Slovenia is totally idle. However, during this time, some municipalities and companies were able to demonstrate good practices in the field of waste sludge management. For example, in the Municipality of Celje, a co-incineration plant has been set up, where up to 5,000 tons of dehydrated waste sludge can be burned annually. In the town of Puconci, on the far east side of the country, dehydrated sludge is mixed with ash, and a substance called CEROPIT is formed. This substance is very sticky, but organic and it is thus further used in the stratification process of landfilling the waste. The company has

a permit for transforming 9,000 tons of waste sludge annually. 3,600 tons are provided from their own local treatment plants, and the rest is imported, from other municipalities in the country. So, there is still a lot of idle waste sludge on the market that would be immediately suitable for further use in the P-2-G hubs.

As described before, Slovenia is a very small country, but is nevertheless reach in wood and woody biomass. Idle amounts of waste sludge, also represent a good potential, which can be used to generate energy, in P-2-G hubs, to be stored in the form of gas. No other major and highly significant biomass potentials in the Republic of Slovenia were identified in this study.

5.3.2 DESCRIPTION OF SLOVENIAN INFRASTRUCTURE LANDSCAPE

The energy mix of the Slovenian energy system is represented by the operation of major and minor energy systems. Major energy systems include the continuous operation of major hydroelectric power plants, located on the rivers Sava, Drava and Soča, Nuclear power plant Krško, major thermal power plants (Šoštanj, Trbovlje, Ljubljana) and Gas-fired power plant Brestanica. There are 4 major groups of hydroelectric power plants in Slovenia, divided by different areas and rivers in the country, which are organized as 4 independent entities: Soča power plants Nova Gorica (sl. SENG), Drava power plants Maribor (sl. DEM), Hydroelectric power plants on the lower parts of the river Sava (sl. HESS), and Sava power plants Ljubljana (sl. SEL). There are only three major thermal power plants left in Slovenija: Thermal power plant Šoštanj (which is the biggest one), Thermal power plant Trbovlje and Heating power plant Ljubljana. The minor energy systems of the Slovenian energy mix are represented by minor hydroelectric power plants, two wind turbines (Wind turbine Razdrto and Wind turbine Dolenja vas), smaller operating biomass power plants, various sets of photovoltaic power plants (currently the largest one; Solar power plant Prapretno, with nominal power 3,036 MWp) and operating biogas power plants, which are mostly located in the east part of the country.



Source: Statistical Office of the Republic of Slovenia (slo. SURS)

In Slovenia, one third of electricity is still produced from carbon sources, more than a third is obtained from nuclear energy, and a third directly from renewable energy sources (water, solar, wind, biogas, biomass etc.).

In February 2020, the Slovenian government adopted the *National Energy and Climate Plan* (*NECP*), outlining the energy strategy targets for 2030, with an outlook for 2040. By 2030, Slovenia aims to have renewable energy (RES) make up at least 27% of total energy usage, while making up 43% of total electricity consumption. It is also expected that two thirds of energy consumption in buildings will be sourced from RES.

Alongside the adoption of the *NECP*, Slovenia is preparing the *Spatial Development Strategy of Slovenia 2050*, which also defines the impact of various RES on environment and nature. Accordingly, the strategy prohibits the installation of wind power plants in protected areas and restricts it to areas far away from settlements. Furthermore, the use of solar power is currently envisaged only on areas of construction land, infrastructure facilities and devalued areas (e.g., abandoned areas of mineral excavations, waste landfill, etc). The strategy is being prepared by the Ministry of the Environment and Spatial Planning and is expected to be completed shortly.

Investments in the renewables sector are highly dependent on the availability of financing mechanisms. The *Slovenian Energy Agency* is the main concessionaire for tenders for the feed-in support scheme. Power plant operators, awarded by public tender, may choose between guaranteed purchase and operating premium. If they choose guaranteed purchase, the Centre for RES/CHP (CP), under the support of Borzen, d.o.o., takes the electricity from the power plant and sells it to the market (the producer is thus included in the special balance group, operated by CP). If they choose the operating premium, the producers sell the energy on the market, while CP only pays a premium as a difference between the full (guaranteed purchase) price and the market price, which is determined annually, also based on plant type. Eligible for the feed-in support are the producers with power plants of installed capacity up to 10MW, excluding wind power plants, where the installed capacity may be up to 50MW.

In March 2020, the Slovenian government adopted *the Decree on Small Installations for the Production of Electricity from Renewable Energy Sources or Through High Efficiency Cogeneration*. It sets out the types of installations for energy production from renewable energy sources and high-efficiency cogeneration that do not require a building permit, e.g., “small power plants”. Solar power plants with the maximum power of up to 1MW are, according to the Decree, considered small power plants and do not require a building permit to be installed. The Decree simplifies investing in renewables and it represents a welcome change as procedures for obtaining building permits in Slovenia can be time-consuming. As certain regions in Slovenia are windy, there are many opportunities for the construction of wind power plants. The main obstacle on the path towards building new hydro and wind power plants are NGOs and locals, who oppose the construction of such power plants.

Recently, the government identified the development of hydro power plant Mokrice, on the river Sava as a main focus and priority in the forthcoming cohesion period. Moreover,

recent changes in the law restricted the influence of NGOs in the process for obtaining building permits.

The government also adopted the *Act on the Promotion of the Use of Renewable Energy Sources*, which sets out measures to promote and increase energy efficiency, particularly to improve the energy efficiency of buildings, achieve security of energy supply and boost the use of renewable energy sources. There are many (co)financing opportunities for the investments in the energy sector available, especially in renewables, and especially now, at the start of a new cohesion period. In addition to tenders for the feed-in support scheme, which are published around twice a year, additional co-financing mechanisms are available. Loans by SID Bank, the Slovenian development and export bank, are available to public sector and ESCO companies for the energy renovation of public sector buildings. Eco Fund, the Slovenian Environmental Public Fund, also provides several options for obtaining non-refundable funding sources for investment in energy efficiency.

ELECTRIC ENERGY SUPPLY

The electricity transmission system in the Republic of Slovenia is operated only by the company ELES d.o.o. The national distribution system is operated exclusively by the company SODO d.o.o., which performs the economic public service of the electricity distribution operator on the territory of the Republic of Slovenia. It provides the distribution network services with a reliable, secure, and efficient electricity supply for more than 933.000 users in the Republic of Slovenia.

Pursuant to the contract on the lease of electricity distribution infrastructure and the provision of services for the electricity distribution system operator, the following distribution companies carry out distribution activities on behalf of company SODO; Elektro Celje, d.d., Elektro Gorenjska, d.d., Elektro Ljubljana, d.d., Elektro Maribor, d.d. Elektro Primorska, d.d.

NATURAL GAS SUPPLY

In the Republic of Slovenia, supply of natural gas to the customer is provided by the natural gas supplier (transmission system operator) and the distribution system operator, which may be merged within one company or two different companies. If the supplier and the operator are not the same company, the customer may receive two separate invoices, one for the gas supply service and the other for the use of the network. Upon request, the customer can receive a joint single invoice on which the supplier charges for his own account the cost of gas supply and on behalf of the operator also the cost of using the network and performing consumption measurements.

The operator of the Slovenian transmission gas network is the company Plinovodi d.o.o. All companies engaged in the distribution of natural gas in Slovenia also act as suppliers of natural gas. In total, there are 13 operators (distributors) of the gas distribution system, providing gas for more than 80 local communities.

BIOCHAR SUPPLY

Biochar is not yet produced in Slovenia, nor as an energy source, nor as a secondary source for any production or other energy process. The information about Slovenian biochar market can only be provided from the traders. It is only available as an end product, sold in the retail. It is imported and soled as an agricultural fertilizer. There are some companies, which produce it, only in small amounts and only for the agricultural use. The biochar is produced by a pyrolysis process in a small scale, only by companies, which are engaged in the production of garden substrates, e.g. Humko d.o.o. It is sold in bags and by the litres, not kilograms. It is usually sold in 5, 10, 20 and 30 Litre bags.

WATER SUPPLY SECTION

Sources of drinking or sanitary water in the Republic of Slovenia are distributed by various national and regional public utility companies (E.g., Public Utility Company of Velenje, Public Utility Company of Slovenj Gradec, Utility Kranj). In general, the legal area of water management is regulated by the *Water Act*.

The use of private water sources (wells, private water catchments, ponds, streams), directly on the parcel of the owner is permitted and therefore also charged, but the financing of all the necessary water infrastructure is really up to the owners of the private resources. However, the mentioned exploiters of private water resources are also obliged to pay all other costs related to the transport and treatment of wastewater to the competent public utility company and thus do not pay only for the discharge of communal wastewater, but also for its cleaning, the environmental tax for the discharge of wastewater, the treatment of rainwater, the discharge of rainwater, etc. VAT is also added.

5.3.3 USE CASE ANALYSIS

Three locations for the potential P2G investment were considered. The first case study is an already existing photovoltaic power plant – SE PRAPRETNO, which was constructed on the top of the debris from the coal industry, thus in the degraded area, which was not suitable for any other use. The second one is one of the biggest industrial plants in Slovenia - Talum d.d., which is one of the largest producers of primary aluminium and aluminium alloys in Slovenia. Finally, the third study case was only implemented as a green on-field project, which could be implemented anywhere, at any location, which would be preferably based near the used and available raw biomass sources, water sources, near various transport links, IP's, REP's, close to the end consumers, etc.

The first version of the optimization tool (OT V1) was updated in August of 2022, by its developers - University of Zagreb Faculty of Electrical Engineering and Computing. Thus, all the other partner's prefeasibility studies were also accordingly updated. This document was updated in the October of 2022, representing the last update of the deliverable by the end of the DanuP-2-Gas project.

STUDY CASE 1 - RENEWABLE ENERGY PLANT - SE PRAPRETNO

Solar power plant SE PRAPRETNO is currently the largest operating photovoltaic installation in Slovenia. It is located in the small town of Prapretno near Hrastnik, where it was built in a degraded area, where in the past years the coal ash and other waste materials related to the operation of the nearby thermal power plant and coal mine were layered. Thus, the area will not be useful for any other use (farm, housing etc.), for another few hundred years. In the light of this events, the biggest national energy holding – HSE Group, which is the largest producer and seller of electricity from domestic sources on the wholesale market in Slovenia and the largest Slovenian producer of electricity from renewable sources, constructed the photovoltaic power plant. With the nominal power of 3,036 MWp it is currently the biggest photovoltaic power plant in Slovenija.

The renewable energy plant SE PRAPRETNO has the following characteristics:

Nominal power: 3,036 MWp

Expected annual electricity production: 3,4 GWh

Number of installed panels: 6900

Nominal power of panel: 440 Wp

Average daily electricity production: 10 MWh

Number of powered households: 800

The total installation capacity of the area: 15 MWp

Estimated number of annual operating hours: 1100

Source: https://www.hse.si/sl/

As part of the DanuP-2-Gas project, the PRAPRETNO solar power plant was selected as STUDY CASE no. 1, in which we studied the possibility of establishing a P-2-G hub, next to the already existing power plant, which in theory turned out to be quite and effective, economical, and successful option, as the results were encouraging. The results of the study case are presented in the next chapter. Despite the fact that the studied renewable energy sources power plant was built and is intended for the production of electricity, which the mentioned power plant generates in a very remote area that is not close to water and biomass sources, and has very poor transport connections, the results of the OT theorised the savings in the amount of approximately 97 million €, if the future market price would stays as it was by the time of investigation. In that case, the P2G hub would be paid off in just 5,4 years, which is relatively fast and the implementation of the P2G hub in line with the already established photovoltaic power plant, should present quite an effective solution or an advanced upgrade. Similar results with a high level of savings reduction were be observed in the context of gas price increases.

STUDY CASE 2 – INDUSTRIAL PLANT - TALUM D.D.

The second study case was based on the operation of one of the biggest Slovenian industrial plants company TALUM D.D., which is located in the eastern part of the country, near a town Kidričevo. The company is highly specialized in alumina and aluminium products with an annual production capacity of around 156.000 tonnes.

The company was founded in 1942 by the German company - Vereinigte Aluminium Werke, which built the first alumina factory in Slovenia in Strnišče (now Kidričevo). By the end of World War II, the factory was 70% completed, but the construction had to be halted. The factory was then finished in February 1954 and the first aluminium was produced in November the same year. The early capacity of the factory was 45.000 tonnes of alumina and 15.000 tonnes of aluminium per year.

Source: https://www.talum.si/

The first contract was established in 1957 with the French company – Pechiney, to supply a quantity of 80.000 tonnes of alumina. In 2004, a large-scale modernisation programme started at Talum d.d., which involved the construction of other new potlines for aluminium smelting. The total aluminium production from November 1954 to August 2004 amounted to around 2.560.069 tonnes, resulting in an annual production of around 51.000 tonnes of aluminium. Due to the long-term loss, several subsidiary companies were closed in 2015: Talum Ulitki, Talum Livarna. In 2016, the company became the "best employer in the Podravje region", with Talum d.d. employing more than 1,300 workers.

The following characteristics of the company are presented:

Annual aluminium production: 150.000 tonnes

Electrical energy consumption per produced ton: 6,6 MWh/t

Natural gas consumption per produced ton: 160 Nm^3/t

Aluminium production in 2020: 114.752 t

Natural gas consumption in 2020: 18.360.320 Nm^3

Electrical energy consumption in 2020: 760 MWh

For the second study case, the same gas market, grid investment and electricity market prices were used, as for the first and the third study case, due to the fact that this was the situation in the country at the time. In the first version of the optimization tool the second study case proved to be the most successful of the three, as it is logical that there is a high energy consumption present for the whole year in the industrial areas, and not

just seasonal. As it can be seen from the examples of the other partners, the operation of the P-2-G hub in the context of the operation of large industrial factories makes the most sense, since the production and consumption of energy can be additionally adapted to the operation of the factory and the production process.

Using the second version of the optimisation tool, we also got similar results to the first version. Interestingly, the implementation of the P-2-G hub makes the most sense when we also use grants in the investment, because then our investment costs are lower than if we would only invest in the hub by ourselves, which would highly increase the investment risk. As we can see in the results presented in the following sections and based on the optimization tool prediction, the implementation of a P-2-G hub at the industrial plant TALUM d.d. site would be beneficial and cost-effective, as we would save approximately 124 million € over a payback period of about 5 years, which makes sense, as the consumption of primary and secondary energy sources at the TALUM d.d. industrial plant is one of the highest among all business energy uses in Slovenia.

However, a drastic increase in the price of gas also drastically reduces the savings, as it can be seen in the examples where 5- and 10-times factors of the gas price are used.

STUDY CASE 3 – P-2-G HUB AS GREEN FIELD PROJECT

For the last (third) study case also, the same gas market, grid investment and electricity market prices were used, as before, and that was also due to the fact that this was the situation on the market in the country at the time. The results of the study case are presented in the next chapter. Given the fact that the use of the first version of the optimisation tool showed a rather pointless investment in P-2-G on-field, we can say differently for the second version of the optimisation tool, as the results show us some sensible solutions. It seems that the implementation of a P-2-G hub on field would be profitable, especially when the gas price is between the current price and five times the trend price. However, when the gas price reaches the ten times factor of the current price, the investment in an on-field P-2-H is not so sensible anymore.

CONCLUSIONS BASED ON THE OT RESULTS

The results of the feasibility study showed us that usually the most ideal location for a P2G hub is a potential industrial facility or in some cases REP, as its operation can ensure a reduction in emissions and thus its sustainability. The expansion of industrial facilities and their transformation into P-2-G hubs can further help to reduce the demand for energy in the areas of industrial hubs and, consequently, to reduce their dependence on external networks of energy sources. In addition to the above-mentioned advantages, such hubs would help to meet the large energy self-sufficient needs of companies or Industrial Plants. Furthermore, the commercial consumption of the biogas would be also possible on these sites, given the production potential of the electrolysers of such facilities, which could help create hydrogen points. While this could result in some concentration of technology in the country, it could also create more power generation centres than currently exist, thus helping the already ongoing decarbonisation process.

The results also showed us that the establishing of P-2-G hub by the existing renewable energy plants does not always make sense. E.g., - The simultaneous construction of a P-

2-G hub on the existing location of the SE PRAPRETNO photovoltaic power plant makes sense, perhaps only for the production of hydrogen with the help of an electrolyser, since the full utilization of this already existing location could be represented by the use of excess electricity (produced on a sunny day at the time, when the el. consumption in households is low) for the purpose of hydrogen production. The results also showed that implementing a P-2-G hub as an on-field project is feasible and economical, but its location is nevertheless very important. It is certainly important that both the IP, the REP and the potential on-filed P-2-G hub are located close to the electricity transmission grid and the natural gas transmission grid, close to transport hubs, primary biomass sources and other resources that are important for the smoothest possible operation of the P-2-G hub.

5.3.4 EXISTING FUNDING POSSIBILITIES

There are 4 funding possibilities currently (September 2022) present in the Republic of Slovenia. The following funding possibilities are marked with a sequence number and the phrase SI – marking the country of eligibility is Slovenia. Some of the incentives were dropped in the year of 2022, due to the instability of EU energy market, caused by the time of crysis.

SI-1 - Subsidy 84SUB-EVOB20

Thematic scope: Transport infrastructure

Type: Investment funding

Legal/financial form: Grant

The context of the funding instrument: The subject of the public call for Subsidy are non-refundable financial incentives for investments of the citizens in the purchase or conversion of more environmentally friendly road transport vehicles, which fall into one of the two following categories of road vehicles; purchase of a new/test vehicle powered by electricity or conversion of the vehicle into an electric vehicle so that the series-installed internal combustion engine will be replaced by a propulsion electric motor.

Possible usage of the funding instrument in the P2G context: The electricity demand by electric vehicles will increase the electric grid load, while P2G systems are suitable for producing clean hydrogen from excess electricity for fuel cell electric vehicles. Investment in hydrogen fuel cell electric vehicles could therefore encourage broadening a network of infrastructure based on power-to-gas (P2G) applications.

Legal entity responsible for the funding instrument: Slovenian Environmental Public Fund (EKOSKLAD, Bleiweisova cesta 30, Ljubljana, Slovenija)

Geographic scope of the funding instrument: Slovenia

Eligibility criteria: all full aged citizens without tax debts

Co-financing rate: depending on the vehicle category

Volume and duration of fundable activities:

The amount of the non-refundable financial incentive depends on the category and is up to:
−EUR 4,500.00 for the purchase of a new electric vehicle with zero CO2 emissions and for a vehicle converted to electric drive of category M1
−EUR 3,500.00 for the purchase of a test electric vehicle with zero CO2 emissions of category M1
−EUR 3,500.00 for the purchase of a new electric vehicle with zero CO2 emissions and for a vehicle converted to electric propulsion of category N1
−EUR 1,500.00 for the purchase of a new electric vehicle with zero CO2 emissions and for a vehicle converted to electric propulsion of category L7e
−EUR 1,000.00 for the purchase of a new electric vehicle with zero CO2 emissions for an electrically converted vehicle of category L6e
−EUR 750.00 for the purchase of a new CO2-free electric vehicle of category L3e or L4e or L5e
−EUR 500.00 for the purchase of a new CO2-free electric vehicle at the category L2e
−EUR 300.00 for the purchase of a new electric vehicle with zero CO2 emissions of category L1e-B.
Duration: until publication of cancelation in the Official Gazette of the Republic of Slovenia

Limitations: described in the context

Periodicity assessed based on its so-far occurrence: yearly

Webaddress: https://www.ekosklad.si/prebivalstvo/pridobite-spodbudo/seznam-spodbud/elektrina-in-hibridna-vozila/elektricna-in-hibridna-vozila-subvencija-276

SI-2 - Loan 67OB22

Thematic scope: Transport infrastructure Type: Investment funding

Legal/financial form: Loan

The context of the funding instrument: The loan is suitable and available for electric vehicles (Including FCEVs-Hydrogen Technology), gas vehicles, wood biomass heating devices, gas condensing boilers and micro-cogeneration productions. The loan in the form of 3-month 1,3% EURIOBOR repayable funds can be obtained for the purchase of new or used electric vehicle (Including FCEVs-Hydrogen Technology), gas vehicle, wood biomass heating device, gas condensing boiler and micro-cogeneration production. The loan is secured by Zavarovalnica Triglav, d.d., Ljubljana, in accordance with the terms of the call. The borrower repays the loan in monthly annuities, which is generally not lower than EUR 40.00. The maximum possible annuity for a loan is determined in accordance with the rules for determining creditworthiness.

Possible usage of the funding instrument in the P2G context: The electricity demand by electric vehicles will increase the electric grid load, while P2G systems are suitable for producing clean hydrogen from excess electricity for fuel cell electric vehicles. Investment in hydrogen fuel cell electric vehicles could therefore encourage broadening a network of infrastructure based on power-to-gas (P2G) applications.

Legal entity responsible for the funding instrument: Slovenian Environmental Public Fund (EKOSKLAD, Bleiweisova cesta 30, Ljubljana, Slovenija)

Geographic scope of the funding instrument: Slovenia

Eligibility criteria: all full aged citizens without tax debts

Co-financing rate: Depends on the amount of recognized investment costs.

Volume and duration of fundable activities: The minimum amount of loan is 1500,00 €, the maximum amount is not specified. Duration of fundable activities is until the publication of cancelation in the Official Gazette of the Republic of Slovenia Limitations: The loan must be secured with insurance instrument. Combustion appliances and vehicles must be made and produced in accordance with the regulations of the law (size, power, emission standards, etc.). The duration of repayment with monthly amounts is limited up to 10 years. A significant change compared to the previous public call is the stricter conditions for the purchase of new or used hybrid passenger cars, namely that the CO2 emission value in the combined driving mode can be a maximum of 85 g / km.

Periodicity assessed based on its so-far occurrence: yearly

Web address: https://www.ekosklad.si/prebivalstvo/pridobite-spodbudo/seznam-spodbud/elektricna-vozila-3/elektricna-vozila-kredit-3

SI-3 - Loan 66PO21

Thematic scope: Power-2-gas technology, Biomass

Type: Investment funding

Legal/financial form: Loan

The context of the funding instrument: This is a loan from the Eco Fund for Environmental Investments, or the investment phase defined in the project in the following measures: reducing greenhouse gas emissions, reduction of air pollution (except reduction of greenhouse gas emissions), waste management, water protection and efficient use of water, waste water disposal or drinking water supply, and initial investment in environmental technologies. The granted loan must be adequately secured by one or more of the following insurance instruments; mortgage on commercially interesting real estate, the pawn of commercially interesting movable property etc.

Possible usage of the funding instrument in the P2G context: Implementation of the initial investment in environmental technologies that will reduce energy consumption and emissions such as RES technologies that could be coupled with power-2-gas applications.

Legal entity responsible for the funding instrument: Slovenian Environmental Public Fund (EKOSKLAD, Bleiweisova cesta 30, Ljubljana, Slovenija)

Geographic scope of the funding instrument: Slovenia

Eligibility criteria: All legal entities without any state, tax, social or public debts including without overdue financial obligations to the Eco fund (EKOSKLAD).

Co-financing rate: The loan is approved as a percentage of the recognized investment costs. The maximum share of the loan is 85% of the recognized investment costs.

Volume and duration of fundable activities: The amount of an individual loan is limited to a minimum loan amount of EUR 25.000 and a maximum loan amount of EUR 2 million. Duration of fundable activities is until the publication of cancelation in the Official Gazette of the Republic of Slovenia

Limitations: The maximum debt of the borrower with the Eco Fund may not exceed EUR 10 million.

Periodicity assessed based on its so-far occurrence: yearly

Web address: https://www.ekosklad.si/iskanje?segment=gospodarstvo&s=66PO21

SI-4 - Guaranteed purchase of electricity

Thematic scope: Electricity generation or consumption suitable for coupling with P2G hubs

Type: RES investment funding

Legal/financial form: Support scheme – Feed in tariff

The context of the funding instrument: In the case of a guaranteed purchase, the support center ran by BORZEN electricity market operator, takes over the electricity and pays for it at the price determined in accordance with the decision on the granting of support issued by the Energy Agency. The company with guaranteed purchase of electricity is classified in a special balance group or subgroup formed by the support center (Eco Balance Group). The Support Center pays for electricity that is delivered to the public network and taken over by the Eco Balance Group. Beneficiaries who obtain an Eco contract undertake to choose the type of support as a guaranteed purchase of company production. From the point of view of the support scheme, only the amount of electricity considered to be distributed to the public network is relevant as guaranteed purchase. In the case of guaranteed purchase, the Support Center can only take over and pay the balance sheet recognized quantities.

Possible usage of the funding instrument in the P2G context: Promoting and increasing energy production from renewable energy sources will lead to higher load of electric grid and therefore more excess electricity that could be stored in P2G systems.

Legal entity responsible for the funding instrument: Borzen, electricity market operator (družba BORZEN, Dunajska cesta 156, Ljubljana, Slovenija)

Geographic scope of the funding instrument: Slovenia

Eligibility criteria: small cogeneration and RES power plants with maximum power of 1 MW

Co-financing rate: guaranteed purchase and fixed price of all production

Volume and duration of fundable activities: there is no particular or defined limited duration

Limitations: maximum plant power must be below or equal to 1 MW, age for RES plants hardware is limited to maximum of 15 years and maximum of 10 years for cogeneration plants. Companies that have an Eco contract or a guaranteed purchase do not and must not have a separate contract for the sale of electricity.

Periodicity assessed based on its so-far occurrence: permanent

Web address: https://www.borzen.si/sl/Domov/menu2/Center-za-podpore-proizvodnji-zelene-energije/Sistem-podpor/Vrste_podpor

5.4 EXISTING BARRIERS

In the following chapter existing barriers and needed actions for the deployment of P2G projects in Slovenia are listed.

Legal barriers

- Lack of P2G definition in national legislation.
- The clarity of definition of energy storage (facility) in electricity supply act 2021.
- Electricity and gas sector fragmentation from the legislative regulation perspective.

Techno-economic barriers

- Lack of transmission/distribution network analysis and quality standards related to feeding in the hydrogen and 'renewable natural gas'.
- Gas system adjustment pace.

Socio-technical barriers

- Clear definition of charges that would apply specifically for a P2G plant.
- Lack of more defined specifications on exemptions regarding the payment of contributions that would apply for P2G.
- Double taxation/levies for P2G facilities.

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 this gaps and barrier and to achieve the goals of the roadmap, are summarised in this chapter.

Action items needed to overcome legal barriers

- The definitions of P2G hubs, hydrogen technologies, etc. should be clarified in the legislation of the Republic of Slovenia. It would also be necessary to amend all laws that touch on these areas and to clearly describe where all Slovenian legislation touches on the operation of the technologies studied in the DanuP-2-Gas project.
- It would be necessary to clarify the definition of energy storage (facility) in electricity supply act 2021.
- It would also be necessary to merge several law acts to make broader and clearer laws, so that there are fewer regulations and that the legislative instruments of the sector are not spread over several different legislations.

Action items needed to overcome socio-technical barriers

- Investing in the development of the transmission/distribution network analysis implementation and development of the quality standards related to feeding in the hydrogen and 'renewable natural gas'.
- Government investment in the development of the gas network and system, which should be more deliberate, faster, smoother, and more sustainable.

Action items needed to overcome techno-economic barriers

- The state should clearly define the definition of charges that would apply specifically for a P2G plant.
- The specifications of the contribution exemptions that would apply to P2G should be clearly defined by the State and the Government. Planning and installation of a pilot test plant with the possibility of testing and analysing the impact of injecting various renewable gases into the transmission system
- Facilities using P2G technology should not be double-taxed, and they should even be exempt from certain taxes and be included in all kinds of CHP and RES support schemes available, this should be ensured by the State.

Further action items and recommendations

The rules for the operation, investment, and operation of Power to Gas and Power to X systems should be clearly defined in the relevant legislation acts. At the same time, the state should also provide non-repayable financial incentives and loans to the sector through various investment measures and channels to stimulate interest and investment in the sector.

LIST OF ABBREVIATIONS

NECP	National Energy and Climate Plan of the Republic of Slovenia (slo. NEPN)
P2G	Power to gas
OT	Optimization tool

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The following web pages were used to indirectly access the data with which the chapters above were shaped and contextualized:

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