Support to REPowerEU

Country report

Slovenia

This project is funded by the EU via the Technical Support Instrument and implemented by Trinomics and its partner organisations, in collaboration with the European Commission. The views expressed herein can in no way be taken to reflect the official opinion of the European Union.

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Trinomics

Rotterdam, March 31st 2023

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Slovenia

In association with:

IRI UL

CONTENT

Executive summary

The Slovenia REPowerEU Country Report discusses the potential measures that the country could take to improve its energy resilience in the face of energy supply shocks in Europe.

Energy dependence

Practically all methane used in Slovenia is imported as natural gas. In 2021, around 51% of the total gas demand was imported directly from Russia. Around 28% of the gas demand was imported from Austria (a share of these imports is in fact an indirect import from Russia), 11% from Italy and 10% from other sources. The Slovenian dependence on natural gas for electricity generation as a share of the total demand can be considered negligible (gas represents around 2%). Regarding electricity, beside some cogeneration units, gas power plants are used as peak plants in times when electricity is scarce. As the Slovenian electricity grid is well connected with neighbouring countries (interconnection capacity totalling to around twice the peak country demand), the electricity adequacy risk from this aspect is low. The structure of Slovenia's natural gas consumption by sector in 2021 is as follows: industry (61.0%), transformations (20.1%), households (14.4%), other (3.3%), non-energy use (0.7%), mobility (0.5%), and energy sector (0.1%). Natural gas accounted for only 10% of households' final energy consumption in 2020, trailing behind biomass (39%), electricity (28%), and heating oil (12%), and just ahead of district heating (7%). Slovenia has no LNG plants or LNG import terminals, nor is there a natural gas storage facility in the country. Concerning oil and petroleum products, imports from Russia stood at only 6% in 2021. Regarding solid fossil fuels, Slovenia can be considered 90% self-sufficient, with the majority of imports coming from Indonesia.

Key challenges and opportunities in the context of REPowerEU

Energy savings

Some initiatives have been identified providing small and medium enterprises with energy advisory services. Campaigns by non-governmental stakeholders have also been launched with the aim of raising awareness on high energy prices and mitigating their impact on consumers.

Nevertheless, only limited activities focus on inefficient heating appliances. There is scope for increasing the spectrum of activities that would encourage an energy efficient behaviour of end-users. There is also scope to improve data on whether big enterprises are undertaking sufficient investments into energy efficiency and if not, to identify the reasons.

Accelerated renewable energy deployment

Some legal measures have been passed or are in the pipeline aiming to facilitate an efficient and socially acceptable renewable energy deployment. Additional measures (best practices) could also be considered, such as enabling steps of the procedure to take place in parallel, positive administrative silence, and streamlined data exchange between different entities involved in permitting or grid connection processes. Furthermore, the permitting and grid connection procedures could be digitalised in full.

Regarding solar PV, a list of potential grid connection points has been published. Nevertheless, barriers to grid connection can be found on the low-voltage level (residential solar PV), where there is scope for improvement of the grid connection decision-making processes and smart management of the low-voltage network (increasing the capacity of installed solar PV while occasionally permitting remote curtailment of excessive electricity production).

District heating

In district heating, natural gas supplied approximately one-third of the primary energy for heat production (31.48%), compared to coal's 47% and renewables' 17.5%. Only a small percentage of heat was generated by waste-to-energy plants (2.6%), industrial waste heat (0.25%), and electricity (0.01%). There is scope to increase the share of thermal solar installations and biomass combustion (with appropriate air quality monitoring) or biomass gasification and subsequent cogeneration of electricity and heat.

Transport

Effective changes in the transport sector will be key to Slovenia's energy transition. Presently, the number of journeys made by private motor vehicles represent 67% of the number of all routes of travel. To decrease this number, radical improvements will be needed in public transport to increase its usage and consequently relieve road traffic. New railway routes should be constructed, and the existing ones modernized (electrified). There is also an urgent need to switch from fossil fuels to more environmentally friendly alternative fuels, most notably electric vehicles, while also promote the increased use of biomethane and hydrogen where possible. Successful integration of electric vehicles will require an effective strategy that focuses on smart charging and the deployment of more charging points in locations where the reliable operation of the electricity grid will not be adversely affected.

In depth support on priority areas

The report contains an in-depth investigation into the areas of biogas and hydrogen deployment.

Proposed reforms and investments in the context of the REPowerEU initiative

Based on an extensive analysis and contacts with stakeholders and authorities in Slovenia, the following reforms and investments are proposed:

Table 1: List of proposed reforms and investments in the context of the REPowerEU initiative

Title	R/I	Description
Introduction and enforcement of long-term sustainability targets for the industrial sector	R	• Companies will soon be required to report on sustainability matters, increasing accountability and facilitating transition to sustainable economy. EU targets for decarbonization in industrial sector could be accelerated by targeted approach, using existing National Energy and Climate Plan (NECP) to reduce 43% GHG by 2030. A mandatory requirement for companies to disclose plans for achieving targets could be based on forthcoming Corporate Sustainability Reporting Directive (CSRD).
Create and implement financial incentives to support pilot project funding, including support with permitting and licensing	I	• Pilot projects for alternative energy sources need financial incentives to accelerate implementation, reduce dependence on fossil fuels, and demonstrate viability for commercialization. Investment grants and subsidies can support feasibility studies and accelerate development of useful solutions for wider use.
Transitioning of district heating systems to affordable and sustainable energy sources	R	• Develop financial support for district heating modernization and expansion, including increasing the share of RES, incorporating thermal storage and industrial waste heat. • Strive towards transitioning to more efficient and more flexible low-temperature DH networks. • Consider all major sources of waste heat and require them to feed into district heating when cost-effective. • Broad national educational and awareness-raising campaign on the necessity and procedure of transitioning to a climate-neutral society.

Reforming the grid connection procedure for low-voltage solar PV	R	• Digitalise all connection procedures, forms and communication. • Replace the current approval procedure, whereby connection is approved considering historical static analyses of the subsection of the grid with an "optimal curtailment policy", where more installed capacity is allowed, subject to curtailment in case of oversupply. • Require inverters to enable remote switch off, as well as continuous output power adjustment. • Design schemes sharing the financial burden of curtailment over all producers connected to the same subsection of the grid.
Incentivise smart management of distribution grids	R	• Complement or replace the regulated-rate-of-return regulation (incentivising CAPEX-heavy investments in infrastructure over high-OPEX smart solutions) with new indicators (such as utilization factor of a power line) stimulating a more efficient utilisation of the grid.
Disseminate knowledge among citizens, investors, municipalities and other stakeholders	R	• Increase familiarity of the public/investors with environmental impact assessments (EIAs) and other complex procedures related to the RES permitting process. • Develop and roll-out a capacity building programme for all municipalities and regional authorities. • Develop an online repository of examples of existing RES community projects to facilitate investment decisions for citizens and investors.
Transforming the transport sector	R, I	• Advance the fuel shift in public transport. • Strategically place infrastructure for alternative fuels in transport (consider the electrical grid, the possibilities for the production of low-carbon gases, as well as the demand from different traffic flows). • Improve the functionalities of EV charging stations to benefit the grid and the user. • Promote cycling or walking for daily commutes.
Reforms regarding biogas and biomethane	R, I	• Develop a state-level action plan on the potential of biogas. • Assess the opportunities for biomethane production in agriculture. • Develop a national action and investment plan on the long-term potential of biomass, with a focus on biomass gasification. • Implementing a certificates-of-origin scheme for methane. • Implement a subsidy scheme for production of bio/synthetic methane.
Reforms regarding hydrogen	R	• Develop a state-level action plan on the potential of hydrogen. • Investigate the potential of individual companies regarding hydrogen. • Implement a support scheme for the production or use (implying market-based production) of renewable hydrogen.
Strengthen the institutional capacity for best practices for the use of biogas, biomethane and renewable hydrogen	R	• An action plan for the use of biogas, biomethane, and renewable hydrogen would provide clarity to the relevant sectors of the economy and strengthen the institutional capacity for best practices through mapping potential production and involving different stakeholders. Involvement in the North Adriatic Hydrogen Valley can serve as a good baseline for the action plan and capacity building.

R: Reform, I: Investment

1 Introduction

In May 2022, the European Commission presented the REPowerEU Plan, its response to the hardships and global energy market disruption caused by Russia's invasion of Ukraine. The REPowerEU plan sets out a series of measures to rapidly reduce the EU's dependence on Russian fossil fuels and fast-forward the green transition while increasing the resilience of the EU-wide energy system. It is based on three pillars: diversifying gas supplies; accelerating renewable energy deployment in homes, industry, and power generation; and reducing demand for fossil fuels, including through energy efficiency measures.

In the context of the REPowerEU plan, the European Commission is providing support under the Technical Support Instrument (TSI) to 17 Member States to help identify the most suitable reforms and investments to phase out their dependency on Russian fossil fuels. The technical support will focus on areas such as diversifying energy supplies, accelerating the transition to renewable energy, and increasing energy efficiency.

DG REFORM contracted a consortium led by Trinomics to provide technical support to 15 of those Member States. The work carried out under this technical support project will provide relevant analysis and elements to the Member States under the REPowerEU objectives. Member States may consider implementing some of the measures identified in the context of the REPowerEU initiative. This report concerns the technical assistance provided to Slovenia.

The information contained in this report does not represent the views of the European Commission, nor does it constitute an endorsement of the European Commission of its content. The authorities of Slovenia remain fully responsible for any measures they choose to pursue in the context of REPowerEU.

The work performed under this project includes:

1. An analysis of energy-related dependencies (chapter 2).
2. The identification of possible reforms and investments to support REPowerEU objectives (chapter 3).
3. In-depth support on priority areas (chapter 4).
4. Hands-on support (chapter 5).

The work was delivered between June 2022 and February 2023 by a team of local consultants and international experts. For Slovenia, the Institute for Innovation and Development of the University of Ljubljana (IRI UL) was the prime responsible organization.

2 Energy dependence

In this section, we present a high-level overview of energy related dependencies specific to Slovenia, including energy demand and supply dynamics, energy mix, and supply chain dependencies related to energy technologies and critical raw materials.

2.1 Energy demand

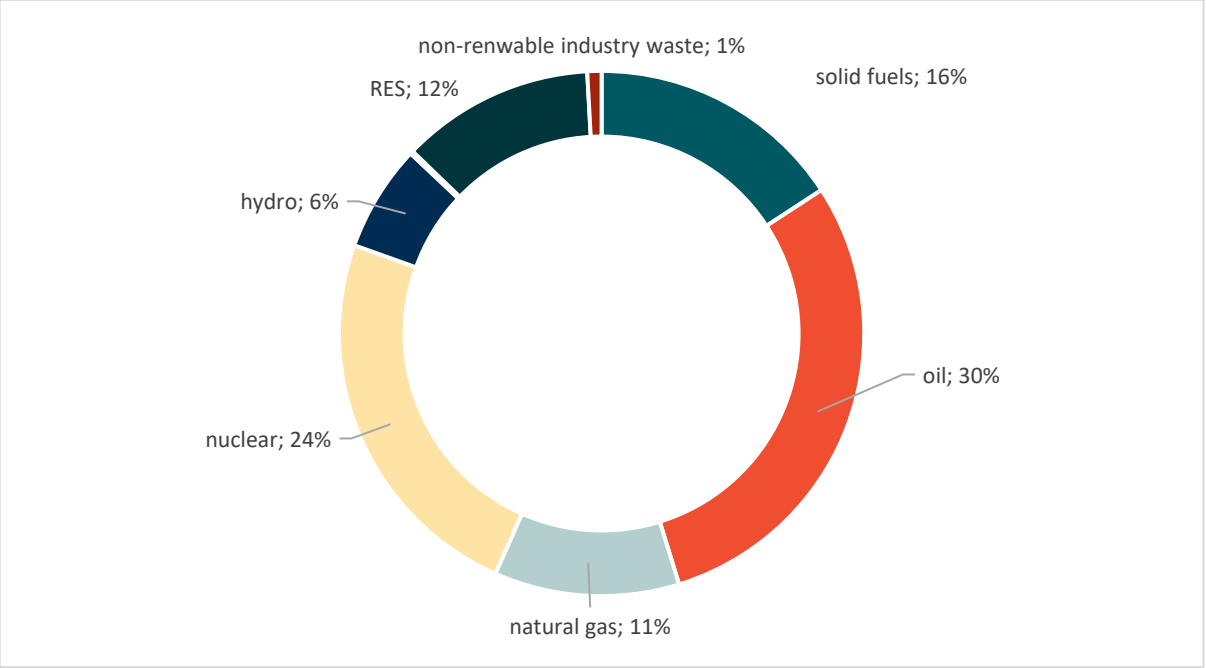
Slovenia has a dynamic energy demand. The latest data (2021) estimates Slovenia's final energy consumption at 54 TWh[1], whereas for example, the final energy consumption in 2018 was 58 TWh[2]. This reduction of almost 10% can be attributed mainly to the COVID-19 pandemic and its impact on the operations of the commercial and industrial sectors. By looking further back, Slovenia's final energy consumption from 2014 to 2018 was approximately 5% above the average energy consumption at the EU level per capita. Furthermore, by evaluating the energy dependencies during the same period, the dependency level in 2018 was estimated at 50% whilst the latest data show a lower dependency level, estimated at 45.7%.

2.2 Energy supply

In 2021, the total energy supply in Slovenia was estimated to 74 TWh[3], which includes national generation of energy, imports, exports, change in storage capacity, and international maritime storage facilities. In the same year, the energy supply mix was comprised of 57% fossil fuels (solid fuels, oil and natural gas), 24% nuclear (from the sole nuclear power plant of the country), 18% renewable energy (of which a dominant share being energy generated by hydropower plants) and a marginal share (1%) of non-renewable industry waste (Figure 1).

[1] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/energetska_bilanca/ebrs_2021.pdf
[2] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/energetska_bilanca/ebrs_2018.pdf
[3] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/energetska_bilanca/ebrs_2021.pdf

Figure 1: Energy supply by fuel (2021)[4]



2.2.1 Energy from fossil fuels

Natural gas

Looking only at the statistical import numbers, Slovenia's share of Russian gas imports seems smaller than it actually is. This is due to statistical methodology where only direct sales contracts with Russian companies are considered as Russian imports, but in reality, a majority of the imports from neighbouring countries, especially Austria, also come from Russia[5]. Statistically, Slovenia's sources of imports are the following: Russia, (51% share of total demand - increased from 36% in 2020), Austria (28% share of total demand), and Italy (11% share of total demand) and 10% from other sources[6]. The share of renewable gases is considered as negligible and is therefore not presented in this section of the report.

In 2021, the demand and supply dynamic for natural gas was the following:

- A total of 12.0 TWh was imported;
- 10.1 TWh was consumed; and
- 1.8 TWh was exported.

Whilst the Slovenian dependency on natural gas for electricity generation can be considered negligible (estimated at around 2%), the use of natural gas for heating and industrial processes is significant. In 2017, the share of natural gas for heat supply via district heating networks was 27%[7], the share of natural gas for space heating, hot water, and cooking in households was 10% and the share of natural gas for various industrial processes was 34%[8].

[4] https://www.agen-rs.si/-/porocilo-o-stanju-na-podrocju-energetike-v-sloveniji-v-letu-2021
[5] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_energy_mix_and_import_dependency#EU_energy_dependency_on_Russia
[6] www.stat.si
[7] http://kazalci.arso.gov.si/sl/content/delez-energetsko-ucinkovitih-sistemov-daljinskega-ogrevanja
[8] https://www.i-energija.si/ienergija/energetika-v-sloveniji-in-svetu-statistika/

Natural gas pipelines are established with Austria, Italy, and Croatia, whilst the connection with Hungary is expected to be completed in 2024. The overall capacities of pipelines and planned upgrades are summarized in Table 2 below.

Table 2: Slovenian gas import capacity (current and planned pipelines)[9]

Available technical capacity of the gas transmission system (in million kWh/day)								
Transmission system operator	Interconnection points	Type	2021	2022	2023	2024	2025	2026
Pipelines	Ceršak (Slovenia – Austria)	entry	139.2	139.2	139.2	217.7*	217.7*	217.7*
		exit	0.0	0.0	0.0	162.0*	162.0*	162.0*
GCA	Murfeld (Austria – Slovenia)	entry	0.0	0.0	0.0	166.5	166.5	166.5
		exit	112.5	112.5	112.5	217.7	217.7	217.7
Pipelines	Rogatec (Slovenia – Croatia)	entry	7.7	48.5	48.5	169.7**	169.7**	169.7**
		exit	68.3	68.3	68.3	230.3**	230.3**	230.3**
Plinacro	Rogatec (Croatia – Slovenia)	entry	53.7	53.7	53.7	215.7	215.7	215.7
		exit	7.7	48.5	48.5	169.7	169.7	169.7
Pipelines	Šempeter pri Gorici (Slovenia – Italy)	entry	28.3	28.3	28.3	28.3	28.3	49.0***
		exit	25.7	25.7	25.7	25.7	25.7	49.0***
Snam Rete Gas	Gorizia (Italy – Slovenia)	entry	21.5	21.4	21.4	21.4	21.4	21.4
		exit	47.2	47.2	47.2	47.2	47.2	47.2
Pipelines	Pince (Slovenia – Hungary)	entry	0.0	0.0	0.0	12.9***	12.9***	49.0***
		exit	0.0	0.0	0.0	12.9***	12.9***	49.0***
FGSZ(i)	Tornysizent Miklos (Hungary –Slovenia)	entry	0.0	0.0	0.0	12.8	12.8	59.3
		exit	0.0	0.0	0.0	12.8	12.8	59.3
Note *	Upon completion of stage 2 of the CS Kidričevo – C5 project (TRA-N-94) and upgrade of the interconnection Ceršak - C4 project (TRA-N-389).							
Note **	Upon completion of the upgrade of the interconnection Rogatec – C12 project (TRA-N-390).							
Note ***	Upon completion of Unit 3 of CS Ajdovščina – C1 project (TRA-N-92) and the BMCS Vrtojba in the framework of project C2 (TRA-N-108).							
Note ****	Upon completion of the interconnection with Hungary (jointly with Stage 3 of the COD extension) - C3 project (TRA-N-112).							

The key challenges related to the import and export of natural gas are the lack of natural gas storage facilities and liquefied natural gas (LNG) plants, as well as the existence of three cross-border handover points of the transmission system only. Due to these challenges, Slovenia (along with Luxembourg and Sweden) is exempt from criterion N-1[10]. The validity of this exemption will remain, as long as Slovenia will maintain at least two interconnection points with the other Member States, has at least two different natural gas supply import points, and has no natural gas storage facilities or LNG plants.

[9] Plinovodi d.o.o., https://www.plinovodi.si/media/5303/development-plan-2021-2030.pdf
[10] (N-1)-Criterion: The rule according to which elements remaining in operation within TSO's Responsibility Area after a Contingency from the Contingency List must be capable of accommodating the new operational situation without violating Operational Security Limits.

Oil and petroleum products

In 2021, Slovenia consumed approximately 1.86 million tons of oil and petroleum products, imported 3.43 million tons, and exported 1.43 million tons. Slovenia imports as much as 99.5% of oil and petroleum products to cover its own needs. Based on the statistical data from 2021, the main imports come from Greece (17%), Italy (15%), Saudi Arabia (15%), Egypt (10%) and Austria (8%). Imports from Russia have decreased from 16% in 2020 to only 6% in 2021.

Solid fossil fuels

In 2020, Slovenia consumed approximately 3 491 kilotons of solid fossil fuels; 3 175 kilotons were from in-country production, 390 kilotons were imported, and 2.6 kilotons were exported. In this regard, Slovenia can be considered 90% self-sufficient. The major import source of solid fossil fuels is brown coal from Indonesia (8.8%).

2.2.2 Energy from renewable energy sources

In 2020, renewable energy sources (RES) represented a 25% share of the final energy consumption, which includes 0.86% statistical transfers[11] via the import of 465 GWh of energy from RES from other EU Member States, namely the Czech Republic[12]. In this regard, the 20% RES threshold in final energy consumption objective of the EU's Climate and Energy Package was met. Nevertheless, the RES share in final energy consumption will most likely need to be increased over the short-term in order to meet the thresholds set in the expected update of NECP.

In 2021, the estimated share of RES in final energy consumption was 23.5%, which can mainly be attributed to an increase in the activities of the commercial, industrial and transport sectors after the easing of COVID-19 pandemic measures, such as lockdowns[13].

The annual shares of RES in the final energy consumption and per key sectors are summarized in Table 3.

Table 3: Share of RES in final energy consumption per sector (2015 - 2020)

	2015	2016	2017	2018	2019	2020
Total RES (%) in final energy consumption	22.9	22.0	21.7	21.4	22.0	25.0
RES - heating and cooling (%)	36.2	35.6	34.6	32.3	32.2	32.1
RES – electricity generation (%)	32.7	32.1	32.4	32.3	32.6	35.1
RES - transport (%)	2.2	1.6	2.6	5.5	8.0	10.9

Based on preliminary 2021 data, RES accounted for 36.7% of Slovenia's electricity generation, with hydro representing 92.2%, solar PV 4.8%, and biomass 2.9% of this share. The generation of electricity from wind power plants can be considered negligible as it represents only a 0.1% share[14].

2.2.3 Summary of Slovenian energy dependencies

A summary of the energy dependencies of Slovenia is presented in Table 4.

[11] Energy indicators by INDICATOR and YEAR. PxWeb (stat.si)
[12] https://www.agen-rs.si/-/porocilo-o-stanju-na-podrocju-energetike-v-sloveniji-v-letu-2021
[13] https://www.agen-rs.si/-/porocilo-o-stanju-na-podrocju-energetike-v-sloveniji-v-letu-2021
[14] https://www.agen-rs.si/-/porocilo-o-stanju-na-podrocju-energetike-v-sloveniji-v-letu-2021

Table 4: Indicators of the energy dependence of Slovenia[15, 16, 17, 18]

Indicator	Unit	Time period
Final energy consumption (total)	53 166 GWh	2021
Energy consumption trend (5-year change)	-9.7%	% change past 5 years
Energy mix (final energy consumption)	Petroleum products: 41.5% Electricity: 26.3% RES: 14.0% Natural gas: 12.8% Heat: 3.8% Industrial waste: 1.0% Hard fuels: 0.6%	2021
Energy dependence on imports for the total primary energy consumption	46.9%	2021
Fossil fuel import share	Natural gas: 99.4% Oil and petroleum products: 99.5% Solid fuels/coal: 15.2%	2021
Reliance on Russian fossil fuels	Total energy: 17.6% Natural gas: 81.0% organized market + 19% bilateral trades Petroleum products: 24.9% Coal: 0.8%	2020
LNG import capacity	0	2021
Share of demand currently covered by LNG imports	0	2021
Planned LNG capacity expansions	0	2021
Gas pipeline capacity (per source country)	AT-SI: 422% of gas demand SI-HR: 208% of gas demand HR-SI: 23% of gas demand IT-SI: 86% of gas demand SI-IT: 78% of gas demand	2021
Share of demand currently covered per pipeline	AT-SI: 86.0% of gas demand SI-HR: 10.3% of gas demand HR-SI: 0.5% of gas demand IT-SI: 0.3% of gas demand SI-IT: 2.9% of gas demand	2021
Gas storage capacity	0	2021
Planned gas storage capacity expansions	0	2021
Biomethane production capacities and/or volumes	0	/
Biogas production capacities and/or volumes	16.7 MW 90.8 GWh	2021
Electricity generation mix	Hydro: 40.9% Thermal: 26.1%	2021

[15] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/energetska_bilanca/ebrs_2021.pdf
[16] https://www.stat.si/StatWeb/Field/Index/5
[17] https://www.plinovodi.si/media/5303/development-plan-2021-2030.pdf
[18] https://www.agen-rs.si/-/porocilo-o-stanju-na-podrocju-energetike-v-sloveniji-v-letu-2021

	Nuclear: 21.9% Combined Heat and Power: 5.7% Solar PV: 3.4% Biomass: 1.2% Biogas: 0.7%	
Electricity interconnection capacity	4.38 GW 114% of domestic power generation capacity	2021
Solar + wind share of electricity generation	3.4%	2021
5-year growth in solar PV + wind share	1.6% in 2016 – 3.4% in 2021 0.36%-point increase/year	Difference between the most recent year and 5 years ago

Another consideration for Slovenia's energy dependence is related to its power grid, which is interconnected with all four of its neighbouring countries. To strengthen the ability for cross-border electricity exchange, several strategic power grid projects are underway and cover new networks, as well as upgrade and expansion work on existing ones. For example, in 2022 a new interconnection was built between Slovenia and Hungary with a power capacity of 1 200 MW in both directions. Furthermore, plans have been set to increase the maximum power interconnection between Slovenia and Croatia from existing 1 500 MW to 2 000 MW. A summary of power grid interconnections is shown in Table 5.

Table 5: Slovenian electricity interconnections information and capacities[19]

Country interconnections	Description	Capacity
Slovenia – Austria	Two 400 kV transmission line systems and one 220 kV transmission line.	SI → AT 950 MW AT → SI 950 MW
Slovenia – Croatia	Three 400 kV transmission line systems, two 220 kV, and three 110 kV transmission lines.	SI → HR 1 500 MW* HR → SI 1 500 MW*
Slovenia – Italy	One 400 kV transmission line system and one 220 kV transmission line.	SI → IT 730 MW IT → SI 680 MW
Slovenia – Hungary	Two 400 kV transmission line systems.	SI → HU 1 200 MW HU → SI 1 200 MW

*Expected to be 2 000 MW in the future (date not known)

[19] https://www.eles.si

3 Identification and selection of reforms and investments for REPowerEU

3.1 Gap analysis

The gap analysis presented in this chapter provides an overview of the results of an assessment of reforms, investments, and institutional capacity building in the sector of RES and energy efficiency and that will be critical for achieving the objectives of REPowerEU.

The following aspects have been reviewed:

- Energy efficiency sector:
  - Promoting energy efficiency
  - Energy demand management – the built environment
- Heating and cooling sector:
  - District heating
  - Heat pumps
- RES sector and accelerating RES deployment:
  - General site selection (permitting and grid connection)
  - Solar PV
  - Wind power
- Security of supply and energy diversification
  - Decarbonization of natural gas supply
  - Reducing fossil fuel consumption in industry
  - Biogas, biomethane and hydrogen, produced with electricity from renewable sources
- Transport sector

The main objective of this analysis is to identify any potential gaps, challenges, and barriers that may hinder the deployment of energy efficiency measures and RES projects, and that can be addressed in the context of the REPowerEU initiative. These gaps and barriers were mostly identified based on the report authors' understanding and knowledge of the condition of the Slovenian energy sector and based on a comparison with and correlation to international best practices, examples of successful investments and reforms in other Member States, review of peer-reviewed and grey literature, as well as feedback received from key stakeholders during interviews.

3.1.1 Saving energy

3.1.1.1 Promoting energy efficiency

General overview

The amendments to the revisions of the "Energy Efficiency Directive[20]" and the "Energy Performance of Buildings Directive[21]" propose to increase the energy efficiency target from 9% to 13% compared to the projections of the reference scenario for 2020. The government of Slovenia has implemented several

[20] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en
[21] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

policies aimed at achieving short-term energy savings and also ensure future-proofing for the 2030 energy efficiency targets in the expected update of the NECP[22]. For example, Eco Fund (Slovenian Environmental Public Fund - Eko sklad) has an ongoing campaign aimed at households that provides subsidies for investing in energy efficiency measures (i.e. loans and subsidies for complete or partial renovation of a residential building, facade insulation, replacement of windows, and the purchase of energy efficient household appliances) and investing in RES (i.e. loans and subsidies for small-scale solar power plants)[23]. Under the regional chambers of commerce for small and medium enterprises (SMEs)[24], there are approximately 60 regional offices focusing on providing SMEs with various energy advisory services in the framework of several EU funded projects[25]. Furthermore, to increase the understanding of the importance of energy efficiency, there are several publicly available web pages partly addressing the topic of energy savings, such as Čas za zemljo[26], Trajnostna Energija[27] and EkoPortal[28] (for the educational sector). Lastly, due to the current volatility of energy prices, several campaigns by different non-governmental stakeholders have been launched to raise awareness on reducing or mitigating the risks of high energy prices (e.g., energy demand management, RES deployment, etc.), such as:

- Electricity suppliers: PETROL[29], ECE[30], Elektro-Energija[31]
- Private Sector: Porabi manj INFO[32]
- NGO: FOCUS - Society for Sustainable Development[33]
- Other (web portals): Varčujem z energijo[34]

Identified measures that are targeting the promotion and the acceleration of the deployment of energy efficiency measures are the following (but not limited to):

- The Recovery and Resilience Plan of Slovenia (RRP)[35] includes several key reforms and investments specifically targeting energy efficiency – with targets and milestones[36], such as for example component "C1 K1 – renewable energy sources and energy efficiency – energy efficiency in the commercial sector" and "C1 K2: Sustainable building refurbishment – Sustainable refurbishment and management of buildings".
- The Slovenian Environmental Public Fund (Eco Fund)[37] provides support to households, businesses, and the public sector. It includes programs aimed at energy-poor households, such as a 100% subsidy for facade insulation, solar power plants, heat pumps, electric vehicles, etc.
- The Ministry of Infrastructure, Energy portal[38]: organized public tenders for co-financing the energy renovation of public buildings owned and used by municipalities.

[22] https://www.gov.si/zbirke/projekti-in-programi/nacionalni-energetski-in-podnebni-nacrt/
[23] https://ekosklad.si/prebivalstvo/informacije/nasvet
[24] https://www.stajerskagz.si/projekti/celovit-pristop-k-energetski-ucinkovitosti-v-malih-in-srednje-velikih-podjetjih-smempower-efficiency/
[25] https://ekosklad.si/prebivalstvo/ensvet/pisarna
[26] https://www.caszazemljo.si/
[27] https://www.trajnostnaenergija.si//
[28] https://eko-portal.si/home
[29] https://www.petrol.si/znanje-in-podpora/1/clanki/11-nasvetov-za-varcevanje-z-elektricno-energijo.html
[30] https://www.ece.si/za-dom/energetske-resitve/varcevanje-z-energijo/
[31] https://www.ece.si/za-dom/energetske-resitve/varcevanje-z-energijo/
[32] https://www.porabimanj.info/nasveti/
[33] https://focus.si/
[34] https://www.varcevanje-energije.si/
[35] https://www.eu-skladi.si/sl/po-2020/nacrt-za-okrevanje-in-krepitev-odpornosti
[36] Načrt za okrevanje in odpornost - Mejniki in cilji
[37] Subvencije in ugodni krediti za okolju prijazne naložbe, Eko sklad
[38] https://www.energetika-portal.si/javne-objave/arhiv-energetika/javni-razpisi/r/javni-razpis-za-sofinanciranje-energetske-prenove-stavb-v-lasti-in-rabi-obcin-v-letih-2021-1266/

- Various actions by NGOs target energy-poor households by supplying low-cost energy-saving appliances.

Gap analysis

The following gaps in promoting energy efficiency measures have been identified:

- Little to no activities (reforms, subsidies, capacity building) have been identified that focus on inefficient heating appliances. For example, whilst existing inspection frameworks for small combustion units aim to identify heating appliances with significant air pollution emissions (mostly NOx), no specific guidelines have been established for those heating appliances with a low-efficiency rating[39]. Whilst significant emissions levels may generally indicate a lower efficiency of the heating appliance, the two aspects can be mutually exclusive.
- Limited activities have been identified (with specific objectives, targets and/or methods for measuring efficacy) that would encourage an energy efficient behaviour of end-users, for example various "soft measures" such as turning off space heating in unused spaces, utilizing glazed surfaces for increasing passive thermal gains during a sunny day in winter, reducing room temperature by 1-2°C, etc. It should be noted that these soft measures addressing behavioural changes were addressed to some extent in the framework of the H2020 program[40], e.g. "How to set up actions to improve comfort and decrease energy use", "With habits, we can significantly decrease energy use". As part of this program, "Temperature training" activities took place (health – energy-related activities). If such activities were to be better promoted (including by various state-owned agencies and/or energy distribution companies), their outreach (e.g. number of people engaged) and success could be improved. For example, schools could implement "Energy Efficiency Heroes" where pupils would be responsible for promoting "soft measures" such as closing curtains after a class to reduce heat loss in winter period.
- The 2021 Annual report on Slovenia's power sector[41] identified potential energy savings in 240 Slovenian companies amounting to more than 5 TWh (around 20% of their energy consumption). No activities have been detected that would assess whether the measures (investments) in energy savings are being performed at a pace that makes economic sense. If it is the case that companies avoid investments into energy efficiency, it should be investigated whether the reason is poor incentives in terms of inadequate energy price signals, lack of knowledge or other. An informed public entity could prepare a guidance note, summarising the possible measures that the companies can take.

3.1.1.2 Energy demand management – the built environment

General overview

The Slovenian "Long Term Renovation Strategy[42]" includes an assessment of the existing building stock to determine the overall energy performance of the buildings analyzed by using Energy Performance

[39] Decree on the inspection, cleaning and measurement of small combustion units
[40] https://www.mobistyle-project.eu/en/mobistyle/Pages/default.aspx
[41] https://www.agen-rs.si/documents/10926/38704/Poro%C4%8Dilo-o-stanju-na-podro%C4%8Dju-energetike-v-Sloveniji-v-letu-2021/17048023-cfc5-4283-8e48-5fa078ad2ae6
[42] https://www.energetika-portal.si/dokumenti/strateski-razvojni-dokumenti/dolgorocna-strategija-za-spodbujanje-nalozb-energetske-prenove-stavb

Certificates (EPCs) and to identify buildings with low energy performance ratings that can be the focal area of future policy making.

The analysis showed that 45.8% of assessed single-apartment and standalone buildings and 7.6% of multi-apartment buildings have poor energy performance ratings, with EPC grades of F (specific annual energy use between 150 and 210 kWh/m^2) and G (specific annual energy use above 210 kWh/m^2). The key conclusion of the analysis is that approximately 100 000 single-apartment and standalone buildings and over 24 000 multi-apartment buildings are at risk of energy poverty and poor energy affordability.

Whilst some measures tackling these issues are supported through the Eco Fund (see Section 3.1.1); for example, the support mechanism for the Optimization of the heating system in multi-dwelling buildings[43], a new addition to the possible measures of tackling energy affordability was developed in accordance with the "Energy Performance of Buildings Directive", which sets objectives for deploying rooftop solar PV systems on buildings:

- By 31st December 2026: rooftop solar PV needs to be installed in all new public and commercial buildings, with a useful floor area greater than 250 m^2,
- By 31st December 2027: rooftop solar PV in all existing public and commercial buildings, with a useful floor area greater than 250 m^2,
- By 31st December 2029: rooftop solar PV in all new residential buildings.

Gap analysis

The following gaps in energy demand management in the built environment have been identified:

- No activities have been identified that would specifically target implementing low-cost energy efficiency measures in the least efficient building stock. There are others – but limited, available resources for addressing such possible measures, which could provide a baseline for adopting reforms and investment propositions to support the upgrade of the low-energy performance building stock. For example, in the EU funded project Enerfund[44] a tool that evaluates and ranks energy renovation and refurbishment opportunities based on a variety of criteria, such as EPCs, the number of active government schemes, the number of certified equipment installers, etc, was developed.
- No specific measures have been identified that would directly target the performance of existing natural gas boilers, e.g. by reducing the set temperatures for boilers to a maximum of 60°C (with higher temperatures only being available for building stock with poor thermal insulation of its envelope), avoiding the installation of oversized boilers by way of appropriately designing the heating systems according to each building's needs, installing load or weather compensation or hydronic balancing to dynamically adapt the supply temperature of hot water to heating bodies based on actual conditions.
- Some targeted measures exist for air conditioning and ventilation systems in non-residential buildings; for example, Eco Fund provides subsidies for investing in heat recovery ventilation systems with recuperation, ventilation systems are supported in the context of energy renovations of non-residential buildings[45], and bespoke training for HVAC auditors[46]. However,

[43] https://www.ekosklad.si/prebivalstvo/pridobite-spodbudo/seznam-spodbud/optimizacija-sistema-ogrevanja-v-vecstanovanjski-stavbi/optimizacija-sistema-ogrevanja-v-vecstanovanjski-stavbi-subvencija
[44] https://enerfund.eu/
[45] PURES – Rules on efficient use of energy in buildings with a technical guideline.
[46] https://web.fs.uni-lj.si/LOSK/pregledi-ks/

based on market analysis, the uptake of such measures and investments can be considered as slow.

- According to some stakeholders, there is too little energy contracting being performed (public-private partnerships for investments into insulation and energy refurbishments of buildings owned by public entities (who are lacking the upfront capital needed for the investment).
- No activities have been identified that would provide special incentives for investments into increased energy efficiency of households (insulation & windows) specifically in preparation for winter 2023/24. The activities could be in the form of information dissemination or extra financial/crediting support.
- There is an absence of a market-based demand interruptibility mechanism (e.g. in the form of an auction) what would be used in times of energy shortages. For natural gas, the priority list for emergency shut offs is imposed by Article 13 of the Legal Act on the emergency plan for natural gas supply[47]. We understand that is would be more economically efficient to implement (or complement the measure with) a market-based demand interruptibility mechanism for industry consumption, as companies are expected to better understand their specific value of lost load.
- Some of the recently adopted political measures do not incentivise energy consumers to consume less energy. The decree limiting retail electrical energy prices for all household consumers appears to not be in line with Article 5 of the Directive (EU) 2019/944 (paragraphs 3 and 6). The measure should be amended to apply only to energy poor households or to cover only part of the user's consumption (according to Article 13 of the Regulation (EU) 2022/1854), where part of the consumption would be exposed to market prices to incentivise energy saving and behavioural changes.
- Some programs and projects targeted specifically at energy-vulnerable consumers already do exist[48]. Nevertheless, considering that a regulation on the determination of energy-poor households was finally passed[49] in October 2022, the potential exists to identify more accurately the households that face the greatest hardships due to energy prices, and subsequently design more targeted support measures in this context. Indeed, in order to not jeopardise the efficient functioning of energy markets and the energy transition processes, short-term aid should be limited to the vulnerable and the poor population. In line with this and with the newly passed regulation, targeted policies alleviating energy poverty both in the short and the long term could be increased in scale, subject to the assessment performed on the basis of the new regulation. In the short term, existing measures such as energy vouchers help improve the quality of life during the economic hardship expected with the energy crisis. It would be more productive to substitute some general but economically inefficient measures (such as price caps) with direct support to the consumers that need it the most (the short-term measures include lump-sum transfers and deferred payments). At the same time, some incentive for energy-poor consumers to invest (with state support) into long-term solutions should be maintained. In the long term, investment and dissemination measures towards energy efficiency should be determined and implemented.

  Beside the national level, energy poverty should also be assessed on a local level, in order to enable even better targeted measures.

[47] Uradni list (Official Journal) 136/22.
[48] https://www.energetika-portal.si/podrocja/energetika/energetska-revscina/preucitev-in-strokovne-podlage-za-razvoj-ukrepov-za-boj-proti-energetski-revscini/
[49] https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina/2022-01-3199/uredba-o-merilih-za-opredelitev-in-ocenjevanje-stevila-energetsko-revnih-gospodinjstev

3.1.2 Accelerating renewable energy deployment

3.1.2.1 Overview of the key regulatory environment

The following key reforms and policies frame the deployment and acceleration of RES in Slovenia:

- **Act on the Promotion of the Use of Renewable Energy Sources (2022)**[50] - this law governs the implementation of state-level and municipal-level policies for RES deployment, and sets a binding target for the share of energy from RES in gross final consumption in the Republic of Slovenia, provides information on financing methods and frameworks, regulates the certificates of origin, and other key aspects for promoting RES in Slovenia – covering the generation of electricity, heat, cooling as well as renewable fuels for the transport sector.
- **Electricity Supply Act (2022)**[51] - was enforced to streamline the Energy Law and represents one of the six laws that are required to regulate areas covered by the Energy Law. The Electricity Supply Act provides a policy environment for regulating relationships between electricity suppliers and end customers and provides guidelines for setting up and operating energy communities. The key change from the Energy Law is that end-users can now be considered "pro-sumers", which means they can actively participate in the strategic electricity demand and generation dynamics that will assist with the stability of the power grid. End-users can now enter into contractual arrangements with multiple suppliers and choose a dynamic pricing tariff that is tied to the ongoing fluctuations in wholesale costs.
- **Action Plan setting out a governance model for renewable energy producers (2022)**[52] - the purpose of the Action Plan is to accelerate the deployment of RES in the power generation sector and is aimed to be one of the key policy instruments to support the contribution of Slovenia to EU's renewable energy targets. The Action Plan supports the deployment and acceleration of additional RES by way of streamlining current regulatory and administrative barriers – covering local, regional, and national spatial planning and establishing a single point of contact to provide institutional support to end-users for the deployment of RES. Furthermore, it also incorporates biodiversity considerations in the strategic RES mapping in Slovenia.
- **Act on the deployment of installations for the production of electricity from the RES (2023)** - The Ministry of Infrastructure published a draft Act on the deployment of installations for the production of electricity from the RES[53] for public consultation in September 2022, which was adopted by the government in February 2023[54] and is currently awaiting the adoption by Parliament. The main purpose of the Act is to streamline the deployment of RES projects, through the establishment of areas of priority deployment of RES projects (including characterization of any RES project siting specifics in these areas), peculiarities of spatial planning, comprehensive assessment of planning applications and the assessment of environmental impacts, installation of innovative RES technologies in areas with a large untapped potential (i.e., solar PV on noise barriers of highways, floating solar PV, agro-voltaic, etc.).

[50] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8236
[51] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8141
[52] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/dcn_ove/dcn_ove_sep2022.pdf
[53] https://www.gov.si/novice/2022-09-20-manj-administrativnih-ovir-pri-umescanju-naprav-za-proizvodnjo-elektricne-energije-iz-obnovljivih-virov-energije-in-vec-alternativnih-goriv-v-prometu/
[54] https://www.gov.si/novice/2023-02-23-vlada-dolocila-predlog-besedila-zakona-o-uvajanju-naprav-za-proizvodnjo-elektricne-energije-iz-obnovljivih-virov-energije/

- Map of locations where connecting large-scale solar PV installations to the network is possible - The Slovenian TSO and DSOs have assessed the potential locations where large solar PV installations can be readily connected to the grid and published separate reports on the PV connection potential of the transmission[55] and the distribution[56] network. For the transmission network, the TSO drafted a list of areas (energy infrastructure, degraded land, and other areas) where connecting large solar PV (above 10 MW) plants is feasible. Any technical (e.g., expanding the substation) and environmental (e.g., water protection area) issues related to a location, and the locations are ranked. For the distribution network, a similar list was drafted by the DSOs, where the potential for solar PV plants of up to 5 MW (max limit per transformer) is assessed. The list is complemented by an online interactive map of the possible connection points[57].

Optimization of permitting processes for RES

One of the key administrative barriers is linked to the current status of the permitting process for RES. Due to the complexity of the permitting procedures, the lack of clear responsibilities and overlapping roles among the various authorities included in the permitting process often cause delays in obtaining permits for RES. Therefore, appropriate organisational structuring and clear responsibilities need to be implemented on a governmental level; particularly in relation to ensuring that the issuance of various local permits is in line with all national methodologies and best practices, and that sufficient institutional capacity is ensured (i.e., that the person responsible for issuing construction permits for ground-mounted solar PV projects is well versed with the technology as well as the best practices for the development and construction of such projects).

To further optimize the permitting process, practices from the other Member States could be adopted, for example:

- Austria enables parallel execution of the permitting process. For example, the permitting process for developing the site (i.e., construction permits) and grid connection applications can be carried out in parallel, which generally speeds up the permitting process[58].
- Under certain EU laws, the absence of a (negative) outcome of permitting process from a relevant authority could be considered as the authority issuing a valid permit[59]. Although limitations apply, such a process would mitigate the risks of certain authorities delaying the outcome of permitting processes without any justification.
- The permitting process for the adoption of hydrogen for power generation or for end-use should consider the overall technical characteristics of each hydrogen application[60]. For example, bankable hydrogen technologies in areas with negligible environmental and social impacts should have a more streamlined permitting process than market-proven hydrogen technologies where the operational characteristics are not yet known or proven.

[55] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/sodo/pr_2_pregled_moznosti_prikljucitve_vecjih_se_na_do.pdf
[56] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/sodo/pr_3_julij_moznosti_prikljucitve_vecjih_se_na_po.pdf
[57] https://geo-portal.si/gisapp/sodokart?public=on&lang=sl
[58] Lex - 52022SC0149 - EN - EUR-Lex (europa.eu)
[59] EUR-Lex - 52022SC0149 - EN - EUR-Lex (europa.eu)
[60] European Clean Hydrogen Alliance, 'Paving the way for permitting of hydrogen projects in the European Union: Barriers and recommendations', no. June, pp. 1–17, 2022.

Digitalization of procedures

Some examples of the digitalization of the various procedures related to RES deployment are summarized below.

- As of August 2022, three of the five distribution companies (Elektro Ljubljana, Elektro Celje, and Elektro Gorenjska) accept grid connection applications electronically (submitted via e-mail).
- Eco Fund supports electronic submissions (e-mail) of documentation needed for processing subsidies for investing in RES and energy efficiency measures.
- The Energy Agency of Slovenia allows for the electronic submission of applications for competitively allocated feed-in-premium support for RES. However, project documentation must still be submitted in physical form.

Whilst the above examples of digitalization allows to speed-up processes related to RES project deployment, further efforts could greatly reduce the general administrative burdens and free up administrative resources; the lack of which is also considered to be problematic in Slovenia[61].

3.1.2.2 Deployment of solar PV systems

The total installed capacity of rooftop solar PV has been gradually increasing over the past 10 years, mostly due to general market acceptance of this technology and the reduction in investment costs for installing solar PV systems. Nevertheless, the key issues that the investors and developers are facing are typically related to grid connection permits[62], and the key barriers for solar PV deployment mainly relate to ground-mounted configuration, grid connection application and site-specific permitting.

Promoting private investments in RES projects

The general lack of investment in RES projects by the commercial and industrial sectors is one of the main causes of the slowing down in the rate of new RES installations in Slovenia. Business investments generally face a slow decline, which can partly be explained by the relatively restrictive business environment, the large presence of publicly owned entities in the economy, and an underdeveloped venture capital market[63].

In addition, a stark difference in the gross domestic product (GDP) per capita is noted between Eastern and Western Slovenia (73% vs 106% of the EU average)[64]. However, Eastern Slovenia has a higher solar irradiance than Western Slovenia (not considering the Littoral region). Considering this, efforts could be made towards stimulating investments in solar PV systems in that part of the country. Official national or regional planning of solar PV systems could concentrate on eastern Slovenia to encourage private investment in solar PV projects, which would generate a higher return on investment and stimulate the local economy.

Gap analysis

Barriers concerning site selection

Until mid-2022, Slovenia did not have a consolidated mapping of areas that are suitable for deploying ground-mounted solar PV systems and that are not considered protected areas from an environmental

[61] https://op.europa.eu/en/publication-detail/-/publication/0e9db9fa-d653-11ec-a95f-01aa75ed71a1/language-en
[62] European Commission, '2022 Country Report - Slovenia Accompanying', pp. 9–25, 2019.
[63] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0273&from=EN
[64] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022SC0273&from=EN

and social viewpoint; for example, areas included in the Natura 2000 program cover 37% of the entire country. A potential solution to tackle this barrier is encouraging state and local authorities to pre-identify suitable sites for the construction of ground-mounted solar PV projects, also known as go-to areas. Such go-to areas could also potentially unlock options for deploying smart energy infrastructure, including the installation of hydrogen electrolysers, which generate renewable hydrogen from RES generation in times of high production relative to demand. In mid-2022, both the TSO and DSO published a list of potential grid connection points where installing RES generation (solar PV) is feasible. In addition, a proposed act on siting of installations for the production of RES electricity, in public discussion as of late 2022, provides a baseline for further activities in the direction of identifying go-to areas for RES power plants.

Furthermore, due to the relatively high percentage of protected areas (environmental and social considerations), further efforts could be dedicated to enhancing the awareness of the various stakeholders (investors, developers, and local authorities) about best practices for RES project deployment and mitigation measures to address issues related to site selection –carrying out detailed site studies (such as geotechnical and hydrological studies),carrying out environmental impact assessments (EIAs)[65], carrying out Key Informant Interviews[66] with communities affected by the projects, etc.

Barriers related to grid connection

Whilst RES deployment is accelerating, grid upgrades that are required to enable new RES capacity have not been carried out to the extent required. This is mainly the case with small-scale rooftop solar PV deployment in the residential sector, as the low-voltage network can often be inadequate to absorb the variable electricity generation from solar PV – particularly in rural areas. Therefore, investments in necessary grid upgrades (electric power grid modernization to promote decarbonization efforts, reduce grid congestion, enhance regional interconnections and local distribution), in other grid infrastructure (new materials such as high-temperature superconductors to reduce transmission and distribution losses, electricity storage, demand-side management, advanced metering infrastructure, etc.) and in the development of smart-grid solutions will be key to enabling further integration of solar PV in the local power grids. For example, ELES – the Slovenian transmission system operator - is planning to implement several key projects[67] that will assist with modernization efforts of the power transmission system, such as upgrade of several transmission lines, as well as support projects of common interest, such as the GreenSwitch which will optimize use of the existing power infrastructure and allow the integration of new technologies and advanced functionalities in the transmission and distribution networks in Austria, Croatia and Slovenia.

Until such works are carried out, the establishment of energy communities could be a viable alternative for residents that live in areas where the grid is not sufficiently reinforced to allow the installation of rooftop solar PV on their own houses (or live in multi-apartment buildings), and they would have the ability to invest in – and profit from, RES projects that could be developed in other areas in Slovenia. One such example is the H2020 Compile project[68] in Luče, which represents a case of a rural low voltage network with a weak and unstable connection to the medium voltage grid. Luče also has a relatively weak local power grid which often encounters power failures and limits the integration of RES, as the voltage

[65] D. Jur, S. Rajković, and J. T.- Kelpšaitė, 'Technical support for RES policy development and implementation – Simplification of permission and administrative procedures for RES installations (RES Simplify)', no. March, 2021.
[66] https://id4d.worldbank.org/sites/id4d/files/WB-ID4D-Understanding-Peoples-Perspective-on-Identification-A-Qualitative-Research-Toolkit.pdf
[67] https://www.eles.si/projekti
[68] https://www.compile-project.eu/sites/pilot-site-luce/

during the day rises above the limits. Outages are most common during times of extreme weather events like storms and thunderstorms. There are several tangible energy community projects already established in other European countries which could serve as further paragon examples for the adoption of such business models in Slovenia, especially in the case of joint development with the transmission and distribution system operators. For example, Energy Garden has launched a new community share offer, where residents can invest in up to 1 MWp of community-owned renewable energy to the UK's Railways, earn a 5.5% return on investment and support the development of green spaces and youth training programmes in London[69]. Furthermore, penalties for unnecessarily prolonging grid connection application decisions for system operators (distributors) could also be introduced[70].

3.1.2.3 Deployment of wind power

General overview

In Slovenia, wind power generation represents a negligible fraction of the energy generation mix, with a single wind power plant being operational (2.3 MW near Dolenja vas). In general, Slovenia does not have significant areas with suitable wind conditions. For example, the Primorska region has frequent high wind events that are unsuitable for the safe and reliable operation of wind turbines (above 5 m/s). Nevertheless, even the generally low potential for wind power deployment could be exploited where technical conditions are favourable and other RES may not be viable to deploy (i.e., the steepness of the terrain in that region is not suitable for the installation of solar PV plants). For example, Dravske elektrarne Maribor (DEM) is constructing a 10.5 MW wind power plant in the Košenjak mountainous area above Dravograd, near the Austrian border[71], a remote area with favourable wind conditions and low environmental and social risks. Furthermore, Holding Slovenskih Elektrarn (HSE) is also considering the installation of two wind power projects: a 13.5 MW project in Paški Kozjak[72] and a 21.6 MW project in Rogatec[73].

Due to the low levelized cost of electricity (LCOE) of wind power compared to other RES[74], there were several successful applications for the installation of wind power plants over the past few years, which would be supported through feed-in premium mechanisms. However, whilst the selected sites may have had favourable wind conditions, none of the projects that were approved reached construction phase – mainly because the program was focused on selecting projects based on the lowest LCOE and did not include the requirement that construction and connection permits should be secured; hence the majority of these projects failed to obtain permits. This is the key reason why subsequent government tenders for large-scale RES support require that all RES projects proposed for feed-in premiums have already secured a construction permit.

Therefore, wind power is generally considered as a viable power generation source in Slovenia, however, bespoke country-wide zoning and geospatial planning is required in order to identify areas with favourable technical, environmental and social conditions, which could be developed into tangible wind power projects. Furthermore, other types of bankable transaction structuring could be adopted for wind power

[69] https://communityenergyengland.org/pages/share-offers
[70] https://op.europa.eu/en/publication-detail/-/publication/0e9db9fa-d653-11ec-a95f-01aa75ed71a1/language-en
[71] https://veter.dem.si/projekti/ojstrica
[72] https://www.gov.si/assets/ministrstva/MOP/Dokumenti/DPN/Javne-razgrnitve/PVE-Paski-Kozjak/PVE_Paski_kozjak_povzetek_za_javnost.pdf
[73] https://www.gov.si/assets/ministrstva/MOP/Dokumenti/DPN/Javne-razgrnitve/PVE-Rogatec/PVE_Rogatec_povzetek_za_javnost.pdf
[74] https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf

projects, such as public-private partnerships (PPPs) and / or independent power producers (IPPs), including in connection to the potential for establishing energy communities, where the local communities could co-invest in these projects; this may also help limit any potential opposition to develop such projects from local communities.

Gap analysis

A mix of administrative and permitting barriers are the main responsible for the difficulties in the deployment of wind power projects, together with difficulties with site selection and grid connection permits, and the opposition of the local communities where wind power projects were proposed to be deployed[75]. Therefore, a suitable first step towards promoting wind power project deployment in Slovenia, would be the establishment of a country-wide site suitability map, which would explore factors such as wind regime, proximity to grid infrastructure, exclusion zones (e.g. residential areas, protected areas), etc.

3.1.3 Diversification of energy sources

3.1.3.1 Decarbonization of the natural gas supply

General overview

One of the key objectives of National Energy and Climate Plan (NECP)[76] is to establish suitable technical, regulatory, and economic conditions that would facilitate and accelerate the decarbonization of the gas supply in Slovenia. There are plans to implement a bespoke regulatory environment for the use of alternative gas in the natural gas network, including the development of a market for alternative renewable gases in line with EU legislation.

An overview of solutions for the decarbonization of the natural gas supply with alternative renewable gases is provided below:

- Hydrogen – generated through electrolysis of water using excess renewable electricity (sector coupling),
- Synthetic methane – generated by CO_2 or CO hydrogen methanation in catalytic or biological methanation reactors, in which hydrogen, CO, and CO_2 are obtained utilizing the gasification of organic materials, using the hydrogen mentioned in the bullet-point above and CO_2 recovered from waste CO_2 streams,
- Biomethane - methane obtained from the gasification of woody biomass or from biogas produced by the decomposition of organic substances such as slurry, crop residues, plant material, municipal effluent in sewage treatment plants, etc., under anaerobic conditions in fermenters (digesters). Because of its composition, biogas is not suitable for injection into the natural gas network and needs to be upgraded into biomethane.

Gap analysis

To accelerate the decarbonization of natural gas supply in Slovenia, a suitable enabling environment will need to be established. There are currently no economic incentives for promoting the use of

[75] European Commission, Technical support for RES policy development and implementation: delivering on an increased ambition through energy system integration. 2021.
[76] https://ec.europa.eu/energy/sites/ener/files/documents/si_final_necp_main_en.pdf

renewable gases, however, the current energy crisis sparked an interest in adopting such technologies to reduce the reliance on natural gas imports – particularly in the industrial sector, where natural gas represents one of the key energy sources for production processes.

3.1.3.2 Biogas, biomethane and renewable hydrogen

General overview

There are currently several project initiatives underway in Slovenia for producing biomethane, synthetic methane, and renewable hydrogen. According to the stakeholder consultations carried out under the REPowerEU initiative, the majority of projects (which will be pilot scale) are currently between the feasibility and the conceptual design stage.

Some key initiatives and projects are summarized below:

- H2GreenTECH is an Interreg Slovenian-Austrian project (Styrian Chamber of Commerce), which is aimed to strengthen regional cooperation and research and innovation in the field of hydrogen technologies, R&D centres, and higher education. The consortium is comprised of 3 Slovenian and 4 Austrian partners.
- A letter of intent was signed among the government of Slovenia, the government of Croatia, and Italy's autonomous region of Friuli Venezia Giulia for the establishment of a North Adriatic Hydrogen Valley. This project aims to promote the generation, storage, distribution, and use of hydrogen in the energy, industry, and transport sectors. This will be achieved by establishing innovative cross-border projects to accelerate the deployment of hydrogen technologies.
- RESHUB project (Defence RESilience HUB Network in Europe) will establish a network of self-sufficient energy hubs (piloted by the Slovenian Ministry of Defence (Si MoD)), with the strategic objectives of developing a successful proof of concept for the roll-out of such hubs across the EU. This opens up the possibility of connecting the defence and security sectors within the EU in the form of a "hydrogen motorway" comprised of energy-autonomous logistic hubs.

Gap analysis

Whilst the interest in adopting these energy sources can be considered high (particularly in light of the current energy crisis), the key barriers reported by the stakeholders that we interviewed for the purpose of REPowerEU, range from poor bankability (for example due to high capital expenditure on equipment), lack of clear guidelines from the government regarding permitting conditions and/or potential financial support through subsidies or other forms of incentives (e.g., supporting contracts for difference) to high or unknown operational risks due to the infancy of technologies. Such projects are currently predominantly developed under various strategic European projects (Interreg project, North Adriatic Hydrogen valley and the initiative of Friuli, Slovenia, and Croatia, RESHUB project, etc.).

3.1.4 Reducing fossil fuel consumption in industry

General overview

To strengthen security of supply and achieve a sustainable energy mix over the long term, targeted measures will need to be developed for the industry sector in Slovenia. It currently generates 24% of Slovenia's GDP and represents a share of 26% of the final energy use (2017 data). Electricity and natural gas jointly represented a 77% share of the total energy mix in the industry sector (2017 data); with

electricity representing a 43% share and natural gas a 34% share. The remaining 23% were comprised of 9% of RES (woody biomass, biogas, solar PV, etc.), 7% of petroleum products, 4% of DHS, and 3% of solid fuels[77].

The NECP sets a target of a 43% reduction in GHG emissions by 2030 in the industrial sectors that are excluded by the emission trading system (ETS); for the industrial sectors that are included in the ETS, "emission coupons" either need to be purchased or obtained from the government to allow such businesses to offset their carbon footprint, therefore bespoke targets are not as relevant as for the industrial sectors that are currently excluded from the ETS. Furthermore, a 30% share of RES in the industry sector is envisioned by 2030 with a particular focus on promoting CHP from woody biomass (a 52% share of fuel consumption by 2030 and a 53% share by 2040). Natural gas is projected to account for a 47% share of total fuel consumption by 2030 and a 40% share of total fuel consumption by 2040. Provisions are also made for increasing the share of hydrogen to 7% of total fuel use by 2040 (equivalent to 12 ktoe).

The Slovenian Industrial Strategy from 2021 to 2030[78] sets the strategic vision and goals for the development of industry and the economy for the period from 2021 to 2030, with key focus areas being the transformation of the industry into a green, creative, digital, and socially inclusive sector. The responsibility for the implementation of the strategy lies with the Ministry of Economic Development and Technology. Some of the key measures proposed include:

- issuance of public tenders that will promote growth, technological development, and innovation,
- issuance of financial incentives from the Slovenian Enterprise Fund, SID Bank, and the Slovenian Regional Development Fund,
- adoption of legislation regulating various areas of ongoing business operations to promote the green transition.

Gap analysis

Considering the key role of the Slovenian industrial sector in energy use, long-term targets will need to be set and realised to achieve the objectives of green transformation. The industry is envisioned to play a key role in the adoption of advanced technologies (carbon capture and utilization, carbon capture and storage, waste heat recovery, etc.) and innovative business models (flexibility management, demand side response, block-chain, etc.); particularly during the initial adoption phases via dedicated pilot projects that can be supported both from a regulatory and a financial viewpoint by the government. Some of these areas are already addressed in the Recovery and Resilience Plan (RRP), such as:

- Strengthening of energy management (governance),
- Increasing the potential of energy efficiency in industry, especially in investments and in the construction sector,
- Increasing awareness of energy efficiency also by extending the monitoring of indicators and goals for achieving energy efficiency to companies, especially SMEs,
- Pilot implementation of a technological solution or tool for the ETS register for companies included in the ETS system.

[77] Integrated national energy and climate plan of the Republic of Slovenia (2020) https://energy.ec.europa.eu/system/files/2020-06/si_final_necp_main_en_0.pdf
[78] https://www.gov.si/en/news/2022-05-03-slovenian-industrial-strategy-2021-2030/

Nevertheless, the key barrier to achieving NECP (and other key) targets in the industry, will be to provide sufficient incentives (permitting support, financial incentives and subsidies, tax benefits, etc.) in the short term to promote the deployment of pilot projects to demonstrate the bankability of projects, as well as ensure that mandatory energy efficiency, RES and GHG emissions targets are achieved. Only tangible projects will help increase the market appetite for innovative technologies over the long term.

3.1.5 Heating and cooling sector

3.1.5.1 District heating

General overview

District heating remains an important pillar of the heat supply in Slovenia, particularly in densely populated urban areas. According to 2021 data, heat is supplied in 112 distribution systems from 54 heat suppliers in 69 Slovenian municipalities, including in the capital Ljubljana. District heating systems provided heat to a total of 109 972 customers, 99 803 of whom were residential customers[79].

In 2017, the heat generated in District Heating Systems (DHS) was equivalent to 213 kilotons of oil equivalent (ktoe)[80] and fossil fuels were the primary energy source for district heat production, with approximately 56% of heat being generated from coal, 26.5% from natural gas, and 16.5% from RES. Furthermore, the primary source of heat generation in Slovenia was combined heat and power (CHP) plants, representing a total of 86.8% of all heat generated[81]. The National Energy and Climate Plan (NECP) predicts that the heat demand that is to be supplied by existing DHS will decrease to 178 ktoe by 2030 and 168 ktoe by 2040.

The currently estimated fuel mix in DHS comprises:

- Coal CHP: approximately 40 ktoe,
- Biomass CHP: approximately 70 ktoe,
- Natural gas CHP: approximately 80 ktoe,
- Biomass boilers: approximately 15 ktoe,
- Heat pumps: approximately 5 ktoe.

In terms of future developments of the DHS in Slovenia, several opportunities were identified in the report "*Summary of the analysis of scenarios for deciding on the Long-Term Climate Strategy of Slovenia until 2050"*[82], which was prepared within the project LIFE Climate Path 2050[83]; specifically LIFE ClimatePath2050 "Slovenian Path Towards the Mid-Century Climate Target", LIFE16 GIC / SI / 000043. The report includes recommendations for the upgrade of existing DHS through densification and expansions, as well as recommendations for developing new DHS. According to the study, the Public (an estimated 23.1% of total heat demand in 2030) and the Services sector (an estimated 44.1% of total heat demand in 2030) in densely populated areas have a substantial untapped potential for the deployment of new DHS.

[79] https://www.agen-rs.si/web/emonitor/delovanje/daljinska-toplota
[80] http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/energetska_bilanca/ebrs_2017.pdf
[81] https://keepwarmeurope.eu/countries-in-focus/slovenia/english/
[82] Povzetek analize scenarijev za odločanje o Dolgoročni podnebni strategiji Slovenije do leta 2050; September 2050 (energetika-portal.si)
[83] Life Climate Path 2050. https://podnebnapot2050.si/?lang=en

For the Services sector, the potential for expansion of coverage by DHS is estimated at 127% - from the existing 4 775 000 m^2 to 10 858 000 m^2 of DHS area serviced. In the Residential sector, the potential for expansion of coverage by DHS is estimated at 60% - from 8 378 000 m^2 to 13 393 000 m^2, with the greatest technical potential for DHS system expansion in multi-apartment buildings. The proportion of heat supplied to buildings via DHS would increase from 15% in 2017 to 18% by 2030 and 24% by 2050. Another key aspect is the diversification of energy sources for heat generation. It is envisioned that by 2030, the use of coal for heat generation will be significantly reduced with the gradual closing of the Velenje coal mine and shutdown of thermal power plant Šoštanj, switching to natural gas in the largest DHS, and an increase in decentralized RES supplying heat to DHS. After 2040, the proportion of carbon-neutral gaseous fuels is expected to increase.

Diversification of energy sources for DHS will also depend on the utilization of alternative energy sources. The evaluation of regional RES and waste/excess-heat potential is most commonly defined through the "*Local energy concepts"*[84], which is required by law and is one of the key tools for planning local energy policy strategies (for example, Ljubljana adopted one in May 2022[85]). The local energy concept is a local community management program in the field of energy supply and use, which includes measures for the efficient use of energy and the method of supplying energy from renewable sources, cogeneration, excess heat and other sources. The Local energy concept is based on "Rules on the methodology and mandatory content of the local energy concept"[86] but the content, its overall quality, and potential for implementation vary. With regards to regional DHS planning, the current status of activities can be considered poor on a regional level, though there are some initiatives for regional Sustainable Energy Action Plans ("SEAPs").

Strategic DHS works (new DHS, expansion of existing DHS, upgrade works) are primarily supported via public tenders co-financed by the European Union from the Cohesion Fund and implemented under the Operational Program for the Implementation of European Cohesion Policy in the period 2014-2020 (priority axis Sustainable use and production of energy and smart grids, investment Promoting energy production and distribution which originates from renewable sources)[87]. The main purpose of these public tenders is the allocation of grants for co-financing DHS works related to the transition towards RES (woody biomass and solar thermal energy) in Slovenia. There are also government-level grants available for investments in both new DHS RES and the expansion of existing DHS RES; currently, the total allocated capital for supporting these investments in 2021, 2022, and 2023 is €16 million. Furthermore, RRP's component "*C1 K1: Renewable Energy Sources and Energy Efficiency - Energy efficient restructuring of district heating systems with the use of renewable sources*" includes a €11 million grant to be funded via RRP and a national contribution of €30 million for the upgrade of DHS with distributed RES (expressed in MW of additional thermal power). The investment shall be implemented through a competitive tender procedure launched in 2022 and shall exclude the use of biomass in breach of the requirements of Directive (EU) 2018/2001.

Whilst some tenders have been published for the establishment of DHS with RES as an energy source (mainly biomass and solar thermal systems), such DHS is currently considered underdeveloped considering the overall potential in Slovenia. For example, there are several municipalities with large wooded areas

[84] https://www.energetika-portal.si/podrocja/energetika/lokalni-energetski-koncept/
[85] https://www.ljubljana.si/assets/Uploads/11.-tocka-LEK-MOL.pdf
[86] http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12426
[87] https://www.eu-skladi.si/en/cohesion-by-2020-1

(Kočevje, Ribnica, Črnomelj, Kranjska Gora, etc.) that could utilize locally produced woody biomass for generating heat to be supplied via smaller-scale DHS and several upgrade works for transitioning existing DHS from natural gas to biomass are underway (see below). On the other hand, the solar thermal sector is not (yet) high on the agenda among sectors to be developed or supported in Slovenia. Despite one solar DHS project being completed a few years ago, no further developments have been made for deploying solar thermal DHS; which is further corroborated by reviewing recent tenders from the Slovenian Infrastructure Ministry for co-financing of RES fueled DHS, as only woody biomass DHS and solar thermal DHS[88] were proposed. Furthermore, whilst not considered RES, the use of excess or waste heat from industrial or service processes in Slovenia is in a nascent phase but the volume of waste heat utilization is gradually increasing and is foreseen to become one of the key heat sources in the future. As such, there is potential to feed heat generated from waste industrial heat to DHS; for example, excess heat (in the form of steam condensate from the production processes of the pharmaceutical company Lek) is fed into DHS, which is operated by "Energetika Ljubljana". The amount of excess heat utilized is estimated to be sufficient to cover the demand for space heating and hot water for approximately 300 homes[89].

Regarding the above considerations for RES DHS and the broad potential for expansion and upgrade works in existing DHS, the following pilot projects are aimed to strengthen the role of DHS in the overall heat supply mix and Slovenia's decarbonization efforts. Examples of such pilot projects include:

- DHS Ptuj: modernization and transition from natural gas to woody biomass,
- DHS Slovenj Gradec: transition from natural gas to biomass, installation of a new biomass boiler and ancillary equipment,
- DH Velenje: heat supply network upgradation works (renovation, optimization, and digitization),
- Transformation of residential districts into energy-efficient clusters, where heat (space heating and hot water) can be supplied via DHS,
- Holistic energy-climate information system, which will assist in the optimization of DHS operations.

Gap analysis

There are several strategic gaps in the current enabling environment for the adoption of DHS that constitute barriers to meeting the goals set in NECP and other strategic documents.

One of the main gaps lies with the unlocking of the potential of smaller-scale DHS (including cooling) that can be deployed even in rural areas, such as villages. It is considered that the main barriers to the adoption of such DHS are the low awareness of positive impacts of centralized small-scale DHS (especially higher heating efficiency and reduced air pollution), unclear policies for DHS above 1 MW in thermal capacity, the transition towards the installation of heat pumps and biomass boilers, and a historically low price of heating oil and natural gas[90]; with the latter aspect being the key potential driver over long-term for the adoption of smaller-scale DHS.

Another barrier is due to the complexity of DHS as any strategic changes (for example, heat generation source) in the heat network may have an adverse impact on the overall efficiency of DHS operations. For example, in the municipality of Velenje, the supply temperature of hot water is above 100 degrees

[88] https://solarthermalworld.org/news/slovenia-falling-sales-despite-funding-increase/
[89] https://www.energetika.net/eu/novice/envision/slovenia-energetika-ljubljana-uses-excess-heat-from-lek-for
[90] https://www.coolheating.eu/en/slovenia.html

Centigrade and a single, centralized heat generation source supplies heat to the network. By contrast, newer generations of DHS have a supply temperature of around 70 degrees Centigrade and are typically comprised of several decentralized heat generation sources, including RES. In older generation DHS, reduction of the supply and return temperature regime is subject to extensive upgrade and renovation works that need to be carried out in the entire heat network – from the generation source (utilization of waste heat from the thermal power plant Šoštanj), pipelines, centralized substations, heat exchangers and internal heating systems of end-users (especially in older multi-apartment buildings where higher supply temperatures are needed to achieve adequate thermal comfort).

Another key barrier to rapid deployment of necessary upgrade and expansion works, as well as the deployment of new DHS, can be attributed to the fact that municipalities and DHS operators have to carry out feasibility and design studies – either using internal knowledge or hiring external advisory and engineering firms; thus relying on their internal budgets. As such studies can be costly and have to be pre-approved from a financial viewpoint, securing the necessary funds can often be a lengthy process. Once the studies are carried out and conceptual designs developed, DHS works are typically carried out with investment support via dedicated tenders[91].

3.1.5.2 Heat pumps

General overview

One of REPowerEU's objectives over the next 5 years is to support the doubling of deployment of heat pumps, totalling 10 million units installed. Such a high deployment rate will most likely be supported through different financial incentives (such as subsidies) to reduce capital costs of equipment or operating expenditures for end-users.

In the context of Slovenia, heat pumps are mostly replacing older heat generation systems in semi-urban/rural areas where DHS has not been adopted and predominantly in individual houses. In areas served by DHS (predominantly urban areas), end-users are often discouraged by DHS operators from decoupling from DHS to prevent large imbalances of demand and supply dynamics and to maintain affordable levels of heat supply. For example, the *"Decree on Priority Use of Energy for Heating in the Area of the City of Ljubljana"*[92] includes provisions for allowing heat pump installation (geothermal / brine) in areas that are not covered by the existing DHS, provided that the installation and operation of heat pumps comply with the regulations and policies governing water use and water protection areas in Ljubljana. Heat pump installations currently do not require any permits from electricity distribution companies, albeit it is generally considered that with a high deployment rate, some limits may apply depending on the condition of the grid infrastructure in the area. Presently, some heat pumps require a three-phase electrical connection to achieve reliable operation and prevent disruptions in the local power grid.

In terms of future deployment of heat pumps in Slovenia, several opportunities were identified in the report "*Summary of the analysis of scenarios for deciding on the Long-Term Climate Strategy of Slovenia*

[91] https://www.gov.si/novice/2021-03-05-objavljen-javni-razpis-za-sofinanciranje-daljinskega-ogrevanja-na-obnovljive-vire-energije/
[92] https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina?urlid=201641&stevilka=1817

until 2050"[93], which was prepared within the project LIFE Climate Path 2050; specifically LIFE ClimatePath2050 "Slovenian Path Towards the Mid-Century Climate Target", LIFE16 GIC / SI / 000043. More specifically, an analysis was carried out regarding the future energy mix for heating in the residential sector – models were developed separately in dense ("GPO") and sparsely populated ("RPO") areas and separately for single- and multi-apartment buildings. The results of the model project a significant increase in heat pump deployment in single-dwelling buildings; in GPOs, the share of heat pumps installed is projected to increase from 7.3% to 51.6% by 2050, and in RPOs from 9.8% to 27.4% by 2050. Heat pump technology is projected to mainly consist of air-to-water heat pumps (due to the overall low cost of such systems) and brine / geothermal heat pumps – mainly in shallow geothermal configurations.

The residential sector has access to the following types of subsidies, which are distributed by Eco Fund:

- Until March 2022, between 20 to 50% of the total investment value was available to end-users in the residential sector, which correlates to a maximum subsidy of €2 500 or €5 000 depending on the heat pump technology (for example, water-to-water receives more than air-to-water).
- A subsidy for joint investments in multi-apartment buildings provides remuneration of 25% of the total investment value of a heat pump system. For socially disadvantaged citizens, this subsidy covers 100% of the total investment value.
- From July 2020 till March 2022, a subsidy was available for the installation of heat pumps for domestic hot water preparation in socially disadvantaged households ("ZERO500") covering 100% of the total value of the investment.

An additional form of financial support for promoting the deployment of heat pumps is via a green loan program ("670B22"), which makes available affordable loans to support the partial recovery of total investment costs at interest rates of 1.3% and a refinancing period of ten years.

Gap analysis

Over the past few years, the major focus of heat pump deployment in Slovenia was mainly on single residential buildings (houses). There are no considerable gaps in the deployment of such systems in such an application, considering that air-to-water and shallow geothermal heat pumps are considered mature technologies, have available subsidies, and have a large network of equipment providers and installers.

Nevertheless, the key gap may lie in the deployment of heat pumps in the commercial and industry sectors, particularly where large-scale heat pumps can use waste heat from various processes or can be deployed in water bodies and feed the heat generated to DHS. Such projects can unlock new potential for local heat generation and have a positive impact on the environment, particularly when offsetting existing fossil-fuelled boilers and other inefficient heat supply infrastructure.

3.1.6 Transport sector

General overview

The Slovenian transport sector represents approximately 40% of total energy demand, therefore it is of vital importance that adequate measures are in place that will ensure the use of "greener" fuels and

[93] https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/nepn/dokumenti/life_climatepath2050_strokovne_podlage_nepn_dpss.pdf

encourage the use of public transport as much as possible to contribute to the decarbonization of the transport sector.

It is considered that Slovenia needs to adequately manage the rapid growth of passenger and freight transport and direct traffic flows towards alternative means of transport – including by way of promoting the expansion of the cycling and pedestrian infrastructure and other measures to encourage a reduction in road traffic, such as the use of public transport, car sharing, etc. The target is to reduce the number of journeys by private motor vehicles (now representing 67% number of routes of all travel) and significantly increase the number of journeys by foot, bicycle, or low-carbon public transport.

To achieve these strategic objectives, the NECP envisions the following measures:

- upgrade of the railway infrastructure (project preparation to be completed in the following years), increase in the capacity of passenger corridors, and upgrade of lines to meet the Trans-European Transport Network (TEN-T) standards,
- development of an integrated public transport (optimization of schedules, integration of urban transport, establishment of a single operator for public passenger transport),
- promotion of sustainable transport options,
- promotion of alternatives to private vehicle use (teleworking, modified parking policy, etc.),
- the integration of national, regional, and local spatial and transport planning,
- arranging micro-mobility nodes where possible,
- support the electrification of the Port of Koper,
- implement a digital platform that will promote public passenger transport, forms of co-travel, and the creation and establishment of new sustainable mobility business models,
- analyse the prospects of banning the sale of new and the import of second-hand vehicles that use liquid fossil fuels,
- provide an adequate support environment for the introduction of alternative fuels such as liquefied natural gas (LNG) for freight transport and compressed natural gas and other synthetic fuels and hydrogen (H_2) for road transport,
- streamline administrative procedures in the electrification of transport.

Key reforms tackling these issues are:

- Mobility reform (Component 4 NECP): the key aim of the proposed reforms and investments of the Sustainable Mobility component is to promote the use of public transport and rail passenger and freight transport, the use of alternative fuels in transport, and the digital transformation of rail and road transport.
- The Management of Public Passenger Transport Act was passed in April 2022[94]. The aim of this reform is to promote and enhance the accessibility and competitiveness of public transportation – particularly considering the impacts of the COVID-19 pandemic. The Act established an integrated public passenger transport operator that will facilitate the integration of rail and bus public transportation with intercity, urban, school, and worker transportation. It will be complemented by a new law on public passenger transport and the formation and operation of

[94] http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8478

a new integrated public transport operator. This is anticipated to lead to increased use of public passenger transportation.

- The Act on infrastructure for alternative fuels and promoting the transition to alternative fuels in transport was proposed in 2022[95]. The public discussion of the law concluded in October 2022, and the law is envisaged to be passed in2023. The Act aims to introduce systemic measures to implement alternative fuel infrastructure, i.e., increasing the RES share in traffic. In particular, the Act aims to implement an accessible and easy-to-use public charging infrastructure on a local, regional, and national scale, design financial incentives to accelerate the deployment of such infrastructure and encourage private investment in the field.

Gap analysis

Whilst the electrification of private transport is already underway and electric modes of private transport (cars, bikes, scooters, etc.) are becoming widely adopted, a key gap is linked to the establishment of a country-wide infrastructure that will support the electrification of transport and to the implementation of a clear enabling environment for the transformation of the commercial and public transport into a low carbon one. According to discussions with key stakeholders within the REPowerEU projects, the key concerns are limited existing infrastructure that would support low-carbon energy/fuel sources for vehicles, high capital costs of changing vehicle fleets, and limited knowledge of long-term maintenance requirements.

3.1.6.1 Inclusion of local communities in RES projects

To gauge interest in proposed RES projects, best practices for RES deployment typically recommend carrying out public consultations with local communities during the early stages of project development and throughout construction phases. This is to ensure that the local community is consulted on and informed regarding the intentions of deploying a RES project in their local area, to understand their viewpoints and potential points of conflict, as well as to explain the added value of the project and how the project is envisioned to impact them (visual aspects, job creation, revenue share, energy communities, etc.).

In 2022, the "*Decree on compensation for the use of space for a wind turbine*" introduced direct compensation as a share of the income of the wind power plant to be paid to the municipality in which the plant is located; this is a step in the right direction to build trust with municipalities and the local population, as tangible projects help to build a positive reputation on a national level[96].

A further step would be to actively involve the local communities to financially participate in RES projects, which could also address the generally low level of current investment in Slovenia. For example, in Spain, the local communities can invest in a (up to) 20% share of large-scale RES projects; a similar mechanism is also in place in France[97].

3.1.6.2 Development of "green" skills

To meet RES deployment, energy efficiency, and diversity of energy supply strategic objectives, institutional capacity building will be required at all levels. Formal and informal education will help Slovenia build research, academic, expert, and professional abilities. An interdisciplinary approach

[95] https://e-uprava.gov.si/drzava-in-druzba/e-demokracija/predlogi-predpisov/predlog-predpisa.html?id=14676
[96] http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED8486, article 21
[97] European Commission, 'Guidance to Member States on good practices to speed up permit-granting procedures for renewable energy projects and on facilitating Power Purchase Agreements', vol. 15, no. 2, pp. 1–23, 2016.

towards long-term skills development in these strategic areas, particularly encourages environmental studies in natural sciences, engineering, social sciences, and humanities. By 2023, at least five focused energy transition research projects (at least two transdisciplinary) will be solicited, or funds will be granted for long-term adaptation-related initiatives (e.g., LIFE programme[98]). The aim is for the pool of climate change adaptation and green transition professionals to grow, and brain drain to be prevented. The Resolution on Slovenia's Long-Term Climate Strategy until 2050 (ReDPS50) is aimed at unifying research and teaching programs and systematizing aspects of the finance sector pertinent to green transition objectives.

Over the short-to-medium-term, focus will have to be placed on providing adequate professional training and hands-on support for RES and energy jobs, such as equipment manufacturers and installers for solar thermal collectors, heat pumps, shallow geothermal heat pump systems, wood biomass boilers, and solar PV systems, to strengthen the quality of workmanship and ensure that such systems will be installed according to relevant regulatory and engineering standards as well as international best practices and guidelines. There are several programs currently available for the education of professions that are considered deficient (e.g. electrician technicians, mechanical technicians), regular training for issuers of EPCs (level 1 and 2)[99], training for auditors of ventilation systems[100], etc. "*Rules on the professional training and examination required for energy installation managers*"[101] also set provisions for installers of solar PV systems. However, there are currently no major government and targeted programs and certification schemes to support significant acceleration in the training and upskilling of energy in buildings-related professionals (e.g., heating engineers, electricians, skilled construction workers, rooftop PV installers). Considering that key opportunities for promoting the green transition in Slovenia are related to energy use in the built environment, there is a significant need for expanding the workforce for the deployment of RES and energy efficiency measures in this sector.

According to a study by Energy Cities[102], achieving the transformation of the building sector will require an additional labour force for Slovenian municipalities, which is equivalent to 996 full-time employees (FTE) per year for the period from 2022-2030 at a cost of €48 million. According to the analysis, Slovenia is categorized among countries with limited development of the local public sector. Currently, local government staff expenditure represents about 4% of Slovenian GDP.

[98] LIFE PROGRAMME, https://cinea.ec.europa.eu/programmes/life_en
[99] https://energetskaizkaznica.si/usposabljanje/#izkaznica
[100] https://web.fs.uni-lj.si/LOSK/pregledi-ks/
[101] http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12292
[102] Human capacity in local governments: The bottleneck of the building stock transition (April 2022). https://energy-cities.eu/wp-content/uploads/2022/05/EnergyCities21_PolicyPaper_CapacityNeeds_EN_FINAL-2.pdf

3.2 Impact analysis

3.2.1 Summary of potential investments and reforms in the context of the REPowerEU Initiative

Based on the results of the gap analysis – addressing key areas of interest that may not be adequately addressed in RRP, NECP and similar policy frameworks, potential investments and reforms have been developed. The table below provides an overview of the gaps that we identified per area as well as the investments / reforms that could be considered to address those gaps.

The results of this analysis are shown in Table 6.

Table 6: Proposed reforms and investments

Topic area	Description of the gap	Suggested reform/investment to address the gap
Energy efficiency sector		
Promoting energy efficiency		
Promoting energy efficiency in less efficient heating appliances	Limited activities (reforms, subsidies, capacity building) have been identified that focus on inefficient heating appliances. (Section 3.1.1.1 – Gap analysis)	**Investment** – Continuously support the replacement of old, less efficient heating appliances with subsidies and grants.
Increasing the awareness of end-users about energy efficiency	Limited activities have been identified that would encourage an energy efficient behaviour of end-users. (Section 3.1.1.1 – Gap analysis)	**Investment** – Implement a public awareness campaign to address the importance of energy efficiency, particularly in light of the current energy crisis and high energy/fuel costs.
Energy demand management - the built environment		
Promoting energy efficiency in the least efficient building stock	No activities have been identified that would specifically target implementing low-cost energy efficiency measures in the least efficient building stock. There are others – but limited, available resources. (Section 3.1.1.2 – Gap analysis)	**Reform** – Set a governmental action plan to identify the least efficient building stock and the refurbishment work required to increase its energy efficiency. **Investment** – Continuously support the renovation of the least efficient building stock in coordination with the action plan developed.
Promoting more efficient natural gas boiler settings and control measures	No specific measures have been identified that would directly target the performance of existing	**Investment** – Implement a public awareness campaign to address the importance of appropriate boiler settings and control measures. Offer subsidies for improved

	natural gas boilers. (Section 3.1.1.2 – Gap analysis).	control measures such as setting heating curves based on weather conditions.
Promote more efficient air conditioning and ventilation systems and controls	Some targeted measures exist for air conditioning and ventilation systems in non-residential buildings. (Section 3.1.1.2 – Gap analysis).	**Investment** – Implement a public awareness campaign to address the importance of efficient air condition and ventilation systems. Offer subsidies for improved control measures such as HVAC control based on room occupancy/weather control.
Heating and cooling sector		
District heating		
Promoting the deployment of smaller-scale DHS	One of the main gaps lies with the unlocking of the potential of smaller-scale DHS (including cooling) that can be deployed even in rural areas, such as villages. (Section 3.1.2.1 – Gap analysis).	**Reform** – Set up an action plan for the deployment of smaller-scale DHS, including prioritization of areas of interest and stakeholder mapping, and focus on "to-be" built housing areas. **Investment** – Make grants available to municipalities and housing estate developers for feasibility studies for DHS. Provide subsidies for technology costs, project development and construction work.
Strengthen policies for DHS above 1 MWh	See Section 3.1.2.1 – Gap analysis	**Reform** – Provide regulatory clarity for DHS above 1 MW thermal power.
Strengthen policies and action plans for the deployment, upgrade, and refurbishment of DHS, in coordination with the parallel deployment of heat pumps (especially in the residential sector)	Barriers due to the complexity of DHS, especially in older centralized DHS (Velenje) that require hot water above 100 degrees - reduction of the supply and return temperature regime is subject to extensive upgrade and renovation works that need to be carried out in the entire heat network (Section 3.1.2.1 – Gap analysis).	**Reform** – Set up an action plan for the deployment (including upgrades and refurbishments) of DHS on a national level, including prioritization of areas of interest and stakeholder mapping. **Investment** – Make grants available to municipalities for feasibility studies for DHS deployment (including upgrades – and refurbishments) and provide subsidies for purchase, development and construction works.
In line with the development of an action plan for DHS, promote the undertaking of feasibility studies for DHS.	Another key barrier to rapid deployment of necessary upgrade and expansion works, as well as the deployment of new DHS, can be attributed to the fact that municipalities and DHS operators have to carry out costly feasibility and	**Reform** – Set up an action plan for the deployment (including upgrades and refurbishments) of DHS on a national level, including prioritization of areas of interest and stakeholder mapping. **Investment** – Make grants available to municipalities for feasibility studies for DHS

	design studies (Section 3.1.2.1 – Gap analysis).	deployment (including upgrades – and refurbishments) and provide subsidies for purchase, development and construction works.
Heat pumps		
Strengthen policies and action plans for the deployment of heat pumps in the non-residential sector	The key gap may lie in the deployment of heat pumps in the commercial and industry sectors, particularly where large-scale heat pumps can use waste heat from various processes or can be deployed in water bodies and feed the heat generated to DHS (Section 3.1.2.2 – Gap analysis).	**Reform** – Set up a policy and action plan for the deployment of heat pumps in the non-residential sector, including mapping areas of interest where such systems could be a viable alternative to DHS deployment. For example, focusing on industry and more specifically waste heat recovery, mapping areas near water bodies where heat could be extracted from surface-level water bodies (lakes and rivers).
RES sector and accelerating RES deployment		
Deployment of solar PV systems		
Promote the development of local/regional maps of potentially suitable areas for ground-mount solar PV deployment	There is currently no consolidated mapping of areas that are suitable for deploying ground-mounted solar PV systems and that are not considered protected areas from an environmental and social viewpoint (Section 3.1.3.2 – Barriers concerning site selection)	**Reform** – Plan the development of a national map of the solar PV potential, identifying areas of interest based on site suitability, permitting requirements, proximity to the grid and environmental and social risks.
Strengthen the institutional capacity about best practices for solar PV project deployment	Lack of support from state and local entities (Section 3.1.3.2 – Barriers concerning site selection)	**Investment** – Implement a public awareness campaign to address the importance of solar PV deployment, and hands-on training for key stakeholders in the project development process (e.g., permitting at municipal level).
Develop an action plan for the upgrade of the power grid in Slovenia – primarily focusing on low voltage network	Whilst RES deployment is accelerating, grid upgrades on the low voltage network that are required to enable new RES capacity have not been carried out to the extent required (Section 3.1.3.2 – Barriers concerning grid connection)	**Reform** – Set up a policy and action plan to strengthen the low voltage power grid at national level, including the identification of areas with potentially weak grids (constraints) and investment planning with TSO/DSO for upgrade works in line with envisioned timeframes.
Promote the development of energy communities	There is a considerable lack in the development of energy	**Investment** – Implement a public awareness campaign to address the importance of

	communities - only a handful of RES communities exists, which are energy communities within the same transformer station (Section 3.1.3.2 – Barriers concerning grid connection)	energy communities in the Slovenian energy mix, including a dedicated task force at governmental level that would be the key point of contact for enquiries into establishing and managing energy communities. **Reform** – Provide adequate by-law acts in the Electricity Supply Act that would provide clear guidelines, templates, options for dynamic energy sharing keys and other relevant topics for setting up energy communities.
Develop an action plan for promoting private investments in large-scale and commercial-scale solar PV projects – also in connection with the mapping of potentially suitable areas	Lack in the development of energy communities also affects private investments in PV (Section 3.1.3.2 – Promoting private investments in RES projects)	**Reform** – Set up a policy and action plan to increase private investments in large-scale and commercial-scale solar PV projects, including options to establish projects under public-private partnerships.
Deployment of wind power		
Promote the development of local/regional maps of potentially suitable areas for wind power project deployment	A mix of administrative and permitting barriers is the main reason for the difficulties in the deployment of wind power projects – even in areas with favourable wind conditions. Furthermore, difficulties with site selection, grid connection permits, and the opposition of the local communities where wind power projects are proposed to be deployed decrease the overall potential for wind power project deployment (Section 3.1.3.3 – Gap analysis)	**Reform** – Implement a plan for the development of a national map of the wind power potential, identifying areas of interest based on site suitability, permitting requirements, proximity to the grid and environmental and social risks.
Strengthen the institutional capacity about best practices for wind power project deployment	Lack of support from state and local entities (Section 3.1.3.3 – Gap analysis)	**Investment** – Implement a public awareness campaign to address the importance of wind power deployment, and hands-on training for key stakeholders in the project development process (e.g., permitting on the municipal level).
Security of energy supply and energy diversification		

Decarbonization of the natural gas supply		
Develop an action plan for the promotion of renewable gas, with a particular focus on the industry and commercial sectors	There are currently no economic incentives for promoting the use of renewable gases (Section 3.1.4.1 – Gap analysis)	**Reform** – Set up a policy and action plan to increase the use of renewable gases in the industry (natural gas as process fuel) and commercial sectors.
Develop incentives for switching from natural gas to renewable gases		**Investment** – Develop financial incentives to boost the use of renewable gases.
Reducing fossil fuel consumption in the industry		
Develop, implement, and enforce long-term targets for the green transformation of the industry sector	The key barrier to achieving NECP (and other keys) targets in the industry lies in insufficient incentives (permitting support, financial incentives and subsidies, tax benefits, etc.) (Section 3.1.4.2 – Gap analysis)	**Reform** – Establish stricter binding climate neutrality targets for the industry sector with several interim milestones and develop an action plan for the uptake of green and energy efficiency projects.
Promote the use of advanced technologies and innovative business models		**Reform** – Develop action plans for the uptake of advanced technologies and innovative business models to achieve climate neutrality in the industry sector.
Develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing		**Investment** – Provide financial incentives to developers/owners of pilot projects – including funding of feasibility studies, support with permitting and licensing and developing operational incentives such as “contracts for difference”.
Biogas, biomethane and renewable hydrogen		
Strengthen the institutional capacity to develop best practices for the use of biogas, biomethane and renewable hydrogen	The key barriers range from poor bankability (for example due to high capital expenditure on equipment), lack of clear guidelines from the government regarding permitting conditions and/or potential financial support through subsidies or other forms of incentives (e.g., supporting contracts for difference) to high or unknown operational risks due to the infancy of technologies (Section 3.1.4.3 – Gap analysis)	**Reform** – Develop action plans for the uptake of biogas, biomethane and renewable hydrogen, including stakeholder mapping, technology deployment timeframes and market guidance reports on best practices for the adoption of these technologies.
Develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing		**Investment** – Provide financial incentives to developers/owners of pilot projects – including funding of feasibility studies, support with permitting and licensing and developing operational incentives such as “contracts for difference”.

Transport sector		
Strengthen the institutional capacity regarding the regulatory requirements for publicly accessible e-mobility infrastructure deployment	Lack of awareness of existing enforceable targets for deploying e-mobility charging stations on public parking places/adjacent to public buildings. (Section 3.1.5 – Gap analysis)	**Reform** – Develop institutional capacity to set and enforce targets for the promotion of green transport, including private, public, commercial and industrial modes of transportation.
Develop an action plan for the transport sector, including the promotion of alternative fuels and incentives to drive market uptake		**Reform** – Develop action plans for the transport sector, including mapping of key stakeholders, matching supply and demand, reviewing alternative fuels and define their deployment strategy (including infrastructure development). **Investment** – Provide financial incentives (such as subsides, tax deduction) to business owners that want to switch to greener modes of transport. For example: cycle to work, walk to work, ridesharing.
Other		
Promote the inclusion of local communities in RES projects – through stakeholder engagement, key informant interviews and energy communities	Lack of support from state and local entities (Section 3.1.6.1 – Inclusion of local communities in RES projects)	**Investment** – Implement a public awareness campaign to address the importance of energy communities, guidelines for establishing them, examples of best practices and establishing a national-level task force to promote energy communities.
Develop policies and action plans for the development of green skills through hands-on support, training, formal education, professional certifications, and mentorship programs	Lack of support from state and local entities (Section 3.1.6.2 – Development of green skills)	**Reform** – Develop an action plan for the future development of green skills, including subsidizing training/mentorship schemes and subsidizing universities for developing and promoting programmes in relation to green skills.

3.2.2 Impact assessment

The impact assessment of the proposed reforms and investments is presented in Table 7.

Note:

- **REPowerEU** impact on fossil fuels: based on the assessment of how much gas or oil demand could be potentially reduced with the proposed measure (LOW, MED or HIGH);
- **Administrative complexity**: based on effort required to put it in place and start realizing the planned actions (LOW, MED or HIGH);

- **Expected timelines** for impacts: based upon when the expected impact of the reform/investment on fossil fuel consumption would materialise.

Furthermore, the impacts (LOW, MED, HIGH) were determined based on the following methodology:

- **Impact on fossil fuels reduction:**
  - LOW – low impact on reducing fossil fuel use; mainly targeted at consumers with a low overall demand for fossil fuels and an indirect impact on reducing fossil fuel use (example: awareness campaigns).
  - MEDIUM – medium impact on reducing fossil fuel use; mainly aimed at consumers who have a medium demand for fossil fuels and thus have an indirect medium impact on the demand for fossil fuels.
  - HIGH - high impact on reducing fossil fuel use; primarily aimed at consumers with a high overall need for fossil fuels and therefore have a direct and high impact on reducing fossil fuel use.
- **Administrative complexity:**
  - LOW – low administrative complexity, with clear procedures and processes and standards in place.
  - MEDIUM – medium administrative complexity, with less clear procedures and processes and a handful of tangible projects that could be used as examples for decision making. Administrative processes need to be modified or upgraded.
  - HIGH - high administrative complexity, with no clear procedures and processes, and no tangible examples to derive decision from. Administrative processes need to be developed from scratch.

Table 7: Impacts of potential reforms and investments

Areas	Reforms/investments	Impact on fossil fuel use reduction	Expected timelines for impacts	Admin complexity
Promoting energy efficiency	Replace less efficient heating appliances	LOW	2023-2026	LOW
	Increase end-user awareness about energy efficiency	MEDIUM	2027-2030	MEDIUM
Energy demand management - the built environment	Promote energy efficiency in the least efficient building stock	HIGH	2027-2030	MED

	Promote more efficient natural gas boiler settings and control measures	LOW	2023-2026	LOW
	Promote more efficient air conditioning and ventilation systems and controls	LOW	2030+	LOW
District heating	Promote the deployment of smaller-scale DHS	HIGH	2027-2030	MED
	Strengthen policies for DHS above 1MWth	HIGH	2027-2030	MED
	Strengthen policies and action plans for the deployment, upgrade and refurbishment of DHS, especially in correlation with the parallel deployment of heat pumps (especially in the residential sector)	HIGH	2023-2026	HIGH
	In line with the development of an action plan for DHS, promote the undertaking of feasibility studies for DHS.	HIGH	2023-2026	LOW

Heat pumps	Strengthen policies and action plans for the deployment of heat pumps in the non-residential sector	MED	2027-2030	MED
Deployment of solar PV systems	Promote the development of local/regional maps of potentially suitable areas for ground-mount solar PV deployment	MED	2023-2026	MED
	Strengthen the institutional capacity about best practices for solar PV project deployment	LOW	2023-2026	MED
	Develop an action plan for the upgradation of the power grid in Slovenia	LOW	2027-2030	MED
	Promote the development of energy communities	MED	2023-2026	MED
	Develop an action plan for promoting private investments in solar PV projects – also in connection with the mapping of potentially suitable areas	LOW	2023-2026	MED

Deployment of wind power	Promote the development of local/regional maps of potentially suitable areas for wind power project deployment	MED	2023-2026	MED
	Strengthen the institutional capacity about best practices for wind power project deployment	LOW	2027-2030	MED
Decarbonization of the natural gas supply	Develop an action plan for the promotion of renewable gas, with particular focus on the industrial and commercial sectors	HIGH	2023-2026	HIGH
	Develop incentives for switching from natural gas to renewable gases	HIGH	2023-2026	HIGH
Reducing fossil fuel consumption in the industry	Develop, introduce and enforce long-term targets for the green transformation of the industrial sector	HIGH	2030+	HIGH
	Promote the use of advanced technologies and innovative business models	HIGH	2027-2030	HIGH

	Develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing	HIGH	2023-2026	HIGH
Biogas, biomethane and renewable hydrogen	Strengthen the institutional capacity for best practices for the use of biogas, biomethane and renewable hydrogen	MED	2027-2030	HIGH
	Develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing	MED	2027-2030	HIGH
Transport sector	Strengthen the institutional capacity regarding the regulatory requirements for e-mobility infrastructure deployment in the public sector	MED	2023-2026	MED
	Develop an action plan for the future of the transport sector in Slovenia, including the promotion of alternative fuels and incentives to drive market uptake	MED	2027-2030	MED
Other	Promote the inclusion of local communities in RES projects – through stakeholder engagements, key informant interviews and energy communities	MED	2027-2030	MED

	Develop policies and action plans for the development of green skills – from hands-on support, training, formal education, professional certifications and mentorship programs	HIGH	2023-2026	HIGH

Whilst the above impact assessment is of preliminary nature, it provides some guidelines for areas of interest that should be addressed in REPowerEU – either due to their potentially high impact on the REPowerEU objectives or because they aren't adequately included in other frameworks (such as RRP or NECP).

Taking into consideration the impact characterization of proposed investments and reforms (from low to high), a shortlist was created. The methodology for shortlisting investments and reforms considered their broad potential in the context of REPowerEU, complexity of implementation and overall timeframes. Furthermore, whilst not explicitly stated in Table 6, some reforms and investments may be broadly considered in other national programs and initiatives. Therefore, the focus for shortlisting was also given to topic areas for which the risk of overlap with other such initiatives is considered as low. Taking these aspects into consideration, the following key reforms and investments have been shortlisted for further consideration:

- Reducing fossil fuel consumption in industry:
  - Reform: develop, introduce and enforce long-term targets for the green transformation of the industrial sector
  - Investment: develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing
- Biogas, biomethane and renewable hydrogen:
  - Reform: strengthen the institutional capacity for best practices for the use of biogas, biomethane and renewable hydrogen
  - Investment: Develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing
- District heating:
  - Investment: Transitioning district heating systems to affordable and sustainable energy sources
- Optimization of permitting processes for RES:
  - Reform: Develop and roll-out technical and administrative guidelines for the issuance of permits for RES projects
  - Investment: Develop and roll-out a capacity building programme for all municipalities and regional authorities
- Enable different business models for deploying RES projects:
  - Investment: Develop and establish financial incentives for supporting the development of RES projects via different business models
- Transport:
  - Reform: develop, introduce, and enforce medium- to long-term targets for the green transformation of the transport sector.

These investments and reforms are further discussed in Section 3.3 of the report.

3.3 Proposal for reforms and investments in the context of the REPowerEU Initiative

In line with the results of the impact analysis (as presented in Chapter 3.2), this chapter will define the reforms and investments, which:

- Have been identified as part of the reforms/investments with the highest impact;
- Could be implemented by 2026 at the latest, with impacts materialising by 2030.

3.3.1 Reducing fossil fuel consumption in industry

Considering that the industrial sector is a key stakeholder in the energy sector (see Chapter 3.1.4.2.), its decarbonisation will have a significant impact on the energy mix and security of supply. Furthermore, with the upcoming Corporate Sustainability Reporting Directive[103] (CSRD), which is expected to be enforced by 2025 at the latest, the larger companies within the industrial sector will have to start reporting their sustainability metrics as part of their non-financial reports. Therefore, the current volatility of energy prices on markets and the CSRD may be the catalyst for companies within the industrial sector to also start focusing on reducing their energy demand, increasing their energy efficiency and energy self-sufficiency, and ensuring that the double materiality factors (how their operations impact the local environmental and social aspects) are understood and transparently reported.
The proposed investments and reforms that could accelerate the sustainable transition of the industrial sector are presented below.

Table 8: Reform - Introduction and enforcement of long-term targets for the green transformation of the industrial sector

Information	*Policy measure*
Objective	I-1.1 - Introduction and enforcement of long-term targets for the green transformation of the industrial sector
Description	According to the CSRD (Corporate Sustainability Reporting Directive), companies will soon be required to publish comprehensive information regarding sustainability matters. This will increase the accountability of companies, prevent divergent sustainability standards, and facilitate the transition to a sustainable economy. Significant transition to a low-carbon circular economy is highly dependent on the development of new breakthrough technologies that are not yet on the market or are just beginning to be developed in the fields of heat, electrification, and production processes. Certain developed technologies, including the production and utilization of hydrogen and the collection, storage, and utilization of carbon, have yet to be properly and affordably integrated into the manufacturing processes of energy-intensive industries. Although the EU decarbonization targets are applicable to the industrial sector as well, taking a more targeted approach to the development of decarbonization targets in the industrial sector would speed up the EU commitment to become climate neutral. Initial decarbonization targets could be based on the already existing NECP, which calls for a reduction of

[103] https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

Information	*Policy measure*
	43% in greenhouse gas emissions by the year 2030 in the industrial sectors that are exempt from the ETS. This could be accomplished, for example, by introducing a mandatory requirement for such industrial players to disclose their plans regarding how these targets will be achieved, either via milestones or with a target of 2030. Such a reform could be partially based on the forthcoming CSRD because the majority of the largest industrial players in Slovenia will be required to publicly disclose their carbon footprint and energy use, and they will also be responsible for ensuring that the reports are validated by third parties who are not affiliated with the companies in question (e.g., CSRD assurance).
Costs	Vary from one case to another
Financing sources	Slovenian Enterprise Fund, SID Bank, and the Slovenian Regional Development Fund Own resources of companies
Expected implementation schedule/duration	2025-2030
Relevant for winter 2023/24?	No
Complementarity and/or substitution with other measures	I-1.2 - Create and implement financial incentives to support pilot project funding, including support with permitting and licensing P-3.1 - Increase familiarity of the public/investors with environmental impact assessments (EIAs) and other complex procedures related to the RES permitting process H-1.1: Adopt a national hydrogen action plan to provide direction, guidance, and foresight to the industry
Expected results and contribution to REPowerEU objectives	Transitioning to cleaner energy sources, bolstering industrial competitiveness, and supporting global leadership in technology. The transition to a low-carbon circular economy presents an opportunity for economic growth because it generates tangible financial benefits for companies and the economy, fosters innovation, and reduces negative environmental impacts along the supply chain. Increased automation and competitiveness pressure will necessitate increased investment and innovative, lean business models. The machine-building and electrical industries will be notable exceptions, as their high growth in added value will prevent a decline in employment. By 2030, the number of workers will have decreased by 15 000 compared to 2020. The nominal growth in added value (which best reflects the organic growth of operations) will prevent a faster reduction in the number of employees,

Information	Policy measure
	which will be primarily caused by an increase in production automation and a more intensive collaboration between the industry and other sectors of the economy. The trend of decreasing employment in the majority of processing activities will be followed by a parallel increase in employment in processing-related service sectors, particularly in the employment of referred labor force, installation, creative industries, legal, tax, business consulting, cleaning, and other support functions. The trends of excluding support functions from parent companies will result from the optimization of business models in accordance with the role models of the most successful foreign companies. In other words, the employment multiplier for processing activities will increase by 2030 since every job in processing activities will greatly contribute to a new job in the service sector[104].

Table 9: Investment - Create and implement financial incentives to support pilot project funding, including support with permitting and licensing

Information	Policy measure
Objective	I-1.2 - Create and implement financial incentives to support pilot project funding, including support with permitting and licensing
Description	Pilot projects supported by investment grants would help demonstrate technologies that can achieve financial viability and market acceptance while providing or using cleaner forms of energy and reducing dependence on fossil fuels. Several pilot projects for the use of alternative and green sources of energy have been developed by the industrial sector; however, as such technologies may not yet be fully bankable, these pilot projects are primarily at pre-development stage. By offering fiscal and bankability incentives, loans, and subsidies to pilot projects in the pre-development phase for which feasibility studies have demonstrated that the proposed measures or technologies are technically and commercially viable, could accelerate the uptake and implementation of useful services/products/solutions and speed up their development to a final product suitable for wider use. In addition to providing or using cleaner forms of energy and decreasing reliance on fossil fuels, tangible projects supported by investment-type support would aid in demonstrating technologies that can achieve bankability and market acceptance, as well as demonstrating their viability for commercialization.
Costs	Vary from one case to another
Financing sources	Own resources of companies European Funds (Horizon Europe, LIFE, etc.) Slovenian Enterprise Fund, Slovenian Regional Development Fund

[104] Slovenian Industrial Strategy 2021-2030, https://www.gov.si/en/news/2022-05-03-slovenian-industrial-strategy-2021-2030/

Information	*Policy measure*
Expected implementation schedule/duration	2023-2030
Relevant for winter 2023/24?	Yes
Complementarity and/or substitution with other measures	I-1.1 - Introduction and enforcement of long-term targets for the green transformation of the industrial sector H-1.1: Adopt a national hydrogen action plan to provide direction, guidance, and foresight to the industry
Expected results and contribution to REPowerEU objectives	The government should support the decarbonization of industrial production by providing more favorable tax conditions in the event that investments in energy efficiency are implemented. Regulatory sandboxes can facilitate the piloting and testing of various low-carbon energy solutions. Working on pilot projects also provides opportunities to strengthen partnerships between industry and universities/institutes, strengthen ties with local businesses, and foster a culture of collaboration between higher education and industry. Future workforce development is dependent on the design and delivery of innovative educational programs in close collaboration with industry partners. For academics, these benefits may include the opportunity to address challenging research questions with real-world applications, to observe the tangible effects of their research, and to gain access to new skills, data, or equipment. Companies can improve their business performance by developing new techniques or technologies, reducing the risk of research investments, and expanding their capabilities and expertise.

3.3.2 Biogas, biomethane and renewable hydrogen

Due to the current high prices of natural gas security of supply challenges, alternative energy types to natural gas are currently being sought by all stakeholders that use natural gas as their fuel source. Furthermore, any negative news about natural gas supply have a drastic impact on the market prices[105]. Therefore, proposed investments and reforms need to focus on supporting fuel types or energy carriers that could replace natural gas on a larger scale, which can be produced or sourced locally and that could be implemented by 2026 at the latest:

1. **Reform**: Strengthen the institutional capacity for best practices for the use of biogas, biomethane and renewable hydrogen – the development and publication of an action plan would provide clarity to the private, commercial, and industrial sectors regarding the positioning of biogas, biomethane and renewable hydrogen in the energy mix of Slovenia and serve as a capacity and knowledge building exercise to the key stakeholders in the energy sector. Such an

[105] https://www.euronews.com/my-europe/2022/08/25/europes-gas-prices-have-broken-a-new-record-how-high-can-they-go

action plan would need to develop maps of potential of production and demand for these fuels, include local governments on municipality level, and other key stakeholders (the industrial sector, the forestry department, transport sector, pilot projects in development, etc.), to gauge priority areas for the deployment of these technologies. A good baseline for the development of an action plan and capacity building could be an active involvement in the development of the North Adriatic Hydrogen Valley (Italy, Slovenia, and Croatia).

2. **Investment**: Develop and establish financial incentives for supporting pilot projects, including support with permitting and licensing – similarly to the proposed investment in the "reducing fossil fuel consumption in industry" section of this chapter, the industrial sector has explored several pilot projects for the use of biogas, biomethane and renewable hydrogen, however, due to either high capital costs of equipment or operational costs, such projects are currently on hold due to their investment potential being considered as poor. Fiscal and bankability incentives, loans and subsidies to pilot projects that are in the pre-development stage and for which the feasibility studies showcased that the proposed measures or technologies are viable from a technical point of view, could help in achieving REPowerEU's goals and promote market uptake of such technologies. In turn, a rapid deployment of such technologies could drive down long-term costs (similarly to how the costs of solar PV have been declining with an accelerated market uptake).

Biogas, biomethane and renewable hydrogen proposed reforms and investments are described more into details in chapters 4.1 and 4.2.

3.3.3 District heating

The upgrade of existing district heating systems (DHS) will have a major impact on the long-term sustainability of the local communities that are heated via DHS. Current DHS in Slovenia are still heavily reliant on central sources of heat generation, which are typically fuelled by fossil fuels. In 2021, fossil fuels dominated heat supply (79.7%), while renewables and waste heat accounted for a much smaller share (20.3%). Coal supplied 47% of the primary energy to produce heat for distribution systems from fossil fuels, followed by natural gas with 31.5% and oil and petroleum products with only 1.2%. Regarding renewables and waste heat, woody biomass accounted for 17.3%, followed by biodegradable waste (2.6%), and only 0.4% from all other sources (geothermal energy, solar thermal energy, electricity, and industrial waste heat)[106]. 67 out of 112 registered heat distribution systems that distribute heat as a service of general economic interest or market activity or from a private distribution system were energy efficient in 2021. The greatest number of distribution systems, 53, met the energy efficiency criterion of at least 50 percent of the distributed heat being directly or indirectly produced from RES. No distribution system met the criterion that a minimum of fifty percent of the distributed heat must be generated from waste heat.[107] In the coming years, it will be necessary to transform or upgrade existing district heating systems from 1st – 2nd generation to 3rd – 4th generation (1G to 3G/4G generation) to allow the integration of RES as additional generation sources and to enable energy storage. The current system in Velenje (coal region) for example operates at high temperatures (120+°C) and does not allow direct connection of RES. It would be difficult to justify, economically and politically, investments in a parallel, lower-temperature district heating system, as long as the existing system is seen as adequate in terms of the provision of the main service (heat). In any case, it will be necessary to examine the possibility of energy renovations to reduce

[106] Energy Agency of the Republic of Slovenia (2022), Report on the energy situation in Slovenia 2021 https://www.ceer.eu/documents/104400/7517827/C22_Slovenia_EN/70e75cb8-0f4b-8b71-8663-0c3decbf1545
[107] https://www.ceer.eu/documents/104400/7517827/C22_Slovenia_EN/70e75cb8-0f4b-8b71-8663-0c3decbf1545

heat demand, increase pipeline flows and allow the possibility of operating at lower temperatures. In its NECP, Slovenia has committed to prepare an assessment of the potential for efficient heating and cooling which was completed in 2021 and published in the document titled *Comprehensive assessment of the potential for efficient heating and cooling in Slovenia*[108]. The assessment also points to a comprehensive heating and cooling strategy, an action plan for district heating, heat map and tools for local planning, information and publicity, alleviation of fuel poverty and promotion of research and innovation for transition to a climate-neutral society. Furthermore, several ongoing initiatives and (new) pilot projects are strengthening the role of district heating in future energy systems by implementing energy and climate plans that will enable the modernization and long-term development of district systems. District heating systems in Ptuj (modernization and transition from natural gas to biomass), Slovenj Gradec (modernization and transition from natural gas to biomass), and Velenje are examples of such pilot projects (network renovation and optimization, digitization).

In accordance with NECP and assessment of the potential for efficient heating and cooling (HC) in Slovenia, to increase the share of decentralized generation sources in DHS (such as from RES), the following general policy measures are proposed:

1. Develop and bolster existing financial support programmes for the modernization and expansion of existing district heating networks, the development of new low-temperature district heating networks, and the accelerated deployment of investments in renewables (such as large heat pumps, geothermal, solar thermal), thermal heat storage, and industrial waste heat.
2. Municipalities with a population greater than 15,000 should immediately initiate the development of local heating and cooling strategies. These plans are required to identify local renewable energy and waste-heat potentials, establish zones for future heat supply via district heating, and prepare the orderly phase-out of fossil fuels in buildings by 2040, including the decommissioning of existing gas networks.
3. Provide a dedicated financial support programme to assist district heating companies in developing plans for achieving complete decarbonisation (100% renewables and waste heat) by 2040 within stringent sustainability constraints (e.g. biomass potential).
4. When developing local heating and cooling plans, consider all major sources of waste heat (such as data centres, metro stations, supermarkets, and waste-water treatment plants) and require them to feed into district heating systems whenever it is cost-effective.
5. Concentrate building renovation efforts on specific areas of the district heating network to reduce the heating temperature.
6. Broad national educational and awareness-raising campaign on the importance and process of moving toward a climate-neutral society (e.g., educating users of wood biomass appliances about the proper fuel and method of heating, educating vendors and installers of RES and EE appliances, business managers, energy managers, etc.).
7. A more focused approach to research and innovation, including in the humanities, social sciences, and social-natural sciences, as well as more focused research initiatives in areas like efficient cooling and waste heat use, etc.

The transformation of DH systems into low-temperature (65-70°C) DH heating, so called 4th Generation DHS, with the utilization of heat from solar, geothermal or any other RES energy, waste heat, supported by the refurbishment of the building sector and the implementation of seasonal storage, will provide an energy chain basis for the defosillization of the country. In accordance with that the proposed concrete policy measure is presented below more into details.

[108] https://energy.ec.europa.eu/system/files/2022-01/SI%20CA%202020%20en.pdf

Table 10: Investment - Transitioning of district heating systems to affordable and sustainable energy sources

Information	*Policy measure*
Objective	D-1.1 - Transitioning of district heating systems to affordable and sustainable energy sources
Description	Transform or upgrade existing district heating systems from 1st-2nd generation to 3rd-4th generation (1G to 3G/4G generation) to allow the integration of renewable energy sources as additional generation sources and to improve energy efficiency. The transformation of the heat distribution system is required for the efficient incorporation of heat from RES. The system must be adapted to operate at lower temperatures (from 120°C to 60-80°C), which includes adapting the system to the users, adapting the heat stations, modernising the pipelines, and planning the development of the system so that, in addition to the current centralised aspect, it is possible to install distributed sources, which are then connected to a single system. In the first phase, the alternative source will ensure a balanced operation of the distribution system during the summer, but it cannot guarantee a full supply during the winter. Consideration should also be given to the use of biomass and other organic waste to ensure peak power during the winter months. New technologies based on zero environmental emissions (gasification) or on advanced particulate filtration will guarantee emission-free electricity production. The local availability of suitable feedstock, whether biomass, sewage sludge, or other waste, must be supported adequately by key stakeholders and the local community. Biomass or organic matter production could be increased in degraded areas of the valley or in lakes, capturing carbon from the atmosphere during the growth cycle and using it as an energy source in closed cycles to generate heat. Moreover, investments in renewable sources of energy will result in the acquisition of new expertise required for the region's continued energy transition and will complement other energy-related activities aimed at preserving and creating high-value jobs in the region.
Costs	10-50 million EUR (depending on the length of the DH system)
Financing sources	Slovenian Enterprise Fund, SID Bank, and the Slovenian Regional Development Fund Just Transition Fund Own resources of the municipalities or municipality company Private funders
Expected implementation schedule/duration	2023-2040

Information	*Policy measure*
Relevant for winter 2023/24?	YES
Complementarity and/or substitution with other measures	I-1.1 - Introduction and enforcement of long-term targets for the green transformation of the industrial sector (partially through the use of the waste heat from the industry processes for example)
Expected results and contribution to REPowerEU objectives	The production of thermal energy from RES will have a positive impact on meeting Slovenia's emission targets and reducing dependence on fossil fuels with increasing self-sufficiency, reduction of GHG emissions, improving the reliability of heat supply, reduction of the risk of emission allowance prices, increasing the activity of local suppliers of equipment or services. The primary conclusion is that when the technology shifts, there is little change in the primary business models used by the second and third generations of DHS. Energy savings, lower distribution losses, capitalizing on the value of green (a low CO_2 technology), placing a value on the creation of jobs locally (since decentralized heat production is more labor intensive than centralized), avoiding fuel transports (distant fuels are replaced by local heat sources), and a direct, close, and long-term relationship with their customers could be better exploited by the industry (necessitated by the closer collaboration between provider of waste heat, DH company and heat customer). The investment cost of the low-temperature solution is greater than that of conventional solutions, but it has positive effects both in terms of climate impact and the number of jobs created locally, as low-temperature investments require more local labor. Therefore, it can be argued that the jobs created will be long-term, local, and qualified. Add to that the avoidance of transporting fuel to the central heating unit (transportation generates CO_2 emissions and reduces the green value of the DH installation) and the lower grid cost due to the use of prefabricated pipes that require a shorter installation period and fewer civil works, and the value of the low temperature heat recovery investment could make this a better business decision[109].

3.3.4 Optimization of permitting processes for RES

In order to ensure that Slovenia will be able to meet future RES deployment targets, it would be prudent to establish an enabling environment that would help ensure that the set targets are met in a timely manner. This would mostly be based on the optimization of administrative processes – and more specifically optimized permitting processes - with the following proposed reforms and investments:

1. **Reform**: Develop and roll-out technical and administrative guidelines for the issuance of permits for RES projects, following international best practices and in line with the development of

[109] Lygnerud, K. (2019), Business Model Changes in District Heating: The Impact of the Technology Shift from the Third to the Fourth Generation Energies, 12(9): 1778, https://doi.org/10.3390/en12091778

priority areas or maps for solar PV and wind projects (as suggested in other reforms in Table 5). It would be prudent to review all rejected permits on an annual basis.

2. **Investment**: Develop and roll-out a capacity building programme for all municipalities and regional authorities, which would help ensure that the people responsible for analysing and issuing permits are fully qualified, understand the business models behind proposed RES projects, and understand the intricacies of RES project development. This could potentially include a national dedicated taskforce of experts that are solely responsible for the analysis and issuance of permits and optimize the time needed to issue or reject permits for RES project deployment.

The proposed concrete policy measures are presented below in sections 3.3.4.1 – 3.3.4.3.

3.3.4.1 Proposal 1: Amending procedures and regulation related to DSOs

Table 11: Reform - Replace grid connection procedures for low-voltage-grid connected PV systems with automatic approval and active curtailment

Information	*Policy measure*
Objective	P-1.1 - Replace grid connection procedures for low-voltage-grid connected PV systems with automatic approval and active curtailment
Description	Currently, investors that want to invest into small scale rooftop solar need to acquire a permit for the total installed capacity of the solar power plants, after which either full utilization of the PV plant is approved, or the plant is not approved at all. This methodology is restrictive in nature and impedes an economically efficient speed of RES deployment that could be managed by real-time curtailment. The rooftop low-voltage connected PV can be economically – and, from the grid perspective, technically) – less efficient than larger scale pooled PV investments. Nevertheless, low-voltage-level connected solar will remain a long-term reality in Slovenia, in line with the proposal amending the Energy Performance of Buildings Directive and imposing a mandate that all new residential buildings be equipped with PV from 2029 and considering the dual-use-of-space principle entering national legislation as well. The current approval process is based on minimizing the possibility of local oversupply (and overvoltage, thereby necessitating curtailment), therefore, in some sections of the network, connecting new solar PV is denied citing reasons of operational security. The optimal level of solar PV curtailment is not zero, as such policy disincentivizes smart solutions and fails to consider the benefit of economies of scale when opting for larger PV investments that outweigh the income loss due to occasional curtailment. Current inverter technology supports curtailment due to voltage issues (e.g. droop control); many inverters allow remote control of the system output. In accordance with that a requirement we propose that all new rooftop solar are equipped with such inverters (see below measure P-1.2 – Implement

Information	*Policy measure*
	regulations regarding the functionality (active power curtailment, reactive power control) of newly installed distributed solar PV inverters). If curtailment is made without communication with the DSO (droop control), a common curtailment standard should be implemented that would prevent some PV owners to inject more energy that their neighbours. Furthermore, in this case, producers at the end could expect to experience more curtailment. This could be solved by considering the network subsection as a whole, and attribute to all PV producers the same (relative) level of curtailment and adjusting their market position ex-post. In line with the above, existing rooftop PV with inverters not enabling voltage & power output control could be made financially responsible for the oversupply that they occasionally cause in the network. In the future, with increased communication between grid users and the advancement of flexibility markets, curtailment could also be done on a basis of system-wide economic efficiency by assigning a price to each unit of curtailed energy. In the transition period leading to optimal curtailment, it should not be commonly accepted that each household PV producer has the right to inject their full production into the grid (a common good) at all times. Slovenian Environmental Public Fund - Eko sklad will prioritize financial support to battery storage (over support to solar PV) from 2023 onwards. This will support the roll-out of household batteries, which can assist in managing the local grid with an increased share of PV. Therefore, if financial incentives are introduced concerning the management of power quality at the local grid level (e.g. critical peak tariffs defined in the proposed new grid tariff methodology envisaged for 2024), the incentive of electricity storage and consumption shifting would apply to households in the same subsection of the low-voltage grid. In the long term, efficient use of batteries can only be assured by adequate real time technical or economic signals as to the state of the grid. Curtailment could be implemented without compensation to the investor. Before the investment, the investor could be made aware of the conditions of the local grid and the probability of curtailment.
Costs	If no compensation for curtailment, the costs are negative, as they remove the administrative and research process of grid connection authorization.
Financing sources	Private capital (people as sole investors, through energy communities, crowdfunding, etc.) Slovenian Environmental Public Fund
Expected implementation schedule/duration	Could be implemented by amending Article 71 of *System operating instructions for the electricity distribution system* (SONDSEE) (3 months) or

Information	Policy measure
	by amending the internal decision-making procedures of grid operators, related to the provisions of the aforementioned Article.
Relevant for winter 2023/24?	Yes. Increased PV production can take place already in winter 2023/24, however, local oversupply and overvoltage problems are expected to arise in spring/summer months.
Complementarity and/or substitution with other measures	Complementary measure: P-1.2 – Implement regulations regarding the functionality (active power curtailment, reactive power control) of newly installed distributed solar PV inverters Substitutionary or complementary measure: increase public awareness of pooled investments into larger scale RES, benefitting from the economies of scale and arguably presenting lower system costs if connected to a higher grid voltage level. Together with an estimation of curtailment probability, the DSO could also provide a potential investor with the list of larger scale PV projects currently seeking co-investors, for the investor to consider this alternative. Nevertheless, if in the future, appropriate financial signals are introduced incentivizing the management of distributed PV production, low-voltage and high-voltage alike, an efficient long-term equilibrium should be found.
Expected results and contribution to REPowerEU objectives	The share of connection applications that is rejected has increased year-on-year (8.8% in the first half of 2022 compared to 5.1% in 2021 and 2.2% in 2020). Furthermore, the total number of applications is increasing (6 000 in 2020, 14 000 in 2021 and 15 000 in the first half of 2022). In H1-2022, 1 346 applications were rejected[110]. Supposing an average plant capacity of 10 kW, this corresponds to a cumulative annual potential of around 13 MW in H1-2022 if the measure were already in place. If in 2023 and 2024, the trends are assumed to continue linearly, we could see around 30 000 applications per year (estimated yearly 2022 value), of which 15% (linear approximation of the trend) would be rejected. Supposing an average plant capacity of 10 kW, this corresponds to a cumulative annual potential of around 45 MW in 2023. As of November 2022, the to-date application rejection rate was 18%. If we assume a rejection rate of 30% in 2023 and 2024, the cumulative annual potential is 90 MW. Supposing an annual production of 1 050 kWh/kWp and a 5% annual curtailment rate (5% of the potential energy is not produced), the increase in connections would yield around 45 or 90 GWh (depending on the rate of rejection) of additionally produced electrical energy every year.

[110] https://www.zurnal24.si/pod-streho/varcna-hisa/nastaja-zemljevid-kje-bo-prikljucitev-mozna-in-kje-ne-391465

Table 12: Reform – Implement regulations regarding the functionality (active power curtailment, reactive power control) of newly installed distributed solar PV inverters

Information	*Policy measure*
Objective	P-1.2 – Implement regulations regarding the functionality (active power curtailment, reactive power control) of newly installed distributed solar PV inverters
Description	Implement the necessary regulation to oblige all grid-connected distributed PV to be equipped with an inverter that allows remote changing of export limits and switch-off. Furthermore, consider implementing a requirement that inverters enable voltage regulation by controlling the output of active or reactive power. Currently, there is no standard for remote control of distributed solar PV. Requiring PV inverters to include the "smart grid" functionalities would contribute to a more efficient use of the network at hand, enable PV export limits in times of local grid oversupply, and facilitate the development of virtual power plants in the mid- to long term. An appropriate transitionary period for this measure should enable investors and equipment providers to adjust their stock. See a similar measure[111] implemented in Australia in 2020.
Costs	Minor budgetary costs (of the legislative and administrative change). Increased CAPEX for PV investors in the short-term, an expected decrease in system costs over the longer term.
Financing sources	NAP
Expected implementation schedule/duration	Legislative procedure (6 months)
Relevant for winter 2023/24?	Yes.
Complementarity and/or substitution with other measures	Complementary measure: P-1.1 - Replace grid connection procedures for low-voltage-grid connected PV systems with automatic approval and active curtailment
Expected results and contribution to REPowerEU objectives	The measure would result in a greater capacity of the grid to absorb distributed solar PV, therefore the measure would further increase RES deployment in the mid- to long-term. The measure is complementary to measure P-1.1 and would help avoid rejected applications for rooftop solar PV. We expect a further increase in the production of electricity by rooftop solar on top of that already described in measure P-1.1

[111] https://www.energymining.sa.gov.au/industry/modern-energy/solar-batteries-and-smarter-homes/regulatory-changes-for-smarter-homes

Table 13: Reform – modernize the regulation and performance assessment of DSOs

Information	*Policy measure*
Objective	P-1.3 - Implement TOTEX-based regulation. Implement new ways of assessing the performance of DSOs.
Description	Currently, DSOs in Slovenia are subject to a regulated return rate based on the capital costs of the solutions that they implement. This incentivizes DSOs to prefer investments in infrastructure over smart grid solutions that present lower CAPEX but higher OPEX[112]. Similarly, new indicators for assessing the performance of DSOs should be implemented. For example, monitoring the utilization factor of e.g. a power line would present an incentive to seek innovative solutions for its efficient utilization.
Costs	NAP
Financing sources	NAP
Expected implementation schedule/duration	12 months.
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	/
Expected results and contribution to REPowerEU objectives	The measure would contribute towards a facilitated integration of variable energy sources and demand response. While the impact is difficult to quantify, we deem this measure qualitatively as highly impactful, given that funds needed for infrastructure investment in the Slovenian distribution grid amount to more than 4 billion euros in 2021-2030[113]. If only one percent of new infrastructure investments are replaced with innovative alternatives, 40 million worth of CAPEX investment needs can be avoided over the decade and replaced with solutions with a presumed lower total cost.

3.3.4.1 Proposal 2: Streamlining permitting processes

Table 14: Reform - Digitalise all procedures related to RES deployment

Information	*Policy measure*
Objective	P-2.1 - Digitalise all procedures related to RES deployment

[112] A similar argument regarding the CAPEX bias in the regulation of TSOs was made by ACER in its November 2021 paper titled *Position on incentivising smart investments to improve the efficient use of electricity transmission assets.*
[113] https://www.sodo.si/storage/app/uploads/public/5ff/701/b40/5ff701b40a4eb853335849.pdf (page 55)

Information	*Policy measure*
Description	It is unfortunate that, despite the state of communication technology, some documents in RES-related procedures are required to be submitted or are received by an investor exclusively in physical form and a digital submission is not available)). This is potentially a breach of Article 16(2) of the EU Renewable Energy Directive 2018/2001. This is partly addressed by the proposed Act on the siting of installations to produce electricity from renewable energy sources; however, some institutions, such as the NRA, still require physical communication e.g. in tenders[114] allocating support to RES. Furthermore, efforts could be made towards data sharing between entities involved in procedures related to RES deployment. E.g. automatic sharing of documents could be enabled between the distribution operators, the Surveying and Mapping Authority (GURS), and other relevant entities.
Costs	Negative costs as material and administrative costs are reduced in a transition away from printed communication.
Financing sources	NAP
Relevant for winter 2023/24?	No.
Expected implementation schedule/duration	If physical communication is required by legislation, the entirety of the legislative procedure (some months). If exclusively physical communication is an arbitrary choice of a public entity, relatively fast.
Complementarity and/or substitution with other measures	/
Expected results and contribution to REPowerEU objectives	Accelerated RES deployment, increased investor satisfaction, improved image of public institutions as making active efforts in advancing the energy transition. The efficiency savings in time, resource, and personnel use in transitioning to digital communication cannot be reliably quantified for this case, but they are reflected in the cross-sectoral trend of digitalization. While we do not deem the measure as very impactful (vis-à-vis other challenges of the sector), we do consider it as relatively easy to implement.

The above can be complemented with additional supporting measures.

- Implement regulations that would consider the absence of a (negative) outcome of permitting process from a relevant authority as the authority issuing a valid permit (positive administrative silence).

[114] https://www.agen-rs.si/documents/10926/382438/Besedilo-javnega-poziva-k-prijavi-projektov-OVE-in-SPTE/6cce9a64-01d2-4e61-8df5-4fdc5bc99759

- Parallel execution of the permitting process (Some stages of the RES permitting process could be executed in parallel (e.g. grid connection and construction permits), instead of one being a requirement for an application for the other.).
- Increase and improve the cooperation between the Ministry for the Environment and Spatial Planning and the Ministry of Infrastructure on energy-related matters.
- Implement regulations that would consider the absence of a (negative) outcome of permitting process from a relevant authority as the authority issuing a valid permit.

3.3.4.2 Proposal 3: Improving knowledge-sharing for potential investors

Table 15: Reform - Increase familiarity of the public/investors with environmental impact assessments (EIAs)

Information	*Policy measure*
Objective	P-3.1 - Increase familiarity of the public/investors with environmental impact assessments (EIAs) and other complex procedures related to the RES permitting process.
Description	A lack of experience with EIAs has been identified by some stakeholders. We are advocating for greater transparency and knowledge in this field, so that potential investors can better prepare and partake in the permitting procedure in a more streamlined way. The ministry responsible could offer online workshops including a walk-through the EIA process (and/or other procedures related to RES permitting).
Costs	Negligible additional administrative costs.
Financing sources	NAP
Expected implementation schedule/duration	3 months.
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	/
Expected results and contribution to REPowerEU objectives	The measure would result in increased efficiency of RES permitting procedures and increased investor confidence. The impacts of the measure cannot be reliably quantified. Qualitatively, we do not deem the measure as very impactful in comparison to other challenges in the sector, however, we do consider that it can be implemented with little resources.

3.3.5 Enable different business models for deploying RES projects

Nowadays, there are several business models and transaction structuring options available for deploying RES projects, as such, it is recommended that the following is developed:

1. **Investment**: Develop and establish financial incentives for supporting the development of RES projects via different business models, such as corporate Power Purchase Agreements, on-site Power Purchase Agreements, independent aggregators of flexibility (for example, solar PV co-developed with a battery storage system).

The proposed concrete policy measures are presented below in Table 16 and

Table 17.

Table 16: Reform - Develop and roll-out a capacity building programme for all municipalities and regional authorities

Information	*Policy measure*
Objective	B-1.1 - Develop and roll-out a capacity building programme for all municipalities and regional authorities
Description	Develop an educational/training programs for decision-makers at the municipal (and, soon-to-be-established) regional level. Share experience in developing, managing, and disseminating existing practices in municipal-level energy communities.
Costs	1 person-month cost / year
Financing sources	Could be considered as part of regular tasks of relevant public employee
Expected implementation schedule/duration	3 months
Relevant for winter 2023/24?	Partially (depending on the implementation timeline of projects).
Complementarity and/or substitution with other measures	Complementary measure: Develop an online repository of examples of RES community projects
Expected results and contribution to REPowerEU objectives	The measure would result in greater awareness of possibilities of community and citizen action in the energy field. The impacts of the measure cannot be reliably quantified. We do not deem the measure as very impactful in comparison to other challenges in the sector, however, we do consider that it can be implemented with little resources.

Table 17: Investment - Develop an online repository of examples of RES community projects

Information	*Policy measure*
Objective	D-1.2 - Develop an online repository of examples of RES community projects
Description	Setup an online portal managed by the relevant national authority where types of energy communities and business models that are possible considering the current legislation would be showcased to citizens. This would increase public awareness on possibilities of cooperation and investments in energy projects.
Costs	50k EUR
Financing sources	/
Expected implementation schedule/duration	3 months
Relevant for winter 2023/24?	Partially (depending on the implementation timeline of projects).
Complementarity and/or substitution with other measures	Complementary measure: Develop and roll-out a capacity building programme for all municipalities and regional authorities
Expected results and contribution to REPowerEU objectives	The measure would lead to increased awareness of possibilities of community and citizen action in the energy field. The impacts of the measure cannot be reliably quantified. Qualitatively, we do not deem the measure as very impactful in comparison to other challenges in the sector, however, we do consider that it can be implemented with little resources.

3.3.6 Transport

There currently is a lack of guidelines and policies targeted at the future of transport in Slovenia. Therefore, the following is recommended:

1. **Reform**: develop, introduce and enforce medium- to long-term targets for the green transformation of the transport sector, focusing on reforms, policies, investments and institutional capacity building to strengthen this transition for specific sub-sectors; for example, it is expected that private passenger travel will mostly rely on the adoption of electric vehicles.

electrification is also envisaged for heavy transport, both in terms of infrastructure and vehicle production, whilst public transport (and in some part also heavy transport[115]) will most likely rely on other alternative fuels due to the range of travel requirements – this could include biogas. It should be stressed, of course, that the key is to reduce the use of private transport and increase the proportion of journeys made by public transport.

As of now the law on infrastructure for alternative fuels and promoting the transition to alternative fuels in traffic is pending adoption by the Parliament[116]. This act lays down the foundations for planning the national policy framework for development of infrastructure for alternative fuels in transport, mandatory targets for the establishment of sufficient infrastructure for alternative fuels in transport, measures to promote the transition to alternative fuels for road vehicles, stationary aircraft and vessels and the sources and methods of their financing. Further it also regulates the establishment and operation of the public utility service for the establishment and management of charging parks with a total output power of 3 000 kW and more, the obligations of operators of charging and supply points, technical requirements related to the establishment, operation and maintenance of infrastructure for alternative fuels in transport and requirements regarding information for users, regulates the method and procedures for registering the infrastructure for alternative fuels in transport and keeping records, and regulates the establishment and operation of the Centre for promoting the transition to alternative fuels in transport. The law clearly sets out a plan for the efficient deployment of more electric vehicle charging stations, in the case of other alternative fuels such as biomethane and hydrogen, the law does not go into such detail. National targets for hydrogen and methane (mainly produced from RES) will be set out in the national policy framework (strategies and action plan), which will follow the targets outlined in the NECP.

On 11 October 2022, the Integrated Transport Planning Act was published in the Official Journal of the Republic of Slovenia. The Act defines the basic concepts of integrated transport planning, the types and content of integrated transport strategies, the objectives and principles of integrated transport planning in the context of spatial planning, the co-financing of measures and financial incentives for the implementation of measures under this Act, and information, awareness-raising and education in the field of sustainable mobility. The new approach to transport planning proposed by the law will consistently consider the balance of all transport subsystems and give priority to traffic management. The main purpose of the adopted law is therefore to establish a legal framework for an integrated approach to transport planning that goes beyond the current, mainly sectoral approach, to support the process of reducing the negative environmental impacts of transport, reducing energy use and making more efficient use of space in relation to transport, and to establish a systemic source of co-financing for sustainable mobility measures with a limited timeframe.

For integrated transport planning to be implemented by municipalities, co-financing will be covered by the national budget up to a maximum of 80%. The development of mobility plans and measures to mobility plans, alternative forms of mobility and the use of alternative fuels in transport through education programmes, public information and awareness-raising, financial incentives and other support programmes can also be co-financed by the national budget up to a maximum of 80%.

The resources to finance the above measures are provided within:

- municipal budgets to finance measures based on the municipal and regional Integrated Transport Strategy
- the state budgets

[115] https://data.consilium.europa.eu/doc/document/ST-9111-2022-INIT/x/pdf

[116] https://www.gov.si/novice/2023-02-23-vlada-sprejela-predlog-besedila-zakona-o-infrastrukturi-za-alternativna-goriva-in-spodbujanju-prehoda-na-alternativna-goriva-v-prometu/

- the Climate Change Fund
- funds collected from energy efficiency contributions under the Energy Efficiency Act

The Act provides that the Ministry shall provide education, information exchange and promotion of integrated transport planning opportunities at national, regional, and local levels. Where appropriate, it shall include the representatives of other ministries or external experts

We present measures in three proposals along the below sections 3.3.6.1 to 3.3.6.3.

3.3.6.1 Proposal 1: Advancing fuel shift in public transportation

Table 18: Reform – Advancing fuel shift in public transportation

Information	*Policy measure*
Objective	T1.1 – Advancing fuel shift in public transport
Description	This policy measure can be separated into two sections: modernization/ electrification of the Slovenia's railway system and transition to biomethane/hydrogen usage for bus transit. 1. **Modernisation/ electrification of the railway system** Slovenia's railway system is outdated and in urgent need of modernization and electrification (about half of the lines are non-electrified). There is a need to renew existing lines and build new ones to relieve road traffic. It is essential that the new modern railway system would provide fast, efficient and clean way of transport for all. 2. **Bus transit - transition to hydrogen/electrification** Decarbonising the transport sector also requires a shift to cleaner fuels for bus transport. Currently, a share of the Ljubljana city bus fleet is powered by methane (17%), and 8 electric vehicles have been added to the Kranj city fleet. This share will increase in the future, while hydrogen use would also be included in the transition, as ECP co-financing is foreseen for both electrification and hydrogen (methane financing excluded). The main focus should be on electric buses, as this would avoid the problem of supplying methane or hydrogen. Production of both gases is limited in Slovenia (especially in some parts), and priority focus area for their use would be replacing natural gas in high-temperature industrial processes. Given the current situation and the impetus to accelerate the transition towards decarbonisation of the transport sector, switching to electric vehicles would be a more economically viable option due to the lack of charging and production infrastructure already in place (example of city of Montpellier cancelling 50 hydrogen buses, after realizing that the operating costs would be six times higher than that of electrical buses[117]). Still, it has to be noted that the economics of battery vs H_2 bus may change in the long term. Investments are needed to purchase new vehicles and to set up appropriate charging

[117] https://objectif-languedoc-roussillon.latribune.fr/politique/politiques-publiques/2022-01-06/pourquoi-la-metropole-de-montpellier-renonce-aux-bus-a-hydrogene-899735.html

Information	*Policy measure*
	infrastructure. To enable a quick and efficient transition, a part of investment costs could be covered by the government in the form of subsidies (e.g., 20% of the investment costs).
Costs	1. 450 million EUR yearly[118] 2. 108.5 million EUR to replace existing fossil fuel powered city buses in Ljubljana with electric buses.
Financing sources	Slovenian Enterprise Fund, SID Bank, and the Slovenian Regional Development Fund Budgetary resources, various EU grants and reimbursements funds, possible cross-financing, Climate Fund, Reconstruction and Resilience Fund
Expected implementation schedule/duration	Until 2035 for public transit, 2050 for the railway system
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	1. **Complimentary measure:** organising campaigns to encourage the public use of the railway transport **Complementary measure:** address the "first and last mile" issue. Slovenia is characterised by a dispersed population, and to increase the use of rail transport, it is essential to provide an adequate number of car and bicycle parking spaces close to the city's railway or bus stations. Residents of remote villages would consequently use public transport more often to get to work, which would relieve the burden on road traffic, reduce the consumption of motor fuels and consequently greenhouse gas emissions. Parking spaces would be affordable, and the price would include a train ticket. **Complementary measure:** explore possibilities of biomethane as tractor fuels (see the agricultural circular economy proposals in Chapter 4.1). **Complimentary measure:** Switch to biomethane. A switch to biomethane would make sense in parts of the country where its production is sufficiently high (e.g. in the north-eastern part of Slovenia[119]).
Expected results and contribution to REPowerEU objectives	Electrification of the railway system would directly decrease the dependence on Russian fossil fuels. Additionally, modern and fast train connection could be used by more people to commute and consequently relieve pressure on the road traffic. Similarly, transition to hydrogen would lower the dependence on Russian fossil fuels.

[118] https://www.gov.si/assets/organi-v-sestavi/DRSI/Dokumenti-DRSI/Zeleznice/Vizija-2050+-oktober-2021.pdf
[119] https://borzen.maps.arcgis.com/apps/webappviewer/index.html?id=9a8d05acccff4a908f66de6958c9a3bc

Information	Policy measure
	Today, according to the Statistical Office of the Republic of Slovenia, 83% of passenger kilometres are travelled by car, 6% by bus, 2% by train and 9% by foot, bicycle or other means, with the aim that by 2050 only half of all passenger kilometres will be travelled by car, 25% by public transport and 25% by foot or bicycle. At the same time, this would increase the number of jobs accessible within 30 minutes by public transport by 30%. This should reduce pollutant and noise emissions, improve air quality, and reduce climate change's impact.

3.3.6.2 Proposal 2: Improving the functionalities of EV charging stations

Table 19: Reform - Improving the functionalities of EV charging stations

Information	Policy measure
Objective	T1.2 - Improving the functionalities of EV charging stations
Description	In addition to the accelerated installation of new EV charging stations, some functionalities should be exploited for the effective integration of this large number of charging stations into the system: 1. **Use of flexibility in EV charging** To integrate electric vehicles effectively into the system, their potential for flexibility must be exploited. A legislative framework and financial instruments are needed to encourage end-users to provide flexibility. This can be done by establishment of the flexibility market, as no such mechanism currently exists in Slovenia. Legislative measures allowing operators and aggregators to access in-vehicle-data free of charge need to be put in place. 2. **Install new recharging points with smart charging capability** New publicly accessible charging stations should support bidirectional charging (bidirectional flow of energy), where appropriate to contribute to grid stability and quality of electricity supply. Smart meters need to be gradually deployed in addition to charging infrastructure with digital metering capabilities in a centrally coordinated manner. Smart charging should be enabled in both new and renovated residential and commercial buildings. For this, policies should promote smart charging for both public and private charging infrastructure[120]. Planning for the charging points should be based on technical factors, mobility needs and geography with cooperation from both the DSO and the TSO. To ensure a non-discriminatory access to in-vehicle data, third parties should have an easy access to EV data (such as state of charge, usage pattern…), subject to prior consent of the data owner (this issue should be tackled on the EU level). The energy market should be expanded, enabling the

[120] Best practices and assessment of regulatory measures for cost-efficient integration of electric vehicles into the electricity grid; European Commission; 2021

Information	*Policy measure*
	development of a competitive smart charging market. Deployment of the smart chargers needs to be coupled with renewable energy generation and if possible, in combination with stationary storage to achieve the best results. 3. **V2G-frequency regulation services by EV fleets** A fleet of EVs can successfully support the grid by providing frequency regulation services. Legislative frameworks for allowing such operations and financial instruments (V2G market) to incentivize end-users need to be put in place. Double taxation should be avoided in the case of bidirectional charging as it presents one of the biggest barriers in addition to lack of dynamic pricing schemes and electricity network tariff. Research projects tackling the issue of battery degradation and successful V2G integration should be supported.
Costs	75 million EUR
Financing sources	Slovenian Enterprise Fund, SID Bank, and the Slovenian Regional Development Fund Various EU grants and reimbursements funds
Expected implementation schedule/duration	2030 onwards
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	Complementary measure: Reinforcements of the distribution grid and adoption of market-based flexibility solutions To facilitate the participation of small electricity end-users, additional modifications to the rules governing the short-term and ancillary markets should be considered. The role of aggregators, efficient information exchange, and adequate agreements between aggregators and suppliers/balance-responsible parties are essential for this development to occur. It is crucial to make all flexibility services accessible to all types of flexibility providers and voltage levels. There is a need for precise product definitions, aligned with the Network codes at the European level and taking technology neutrality into consideration.
Expected results and contribution to REPowerEU objectives	Improving the functionalities of EV charging stations would contribute to a more efficient integration of electric vehicles into the system, which would indirectly reduce dependency on Russian fossil fuels. The impacts of the measure cannot be reliably quantified, given the possibility of other subsidies or support schemes. Qualitatively, we deem the measure as very relevant.

3.3.6.3 Proposal 3: Other measures (modal shift)

Table 20: Reform - Other measures (modal shift)

Information	*Policy measure*
Objective	T1.3 - Other measures (modal shift)
Description	1. **Incentive & dissemination schemes to promote cycling or walking on daily commutes** Private motor vehicle journeys represent 67% of all journeys in Slovenia, which results in traffic congestions and suboptimal air quality. This percentage could be reduced by encouraging cycling or walking on daily commutes. A system of financial incentives such as tax breaks, allowances and the like should be put in place. Additionally, a campaign promoting financial, health and other benefits would greatly contribute to public awareness. 2. **Further development of the existing regulation on green public procurement for road vehicles**[121] The current regulation on green public procurement determines the number of clean or low-emission vehicles required, based on the number of vehicles in procurement tenders. For example, for 1-4 vehicles covered by a procurement contract, the mandatory number of clean vehicles is 1, and for 5-9 vehicles it is 2. The higher number is therefore 25% of all vehicles covered by the contract. In the future, we propose to raise this percentage to 50% of all vehicles covered by the contract, which would have the effect of accelerating the transition to a cleaner fleet.
Costs	No extra costs of implementing the proposed change in the regulation.
Financing sources	Budgetary resources
Expected implementation schedule/duration	By 2025
Relevant for winter 2023/24?	Yes.

[121] Decree on green public procurement, subject: Road transport vehicles and transport services, 2021

Information	*Policy measure*
Complementarity and/or substitution with other measures	**Complimentary measure:** Construction of dedicated cycle lanes in areas where there are none. **Complimentary measure:** Encouraging work from home wherever possible.
Expected results and contribution to REPowerEU objectives	Decreasing the percentages of journeys by private motor vehicles would directly decrease collective fuel consumption. Encouraging the purchase of cleaner vehicles would reduce fossil fuel consumption. This should reduce pollutant and noise emissions, improve air quality, and reduce climate change's impact. According to the Statistical Office of the Republic of Slovenia, 83% of passenger kilometres are travelled by car, 6% by bus, 2% by train, and 9% by foot, bicycle, or other means. By 2050, only half will be travelled by car, 25% by public transport, and 25% by foot or bicycle[122].

[122] https://www.gov.si/assets/organi-v-sestavi/DRSI/Dokumenti-DRSI/Zeleznice/Vizija-2050+-oktober-2021.pdf

4 In-depth support on priority areas

4.1 Biogas and biomethane

Biogas production from agricultural and food wastes at biogas plants provides opportunities for ecologically less dubious uses of manure, reduces carbon dioxide (CO_2) emissions, and can be used as a source of energy for heating and electricity. Additionally, the state supports the biogas energy supply by guaranteeing the purchase and price of electrical energy. Among the disadvantages of biogas plants are the relatively high intensity of their investments and the possibility of fluctuations in the supply of heat energy resulting from instabilities in the availability or delivery of wastes as a raw material. The strategic objective in Slovenia is to develop instruments and measures to increase biogas production and biogas energy supply on the predominant small livestock and crop farms.

4.1.1 Current state of biogas deployment in Slovenia

Prior to 2002, the only sources of biogas production in Slovenia were wastewater treatment plants and municipal waste. Before 2002, only Ihan's largest pig farm produced biogas from manure and waste. Since 2002, a government regulation on the purchase of electricity from qualified electricity producers has permitted electricity producers to charge higher prices for electricity generated from waste and similar raw materials, thereby encouraging investment in biogas plants on larger (livestock) farms. As a result, there are few large-scale biogas plants producing thermal energy from animal products and other agricultural food waste in operation in Slovenia.

Table 21: Installed power and yearly production for biogas power plants

Biogas	Installed power of units in the RES support scheme[123] [MW]*	Yearly production[124] [GWh]
2019	23.3	77
2020	29.9	89
2021	14.8	92
2022	13.4	NA

**Installed power of units in the RES support scheme*

Table 22: Overview of the largest biogas plants in Slovenia

Name	Current	Future plans
KOTO d.o.o.	• Already have a biogas plant which yearly produces 4 GWh of electricity and 2 GWh of heat	• Plans to process biogas to biomethane • Start of production around 2024 (planned 2 million m^3/year)
Komunala Velenje	• In 2021 they improved the efficiency of biogas production and the upgrade of CHP capacity (from 150 kW to 210 kW)	• No plans

[123] https://www.borzen.si/sl/Domov/menu2/Center-za-podpore-proizvodnji-zelene-energije/Poro%C4%8Dila-in-podatki/Seznami
[124] https://www.agen-rs.si/-/porocilo-o-stanju-na-podrocju-energetike-v-sloveniji-v-letu-2021

	they ensured full thermal energy and more than 60% electricity self- sufficiency	
Perutnina Ptuj	• One biogas plant (Draženci) • Installed power of 775 kW	• No plans in Slovenia, maybe in other countries such as Croatia or Serbia
Panvita Ekoteh d.o.o.	• 3 biogas plants in operation (Nemščak, Jezera and Motvarjevci) • Total installed power of 3.3 MW • Yearly production: 27.1 GWh of electricity and 5.8 GWh of heat	• No plans in the near future

4.1.2 Biogas potential

The tables below show the estimated demand biomethane in various sectors for 2025 and 2030, based on the calculations made by E3Modelling and our internal calculations.

Table 23: Estimated potential for biomethane use by sectors[125]

Biomethane use (GWh)	2025	2030
Maritime	0	0-5
Road transport	25-35	35-40
Power sector	200-300	200-400
Industry	2-5	25-40
Domestic sector*	0	10-20
Total	227-340	270-500

Table 24: Estimated electricity production via biomethane plants[126]

Year	Production (GWh)
2025	25.1
2030	50.4
2035	71.5
2040	69.5
2045	57.8
2050	65.1

As can be seen in the tables, there is potential for biomethane plants, particularly in the energy sector, and to a lesser extent in the transportation and industry sectors. Small-scale farms, which dominate Slovenia's agricultural structures, have fewer opportunities to produce heat and electricity from biogas plants. This presents an opportunity for the future development of heat and electrical energy in rural areas where agriculture, especially animal production, is significant.

[125] Calculations made by E3Modelling
[126] Internal calculations, IRI UL

4.1.2.1 Gasification of woody biomass

The advantages of using woody biomass in CHP plants are numerous. The main advantage is the highly efficient conversion of low-quality fuels, such as forest residues, waste wood and low-quality wood, into synthetic gas from which high-quality electricity and heat can be generated. The conversion process is completely safe and environmentally friendly, with zero emissions of sulphur and other hazardous compounds and a real reduction in carbon dioxide emissions.

The Department of Wood Engineering, Biotechnical Faculty UL carried out a study[127] of the potential woody biomass in the Republic of Slovenia and the possibilities for its energy exploitation, comparing the available woody biomass potentials and the current use of woody biomass. The current use of woody biomass from wood-processing plants is 476 000 m^3/year, while the study shows that the potential for utilisation is higher, at 1 190 000 m^3/year. Most sawmills[128] sell or rent their sawmill residues or use them for their own purposes (incineration for heat production or woodchip production). Around a third of the residues are used to produce pellets and briquettes, and a percentage of companies take the residues to landfill.

Modular wood biomass gasification plants represent a large and hitherto untapped potential. Such modular units would not be difficult to deploy, as they would be located in industrial plants with a high connection capacity. Such units could deliver 80 to 90 kW of power, 50 kW electric and 50 kW thermal. The rest (10-20%) is used for the pre-treatment of the input material. There are between 300 and 600 such sawmills in Slovenia. By setting up modular wood biomass gasification plants in every sawmill in Slovenia between 300 and 400 MWh of electricity and up to 400 MWh of heat could be generated per year.

When assessing the economics of woody biomass gasification, the negative environmental externalities and efficiency losses of current biomass use should be considered. Externality like air pollution by individual woody biomass combustion presents an air quality problem especially during the colder season.

4.1.3 Barriers: biogas

Barriers to biogas deployment have been identified via structured interviews with relevant Slovenian stakeholders and standalone desktop research. Existing good practices from other countries have also been considered. The barriers to biogas deployment are presented in tabular format below.

Topic area	Description of the gap	Suggested reform/investment to address the gap
Biogas		
Legislation		
Legislation	Wood waste legally still classifies as industrial waste	If impactful, reclassify wood waste.
Legislation	The Forest Act has remained relatively unchanged since 1993.	The Implementation Document for the Development of the Timber Industry by 2030 – calls for an increase in the

[127] Humar Matjaž (2008), Potencial lesne biomase za energetske namene v Sloveniji, https://repozitorij.uni-lj.si/Dokument.php?id=132273

[128] Ščap, Š., Krajnc, N., & Prislan, P. (2021). Stanje žagarske panoge v Sloveniji v letu 2019, https://dirros.openscience.si/Dokument.php?id=18797&lang=slv

		volume of wood to be processed from 2.2 Mm^3 to 3 Mm^3.
Legislation	Legislation does not prevent dumping manure on fields, making the resource scarce for the purpose of producing biogas.	Explore the implications of the use of thermally untreated manure as fertilizer, considering potential externalities for the biosphere. If sensible, redirect manure into biogas production processes.
State administration		
Lack of national strategies	A strategy is needed to assess the multi-sectoral potential of biomass (from the raw material onwards).	Conduct a multi-sectoral analysis into expanding the potential and use of wood biomass. Determine use cases for wood in different parts of the quality/value chain.
Lack of national strategies	A strategy is needed to de-fragment the agricultural sector, at least for the purpose of biomethane production. (*The Slovenian agricultural sector is more dispersed than e.g. German*).	Develop a strategy to find synergies in pooled production of biogas using farm byproducts.
Lack of national strategies	There is no unification of stakeholders who would want to seek synergies in implementing RES solutions.	Unification in the biogas sector is done on a limited level (4 companies are involved). Expand this consortium and extend the good practice to other RES sectors.
Lack of national strategies	Certain private owners do not actively manage their forests.	Develop a strategy and incentives to stimulate sensible management of private forests and produce efficient quantities of biomass.
Lack of cooperation between public entities	In devising strategies, too little communication takes place between the ministries responsible for the environment (environmental aspects) and for	Improve communication between the Ministry for the Environment and the Ministry of Infrastructure.

	infrastructure (economic aspects).	
Networks and connectivity		
Unavailability of the natural gas grid	There is no study on the expansion potential of the gas grid to cover biomethane injection points.	Conduct a study on the potential to expand the transmission or distribution gas grid, considering the businesses interesting in injecting biomethane into the grid.
Technological aspects		
Lack of technology and experience	According to interviewees, there is little knowledge on how to inject and purify biomethane to be injected into the gas grid, and this learning process is also hindered since the Gas Grid Code disallows widespread injection (only small pilot projects exist).	A novel Gas Grid Code is in the pipeline, but the acts are not yet in place.
Lack of technology and experience	Slovenia lacks proprietary technology; biogas solutions are purchased abroad. Furthermore, only limited funds are used, often of outdated technology.	Assess possibilities for local investment into R&D.
Lack of technology and experience	There is a lack of talent and skills for the introduction of hydrogen and biomass.	Assess possibilities for investment into state-level education and training programs related to biogas and hydrogen technologies.
State support and incentives		
Incentive schemes	There is a lack of a guarantees-of-origin scheme for (bio)methane.	Implement such a scheme, analogous to the certificates-of-origin scheme.
Subsidies	Public enterprises have to apply for subsidies with a private enterprise acting as partner.	Assess the rationale behind the rule.

Subsidies	There is currently no subsidy scheme for biomethane; the only type of support is for biogas used in power production.	Introduce direct subsidies for biomethane.
Subsidies	Only small plants/farms (up to 50 kW) are supported by the Ministry, it would be preferable to also support larger biogas/biomethane plants.	Expand support to larger biogas/biomethane plants.
Subsidies	High prices of fertilisers result in higher prices of manure as source of biogas.	/
Obtaining permissions	There is a lack of experience with environmental impact assessment and construction permit processes.	Disseminate good practices in well-managed environmental impact assessments and construction permit applications.

4.1.4 Concrete proposals: biogas

This chapter discusses some concrete proposals towards an efficient and impactful deployment of biogas production in Slovenia. Under each proposal, several measures are presented (not necessarily interdependent.

We first present two groups of measures in tabular form. Then, the measures are further elaborated in the accompanying text.

4.1.4.1 Proposal 1: State-level initiatives on the potential of biogas

Table 26: Reform - Develop a state-level action plan on the potential of biogas

Information	*Policy measure*
Objective	B-1.1 – Develop a state-level action plan on the potential of biogas
Description	Develop a state-level action plan for biogas expansion that would provide guidance to stakeholders. The points mentioned in this measure should be included in the relevant policy documents (for example the revised NECP or other strategic documents). The potential of biogas production should be assessed, considering the tradeoffs of using raw materials (agricultural manure/biomass/food crops/PV land space/municipal waste). Study the potential of local biogas use in CHP plants vis-à-vis purification and injection into the

Information	*Policy measure*
	grid. Study the necessity to begin systematically educating and training staff. While business case assessments for biogas are being performed by companies individually, such analyses could also be performed by a public entity with centralized knowledge, which could also assess societal externalities of biogas introduction in the longer term and explore the potential of synergies between different companies. Attention could be paid to potential cross-sectoral partnership opportunities between different companies. For example, some industries seek renewable gases e.g. for burners. If this process can take place with unpurified biomethane, synergies could be established with biogas plants constructed in the immediate vicinity of the industries.
Costs	No extra costs.
Financing sources	Budgetary resources
Expected implementation schedule/duration	One year.
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	Partially, optimization of biogas production is handled by the market (meat producing stakeholders have been producing biogas since 2012). Still, some issues (e.g. determining the societal preference of using manure for fertilization or rather for biogas production, local consumption vs injection of biogas, state-level provision of knowledge and know-how) can be better resolved at the state level.
Expected results and contribution to REPowerEU objectives	The measure would provide more certainty to investor. In addition, they could benefit from synergies and economies of scale. The impacts of the measure cannot be reliably quantified at this stage. Qualitatively, we deem the measure as very impactful.

Table 27: Reform – Defragmentation of the agricultural sector for the purpose of biomethane production

Information	*Policy measure*
Objective	B-1.2 – Defragmentation of the agricultural sector for the purpose of biomethane production
Description	Explore ways to pool production of biogas by Slovenia's multiple small farms. Seek ways to foster local cooperation to benefit from the economies of scale when processing agricultural slurry/manure. Develop a strategic document providing guidance to stakeholders on the topics. Using manure as the input material in biogas production would result in important positive externalities in reducing the burden of manure storage and the associated leaks into the environment during the cold part of the year.

Information	Policy measure
	The national authority (the Ministry) could also inform citizens and local communities about the possibility of such projects. Incentives for pilot undertakings could be provided. A database of farms together with an estimate of their manure production does exist. Furthermore, the use of farmlands is known (food, animal fodder, other crops). Cross checking this and including the geographic and social elements, potential locations for biogas farms could be devised. The identified potential would be offered to private investors cooperating with farms (collecting manure, returning digestate), or to energy community initiatives that would manage the plant themselves and potentially undertake other investments (e.g. agrivoltaics). A study performed on a regional level could assess the possibilities of transporting manure by means of pipelines where efficient and safe (example in Denmark).
Costs	No extra costs.
Financing sources	Budgetary resources
Expected implementation schedule/duration	2023: Strategic planning and communication: up to 1 year. Designing an appropriate support scheme up to 1 year. 2024 onwards: Constructing a biogas plant: up to 1 year (depending on individual projects).
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	/
Expected results and contribution to REPowerEU objectives	The electricity production potential of biogas from agricultural waste (natural fertilizers) was estimated at 100 GWh by the Ministry's 2014 report[129]. Important sector-coupling gains can be made from processing the manure that would otherwise need to be stored and/or disposed of (especially during winter months). The measure would contribute to the objective of diversifying the energy supply. The impacts of the measure cannot be reliably quantified at this stage. Qualitatively, we deem the impact of the measure as medium.

Table 28: Reform - Develop a national action plan on the long-term potential of biomass

Information	Policy measure
Objective	B-1.3 – Develop a national action and investment plan on the long-term potential of biomass

[129] Strategy for the exploitation of biomass from agriculture and forestry in for energy purposes« (Table 5) http://arhiv2014.skupnostobcin.si/fileadmin/sos/datoteke/pdf/Barbara/PREDLOGI_PREDPISOV/Kmetijstvo/Strategija_biomasa_priloga.pdf

Information	*Policy measure*
Description	Biomass use in Slovenia is a multi-faceted question, not solely limited to the potential of biogas production, but is rather related to several other topics discussed in this report, including energy efficiency, district heating. Nevertheless, it is discussed in the section of in-depth support on biogas. Firstly, there is untapped potential in woody biomass use for the production of biogas (mentioned in 4.1.2.1 and further elaborated in 4.1.4.2). Derivatives from biomass (biomethane, bioethanol) as liquid or gaseous energy carriers have the relevant potential in decarbonizing the Slovenian traffic sector, the most intense sector in terms of energy use[130] (and, arguably, in terms of decarbonization difficulty). It should be assessed, on a national level, whether and how this potential can be exploited. Furthermore, it has been identified in the gap analysis that little to no activities (reforms, subsidies, capacity building) have been identified that focus on inefficient heating appliances. Aging individual heating appliances based on the combustion of biomass combined with behavioural practices of improper wood storage and materials used in combustion present an important health problem in the country[131]. It should be noted that while state support is available for the replacement of old heating appliances, at the same time, newly installed appliances for individual central heating using biomass combustion are also available, which is a suboptimal[132] strategy as regards air pollution reduction (even though it may be more cost-effective, which, however, is partly so due to the negative environmental externality[133] that is not taken into account). The long-term strategy of the country regarding individual heating with biomass combustion is unclear, and, given the environmental externalities that are to become more impactful with the expected increase[134] in the use of biomass combustion due to energy price increases, insufficiently investigated. The Agency for the Environment currently only publishes[135] air quality readings for 16 cities in Slovenia, which provides a barrier to quantifying adverse health impacts in other, less-populated cities of Slovenia with a higher share of biomass heating appliances. The effects of continued support for individual heating with biomass should be investigated on a national level, and a numerical assessment of the

[130] http://kazalci.arso.gov.si/sl/content/raba-koncne-energije-po-sektorjih-2
[131] https://eeb.org/wp-content/uploads/2021/09/Where-theres-fire-theres-smoke_domestic-heating-study_2021.pdf , https://novice.svet24.si/clanek/novice/slovenija/5c3349f8d7ede/ti-delci-so-nevarni, https://n1info.si/poglobljeno/les-obnovljivi-vir-toksicnih-snovi-v-zraku/,
[132] https://eeb.org/wp-content/uploads/2021/09/Where-theres-fire-theres-smoke_domestic-heating-study_2021.pdf,
[133] https://eeb.org/wp-content/uploads/2021/09/Where-theres-fire-theres-smoke_domestic-heating-study_2021.pdf, Table 3.
[134] https://n1info.si/poglobljeno/les-obnovljivi-vir-toksicnih-snovi-v-zraku/
[135] https://www.arso.gov.si/zrak/kakovost%20zraka/podatki/dnevne_koncentracije.html

Information	*Policy measure*
	negative externalities of different types of heating appliances performed[136]. In addition, the responsibilities on the subject of air pollution by heating appliances are currently shared between national and municipal authorities, which can lead to regulatory inefficiency[137]. Responsibility should be reorganised so as to result in effective policymaking. One solution is a national strategic predisposition to small local district heating networks, especially in areas of higher population or where new residential zones are being designed. Larger-scale heating appliances are more thermally efficient, and even if using biomass combustion, assuring safe composition of exhaust gases can be obtained in a more cost-efficient way. Secondly, in cases where district heating is not feasible, transition to heating appliances such as heat pumps should be accelerated, coupled with a dissemination campaign based on social responsibility. Note, however, that the Netherlands is phasing out subsidies for biomass heating on a large-scale as well, citing pollution and the length of the associated carbon cycle[138]. Lastly, as described in other measures within this proposal, use of biomass in biogas production processes can be investigated in combination with use of other materials (such as agricultural waste). Any strategic document should consider the whole biomass value chain and seek to allocate biomass to the most valuable use at each stage, where oxydisation (burning) should be deemed as the least preferable[139].
Costs	Administrative costs as part of the duties of the relevant Ministries. Investment costs as determined by the legislative framework for support given out by the relevant authority (currently Eko Sklad).
Financing sources	Budgetary resources
Expected implementation schedule/duration	2 years
Relevant for winter 2023/24?	Partially.
Complementarity and/or substitution with other measures	Complementary with measures on energy efficiency.

[136] Such as: https://eeb.org/wp-content/uploads/2021/09/Where-theres-fire-theres-smoke_domestic-heating-study_2021.pdf
[137] See e.g. note by municipal authorities on the inefficacy of national authorities (https://pbs.twimg.com/media/FDDHoL0WUAo5DKp?format=jpg&name=large). At the same time, regulations on the prioritisation of different types of household heating are handled on the municipal level, as per Article 29 of the Energy Act (http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6665)
[138] https://news.mongabay.com/2021/03/dutch-to-limit-forest-biomass-subsidies-possibly-signaling-eu-sea-change/
[139] https://www.euractiv.com/section/biomass/news/wood-energy-sector-worried-by-eu-attempt-to-limit-biomass-use/

Information	Policy measure
Expected results and contribution to REPowerEU objectives	The measure would contribute to the objective of efficient energy use, establishing a circular economy and maintaining the quality of life. The impacts of the measure cannot be reliably quantified at this stage. Qualitatively, we deem the impact of the measure as high.

The above can be complemented with additional supporting measures.

- Implement dissemination schemes to inform/incentivize companies to harvest biogas resulting from their activity (meat farms, breweries, etc.).
- Conduct a study assessing the potential to expand the gas grid to cover possible biomethane injection points. Biomethane injection may only make sense in cases of large-scale biogas production, where purification and injection make more economic sense. (Some stakeholders that produce biogas point out that they cannot inject it to the gas grid, as it is not present at their location. They note that they are unaware of any study assessing the potential to expand the gas grid for the purpose of injection.)
- Increase the cooperation between the ministry for the environment and the ministry of infrastructure (covering energy), to better coordinate on strategic guidance and in biogas permitting procedures.

4.1.4.1 Proposal 2: State support schemes for biogas

This proposal consists of two policy measures described in the tables below.

Table 29: Reform – Policy measure Implementing a certificates-of-origin scheme for methane

Information	Policy measure
Objective	B-2.1 – Implementing a certificates-of-origin scheme for methane
Description	A certificate-of-origin scheme exists for electricity, but not for (bio)methane. The implementation of such scheme would incentivize production of methane from organic sources (as well as other renewable sources – synthetic methane). This regulatory measure is only a minor market intervention, leaving autonomy to private investors but increasing the informational transparency and facilitating corporate responsibility. As a similar scheme already exists for electricity, the know-how is already there, and responsibilities can be assigned easily. For the scheme to be effective, a trading system should be established, whereby the producers of methane from less carbon-intensive sources would obtain earnings from the sale off certificates. Note that this scheme can be exclusive with a direct support scheme to bio- or synthetic methane production, if adjustment to the support levels is made based on the number of certificates sold.
Costs	The costs are expected be similar to the costs of the analogous scheme for electricity.
Financing sources	Budgets of responsible authorities (NRA or the support scheme operator).
Expected implementation schedule/duration	12 months

Information	Policy measure
Relevant for winter 2023/24?	No.
Complementarity and/or substitution with other measures	Can be complemented or substituted by a state support scheme to biogas.
Expected results and contribution to REPowerEU objectives	The measure would contribute towards the transparency of the developing biomethane market. It would enable a correct provision of information to methane buyers to stimulate purchases from renewable sources. The impacts of the measure cannot be reliably quantified, given the possibility of other subsidies or support schemes. Qualitatively, we deem the measure as very relevant.

Table 30: Reform – Implementing a subsidy scheme for the production of biomethane

Information	Policy measure
Objective	B-2.2 – Implementing a subsidy scheme for the production of biomethane
Description	Currently, biomethane production is subsidized only indirectly, via operating support for RES-produced electricity. Implement a scheme that would help start the underdeveloped biomethane market. Considering the positive externalities that would arise from producing biogas by processing material that is potentially harmful to the biosphere (agricultural waste, manure, urban wastewater), support could be allocated based on the environmental harm avoided by producing a certain quantity of biogas.
Costs	Depends on type (operational, CfD) and duration of support.
Financing sources	Contribution for CHP and RES, Budgetary resources, Climate Fund.
Relevant for winter 2023/24?	No.
Expected implementation schedule/duration	At least a year for the implementation of the scheme. Duration of the scheme is subject to discussion, likely at least 10-15 years.
Complementarity and/or substitution with other measures	As an alternative to support schemes directly targeting supply, measures incentivizing use of (thereby demand for) biomethane could be implemented; see e.g., the certificates-of-origin scheme proposal. Another alternative is facilitation of corporate PPAs for long-term biomethane purchases.
Expected results and contribution to REPowerEU objectives	Contribution towards implementing a functioning biomethane production sector. This will result in diversifying the electricity supply.

Information	Policy measure
	If the potential assessed by the Ministry in 2014[140] were taken advantage of, around 1 TWh of non-fossil electrical energy could be produced. An additional 0.5 TWh of non-fossil thermal energy could also be obtained.

4.1.4.2 Biomass as a resource for biogas production

Some stakeholders point at Slovenia's potential and issues in the forest biomass sector. According to the Forest Act, the Slovenia's long-term goal is to increase the surface area of forests; however, the envisaged final forest surface is not specified. The annual increment of Slovenia's forests is around 7 million cubic meters, of which noticeably less (4-6 Mm3) is harvested[141]. Around half of the harvest is processed. Slovenia's imports of wood pulp (equivalent to around 0.6 Mm3 of wood biomass) could potentially be replaced by wood that would be grown within the country. Another potential for an increased use of wood biomass is cellulose processing, where bioethanol can be produced (its potential use principally in transport). Another by-product of this process is lignin, usable in the construction industry.

Stakeholders point out to the need for national strategies to be devised or for synergies to be found at the national level. Firstly, and relating to the above, the potential of biomass should be addressed in a multi-sectoral way, starting from the raw material. Furthermore, certain private forest owners do not actively manage it – where applicable, additional incentives could be designed to foster more an efficient private forest management. Regarding multi-sectoral strategies, the stakeholders call for a better cooperation between the ministries responsible for the environment (better equipped to consider environmental aspects) and for infrastructure (better equipped to consider economic aspects).
Strategies could also be designed for dissemination of good practices related to biogas production to the public. In the example of agricultural waste processing, farmers could be informed about the potential of slurry gasification to derive digestate, a more practical fertilizer than slurry.

4.1.4.3 Other resources for biogas production

Similarly to the forest sector (where there are more than 400 000 private owners in Slovenia), the agricultural sector too consists of many smaller farms. For the purpose of biogas/biomethane production, the sector can be considered as fragmented, and not benefitting from economies of scale. Reconsidering cooperatives and seeking other ways of local or national cooperation are options fostering the potential of the Slovenian agricultural sector in producing renewable gases. We see potential in the processing of slurry (especially in wintertime, when a prohibition to dispose it on fields applies). This could be organised by either a private biogas plant investor, or withing an energy community that involves biogas production. The energy potential of gasification of agricultural products and by-products is limited, especially vis-à-vis other potentials to produce low-carbon electricity. Currently, as mentioned, subsidies for biomethane production are indirect, as they apply to electricity production. If new subsidy schemes are implemented, they could focus on compensating positive externalities that arise from implementing human, animal or agricultural waste processing plants that also produce biogas. They could also specifically focus on supporting purified biogas (biomethane) that is injected into the gas grid on a larger scale.
Examples of gas capturing are present in the meat sector as well. An example of a piggery farm in Australia shows that capturing gas and using it as a source of heat and electricity on the farm presents a

[140] Strategy for the exploitation of biomass from agriculture and forestry in for energy purposes« (Table 5) http://arhiv2014.skupnostobcin.si/fileadmin/sos/datoteke/pdf/Barbara/PREDLOGI_PREDPISOV/Kmetijstvo/Strategija_biomasa_priloga.pdf
[141] https://siol.net/novice/slovenija/v-gozdovih-se-povecujeta-lesna-zaloga-in-prirastek-552552

viable business case. There are some examples of capturing biogas in the meat industry already present in Slovenia; however, it could be more widely adopted.

Producing biogas using wastewater could see wider implementation in Slovenia. There is an example of successful cooperation between a wastewater processing plant and the distribution gas grid operator, where the purified biogas obtained in wastewater processing is injected into the grid.

4.1.4.4 Biogas transport, purification and injection into the grid

As wastewater processing is usually performed on a relatively large scale and in the vicinity of cities with their gas grids, this presents greater feasibility in injecting the biomethane into the grid. In most other cases described above, however, it is usually more prudent to use the biogas on-site (to produce electricity and/or heat).

4.2 *Renewable and fossil-free hydrogen*

In this section, the hydrogen sector is discussed. While considering that in the long-term, the development of renewable hydrogen production is of biggest importance, we also discuss transitionary measures involving fossil free hydrogen production.

It is prudent that specific sectors be identified where dedicated use of hydrogen is to be implemented first. In this report, we propose that high-temperature industrial processes and certain sectors of heavy transport be prioritised in this context.

4.2.1 Current state of hydrogen in Slovenia

There are currently no (big) hydrogen projects in Slovenia, but several businesses have plans to incorporate the technology in the near future.

Table 31: Future projects involving hydrogen in Slovenia

Name	Description
Project SLOP2G[142]	• Partnership between four Slovenian companies: Plinovodi, ELES, Holding Slovenske elektrarne in Hidroelektrarne na spodnji Savi • Merging of electricity and gas sectors • Integration of two energy sites, where renewable electricity and electricity peaks in the system will be converted into renewable hydrogen, which will be further converted into synthetic methane through methanation • At both sites, the renewable hydrogen and synthetic methane will be available for injection into the gas transmission network (injected separately with renewable hydrogen into hydrogen pipeline and synthetic methane into the gas transmission network) and for use by industrial (i.e. asphalt and cement production) and commercial end-users (i.e. big shopping centres) • Setting up of an optimisation and simulation model to optimise the sources of electricity needed for the production of renewable hydrogen and the consumption of mixtures of hydrogen and synthetic gas with natural gas • Establishment of a trading platform for renewable gases with certificates of origin for green gas
North Adriatic	• The North Adriatic Hydrogen Valley is the first European transnational project to create a dedicated hydrogen valley. The three-country partnership (Croatia, Italy, Slovenia), led

[142] https://www.hse.si/en/slovenian-green-hydrogen-and-connecting-electricity-and-gas-sectors-in-slop2g-project-en-translation/

Hydrogen Valley (NAHV)[143]	by Slovenian company Holding Slovenske Elektrarne, the country's largest electricity producer and trader, involves 34 organisations and covers the entire chain, from production through storage and distribution to the end use of hydrogen in various sectors, notably industry and transport. • The project proposal was submitted for application in September 2022 and awarded with a 25 million EUR grant in January 2023. It will last 72 months, starting most likely in the second half of 2023. • The consortium consists of 34 partners from research, institutions and industry – energy and transport. • Key industry players from all three countries will develop pilot projects to produce more than 5 000 tonnes of renewable hydrogen per year from renewable energy sources, as well as its storage, distribution and use. The ultimate goal of the project is to decarbonise important industrial sectors such as steel and cement production and to provide sustainable transport solutions linked to reducing the carbon footprint. • It is part of the Clean Hydrogen Partnership of REPowerEU, which contributes to REPowerEU objectives by scaling up renewable hydrogen production, supply and consequently to meet the growing demand from industry, transport and other sectors. • Establish value chains from production, storage and distribution to the end-use of hydrogen in various sectors, notably industry and transport. This will contribute to the objectives of the European Green Deal and the European Hydrogen Strategy.
Steklarna Hrastnik[144]	• Steklarna Hrastnik developed a process that partially replaces the use of natural gas in glass melting by using hydrogen produced with electricity from its own solar power plant.
SIJ Acroni[145]	• SIJ Acroni uses hydrogen in its technological process. A few years ago, they used to produce it in their own hydrogen plant, but production was discontinued. They are now buying hydrogen on the market in gaseous form and are considering setting up a hydrogen plant with a capacity of one megawatt. In addition to producing hydrogen for technological purposes, the steelworks are also examining the possibility of producing hydrogen for injection into the gas grid.

Table 32: Estimated potential for hydrogen use by sectors[146]

Hydrogen use (GWh)	2025	2030
Net imports	0	20-100
Rail transport	0	1-2
Road transport	2-4	200-350
Industry	0	10-50
Input to E-fuels	0	152-300
Total	2-4	368-722

[143] https://www.hse.si/sl/projekt-severnojadranske-vodikove-doline-v-katerem-je-vodilni-partner-hse-prejel-25-milijonov-nepovratnih-sredstev/
[144] https://oe.finance.si/8967457/Inovacija-s-katero-v-Steklarni-Hrastnik-z-vodikom-izpodrivajo-fosilna-goriva
[145] https://oe.finance.si/8966889/Nacrti-SIJ-Acronija-velika-soncna-elektrarna-izraba-odvecne-toplote-in-vodikarna
[146] Calculations made by E3Modelling

Table 33: Estimated production of hydrogen through electrolysis[147]

Year	Production (MWh)
2025	0.1
2030	1.0
2035	2.3
2040	12.3
2045	30.2
2050	30.1

4.2.2 Barriers: hydrogen

As seen, there are some pilot initiatives in including hydrogen in production processes of some major industry players. Some initiatives regarding demand for hydrogen exist as well (pilot vehicle fuelling stations). Still, the renewable hydrogen sector in Slovenia is currently in its infancy.

The industry stakeholders understand the necessity to implement hydrogen into their production processes within the century. It is also understood that some parts of the traffic sector will have to rely on this energy vector. Stakeholders do, however, point out to several difficulties.

The difficulties seem to arise from the high costs of implementing the technology, coupled with Slovenia's small size and import dependency as regards e.g. electrolysers. Stakeholders also point out to a lack of a national strategy for this sector. It should be noted that some estimates of renewable hydrogen CAPEX and OPEX made by the interviewed stakeholders appear to be much higher than the costs estimated by the relevant literature. The detected barriers are summarised in Table 34.

Table 34: The barriers to hydrogen deployment

Topic area	Description of the gap	Suggested reform/investment to address the gap
Hydrogen		
State administration		
Lack of national strategies	A strategy is needed to assess the complete national potential of hydrogen.	Conduct a multi-sectoral analysis into expanding the potential and use of hydrogen. Assess the potential for key industries and individual business subjects.
Economic barriers		
High costs	High investment and operating costs of hydrogen projects.	Facilitate renewable PPAs to attract business partnerships, providing green electricity at a steady price. Utilise the potential of hydrogen production to benefit from price fluctuations on electricity spot markets. Participation in transnational or regional projects, including the

[147] Internal calculations, IRI UL

		Northern Adriatic Hydrogen Valley (NAHV)[148]. NAHV will promote the potential of hydrogen technologies in order to attract investment and establish a value chain from hydrogen production to hydrogen use. Implement a contract-for-difference scheme, considering best practices from other countries.
Small market size	As Slovenia is small, opportunities to benefit from the economies of scale are limited.	Improve local and regional cooperation. Pool purchases of hydrogen infrastructure (e.g. electrolysers). Consider the potential of the local industry to invest in activities related to producing the infrastructure required for hydrogen projects.
State administration		
Lack of subsidies	There is currently no general scheme to support hydrogen projects. No funds are sourced from the Climate Fund.	Consider implementing economically efficient support schemes for renewable hydrogen production to reduce initial investment uncertainty and compensate investors for the positive externalities of their investment. Consider implementing technology-neutral CO_2-reduction tenders for state support (e.g. SDE++ in the Netherlands).

4.2.3 Concrete proposals: hydrogen

In this section, we describe concrete proposals to tackle the barriers described above and to advance the deployment of hydrogen projects in general. Each proposal consists of multiple separate measures that are not necessarily inter-dependent.

Note that due to the development stage of the sectors, proposals relating to hydrogen are of long-term nature and generally do not apply to winter 2023/24.

4.2.3.1 Proposal1: State-level initiatives on the potential of hydrogen

This proposal consists of two stand-alone policy measures – adopting a national hydrogen strategy (macro level) and a central authority assisting with investigating the potential of individual companies (micro level). The proposals are described in more detail in the tables below.

[148] https://ecubes.si/north-adriatic-cross-border-hydrogen-valley-launched-today/

Table 35: Reform – Adopt a national hydrogen action plan

Information	Policy measure
Objective	H-1.1: Adopt a national hydrogen action plan to provide direction, guidance, and foresight to the industry
Description	Slovenia is one of the few EU Member States that do not have a dedicated hydrogen strategy. Such a strategy could provide guidance to stakeholders as they assess the future viability of their potential investments. Nevertheless, as the preparation of a stand-alone strategy is a complex and long-lasting procedure subject to resource constraints of the relevant public entities, we propose that the action points described below can also be included in existing strategic documents (e.g. the NECP). The strategy or action plan could focus one the concept of first creating demand for hydrogen, then increasing hydrogen production from renewable sources and building the necessary infrastructure. In the strategic document, Slovenia could explore the issues in establishing hydrogen demand. The per-sector potential of hydrogen should be determined. Clear statements should be made to stakeholders regarding the technologies that are to be used to tackle specific sectors. A clear signal that some sectors (heating and cooling, car transport) will be tackled with other technologies would help in providing guidance to businesses. Regarding traffic, however, as a transit country, Slovenia could consider inducing hydrogen demand for long-distance road cargo and supporting charging stations on the relevant highways (one pilot project already exists). Furthermore, some sections of the railway operated by diesel trains. Considering the environmental, societal, and energy-security impact of diesel trains, a study should be conducted on the most future-proof abatement method: powering trains by biodiesel, hydrogen, or electrification of the railway. Strong hydrogen demand could also be induced for urban and regional bus transportation (should it prove more sensible than electrification in the long term), by larger-scale charging stations at bus hubs. Other sectors with hydrogen demand potential should be analysed. Possibilities of hydrogen production should be assessed as well. Some companies already produce fossil-based hydrogen. Slovenia's electricity transmission grid is relatively uncongested, so hydrogen production using electrolysers could be produced directly at the site of its consumption. This notwithstanding, should the construction of a new unit of the Krško nuclear power plant take place, the possibility of coupling the project with (on-site) fossil free hydrogen production could be assessed. This could assure the virtual flexibility of the power plant and improve its economics. Slovenian companies would, as things stand, be required to buy electrolysers abroad. Leading EU companies producing electrolysers are slowly transitioning to production of large-scale electrolysers (above 10

Information	Policy measure
	MW, in the long term above 100 MW). As the Slovenian market is relatively small, possibilities for cooperation within the country and the region need to be explored. The potential for Slovenian companies to participate as partners or sub-contractors in large-scale international energy projects could also be investigated. Regarding capital costs of production of hydrogen in general, an analysis could target: • the possibilities of pooled larger-scale purchases of electrolysers or ensure the development of cross-border infrastructure to import renewable hydrogen from EU regions with high production of renewable hydrogen. • potential for investments in the production of electrolysers (at a local or regional level). Regarding operational costs: • Assess the possibilities of preferential treatment for less carbon-intensive forms of hydrogen. • Facilitate PPAs for hydrogen producers to access low-cost base electricity. • Efficient spot and flexibility markets should enable the electrolysers to also benefit from price fluctuations. If necessary, complement with contract-for-differences schemes based on a reference price of e.g. producing hydrogen with natural gas. Such a reference price should be determined in a competitive procedure. In case that parallel hydrogen infrastructure is established, development should consider the existing industries already producing and consuming hydrogen, thereby substituting other means of transport. The strategic document could provide insight into how a smooth transition from a natural-gas-dominated system to a hydrogen-only system can be achieved in specific sectors of greatest priority.
Costs	No extra costs of implementing the proposed change in the NECP.
Financing sources	Budgetary resources
Expected implementation schedule/duration	6 months.
Relevant for winter 2023/2024?	No.
Complementarity and/or substitution with other measures	Complementary measure: H-1.2 - Investigate the hydrogen potential of individual companies
Expected results and contribution to REPowerEU objectives	The measure would contribute towards implementing a functioning hydrogen sector. It would assure greater information transparency to investors. Increase public awareness of the possibilities of hydrogen. The impact of the measure cannot be reliably quantified at this stage. We qualitatively assess the measure as highly impactful.

Table 36: Reform - Investigate the hydrogen potential of individual companies.

Information	Policy measure
Objective	H-1.2 – Investigate the hydrogen potential of individual companies
Description	Implement a national "hydrogen potential research task force" entrusted with assessing the individual potential of Slovene companies to implement hydrogen in their production processes. Explore the possibilities of inter-company synergies. Assessments of the possibility of implementing hydrogen have been performed by some companies individually (e.g. Steklarna Hrastnik). However, such analyses could also be performed by a public entity with centralized knowledge, which could also assess the societal externalities of hydrogen introduction in the longer term and explore the potential of synergies between different companies and consider in the analysis the possible positive externalities (e.g. increased safety when transitioning from steam reforming to electrolysis). Complemented by a national hydrogen strategy, this measure should identify the industries and businesses with key potentials to implement hydrogen in their production processes. This measure would support knowledge sharing and cooperation between the private and public sectors.
Costs	20k – 50k EUR
Financing sources	Budgetary resources.
Expected implementation schedule/duration	6 months.
Relevant for winter 2023/2024?	No.
Complementarity and/or substitution with other measures	Complementary measure: H-1.1: Adopt a national hydrogen action plan to provide direction, guidance, and foresight to the industry
Expected results and contribution to REPowerEU objectives	The measure would contribute towards implementing a functioning hydrogen sector. The impacts of the measure cannot be reliably quantified at this stage. Qualitatively, we deem the measure as medium-impactful.

Proposal 2: State support schemes for renewable hydrogen

This proposal consists of a policy measure addressing state support to renewable hydrogen projects.

Table 37: Reform - Implementing a subsidy scheme for the production of hydrogen

Information	Policy measure
Objective	H-2.1 - Implementing a subsidy scheme for the production of renewable hydrogen
Description	There is no general support scheme for the development of H_2 projects. A scheme would incentivize renewable hydrogen pilot projects, focusing on a dedicated use of hydrogen. Existing examples of good practice in some sectors of the nation's industry show that there is strong awareness of the necessity to transform production processes in the long term. The public scheme should only apply to initiatives where the added value of hydrogen is greatest (i.e. not to traffic and heating, where a more efficient electric alternative exists). The scheme should include a competitive element that would incentivize the most sensible projects. Possibilities could be explored of technology-neutral support schemes that would reward projects with greatest CO_2 reduction potential (e.g. the SDE++ scheme in the Netherlands). As opposed to supply support, consider the possibilities of subsidizing or mandating renewable hydrogen demand, which in turn would incentivize H_2 production where most efficient, and thereby stimulate the value chain. Hydrogen sinks are needed and are a prerequisite for a sensible expansion of H_2 production, therefore policies should always start from the demand side and then try to stimulate the supply chain in the most efficient manner possible.
Costs	Depends on the type (investment support, operational, CfD), duration of support and the sector of demand. We propose that the support focus on high-temperature industrial processes and heavy transport.
Financing sources	Climate Fund
Expected implementation schedule/duration	At least a year for the implementation of the scheme. Duration of the scheme is subject to discussion.
Complementarity and/or substitution with other measures	Could be substituted or complemented with increased take-up of long-term PPAs.
Expected results and contribution to REPowerEU objectives	The measure would contribute towards implementing a functioning hydrogen sector. The impacts of the measure cannot be reliably quantified at this stage – the economics depend on the type of support chosen. Qualitatively, we deem the measure as medium-impactful.

4.3 Winter 2023/24

Given the non-short-term nature of most measures described in this chapter, we also propose some short-term measures in different areas, particularly applicable for the winter 2023/24:

- Move towards and prepare for an increased number of investments in energy efficiency of buildings during the summer of 2023. Disseminate about the necessity of good insulation, possibilities of recuperative ventilation etc. Inform citizens about existing state co-financing schemes (Eko sklad) and provide estimations of savings. Investments into energy efficiency will be most attractive if citizens are exposed to prices of energy that are not kept artificially low by state intervention. Support would be more efficient if targeted only at vulnerable households in the form of lump-sum transfers. If identifying vulnerable consumers is not possible, regulated prices could be applied only for a part of the consumption.
- Implement energy efficiency measures in all public buildings. To assure funding, implement public-private partnerships (energy contracting).
- In expectation of a Russian diesel import ban, public entities could show a good example by implementing partial teleworking policies in all public institutions where feasible, with the goal of reducing the consumption petroleum derivatives.
- Concerning legislative measures, abstain from keeping fuel prices artificially low, as this presents an increased demand and disincentive for efficient behaviour.
- Implement a market-based interruption mechanism for the prioritisation of shut-offs in a potential emergency in gas demand. This would allow companies to assess their individual value of the energy not supplied and avoid centrally planned interventions that carry a potential of ineffectively halting the economy.

5 Hands-on support

The ministry has requested a knowledge capacity activity regarding the technologies for hydrogen, biomethane, biogas, and gasification of wooden biomass, their SWOT analysis and potential, support schemes and best practices around the EU, and the feedback gathered from Slovenian industry within the REPOWER project.

This will be carried out in a form of a 2-day workshop (1-day hydrogen + 1-day biomethane, biogas, and gasification of wooden biomass) for the employees of the ministry and other government stakeholders. The estimated effort for this is 10 person-days.

5.1 Summary of hands-on support provided to the Member State

As part of the process of revising the National Energy and Climate Plan (NECP), the Ministry of Infrastructure held a consultation with industry experts on "*The future of natural gas and alternatives*" on November 16, 2022. The purpose of the consultation was to discuss the key orientations and assumptions underlying the development of the new NECP projections with a larger audience of experts. On a panel with other professionals from system operator of the electricity transmission grid ELES, Slovenian manufacturing company KOTO d. o.o., company managing the gas transmission network Plinovodi d.o.o., Jožef Stefan Institute, and Ljubljana heating company Energetika d.o.o., Dr. Tomi Medved presented the preliminary findings of our work on biomass potential and gasification of wood biomass. Panelists shared their insights and experiences and exchanged opinions regarding the current challenges of the future supply of natural gas and new gases, the potential and viability of natural gas alternatives, and the future development of gas infrastructure. The current version of this report has been augmented with numerous useful insights.

6 Annex A

Table 38: The list of the stakeholders consulted

Nr.	Stakeholder
1	Biomasa
2	Agricultural Institute of Slovenia
3	The Slovenian Forestry Institute
4	Ministry of Infrastructure
5	Jozef Stefan Institute x 2
6	Faculty of Mechanical Engineering x 2
7	Faculty of Electrical Engineering x 2
8	Public Utility Company Velenje
9	Energetika Maribor
10	KSSENA (Local Energy Agency)
11	Salonit Anhovo
12	SIJ (Slovenian Steel Group)
13	Steklarna Hrastnik
14	Kalcit
15	Belinka
16	Ministry of the Environment and Spatial Planning
17	KOTO
18	Perutnina Ptuj
19	Energetika Maribor
20	Holding Slovenske Elektrarne

In addition, we would like to thank colleagues from the four Slovenian Distribution System Operator companies Elektro Ljubljana d.d., Elektro Primorska d.d., Elektro Gorenjska d.d., and Elektro Celje d.d. for their helpful comments and suggestions regarding the deployment of renewable energy and the optimization of permitting processes.

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