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STORE&GO

Legislative and Regulatory Framework for Power-to-Gas in Germany, Italy and Switzerland

D7.3

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List of Abbreviations

AEEG/ARERA	Italian Regulatory Authority for Electricity Gas and Water
AIA	Integrated environmental authorisation
BMWi	German Federal Ministry of Economic Affairs
CHF	Swiss Franc
CHP	Combined heat and power
CIC	Italian Certificate of Release for Consumption
DETEC	Swiss Federal Department of the Environment, Transport, Energy and Communications
DVGW	Deutscher Verein des Gas- und Wasserfaches
EIA	Environmental impact assessment
ELcom	Swiss Federal Electricity Commission
ENTSO-E	European Network for Transmission System Operators Electricity
ENTSO-G	European Network for Transmission System Operators Gas
ERC	Swiss emission reduction certificate
EU	European Union
EU-ETS	EU Emission Trading Scheme
Gcal	Gigacalories
GSE	Gestore Servizi Energetici
GW(h)	Gigawatt(-hour)
ISO	Independent system operator
ITO	Independent transmission system operator
KW(h)	Kilowatt(-hour)
LCOE	levelised costs of producing energy
LME	State Office for Mining, Geology and Minerals of Brandenburg
LNG	Liquefied Natural Gas
MW(h)	Megawatt(-hour)
OU	Strict ownership unbundling
PEM	Proton Exchange Membrane
PV	Photovoltaic
RES	Renewable Energy Source
SFOE	Swiss Federal Office of Energy
SNG	Substitute or synthetic natural gas
SVGW	Schweizerische Verein des Gas- und Wasserfaches
VIU	Vertically integrated undertaking
VSE	Verband Schweizerischer Elektrizitätsunternehmen
VSG	Verband der Schweizerischen Gasindustrie

Executive Summary

Object and Scope of this Deliverable

The STORE&GO project is a Horizon 2020 project which demonstrates three innovative power-to-gas concepts at demonstration sites in Germany (Falkenhagen), Switzerland (Solothurn), and Italy (Troia).[1] The overall objective of the project is to demonstrate how power-to-gas can provide synergies between electricity and gas as energy carriers for the transportation, storage, and end-use of renewable energy.

This report is the second Deliverable under the scope of Task 7.3 of the STORE&GO project. Task 7.3 has as its goal to identify legal and regulatory challenges for the deployment of power-to-gas at the European Union (EU) and national level. A first Deliverable, titled *“European Legislative and Regulatory Framework on Power-to-Gas”*, has been published by the end of 2017.[1] The focus of this second Deliverable is on the national legal framework applicable to power-to-gas in Germany, Italy, and Switzerland, the three countries in which the STORE&GO pilot sites are located. The original title of this Deliverable as stated in the Grant Agreement is “Report on the licensing modalities, regulatory regimes and complexities at the three demo sites”. However, to make the title more self-explanatory to the reader unfamiliar with the project, it was slightly adapted, without changing the scope of the Deliverable. Topics which are covered are: legal classification of power-to-gas, unbundling of power-to-gas in relation to system operation and gas storage system operation, national authorisation procedures for the STORE&GO pilot plants, legal measures facilitating the injection of synthetic, or substitute, natural gas (SNG) into the gas network, exemptions from network tariffs and other charges, and national support schemes related to the use of SNG.

Overview of content per chapter

Chapter 3 addresses the question of how power-to-gas is classified under national energy legislation. For every country under assessment, it is examined whether power-to-gas is covered under legal definitions related to storage in the electricity context, final electricity consumption, and gas/electricity production. This review reveals that a clearly delimited legal definition of storage in the electricity context is either absent (Germany and Switzerland) or is limited to power-to-power technologies (Italy). In the latter case, as concluded under chapter 7 of this report, power-to-gas is not granted the same incentives as power-to-power storage. It was also found that power-to-gas is simultaneously treated as the final consumption of electricity and a gas production activity, or when combined with a combined heat and power installation, as electricity production. Only Switzerland excludes power-to-gas from the concept of final consumption when the reconversion of SNG into electricity takes place.

Chapter 4 provides an analysis of the national unbundling rules for network- and storage system operators in the context of power-to-gas. It was found that Germany, Italy, and Switzerland all lack national unbundling rules which explicitly address the ownership and operation of power-to-gas facilities by system operators. The consequence of power-to-gas being classified as gas production is, however, that transmission system operators in all three countries under assessment must refrain from operating such a facility. The unbundling rules prohibit such regulated entities to perform competitive activities such as production and supply. Furthermore, in neither of the three jurisdictions is an affirmative legal framework in place which allows these system operators to operate a power-to-gas-to-power chain in support of their legal task to transport energy and maintain system integrity.

[1] See STORE&GO project website: www.storeandgo.info.

At the distribution level, only Swiss law would allow a distribution system operator to operate a power-to-gas facility, as Swiss unbundling rules at that level are less stringent than those in Germany and Italy. For these two countries, the EU rules prescribe that a distribution system operator has to be legally and functionally unbundled from (gas) production.

Finally, it is unclear to what extent the combined operation of a gas storage facility and a power-to-gas facility is allowed, as gas storage system operation must also be legally and functionally unbundles from production activities. A table summarising the findings in this chapter is included on page 36.

Chapter 5 presents the results of an inventory of the authorisation procedures for the STORE&GO pilot sites. A first conclusion from this chapter is that power-to-gas installations are treated as installations for the production of chemicals, instead of installations for the production of an energy commodity. As a result, the authorisation procedure for power-to-gas installations may be more burdensome than for biogas installations. Second, in neither of the three reviewed jurisdictions is a power-to-gas operator obliged to operate under a same permit as operators of natural gas production sites, as this does not involve the exploitation of mineral or natural resources. Finally, only Italy has introduced a unified authorisation procedure which allows to streamline the different permit applications through one authority. A table summarising the findings in this chapter is included on page 46.

Chapter 6 examines the legal conditions and measures for accommodating SNG into the natural gas network. Questions which are addressed are i) whether national gas legislation classifies SNG as a (renewable) gas; ii) what the connection conditions for a power-to-gas plant are, and whether a cost distribution mechanism is in place; iii) which technical gas quality specifications apply, and; iv) if a framework is in place to remedy potential capacity constraints at the distribution level. It was found that Germany in this regard can be identified as a “best-practice country”, as it has introduced various privileges which should promote the injection of SNG as biogas into the gas network. For example, for connections to the gas network below 1 kilometre in length, 75% of the costs are born by the system operator. Furthermore, system operators may be required to install overflow installations which enable renewable gas, which is often injected at the distribution level, to flow to the transmission level, thereby relieving distribution networks from potential capacity constraints. A table summarising the findings in this chapter is included on page 64.

Chapter 7 covers the different cost components which have to be paid by final consumers of electricity and examines whether exemptions exist for operators of power-to-gas installations. As electricity is an essential feedstock of the power-to-gas process, the electricity price and related additional costs have a large impact on the business case. Chapter 3 already concluded that the feed-in of electricity to the electrolyser is generally considered to be final consumption. Final consumers of electricity are required to pay for various cost components which are stacked on top of the electricity commodity price. The most common are network tariffs (so called “L-charges”) and surcharges earmarked for the financing of support schemes. As this would mean that both the power-to-gas operator *and* the actual final consumer of the energy would have to pay such charges, the results is a double taxation of the same unit of energy. This chapter shows that exemptions from network tariffs for power-to-gas without reconversion to electricity only exist in Germany. In Italy and Switzerland such exemptions only exist for the power-to-gas-to-power scenario.

With regard to surcharges for the financing of support schemes, exemptions exist for the power-to-gas-to-power storage process, and possibly for the power-to-gas process as”energy intensive activity”. A table summarising the findings in this chapter is included on page 73.

The consequence of the current situation described in this chapter, which is especially advantageous for power-to-power storage, is that the transfer of renewable energy from the electricity system to other sectors is discouraged.

Chapter 8 provides an overview and analysis of the national incentive schemes which may support the use of SNG. In order to compensate for the relatively high production costs of SNG in relation to natural gas, support schemes will be required for the short- to mid-term. Support schemes for renewable energy are often focused on a specific technology or specific end-use. An important conclusion of this report is that Germany, Italy, and Switzerland all have taken power-to-gas and SNG into consideration in the design of one or more support schemes. The production of SNG as fuel for transportation is receiving the most incentives. Another important conclusion is that financial support may be conditioned on the source of carbon for SNG production (fossil, biogenic or ambient). For example, under a recently adopted Italian support scheme for biomethane as transportation fuel, SNG is only included when the carbon is of a biogenic nature. In Switzerland, a motion has been adopted to support vehicles which can be fuelled by SNG, but only when the carbon is supplied through ambient air capture.

Electricity production from SNG is only directly supported in Germany. To facilitate a power-to-gas-to-power chain in which the SNG can be transported from the power-to-gas installation through the gas network to a power generation unit at a different location, a mass balancing system can be used. Through such mass balancing, SNG, as so-called “storage gas”, can be tracked within the gas network. This allows the natural gas which is eventually withdrawn from the network to be identified as “virtual storage gas”. As the height of the financial support for electricity production from SNG as storage gas does not take into account the costs for power-to-gas conversion, storage, and the transport of SNG through the gas network, it is argued that this current scheme is not economically reasonable or profitable. This could be remedied by introducing a similar flexibility premium as for programmable electricity generation from biogas.

With regard to the use of SNG for heating purposes, it is found that the German and Italian support schemes for renewable heat do not apply to SNG. This places SNG in a disadvantaged position compared to biomass-based gases, which are included under the respective schemes. In Switzerland, measures are proposed to decrease emissions from fossil sources used for heating in the building environment. Here it is discussed that SNG is not to be considered as a fossil fuel, and can thereby contribute to the Swiss ambition to decarbonise the heating sector.

Finally, it is concluded that statutory frameworks for guarantees of origin for SNG and other renewable gases are lacking in all three countries. A table summarising the findings in this chapter is included on page 90.

1 Introduction

This report is the second Deliverable under the scope of Task 7.3 of the STORE&GO Horizon 2020 project.[2] This Task has as its goal to identify legal and regulatory challenges for the deployment of power-to-gas at the EU and national level. A first Deliverable, titled *"European Legislative and Regulatory Framework on Power-to-Gas"*, has been published at the end of 2017.[1] The focus of this second Deliverable will instead be on the national legal framework applicable to power-to-gas in Germany, Italy, and Switzerland, the three countries in which the STORE&GO pilot sites are located.

1.1 Power-to-Gas in the STORE&GO Context: Overview of the Three Pilot Plants

Power-to-gas is the process through which, in a first stage, electrical energy is used as input for the production of hydrogen (H_2) through the decomposition of a water molecule by electrolysis.[2] The by-product of this process is oxygen (O_2) which can be released into the atmosphere. In an optional second stage, the hydrogen can be synthesised with carbon dioxide (CO_2) into methane (CH_4) through a catalytic Sabatier process or through biological methanation.[3] As the methane produced through power-to-gas is of a similar quality as natural gas, the gas produced through the two-stage process is generally referred to as "synthetic- or substitute natural gas" (SNG). The heat which is produced has a by-product due to the exothermic nature of the methanation process can be captured and utilised in various (industrial) applications. The carbon dioxide required for the methanation stage can be obtained from a variety of sources such as industrial and power generating installations (endpoint), biogas purification (biogenic), or the ambient air (ambient).

The concept "power-to-gas" used by industry or in the literature may refer to the single stage process of power-to-hydrogen or the two-stage power-to-SNG process.[2] Hydrogen in itself can be utilised in electricity generation and mobility through fuel cell technology, or serve as a feedstock for industrial applications. As illustrated in Figure 1-1, the emphasis within the STORE&GO project goes beyond the production of hydrogen. All STORE&GO plants deploy the two-stage power-to-gas process for the production of SNG.

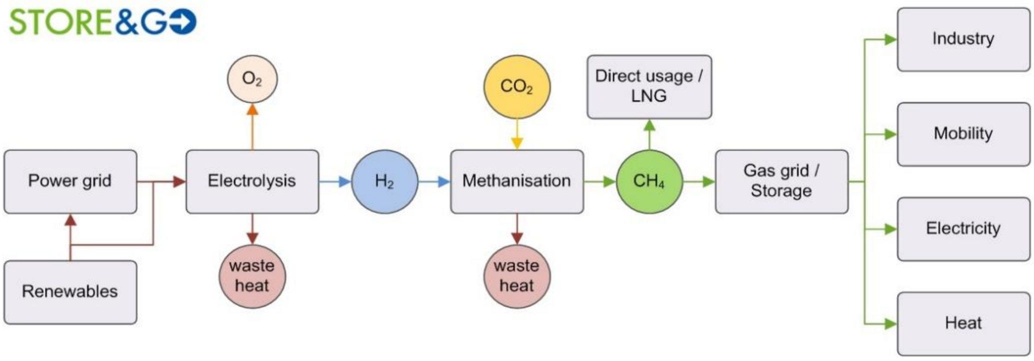

Figure 1-1: Overview of the two-stage power-to-gas supply chain (image by STORE&GO)

The three STORE&GO demonstration sites in Falkenhagen (Germany), Solothurn (Switzerland), and Troia (Italy) have been designed and located in such a way as to test the operation of a power-to-gas plant under different local conditions. The configuration of the pilot sites differ in choice of electrolysis and methanation technologies, carbon sources, and electricity and gas grid conditions. Table 1-1 provides an overview of the different characteristics of the three pilot sites.

[2] See STORE&GO project website: www.storeandgo.info.

	Demonstration site Falkenhagen (Germany)	Demonstration site Solothurn (Switzerland)	Demonstration site Troia (Italy)
Representative region with respect to typical generation of RES	Rural area in the North East of Germany with high wind power production and low overall electricity consumption	Municipal area in the Alps region with considerable RES from PV and hydro production	Rural area in the Mediterranean area with high PV capacities, considerable wind power production, low overall electricity consumption
Connection to the electricity grid	Transmission grid	Municipal distribution grid	Municipal distribution grid
Connection to the gas grid	Long distance transport grid	Municipal distribution grid	Regional LNG Distribution network via cryogenic trucks
Plant size (in relation to the el. power input)	1 MW	700 kW	200 kW
Methanation technology to be demonstrated	Isothermal catalytic honeycomb/structured wall reactors	Biological methanation	Modular milli-structured catalytic methanation reactors
CO_2 source	Biogas or bioethanol plant	Waste water treatment plant	CO_2 from atmosphere
Heat integration possibilities	Veneer mill	District heating	CO_2 enrichment
Existing facilities and infrastructure	2 MW alkaline electrolyser, hydrogen injection plant	350 kW PEM electrolyser, hydrogen injection plant, district heating, CHP plant	1 MW alkaline electrolyser

Table 1-1: Overview STORE&GO demonstration sites

1.2 Correlation with Deliverable 7.2 on EU Legislation

Task 7.3 is subdivided into two Deliverables. Deliverable 7.2, available at www.storeandgo.info, has presented a review of European Union (EU) legislation relevant to power-to-gas.[1] This Deliverable 7.3 will cover the national legislative frameworks of Germany, Switzerland and Italy. Together, Deliverable 7.2 and 7.3 will provide input for policy recommendations in the project-wide roadmap which will be drafted during the final stages of the STORE&GO project.

An overview of the topics covered under both Deliverables is provided in Table 1-2 below. This Table allows the reader to link the content on the national frameworks under the current Deliverable 7.3 with the reviewed EU framework under Deliverable 7.2. It thereby functions as a correlation table.

Content Deliverable 7.3	Chapter	Correlated Chapter under Deliverable 7.2
National energy and climate targets	2	3
Classification of power-to-gas	3	5
Unbundling rules in the context of power-to-gas	4	5

Authorisation procedures for power-to-gas	5	10
Legal Framework for accommodating SNG in the gas network	6	7
Network tariffs, taxes, and other surcharges	7	9
Support Schemes for the Use of SNG	8	8 & 9

Table 1-2: Correlation Deliverables 7.3 and 7.2

Note that an assessment of power-to-gas in the electricity sector will be provided under work package 6 of the STORE&GO project.[4]

1.3 Methodology

The research for this Deliverable has been executed by way of:

- Desk study of primary and secondary literature;
- Collection of input from the three STORE&GO pilot sites through questionnaires, and;
- Interaction with external country experts.

In order to make the findings of each chapter more accessible to the reader, various tables have been included under this Deliverable which allow for comparison between the different national legal frameworks. Where appropriate, these findings have been allocated a colour (green, orange, or red) as to indicate the extent to which these measure can be characterised as having a supportive (green) or discouraging (red) effect on power-to-gas. Orange indicates that the precise content of a measure is open to interpretation or that its application to power-to-gas is conditioned.

1.4 Acknowledgments

The author of this report would like to express his gratitude to the following persons for providing input and advice: Alessandro Rossi (EII), Andrea Mazza (Polito) Andrew Lochbrunner (Regioenergie Solothurn), Christoph Plattner (Swiss BFE), Helge Föcker (Uniper), Jachin Gorre (IET), Luca di Marte (University of Groningen), and Micheal Schmid (Erdgas VSG). Many thanks go also out to the following reviewers: Ruven Fleming (University of Groningen), Martin Seifert (SVGW) and Kathrin de Bruyn (EIL).

2 Introduction to National Energy and Climate Ambitions and Relevant Institutions

This chapter will, under section 2.1, briefly discuss the energy and climate objectives of the countries under assessment. The most relevant national institutions involved in policy- and rule making are introduced in section 2.2.

2.1 National Energy and Climate Ambitions

Table 2-1 below provides an overview of the quantitative national climate targets set by Germany, Italy and Switzerland, and by the EU. The main points under the national climate plans are discussed in the subsequent sections.

	EU	Germany	Italy	Switzerland
2030				
RES share in final consumption	27%	30%	28%	
RES-Electricity	45%	65%	55%	Increase of 48.800 GWh of RES-E by 2035 (of which 11.400 GWh non-hydro and 37.000 GWh hydro)
RES-Heating			17-19%	
RES-Transport			28-30%	
CO_2 Emission Reduction (relative to 1990)	40%	55-56%		50%
Energy Efficiency	-27% (compared to a business as usual scenario)		-30%	-43% (in 2035 compared to 2000)
2050				
RES share in final consumption		60%		
RES-Electricity		80<%		
CO_2 Emission Reduction (relative to 1990)	80-95%	80-95%	80<%	70-85%
Energy Efficiency		-50% (compared to 2008)		

Table 2-1: National Energy and Climate Objectives

2.1.1 Germany

The transitional process towards a decarbonised energy system in Germany is known as the *Energiewende*, literally meaning: “energy turn-around”. Although the term *Energiewende* has been around for decades, the long-term climate strategy underlying this turn-around was presented in 2016 under the Climate Action Plan 2050 (*Klimaschutzplan 2050*).[5] Important themes under the climate strategy towards 2050 are electrification, digitalisation, energy efficiency, and the phase-out of electricity generation from nuclear and coal. The Climate Action Plan contains little reference to natural gas. Although the use of gas infrastructure is mentioned in the context of sector-coupling and the need of efficient coordination between the different energy infrastructures for electricity, heat, and gas. The most important legal instrument driving this plan forward is the Renewable Energy Act (*Erneurbare-Energien-Gesetz*, hereafter "EEG").

The 2018 coalition agreement for a new government between the CDU/CSU and SPD includes the ambition to support the further development and market introduction of power-to-gas and power-to-liquids.[6] Also energy storage in general and the potential of hydrogen for various sectors are addressed.

2.1.2 Italy

In 2017, the Italian Ministry of Economic Development and the Ministry of the Environment jointly presented Italy's National Energy Strategy (*Strategia Energetica Nazionale*) for 2030.[7] Although the document lacks legally binding force, the strategy sheds light on Italy's energy and climate ambitions and policy for the period until 2030. The strategy is designed around the themes competitiveness, sustainability, and security, also known as the "energy policy triangle".

In terms of energy production, Italy's National Energy Plan reveals the ambition by the Italian Government to phase-out coal as a source for power production by 2025. The increase in the share of renewable energy in electricity generation will need to come from solar, wind, and hydro power. As will be discussed in more detail under section 8.2, the production and consumption of biomethane, including SNG, for transportation will be stimulated through a newly adopted Biomethane Decree.[3] Through such support, the Italian government hopes to prevent that it will fail to achieve the 10% renewable energy target for the transportation sector for 2020 which is prescribed under EU legislation.[4] Natural gas is expected to play an important role as a back-up source for electricity generation and heating. This will require an expansion of existing gas infrastructure, including facilities to receive and regasify liquefied natural gas (LNG). Power-to-gas is mentioned as a technology which enables the intelligent integration of energy networks and is considered a promising storage technology and pathway to produce renewable fuels.

2.1.3 Switzerland

Switzerland already has a relatively high share of renewable energy in its energy mix. Due to the favourable natural conditions, almost 60% of electricity in Switzerland is produced from hydro power. Another 33% is produced by nuclear installations.[5]

In 2016, the Swiss Parliament approved the Energy Strategy 2050 (*Energiestrategie 2050*) which sets out the long-term direction for Swiss energy and climate policy.[6] The four strategic objectives of the Strategy are increasing energy efficiency, an increase in use renewable energy, the phase-out of nuclear energy, and international collaboration. The first piece of legislation which should give effect to the Energy Strategy for 2050, the revised Energy Act (*Energiegesetz*), was adopted in 2017 after having received the approval of the Swiss public through a referendum. Combined heat and power production is expected to play an important role as back-up for intermittent renewable energy production. Another important measure is the linkage of the Swiss and EU emission trading schemes in 2019.

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[3] Although not yet officially published, this Decree will be referred to as the "2018 Biomethane Decree", the text thereof is accessible through: http://www.sviluppoeconomico.gov.it/images/stories/normativa/DM-biometano-2-marzo_2018_ FINALE.pdf...

[4] Article 3(4) of the 2009 Renewable Energy Directive (2009/28/EC).

[5] *See* for energy statistics: http://www.bfe.admin.ch/themen/00526/00541/00542/index.html?lang=en

[6] *See* for an introduction to the Energy Strategy 2050: http://www.bfe.admin.ch/energiestrategie2050 /06445/index.html?lang=en.

2.2 Relevant Institutions

2.2.1 Germany

Germany is a federal republic consisting out sixteen states (*Länder*). This means that certain matters fall under the exclusive competence of the national legislator (*Bund*), while over other issues the national legislator and the states hold concurrent legislative powers. On matters of concurrent legislative power, the states have the power to legislate so long as, and to the extent that, the federation has not exercised its legislative power by enacting a law on that issue.[7] Among the issues of concurrent legislative powers are: economic matters (including mining, industry, and energy), labour law, protection of nature and landscape management, and regional planning.[8] On the matter of energy, the federal legislator has issued an extensive *acquis* of laws applicable to the energy sector. The centre piece of German energy law legislation is the Energy Industry Act of 1935 *(Energiewirtschafgesetz,* hereafter "EnWG"), last amended in 2017. The Federal Ministry of Economy Affairs and Energy (*BMWi*) is the most important ministerial department for the development of energy policy.

In the field of environmental protection and spatial planning, the states still maintain extensive legislative concurrent powers.[8] Although the federal legislator has also enacted legislation in these areas, the German Constitution, or Basic Law (*Grundgesetz für die Bundesrepublik Deutschland*), stipulates that the states are still allowed to adopt legislation in these areas as long as this does not lead to conflicts with federal legislation.[9] This allows the states to play an important role in the authorisation procedure of energy project, *see* chapter 5.

The energy sector is regulated by the Federal Regulatory Agency (*Bundesnetzagentur*) and the Federal Cartel Office (*Bundeskartellamt*). The *Bundesnetzagentur* has no general normative powers, but is only allowed to issue individual and specific instructions.[8]

2.2.2 Italy

The primary legislative instrument in Italy is the Legislative Decree, which are national laws adopted or ratified by the Italian Parliament. Although Italy is not formally a federal state, the Constitution of the Italian Republic (*Costituzione della Republica Italiana*) contains a similar concept of concurrent legislative powers as in Germany. Article 117(3) of the Constitution establishes that the "production, transport, and national distribution of energy" are matters of concurrent legislative powers shared between the national state and the regions. In practice, this allows the state to adopt framework legislation which reserves certain discretion for the 20 regions.

So called "secondary legislation" for the energy sector is adopted by the Ministry of Economic Development in the form of ministerial decrees. In the area of climate and environmental issues, such ministerial decrees are adopted by the Ministry for the Environment, Land and Sea. These decrees must have their legal basis in primary legislation issued by the Italian parliament.

Acting as the independent national regulator for the energy sector, the Italian Regulatory Authority for Electricity Gas and Water (*L'Autorità di Regolazione per Energia Reti e Ambiente,* or ARERA) adopts Resolutions for the implementation of the Legislative and Ministerial Decrees. As before the 1st of January 2018, the authority was still known as the Italian Authority for Electricity and Gas (AEEG), the regulator will be referred to as AEEG/ARERA. The AEEG/ARERA has as its task to protect all system users and consumers, to promote competition, efficiency, and cost-effectiveness,

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[7] Article 72(1) of the Basic Law for the Federal Republic of Germany last amended on 23 December 2014.
[8] Article 74(11, 12, 29, and 31) of the Basic Law for the Federal Republic of Germany last amended on 23 December 2014.
[9] Article 72(2) and (3) of the Basic Law for the Federal Republic of Germany last amended on 23 December 2014.

and to promote environmental protection.[9] To this end, the AEEG/ARERA establishes the methodologies for calculating the network tariffs, promulgates resolutions on issues in the electricity and gas sector, and has a advising and reporting responsibility towards the government and parliament.[10] Its task is, therefore, much more normative than that of the German *Bundesnetzagentur*.

Finally, the *Gestore Servizi Energetici* (GSE) is responsible for the coordination and execution of measures promoting the development of Renewable Energy. GSE is a private company with the Ministry of the Economy and Finance as its only shareholder. Importantly, the regions possess administrative powers within the renewable energy sector.

2.2.3 Switzerland

Switzerland is a federal state in which the 26 regions, known as cantons (*Kantone*), have competence over all issues which have not been delegated to the national level.[11] With the adoption of the Federal Energy Act, the CO_2 Act (*CO_2 Gesetz*), the Nuclear Energy Act (*Kernenergiegesetz*) and the Electricity Supply Act (*Stromversorgungsgesetz*), the national government has made the regulation of the energy sector primarily a federal issue. A proposal for a Gas Supply Act (*Gasversorgungsgesetz*) is expected to be made public for consultation in 2019.[12] The Federal Energy Act emphasises the need for coordination between the national state, cantons, and municipalities, and between the authorities and energy industry.[13]

For an act (*Gesetz*) to be adopted, it has to pass in both the National Council and the Council of States which together form the Swiss Federal Assembly (*Bundesversammlung*). These acts often allow the Swiss government, the Federal Council (*Bundesrat*), to adopt more specific implementing measures under an ordinance (*Verordnung*). In so far as it does not lead to conflicts with federal legislation, the cantons are allowed to adopt more specific energy related acts. For example, Canton Solothurn, where the STORE&GO plant is located, has adopted its own Energy Act. Finally, the Federal Environmental Protection Act (*Umweltschutzgesetz*) awards the cantons considerable discretion in the setting of detailed rules on environmental protection and authorisation procedures.

The Swiss Federal Office of Energy (SFOE) of the Federal Department of the Environment, Transport, Energy and Communications (DETEC) is responsible for the coordination of issues related to energy supply and consumption. It, *inter alia*, supports research and development in the field of energy storage. The task of regulator for the electricity sector is delegated to the Federal Electricity Commission (ELcom). For the gas sector, in which the degree of regulation can be described as marginal, the task of oversight lies with the SFOE and the Swiss courts ruling in disputes over civil law and competition law.

Although Switzerland and the EU have negotiated several bilateral agreements in various areas, negotiations on an agreement for the electricity sector are currently on hold. Nevertheless, the Swiss Electricity Supply Act and announced Gas Supply Act are already taking into consideration the common EU rules for the electricity and gas sector. Furthermore, Swissgrid and Swissgas are as respective electricity and gas transmission system operator involved in the work of the European Network for Transmission System Operators Electricity (ENTSO-E) and gas (ENTSO-G). Swissgrid as founding member of ENTSO-E and Swissgas as observer within ENTSO-G.

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[10] Legislative Decree No. 481/1995 of 14 November 1995.
[11] Article 3 of the Swiss Federal Basic Act of 18 April 1999 (*Bundesverfassung der Schweizerischen Eidgenossenschaft).*
[12] *See* for information of the development of a Gas Supply Act: http://www.bfe.admin.ch/themen/00486/00488/06662/index.html?lang=en.
[13] Article 4 of the Swiss Federal Energy Act of 30 September 2016.

3 Classification of Power-to-Gas within the Energy Supply Chain

None of the legal frameworks of Germany, Italy or Switzerland contain a definition of power-to-gas. As a result, the legal classification of power-to-gas (facilities) has to be determined in the context of the existing legal definitions on (energy) storage, end-users, and production/generation under the respective national laws. Legal classifications and definitions often function as gatekeepers that are limiting the scope of application of certain legal measures to specific technologies or activities. For example, the classification of an activity as final consumption may result in an obligation to pay certain network charges, consumer taxes, or other surcharges. Similarly, classifying an activity as production will have a direct influence on the answer to the question whether a transmission or distribution system operator is allowed to deploy this activity or not.

Existing EU and national energy legislation is still to a large extent designed around the “traditional” activities of production, transportation, supply, and consumption.[14] As gas storage facilities have been part of the natural gas supply chain for decades, specific rules for the operation of such assets have also been developed. Not until recently have legislators started to address the question how technologies which store electrical energy should be classified.[1]

Storage of energy generally involves the charging, actual storage, and discharging of energy. With storage in the electricity context, electricity is charged and converted to a medium which can be stored. After the actual storage, the energy is discharged as electricity. Alternatively, through cross-sectoral power-to-x technologies, the energy can be discharged in the form of gas or heat. The discussion under chapter 5 of Deliverable 7.2 already illustrated that there is an ongoing and lively debate on how to delimit the charging and discharging of stored energy from consumption or production. It was also concluded in this chapter that power-to-gas is even more difficult to fit under one class or activity due to the different scenarios in which power-to-gas can be deployed and due to the existence of parallel classifications under EU electricity and gas legislation. Power-to-gas may be used for power-to-gas-to-power storage when connected to a combined heat and power installation, or may be deployed for the production of SNG designated for heating or transportation. From the perspective of energy transportation, power-to-gas as energy conversion technology can be deployed to transport energy as molecules instead of electrons, thereby using the gas network as an extension of the electricity grid.[10]

This chapter will assess how power-to-gas can be classified under the national energy laws of Germany, Italy, and Switzerland. To this end, section 3.1 will discuss the possible classification of power-to-gas as storage, section 3.2 will review to what extent the feeding of electricity to the electrolyser is considered final consumption, and section 3.3 will cover the possible classification of power-to-gas as production activity.

3.1 Power-to-Gas as Storage

Unless indicated otherwise, storage in this section refers to technologies which enable the storage of *electrical* energy. On the classification of power-to-gas as storage two questions arise:

1) do the national energy laws include a definition of storage in the electricity context?;
2) if yes, does the definition cover cross-sectoral storage technologies such as power-to-gas even when the energy is discharged as gas without the aim of reconversion to electricity?

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[14] *See* 2009 Electricity- and Gas Directives (2009/72/EC and 2009/73/EC).

The second question already indicates that a definition of "storage" in the electricity context may be limited to power-to-power (thus requiring the reconversion of the energy stored to electricity), or may be of a cross-sectoral nature and include power-to-x technologies, including power-to-gas.[1] The assessment under Deliverable 7.2 on the definition of "energy storage" under the proposed EU Recast Electricity Directive, which is part of the Clean Energy for All Europeans Package, led to the conclusion that the European Commission has opted for a cross-sectoral approach, thus including storage technologies which charge electricity and discharge gas or heat (*see* Table 3-1).[1] At the time of publishing of this Deliverable, the European Parliament and the Council of the European Union both support this cross-sectoral approach.[15] Negotiations on the final text of the Recast Electricity Directive were still ongoing.

As existing EU legislation does not yet contain a definition of storage in the electricity context, Member States, and Switzerland as non-EU Member States, still possess the freedom to develop their own legal conditions for the deployment of energy storage and power-to-gas. It should be noted, however, that Germany and Italy will be required under European law to transpose the eventually adopted Recast Electricity Directive into national law. This means that they will have to adopt their legal frameworks on storage accordingly. In anticipation of the outcome of this legislative process at the EU level, the current national approaches to the concept of storage, and how this relates to power-to-gas, will be discussed below. A schematic overview of the findings in this section is provided in Table 3-1 below.

Terminology encountered	**Definition on storage provided?**	**Does the definition apply to power-to-gas when energy is not reconverted to electricity?**
Proposal European Commission		
Energy Storage Article 2(47) of the Recast Electricity Directive	"Energy storage" means, in the electricity system, deferring an amount of the electricity that was generated to the moment of use, either as final energy or converted into another energy carrier."	Yes, *see* Deliverable 7.2
Germany		
Installations for the storage of electrical energy Articles 1(4), 1a(3),12, 13b(1 and 5),13i(3), 13k(4), 18(2), 19(1), 31(3), and 118(6) of the EnWG 2017	No	Should be inferred from context of the provision in which this term is used
Electricity storage Article 119(2) EnWG 2017	No	Unsure, likely only applies to power-to-power storage
Installations for the conversion of electricity in other energy carriers Article 119(2) EnWG 2017	No	Yes

[15] Documents on the legislative process concerning the Clean Energy for all Europeans Package and the latest position by the Parliament and Council can be accessed at EUR-LEX: http://eur-lex.europa.eu. The conclusions in this Deliverable are based on document No. 15886/17 by the Council and document No. A8-0044/2018 by the Committee on Industry, Research, and Energy of the Parliament.

Italy		
Systems for the storage of electrical energy Article 2(m) of the AEEG/ARERA Resolution 547/2014/R/EEL	"A "storage system" is a set of devices, equipment and management and control logics, functional for the absorption and release of electricity, designed to operate continuously in parallel with the network with a third party access obligation. The storage system can be integrated or not with a production plant (if present)."	No
Switzerland		
Electricity storage Article 6(1) of the Federal Energy Act	No	No

Table 3-1: Encountered terminology on storage in relation to power-to-gas

3.1.1 Germany

Already in 2013, the storage of electricity was recognised by the then incoming government as an option for providing flexibility to the electricity system. In its coalition agreement, the incoming German government expressed its expectation that, in the future, a mix of different storage options would be required.[11] Because of this plurality of storage technologies, a technology neutral legal framework was envisioned. Nevertheless, after five years and revisions in 2014 and 2017, the EnWG does still not provide a definite and clear definition of energy- or electricity storage. Although the EnWG 2017, under Article 3(31), includes a definition on "storage facilities" (*Speicheranlage*), this term only applies to facilities used for the stocking of (natural) gas:

> *"A storage facility is a facility owned or operated by a gas supply company for the storage of gas, including the part of LNG plants used for storage, with the exception of the part used for production, and excluding facilities which are reserved exclusively to operators of gas networks in the performance of their duties."* (Article 3(31) of the EnWG 2017, translation by author)

This definition of a gas storage facility under the EnWG mirrors the definition under the EU 2009 Gas Directive (2009/73/EC). As can be inferred from its wording, the definition is limited to facilities for the storage of gas. Although, as will be discussed under chapter 6, the term "gas" under the EnWG 2017 encompasses hydrogen and SNG, the activity of the power-to-gas plant itself is not the storage of a gas. The essence of power-to-gas technology is rather the conversion of electrical energy into a gaseous form which can *subsequently* be stored in gas storage facilities or gas pipelines. It would thus be difficult to argue that a power-to-gas facility falls under the definition of "storage facility" under the EnWG, even when the power-to-gas facility located on-site of the gas storage facility.[12]

In absence of a definition in the EnWG on storage in the electricity context, the BDEW, the German Association of Energy and Water Industries (*Bundesverband der Energie-und Wasserwirtschaft*), proposed in 2014 a definition of "energy storage" (*Energiespeicher*) and a definition for "electricity storage in the electricity supply system" (*Stromspeicher im Stromversorgungssytem*): [13]

> *Energy storage (Energiespeicher)*
>
> *"Installations which withdraw energy with the aim of the electrical, chemical, electrochemical, mechanical or thermal storage thereof, and which make this energy available again at a later point in time."* (translation by author)

Electricity storage in the electricity supply system (Stromspeicher im Stromversorgungssytem)

"Energy storage, which withdraws electrical energy from a public supply network, intermediately stores this energy, and injects the discharged electrical energy in a public supply network, The purchase of the electrical energy for the purpose of intermediate storage is no end-use". (translation by author)

The first proposed definition of energy storage would include power-to-x technologies, while the latter definition of electricity storage would require the reconversion of the stored energy into electricity, thus only including power-to-x-to-power technologies. Neither of these two proposed definitions made its way to the EnWG. The idea of differentiating between power-to-power and power-to-x technologies can, however, be found in the EnWG. For example, Article 119(2) speaks of installations for electricity storage (*Anlagen zur Stromspeicherung*) and installations for the conversion of electricity in other energy carriers (*Anlagen zur Umwandlung elektrischer Energie in ein anderen Energieträger*). This differentiation seems to suggest that the term "*stromspeicher*" (electricity storage) only refers to technologies which convert the energy back to electricity after storage. Importantly, the term "installations for the conversion of electricity in other energy carriers" is used only once in the EnWG in the context of the roll-out of a research and development programme related to digitalisation.

Various other provisions in the EnWG make reference to the undefined term "installations for the storage of electrical energy" (*Anlagen zur speicherung elektrischer energie).*[16] Article 118(6) EnWG, which establishes an exemption from network tariffs for such installations, makes explicit mention of power-to-gas as eligible technology, even when the gas is not eventually reconverted to electricity. In this context, it thus seems that the German legislator considers power-to-gas as a sub-category of "installations for the storage of electrical energy".[14][12] For other contexts in which the term "*Anlage zur speicherung elektrischer energie"* is used, it is less clear whether this also covers power-to-x technologies.[17]

The conclusion is that the EnWG contains different terminology to refer to technologies which aim to store electricity. In absence of clear definitions on "*stromspeicher*" or "*Anlagen zur speicherung elektrischer energie*", there remains uncertainty as to which storage technologies and applications fall under these concepts. This makes it essential to examine on a case-by-case basis from the context of a particular provision whether or not this applies to power-to-gas, especially when no reconversion into electricity is intended to take place.

3.1.2 Italy

The storage of electricity in Italy occurs predominantly through pumped hydro storage. As of 2016, there were 19 pumped hydro storage facilities operational in Italy, with a combined capacity of over 7.7 GW.[18] However, the 1999 Bersani Decree No 79/1999, which lays down the rules for the Italian electricity sector, as well as the 2011 amendment thereto through Legislative Decree No 93/2011, do not provide a definition on storage in the electricity context. To bring more legal certainty to the developing Italian energy storage sector, an Inter-ministerial Decree of 2012 requested the regulatory authority, the AEEG/ARERA, to develop measures for the integration of systems for the storage of electrical energy. In response, the AEEG/ARERA issued Resolution 574/2014/R/EEL on "Provisions regarding the integration of systems for the storage of electrical energy in the national electricity system" (hereafter "Resolution 574/2014/R/EEL"). Under this Resolution, "systems for the storage of electrical energy" (*sistemi di accumulo di energia elettrica*) are defined as:

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[16] *See* Articles 1(4), 1a(3),12, 13b(1 and 5),13i(3), 13k(4), 18(2), 19(1), 31(3), and 118(6) of the EnWG 2017
[17] For example in Article 12 and 13(b) of the EnWG 2017.
[18] Information about installed storage capacity per country is provided by http://www.energystorage exchange.org (data retrieved on 28 February 2018).

> *A "storage system" is a set of devices, equipment and management and control logics, functional for the absorption and release of electricity, designed to operate continuously in parallel with the network with a third party access obligation. The storage system can be integrated or not with a production plant (if present)*. [19] (translation and underlining added by author)

Looking at wording of the above cited definition on "storage systems", especially the underlined section, the definition requires that the system is capable of absorbing *and* releasing electricity. As such, a power-to-gas installation which is not (directly) connected to a re-electrification unit, for example a combined heat and power installation, is not covered under this definition. As a consequence, the operator of power-to-gas plants which are connected to the gas system are denied the same incentives as those awarded to operators of batteries or pumped hydro storage units under Resolution 574/2014/R/EEL. For example in relation to exemptions from network tariffs and other surcharges (*see* chapter 7).

The limited attention to power-to-power technologies under the current Italian regulatory framework may change in the future. Under the heading "storage systems" in the National Energy Strategy 2017, power-to-gas is explicitly discussed as an example of an intelligent storage technology for the integration of electricity, water, and gas networks.[7]

3.1.3 Switzerland

Due to the favourable geographical conditions, Switzerland has extensive experience with the storage of electricity through pumped hydro storage facilities. This explains why pumped hydro is the only storage technology which has been awarded explicit attention in the Electricity Supply Ordinance (*Stromversorgungsgesetz*) and the Energy Act. With the entry into force in 2018 of the revised Energy Act and Energy Ordinance (*Energieverordnung*), electricity storage (*stromspeicher*) is being awarded modest attention under Swiss federal energy law. Article 6(1) of the Federal Energy Act now explicitly mentions that the energy supply chain includes storage. The article refers to two different types of storage: "*Lagerung*" and "*Speicherung*". The former term refers to storage in the context of nuclear energy, the latter to the storage of electricity.[20] A definition of what constitutes storage in the electricity context is, however, lacking. For the moment, the Federal Council expressed its opinion that only technologies which charge *and* discharge electricity should be treated as storage in a similar fashion as pumped hydro storage.[21] As such, the treatment of power-to-gas by the Swiss authorities as storage technology will depend on its deployment, i.e. whether the power-to-gas conversion, the storage, and the reconversion to electricity take place at one location.

3.2 Power-to-Gas as Final Consumer

Generally perceived as one of the largest obstacles to the profitable deployment of energy storage and power-to-gas is the obligation to pay final consumer network charges, taxes, and other surcharges.[22] This treatment of energy storage installations as final consumption during the charging phase has been broadly criticised (*see* section 9.4 of Deliverable 7.2). This criticism revolves around the fact that the electricity is not actually consumed during the storage process, but instead by the final customers to whom the energy is supplied after storage.[1] If both the storage operator and the actual final consumer are obliged to pay the various charges and taxes, this would lead to a double taxation of the same energy.[1] For power-to-gas, where the converted and stored energy can be put to use both within as well as outside the electricity system, the argument is the same. The actual

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[19] Article 2(m) of the AEEG/ARERA Resolution 547/2014/R/EEL.

[20] *See* applied wording under the Nuclear Energy Act of 21 March 2003, No. 732.1 and the Federal Energy Act of 30 September 2016.

[21] Position by the Federal Council of 25 May 2016 on Motion 16.3265, "Equal treatment of storage technologies in network charges".

[22] *See* discussion under section 9.4 of STORE&GO Deliverable 7.2.

consumption does not occur during electrolysis, but when the hydrogen or SNG is used for electricity production, heating, or transportation.

Against this background, this section will assess whether the withdrawal of electricity by energy storage and power-to-gas installations is qualified as final consumption under the respective national laws under assessment. A schematic overview is provided below under Table 3-2. Possible (temporary) exemptions for network charges, taxes, and other surcharges related to the withdrawal of electricity for electrolysis are discussed under chapter 7.

	Definition of "final consumer"	Exclusion for power-to-x-to-power storage?	Exclusion for power-to-gas?
Germany	"natural or legal persons purchasing energy for their own use"	No	No
Italy	"natural or legal persons purchasing energy for their own use"	No	No
Switzerland	"customer who purchases electricity for its own use. Excluded here from is the purchase of electricity for (…) the propulsion of the pumps in pumped storage power plants"	Yes	No

Table 3-1: definitions of "final consumer" in relation to power-to-gas

3.2.1 Germany

The question whether operators of energy storage and power-to-gas facilities should be regarded as final consumers is extensively debated in German literature.[12][14][17] Article 3(25) EnWG 2017 defines a "final consumer" (*Letzverbraucher*) as a *"natural or legal persons purchasing energy for their own use"* (translated by author). This definition is an almost literal transposition of the definition of "final customer" under Article 2(9) of the 2009 Electricity Directive. It is assumed under both these definitions that the purchaser and end-user are one and the same person. The fact that there also exist entities which purchase energy *not* for their own use is reflected in the definition of "wholesale customer" under Article 3(21) of the EnWG 2017 (Article 2(8) of the 2009 Electricity Directive). Here, it is stated that a "wholesale customer*"* (*Großhändler*) means *"a natural or legal person purchasing electricity for the purpose of resale inside or outside the system where he is established*" (translated by author). Although the description of a wholesale customer seems to provide a more realistic reflection of the activity of an operator of a stationary energy storage or power-to-gas facility, the current situation in Germany is that energy storage is, nevertheless, considered to be an end-use activity.

In 2010, the German Federal Court (*Bundesgerichtshof)* determined that pumped hydro storage facilities, during the pumping phase, are to be considered as final consumers of electricity.[23] In this particular case, the operator of the pumped storage facility bought the electricity from the market. The Court stated that: *"indeed, from an economic perspective, the entire system may be considered a system in which energy is stored. However, as the energy is initially consumed, by converting it into mechanical energy, this constitutes an act of final consumption; the purpose of the consumption is irrelevant"* (translated by author). The reasoning in this ruling has been repeated by the German

[23] Decision of 17 November 2009 by the *Bundesgerichtshof*, EnVR 56/08.

government.[24] In the literature it is generally accepted that this classification of pumped hydro storage as final consumption applies equally to other electricity storage technologies such as power-to-gas and compressed air energy storage. [14][17]

3.2.2 Italy

The definitions of "final consumer" (*cliente finale*) and "wholesale consumer" (*cliente grossista*) under the Bersani Decree are the same as under German and EU legislation.[25] Although AEEG/ARERA Resolution 574/2014 on the integration of storage technologies contains provisions on how storage should be treated in relation to consumer charges and taxes, it does not exclude storage from the scope of the definition on "final consumption" under Article 2(4) of the Bersani Decree. It follows from the introductory text to this Resolution that the AEEG/ARERA did not want to opt for such an approach, as it would be difficult to determine whether electricity is stored or consumed in the scenario that a storage unit is also connected to a consumption unit.

For the moment it should, therefore, be concluded that a power-to-gas installation, independent of whether reconversion occurs or not, is to be considered as a final consumer of electricity.

3.2.3 Switzerland

Article 4(1) of the Electricity Supply Act defines an "final consumer" (*Endverbraucher*) as a "*customer who purchases electricity for its own use. Excluded therefrom is the purchase of electricity for (…) the propulsion of the pumps in pumped storage power plants"* (translation by author). As such, operators of pumped hydro storage plants are not considered final consumers under Swiss energy legislation. This automatically relieves pumped storage facilities from paying final consumer charges, without the need for an exemption. Whether other storage technologies are similarly excluded from the definition of final consumer is not clarified under the Electricity Supply Act. However, as will be discussed under section 7.3, at least in the context of electricity network tariffs, the Swiss authorities awards equal treatment to storage technologies which discharge the stored energy as electricity into a public network.

On the question whether the power-to-gas plant operator is a final consumer when the SNG is not reconverted, the Federal Council has stated: *"from the point of view of the Electricity Supply Act, a power-to-gas plant which does not inject electricity back into the electricity grid is an end consumer".*[26]

3.3 Power-to-Gas as Producer

The power-to-gas energy storage chain involves at least one conversion process (from power to a gas) and possibly two (when the gas is subsequently used for electricity generation). The conversion of one energy carrier into another is generally perceived to be a production activity. This certainly is the case for conventional gas-to-power and cogeneration.[27] Whether this is similar for the reconversion of energy into electricity after storage is debatable. It was the former Director-General of the Directorate-General for Energy of the European Commission, Philip Lowe, who wrote a letter in 2013 to EURELECTRIC stating: "*storage is, by definition, not generation: storage has a negative efficiency and costs, irrespective of the technology, whether it stores electricity, heat, cold, water, or air. (…) This is why storage cannot be classified as generation, irrespective of its technology, size or location*."[19] Another argument against classifying storage, including power-to-gas, as production

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[24] BT-Drs. 17/4968, S. 3, .

[25] Article 34(1) of Legislative Decree No. 93/2011, amending Articles 2(4) and Article 2(5) of Legislative Decree No. 79/1999.

[26] Response by the Federal Council to Motion 16.3265 of 4 November 2011 by the Commission for Environment, Spatial Planning and Energy.

[27] *See* Article 2(1) of the 2009 Electricity Directive (2009/72/EC).

is that it converts a secondary energy carrier into another energy carrier, instead of a primary source to a secondary carrier.

The answer to the question whether power-to-gas is production or not will especially be relevant for the discussion on the issue of unbundling, as system operators are not allowed to perform production and/or supply activities (*see* section 4.1). Therefore, this section will assess whether power-to-gas is considered a production activity for both the power-to-gas process and the power-to-gas-to-power process. An overview of the findings is provided below under Table 3-3.

	Definition of electricity/gas production	**Is power-to-gas conversion considered gas production?**	**Is power-to-gas-to-power considered electricity production?**
Germany	Electricity: "installations for the generation of electrical energy" Gas: none	Yes	Not clearly defined
Italy	Electricity: "installations for the generation of electrical energy" Gas: only of natural gas production: "extraction of natural gas from fields"	Yes	Yes
Switzerland	Electricity: None Gas: None	Yes	Yes

Table 3-3: Definitions on "production" in relation to power-to-gas

3.3.1 Germany

A first question is whether a power-to-gas installation could be considered a gas production activity when the energy is injected into the gas grid without the aim of reconversion into electricity. The term "energy installations" (*Energieanlagen*) under the EnWG encompasses installations for the production, storage, transmission or release of energy.[28] What type of activities should be considered as gas production remains, however, undefined under the EnWG, or for that matter, under EU energy law. Nevertheless, the EnWG contains clear hints that the German legislator considers power-to-gas as a production (*Erzeugung)* activity. Under both the definitions of "gas" and "biogas" is included: *"hydrogen, which has been produced by water electrolysis, and synthetically produced methane"* (emphasis added).[29] Also the Bundesnetzagentur, the regulatory authority for the energy sector, has expressed the position that it considers the power-to-gas process as gas production (*Gaserzeugung*).[20]

A second question is whether power-to-gas-power could be considered as electricity generation during the conversion of SNG to electricity. The EnWG 2017 defines generation installations (*Erzeugungsanlagen*) as "*installations for the generation of electrical energy*".[30] Historically, pumped hydro storage facilities have been treated as such generation installations as the business model thereof is founded on price arbitrage in electricity markets and participation in balancing markets.[14][21] Furthermore, pumped hydro installations are often part of a conventional hydro power installation which makes it more difficult to differentiate between storage and generation.

[28] Article 3(15) of the EnWG 2017.
[29] Articles 3(10(c)) and 3(19(a)) of the EnWG 2017.
[30] Article 18(c) of the EnWG 2017.

It can be questioned whether similar treatment is still appropriate for all storage technologies after the introduction under the EnWG of the term “installations for the storage of electrical energy”. Article 12(4) of the EnWG, establishing an obligation for entities connected to the electricity network to provide data to the system operator, already differentiates between installations which generate electricity, and those which store electricity. This provision lists the following separate entities:

1. operators of electricity generation installations,
2. operators of installations for the storage of electrical energy,

This differentiation seems to suggest that operators of installations for generation and operators of installations for storage are different type of actors within the electricity system.

The EnWG also contains multiple references to “installations for generation and/or storage of electrical energy”.[31] This choice of wording suggests that the German legislator differentiates between an installation which can simultaneously perform generation and storage, and those which do one or the other. It has been suggested that a gas-to-power installation which exclusively reconverts previously stored energy into electricity, without the aim of the subsequent marketing thereof, would then not be considered as generation installation.[17] Such a scenario could be deployed by system operators who want to use power-to-gas in support of their legal task. However, the side-by-side mentioning of generation and storage installations is also interpreted as proof that the legislator considers storage, in general, as production.[12] These different positions already indicate that it would be necessary that the relation between electricity generation and storage is clearly delimited in the EnWG.

In short, it can be concluded from this section that when the SNG produced through power-to-gas is injected into the gas network for other purposes than later electrification, it is most likely that this is a gas production activity. Whether a classification as electricity generation/production is appropriate when reconversion does take place is for the moment not clear and should, therefore, be clarified by the German legislator.

3.3.2 Italy

The concept of gas production under the Letta Decree No. 164/2000, which sets the rules for the Italian gas sector, was initially only linked to the term “cultivation” (*coltivazione*), which is defined as the extraction of natural gas from fields.[32] Considered as gas undertakings were those companies involved in the import, export, *cultivation*, transport, distribution, sale, purchase, or storage of natural gas, including liquefied natural gas.[33] Following an amendment in 2011, the scope of the Letta Decree has been expanded to include other gases than natural gas (*see* section 6.2.1). As a result, the word “cultivation” has been replaced with “production” (*produzione*), although a definition thereof has not been provided.

An important hint that the Italian legislator may consider power-to-gas as gas production can be found outside the Letta Decree. As will be discussed under chapter 8 on national support schemes, the Italian Government considers SNG (when the carbon stems from biogas upgrading) to be a biomethane and has issued a new “Biomethane Decree” containing measures to promote the consumption thereof.[34] In the context of this Decree, the operator of a power-to-gas installation is treated as a *producer* of biomethane. Further guidance outside this context on whether power-to-gas is gas production is, however, lacking for the moment. Nevertheless, this equal treatment of a power-to-SNG installation with a biogas upgrading installation under the Biomethane Decree

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[31] *See* Chapter 3 of the EnWG 2017.
[32] Article 2(h) of the Letta Decree No. 164/2000.
[33] Article 2(t) of the Letta Decree No. 164/2000.
[34] Final Text of the Ministerial Decree by the Ministry of Economic Development of 2 March 2018 on the “Methods for Incentivising the Introduction of Biomethane into the Natural Gas Network”, hereafter “Biomethane Decree 2018”.

suggests that a power-to-gas facility, which injects molecules into a gas network, is likely to be considered gas production.

Likewise, under the power-to-gas-to-power scenario, the discharging of electricity is likely to be perceived to be a production activity. Under AEEG/ARERA Resolution 574/2014/R/EE on the integration of storage systems, storage system are treated as a generating unit which operate alone or together with other generation units.[35] This means that, at least with regard to the connection to the electricity network and dispatch, storage systems are to be regarded as generation units.

3.3.3 Switzerland

There is no definition of "gas production" under Swiss energy law. This can be explained by the fact that, both currently and in the past, there is no natural gas extraction taking place in Switzerland.[22] The precise legal delimitation of different activities within the gas sector is thus unclear. The new Gas Supply Act which may remedy this uncertainty is expected to be published for consultation in mid-2019.[36]

A scarce reference to the power-to-gas process as "production" (*herstellung*) can be found in the Mineral Oil Tax Ordinance (*Mineralölsteuerverordnung*) which, at one occasion, addresses *"production plants that <u>produce</u> biogas, biohydrogen or synthetic gas"*.[37] As, however, this Ordinance only applies to transportation fuels and is written for a specific purpose, the taxation of fuels, it is not appropriate to deduce a general conclusion therefrom that a power-to-gas plant is always a gas production. An alternative argument, however, to come to this conclusion would be to invert the remark by the Federal Council that *"from the perspective of the electricity supply act, a power-to-gas plant which does not inject electricity back into the electricity grid is an end consumer"*.[38] From the gas perspective, such a power-to-gas plant could then be considered to be production.

With regard to the deployment of power-to-gas with subsequent reconversion into electricity, an analogy can be made with pumped hydro storage. There exists no explicit classification of pumped hydro storage as electricity producing activity under Swiss law. Nevertheless, operators of pumped hydro facilities are selling their electricity on wholesale markets, thereby competing against stand-alone electricity generators.[23] Therefore, in absence of a separate classification for storage facilities, pumped hydro installations are treated as electricity generation units under the Energy Act, the Electricity Supply Act and Ordinance, and the Guarantees of Origin Ordinance (*Herkunftnachweisverordnung*).[21] This allows operators of pumped hydro storage facilities to provide ancillary services to the system operator (Article 5 of the Electricity Supply Act) and to demand a connection to the electricity network (Article 3 of the Electricity Supply Ordinance). As there is no separate legal framework or category for storage yet, it is most likely that the conversion of hydrogen and SNG produced through power-to-gas into electricity is to be treated equally as electricity generation.

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[35] Article 2 and 4 of AEEG/ARERA Resolution 574/2014/R/EE.
[36] *See* for information and preparatory studies on the new Gas Supply Act http://www.bfe.admin.ch/themen /00486/00488/06662/index.html?lang=en.
[37] Article 45e of the Mineral Oil Tax Ordinance of 20 November 1996, No. 641611. The relevance of the Mineral Oil Tax for power-to-gas is discussed under section 8.3.
[38] Response by the Federal Council to Motion 16.3265 of 4 November 2011 by the Commission for Environment, Spatial Planning and Energy.

4 Unbundling Rules in the Context of Power-to-Gas

It was already extensively discussed under chapter 5 of Deliverable 7.2 of the STORE&GO project that EU energy legislation divides the energy sector into competitive activities deployed by entities operating in the free market (production, trade, and supply), and regulated activities deployed by system operators as natural monopolists (transmission and distribution). Both within the EU as in Switzerland, a company or group of undertakings which exercises control over both competitive and regulated activities is considered a so-called “vertically integrated undertaking” (VIU).[39] There are different scenarios for the deployment of power-to-gas by entities operating in the competitive and regulated domain of the energy sector.[4] For example, in the competitive domain, power-to-gas as energy storage can be used as load levelling technology in combination with electricity generation or as production pathway for renewable gases or liquids. In the regulated domain, power-to-gas can be deployed by system operators as alternative to electricity network reinforcements or in support of network stability.

This chapter will first, under sections 4.1, assess to what extent transmission and distribution operators, for both the electricity and gas sectors, are allowed to own and operate a power-to-gas facility. Subsequent section 4.2 will review to what extent the combined operation of a gas storage and power-to-gas installation is allowed. The emphasis is thus on the combined operation of regulated assets and a power-to-gas installation. The discussion in this chapter will build further on the findings under the previous chapter which revealed that power-to-gas(-to-power) and energy storage, in absence of a specific framework for electricity storage technologies, is generally considered as an activity involving either the production of gas or the generation of electricity.

4.1 Operation of a Power-to-Gas Installation by System Operators

In order to ensure the neutral and non-discriminatory operation of transmission and distribution networks, the EU unbundling rules prescribe that the operation of regulated activities must occur independent from competitive activities.[40] It was established under chapter 5 of Deliverable 7.2 that the proposal by the European Commission for a Recast Electricity Directive treats energy storage, including power-to-gas, in the first place as a competitive activity. Therefore, as a basic rule, system operators would not be allowed to control and own energy storage facilities, including power-to-gas facilities.[41] Services offered by energy storage should instead be contracted by system operators after an open tender procedure or at organised balancing markets. Only where the market is absent or shows no interest could system operators themselves develop and operate storage system.[1] As negotiations on the definite text of the Recast Electricity Directive were still ongoing at the time of publishing of this report, this proposed unbundling regime for storage is still susceptible to change.

For the moment, in absence and in anticipation of EU rules on the ownership and control of storage facilities, national approaches on this issue are of a heterogeneous nature. The relevant national rules for both the transmission and distribution level are discussed in the following sections.

4.1.1 Transmission Level

This section will examine whether the respective national laws under assessment allow a transmission system operator to have direct control over the operation of a power-to-gas installation. For the analysis in this section it is necessary to recall the different unbundling models under EU

[39] Article 2(21) of the 2009 Electricity Directive (2009/72/EC) and Article 2(20) of the 2009 Gas Directive (2009/73/EC). For Switzerland *see* [30].
[40] *See* 2009 Electricity Directive (2009/72/EC)
[41] Article 36 and 54 Recast Electricity Directive (COM(2016) 864 final/2).

energy law for transmission system operators. Importantly, as will be discussed, these models are also *mutatis mutandis* applied in Switzerland. The unbundling rules under the 2009 Electricity Directive (2009/72/EC) and Gas Directive (2009/73/EC) allow EU Member States to choose between three different unbundling models:

1. *strict ownership unbundling* (OU model): the same legal person or group is prohibited to simultaneously exercise control over a production or supply undertaking, and over a transmission system or system operator, and *vice versa*;
2. *independent system operator* (ISO model): ownership of the network may remain within the vertically integrated company, however, an independent third party system operator must be appointed who controls the operation of the network and is allowed to make investment decisions;
3. *independent transmission system operator* (ITO model): both the ownership of the network and the operation thereof remain within the vertically integrated company, however, various stringent rules in the Directives must be followed to ensure the independency of the system operator.

Figure 4-1 below provides a schematic overview of the different unbundling models.

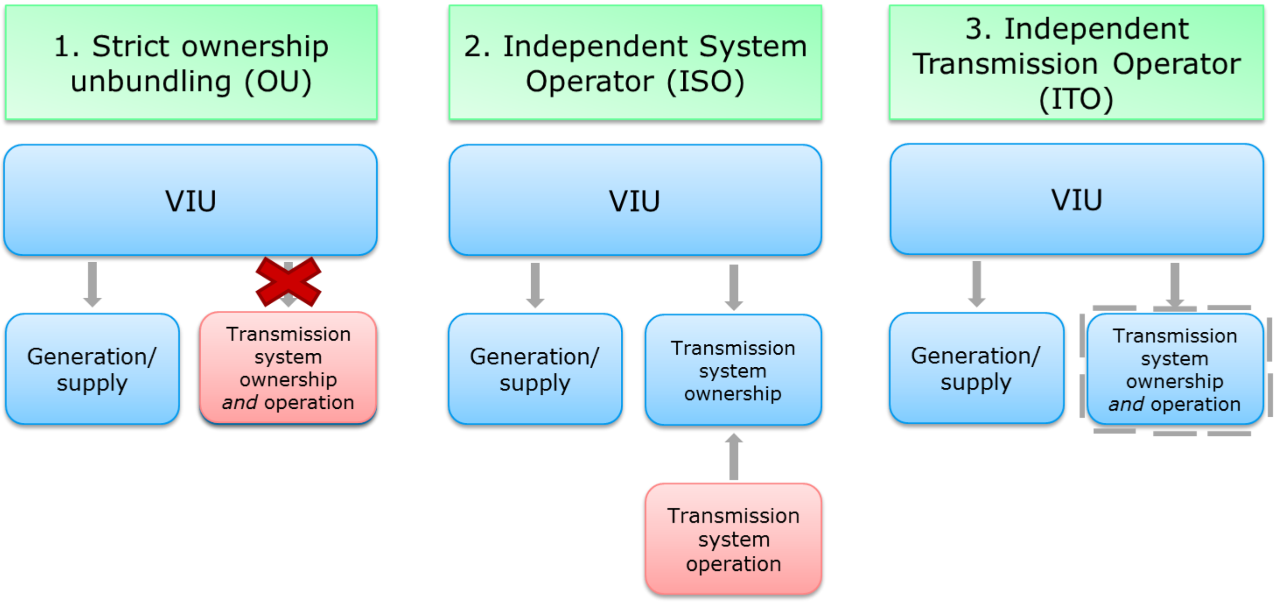

Figure 4-1: Unbundling models for transmission system operators under the 2009 Electricity- and Gas Directive. "VIU" refers to "vertically integrated undertaking". (image by author)

Importantly, under none of these unbundling models is it allowed for a system operators itself to be directly involved in the production and/or supply of energy. Even under the ISO and ITO model, where production and supply are allowed to take place within the same group as system operation, these activities always have to take place under separate subsidiaries. It is also important to note that the unbundling rules apply cross-sectoral between the electricity and gas sector.[42] As such, a gas transmission system operator is not allowed to be directly involved in electricity generation, and an electricity transmission system operator not in gas production.

The (lack of) national approaches to integrating power-to-gas and assets for the storage of electricity under the unbundling model are discussed below.

4.1.1.1 Germany

Germany has transposed the EU rules on unbundling into national law under Articles 6 to 10e of the EnWG 2017. Similar to the current EU unbundling rules under the 2009 Electricity- and Gas

[42] Article 9(3) of the 2009 Electricity and Gas Directives (2009/72/EC and 2009/73/EC).

Directive, the German unbundling rules under the EnWG contain no specific provisions or conditions on the ownership and control of storage in the electricity context or power-to-gas facilities. As a consequence, the unbundling rules do not explicitly clarify whether the deployment of these activities is allowed by regulated entities, or should be separated therefrom and be reserved for market parties. Certain conclusions can, nevertheless, be drawn from the existing provisions.

Article 6(1) EnWG 2017 states as a general rule of unbundling that, in order to ensure the non-discriminatory operation of networks, system operation must be executed independent from other activities within the energy supply chain, in conformity with the more specific rules unbundling rules under Articles 6a to 10 EnWG. The German legislator has confirmed that these unbundling rules horizontally to undertakings which are active in both the electricity and gas sector.[43]

In accordance with EU law, the EnWG allows system operators to choose from three unbundling models: the strict ownership unbundling model (OU) (Article 8 EnWG), the independent system operator model (ISO) (Article 9 EnWG), and the independent transmission system operator model (ITO) (Article 10 EnWG). The choice is then left to the individual network operators. Where most electricity transmission system operators in Germany have opted for the ownership unbundling model, gas transmission networks are dominantly operated under the ITO model.[24] The ISO model is not used in practice.

A first observation is that under the scenario that the operation of a power-to-gas installation involves gas production, system operators need to refrain from directly operating such an installation. This is the same for both the OU and ITO model. A difference is that under the ITO model it would be allowed to maintain the power-to-gas facility within the VIU, although structured under a separate subsidiary than the network operation. This would not be allowed under the OU model.

German legal commentators have argued that ownership by system operators of power-to-gas and energy storage facilities is possible under the power-to-gas-to-power scenario.[12][17][25] This scenario requires that the facility is operated by system operators exclusively in fulfilment of their legal tasks. The residual capacity of the storage unit, not used in support of grid operation, could then be marketed to third parties. In support of this claim, these commentators point to various provisions in the EnWG which seem to be permissive to such deployment of storage facilities by transmission system operators.[12][17] Amongst others, reference is made to Article 13(1) EnWG which allows the transmission system operators to take network relevant measures in case of disturbances. Another provision which is discussed in this context is Article 12(3) which states that system operators should be allowed to use *“suitable technical equipment, for example to provide reactive and short-circuit power, which are not systems for generating electrical energy.”*[12] Others point to the definition of gas storage facilities in Article 3(31) EnWG which explicitly mentions the possibility that gas transmission system operators make use of gas storage facilities exclusively in fulfilment of their tasks. Here is it suggested that this principle could be extended to storage in the electricity context.

Despite the arguments brought forward by commentators, the German regulator of the energy sector (*Bundesnetzagentur*) has taken the position that energy storage is first of all an activity reserved for market parties.[26] The regulator envisions only limited deployment and operation of such facilities by system operators. More specific for power-to-gas, the *Bundesnetzagentur* has expressed the position that *gas* system operators are not allowed to operate power-to-gas installations which withdraw electricity surpluses from the electricity network and inject gas into the natural gas system, even when the gas is eventually reconverted into electricity, as this would constitute a gas production activity (*see* earlier discussion under section 3.3.1).[27] Although this statement merely refers to *gas* system operators, the cross-sectoral application of the unbundling rules would make it then equally

[43] BT-DRS. 15/3917, S.51.

impossible for electricity system operators to operate power-to-gas facilities which involves gas production.

4.1.1.2 Italy

The transposition of the current EU unbundling rules into Italian law has occurred through Legislative Decree No. 93/2011, which implements the 2009 Electricity and Gas Directives (2009/72/EC and 2009/73/EC). This Decree amends the Bersani Decree No. 79/1999 which regulates the electricity sector, and the Letta Decree No. 164/2000 which sets the rules for the gas sector. Similar to the German legislator, the Italian legislator has been offered the choice under European law between three different unbundling models (OU, ISO, or ITO). In the electricity context, Articles 36(2) and 36(7) of Legislative Decree No. 93/2011 determine that the national transmission system operator, being Terna SpA which operates 98% of the Italian electricity transmission system, has to be strictly ownership unbundled under the OU model. As such, not only is Terna itself as transmission system operator prohibited from engaging in generation and supply activities, it can also not be controlled by a holding company which simultaneously has direct or indirect control over generation or supply assets.

For gas transmission system operators, the unbundling rules in Legislative Decree No. 93/2011 provide more flexibility as they may also opt for the ISO or ITO regime.[44] Although initially certified as an ITO, Snam Rete Gas, which has a market share of 94% in the Italian gas transmission market, is currently certified as a fully ownership unbundled undertaking through AEEG/ARERA Resolution 515/2013R/Gas.

With regard to power-to-gas without latter reconversion into electricity, it was concluded under chapter 3 that this falls outside the scope of the definition of “installations for the storage of electricity” under Resolution 574/2014/R/EEL and could rather be considered as a gas production activity. Accordingly, Terna and Snam are excluded from deploying power-to-gas under such a scenario. Furthermore, as both are certified as fully ownership unbundled entities under the OU model, they are not allowed to be part of the same group as an entity operating such a power-to-gas installation.

Another question is whether this would be different under the scenario that the gas is reconverted to electricity and that power-to-gas would be considered the storage of electricity. In absence of experiences with power-to-gas-power in Italy, the unbundling approach towards other technologies for the storage of electricity can be taken as an example. For example, the electricity system operator Terna is already operating several stationary battery pilot projects.[45] The plan by Terna to install 35 MW of battery storage capacity in the south of Italy (Puglia, Molise, and Campania) was approved by the Italian Ministry for Economic Development in 2012.[46] The legal foundation for this approval is Article 17(3) of Legislative Decree no. 28/2011, which implements the 2009 Renewable Energy Directive (2009/28/EC). This provision allows transmission system operators to include the use of energy storage facilities in their national transmission grid development plan in order to ensure the maximum dispatch of variable renewable energy plants. The Decree, in Article 17(4), delegates the responsibility to oversee the deployment of such storage units by transmission system operators to the regulatory authority, AEEG/ARERA. Also Article 36(4) of Legislative Decree No. 93/2011, amending the Bersani Decree, confirms that transmission system operators can realise and manage diffused battery systems for the storage of electricity. How this aligns with the prohibition for Terna to be active in generation or supply is, however, unclear.[28] Arguably the special rules on storage take precedence over the general unbundling rules. Although this would most likely not be in

[44] Articles 10-13 of Legislative Decree No. 93/2011 amending the Letta and Bersani Decree.

[45] *See* for an overview of storage pilot projects operated by Terna: http://www.terna.it/en-gb/sistemaelettrico/progettipilotadiaccumulo.aspx.

[46] Resolution 66/2013/R/eel of 21 February 2013.

conformity with EU law under which the proposed unbundling rules for storage apply in parallel to the existing models.

In practice, the storage projects deployed by Terna are all of an experimental nature. To this end, AEEG/ARERA laid down specific procedures and selection criteria for pilot projects which are allowed to be financed through network tariffs.[47] Simultaneously, an independent commission of experts was installed in charge of assessing and selecting the individual pilot projects. As, however, the pilot projects are only open to electrochemical storage technologies, Terna is prohibited from experimenting with power-to-gas.[48] This puts storage through power-to-gas in an disadvantaged position compared to battery storage.

Another development in the context of storage is Resolution 574/2014/R/EEL on the integration of installations for the storage of electricity, which does not apply to the pilot projects deployed by Terna. It was already concluded under section 3.3.2 that this Resolution establishes that storage technologies are to be treated as generation plants when connected to the network or during dispatch. This would thus also be the case when a power-to-gas plant is combined with a CHP plant. Although the Resolution is silent about the issue of allowed ownership and operation, the consequence of such treatment would be that system operators are prohibited from deploying such activities.

The conclusion is that the Italian legislator seems to promote the deployment of storage through two pathways; an experimental framework for system operators and a general framework for storage by entities operating in the competitive segment of the energy sector. As, however, the deployment of storage by system operators is limited to electrochemical storage applications, there is no legal basis for these operators to deploy a power-to-gas-to-power installation.

4.1.1.3 Switzerland

Coming from a sector dominated by vertically integrated undertakings, the Swiss energy sector is becoming more and more liberalized due to the adoption of the 2007 Electricity Supply Act and various industry agreements under private law for the gas sector.[29][30] Although this liberalization process involved the introduction of rules on the organization of the sector, Swiss energy law does not provide specific unbundling rules for storage.

The unbundling of electricity network operation from other activities is established under Article 10 of the Electricity Supply Act. Article 10(1) stipulates that *“electricity supply companies shall ensure the independent operation of electricity networks. Cross-subsidization between network operation and other areas of activity is prohibited”* (translation by author). Article 18 of the same law prohibits the operator of the national grid to engage in activities in the areas of generation, distribution or trading, or hold equity interests in companies who work in these areas. As Swiss law does not deny holding companies the right to have a majority in both a network company and a company active in generation and/or supply, the Swiss unbundling model for electricity transmission system operators mirrors the ITO model.[31] Another safeguard measure which should contribute to the independent operation of the network is established in Article 11 of the Electricity Supply Act, which stipulates that both transmission- and distribution network operators have to submit a yearly financial statement and cost report to ELCom which needs to be separate from the financial reports on other activities.

The Swiss transmission system is operated by Swiss Grid, an independent stock company which, in accordance with the Electricity Supply Act is not active in the area of electricity generation, trade or supply.[49] Swiss grid does not own or operate storage systems. Article 22 of the Electricity Supply

[47] AEEG/ARERA Resolution 288/2012/R/eel.
[48] AEEG/ARERA Resolution 288/2012/R/eel.
[49] *See:* https://www.swissgrid.ch/en/home.html.

Ordinance requires Swiss grid to procure ancillary services in accordance with transparent, non-discriminatory and market-oriented criteria.[50]

Based on the requirement that network operation has to occur separate from *other activities*, the prohibition of cross-subsidisation, and the requirement to procure ancillary services from third parties, it is unlikely that Swiss Grid is allowed to operate a power-to-gas plant which buys or sells energy on wholesale markets or involves production or supply.

In the gas sector, the high pressure gas transmission network (5 bar and higher) is operated by Swissgas and Transitgas, and various regional gas system operators.[51] As already mentioned under chapter 2 of this Deliverable, the degree of regulation in the Swiss energy sector is much lower than is the case within the EU. Relevant for this chapter, the Federal Pipeline Act (*Rohrleitungsgesetz*) contains no provision on the unbundling of gas system operators or a requirement for the non-discriminatory operation of gas networks. This absence of statutory rules on the separation of commercial activities from regulated activities can be explained by the absence of domestic natural gas production in Switzerland.[22]

As a reaction to the lack of Federal rules on the organisation of the gas sector, several agreements have been closed under private law among industry players. [30] An important agreement is that between energy supply companies and network operator organised in the Association of the Swiss Gas Industry (*Verband der Schweizerischen Gasindustrie,* hereafter "VSG") and large gas consumer organisations in 2012 (hereafter "gas industry agreement").[32] Article 6 of this agreement stipulates that *"network operators need to commit to internal accounting unbundling of network costs from the costs of other activities, as to avoid any cross-subsidisation"* (translated by author). This requirement to unbundle financial accounts in the gas industry agreement is complimented by the general rules of competition law, especially Article 7 of the Federal Act on Cartels and other Restraints of Competition (*Kartellgesetz*), which prohibit abuse of market dominance by natural monopolists.

The private law nature of the gas industry agreement did not, however, result in sufficient legal certainty for the gas industry as a whole or in sufficient systematic safeguards against abuse of dominant market position by network operators.[30] Furthermore, the system of *ex post* oversight by the competition authority and Swiss courts could lead to long and costly proceedings. Therefore, the Federal Council in 2014 announced the drafting of a Gas Supply Act (*Gasversorgungsgesetz*). In 2017, the SFOE announced that it would sent out a draft for consultation of this Gas Supply Act which, according to the SFOE, complies as far as possible with the norms of EU law under the 2009 Gas regulation (No. 715/2009) and 2009 Gas Directive (2009/73/EC).[52] At the time of publishing of this Deliverable, this draft was not yet made available to the public.

Although it is not yet known how the unbundling rules under the new Gas Supply Act will take shape, it is unlikely that these will allow gas system operators to operate power-to-gas facilities which are deployed in the commercial segment of the gas sector. Taking note of the statement by the SFOE that the new Gas Supply Act will comply with EU rules, and considering the spirit of the gas industry agreement, system operation will most likely need to be separated from other activities. It is unknown, however, whether the Gas Supply Act will opt for the OU, ISO, or ITO model.

[50] Article 22 of the Federal Electricity Supply Ordinance of 14 March 2014, No. 734.71.
[51] *See:* http://www.ksdl-erdgas.ch/netzzugang/schweizer-erdgasnetze.html (in German).
[52] *See:* http://www.bfe.admin.ch/themen/00486/00488/06662/index.html?lang=de (in German).

4.1.2 Distribution level

4.1.2.1 Germany and Italy

Under the EU unbundling rules, and thus also those in Germany and Italy, electricity and gas distribution system operators have to be legally and functionally unbundled from all other activities.[53] As figure 4-2 below illustrates, this allows a VIU to be active in both network operation and production/supply in so far as it structures its regulated and competitive activities under separate subsidiaries.

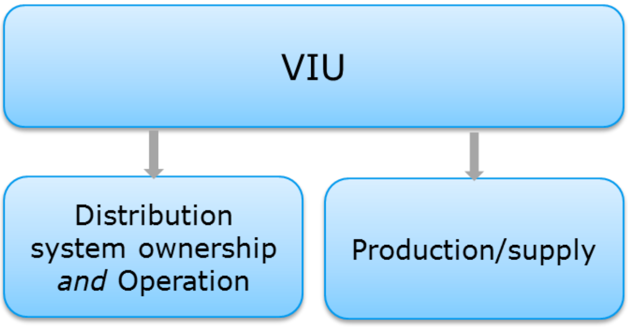

Figure 4-2: Functional and legal unbundling of distribution system operation (image by author)

For Germany, Article 7 of the EnWG 2017 determines that distribution system operators, which are part of a vertical integrated company, need to be independent in its legal form from “other activities”. The requirement of functional unbundling (i.e. independence in organisation, decision-making, and exploitation of the network) is provided for in Article 7a EnWG. In accordance with EU law, Article 7(2) EnWG allows smaller DSOs serving less than 100.000 connected customers to be exempted from the legal and functional unbundling requirements.

The starting point for Italy is the same. Article 38 of Legislative decree No. 93/2011 prescribes that distribution system operators which are part of a vertically integrated undertaking need to be independent in their legal form, organisation, accounting, and decision-making from “other activities” not related to distribution. A difference is, however, that Article 36(4) of Legislative Decree No 93/2011 allows system operators to operate batteries. Similar to Terna, also E-Distribuzione, Italy’s largest electricity distribution system operator, has invested in several battery storage pilot installations for peak shaving, balancing, and voltage control.[33] In light of the proposed unbundling rules for storage by the European Commission, and the development of a commercial storage market in Italy, it is uncertain to what extent these experimental projects by system operators will be continued in the future.

The question for both the situation in Germany and Italy is whether power-to-gas can be considered an “other activity” which cannot be deployed directly by a distribution system operator. It has been argued that the answer may differ on a case-by-case basis, depending on the existence of a conflict of interest and/or threat of discrimination when the distribution operator would simultaneously act as operator of the network and a power-to-gas installation.[17] This would only be the case when the power-to-gas plant is not used for commercial transactions and would not be considered a production activity.

For Germany, the *Bundesnetzagentur* already expressed that power-to-gas(-to-power) does, however, involve production and should not be deployed by system operators.[20] For Italy, it was already discussed that the power-to-gas conversion process is production, which excludes distribution operators from being allowed to take control over such a process. As the current legal

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[53] Article 26 of both the 2009 Electricity Directive (2009/72/EC) and the 2009 Gas Directive (2009/73/EC).

basis for distribution system operators to operate storage systems is limited to batteries, this does not equally allow them to operate a power-to-gas-to-power installation.

4.1.2.2 Switzerland

At the electricity distribution level, Article 10(3) of the Electricity Supply Act requires, at the least, the unbundling of financial accounts. This requirement of separate bookkeeping is repeated under Article 11 of the Electricity Supply Act which obliges distribution system operators to submit separate financial reports concerning the costs for network operation. This limited unbundling requirement explains why the Swiss energy sector at the regional level is still dominated by vertically integrated energy supply companies which are active in both energy production and transportation. These regional companies are heterogeneous in their legal form, organisation, and type of deployed activities and are often owned by cantons or municipalities. This regional approach is encouraged under the Energy Strategy 2050 which allows municipalities to set up an Energy Region (*Energieregio*).[54]

Under Swiss Federal law, it is thus allowed for regional energy companies to simultaneously operate a gas producing power-to-gas installation and an electricity and/or gas distribution network. This is also the case in Solothurn, the Canton where the STORE&GO plant is located.[55] Article 4 of the Energy Act of Canton Solothurn states: *"cantons and municipalities can construct and operate plants for the generation, conversion, storage and distribution of energy themselves or participate in it."*[56] In Solothurn, the *Regio Energie Solothurn* (Energy Region Solothurn) operates, besides the STORE&GO power-to-gas installation, renewable electricity generation installations, a waste incineration plant, a combined heat and power plant, and gas, electricity and heating networks.[57] The power-to-gas plant is a part of a hybrid plant which, being located at the cross-road of these networks, allows for the efficient interaction between electricity, gas and heat.

In short, the bundling of competitive and regulated activities is still allowed in Switzerland at the distribution/regional level.

4.2 Combined Ownership of a Power-to-Gas Installation and a Gas Storage Facility

The central question of this section is whether the combined operation of a power-to-gas installation and a gas storage facility is allowed. Gas storage in this context refers to the physical storage of gas in a gas storage facility which is connected to the public gas network. As power-to-gas may be deployed in the future for the seasonal storage of energy, the storage of SNG in underground gas storage facilities may become an integral part of the power-to-gas energy storage chain. This section will, therefore, assess whether an operator of a power-to-gas installation is allowed to operate a gas storage facility, and whether an operator of one or more gas storage facilities may simultaneously operate an electrolyser/methanation unit when this involves the production of a gas. Alternatively, if such combined operation is not allowed, the SNG can still be stored in gas storage facilities with a third party access obligation operated by other parties.

4.2.1 Germany and Italy

In order to ensure non-discriminatory access for system users to gas storage facilities, EU law prescribes that gas storage system operators need to be independent in its legal form organisation,

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[54] *See* for more information of Energy Regions: http://www.bfe.admin.ch/geoinformation/05061/06361/index.html?lang=en.
[55] Regulation for the Supply of Energy and Water by the Energy Region Solothurn of 11 September 1984.
[56] Energiegesetz Kanton Solothurn of 3 March 1991, SR 941.21.
[57] *See* for the website of Regio Energie Solothurn: https://www.regioenergie.ch/ (in German).

and decision-making from production and supply activities.[58] In conformity with this EU rule, Article 7b of the German EnWG 2017, and Article 18 of the Italian Legislative Decree No. 93/2011 amending the Letta Decree, both determine that operators of gas storage facilities that are part of a vertically integrated undertaking "*shall be independent in terms of legal form, organization and decision-making from other activities not related to transmission, distribution and storage*". This unbundling requirement is represented in figure 4-3 below.

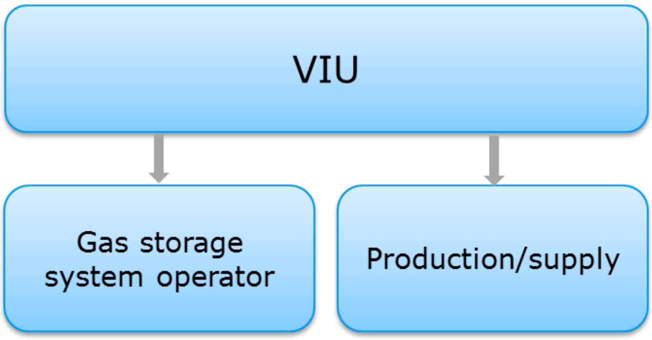

Figure 4-3: Legal and functional unbundling of gas storage system operation from production and supply (image by author)

As a consequence, when power-to-gas conversion is considered to be production, this activity has to be structured under a separate subsidiary from the gas storage system operation. It was already concluded under section 3.3 that the legal status quo in Germany and Italy points towards such a classification of power-to-gas as gas production. There are, however, certain exemptions to the basic rule of legal and functional unbundling, which are also transposed into national law by the German and Italian legislator. The first two exemptions can be inferred from the definition of gas storage facilities under Article 3(31) of the EnWG 2017 and Article 2(q) of the Letta Decree:

> *A storage facility is a facility owned or operated by a gas supply company for the storage of gas, including the part of LNG plants used for storage, with the exception of the part used for production, and excluding facilities which are reserved exclusively to operators of gas networks in the performance of their duties.* (underlining and translation by author)

The first exemption exists for (parts of) a storage facility used in the context of gas production. The European Commission has declared that this exemption may only be invoked when the facility is exclusively used to smooth production swings associated with the specific process of production, fields or areas.[8] It could be argued that when a part of a gas storage facility is used to smooth out the power-to-gas production process (for which the feedstock, electricity, is supplied through intermittent sources) that this part of the facility could be exempted from the unbundling obligation and be operated by a producer. This would require, however, an "evolutionary" interpretation of this exemption for which currently no support can be found in official statements by the EU, German, or Italian legislators.

Also excluded from the definition and correlated unbundling requirements are facilities reserved exclusively for transmission system operators in carrying out their functions. The gas storage facility must then be deployed in fulfilment of the legal task of the gas system operator, e.g. for balancing purposes.[34] This exemption is irrelevant for this section as it does not relate to the combined deployment of gas production and gas storage activities.

A third exemption is that the unbundling rules for gas storage facilities only apply to those which are technically and/or economically necessary for providing efficient access to the system for the supply

[58] Article 15 of the 2009 Gas Directive (2009/73/EC).

of customers.[59] This exemption should, according to the European Commission be interpreted restrictively.[34] The Commission has clarified that a request for storage capacity by the market would in general be sufficient to characterise a storage facility as economically necessary.

It can be concluded that only the first exemption provides an opening for the simultaneous operation of a power-to-gas installation involved in gas production and (part of) a gas storage facility.

4.2.2 Switzerland

There are no large gas storage facilities in Switzerland as in Germany or Italy. Imported gas is stored in pipelines though line packing and in storage facilities in France.[36] For this reason, there is no specific legislation on the allowed ownership and operation of such facilities. A recent study on possible unbundling models for the Swiss gas sector under the expected Gas Supply Acts assumes gas storage to be offered by gas network operators.[30] When gas storage is indeed perceived as a service offered by regulated entities, the simultaneous operation of such a facility and a power-to-gas installation involved in gas production is most likely not allowed, at least not at the transmission level.[60] As the unbundling rules at the regional/distribution level still allow for the combined deployment of regulated and competitive activities, the combined operation of gas storage and a power-to-gas installation will not lead to a legal conflict.

4.3 Overview of Findings

The findings of this chapter are summarised in Table 4-1 below. For the purpose of comparison, also the proposed rules for the ownership and control of energy storage facilities by the European Commission under the Clean Energy for All Europeans Package have been included.

Building further on the findings under chapter 3, it can be concluded from the analysis of this chapter 4 that an affirmative legal basis for the operation of power-to-gas by regulated entities is lacking under German, Italian and Swiss law. An obvious explanation for this can be found in the fact that this legislation preceded the current attention for power-to-gas and related legal debates and, therefore did not award consideration to storage in the electricity context. For the moment, especially for the situation in Germany and Italy, it is unlikely that system operators are allowed to operate a power-to-gas installation, even when the energy is eventually reconverted into electricity and the power-to-gas chain is merely used for transporting energy as molecules from A to B instead of electrons. The legal status quo is that, even though a power-to-gas-to-power roundtrip still involves considerable efficiency losses, both the power-to-gas conversion and the gas-to-power conversion process are likely to be regarded as a prohibited production activity.

The current national (and EU) unbundling rules also seem to be restrictive with regard to the combined operation of a power-to-gas and gas storage facility. Although an evolutionary interpretation of the exemption for parts of storage facilities for production is in theory possible, this is not a foundation which provides sufficient legal certainty.

Looking ahead, it was already stated that Germany and Italy will be required to transpose the eventually adopted EU rules on energy storage into national law. This means that for all storage technologies, including power-to-gas, they will have to adopt a “no, unless…” approach to regulated ownership and operation over such assets. As a consequence, the operation of a power-to-gas plant will, in the first place, be a prerogative for entities operating in the competitive domain of the energy market. Operation of storage facilities by system operators, as is currently the case in Italy, will then only be allowed as derogation.

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[59] Article 7b of the EnWG 2017 and Article 18 of Legislative Decree No. 93/2011.
[60] Article 10(1) of the Federal Electricity Supply Ordinance of 14 March 2014, No. 734.71.

The conclusion is that the current and foreseen unbundling rules, both in spirit and in concrete terms, limit the deployment of power-to-gas to the competitive domain. This constitutes a clear barrier for the deployment of power-to-gas in the regulated domain.

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	Operation of power-to-gas as gas production by transmission system operator	Operation of power-to-gas-to-power as electricity storage by transmission system operator	Operation of power-to-gas as gas production by distribution system operator	Operation of power-to-gas-to-power as electricity storage by distribution system operator	Combined operation of a power-to-gas installation and a gas storage facility
EU (proposed rules Recast Electricity Directive)	No, unless: - No interest by the market; - Facility necessary for the task; - Approval by regulatory authority; - Not used for frequency ancillary services	No, unless: - No interest by the market; - Facility necessary for the task; - Approval by regulatory authority; - Not used for frequency ancillary services; - Electricity is not sold to the market	No, unless: - No interest by the market; - Facility necessary for the task; - Approval by regulatory authority;	No, unless: - No interest by the market; - Facility necessary for the task; - Approval by regulatory authority;	As a basic rule no, but possible exemption through broad interpretation of exemption for gas storage facilities used to smooth production swings
Germany	No, as power-to-gas is perceived as gas production	No, according to the Bundesnetzagentur as this involves production. However, discussion ongoing on possibility for system operators to deploy a power-to-gas-power facility in fulfilment of their task	No, as power-to-gas is perceived as gas production	No, as power-to-gas is perceived as gas production and gas-to-power a generation	As a basic rule no, but possible exemption through broad interpretation of exemption for gas storage facilities used to smooth production swings
Italy	No, as power-to-gas is perceived as gas production	No, current legal basis for regulated operation of electricity storage facilities only applies to electrochemical storage options	No, as power-to-gas is perceived as gas production	No, current legal basis for regulated operation of electricity storage facilities only applies to electrochemical storage options	As a basic rule no, but possible exemption through broad interpretation of exemption for gas storage facilities used to smooth production swings
Switzerland	Undefined, will depend on the content of the announced Gas Supply Act	No, network operation needs to be independent from other activities	Yes, combined deployment of regulated and competitive activities allowed	Yes, combined deployment of regulated and competitive activities allowed	Undefined. For the transmission level it will depend on the content of the gas Supply Act. At the regional/distribution level, the combined operation of storage and production is allowed.

5 Authorisation Procedures for Power-to-Gas Installations

Authorisation procedures aim to prevent or limit adverse effects of an activity for human health and the environment. They are an instrument for authorities to gain information about the potential risks of a project and a tool for these authorities for ensuring that the project developer takes all necessary precautions to protect the environment and human health. As power-to-gas facilities are a relative new type of installation, both authorities and developers have little experience with authorisation procedures for such installations. The objective of this chapter is to share the experiences by the STORE&GO pilot plants and to compare the different procedures applied by the German, Italian, and Swiss authorities.

Information for this chapter has been gathered through questionnaires of which the templates are attached to this Deliverable under Annexes I and II. For all three pilot locations, the electrolyser was already present and in operation for the production of hydrogen. These existing installations have been expanded in the STORE&GO project with a methanation unit. By merely focussing on the authorisation requirements for these methanation units, an incomplete impression of authorisation regimes for power-to-gas plants may be presented. Therefore, also information regarding the construction and development of the preceding power-to-hydrogen projects has been gathered as far as possible and included under the review in this chapter. The preceding hydrogen oriented projects were WindGas Falkenhagen[61] (Germany) and INGRID[62] (Troia, Italy). For Switzerland, where the plant is located in the municipality of Zuchwil of the Canton Solothurn, the STORE&GO methanation unit is an expansion of the Aarmatt hybrid plant[63] which is located at the crossroad of water, electricity, gas, and heat infrastructure.

In general, a power-to-gas facility as deployed in the STORE&GO context can be divided into the following interconnected and juxtapose units:

- H_2 production unit (electrolyser);
- CO_2 production unit (ambient air capture, only in Troia, Italy);
- CH_4 production unit (methanation unit);
- LNG production unit (only in Troia, Italy), and;
- H_2, CO_2, CH_4, and heat pipeline infrastructure.

This Chapter will under sections 5.1 to 5.3 examine the various authorisation procedures to which the STORE&GO pilot sites have been subjected. Subsequent section 5.4 will provide an overview of the findings in these sections.

5.1 Germany

The authorisation procedure for the STORE&GO plant in Falkenhagen, located in the State of Brandenburg, has not been streamlined through a one-stop-shop procedure. Although such coordinated procedures do exist for large wind and solar parks and offshore windfarms, these do not apply to power-to- gas or other storage projects.[9] This means that various departments of the State of Brandenburg have been involved, as well as the District of Prignitz.

5.1.1 Environmental Authorisations

5.1.1.1 Environmental Impact Assessment

The obligation for operators of power-to-gas installations to perform an environmental impact assessment (*Umweltverträglichkeitsprüfung*, hereafter “EIA”) is established under the Environmental

[61] *See* website: https://www.uniper.energy/storage/what-we-do/power-to-gas.
[62] *See* website: http://www.ingridproject.eu/.
[63] *See* website (in German): http://www.hybridwerk.ch/home/technik/.

Impact Assessment Act (*Gesetz über die Umweltverträglichkeitsprüfung*, hereafter “UVP Act”). The objective of an EIA is to *“ensure that, before development consent is given, projects likely to have significant effects on the environment by virtue, inter alia, of their nature, size or location are made subject to a requirement for development consent and an assessment with regard to their effects on the environment”.*[64]

As concluded under section 10.2.1 of Deliverable 7.2, a power-to-gas plant consisting of an electrolyser unit and a methanation unit is likely to constitute an *“integrated chemical installation for the production of basic organic or inorganic chemicals”* under the EIA Directive.[65] For such installations, Member States lack the discretion to decide whether an EIA has to be performed or not. This obligation flows automatically from the listing of “integrated chemical installations” under Annex I to the EIA Directive. Member States maintain, however, discretion to waive the obligation to perform an EIA when a pilot project is undertaken exclusively, or mainly, for the development and testing of new methods or products, and not used for more than two years.[66]

Under the German UVP Act, integrated chemical installations (*Integrierte Chemische Anlage*) are listed under entry 4.1 to Annex I and are, in accordance with the EIA Directive, subjected to an EIA.[67] The possibility to exempt operators of pilot installations from executing an EIA exists under Article 14 of the UVP Act. Before the responsible authority is allowed to make a decision on such an exemption, a so-called “location-based preliminary testing of individual cases” (*Standortbezogene Vorprüfung des Einzelfalls*) has to take place.

For the Falkenhagen STORE&GO plant, the EIA procedure and preliminary assessement had to be coordinated with the State Office for Mining, Geology and Minerals of Brandenburg (*Landesamt für Mess- und Eichwesen Berlin-Brandenburg,* hereafter “LME”). Prior to the inspection of the plant by the LME, the project has been presented at the office of the LME. After the location-based preliminary screening of the site, the LME has decided that an EIA for the STORE&GO pilot plant is not required due to the limited scope of the project.

5.1.1.2 Federal Emission Control Act

The Federal Emissions Control Act (*Bundes-Imissionsschutzgesetz,* hereafter “BImSchG”) and the Ordinance on Installations Requiring a Permit (*Verordnung über genehmigungsbedürftige Anlagen - 4. BImSchV,* hereafter “4. BImSchV”) transpose the EU Industrial Emissions Directive (Directive 2010/75/EU) into German law. The BImSchG and 4. BImSchV establish which industrial installations are required to operate under a permit, and prescribe the requirements with which operators have to conform during the design and operation of an installation. The requirement to operate under a permit applies to installations which, by reason of their nature or their operation, are likely to cause harmful environmental effects or may harm human health or safety.[68] Section 10.2.2 of Deliverable 7.2 already determined that a power-to-gas installation is, in principle, subjected to a permit requirement under EU law.[69] This obligation is mirrored under the German BImSchG and 4. BImSchV and flows from the categorization of a power-to-gas installation as an *“installation for the production of substances or groups of substances by chemical, biochemical or biological conversion at an industrial scale”*.[70]

[64] Article 1(2) of the Environmental Impact Assessment Directive (2011/92/EU).
[65] Entry 6(a,b) of Annex I to the Environmental Impact Assessment Directive (2011/92/EU). An “integrated chemical installation” is an installation *“for the manufacture on an industrial scale of substances using chemical conversion processes, in which several units are juxtaposed and are functionally linked to one another”*.
[66] Entry 13(b) of Annex II to the Environmental Impact Assessment Directive (2011/92/EU).
[67] Article 6 and entry 4.1 of Annex I to the UVP act.
[68] Article 4(1) of the BImSchG 1974.
[69] *See* Article 10 and entries 4.1 and 4.2 of Annex 1 to the Industrial Emissions Directive (2010/75/EU).
[70] Article 4(1)of the BImSchG 1974 and Article 1 and entries 4.1.1 and 4.1.12 of Annex 1 to the 4. BImSchV.

Important requirement is that the public from the start of the project is informed and involved, and is awarded the opportunity to participate in the permitting process.[71]

Installations which are required to operate under a permit are to be constructed and operated in such a way as to:

- Prevent harmful environmental effects and other dangers, considerable disadvantages and nuisances for the neighbourhood and general public;
- Operate by means of state-of-the-art technologies and processes;
- Avoid and recycle waste;
- Use energy in an efficient way.[72]

The Falkenhagen STORE&GO plant has been exempted by the State Agency for the Environment of Brandenburg (*Landesamt für Umwelt Brandenburg*) from the permit obligation under the BImSchG due to its status as pilot plant (*Versuchsanlage*). Article 2(3) of the 4. BImSchV determines that such an exemption exists for installations which exclusively or predominantly are used for the development and testing of new processes, feedstock, fuels or products. This exemption is granted for a period of three years with a possible extension of one year. After this period, the operator has to apply for a full permit in order to be allowed to continue the operation of the power-to-gas plant.

5.1.2 Spatial Planning and Construction Permits

5.1.2.1 Regional Planning Procedure

The regional planning procedure (*Raumordnungsverfahren*) serves the purpose of reviewing projects of a significant spatial scope in terms of their compliance with the requirements of spatial planning and coordination with other plans and measures.[73] The procedure is required under the Spatial Planning Act (*Raumordnungsgesetz*), the Federal Planning Ordinance (*Raumordnungsverordnung des Bundes*), the State Planning Agreement of Berlin and Brandenburg (*Landesplanungsvertrag der Länder Berlin und Brandenburg*) and the Joint Planning Ordinance of Berlin and Brandenburg (*gemeinsame Raumordnungs-verfahrensverordnung der Länder Berlin und Brandenburg*). The responsible authority for the area in which the STORE&GO plant is located is the Joint State Planning Department of Berlin and Brandenburg (*Gemeinsamen Landesplanungsabteilung Berlin-Brandenburg*). Based on the limited spatial scope of the STORE&GO plant, a regional planning procedure was deemed unnecessary.

5.1.2.2 Building Permits for the Methanation Unit

Much of the structures and buildings necessary for the STORE&GO plant were already realised under the preceding WindGas Falkenhagen project. As, however, this project was limited to power-to-hydrogen, construction work was required for the methanation plant. Building permits have been requested for the methanation unit and a heat exchange pipe which connects to a nearby veneer mill. This pipe crosses a street via an overhead construction.

The obligation for a building permit is established under the Building Code of Brandenburg (*Brandenburgische Bauordnung*). The requests for the necessary permits have been submitted to the District of Prignitz which is also administratively responsible for the Falkenhagen area. The approval followed within three months.

5.1.2.3 Construction and Operation of a High Pressure Pipeline

On the site of the Falkenhagen STORE&GO plant, a high pressure pipeline (16< bar) for the transportation of SNG will be constructed which is connected to the high pressure pipeline of the transmission system operator, ONTRAS. Article 5 of the High Pressure Gas Pipeline Ordinance

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[71] Article 10 of the BImSchG 1974.
[72] Article 5(1) of the BImSchG 1974.
[73] Article 2 of the Raumordnungsgesetz 2008.

(*Gashochdruckleitungsverordnung,* hereafter “GasHDrLtgV”) requires a project developer to notify the competent authorities at least 8 weeks before the start of the construction of the pipeline. This notification has to be accompanied by documents based on which the safety of the pipeline can be assessed, including an expert note. Subsequently, the competent authority, in this case the LME, has 8 weeks to raise an objection against the construction on the grounds that the pipeline does not meet the requirements under the GasHDrLtgV.

The GasHDrLtgV states that a high pressure pipeline must be constructed and operated in a way that the safety of the environment is not impaired and harmful effects on humans and the environment are avoided.[74] Articles 3 and 4 prescribe the specific technical requirements for the construction and operation of high pressure pipelines.

The LME has made no objections to the construction of the high pressure pipeline for the Falkenhagen STORE&GO plant.

5.2 Italy

Legislative Decree No 1998/112 requires municipalities to create a single desk and streamlined authorisation procedure for installations involved in production activities (*Sportello unico per le attività produttive,* hereafter “SUAP”) in order to provide the applicant with a unified and timely electronic response.[75] Under the SUAP procedure, plant developers can submit all applications and documentation to the municipality, which then forwards these to the competent authorities.

The SUAP procedure has also been applied to the STORE&GO plant, which is considered a “pilot plant for energy production” by the Troia municipality. Besides being streamlined under the SUAP, the permit procedure for the STORE&GO plant has been further simplified through the direct participation of the Troia municipality as partner within the project. From the start of the project, the municipality has been actively involved in general project meetings and the development of the Troia plant. As such, there was no information gap on the side of the municipality.

5.2.1 Environmental Authorisations

Legislative Decree No. 152/2006, for the last time amended by Legislative Decree No. 104/2017, is an extensive piece of legislation which covers a wide range of environmental regulations (*Norme in materia ambientale,* hereafter “Decree on Environmental Protection”). The Decree transposes, amongst others, into Italian law: the EU Environmental Impact Assessment Directive (2011/92/EU) and the Industrial Emissions Directive (2010/75/EU).

5.2.1.1 Environmental Impact Assessment

The rules on the performance of an EIA (*valutazione d'impatto ambientale*) by certain installations are provided under Title III of Part 2 of the Decree on Environmental Protection. In accordance with EU law, not all projects are required to perform an EIA. As a general rule, the projects listed under Annex II and III of the Decree on Environmental Protection are definitely obliged to perform an EIA.[76] For projects under Annex IV, the necessity of an EIA is determined after a preliminary screening has taken place by the competent authority.[77] The competent authority can be either the National State (projects listed under Annex II) or the Regions (projects listed under Annex III and IV).

For power-to-SNG installations, which can be considered integrated chemical installations, the obligation for an EIA flows from its inclusion under both Annex II and III to the Decree on Environmental

[74] Article 2(1) of the GasHDrLtgV 2011 .
[75] Article 4 of Legislative Decree No 2010/160.
[76] Articles 6(5) and 6(7) of the Legislative Decree on Environmental Protection No. 152/2006.
[77] Articles 6(5) and 6(6) of the Legislative Decree on Environmental Protection No. 152/2006.

Protection. Under Annex II, the National State is the competent authority in so far the volume of SNG production exceeds 200 Gigagrams (Gg).[78] For installations below this threshold, the Regions are the competent authority.[79]

With regard to pilot projects, Articles 6(6(a)) and 6(7(c)) prescribe that projects which serve exclusively or predominantly for the development and testing of new methods or products, and are not used for more than two years, are only required to execute an EIA if this is considered necessary after a preliminary screening. For all pilot projects, the Regions are responsible for the screening process.[80] It was decided by the Regional Agency for the Prevention and Protection of the Environment of Puglia (*Agenzia Regionale per la Prevenzione e la Protezione dell'Ambiente,* herafter "Environmental Agency of Puglia") that the STORE&GO pilot plant does not have to perform an EIA due to the limited scope of the project.

5.2.1.2 Integrated Environmental Authorisation

The integrated environmental authorisation (*autorizzazione integrata ambientale*) under the Decree on Environmental Protection, known as "AIA", has replaced and integrated various individual permit procedures related to the protection of air, water, and land.[81] It thereby follows the integrated approach of the EU Industrial Emissions Directive. Similar to the permit scheme under the German BImSchG, the AIA procedure defines which projects need to apply for a permit, and under which conditions they are allowed to operate (*see* section 5.1.1.2 on these requirements).

Article 6(12) of the Decree on Environmental Protection determines that the installations carrying out the activities listed under Annex VIII to Part 2 are subjected to a permit obligation. Under this Annex VIII, the production of organic and inorganic chemicals is listed as activity under entries 4.1 and 4.2 respectively. The introductory text of Annex VIII confirms that installations or parts of plants used for research, development and testing of new products and processes are not to be subjected to an AIA.

Based on its status as pilot plant, the Environmental Agency of Puglia has exempted the plant from having to operate under a AIA permit.

5.2.2 Spatial Planning and Construction Permits

Chapter IV of Legislative Decree No. 1998/112 establishes that the administrative functions concerning the construction, expansion, termination, reactivation, localisation and relocation of production facilities, including the issuing of concessions or building permits, are attributed to the municipalities. Basic conditions for spatial planning procedures and building permits are defined under the Legislative Decree No. 2001/380, titled "Consolidated text of the laws and regulations relating to building construction" (*Testo unico delle disposizioni legislative e regolamentari in materia edilizia*). Based on these basic conditions, regions and municipalities are required to adopt regulations and procedures in relation to construction work, safety, health and sanitary requirements, fire prevention, seismic risks, energy efficiency, and hydrogeological risks.[82]

For the STORE&GO plant, a building permit, a health and safety permit, and a permit from the firefighting brigade have been requested. A report on seismic risks was already drafted and submitted under the INGRID project. The building permit has been handled and approved by the municipality of Troia. The application for a health & safety permit which is also required under Legislative Decree No. 2001/380 has been forwarded to the health and safety department of the Province of Foggia. Due to

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[78] Entry 6(a) of Annex II to Legislative Decree on Environmental Protection No. 152/2006.
[79] Entry E of Annex III to Legislative Decree on Environmental Protection No. 152/2006.
[80] Entry 8(s) of Annex IV to Legislative Decree on Environmental Protection No. 152/2006.
[81] Article 1 and 2 of Legislative Decree on Environmental Protection No. 152/2006.
[82] Article 23 of Legislative Decree No. 1998/112 and Article 4 of Legislative Decree No 2001/380. More detailed rules on the authorisation procedure on fire prevention are provided under Legislative Decree No 2011/151.

lack of experience with power-to-gas installations, the health and safety department had trouble classifying the installation. This has been a cause for delay in the completion of the SUAP procedure.

5.2.3 Fire Prevention Permit

The requirement for a fire prevention permit follows from the classification of the STORE&GO plant under Presidential Decree No. 151/2011 as a plant producing a flammable and/or combustible gas in cycles globally exceeding 25 Nm^3/h.[83] Also the application for a permit from the fire department delayed the completion of the SUAP procedure. Cause for this delay was the request for further information.

5.3 Switzerland

Authorisation procedures in Switzerland are, as a basic rules, left to the cantons and municipalities. This section will follow the chronological order of authorisations for which the STORE&GO plant in Solothurn had to apply.

5.3.1 Construction Permit

Buildings and structures require a permit from the building authority.[84] Authorisations for the construction of buildings in Switzerland take place at the cantonal or municipal level.[85] For Canton Solothurn, the applicable rules are to be found under the Planning and Construction Act (*Planungs- und Baugesetz*) and the Cantonal Building Ordinance (*Kantonale Bauverordnung*). The application document for a permit must, amongst others, contain information about the construction plan, fire prevention, safety measures, wastewater disposal, air-raid shelters, description of function and activities, potential adverse effects to the environment, floor spacing, and energy use.[86] Based on this information, the request for a construction permit will be approved or rejected. Simultaneously, a decision will be made on eventual environmental permit requirements and the necessity to perform on EIA (*see* section 5.3.2 below).

For the STORE&GO plant, a construction permit has been issued by the municipality of Zuchwil without the need for further environmental authorisations.

5.3.2 Environmental Impact Assessment

Article 10a of the Federal Environmental Protection Act (*Bundesgesetz über den Umweltschutz*) establishes that the obligation to perform an environmental impact assessment (*Umweltverträglichkeitsprüfung,* hereafter "UVP") applies to facilities that can significantly pollute the environment and for which site-specific measures are required to ensure compliance with environmental norms.[87] An UVP is required for new installations and also for changes to existing installations if they involve a considerable transformation, extension or change in use.[88] A change is regarded as considerable if the environmental effects could be large. For both the UVP obligation for new installations and changes to existing installations, the Swiss Office for the Environment (*Bundesamt für Umwelt*) has issued a guidance document.[36][37]

Which specific activities need to be subjected to an UVP is listed under Annex I to the Federal UVP Ordinance (*Verordnung über die Umweltverträglichkeitsprüfung*). Included under the list are facilities with more than 5000 m2 of operating area or with a production capacity of more than 1000 tonnes per

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83 Entry 1.1.C of Annex I to Presidential Decree No. 151/2011.
84 Article 134 of the Planning and Construction Act of Canton Solothurn, No. 711.1, as of 1 March 2013.
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86 Article 5 of the Planning and Construction Act of Canton Solothurn, No. 711.1, as of 1 March 2013.
87 Article 10a(2) of the Federal Environmental Protection Law, No 814.01, as of 1 January 2018.
88 Article 10a(1) of the Federal Environmental Protection Law, No 814.01, as of 1 January 2018.

year for the synthesis of chemical products.[89] This description could fit a power-to-gas installation. The UVP Ordinance delegates the power to adopt more specific rules on the UVP obligation for such installation to the Cantonal legislator.[90]

For the Canton Solothurn, these rules have been published under the Ordinance on Procedural Coordination and Environmental Impact Assessment (*Verordnung über Verfahrenskoordination und Umweltverträglichkeitsprüfung*. The responsible authority for coordinating the UVP is the Office or the Environment of Solothurn. Annexed to the Ordinance is a flow scheme of the appropriate UVP procedure. Although the complexity of this scheme makes a full review of the UVP procedure under this Deliverable not feasible, it should be remarked that all activities are first subjected to a preliminary assessment (*Voruntersuchung*). Based on this assessment it will be decided by the competent authority whether a full UVP is necessary.

As the title already suggests, the Ordinance on Procedural Coordination and Environmental Impact Assessment also sets rules on the material and formal coordination of various spatial and environmental approval procedures. Through such coordination, the request for a preliminary environmental assessment will be processed simultaneously with the request for the building permit. For the STORE&GO plant in Solothurn, the preliminary environmental assessment has taken place simultaneously with the approval procedure for the building permit. Based on the provided environmental specifications, the outcome of the preliminary assessment was that no full UVP has to be performed as the STORE&GO plant does not fulfil the threshold of 5000 m2 of operating area or a production capacity of more than 1000 tonnes per year.

5.3.3 Planning Permission and Operation License under the Federal Labour Act

The Federal Labour Act aims to protect employees at the workplace. This Act determines that developers of industrial installations have to undergo a planning permission procedure (*Plangenehmigungsverfahren*).[91] Responsible for the implementation and coordination of this procedure are the cantons. For this procedure, developers have to submit a report, or plan, which provides details about fire protection safeguards, safety measures, and various technical specifications related to grid connections, machinery, and technical equipment. This plan then has to be approved by the competent authority. If the actually constructed facility complies with the initially approved plan, the cantonal authorities may issue an operation license (*Betriebsbewilligung*).[92] The procedure on planning permissions and operation licenses are further specified under Ordinance 4 of the Labor Act (*Verordnung 4 zum Arbeitsgesetz,* herafter “4 ArGV”) and cantonal legislation.

The obligation to apply for a planning permission and operation license exists for “industrial installations” (*Industrielle Betriebe*), which are installations of a permanent character for the production, processing or treatment of goods or for the generation, transformation or transmission of energy.[93] As the STORE&GO power-to-gas plant is considered to be such an industrial installation, a report has been submitted to the competent authority, which is the Labour Inspectorate of Canton Solothurn (*Amt für Wirtschaft und Arbeit*) and the Technical Inspectorate of the Swiss Gas Industry (*Technisches Inspektorat des Schweizerischen Gasfaches*, TISG). The TISG, which is part of the SVGW, is the accredited inspection body for gas installations, including power-to-gas facilities.

In order to obtain the necessary operation license, the realised STORE&GO plant has to comply with the approved plan. This requires, amongst others, that the TISG has verified that the equipment and machinery are marked with the appropriate certificates and that a fire prevention certificate has been

[89] Entry 70.5 of Annex I to the UVP Ordinance, No. 814.011, as of 1 October 2016.
[90] Article 5 of the UVP Ordinance, No. 814.011, as of 1 October 2016.
[91] Article 7(1) of the Labour Act, No. 822.11.
[92] Article 7(2) of the Labour Act, No. 822.11.
[93] Article 5(2) of the Labour Act, No. 822.11.

obtained from the cantonal fire security association (*Vereinigung kantonaler Feuerversicherungen*). At the moment of publishing of this Deliverable, this procedure was not yet finalised.

5.3.4 Public Involvement

Article 3 of the Planning and Construction Act requires that the population is informed at an early stage about the objectives of a planned construction and is allowed the opportunity to participate in an appropriate manner. The request for a building permit by the STORE&GO plant was, therefore, accessible to the public. No formal objections have, however, been raised to the authorities.

5.4 Overview of the Findings

The findings in this chapter are summarised in Table 5-1 below. The most important conclusion of this chapter is that power-to-gas installations are primarily considered as installations producing chemicals instead of being considered installations producing an energy commodity. As a result, authorisation procedures for power-to-gas installations may be more stringent than those for biogas production and upgrading installations which are considered as energy related activities under EU, German and Italian environmental legislation. For example, where authorities have the discretion to exempt biogas installations from performing an environmental impact assessment, similar discretion does not exist in relation to power-to-gas installations as integrated chemical installations. Furthermore, chemicals producing installations are generally not differentiated on the basis of production capacity, so that small and large facilities fall under the same regime. Based on the outcome of the environmental analysis of the power-to-gas process within STORE&GO, it could be evaluated whether arguments exist to differentiate power-to-gas installations from (other) chemical activities.

A second conclusion is that power-to-gas installations are not required to operate under a special gas production permit. None of the STORE&GO plants was required to apply for a similar permit as is often required for natural gas extraction.[9] Natural gas extraction in Germany and Italy requires a license under a specific act for the exploration and extraction of mineral sources. In Germany this is the Federal Mining Act of 1980 (*Bundesberggesetz,* hereafter “BBergG”). Article 3 BBerG defines mineral sources as all mineral substances, solid, liquid, or gaseous (excluding water), occurring in natural sedimentations or accumulations (deposits) in or on the ground, on or under the seabed, or in sea water. The production of SNG through power-to-gas does clearly not fall under this definition and is, therefore, not covered under the permit regime under the BBerG. Similarly, the permit requirements for gas production only apply to natural gas being produced from underground reservoirs.[94] In Switzerland, there is no national production permit regime in place for natural gas. Various cantons have, however, adopted acts which regulate activities in the subsoil, although this is not the case for Solothurn.[95] The focus on activities in the subsoil excludes power-to-gas from the scope of these acts.

Third, only Italy has introduced a comprehensive streamlined authorisation procedure which also applies to power-to-gas plants, being an installation involved in production activities. The SUAP procedure allows the authorisation process to be streamlined and coordinated by the municipality of Troia.

Finally, none of the STORE&GO plants has encountered serious delays during the authorisation procedures caused by precautionary measures by authorities. Although power-to-gas installations are a recent phenomenon, and an information gap often does exist on the side of the authorities, this has been solved through direct interaction. With new technologies as power-to-gas, especially related to

[94] Royal Decree No. 1443/1927 of 29 July 1927, Presidential Decree No. 484/1994 and Legislative decree No. 625/1996.

[95] *See* for example the act by the Canton Freiburg “on the prospecting and exploitation of hydrocarbons” of 27 February 1960 No. 913.2.

hydrogen production, it is important to start the information flow as soon as possible and to involve authorities at the earliest time possible.

	Legal foundation	Competent Authority	Classification of the power-to-gas installation/activity	Exemption as pilot site	Duration	Integrated into simplified procedure?
Germany						
Environmental impact assessment	Environmental Impact Assessment Act	State Office for Mining, Geology and Minerals of Brandenburg	Integrated chemical installation	Yes, after preliminary screening	Within 1 month	No
Operation permit for industrial installations	Federal Emissions Control Act and Ordinance	State Agency for the Environment of Brandenburg	Installation for the production of substances or groups of substances by chemical, biochemical or biological conversion on an industrial scale	Yes, for a period of three years with a possible extension of one year	Within 1 month	No
Regional planning procedure	- Federal Spatial Planning Act and Ordinance - Federal Planning Ordinance - State Planning Agreement - Joint Planning Ordinance of Berlin and Brandenburg	Joint State Planning Department of Berlin and Brandenburg	None	No, but procedure was deemed unnecessary as to limited spatial scope	Within 1 month	No
Building permit for the methanation unit	Building Code of Brandenburg	District of Prignitz	Methanation unit and heat exchange pipeline	None	Within 3 months	No
Notification of construction and operation of a High Pressure Pipeline	High Pressure Gas Pipeline Ordinance	State Office for Mining, Geology and Minerals of Brandenburg	Construction and operation of high pressure pipeline	None	No objections received within 8 weeks	No
Italy						

Environmental impact assessment	Legislative Decree on Environmental Protection No. 152/2006	Regional Agency for the Prevention and Protection of the Environment of Puglia	Integrated chemical installation	Yes	Within 4 months	Yes, SUAP coordinated by the municipality of Troia
Integrated environmental authorisation (operation permit)	Legislative Decree on Environmental Protection No. 152/2006	Regional Agency for the Prevention and Protection of the Environment of Puglia	Production of organic and inorganic chemicals	Yes	Within 4 months	Yes, SUAP coordinated by the municipality of Troia
Building Permit	Consolidated text of the laws and regulations relating to building construction, Legislative Decree No. 2001/380	Municipality of Troia	Pilot plant for energy production	No	Within 4 months	Yes, SUAP coordinated by the municipality of Troia
Health & Safety Permit	Consolidated text of the laws and regulations relating to building construction, Legislative Decree No. 2001/380	Health Care Department of the Province of Foggia	Pilot plant for energy production installation	No	Within 2 months	Yes, SUAP coordinated by the municipality of Troia
Seismic report	Consolidated text of the laws and regulations relating to building construction, Legislative Decree No. 2001/380	Province of Foggia	-	No	Within 1 months	Yes, SUAP coordinated by the municipality of Troia
Firefighting Brigade Department Permit	Regulation simplifying the regulation of proceedings relating to the prevention of fires, Presidential Decree No. 151/2011	Firefighting Brigade Department of Foggia	Plant producing a flammable and/or combustible gas in cycles globally exceeding 25 Nm3/h	No	Within 4 months	Yes, SUAP coordinated by the municipality of Troia
Switzerland						
Construction permit	- Planning and Construction Act of the Canton Solothurn	Municipality of Zuchwil	-	No	-	Yes, coordinated with environmental

	- Cantonal Building Ordinance					assessment at the canton level
Environmental impact assessment	Federal Environmental Protection Act	Office or the Environment of Solothurn	Facility with more than 5000 m2 of operating area or with a production capacity of more than 1000 tonnes per year for the synthesis of chemical products.	No, but exemption as STORE&GO plant does not meet the threshold off 5000m2 of operating space and 1000 tonnes annual production	-	Yes, coordinated with the building permit at the municipality level
Planning Permission and Operation License	- Federal Labor Act - Ordinance 4 of the Labor Act	Labor Inspectorate of Canton Solothurn and the TISG	Installation of a permanent character for the production, processing or treatment of goods or for the generation, transformation or transmission of energy	No	Ongoing	No

Table 5-1: Overview of findings in chapter 5

6 Legal Framework for Accommodating SNG in the Gas Network

This chapter will examine the national legal measures which are in place to accommodate SNG in the gas networks. One of the main benefits of power-to-gas is that this technology allows renewable energy to be stored in, and transported through, the extensive existing natural gas system. Furthermore, power-to-gas can be considered as an alternative pathway for the production of carbon neutral gases, in addition to biomass digestion and gasification.[1] Another benefit of producing SNG is that its chemical composition (at least 90% methane (CH_4) and limited traces of hydrogen (H_2) and carbon dioxide (CO_2)) is similar to natural gas and does not contain traces of silicones or other components present in biomass-based gases which may be harmful for end-users appliances.[3]

For each jurisdiction, this chapter will assess at least the following issues:

- whether national gas legislation classifies SNG as a (renewable) gas;
- what the connection conditions for a power-to-gas plant are;
- which technical gas quality specifications apply, and;
- if a framework is in place to remedy potential capacity constraints at the distribution level.

Although the emphasis of the STORE&GO project and this Deliverable is on SNG, this chapter will also cover the technical gas quality requirements which apply to the admixing of hydrogen. Furthermore, as Germany has introduced privileges for shippers of SNG, these will also be discussed.

6.1 Germany

As will be explained in section 6.1.1, hydrogen and SNG produced through power-to-gas can be classified as biogas under the EnWG and the Gas Network Access Regulation of 2017 (*Gasnetzzugangsverordnung*) (hereafter “GasNZV”) when the electricity and carbon originate predominantly from renewable sources. Besides general rules for the connection of installations to the gas network and technical rules for the injection of gas, the GasNZV also contains additional privileged rules for installations producing biogas. As power-to-gas is intended to be deployed in connection with renewable sources and/or under a future scenarios with high shares of renewable energy, the subsequent sections on German gas legislation will focus on this special regime for biogas.

6.1.1 Classification of SNG under Natural Gas Legislation

Hydrogen and SNG produced through power-to-gas, if they are injected into a public gas network, are both covered under the definition of “gas” under Article 3(19a) of the EnWG. Note that this definition contains no requirements concerning the origin of the electricity or carbon:

> *Article 3(19a) EnWG: “Gas”*
>
> *Natural gas, biogas, liquefied gas as well as, if they are injected into a gas supply network, hydrogen, which has been produced by water electrolysis, and synthetically produced methane, which is produced from hydrogen produced by water electrolysis and the subsequent methanation thereof.* (translation by author)

The extended scope of this legal definition of gas beyond natural gas is an implementation of Article 1(2) of the EU 2009 Gas Directive which determines that the European common rules on the internal market in natural gas also apply to “*other types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system”* (*see* section 4.3 of Deliverable 7.2). Important consequence of the inclusion of hydrogen and SNG under the definition of “gas” is that the rules on access to the gas network under the GasNZV also apply to these gases.

Operators of power-to-gas installations are awarded preferential treatment under the EnWG and GasNZV when the hydrogen and SNG fulfils the conditions of "biogas". The EnWG defines biogas as:

> *Article 3(10c) EnWG: "Biogas"*
>
> *Biomethane, gas from biomass, landfill gas, sewage gas and mine gas, as well as hydrogen produced through water electrolysis, and synthetically produced methane, when the electricity used for electrolysis and the carbon dioxide or carbon monoxide used for methanation, are verifiably predominantly originated from renewable energy sources within the meaning of Directive 2009/28 / EC (the 2009 Renewable Energy Directive).*

The conditions which flow from this definition are that both the electricity used for the production of hydrogen through water electrolysis, and the carbon used for methanation, must *predominantly* come from renewable sources listed under Article 2(a) of the EU 2009 Renewable Energy Directive.[96] The German legislator has clarified that the inclusion of the term "predominantly" means that at least 80% of the electricity fed into the electrolyser *and* the carbon used for methanation must come from renewable sources.[97] According to the *Bundesnetzagentur*, the 80% benchmark is the average over a whole calendar year.[20]

With regard to the verifiability of the origin of the electricity, the question is whether there should exist a direct line between the RES installation and the electrolyser, or whether electricity can be withdrawn from the network in combination with guarantees of origin or other certificates proofing its origin. Although the answer to this question cannot be directly inferred from the legislation, the *Bundesnetzagentur* seems to leave open the possibility that proof on the origin of the electricity and carbon can be provided through certificates.[20] More explicit and detailed guidance is, however, needed on this issue.

In short, hydrogen and SNG produced through power-to-gas are definitely a "gas" in the context of the EnWG and GasNZV. When both the electricity and carbon come predominantly from renewable sources, these gases are also to be considered "biogas". As will be further explained below, this biogas status is linked to various privileges.

6.1.2 Connection to the Natural Gas Network and Cost Distribution

The term "connection" in this section refers to the physical connection of the power-to-gas installation to a gas transmission or distribution network. Article 17 of the EnWG 2017 contains a general obligation for both transmission and distribution system operators to connect producers and storage installations, including those for the storage of electrical energy, to their networks on the basis of technical and economic conditions that are non-discriminatory, transparent, and fair.

Besides this general connection obligation, Part 6 of the GasNZV contains more specific provisions for the connection of biogas plants. This part 6 has as its objective to enable the injection of biogas into the gas network.[98] Both the concept of "connection taker" (*Anschlusschnehmer*) and "installation" (*Anlage)* apply to installations for the upgrading of biogas to natural gas quality.[99] Although this limitation seems to exclude power-to-hydrogen facilities from the scope of Part 6, the *Bundesnetzagentur* has clarified that both power-to-hydrogen and power-to-SNG facilities must be considered as biogas installations which are eligible for receiving privileged treatment under part 6 of the GasNZV.[20]

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[96] Article 2(a) of the 2009 Renewable Energy Directive (2009/28/EC): *'energy from renewable sources' means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.*
[97] BT-Drs. 17/6072, S. 50.
[98] Article 31 of the GasNZV 2017.
[99] Article 31 of the GasNZV 2017.

Article 33(1) GasNZV prescribes that system operators have to give priority to the connection of biogas installations. The same article also establishes the following connection costs distribution mechanism:

- The system operator has to bear 75% of the costs for connecting the facility to the grid, the connection taker the other 25%. When the connecting pipeline is <1 kilometre in length, the share to be paid by the connection taker is capped at €250.000;
- If the connecting pipeline exceeds 10 kilometres in length, the connection taker has to pay for the additional costs;
- If other connection takers at a later point in time connect to the same connection, there is the possibility for a partial refund.

The system operator is responsible for the maintenance and operation of the connection and associated costs. Finally, Power-to-gas plant operators are required to enter into a network connection contract (*Netzanschlussvertrag*) and a connection usage contract (*Netznutzungsvertrag*) with the system operator.[100]

6.1.3 Technical Specifications for the Injection of SNG

Article 36(1) of the GasNZV requires that in-feeders of biogas ensure that the gas at the entry-point and during injection complies with the gas quality specifications in worksheets G 260 and G 262 of 2007 issued by the German Association for Gas and Water (*Deutscher Verein des Gas- und Wasserfaches*, hereafter "DVGW").[101] These specifications are included in Table 6-1 on page 63. The costs for making the gas "grid compatible" must be borne by the in-feeder, the operator of the power-to-gas plant.[102] However, when the gas quality of the network changes, the costs for alterations to the biogas/power-to-gas installation must be paid by the system operator.[103] The *Bundesnetzagentur* has specified that this shift in costs-responsible party from the in-feeder to the system operator only exists when the network switches from L- to H-gas or *vice versa*.[20] Accordingly, the costs for adapting a power-to-gas installations to a change in hydrogen limits remains allocated to the operator of such an installation. At the exit point, it is the responsibility of the system operator to ensure that the gas quality complies with DVGW worksheet G 685, including odorisation.[104]

A question is whether it is allowed to admix gases to the natural gas grid which at the entry-point do not fully comply with the technical gas quality specification, but are nevertheless compliant at the exit point due to the mixing with the available gas within the natural gas network. The answer to this question can be found by looking at the possibility to inject pure hydrogen into the natural gas network. The *Bundesnetzagentur* is of the position that, although pure hydrogen in itself is not "grid compatible", the admixture of pure hydrogen to the grid is in principle allowed in so far as the mixing of the hydrogen with the gas stream after the point of injection does not lead to complications to the interoperability of gas networks.[20] The amount of hydrogen which can be injected will depend on the local network conditions (e.g. capacity, availability and quality of other gases, pressure, and nearby end-users). Due to the existence of such varying local conditions, DVGW worksheet G 262 only gives the advice that, as a starting point, a hydrogen limit of 10% is technically possible. However, when the gas is used for fuelling compressed natural gas vehicles or gas turbines, this percentage should be lower.[105] The non-binding nature of the proposed hydrogen limit allows system operators certain discretion. ONTRAS, the operator of the transmission system to which the power-to-gas plant is connected, has set the maximum

[100] Article 33(2) of the GasNZV 2017.
[101] Both worksheets are available in the online shop of the DVGW: https://shop.wvgw.de.
[102] Article 36(1) of the GasNZV 2017.
[103] Article 36(2) of the GasNZV 2017.
[104] Article 36(3-5) of the GasNZV 2017.
[105] Section 5.9 of DVGW Worksheet 5.9.

limit at 2%. Even within the range of this limit, the injection of pure hydrogen cannot be guaranteed in case of unforeseeable and temporary swings in locally acceptable hydrogen limits.

In the future, when system operators are confronted with higher quantities of hydrogen, scarce capacity to inject hydrogen may become a serious issue due to the cumulative effect of multiple in-feeders.[17][20] In the event that the capacity cannot be increased due to higher hydrogen limits, it may be necessary for the legislator to adopt a hydrogen injection allocation mechanism which determines how much hydrogen is allowed to be fed in by each producer. For the moment, the *Bundesnetzagentur* is of the position that investments already made in hydrogen production plants have to be protected through the "first come first serve" principle, which favours already connected in-feeders of hydrogen.[20]

6.1.4 Remedies for Capacity Constrains at the Distribution level

Contrary to the current situation in which more than 90% of the gas in Europe enters the gas network at the transmission level, it is expected that the increase in locally produced renewable gas will lead to more gas injected at the distribution level.[38][39] The mostly one-directional design of the gas networks (gas only capable of flowing from the transmission to the distribution level) and limited capacity at the distribution level may result in the following impediments:

- as the pipelines at the distribution level are generally of a limited capacity, and thus allow for less line pack storage capacity, the increased injection of gas at this level may result in capacity constraints and congestion;
- local demand in the vicinity of a production plant may be low, which leads to the accumulation of injected gas when no transfer of the gas to the transmission system is possible;
- locally produced gas may be unable to gain access to centralised underground gas storage facilities which are often connected to the transmission network. [38][39]

Capacity constraints may result in system operators offering firm capacity which is lower than the potential production capacity of a power-to-gas plant.[39] Limited capacity is thus a serious potential barrier for the large-scale injection of locally produced gases such as SNG. A few options may remedy the problem of capacity constraints at the distribution level:

- Network expansion or upgrading;
- Increase connection of large-scale consumers to distribution networks;
- Installation of so called "overflow installations" which enable the reverse flow from the distribution level to the transmission level. Such an overflow involves the deodorisation and compression of the gas.[20][38]

The options of network upgrading and the instalment of overflow installations raises the question who is responsible and who should bear the costs thereof.[39]

In Germany, the system operator has to ensure that the connection of biogas installations, including power-to-gas plants, to the gas network is permanently available, or at least 96% of the time.[106] Article 33(8) of the GasNZV denies the system operator to refuse a connection based on lack of capacity. Article 33(10), in combination with Article 34(2) third sentence GasNZV, requires a system operator, in the event of a refusal of a connection based on capacity constraints, to take all necessary measures to ensure that the capacity of the gas network is increased in order to guarantee the year-round injection and transportation of biogas. Such capacity increase can be achieved through network upgrading or expansions, or through the construction of overflow (*Rückspeisung*) installations which enable the transfer of gas from low pressure pipelines to the transmission system.[107] The costs for the overflow

[106] Article 33(2) of the GasNZV 2017.
[107] Article 33(10) and 34(2) of the GasNZV 2017 and Decision of 11 November 2012 by the *Bundesgerichthof*, EnVR 8/12 .

installation is socialised by incorporating these in the transportation tariffs in the relevant market area.[38]

6.1.5 Privileges for Shippers of SNG as Biogas

Besides the already discussed privileges for producers of biogas, Title 6 of the GasNZV awards two additional advantages to shippers of SNG as "biogas". First, Article 34(1) GasNZV awards priority access to the gas network for shippers (*Transportkunden*) of biogas, in so far as they comply with the gas quality standards by the DVGW.[108] This privileged treatment is a deviation from the general rule that operators have to grant non-discriminatory access to all system users.[109] In order to guarantee such priority access, system operators are obliged to enter into entry- and exit contracts with shippers of biogas.[110]

Another privilege for shippers of biogas follows from Article 35 GasNZV which requires system operators to offer these shippers extended balancing possibilities in comparison to shippers of natural gas.[111] Shippers of gas, either natural gas or biogas, have an obligation to inform the transmission system operator each hour of the volumes of gas they want to inject and withdraw from the gas network.[112] This process is known as "nomination". Subsequently, shippers have to ensure that the actual volume of gas injected at an entry point and withdrawn at the exit point are in balance in conformity with the nominated amounts. If this is not the case, these shippers have to pay an imbalance fee to the system operator, which is responsible for balancing the system.[113]

A first feature of the extended service to shippers of biogas is that the timeframe within which these shippers are allowed to balance their portfolio is extended to 12 months, for natural gas this is only 24 hours.[114] Second, biogas shippers are offered a 25% flexibility in their portfolio, while for shippers of natural gas this is limited to 5%. This flexibility allows biogas shippers to deviate from their nominations without having to pay an imbalance fee.[115] Article 35(8) GasNZV determines, however, that biogas shippers do need to pay €0,001/kWh for the actually used flexibility.

The extended balancing possibilities can be of special importance for shippers of SNG as biogas, as the production thereof will often be linked to the availability of cheap intermittent electricity. The flexibility in balancing allows such a shipper to balance its portfolio over a longer time-frame.

6.2 Italy

The importance and potential impact of technical gas quality standards for the operation of power-to-gas installations became clear during the planning and development phase of the STORE&GO plant in Troia, Italy. Although the initial plan was to produce gaseous SNG, the high costs involved with bringing the SNG into conformity with the maximum allowed hydrogen content of 0,5% resulted in a shift to liquid SNG. As a consequence, the plant will not inject gas into the nearby gas distribution network. Nevertheless, this section will review Italian legislation for the connection of power-to-gas installations

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108 Article 34(1) and 36(1) and (3) of the GasNZV 2017. Article 19 of the GasNZV 2017 and Article 49 of the EnWG 2017.
109 Article 20(1) of the EnWG 2017.
110 Article 34(1) of the GasNZV.
111 See [40] for guidelines on industry practices.
112 Article 15of the GasNZV 2017.
113 Article 22 and 23 of the GasNZV 2017.
114 Article 35(3) of the GasNZV 2017. Article 23(1) of the GasNZV 2017 sets the balancing period for natural gas between 6 AM until 6 AM the next day.
115 Article 35(3) of the GasNZV 2017.

to the natural gas network, and the rules for the injection of SNG, in order to draw conclusions for the deployment of future installations.

6.2.1 Classification of SNG under Natural Gas Legislation

In order to comply with the scope of the EU 2009 Gas Directive (2009/73/EC), article 2-*bis* was added to the Letta Decree No 164/2000 through Legislative Decree No 93/2011, thereby extending the scope of application of the Letta Decree to gases beyond natural gas and liquefied natural gas (LNG).[116] The Decree now also applies in a non-discriminatory manner *"to biogas and gas derived from biomass or other types of gases, to the extent that these gases can be injected into the natural gas system and transported through that system without posing technical or safety problems to the system"* (translated by author). This provision echoes Article 1(2) of the 2009 Gas Directive.

The Italian legislation allows SNG to be treated as a gas of a renewable character, namely as biomethane (*biometano*). Legislative Decree No. 28/2011, implementing the EU 2009 Renewable Energy Directive (2009/28/EC)), defines "biomethane" as: *"gas produced from renewable sources with the characteristics and usage conditions corresponding to those of natural gas and suitable for injecting into the natural gas grid."* (translated by author).[117] The understanding of "energy from renewable sources" under Italian legislation is identical to the definition under the 2009 Renewable Energy Directive (2009/28/EC) (*see* footnote 97).[118] Importantly, the definition of biomethane is not limited to biomass-based gases, but seems to apply to *all* gases produced from renewable sources which are of a similar gas quality as natural gas and can therefore be injected into the gas grid. Pure hydrogen, however, does not seem to be covered under this definition, as this does not have the same characteristics and usage conditions as natural gas.

There is no guidance available as to the exact application of the definition on biomethane to non-biomass based gases from renewable origin such as SNG. Although it can be deduced from the wording of the definition that at least the electricity, as the energetic component, must be of a renewable origin, the question whether this is the same for the carbon source is left open. Similarly to the situation in Germany, it is unclear whether the renewable origin of the electricity can be demonstrated through guarantees of origin. What can be concluded, however, is that the definition is broad enough to include SNG produced through power-to-gas when both the electricity and carbon are of a renewable origin.

6.2.2 Connection to the Natural Gas Network and Cost Distribution

Article 20 of Legislative Decree No. 28/2011 requires the AEEG/ARERA to publish technical and economic conditions for the connection of biomethane production plants to the gas networks. The special connection conditions for biomethane plants should be aimed at a) guaranteeing the safe and technical efficient operation of the gas network; b) to promote transparency and legal certainty with regard to the connection to the network; and, c) to guarantee the low cost of the connection, as well as promoting the extensive use of biomethane.[119]

In compliance with the task assigned to it under Article 20(1) of Legislative Decree No. 28/2011, the AEEG/ARERA, in 2015, adopted a Resolution titled: *"Directive for connecting biomethane plants to the natural gas networks and provisions for determining the amount of biomethane eligible for incentives"* (Resolution 46/2015/R/Gas). Articles 17 to 19 of this Resolution establish a cost distribution mechanism with regard to the connection to the gas network. Article 17 determines that the costs for the operator of the biomethane plant requesting a connection consists out of the cost for network investment minus

[116] Article 30(1) of Legislative Decree No.93/2011, amending the Letta Decree No. 164/2000.
[117] Article 2(1)(o) of Legislative Decree No. 28/2011.
[118] Article 2(1)(a) of Legislative Decree No. 28/2011.
[119] Article 20(2) of Legislative Decree No. 28/2011 as amended by Article 30(2) of Legislative Decree No. 93/2011 and AEEG/ARERA Resolution 46/2015/R/Gas.

the expected network tariff income for the network operator, and minus a 20% discount for the operator of the plant. In accordance with Article 18, the costs for the connection can be paid in instalments over a period of maximum 20 years. Finally, Article 19 establishes that part of the paid costs will be repaid in the event that more network users (e.g. other biomethane plants) at a later point in time make use of the same connection.

6.2.3 Technical Specifications for Injecting SNG

AEEG/ARERA Resolution 46/2015/R/Gas requires that the network operator, Snam Rete gas SpA, in compliance with current technical standards and regulations, defines and publishes the gas quality specifications for the introduction of biomethane into its own network code.[120] As will be discussed in this section, these technical standards and regulations consist out of two different Ministerial Decrees from 2007 and 2013, and a technical standard adopted by the Italian standardisation organization UNI in 2016.

In 2007, the Ministry of Economic Development issued a Decree titled *"Approval of the technical regulations on the chemical and physical characteristics and the presence of other components in fuel gas to be transported"*.[121] The Decree aims to ensure the interconnection and interoperability of production installations, transmission- and distribution systems, gas storage facilities, and regasification units of LNG installations.[122] Relevant for SNG produced through power-to-gas is that the scope of application of the Decree is limited to natural gas belonging to the "second gas family" (with a Wobbe Index between 39,1 and 54,7 MJ/m^3) in accordance with standard UNI EN 437 *"Trial gas - Trial pressure - Categories of equipment"*, but excluding *manufactured gas* and GPL.[123] Although the term *"manufactured gas"* may be interpreted as to include SNG manufactured from electricity and carbon dioxide through electrolysis and subsequent methanation, the term rather refers to hydrogen rich gases, such as town gas or pipe gas.[41] This is also the case in standard UNI EN 437, which at one occasion exchanges the term "manufactured gas" for "town gas" (*gas di cittá)*. This term, therefore, does not apply to SNG. As such, the in-feeder of SNG has to comply with the technical specifications under the 2007 Decree. The specified gas quality parameters under the 2007 Ministerial Decree have been included in the cross-country overview in Table 6-1 on page 63.

The absence of technical rules for other gases than natural gas has been considered the main barrier for the injection of biomethane into the Italian natural gas network.[42] In order to fill this gap, the Ministerial Decree of 5 December 2013 was adopted, which will hereafter be referred to as the "2013 Biomethane Decree".[124] Article 2(1) of the Decree states that biomethane producers have the right to inject biomethane in the gas transmission and distribution network and vehicle fuelling stations. However, Article 8(9) of the same Decree determines that, *until* the entry into force of a European standard on gas quality parameters for biomethane under mandate M/475, only biogas produced through the anaerobic digestion of biomass was allowed to be injected into the natural gas network.[125] The article clarifies that this limitation was imposed in order to protect the health of the population and to ensure the optimal functioning of motor vehicles. Especially biomethane produced through thermochemical pathways, such as biomass gasification, was explicitly denied access to the natural

[120] Article 3(1) of AEEG/ARERA Resolution 46/2015/R/Gas.
[121] Ministerial Decree of 19 February 2007, Gazetta Ufficiale n. 65 of 19.03.2007.
[122] Article 1 of Annex A to the Ministerial Decree of 19 February 2007, Gazetta Ufficiale n. 65 of 19 March 2007.
[123] Article 1 of Annex A to the Ministerial Decree of 19 February 2007, Gazetta Ufficiale n. 65 of 19 March 2007. A gas family is a group of combustible gases with similar burning behaviour linked together by a range of Wobbe indices.
[124] Ministerial Decree of 5 December 2013, Gazetta Ufficiale n. 95 of 17 December 2013.
[125] Article 8(9) of the Ministerial Decree of 5 December 2013, Gazetta Ufficiale n. 95 of 17 December 2013. *See* chapter 7 of Deliverable 7.2 on mandate M/475.

gas network.[126] Although likely unintentional, the limitation to anaerobically produced biomethane from biomass also excludes SNG from being allowed to be injected.

In anticipation of the European Standard of biomethane, the Italian standardisation organisation UNI in 2016 published technical report UNI-TR 11537 *"Injection of biomethane in the natural gas transportation and distribution networks"*. This technical report has, in combination with the Ministerial Decrees of 2007 and 2013, been used as reference by gas system operator Snam Rete Gas when determining the gas quality specifications under its current network code. This network code was approved by the AEEG/ARERA in 2016.[127] The network code prescribes a hydrogen limit of 0,5% based on the maximum value set under UNI-TR 11537. As already mentioned, this 0,5% maximum hydrogen limit formed a techno-economic barrier for the STORE&GO plant in Troia.

In November of 2016, the anticipated European standard EN 16723-1 on *"gas quality specifications for biomethane for injection into the natural gas networks"* was adopted.[1] In December of 2016, the Italian standardisation organisation UNI transposed the European standard into an Italian standard by publishing UNI EN 16723-1.[43] The biomethane gas quality specifications contained therein are also listed in Table 6-1 on page 63. With the adoption of this standard, the discussed *standstill* for the injection of certain biomethane gases under the 2013 Biomethane Decree has ceased.

After the adoption of the European standard on biomethane, AEEG/ARERA has commenced an evaluation of the applicable Italian rules on the injection of biomethane.[128] In a 2017 consultation document[129], the Authority states that system operators, when determining the gas quality specifications in their network codes, should now comply with all the following documents:

a) the Ministerial Decree of 19 February 2007, regarding the components common to natural gas;
b) standard UNI EN 16723-1, regarding the specific biomethane components;
c) the Ministerial Decree of 5 December 2013, regarding restrictions on the use of certain materials in relation to public health needs. This in anticipation of the adoption by the European Standardisation Committee (CEN) of the document "Proposed limit values for contaminants in biomethane based on health assessment criteria "(WI 00408007) which is announced under UNI EN 16723-1, and;
d) the requirement that the biomethane must be free of all components of which the maximum value is not determined by standard UNI EN 16723-1 and/or in the technical report UNI/TR 11537.

The restrictions on the use of certain materials under c) refers to biogas produced by thermochemical methods, such as biomass gasification processes, landfill gases and gases residing from purification processes, from sludge, from undifferentiated urban and non-urban waste and from the organic fraction obtained from the treatment of undifferentiated urban and non-urban waste.[130] This has no consequences for SNG.

Although the Italian government and the regulatory authority have adopted a cautious approach to the introduction of biomethane, there is sufficient basis to argue that SNG, in so far as it conforms with the above stated requirements, is now allowed to be injected into the Italian public gas network. First, although SNG is treated as biomethane in Italy, it's chemical composition is more similar to natural gas than to biomass based gases. Second, all components present in SNG (methane, carbon dioxide, and hydrogen) are now specified under the different technical regulations and standards. As such, not allowing SNG to be injected would likely be in breach of the non-discrimination principle under Article

[126] Article 8(9) of the Ministerial Decree of 5 December 2013, Gazetta Ufficiale n. 95 of 17 December 2013.
[127] AEEG/ARERA Resolution 204/2016/R/gas.
[128] *See* AEEG/ARERA consultation document 484/2017/R/GAS.
[129] AEEG/ARERA consultation document 484/2017/R/GAS.
[130] Article 8(9) of the Ministerial Decree of 5 December 2013, Gazetta Ufficiale n. 95 of 17 December 2013.

2-*bis* of the Letta Decree, which requires the equal treatment of gases which can technically and safely be injected into the natural gas network.

Also for Italy, the question is whether it is allowed to admix gases to the natural gas grid which are not fully compliant with the technical specifications at the point of entry. AAEG/ARERA Resolution ARG/gas 46/15 stipulates that it is the task of the gas system operator to ascertain that the SNG at the entry point meets the technical specifications.[131] The operator may deny the injection of such gas when it fails to comply with the gas quality specifications. Notably, the section on gas quality within the Network code of Snam Rete Gas allows for the injection of natural gas from production fields which do not comply with the defined gas quality specifications.[132] This in-feeding of non-compliant natural gas is only allowed when the conditions for the mixing of this gas in the network with the gas stream are present. This will depend on the availability of sufficient volumes of compliant gas in the network and the specific quality of the gas from the production field. A similar possibility for the mixing of non-compliant biomethane or other gases (for example hydrogen) is not provided for. Arguably, this is a breach of the requirement that other gases must be awarded non-discriminatory treatment in relation to natural gas under article 2-*bis* of the Letta Decree.

6.2.4 Remedies for Capacity Constrains at the Distribution level

Although Legislative Decree No. 28/2011 and the Biomethane Decrees of 2013 and 2018 contain support measures in relation to the connection to the network and the consumption of biomethane, they do not provide instructions on how a system operator must act when confronted with capacity constraints. Guidance on this matter is instead included under the aforementioned AEEG/ARERA Resolution 46/2015/R/Gas. Article 2(4) of this Resolution allows a system operator to deny a connection when concerns arise over, amongst others, capacity constraints. In practice, a system operator then has to provide data on the flow rate during the previous five years which confirm the existence of such a constraint. Resolution 46/2015/R/Gas does not, however, require the system operators to take measures in order to remedy this constraint. Instead, renewable gas producers who are confronted with a refusal of connection or access due to capacity constrains have to resort to the Letta Decree and the amendment thereof through Legislative Decree No. 93/2011.

As made clear under the definition of “distribution system operator” (*gestore del sistema di distribuzione*) under the amended Letta Decree, part of their task is to ensure sufficient long-term capacity to satisfy reasonable requests for the distribution of gas.[133] Articles 16 and 24(1) and (2) of the Letta Decree establish an obligation for gas distribution system operators to connect customers and to grant those customers access to the network, provided that network capacity is available. Article 25 prescribes the procedure for the event that a distribution system operator refuses access or a connection due to capacity constraints. This article requires AEEG/ARERA to verify that the works necessary to overcome this lack or impediment are not technically or economically feasible.

In absence of a specific and explicit requirement for system operators to upgrade their networks or install overflow capacity to accommodate renewable gases, the question is whether such investments are implied under the aforementioned rules under the Letta Decree. This does not, however, seem to be the case. AEEG/ARERA Resolution 138/2004 on criteria aimed at ensuring open access to distribution networks and the model distribution service network code, the latter approved through Resolution 108/2006, both contain no mention of an obligation for system operators to make additional capacity investments or install overflow compressor installations. As a result, there are currently no overflow installations installed in Italy.

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[131] Articles 2(2) and 2(4) of AAEG/ARERA Resolution ARG/gas 46/15.
[132] Point 4.5 of Annex 11/A of the Snam Rete Gas Network Code, Update XLIII.
[133] Article 6(2)(kk-*sexies*) of Legislative Decree No. 93/2011 amending Letta Decree No. 64/2000.

6.3 Switzerland

The Swiss natural gas network consists out of a transit pipeline connecting Germany and Italy, a regional network, and a local network.[134] Before domestic biogas production took off, all gas was imported from connected EU countries.[22] Furthermore, the geographical location of Switzerland in the centre of the European continent make it an important transit country for gas flowing from Germany to Italy. This background explains why the current legal framework under the Federal Pipeline Act of 1964 (*Rohrleitungsgezet*) and Federal Pipeline Ordinance (*Rohrleitungsverordnung*) of 2016 do not contain specific provisions on the position of producers but is more focused on the relationship between network operators and shippers. In comparison to the gas markets within the jurisdiction of the EU and its Member States, the regulation of the Swiss gas market can be characterised as rudimentary. This may change in the future due to the announced Gas Supply Act (*Gasversorgungsgesetz*), the text of which is expected to be published in 2019.[135] The marginal nature of existing gas market legislation in Switzerland also explains why more explicit rules for the sector are established by industry agreements under Swiss private law.[44] For example through the 2012 Industry Agreement (*Verbändevereinbarung*) on access to the gas network for natural gas (*Vereinbarung zum Netzzugang beim Erdgas*).[32]

6.3.1 Classification of SNG under Natural Gas Legislation

The Federal Pipeline Act applies to pipelines for the transportation of petroleum, natural gas, or other liquid or gaseous fuels designated by the Federal Council.[136] In fulfilment of this task, the Federal Council adopted the Federal Pipeline Ordinance which applies to pipelines for the transportation of liquid or gaseous fuels, hydrocarbons or hydrocarbon mixtures such as crude oil, natural gas, refinery gases, petroleum distillates or liquid residues of petroleum refining.[137] This scope is broad enough to cover hydrocarbons from a renewable origin such as SNG. More uncertainty exists about the application of the private industry agreements to other gases than natural gas, as they merely use the term *“Erdgas”* (natural gas). It would be recommended that the announced Gas Supply Act affirms the extent that Swiss gas legislation also applies to alternative gases from a renewable source.

The conclusion of the preceding paragraph is that both the Federal Pipeline Act and Ordinance contain no definition of SNG or other gases from renewable origin such as biogas. A definition of these gases is, however, provided under Directive G13 on the *“Injection of Renewable Gases*” issued by the Swiss Gas and Water Industry Association (*Schweizerische Verein des Gas- und Wasserfaches,* hereafter “SVGW”).[45] This Directive sets the technical and chemical conditions for the feed-in of renewable gases from biomass or other renewable energy sources.[138] The term “renewable gas” (*Erneuerbare Gase)* encompasses biogas, renewable hydrogen, and renewable methane.[139] As “Renewable hydrogen” (*Erneuerbarer Wasserstof*) is considered hydrogen produced from biomass or other “renewable energy carriers”.[140] Finally, “renewable methane” (*Erneuerbares Methan*) is defined as

[134] For a map of the Swiss gas system, *see*: http://www.ksdl-erdgas.ch/fileadmin/user_upload/ksdl-erdgas/Downloads/%C3%9Cbersichtskarte_PK1000.pdf.
[135] *See* for more information of the Gas Supply Act: http://www.bfe.admin.ch/themen/00486/00488/06662/index.html?lang=en.
[136] Article 1 of the Federal Pipeline Act of 4 October 1963, No. 746.1.
[137] Article 1 of the Federal Pipeline Ordinance of 2 February 2000, No. 746.11.
[138] Paragraph 1 of the SVGW Directive G13d on the “Injection of Renewable Gases”.
[139] Paragraph 3 of the SVGW Directive G13d on the “Injection of Renewable Gases”.
[140] Paragraph 3 of the SVGW Directive G13d on the “Injection of Renewable Gases”.

synthetic gas produced through the methanation of renewable hydrogen.[141] The methanation process can be of a catalytic or biological nature.[142]

Further clarification on the conditions for renewable hydrogen and renewable methane are provided under Paragraph 5.3 of Directive G13, which states that:

- installations that produce renewable hydrogen by electrolysis may *only* use electricity from renewable sources, and;
- installations producing renewable methane may *only* use hydrogen produced from electricity from renewable sources. The carbon dioxide or carbon monoxide used for methanation may *not* be produced for the sole purpose of producing renewable methane.

What is understood as a “renewable energy source” is not explicitly defined under Swiss energy legislation. The following renewable sources are, however, listed under the Federal Energy Act in the context of incentives for the feed-in of electricity from renewable energy sources: hydropower, solar energy, wind energy, geothermal energy, and biomass.[143]

6.3.2 Connection to the Natural Gas Network and Costs Distribution

The Swiss Energy Act or the Federal Pipeline Act and Ordinance contain no obligation for gas system operators to connect third parties, including (renewable) gas producers, to their networks. This is different for electricity system operators, which have a statutory legal obligation to grant a connection and access to their networks to third parties, based on non-discriminatory conditions.[144] For the gas sector, the gas industry itself has developed various industry agreements which lay down the conditions for access to the gas network.[145] These agreements are, however, limited to the transportation of natural gas from existing entry points to the final consumer. The right for producers to be physically connected to the gas network, and a possible connection-costs-distribution-mechanism as in Germany and Italy, is not provided for.[146] For the moment, the conditions for such a connection must be negotiated and formalised under a bilateral agreement under private law between the system operator and the connection taker, the operator of the power-to-gas plant. It would be recommended that an affirmative right for producers to be connected is included under the announced Gas Supply Act, including a possible discount for connecting renewable gas production installations as in Germany and Italy.

6.3.3 Access to the Gas Network

Article 13 of the Pipeline Act establishes that a company operating a gas network of 5 bar or more is obligated to contractually take over transports of gas by third parties *if this is technically feasible and economically reasonable,* and if the third party provides reasonable compensation. This means that the system operator is obliged under law to enter into a private contract with a shipper or final consumer, but that the terms of the contract are left to the parties to agree on. Disputes on the obligation to enter into a contract, and/or the terms of the contract, are decided on by the SFOE on a case-by-case basis.[147] According to a report on power-to-gas in Switzerland, the transportation obligation (*Transportpflicht*) of

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141 Paragraph 3 of the SVGW Directive G13d on the “Injection of Renewable Gases”.
142 Paragraph 3 of the SVGW Directive G13d on the “Injection of Renewable Gases”.
143 Article 19(1) of the Federal Energy Act of 30 September 2016.
144 Articles 5 and 13 of the Federal Electricity Supply Act of 23 March 2007, No. 734.7.
145 The relevant documents can be accessed through: http://www.ksdl-erdgas.ch/netzzugang.html.
146 Although an explicit right for producers of renewable gas to be connected to the gas network is lacking under Swiss law or the industry agreements, the connection of final consumers to local gas networks is regulated under the so-called NEMO Manual.[47] In order to be connected, a onetime net connection fee (*Netzanschlussbeitrag*) is required to be paid by the connection requesting party. This fee reflects the actual costs of the connection based on market prices. The costs for the maintenance and renovation of the connection are socialised in the network usage charges paid by end-users. Network operators are granted the flexibility to award discounts to certain customers.
147 Article 13(2) of the Federal Pipeline Act of 4 October 1963, No. 746.1.

Article 13 of the Federal Pipeline Act does not constitute a requirement for system operators to grant access to producers who want to inject gas into the network, but only an obligation to offer transportation services.[46] It is argued in this report that "*the Federal Pipeline Act only covers gas that is already in the grid*".

The absence of a clear *ex ante* right to access the gas network has been considered by the gas industry as an obstruction for the existence of a competitive gas market.[44] As mentioned in the introduction to this section, this has resulted in several industry agreements under private law, among which the Industry Agreement of 2012.[32][44] Under the preamble and Article 2 of this Industry Agreement, it is explicitly stated that the Agreement has as its purpose to ensure an efficient and non-discriminatory access to the Swiss gas system for third parties. Whether this right to access also applies to producers is not defined. The term "network customer" (*Netzkunde*) is limited to suppliers (*Lieferanten*), end-users (*Endverbraucher*), and service providers (*Dienstleister*). Furthermore, access is only granted based on the following minimum reservation conditions:

- a minimum volume of 150 Nm^3/h (reduced from 200 Nm3/h as of 1 October 2015);
- the gas in question is used primarily for the production of process heat for industrial purposes, and;
- the customer allows for load measurement using remote data.[32]

Not only is the minimum volume of 150 Nm^3/h a barrier for small- to medium size power-to-gas installations (e.g the maximum SNG output volume of the STORE&GO plant in Solothurn is 30 Nm^3/h), the requirement on the perceived end-use forms another significant limitation. These conditions confirm that the industry agreements are especially focused on the transportation of imported gas to large industrial consumers. Also the subsequently adopted General Network Usage Conditions for the Swiss Natural Gas Network (*Allgemeine Netznutzungsbedingungen für die schweizerischen Erdgasnetze*) by the industry only establishes a right for access only for network customers who want to enter into agreement (*Netzanschlussvertrag*) with the network operator for the transportation of natural gas.

It can thus be concluded that both the Federal Pipeline Act and the Industry Agreement do not contain a clear right of access to the gas network for domestic producers of gas, including SNG. In the event of a refusal of access, the available remedy for a producer is to start legal proceedings at a Swiss court on the basis that the network operator abuses its monopolistic position, in particular under Article 7 of the Federal Act on Cartels and other Restraints of Competition (*Kartellgesetz,* hereafter "Cartel Act").[148] These general competition provisions under the Cartel Act are also applicable to disputes regarding access to pipeline systems below 5 bar.[44] However, as competition cases in a court are always decided on a case-by-case basis, such an *ex post* approach towards the issue of network access contributes to legal uncertainty.

The Gas Supply Act should address the legal deficiencies identified above by introducing an explicit third party access right to the gas networks which also applies to producers of renewable gases.

6.3.4 Technical Specifications for the Injection of SNG

The obligation for gas system operators to transport gas for third parties is conditioned on the technical feasibility of such a transport.[149] Technical specifications on the required gas composition for the injection of gas into the network are provided by the SVGW. Relevant for SNG are SVGW Directives G18 (gas quality in the natural gas grid), G13 (injection of renewable gases), and G11 (Odorisation). The specifications with which a renewable gas must comply in order to be allowed to be injected into the gas grid to an unlimited extent are provided in Table 6-1 on the next page.

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[148] Bundesgesetz über Kartelle und andere Wettbewerbsbeschränkungen of 6 Oktober 1995, SR 251 (Hereafter "Cartel Act").

[149] Article 13 of the Federal Pipeline Act of 4 October 1963, No. 746.1.

It is possible to inject gases which are not compliant with SVGW Directives G18 and G13 by admixing these to the gas which flows through the gas network. As a minimum requirement, the injected gas must consist at least for 50% out of combustible components. Furthermore, the injected gas must be able to mix into the available gas stream so that the gas is compliant at the first exit point of a consumer.[150] The maximum amount of renewable gas to be injected is then thus determined by the composition of the gas mixture after the entry point and before the first consumer exit point.[151]

Important note to Table 6-1: the values in Table 6-1 below only give an indication of certain gas quality specifications. The legal conditions for individual values may, however, be different under specific circumstances.

Component	Unit (1)	Germany (2)		Italy (3)	Switzerland (4)
		L-Gas	H-Gas		
Wobbe Index	MJ/(S/N)m³	37.8–46.8	46.1-56.5	47.31-52.33	47.88-56.52
Gross Calorific Value	MJ/(S/N)m³	30.2–47.2	30.2–47.2	34.95-45.28	38.16-47.16
Relative Density		0.55-0.75	0.55-0.75	0.5548-0.8	0.5-0.7
Methane	% mol	≤90	≤95	(5)	≥96
Oxygen	% mol	≤3	≤3	≤ 0.6	≤ 3
Carbon Dioxide	% mol	≤10	≤5	≤ 3	<5
Carbon Monoxide	% mol			≤ 0.1	≤ 3
Hydrogen content	% mol	≤10 (6)	≤10 (6)	≤ 0,5	≤ 2
Hydrogen Sulphide	mg/(S/N)m³	≤5	≤5	≤ 6.6	≤ 5
Sulphur from mercaptans	mg/(S/N)m³	≤6	≤6	≤ 15.5	≤ 5
Total Sulphur	mg/(S/N)m³	≤30 Avg/y	≤30 Avg/y	≤ 150	
Hydrocarbon Dew Point	°C (up to 70 bar)	-2	-2	≤ 0	

(1) The Italian technical rules make reference to Sm³., Germany and Switzerland use Nm³.
(2) DVGW Worksheets G260 and G262..
(3) UNI EN 16723-1 and UNI/TR 11537.
(4) SVGW Worksheets G13 and G18
(5) The acceptable value is intrinsically linked with the acceptable range of the Wobbe Index
(6) This is the advised maximum level. System operators are allowed to apply lower levels depending on local circumstances.

Table 6-1: Gas quality specifications

6.3.5 Remedies for Capacity Constrains at the Distribution level

According to the SVGW, which is also a partner within STORE&GO, capacity constraints at the local level may form a barrier for the large-scale injection of renewable gas. Although local storage may be an option, this does not contribute to the distribution of such renewable gas over a larger geographical area. The Federal Pipeline Act and Ordinance do not prescribe how system operators are required to act when confronted with capacity constraints. The Federal Energy Act only speaks of the necessity for the national state and the cantons to take capacity related measures when the lack of capacity results

[150] Paragraph 7.9 of SVGW Directive G13.
[151] Paragraph 7.9.2 of SVGW Directive G13.

in a security of supply risk.[152] Similar action would also be appropriate for accommodating renewable gas in light of the Swiss Energy Strategy 2050.

6.4 Overview of Findings

	Germany	Italy	Switzerland
Does current gas legislation also apply to SNG?	Yes	Yes	Although SNG as hydrocarbon seems to be covered by the Pipeline Act and Ordinance, the private industry agreements seem to be limited to natural gas
Can SNG be classified as a renewable gas?	Yes, as biogas when both electricity and carbon are 80<% renewable. It is, however, unclear whether the renewable origin of the electricity can be demonstrated through guarantees of origin.	Yes, as biomethane. But, conditions for electricity and carbon source are undefined under LD 28/2011. It is unclear whether the renewable origin of the electricity can be demonstrated through guarantees of origin.	Not under Federal gas legislation or the General Network Usage Conditions. SNG is only defined as renewable gas under SVGW Directive G13. Electricity must then originate 100% from a renewable source and the carbon may not be intentionally produced for the methanation process. This Directive only applies, however, to the injection of gases.
Is a cost-distribution system in place for the connection?	Yes, when connection <1km: 25% by producer, 75% by system operator	Yes, 20% discount for biomethane plants	No, conditions set through bilateral agreements between the producer and the system operator
Are the gas quality parameters clearly defined?	Yes, DVGW Worksheets G260 and G262	Yes, UNI EN 16723-1, UNI/TR 11537, and Ministerial Decrees of 2007 and 2013	Yes, SVGW Directives G13 and G18
Is the injection of non-compliant gases allowed?	Yes, but may be constrained by local conditions	Only for natural gas producers	Yes, as long as compliant at first consumer exit-point and the gas consists at least 50% out of combustible components
Are there measures in place which should remedy capacity constrains at the distribution level?	Yes, requirement for network expansions and overflow installations. Cost socialised through tariffs	No	No

Table 6-2: Overview of findings in chapter 6

[152] Article 9 of the Federal Energy Act of 30 September 2016.

7 Network Tariffs, Taxes and other Surcharges

Electricity used for water electrolysis is the main feedstock for the power-to-gas process. The operational costs of a power-to-gas installation are, therefore, for a large part determined by the price paid for this electricity. Besides paying for the commodity electricity, operators of power-to-gas installations may also be confronted with added network tariffs, taxes and other surcharges for final consumers. It was concluded under chapter 3 that power-to-gas installations which produce a gas for transportation or heating purposes are considered as final consumers of electricity in all three countries under assessment. When the hydrogen or SNG is produced for later reconversion into electricity, only Switzerland excludes a power-to-gas installation from being a final consumer, in analogy to pumped hydro storage.

This chapter, under sections 7.1 to 7.3, will examine which additional cost components for final consumers of electricity are stacked on top of the commodity price, and whether exemptions for these costs exist for operators of power-to-gas installations. In addition, where appropriate, it will be assessed whether network charges have to be paid when hydrogen and SNG are injected into the natural gas network. The findings are summarised under section 7.4.

7.1 Germany

The German term "*Stromnebenkosten"* can be translated as 'side-costs to electricity". It refers to different state-imposed cost components which are stacked on top of the commodity price of electricity. These different components, and their share in the total price of electricity paid by final consumers, are illustrated under Figure 7-1 below. Notably, the commodity price constitutes only 19% of the total electricity bill. The remaining 81% of the electricity bill consists of additional costs.

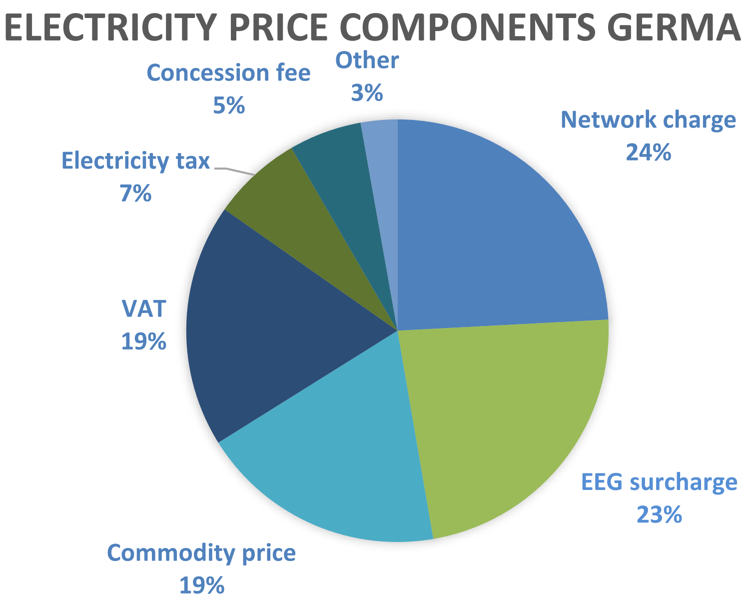

Figure 7-1: Electricity price components Germany (data from [49])

As was concluded under section 3.2.1, an operator of a power-to-gas installation in Germany is treated as a final consumer during the conversion of electricity into hydrogen. For this classification it is irrelevant whether the hydrogen or SNG is reconverted into electricity. In the subsequent sections, it will be assessed whether exemptions from the different costs components exist under German energy law for power-to-gas plants.

7.1.1 Network Tariffs

Users of electricity or gas networks are often required to pay an access or connection tariff. Such network tariffs can be divided into so called “G-charges” for producers connected to the network, and “L-charges” for loads, or final consumers. Germany has introduced both L-charges for final consumers of electricity, and G-charges for producers connected to the gas network. Section 9.4 of Deliverable 7.2 of the STORE&GO project already discussed how an obligation to pay L-charges by both an energy/electricity storage operator and the actual downstream final consumer of the energy leads to a double-charging of the same amount of energy.[1] Such double-charging ignores the fact that storage is only a temporary station for the energy on its way from producer to consumer. This irrationality has been acknowledged by the German legislator. As will be expanded on in this section, an operator of a power-to-gas installation is, under certain conditions, exempted from paying both electricity L-charges and Gas G-charges.

Article 118(6) EnWG 2017 establishes that installations for the storage of electrical energy are, for a period of 20 years after becoming operational, exempted from paying L-charges related to the purchase of electricity which feeds into the installation. Only installations which are built after 31 December 2008 and becoming operational within 15 years after 4 August 2011 can apply. As its starting point, Article 118(6) EnWG 2017 requires that the electricity must be withdrawn from a transmission or distribution network, and must be re-injected into the *same* network after storage. Notably, this condition would exclude cross-sectoral storage technologies which allow for sector-coupling, such as power-to-gas. To prevent the disadvantaged treatment of power-to-gas compared to other storage technologies, the final two sentences of Article 118(6) EnWG 2017 provide relieve for operators of power-to-gas installations which produce gas or biogas. Not only does the requirement of injection in the same electricity network not apply to operators of power-to-gas installations, they are also exempted from paying G-charges while injecting gas into the network to which they are connected. An issue debated in the literature is whether Article 118(6) requires that the SNG is eventually reconverted to electricity or not. One opinion in the literature suggests that reconversion is possibly necessary.[50] However, the majority of commentators believes that the exemption is independent of any further use.[51][52] As such, power-to-gas facilities which become operational before 4 august 2026 are exempted from paying both L-charges during electricity withdrawal, and G-charges during gas injection.

As Article 118 EnWG is of a transitional nature, a more structural approach to the issue of double charging should be considered. This could be achieved by excluding energy storage from the concept of final consumer, or by adopting a permanent exemption from paying network tariffs. An alternative approach, which was already discussed under section 9.4 of Deliverable 7.2, would be to allocate network fees based on the so-called “cost causality principle”. This involves dynamic network tariffs which are zero or close-to-zero for technologies which relieve the network in times of excess supply and discharge during off-peak hours. The 2018 Coalition agreement between CDU/CSU and SPD seems to support such an approach, as it has announced a reform of network tariffs based on such cost causality.[6]

7.1.2 Electricity Tax

Final consumers of electricity are subjected to an electricity tax (*Stromsteuer*).[153] Without an exemption for operators of energy storage facilities, the double-taxation of an amount of energy will occur, similar as with the double charging of network tariffs. At least for stationary batteries, there now exists the possibility for an exemption from the electricity tax.[154]

In the literature, a possibility for tax exemptions for other storage technologies than batteries is being discussed.[12][53] The starting point of this discussion is Article 9(1, sub 2) of the Electricity Tax Act

[153] Article 5(1) of the Electricity Tax Act1999.
[154] Article 5(4) of the Electricity Tax Act 1999.

(*Stromsteuergesetz*) which states that electricity which is withdrawn for electricity generation is relieved from the tax burden. Importantly, Article 12(1) of the Electricity Tax Ordinance (*Stromsteuerverordnung*) limits the scope of this exemption to: 1) electricity used for ancillary and auxiliary equipment of an electricity generation unit, and 2) the electricity consumed for the pumping of water for storage by pumped hydro storage facilities. Although other storage technologies are not mentioned under this exemption, it is argued that they could be eligible by analogy.[17][53] If not, this could distort the level playing field among storage technologies.

For operators of electrolyser installations there is relieve in the form of a possibility to request for a remuneration or reimbursement of the electricity tax.[155] This possibility for compensation is only open to undertakings in the manufacturing sector (*Unternehmen des Produzierenden Gewerbes*) which are undertakings active in Section C (Mining and Extraction of rocks and soils), D (manufacturing), E (energy and water supply), or F (construction).[156] It is argued that when the power-to-gas plant produces hydrogen or SNG without the purpose of reconversion into electricity, such an activity could be classified under group D (manufacturing) as this involves the manufacturing of chemicals.[17] Under the scenario in which reconversion is foreseen, a classification under group E (energy and water supply) could be appropriate.[17]

7.1.3 EEG Surcharge for the Financing of Support Schemes

The "EEG surcharge" (*EEG Umlage*) is a surcharge which is added to the bill of final consumers of electricity in order to cover the costs for support for renewable energy projects under the EEG Act (*EEG Gesetz*).[56] As Figure 7-2 below shows, the amount of EEG surcharge which is stacked on top of the wholesale electricity price has increased extensively in the past few years due to the increase in renewable energy projects.

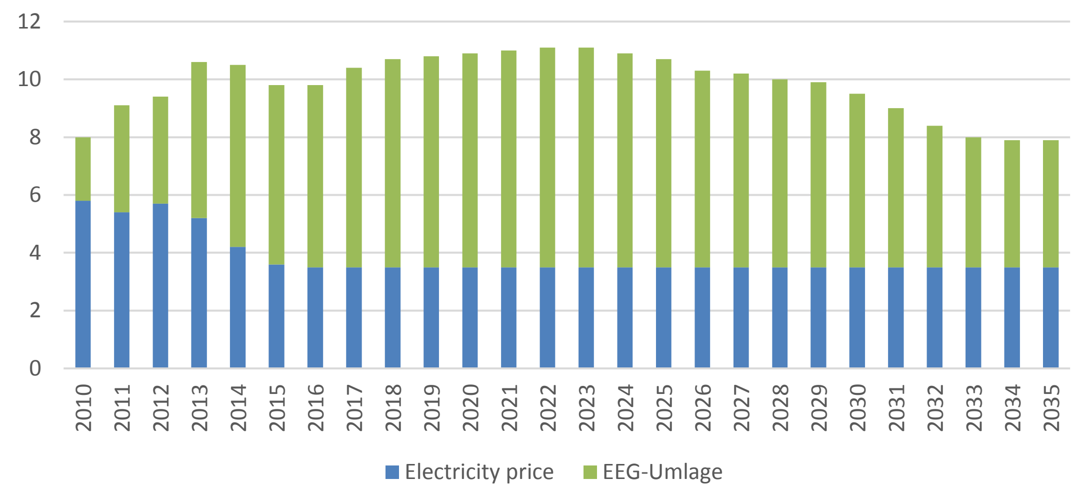

Figure 7-2: Prognosis EEG surcharge in €ct/kWh until 2035 (Source data: [56])

As the above graph illustrates, since 2013 the EEG surcharge constitutes a higher component on the electricity bill than the wholesale electricity price. In absolute terms, the EEG surcharge increased from 2.2 €ct/kWh in 2010 to 7.2 €ct/kWh in 2018, and will peak at 7.6 €ct/kWh in 2022.

It was discussed under section 9.3 of Deliverable 7.2 that the EU guidelines on state aid, under certain conditions, allow Member States to exempt certain groups from paying surcharges which are

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155 Article 9a(1) of the Electricity Tax Act 1999.
156 Article 2(3) of the Electricity Tax Act 1999.

earmarked for the promotion of renewable energy.[54][157] Under German law, such possible exemptions are provided for under Article 61(k) of the EEG 2017.

Article 61(k)(2) EEG 2017 contains a specific exemption for power-to-gas facilities which use electricity from renewable sources for the production of "storage gas" (*Speichergas*). Storage gas is defined under Article 2(42) EEG 2017 as "*any gas that is not renewable, but is produced for the storage of electricity from renewable energy sources by exclusively using electricity from renewable energy sources".* It follows from the wording of this definition that the electricity must for 100% originate from renewable sources. With regard to the source of carbon used to produce storage gas, the German legislator has clarified that the carbon dioxide used for methanation is not allowed to be intentionally produced for the production of SNG.[158]

Importantly, the exemption from the EEG surcharge for the production of storage gas is conditioned on the requirements that the storage gas is injected into the gas grid and designated for re-electrification.[159] To verify that the storage gas is indeed used for electricity generation, a mass-balancing system has to be used in accordance with Article 44(b)(5) of the EEG. Through this mass balancing system, natural gas withdrawn from an exit point can be considered as virtual storage gas. This system of mass balancing is further explained under section 8.1 as this system must also be used to receive financial support for electricity production from storage gas.

7.1.4 Other Side-Costs of Electricity

Besides the already discussed components, the electricity bill of final consumers in Germany also contains the following *Stromnebenkosten*:

- Offshore-liability charge (*Offshore-Haftungs Umlage)*: the revenues of this charge are earmarked for operators of offshore electricity production installations which incur damage due to a disruption or delay in the connection with the offshore network by the system operator.[160] Article 17(5) EnWG allows network operators to socialize these costs among the end-users of electricity;
- CHP surcharge (*Kraft-Wärme-Kopplung Umlage*): electricity system operators are obliged to pay a CHP premium to operators of modern *Kraft-Wärme-Kopplung* (combined heat and power) installations.[161] Similar to the costs for the offshore-liability charge, these costs are socialized through the network fees.
- Surcharge under Section 19, subsection 2 of the Electricity Grid Fee Ordinance (*StromNEV-Umlage*): final consumers can request an individual network tariff under Article 19(2) of the Electricity Network Tariff Ordinance (*StromNEV*). Individual network tariffs can, however, cause downstream operators of electricity distribution networks to lose revenues. As compensation, transmission system operators must reimburse them for these losses. In turn, transmission system operators are allowed to socialise these costs.
- Levy for interruptible loads *(Umlage für abschaltbare Lasten*): suppliers of interruptible capacity from interruptible loads are remunerated by the system operator, which socialises these costs[162];

[157] *See* section 3.7.2. of the Guidelines on State aid for Environmental Protection and Energy 2014-2020 (OJ 2014 C 200/01).
[158] BT-Drs. 17/6071, S. 62.
[159] Article 61(k)(2) of the EEG 2017
[160] Article 17(f) of the EnWG 2017.
[161] Kraft-Wärme-Kopplungsgesetz 2015.
[162] Verordnung über Vereinbarungen zu abschaltbaren Lasten 2016.

- Concession fee (*Konzessionsabgabe*)*:* system operators have to pay a concession fee to municipalities for the use of the public space on which their network is situated. This fee is then passed on to the consumers of electricity[163];

As illustrated in Figure 7-1, these components combined have a share of approximately 3 % on the total electricity bill of final consumers.

While it is suggested[164] that the above mentioned cost components will be omitted by way of the exemption for network tariffs under Article 118 (6) EnWG, the German Federal Court[165] decided that Article 118 (6) EnWG only applies to network tariffs in a strict sense. Due to this recent ruling, it has become clear that neither of the above listed cost components is included by this exception.

7.2 Italy

Besides paying for electricity, final consumers of electricity in Italy also have to pay network charges and general system charges *(oneri generali di Sistema)*. The latter is a collection of various components which were levied as individual charges before 2018.[166] Possible exemptions to both the network tariffs and general system charges are discussed below.

7.2.1 Network Tariffs

Final consumers of electricity in Italy pay L-charges. According to Article 16 of the Integrated Transport Text 2016-2019 (*Testo integrato delle disposizioni per l'erogazione die servizi di trasmissione e distribuzione dell'energia elettrica*), operators of pumped hydro storage plants are exempted from the obligation to pay transmission and distribution network tariffs for electricity used during the pumping modus. Article 3 of AEEG/ARERA Resolution 574/2014/R/eel on the integration of storage systems extends this exemption to other systems for the storage of electricity.

Importantly, as concluded in section 3.1.2, a power-to-gas installation which is not deployed in a power-to-gas-to-power context, and thus not able to withdraw *and* release electrical energy, is not covered under the definition of "storage systems" under Resolution 574/2014/R/eel. Therefore, an exemption from network charges for cross-sectoral storage technologies as in Germany does not exist in Italy. It is also unclear whether an exemption still exists in the power-to-gas-to-power scenario when the gas is transported through the natural gas network to a CHP installation at another location, or whether reconversion has to take place at the same site as the power-to-gas installation.

Italy has no system of G-charges for producers of (renewable) gas who are feeding into the network.

7.2.2 General System Charges

Italy has an extensive scheme of general system charges which are added to the electricity bill of final consumers. Before 2018, there existed nine different types of general system charges

- A2 to cover charges for nuclear decommissioning;
- A3 to cover support schemes for renewable sources;
- A4 to cover the tariff concessions recognized for the railway sector;
- A5 to support research;
- As to cover the charges for the electric bonus;
- Ae to cover breaks to manufacturing industries with high energy consumption;
- UC4 to cover compensation for smaller electrical companies;

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163 Article 48 of the EnWG 2017.
164 *See* [50].
165 Decision of 20 June 2017 by the *Bundesgerichtshof*, EnVR 24/16.
166 EAAG/ARERA Resolution 481/2017/R/EEL, Resolution 922/2017/R/EEL, and Resolution 923/2017/R/EEL.

- UC7 for the promotion of energy efficiency in end uses;
- MCT to cover local compensation for local authorities that host nuclear facilities.[167]

As of the beginning of 2018, in accordance with Legislative Decree No. 21/2016, the system has been somewhat simplified by the AEEG/ARERA by decreasing the number of categories to two:[168]

- A_{SOS} charges for the support of renewable energy and cogeneration; and
- A_{RIM} charges for other expense.

Both the A_{SOS} and A_{RIM} charges are composed of various fixed and variable cost elements. The costs for the A_{SOS} charge for different customers are provided in Table 7-1 below.

	Fixed Quota	**Power Quota**	**Energy Quota**
	€cts per supply point per year	*€cts per Kw per year*	*€cts per Kwh*
MV customers with Pn<=100kW	45,559.32	2,178.96	4.5676
MV customers with Pn<=500kW	42,654.72	1,956.60	4.5637
MV customers with Pn>500kW	41,770.92	1,716.48	4.5598
HV customers (132/150kV)	1,442,402.88	1,412.04	4.4521
HV customers (220 kV)	1,442,402.88	1,412.04	4.4381
HV customers (>=380kV)	1,442,402.88	1,412.04	4.4375

Table 7-1: Cost elements of the A_{sos} component (Data from Resolution 923/2017/R/EEL). (MV= medium voltage level, HV= high voltage level. Pn = nominal power per connection)

There are two possible pathways for operators of power-to-gas installations to receive a (partial) exemption. First, Resolution 574/2014/R/eel not only exempts operators of storage system from having to pay network tariffs, but also from general system charges. The limited applicability of this exemption to power-to-gas was already discussed under the previous section 7.2.1.

The second possible (partial) exemption exists for power-to-gas as an “energy intensive activity” under AEEG/ARERA Resolution 921/2017/R/eel. The A_{SOS} charge includes the A3 component which, similar to the *EEG-Umlage* in Germany, is earmarked for the financing of support schemes for renewable energy projects. In order to protect energy intensive industries, certain activities are partially exempted from paying this A3 component. These exemptions were found to be compatible with the EU “Guidelines on State aid for Environmental Protection and Energy 2014-2020” by the European Commission in Decision C(2017) 3406.[169]

[167] Information about all the individual charges can be obtained on the site of AEEG/ARERA: https://www.arera.it/it/elettricita/auc.htm.htm.
[168] EAAG/ARERA Resolution 481/2017/R/EEL, Resolution 922/2017/R/EEL, and Resolution 923/2017/R/EEL.
[169] *See* section 3.7.2. of the Guidelines on State aid for Environmental Protection and Energy 2014-2020 (OJ 2014 C 200/01) (hereafter “2014 State aid Guidelines” and the Decision by the European Commission of 23 may 2017, C(2017) 3406.

Eligible for an exemption are, amongst others, entities operating in sectors with high international trade exposure covered by Annex III of the just mentioned EU guidelines.[170] As concluded under section 9.3 of Deliverable 7.2, power-to-gas can be classified under this Annex as an activity for the manufacturing of organic and inorganic chemicals. Such an activity that consumes more than 1 GWh of electricity per year is eligible to receive a partial exemption, the height of which depends on the energy intensity ratio.[171] As such, operators of power-to-gas installations which consume more than 1 GWh could apply for a reduction of the A_{SOS} charge as energy intensive activity.[172]

7.3 Switzerland

The electricity price currently paid by the final consumers in Switzerland is made up of the energy commodity price, the costs for network tariffs, and a surcharge for the financing of support schemes. Besides possible exemptions to network tariffs, also potential exemptions to this surcharge will be reviewed.

7.3.1 Network Tariffs

In the electricity context, Switzerland only has a system of L-charges (*Netznutzungsentgelt*). All network fees are thus paid by the end-consumers of electricity.[173] According to Article 4(1)(b) of the Electricity Supply Act, the electricity purchased for the charging/pumping phase of pumped hydro storage facilities does not constitute such end-consumption. As such, the purchase of this electricity by pumped hydro storage facilities is not subjected to network tariffs.[174]

In 2016, the Commission for the Environment, Spatial Planning, and Energy of the Swiss Federal Assembly introduced a motion requesting the Federal Council to change the Electricity Supply Act as to exempt not only traditional pumped storage plants, but also other storage technologies, including power-to-gas, from L-charges. This motion lacked support from both the Federal Council and the General Assembly and was eventually rejected.[175] According to the Federal Council, electricity purchased by other types of storage and conversion installations, which flows through a direct line from a production installation to the storage/conversion installation, is already exempted from network fees.[176] According to the opinion by the Federal Council, further exemptions for storage technologies from network charges is premature since there is no definition on storage yet.[177] The Council also stated that it needs to be further assessed and debated whether such an exemption should be extended to situations where the stored energy is not reconverted to electricity. Such discussion should take place in the context of a new Electricity Supply Act. In general, a future regulation of network user charges must, according to the Council, aim to ensure the highest possible degree of causality. According to the

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[170] AEEG/ARERA Resolution 921/2017/R/eel of 28 December 2017 and section 3.7.2. and Annex III to the 2014 State aid Guidelines.
[171] AEEG/ARERA Resolution 921/2017/R/eel of 28 December 2017 and the Decision by the European Commission of 23 may 2017, C(2017) 3406.
[172] AEEG/ARERA Resolution 921/2017/R/eel of 28 December 2017 and the Decision by the European Commission of 23 may 2017, C(2017) 3406.
[173] Article 14(2) of the Electricity Supply Act of 23 March 2007, No. 734.7.
[174] Article 4(1)(b) in combination with Article 14(2) of the Electricity Supply Act of 23 March 2007, No. 734.7.
[175] Debate and vote in the Federal Swiss Parliament on 16 July 2016 on Motion 16.3265, ‘Equal treatment of storage technologies in network charges’.
[176] Position by the Federal Council of 25 May 2016 on Motion 16.3265, ‘Equal treatment of storage technologies in network charges’.
[177] Position by the Federal Council of 25 May 2016 on Motion 16.3265, ‘Equal treatment of storage technologies in network charges’

Council, at least for the moment, a power-to-gas plant which does not feed electricity back into the network should be considered an final consumer of electricity subjected to network tariffs.[178]

It has been suggested by the Swiss Association of Electricity Undertakings (*Verband Schweizerischer Elektrizitätsunternehmen*, hereafter "VSE") that the exemption for network charges also applies when the electricity is withdrawn from the public network for conversion and storage and re-injected into the electricity network at a later point. The VSE argues that the fact that the electricity is re-injected into the network after storage cannot be reconciled with the concept of final consumption.[66] The SFOE, in response to answers by the author of this STORE&GO Deliverable, has indicated that this is indeed the case.

In short:
- L-charges for the electricity fed to the electrolyser are not to be paid when the electricity is withdrawn from a directly connected wind or solar installation behind a connection point with the public network;
- L-charges for the electricity fed to the electrolyser are also not to be paid when the electricity is withdrawn from the network, stored, and reinjected as electricity at a later point in time;
- L-charges need to be paid when a power-to-gas installation converts electricity into a gas without the reconversion to electricity taking place at a later point in time.

For the gas sector, the income of system operators at the national and regional level comes from network tariffs paid by shippers and the final consumers of gas. The NEMO document drafted by the gas industry explicitly states that the injection of gas (including renewable gas) by producers is not subjected to G-charges.[47]

7.3.2 Surcharge for the Financing of Support Schemes

Similar to Germany and Italy, the financial measures for the promotion of renewable energy in Switzerland are paid through a green surcharge (*Netzzuschlag*) which is added to the electricity bill of end-consumers.[179] As illustrated in Figure 7-3 below, the current surcharge is with 2,3 Rp/kWh (1.9 €ct/kWh) at its highest point. [55] As from 2031 onwards certain subsidies for renewable energy will be dropped (CAPEX subsidies for solar- and hydropower), the surcharge will also drop.

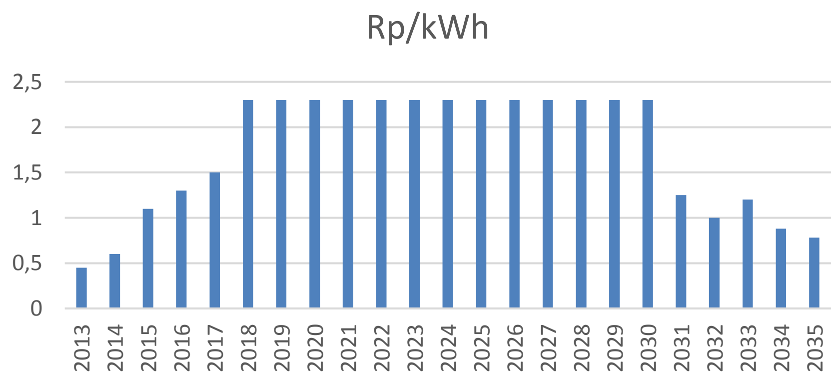

Figure 7-3: Development green surcharge (data by: [55])

There currently exists no explicit exemption for power-to-gas from the green surcharge. Arguably, as with the network charges, a power-to-gas plant is not a final consumer subjected to the green surcharge when the electricity is re-injected into the public electricity network after storage. This would be different

[178] Position by the Federal Council of 25 May 2016 on Motion 16.3265, 'Equal treatment of storage technologies in network charges'.
[179] Article 35 of the Federal Energy Ordinance of 1 November 2017, No. 730.01.

when the SNG is injected into the public gas network. As the Swiss government then considers the power-to-gas process as consumption, the operator of this plant would be obligated to pay the green surcharge.[180]

Similar to the situation in Germany and Italy, a power-to-gas installation could apply for a reimbursement of the *Netzzuschlag* as energy intensive industry. The conditions for such a reimbursement are provided under the Federal Energy Act (Articles 39 to 43) and the Energy Ordinance (Articles 37 to 49). Final consumers whose electricity costs account for at least 10% of the gross added value are fully reimbursed for the paid surcharge.[181] When this electricity costs/gross added value ratio lies between 5 to 10%, final consumers receive a partial proportional reimbursement.[182] No exemption exists for final consumers which deploy an electricity intensive activity in fulfilment of their public task, unless this task involves the operation of a large-scale research facility in a research institute of national importance.[183] Finally, the Federal Council may also provide for a partial reimbursement of the paid network surcharge for other final consumers than those covered under the above categories, which would be severely impaired by the surcharge.[184]

The eligibility to a reimbursement is further conditioned by the following requirements:

- the end-user has committed to increase energy efficiency in a target agreement with the federal government;
- the end-user reports to the Federation on a regular basis;
- the end-user submits an application for the relevant financial year;
- the refund amount is at least CHF 20,000 in the relevant financial year.[185]

7.4 Overview of Findings

	Germany	Italy	Switzerland
Exemption for electricity L-charges	Yes	Exemption likely only under the power-to-gas-to-power scenario	Exemption exists only under the power-to-gas-to-power scenario
Exemption for gas G-charges	Yes	No system of gas G-charges	No system of gas G-charges
Exemption for electricity tax	Yes, either in analogy to pumped storage, or as manufacturing activity using water electrolysis.	None	Switzerland has not introduced an electricity tax
Exemption for surcharges for the financing of support schemes	Exemption from EEG-Umlage possible, but only when storage gas is produced and used for electricity generation	Exemption possible from general system charges in the power-to-gas-to-power setting or as energy intensive industry (1<GWh annual electricity consumption)	Exemption possible under the power-to-gas-to-power scenario or as energy intensive industry

180 Position by the Federal Council on Motion 16.3265 of 25 May 2016, “Equal treatment of storage technologies in network charges”.
181 Article 39(1) of the Federal Energy Act of 30 September 2016.
182 Article 39(2) of the Federal Energy Act of 30 September 2016.
183 Article 39(3) of the Federal Energy Act of 30 September 2016.
184 Article 42 of the Federal Energy Act of 30 September 2016.
185 Article 40 of the Federal Energy Act of 30 September 2016.

Other exemptions	Currently no exemption from the offshore-liability charge, the CHP surcharge, and the surcharge under section 19, subsection 2 of the Electricity Grid Fee Ordinance	None	None

Table 7-2: Overview findings in chapter 7

The treatment of an operator of a power-to-gas installation as final consumer suggests that the electricity withdrawn is used for an end-use application after which the energy cannot be recovered for another purpose. To the contrary, power-to-gas is a storage and conversion technology which enables the exchange of renewable energy between sectors. Although Switzerland sets a good example by excluding pumped hydro storage, and possible other storage technologies, from the definition of final consumption, this is still limited to power-to-x-to-power technologies. Equally, exemptions in Germany from the *EEG-Umlage* and in Italy for network tariffs require that the produced hydrogen or SNG is reconverted to electricity. This silo thinking ignores the fact that a cross-sectorial deployment of power-to-gas may have larger benefits, for example when the hydrogen or SNG is used in industrial applications. The consequence of the current situation, which is especially advantageous for power-to-power storage, is that the transfer of renewable energy from the electricity system to other sectors is discouraged.

Furthermore, the current static network tariff methodologies do not acknowledge that power-to-gas may provide positive externalities for network operation, for example when electricity is withdrawn from the network in times of high supply and low demand. Future design of network tariffs should, therefore, take of account cost-causality.

8 Support Schemes for the Use of SNG

This chapter will provide an overview of certain national support schemes for the promotion of the use of SNG. Support schemes enable gases from renewable sources to be competitive with their fossil equivalent, in the case of SNG: (liquefied) natural gas.[186] German and Italian support mechanisms have to be in compliance with the relevant EU rules on state aid, including the guidance document on "State aid for environmental protection and energy 2014-2020", and the 2009 Renewable Energy Directive (2009/28/EC) (*see* section 9.2 of Deliverable 7.2). These Guidelines determine that aid per unit of energy (also known as operating aid) may not exceed the difference between the total levelised costs of producing energy (LCOE) and the market price of the energy concerned.[187] Furthermore, fixed feed-in tariffs need to be replaced by market-based mechanisms such as direct marketing and auctions.[188] Although Switzerland is not bound by these requirements, a similar shift towards market-based support can be observed.

8.1 Germany

Legal measures for the promotion of energy from renewable sources in Germany are provided for under the EEG 2017.[189] In theory, there is no cap on the total amount of subsidies under the EEG. The EEG-Umlage, which is a surcharge on the energy bill of consumers to finance EEG subsidies, can be raised to balance an increase in subsidies.[56][57] However, as has been proven in the past, a steep raise in the EEG-Umlage may result in societal, and thus political protests, as was the case in 2014 when the EEG-Umlage increased from €3.7 ct/kWh in 2012 to €6.3 ct/kWh. This increase in the energy bill of consumers threatened to diminish the public support for the *Energiewende*, and was a contributing factor to the shift from fixed feed-in tariffs to the current system of market premiums.[57]

For the review in this section of support schemes applicable to power-to-gas and SNG, it first needs to be determined to what extent SNG is covered under the definitions of biogas (*biogas*), biomethane (*Biomethan*) and storage gas (*Speichergas*) under the EEG 2017.

With regard to the definition of "*Biogas*", Article 3(11) of the EEG 2017 specifies that:

> *"biogas' is every gas which is produced through the anaerobic digestion of biomass*

Regarding "*Biomethan*", Article 3(13) of the EEG 2017 provides that:

> *'biomethane' is every biogas or other gaseous biomass which is treated and processed and injected into the natural gas network*

Importantly, the definition of biogas under the EEG 2017 is more narrow than the definition of biogas under the EnWG (see section 6.1.1). While the former only applies to biomass-based gases, the latter also explicitly includes hydrogen and SNG. The limited scope of *Biogas* under the EEG excludes SNG. Similarly, SNG does not fit the description of "*Biomethan*" under Article 3(13) EEG 2017, which equally only covers biomass based gases.

SNG (and hydrogen) do, however, fall under the definition of "storage gas" (*Speichergas*) under Article 3(42) EEG 2017:

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[186] *See* Recital section to the 2009 Renewable Energy Directive (2009/28/EC).
[187] Section 3.3.2.2., paragraph 131 of the 2014 State aid Guidelines.
[188] Section 3.3.2.1., paragraph 124-126 of the 2014 State aid Guidelines.
[189] The EEG 2017 is preceded by the EEG 2000, 2004, 2009, 2012, and 2014.

> *'storage gas' is any gas, that is not renewable energy, but for the purpose of storing electricity from renewable energies is produced by exclusively using electricity from renewable energies* (translated by author)

Contrary to the definition of biogas under the EnWG 2017, which prescribes that the electricity used must predominantly (80<%) be generated from renewable sources, the definition of storage gas under the EEG requires that only electricity *exclusively* produced from renewable sources can be used for the production of SNG. A second difference is that the EnWG 2017 requires that the biogas contains at least 80% carbon from renewable sources, while for storage gases under the EEG the requirement is that the carbon is not exclusively produced for the production of SNG.[190] The definition of storage gas also determines that the gas must be produced for the purpose of storing electricity from renewable energies. According to the legislator, this means that the storage gas must be produced with the aim of re-electrification of the energy contained therein.[52][191]

In short, SNG does not fall under the definitions for biogas and biomethane under the EEG 2017, and is, therefore, not automatically eligible to the same types and degree of (financial) support. The EEG does, however, contain a specific definition for SNG as storage gas, although the electricity must then exclusively stem from renewable sources.

8.1.1 Support for Electricity Generation from SNG

Part 3 of the EEG 2017 covers the possibility for producers of electricity from renewable sources to receive an EEG-subsidy for the electricity fed into the grid, also when the electricity has been intermediately stored.[192] As already briefly mentioned, Germany has moved from a fixed feed-in tariff system to a market-premium system as the main support mechanism for electricity from renewable energy sources.[57] This shift towards more market-based support mechanism is in line with developments and guidelines at the EU level (*see* Deliverable 7.2, section 9.2). In the EEG amendment of 2012, the option of direct marketing of electricity was introduced in parallel to the existing system of fixed feed-in tariffs. The eligibility to such fixed feed-in tariffs is now limited to small installations up to 100 kW.[193] Alternatively, under the direct marketing system, the operator of a renewable energy installation of more than 100 kW is allowed to sell its electricity directly to the market while in addition receiving a market premium paid by the network operator for every kWh injected into the grid. The height of the market premium is determined through competitive tenders.[194]

The conditions for receiving a market premium for electricity from renewable sources are included in the EEG 2017 under Articles 19 to 21. Article 19(1) states that operators of installations which make *exclusive* use of energy from renewable sources for the generation for electricity are eligible to receive a market-premium or feed-in tariff from the system operator. Article 19(3) stipulates that the entitlement to a market-premium or feed-in tariff does also exist when the generated electricity has been intermediately stored *before* being injected into the network.

Important for power-to-gas is that the same article also mentions the possibility for support for electricity generated from storage gas. It was already discussed that the definition of storage gas requires that the electricity being fed into the electrolyser must come exclusively from renewable origins, and that the carbon may not be intentionally produced for the methanation of hydrogen.[195] Such storage gas is allowed to be mixed with other gases from renewable sources such as biogas.[52] Article 44(b)(5) of

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[190] BT-Drs. 17/6071, S. 62.
[191] BT-Drs. 17/6071, S. 62.
[192] *See* Articles 19*ff* of the EnWG 2017.
[193] Article 21 of the ENWG 2017.
[194] Information about the market premium system for different electricity generation technologies can be accessed via: http://www.res-legal.eu/.
[195] Article 3(42) of the EEG 2017.

the EEG 2017 provides that natural gas which is withdrawn from the gas network can be considered to be storage gas, in so far as the quantity of the gas at the end of the year equals the heat-equivalent of the injected storage gas, and a mass balance system has been used throughout the whole transportation chain (*see* subsequent section 7.1.2 on mass balancing). This mass balancing allows a CHP which withdraws the virtual storage gas from the gas network for electricity generation to receive a market premium for the generated electricity.

For power-to-gas, the requirement in Article 19(3) EEG 2017 that the electricity should be intermediately stored *before* being injected into a network means that the electrolyser must be connected directly to an installation generating electricity from a renewable source. The withdrawal of electricity from the network is thus not an option for the production of storage gas in this context. This limitation is likely introduced to avoid the double subsidisation of the same amount of energy.

It has been argued that the current scheme for support for electricity generated from storage gas is not economically reasonable or profitable.[58] Reason is that the amount of support for electricity generated after storage is similar to the amount of support which would have been paid to the injection of the initially generated electricity without storage, less efficiency losses due to the power-to-gas conversion process.[196] In other words, electricity generated from storage gas of which the electricity source is a wind farm, receives the same amount of support as electricity generated by that windfarm. As such, the costs involved with the conversion process, related energy losses, transportation through the gas network, and reconversion into electricity, are not compensated for. [12][58] As the market premium for electricity generation after storage does not internalise the benefits of storage through a “storage- or flexibility premium”, the scheme provides little incentive for power-to-gas-to-power storage.[12]

Such a flexibility premium (*Flexibilitätsprämie*) already exists for the generation of electricity from biogas under Article 50a EEG 2017. This premium is paid by the system operator on top of the feed-in or market premium. The aim of this added premium is to increase renewable electricity production from programmable installations in times of high demand. The amount of the flexibility premium for new plants is €40 per installed kilowatt per year for as long as the biogas plant is eligible for the auctioned market premium or the feed-in tariff.[197] As the combination of a power-to-gas plant with a CHP also contributes to the programmability of electricity from renewable sources, a similar flexibility premium as for electricity produced from storage gas would be appropriate.

8.1.2 System of Mass Balancing and Guarantees of Origin

It was mentioned under the previous section 8.1.1 that natural gas withdrawn from an exit point for electricity generation can be considered “storage gas” if a system of mass balancing has been used. The use of a mass balancing system was also discussed as a prerequisite for an exemption to the EEG-Umlage when producing storage gas (*see* section 7.1.3). In both cases, reference is made to Article 44b(5) of the EEG which describes the essence of mass balancing as follows:

> *Gas withdrawn from a natural gas network can be considered as landfill gas, sewage gas, mine gas, biomethane or storage gas,*
>
> 1. *as far as the amount of gas withdrawn from the network equals in heat equivalent at the end of a calendar year the quantity of landfill gas, sewage gas, mine gas, biomethane or storage gas which has been fed into the natural gas grid elsewhere in the federal territory, and;*
> 2. *if for the entire transport and distribution of the gas from its production or extraction, its feed into the natural gas network, its transport in the natural gas network until it is withdrawn from the gas grid a network mass balance systems has been used*

[196] Article 19(3) of the EEG 2017.
[197] Article 50a(2) of the EEG 2017.

Mass balancing system is an administrative process which allows to track the quantity and quality of a volume of gas from the point of injection to the point of withdrawal. Such a tracking process is necessary as the injected storage gas will mix with the natural gas already flowing through the network. As the natural gas withdrawn can then be identified as storage gas, it is also referred to as virtual storage gas.

The largest register of renewable gases which performs mass balancing services is the *Biogasregister* managed by the German Energy Agency (*Deutsche Energie-Agentur*, hereafter "Dena").[198] There are, however, more registers operational.[199] The Biogasregister is a recognized clearinghouse for subsidies under the EEG and also clears storage gas.[200]

The tracking of a gas through mass balancing takes place through the following steps:

1. A producer injects the produced storage gas into the gas-grid;
2. the storage gas is booked into the Biogasregister (1st documentation point);
3. An third party auditor is inspecting the power-to-gas facility and verifies quantity, property profile and origin of the storage gas within the Biogasregister;
4. Producers and intermediaries split the storage gas quantities and transfer them according to the supply chain to the accounts of other register participants (2nd documentation point);
5. The consumer extracts the storage gas from the gas-grid, he himself or his supplier derecognises the quantities from the Biogasregister (3rd documentation point).
6. The consumer receives a Biogasregister-Extract confirming the quantity and origin of the storage gas, the property profile as well as injection- and extraction information. Within the Biogasregister-Extract, one can e.g. apply for remunerations.[201]

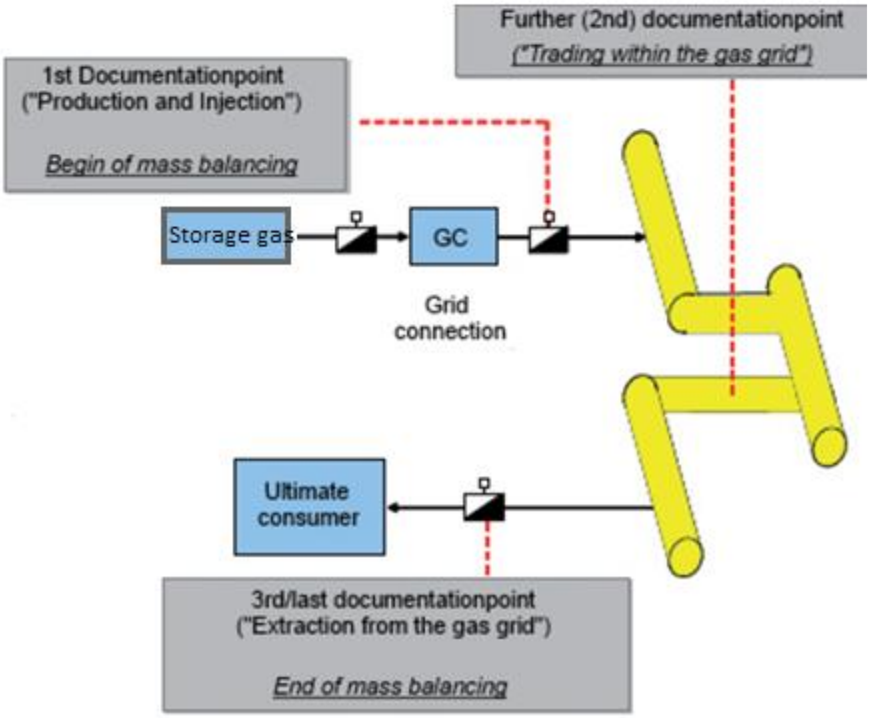

Figure 7-1: Example Storage Gas Mass Balancing process (adapted image from [59])

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[198] *See:* https://www.biogasregister.de/en/introduction.html.
[199] For example ARCANUM, *see* https://www.arcanum-energy.de.
[200] *See* online article: "Biogas Register Germany now also open for power-to-gas - a small introduction to mass balancing" (*in German*), at https://www.speicher-bar.de/power-to-gas-biogasregister-und-massenbilanzierung/, online at 3 April 2018..
[201] *See* for more detailed information: https://www.biogasregister.de/en/home.html.

Under the mass balancing system, renewable gases and the underlying documentation tracking their origin have to be traded as one inseparable package. In a guideline on mass balancing, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety has emphasized that this mass balancing system is different from a "book-and-claim" system, such as for guarantees of origin.[59] Under book-and-claim, a certificate proofing the origin of a gas can be traded independent from the physical gas on a secondary market.[60] Although the Biogasregister does in theory issue such guarantees of origin as a separate service to mass balancing, this only occurs to a very limited extent.[61] This limited volume of trade in guarantees of origin for renewable gases can also be explained by the fact that Article 79 of the EEG 2017 and the Guarantees of Origin Ordinance (*Herkunftsnachweisverordnung*) only require the establishment of a registry for guarantees of origin for electricity.

8.1.3 Support for Use of SNG in Transportation

The use of SNG for transportation is incentivised in Germany by allowing fuel suppliers to count SNG towards their quota obligation. This quota requires them to include more sustainable fuels in their supply mix. As of January of 2015, Germany has replaced the biofuel quota under the Biofuel Quota Act (*Biokraftstoff-Quotengesetz*) for a greenhouse gas reduction quota under the Federal Emission Control Act (*Bundes-Immissionsschutsgesetz*). Entities which place a fuel on the market (often fuel suppliers) must ensure that the total greenhouse gas emissions of the fuels in their fuel supply mix is reduced by 6% in 2020 compared to the baseline set at 83,8 kgCO_2eq/GJ.[202] According to the "Ordinance on the allocation of electricity-based fuels and co-processed biogenic oils to the greenhouse gas quota" (*Verordnung zur Anrechnung von strombasierten Kraftstoffen und mitverarbeiteten biogenen Ölen auf die Treibhausgasquote*), such reduction of greenhouse gas emissions can be achieved by including fuels in the supply mix which have electricity as their feedstock.[203]

The following conditions apply to such electricity-based fuels: 1) the electricity for electrolysis must originate from a non-biogenic renewable source, and 2) it is, in principle, not allowed to withdraw this electricity from a public network.[204] In derogation of this latter requirement, the usage of electricity withdrawn from a public network is only allowed when the power-to-gas installation is located in a "network development area" (*Netzausbaugebiet*) and is exclusively operated on the basis of a contract for the provision of grid stability services to the system operator.[205] The currently identified network development areas, which are areas confronted with regular congestions, are the northern part of Lower Saxony, Bremen, Schleswig-Holstein, Hamburg and Mecklenburg-Vorpommern).[206]

Only the electricity based fuels listed under Table 8-1 below are allowed to be calculated towards the greenhouse gas emission quota.[207] The last column gives the allocated greenhouse gas emission values. These values correspond with the given values under Directive (EU) 2015/652 on calculation methods and reporting requirements for fuel quality.

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[202] Article 37a(4) of the Federal Emission Control Act 1974.
[203] Article 3(1) of the Regulation on the allocation of electricity-based fuels and co-processed biogenic oils to the greenhouse gas quota of 15 May 2017
[204] Article 3(2) of the Regulation on the allocation of electricity-based fuels and co-processed biogenic oils to the greenhouse gas quota of 15 May 2017.
[205] Article 3 of the Regulation on the allocation of electricity-based fuels and co-processed biogenic oils to the greenhouse gas quota of 15 May 2017.
[206]See: https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Ausschreibungen/Wind_Onshore/Netzausbaugebiete/NetzausbauGV_node.html.
[207] Annex 1 to the Regulation on the allocation of electricity-based fuels and co-processed biogenic oils to the greenhouse gas quota of 15 May 2017.

	Fuel	Source and process	Specific greenhouse gas emission value in kg CO_2 equivalent per gigajoules
a)	Compressed synthetic methane	Sabatier-process using hydrogen from non-biogenic renewables produced through electrolysis	3.3
b)	Compressed hydrogen in a fuel cell	Produced from non-biogenic renewable energy through electrolysis	9.1
c)	Compressed hydrogen in a fuel cell	Produced from electricity from coal through electrolysis	234.4
d)	Compressed hydrogen in a fuel cell	Produced from electricity from coal with CCS through electrolysis	52.7

Table 8-1: electricity based fuels and their greenhouse gas emission values

8.1.4 Use of SNG for Heating

In 2016, 44% of total final energy consumption in Germany, and two-thirds of the energy consumed by the industry, was used for heating purposes.[62] Of the renewable heat currently supplied, 87% stems from biomass.[63] In order to become close-to carbon neutral in 2050, the Renewable Energies Heat Act (Gesetz zur Förderung *Erneuerbarer Energien im Wärmebereich*, hereafter "EEGWärmeG"), provides measures to increase the share of renewable heat in the building environment. The obligations contained therein apply to new buildings and renovations. The core obligation of the EEGWärmeG is the "*Nutzungspflicht*" under Article 3, which requires owners of newly constructed or renovated buildings to make "proportionate use" of renewable energy for heating (and cooling) purposes. A barrier for hydrogen and SNG for renewable heating is, however, that these are not covered under the definition of "renewable energy" under Article 2 of the EEGWärmeG. This in contrast to solid, gaseous, or liquid biomass.[208] Under the current state of the law, these gases can thereby not be used in fulfilment of the *Nutzungspflicht*.

8.1.5 Payments for Avoided Network Costs

Article 20a of the Gas Network Fee Regulation (*Gasnetzengeltverordnung,* or GasNEV) awards in-feeders of biogas a remuneration of €0,007/kWh for avoided network costs which is guaranteed for 10 years after putting into operation of the connection to the network. The idea behind this incentive is that decentralised production and injection of gas avoids expensive gas network upgrades and expansions.[17] As the concept of "biogas" under the GasNEV is linked to the definition thereof under the EnWG instead of the EEG, also hydrogen and SNG are included under this measure. The payment of the fee is independent of the extent that such network expansions are actually realised.[17]

8.2 Italy

The legal foundation for measures for the promotion of renewable energy is Legislative Decree No. 28/2011 which transposes the 2009 Renewable Energy Directive (2009/28/EC) into national law. It was already concluded under section 6.2.1 that SNG is covered under this Decree through the definition of biomethane, which is: *"gas produced from renewable sources with the characteristics and usage conditions corresponding to those of natural gas and suitable for injecting into the natural gas grid."*[209]

[208] Article 2(4) of the EEGWärmeG 2008.
[209] Article 2(1)(o) of Legislative Decree No. 28/2011.

Article 21 of Legislative Decree No. 28/2011, titled: *"Incentives for biomethane injected into the natural gas network",* contains a specific regime for the promotion of biomethane. It provides that the injection of biomethane into the natural gas network is to be promoted through a variety of methods of which the conditions need to be specified in a Decree by the Minister of Economic Development to be adopted in agreement with the Minister of the Environment and with the Minister of Agricultural Policies. This resulted in the adoption of the already introduced Biomethane Decree of 5 December 2013.[210] The Decree establishes three types of support schemes for biomethane:

a) biomethane injected in the gas transmission and distribution networks without a defined purpose (*see* below section 8.2.1);
b) biomethane used, after injection into the natural gas network, in high efficiency cogeneration for the generation of electricity (*see* below section 8.2.2).
c) biomethane used in transport after injection into the natural gas network (*see* below section 8.2.3).

The incentive scheme under the 2013 Biomethane Decree is, however, limited in scope and timeframe. Only biogas upgrading plants operation before the end of 2018 are eligible to receive financial support. As such, the scope of application of the 2013 Decree was limited to biomass-based biomethane, thereby excluding SNG of which electricity is the main feedstock.

Looking ahead, the Italian National Energy Strategy for the period until 2030 contains the following passage: *"The estimated biomethane potential (in Italy* eds.*) is lower than the European transport target. The use of biomethane to fulfil related obligations constitutes, therefore, the more efficient way to stimulate the biomethane sector without further burdening the consumers of electricity and gas. There will be no incentives to produce electricity from biomethane, in analogy to what is established in the recent biomethane Ministerial Decree notified to the European Commission, through which the direct incentives for the mere injection into the network and the production of electricity have been eliminated. Biomethane in these sectors will be able to compete through guarantees of origin and by being taken into account in the share of renewables in electricity generation and consumption."*[211]

The Ministerial Decree to which this passage refers is the "Draft Decree for the Injection of Biomethane and Incentives" (*Bozza Decreto immissione in rete Biometano e incentivazione*) which was published in 2016.[212] On the 1st of March of 2018, the European Commission issued a decision confirming that the scheme complies with the EU rules on state aid.[213] Following this approval, the Italian Ministry of Economic Development published the definite text of the Decree on the 2nd of March of 2018.[214] For the purpose of this Deliverable, this new Decree will be referred to as "the 2018 Biomethane Decree".

The preamble of the 2018 Biomethane Decree echoes the above cited message in the National Energy Strategy. It is stated that, even though the 2013 Biomethane Decree has not been successful in producing significant achievements for biomethane production plants, Italy is still on track to meet its targets for 2020, except for the target for the transportation sector of 10%. To spur the growth of renewable energy in this sector, the Decree establishes that priority should be given to promoting the use of biomethane in the transport sector, while for the remaining uses (e.g. heating and electricity) an update of the Decree will be issued after the transport target has been fulfilled.

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[210] Ministerial Decree of 5 December 2013, Gazetta Ufficiale n. 95 of 17 December 2013.
[211] Page 85-86 of the 2017 National Energy Strategy.
[212] Draft of a Ministerial Decree for the for the Injection of Biomethane and Incentives, available at http://www.sviluppoeconomico.gov.it/images/stories/documenti/DM-Biometano%20vers_consultazione%20pubblica_dicembre%202016-gennaio-2017_revfinale.pdf (hereafter "Biomethane Draft Decree").
[213] Decision by the European Commission of 1 March 2018, C(2018) 1379.
[214] *See* http://www.sviluppoeconomico.gov.it/images/stories/normativa/DM-biometano-2-marzo_2018_FINALE.pdf.

A positive development for SNG produced through power-to-gas is that Article 1 of the 2018 Biomethane Decree explicitly includes under the definition of "biomethane": *"fuel produced though the processes of methanation of hydrogen from renewable sources and CO_2 present in biogas destined for the production of biomethane or produced from biological or fermentation processes".* Notably, only SNG of which the carbon originates from a biogenic source is thus considered biomethane under the 2018 Biomethane Decree. This limitation would already be problematic for the STORE&GO plant in Italy which makes use of ambient air capture technology for the provision of carbon as feedstock.

In short, where the 2013 Biomethane Decree still included direct incentives for various uses of biomethane, the primary focus of the 2018 Biomethane Draft Decree is on the transportation sector. The latter also explicitly applies to SNG when the carbon source of a biogenic origin.

8.2.1 Support for SNG injected into the gas networks through Guarantees of Origin

Contrary to Germany and Switzerland where financial support for renewable gas is linked to a specific end-use, the Italian 2013 Biomethane Decree contains support measures for biomethane injected into the natural gas network without being designated to a specific use. Under Article 3 of this Decree, the biomethane producer using organic or industrial by-products is incentivized for 20 years by a market premium. However, as mentioned, the 2018 Biomethane Decree abandons this system of direct financial incentives for biomethane injected into the gas network for undefined purposes. Instead, producers of biomethane will be eligible to receive a guarantee of origin from the GSE which is required to set up a national registry for guarantees of origin for biomethane (*Registro nazionale delle Garanzie di Origine del biometano*).[215]

The purpose of this registry is twofold.[216] First, the basic function of a guarantee of origin is to provide the final consumer with a means of verifying the renewable origin of the gas withdrawn from the network. Second, such a guarantee of origin can be used to be offset against an emission quota obligation under the EU-ETS, in so far as SNG will be awarded a similar zero carbon emission rating as biomass-based fuels in the future (*see* section 9.5.2 of Deliverable 7.2). In this way, the sale of guarantees of origins by biomethane producers to operators of installations covered under the EU-ETS allows this producer to generate extra income.

A barrier for SNG is that only biomethane produced from certain animal, food, agro, and industrial by-products are eligible to receive such guarantees of origin.[217] This may be explained by the fact that the zero rating for biomass streams under the EU-ETS equally does not cover SNG[218]. It was already argued under Deliverable 7.2 that when SNG produced from a biogenic or ambient carbon source has a similar greenhouse gas balance as biogas, the consumption thereof should be awarded a similar zero rating as biomass streams under the EU-ETS. When this is the case in the future, the Italian legislator should also declare SNG to be eligible for tradable guarantees of origins.

The GSE is required to initiate a consultation procedure on the appropriate design of the registry for guarantees of origin for biomethane.[219] Certain minimum conditions are already prescribed under the 2018 Biomethane Draft Decree register. Namely, the registry has to be designed in a way as to allow for secondary trade both within Italy and with buyers from other EU Member States.[220] In the latter case, the guarantee of origin will be cancelled and added to the registry of the other Member State. This interaction with other registries is, however, conditioned on reciprocity.

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[215] Article 4 of the 2018 Biomethane Decree.
[216] Article 4(1) of the 2018 Biomethane Decree.
[217] Article 4(1) of the 2018 Biomethane Decree.
[218] *see* discussion under section 9.5.2 of Deliverable 7.2
[219] Article 4(2) of the 2018 Biomethane Decree.
[220] Article 4(3) of the 2018 Biomethane Decree.

8.2.2 Support for Electricity Generation from SNG

Under the 2013 Biomethane Decree, electricity generated from biomethane in a high efficiency cogeneration installation is incentivised through a feed-in tariff for plants of a capacity lower than 1 MW, and a feed-in premium for power plants with a capacity over 1 MW.[221] Plants over 5 MW have to participate in an auction in order to receive an incentive.[222]

As, due to a boom in electricity from photovoltaics, Italy has already achieved its RES-E target for 2020, incentives for electricity generation from Biomethane are no longer perceived to be efficient.[223] Therefore, the 2018 Biomethane Decree does no longer contain direct incentives for the use of biomethane in high efficiency cogeneration installations.[224]

8.2.3 Support for use of SNG in Transportation

In accordance with its obligation under the 2009 Renewable Energy Directive (2009/28/EC), Italy strives to increase the share of renewable energy in the transport sector to at least 10%. To this end, fuel suppliers are subjected to a mandatory quota.[225] In the build-up to this 2020 target, the mandatory quota is 7,5% for 2018 and 9% for 2019. As Italy is lagging behind on its perceived trajectory towards the 10% target, the 2018 Biomethane Decree places much emphasis on support for fuel suppliers to include biomethane into their supply mix. The support scheme has an indicative budget of €4.7 billion and will run from 2018 until 2022. With regard to the volume of gas eligible for support, a cap has been set at 1.1 billion cubic meters a year. In repetition of what has been said before, SNG is considered to be biomethane under the 2018 Decree when the carbon source is of a biogenic nature.[226]

At the foundation of the incentives under the 2018 Biomethane Decree for the use of biomethane in the transportation sector lies the quota obligation for fuel suppliers. These suppliers can demonstrate their compliance with the quota through so-called "Certificates of Release for Consumption" (*Certificato di Immissione in Consumo*) (hereafter "CIC certificates") which can be obtained by buying biomethane from certified producers. A CIC is issued for each 10 Gigacalories (Gcal) of produced biomethane, corresponding to 41.840 MJ. As biomethane is traded through confidential bilateral agreements, the value of an individual certificate is uncertain.[64] It has been suggested that the range lies between €300 and €500.[65]

Article 5 of the 2018 Biomethane Decree establishes that CICs are allocated by the GSE to the biomethane producer, which can transfer these certificates to suppliers subjected to a quota. Under the 2013 Biomethane Decree, the CICs were instead directly issued to the fuel supplier upon entering into a bilateral agreement with the biomethane producer. The CIC certificates are issued for a period of 20 years. In order to receive the certificates, the biomethane producer has to submit the sale contract and invoices to the GSE.[227]

Article 6 of the 2018 Biomethane Decree provides a specific incentive regime for advanced biomethane (*biometano avanzato*) as an alternative to the support under Article 5. Notably, SNG and liquefied SNG are both considered advanced biomethane as they can be classified as "renewable gaseous and liquid fuels of a non-biological origin" (*combustibili rinnovabili liquidi e gassosi di origine non biologica*).[228]

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[221] Article 5 of the 2018 Biomethane Decree.
[222] Article 5 of the 2018 Biomethane Decree.
[223] Page 85-86 of the 2017 National Energy Strategy.
[224] Page 85-86 of the 2017 National Energy Strategy.
[225] Legislative Decree No. 28/2011 and Ministerial Decree of 10 October 2014 by the Ministry of Economic Development.
[226] Article 1(1) of the 2018 Biomethane Decree.
[227] Article 5(2) of the 2018 Biomethane Decree.
[228] Article 1(5)(c) of the 2018 Biomethane Decree in combination with Entry (q) of Part A of Annex III of the Ministerial Decree of 10 October 2014, Gazetta Ufficiale n. 250 of 27 October 2014.

Advanced biomethane can, at the request of the producer, be directly sold to the GSE, which awards a premium of €375 per CIC and a biomethane price which is equal to the weighted average price at the virtual trading point in the month of sale, reduced by 5 %.[229] The level of this premium will be evaluated every year in order to avoid over-subsidisation. Another advantage for advanced biomethane is that, where normally a CIC is issued for 10 Gigacalories (Gcal), a CIC certificate for advanced biomethane is already issued at 5 Gcal.[230] This scheme is illustrated in Figure 8-2 below.

Figure 8-2: Schematic overview of the support scheme for advanced biomethane as fuel[231]

Finally, relevant for new biomethane plants with an additional liquefaction plant, as for example the STORE&GO plant in Troia, is that these are eligible to be compensated by the GSE up to a maximum of 70% of the production costs to a maximum of €1.200.000.[232]

8.2.4 Use of SNG for Heating

The Italian National Energy Strategy includes the ambition that in 2030, 30% of the energy consumed for heating and cooling stems from renewable energy.[7] In 2015, the share of renewable energy in this sector was 15%.[7] As in Germany, renewable heat is almost exclusively produced from biomass.[67] In order achieve the 30% target, the Italian government has introduced a support scheme for small RES-Heat sources up to 2000 kW[233], known as the *Conto Termico*, and a tax reduction scheme for expenses related to energy efficiency measures, including installation of RES-Heat technologies[234]. Installations capable of consuming hydrogen or SNG are under both schemes not accounted for as eligible technology.

8.3 Switzerland

Swiss legislation provides for various support schemes which already explicitly apply to the production or consumption of SNG, or which could potentially apply. The schemes are coordinated through the SFOE.

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[229] Article 6(1)(a) of the 2018 Biomethane Decree.
[230] Article 5(5) of the 2018 Biomethane Decree.
[231] Decision by the European Commission of 1 March 2018, C(2018) 1379.
[232] Article 5(9) of the 2018 Biomethane Decree.
[233] Ministerial Decree of 16 February 2016, Gazetta Ufficiale n. 51 of 2 March 2016.
[234] Legislative Decree No. 63/2013 of 4 June 2013, Gazetta Ufficiale n. 130, of 5 June 2013.

8.3.1 Support for Electricity Generation from SNG

Article 19 of the Swiss Federal Energy Act establishes a support scheme for generators of electricity from renewable sources. Eligible sources are hydropower, solar, wind, geothermal, and biomass/biogas. Installations which make partial use of fossil sources are excluded.[235] With the entry into force of the revised Federal Energy Act on 1 January 2018, the system of cost covering feed-in tariffs (*System der kostendeckenden Einspeisevergütung*) has been replaced by a system of cost oriented market premiums(*kostenorientiertes Einspeisevergütungssystem*, or KEV). Under the KEV, operators sell their electricity directly to the market and receive a premium calculated from the difference between the market price and a technology-specific KEV-rate.[236]

The Federal Energy Act makes no reference to the possibility for storage technologies or electricity generation from SNG to receive a market premium. To the knowledge of the author of this Deliverable, there exists no official guidance from the Swiss government or legislator on the possibility to receive a KEV after storage. It is argued by the VSE, the association of Swiss electricity undertakings, that energy which is withdrawn from the network, stored, and then discharged is not eligible to receive a remuneration at the moment of reinjection.[66] Only when electricity is injected into the network for the first time would this be eligible to receive a market premium under the KEV system.[66]

8.3.2 Support for Use of SNG in the Transportation

8.3.2.1 Exemption from the Mineral Oil Tax

The Swiss mineral oil tax encompasses a tax on crude oil, other mineral oils, natural gas, the processed products thereof, and engine fuels used for transportation.[237] In addition, engine fuels are subjected to a petroleum surtax. The mineral oil tax is collected from producers and suppliers which may internalise these costs in the final product price paid by consumers.[238] Conditions and exemptions are established under the Mineral Oil Tax Act (*Mineralölsteuergesetz*) and the Mineral Oil Tax Ordinance (*Mineralölsteuerverordnung*).

The Mineral Oil Tax Act provides for a full tax relief for “biogenic fuels” from biomass or other renewable sources which are fed into the natural gas grid as fuel for transportation, or which is delivered directly to a gas station for natural gas vehicles.[239] Also producers of hydrogen and synthetic methane from renewable sources are eligible to such a tax relief. This follows from Article 19a of the Mineral Oil Tax Ordinance which includes under the list of biogenic fuels:

- *Article 19a(f): “biohydrogen”: hydrogen from biomass or other renewable energy sources;*
- *Article 19a(g): “synthetic biogenic fuels”: synthetic hydrocarbons or synthetic hydrocarbon mixtures from biomass or other renewable energy sources.*

A tax relief for biogenic fuels is awarded on the conditions that certain ecological as well as socially accepted production conditions have demonstrably been achieved. The Mineral Oil Tax Ordinance lists three ecological requirements that must be met:

- biofuels must generate at least 40% less greenhouse gas emissions (from cultivation of raw materials till end use) compared to the life cycle emissions of fossil natural gas;
- biofuels must not be significantly more harmful to the environment (from cultivation of raw materials till end use) compared to fossil petrol; and

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[235] Article 19(4)(e) of the Federal Energy Act of 30 September 2016.
[236] Article 21 of the Federal Energy Act of 30 September 2016..
[237] Article 1 of the Mineral Oil Tax Act of 21 June 1997, No. 641.61.
[238] Article 3 of the Mineral Oil Tax Act of 21 June 1997, No. 641.61
[239] Article 2(3)(d) of the Mineral Oil Tax Act of 21 June 2997, No. 641.61 defines “biogenic fuel” as *“fuel produced from biomass or other renewable energy sources”*. Article 12(b) states: *“for biogenic fuels, a tax relief is granted on request”*.

- raw materials must not be obtained from converted land if it was converted after 1 January 2008 and if it represented land with high carbon stock or land with high biodiversity value prior to its conversion.[240]

The social requirements which have to be met are:

- land for the cultivation of raw materials must be legally acquired.
- the cultivation of raw materials and the production of fuel must respected the social regulations applicable in the producing country. The International Labour Organisation's fundamental conventions must be respected in every case.[241]

The production of biohydrogen or synthetic gas must be carried out in a production plant approved by the Federal Customs Administration (*Oberzolldirektion*).[242] Such an approval is granted if:

- the renewable gas complies with the provisions of the SVGW Directive G13 (*see* section 6.3.4);
- the ecological requirements are fulfilled and verified by the Federal Office of the Environment;
- the social requirements for the production conditions are fulfilled and verified by the State Secretariat for Economic Affairs,

Provided that all requirements are met, the Federal Customs Administration grants the manufacturing plant permission to feed biogas, renewable hydrogen or renewable methane as fuel into the natural gas grid.

Another requirement is that the hydrogen or synthetic methane which is injected into the natural gas network must be reported to the clearinghouse of the VSG through monthly production reports.[68][243] The VSG is responsible for collecting further information for the Federal Customs Administration which decides on the definite amount of the tax relief. The tasks of the clearinghouse are as follows:

- Provide proof that the quantities of renewable gas were actually fed into the gas network;
- Provide a guarantee of origin proving that the gas is actually a renewable gas within the meaning of the Mineral Oil Tax Act;
- Track whether the quantities of renewable gas are invoiced in a transparent and correct way;
- Provide proof with regard to the purpose for which the renewable gas is sold (transportation fuel heating, gas, or electricity).[68]

The granting of a tax relief is not dependent on the source of the carbon used for methanation.[46][69] It is thus sufficient that the electricity used for the electrolysis process originates from a renewable source. Importantly, however, as was indicated by the Solothurn STORE&GO plant in their answers to the questionnaire, the ecological conditions for receiving a tax relief may limit the choice of technology for the generation of electricity, even when the source is renewable. For example, when generating electricity from solar power for which the panels are imported from outside the EU, there is a risk that the overall positive ecological balance does not pass the 40% threshold.

8.3.2.2 Offsetting of Synthetic CO_2-neutral fuels for Fleet Emissions Reduction

As of 2012, CO_2 emissions standards for new passenger cars have been in force in Switzerland. By the end of 2020, average emissions for persons vehicles have to be reduced to 95 gCO_2/km, for vans and semi-light trailers this is 147 gCO_2/km.[244] Importers and manufacturers of cars in Switzerland have to comply with these standards in order to reduce overall fleet emissions.[245] To this end, an individual target and average CO_2 value for new cars is allocated to each importer and manufacturer.[246]

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[240] Article 19c of the Mineral Oil Tax Ordinance of 20 November 1996, No. 641611.
[241] Article 19c of the Mineral Oil Tax Ordinance of 20 November 1996, No. 641611.
[242] Article 27 of the Mineral Oil Tax Act of 21 June 2997, No. 641.61.
[243]Article 45e of the Mineral Oil Tax Ordinance of 20 November 1996, No. 641611. *See* www.biogasclearing.ch.
[244] Article 10(1) and (2) of the Federal CO_2 Act of 23 December 2011, No. 641.71.
[245] Article 10(3) of the Federal CO_2 Act of 23 December 2011, No. 641.71.
[246] Article 11 and 12 of the Federal CO_2 Act of 23 December 2011, No. 641.71.

In 2017, the Swiss National Council and the Council of State approved a motion which should stimulate the import and manufacturing of cars which are fuelled by "Swiss-made synthetic CO_2-neutral fuels".[247] The motion delegates to the Federal Council the task to draft the necessary legal and regulatory framework to ensure that importers and manufacturers of vehicles fuelled with Swiss-made synthetic CO_2-neutral fuels receive CO_2 emission credits which can be offset within the scope of the fleet emissions reduction framework. Importantly, the motion only speaks of synthetic fuels produced through power-to-gas or power-to-liquids which are produced from renewable energy and CO_2 supplied through *ambient air capture*. The reason for this limitation to ambient CO_2 which is brought forward in this motion is that this capture technology is currently being developed in Switzerland itself. At the time of publishing of this Deliverable it was not yet known how the motion will be implemented by the Federal Council and which conditions will be attached to the CO_2 emission credits for Swiss-made synthetic CO_2-neutral fuels.

8.3.3 Use of SNG for Heating

The Swiss Cantons collectively have set a 80% CO_2 emissions reduction target for the building environment compared to 1990.[70] This target has been endorsed by the national legislator during the drafting of a revised Federal CO_2 Act (*CO_2 Gesetz*).[71] The adoption process thereof was still ongoing at the time of publishing of this Deliverable.[248] For existing household- and service buildings, Article 9 of the revised CO_2 Act limits the emissions from heating installations consuming *fossil sources* to 6 kilograms per heated m^2. For industrial buildings, the limit is set at 4 kilograms per m^2. For new buildings, from 2029 onwards, the heating installation must refrain completely from emitting CO_2 from fossil sources. The explanatory text accompanying the draft of the revised CO_2 Act mentions heat pumps, waste incineration, and the use of biomass has alternatives for the supply of renewable heat for the building environment.[71]

The question in relation to the use of SNG for heating is whether this falls under the definition of a *fossil source* under the CO_2 Act. Article 2(a) defines a fossil fuel which is used for non-transportation purposes (*fossile Brennstoffe*) as a fossil energy carrier used for the production of heat or light, or used in a thermal installation for the production of electricity, or for the operation of a CHP installation (*Wärme-Kraft-Kopplungsanlagen*). Which particular energy carriers are "fossil" is not defined. The explanatory text to the revised CO_2 Act states, however, that synthetic transportation fuels (*Treibstoffe*) produced through power-to-gas can be renewable, when the electricity stems from a renewable source. The text is silent regarding the carbon source used for the methanation process. By the same reasoning, SNG used for heating would not be considered a fossil source when the electricity is from a renewable source.

8.3.4 CO_2 Levy

Besides having introduced an emission trading scheme, Switzerland also has a system of direct carbon taxation under the Federal CO_2 Act.[249] This act has as its purpose to reduce greenhouse gas emissions, in particular CO_2 emissions, with the aim of limiting the rise in average global temperature to less than 2 degrees.[250] Article 29 determines that the Swiss State collects a CO_2 tax on the production, extraction and import of thermal fuels (fossil fuels used for electricity or heat production). This tax has a ceiling of 120 CHF (€104) per ton of CO_2 emitted. In December of 2017 the Federal Council adopted the text for

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[247] Motion 14.3837 of 25 September 2014 (adopted at 8 March 2017).
[248] *See* for current developments on the adoption of a revised CO_2 Act: https://www.bafu.admin.ch /bafu/de/home/themen/klima/recht/totalrevision-co2-gesetz.html.
[249] Activities which are covered under the emission trading scheme are exempted from CO_2 Tax obligations.
[250] Article 1 of the Federal CO_2 Act of 23 December 2011, No. 641.71.

a revised CO_2 Act. The Draft Act includes an increase of the ceiling of the CO_2 levy to 210 CHF per ton of CO_2 (€182).[251]

In accordance with Articles 2 and 29 of the current CO_2 Act (Article 32 of the Draft CO_2 Act), only producers of fossil thermal fuels are required to pay the levy. The reference to *fossil* thermal fuels excludes SNG from the scope of the CO_2 levy as SNG is considered an carrier of renewable energy when the electricity used is from a renewable source.[71] [72] This has been confirmed by the Federal Office for Energy in reply to answers by the STORE&GO project.

8.3.5 Guarantees of Origin

Article 9(5) of the Federal Energy Act allows the Federal Council to set up an administration for guarantees of origin (*Herkunftsnachweis*) for biogas. The Council has not, however, made use of this mandated power when drafting the subsequent Energy Ordinance. The ordinance only refers to guarantees of origin for electricity. This can be explained by the fact that the Federal Energy Act only contains an obligation for electricity suppliers to prove the origin of the energy supplied to final-consumers. There exists no similar obligation for suppliers of gases of a renewable origin. Of interest to power-to-gas-to-power storage, however, is the stipulation that the energy loss due to a storage process must be extracted from the amount of electricity which is specified under the guarantee of origin.[252]

In absence of a legal framework on guarantees of origin for renewable gases under the Federal Energy Act, several private certification schemes have been introduced.[253] Such certification allows suppliers to market (partially) renewable gas for a green premium price which is higher than the natural gas price.

8.3.6 Emission Reduction Certificates for SNG Production

Switzerland currently has an emission trading scheme in place which, similar to the EU-ETS, functions as a cap-and-trade system.[254] Installations covered under the Swiss scheme can trade emission allowances among each other, or buy “emission reduction certificates” (ERCs) from third parties, including possibly operators of power-to-gas plants.[255] These third parties can obtain such ERCs by deploying projects which:

a) would not be profitable without the proceeds for the sale of ERCs, and;
b) deploy state-of-the-art technology, and;
c) lead to a quantifiable emission reduction compared to the situation that the project would not have been developed.[256]

Excluded from the possibility to receive ERCs are, amongst others, projects which achieve emission reduction through biological or geological CO_2 sequestration.[257] Biological CO_2 sequestration through wood products is, however, not excluded.

To the extent that a power-to-gas project complies with the conditions under a, b, and c, it would depend on the interpretation of “biological or geological CO_2 sequestration” whether such a project is eligible to receive ERCs. It can be argued that catalytic methanation through a Sabatier process is a form of chemical sequestration instead. Whether this is the same for power-to-gas projects which make use of biological methanation processes is uncertain. Arguably, the binding of the CO_2 with H_2 to form CH_4, a

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[251] Article 31(2) of the Draft CO_2 Act, https://www.bafu.admin.ch/dam/bafu/de/dokumente/klima/rechtliche-grundlagen/entwurf-co2-gesetz.pdf.download.pdf/Beilage_05_BG_DE_CO2-Gesetz_zu_BRA_UVEK.pdf.
[252] Article 3(2) of the Federal Energy Act of 30 September 2016.
[253] The largest certification label is “Naturemade”, *see* https://www.naturemade.ch/en/.
[254] The treatment of SNG under the EU-ETS has been examined under section 9.5 of Deliverable 7.2.
[255] Article 15-21 of the Federal CO_2 Act of 23 December 2011, No. 641.71.
[256] Article 5(1)(b) of the Federal CO_2 Ordinance of 1 August 2016, No. 641.711.
[257] Article 5(1)(a) of the CO_2 Ordinance of 1 August 2016, No. 641.711.

chemical, is also a form of chemical sequestration. even when the methanation process is of a biological nature.

In August of 2017, it was announced that the European Commission and Switzerland agreed to link their respective emission trading schemes.[258] It is currently unknown to what extent the Swiss system of ERCs will remain in force.

[258] See press release: https://ec.europa.eu/clima/news/eu-and-switzerland-join-forces-emissions-trading _en.

8.4 Overview of Findings

	Type of support	Requirements on Feedstock	Conditions on connection to the public electricity network	Other Requirements
Germany				
Support for use of SNG for electricity production	Fixed feed-in for small electricity generation installations (<100KW) using storage gas Market premium for installation of 100<KW using storage gas	- Electricity exclusively from renewable sources - Carbon not intentionally produced for methanation process	Conversion of power-to-storage gas must occur before the injection of electricity into the network. Electrolyser must thus be directly connected to generation unit	Use of mass balancing in accordance with Article 44b(5) of the EEG 2017
Support for use of SNG in transportation	SNG (and hydrogen) eligible to be taken into account in greenhouse gas emission quota for fuel suppliers	- Electricity must originate from a non-biogenic source renewable source	In principle not allowed to be connected to the public electricity network, unless the power-to-gas plant is located in a network development area	
Use of SNG for heating	Obligation to make proportional use of renewable sources for heat production	SNG not included under the definition of renewable energy for heating, contrary to biomass-based gases		
Obligation to issue guarantees of origins for renewable gas	Not present, although the Biogasregister to a limited extent issues guarantees of origin on request, the Guarantees of Origin Ordinance does not make reference to renewable gases			
Payments for avoided network costs	In-feeders of biogas, including SNG and hydrogen, are awarded a remuneration of €0,007/kWh for avoided network costs which is guaranteed for 10 years after putting into operation of the connection to the network			
Italy				
Support for use of SNG for electricity production	None			

Support for use of SNG in transportation	- SNG as biomethane can be counted towards mandatory quota for fuel suppliers. Scheme functions as renewable energy obligation/certificate scheme - CAPEX subsidy for liquefaction plant	- Electricity from renewable sources - Only biogenic carbon	SNG must be injected into the natural gas network	
Use of SNG for Heating	- Subsidy for small RES-H installations (<2000 kW) - Tax benefit for energy efficient RES-Heat installations	- Under both schemes, installations consuming SNG are not included as eligible technologies		
Obligation to issue guarantees of origins for renewable gas	Only biomethane produced from certain animal, food, agro, and industrial by-products are eligible to receive guarantees of origin, thus excluding SNG			
Switzerland				
Support for use of SNG for electricity production	None			
Support for use of SNG in transportation	Exemption for Mineral Oil Tax for producers	- Life cycle emission of SNG must be at least 40% less greenhouse gas emissions - Electricity must originate from a renewable source and be produced in Switzerland - Unbiased towards carbon source	There is no requirement for a direct line from a generation unit to the power-to-gas installation. A connection to the public electricity network thus seems to be allowed, as long as the ecological requirements are met and verified	- Power-to-gas plant must be approved by Federal Customs Association. - Produced gas must be registered with the clearinghouse of the VSG
Support for use of SNG in transportation	Motion adopted in the Federal Assembly for the offsetting of synthetic CO2-neutral	- Electricity must come from a renewable source	Unknown, motion has to be transposed into law	

	fuels for fleet emissions Reduction	- Carbon must be supplied through ambient air capture		
Use of SNG for renewable heating	Emission limits for heating installations using fossil fuel in existing buildings. Zero fossil fuel emission standard for heating installations in new buildings from 2029 onwards	SNG is not considered as "fossil fuel"		
CO_2 Levy	SNG not considered as *fossil* thermal fuel and thus relieved from paying the carbon tax			
Obligation to issue guarantees of origins renewable gas	Only statutory obligation to issue guarantees of origin for electricity, not for renewable gas. However, private schemes for renewable gas exist			
Emission Reduction Certificates for SNG production	Emission Reduction Certificates for SNG production which can be traded under the emission trading scheme	- None	- None	Power-to-gas project must comply with the following conditions: a) it would not be profitable without the proceeds for the sale of ERCs, and; b) it deploys state-of-the-art technology, and; c) it leads to a quantifiable emission reduction compared to the situation that the project would not have been developed.

Table 8-2: Overview of findings in chapter 8

9 Conclusions

The objective of this Deliverable 7.3 under the scope of the STORE&GO project was to identify legal barriers at the national level for the deployment of power-to-gas. Such barriers may be linked to for example a prohibition for certain actors in the energy sector to deploy power-to-gas, to financial burdens such as taxes and surcharges, or the lack of support schemes to allow SNG to compete with natural gas and/or biogas. Together with the findings under Deliverable 7.2, the conclusions in this Deliverable will serve as input for the project-wide power-to-gas roadmap which will be presented at the end of the STORE&GO project in 2020.

	Identified issues
Chapter 3: Classification	Absence of clear legal definitions on cross-sectorial storage in the electricity context. This leads to uncertainty on the extent that Power-to-gas is awarded equal treatment as other storage technologies. *See* Table 3-1 at page 18.
	Although under none of the three jurisdictions power-to-gas is explicitly defined as gas production, the conversion of electrons into molecules which are subsequently injected into a gas grid will most likely be treated as such. *See* Table 3-2 at page 24.
	The withdrawal of electricity for the Power-to-gas conversion process is considered final consumption. Classifying power-to-gas as final consumption exposes the operator of such an installation to cost components which are added to the electricity price which will be paid again by the actual final consumer of the energy (leading to double taxation). Only Switzerland excludes power-to-gas from the definition of final consumption when the reconversion of SNG into electricity takes place. *See* Table 3-3 at page 21.
Chapter 4: Unbundling	It was found that Germany, Italy, and Switzerland all lack national unbundling rules which explicitly address the ownership and operation of power-to-gas facilities by system operators. The consequence of power-to-gas being classified as gas production is, however, that transmission system operators in all three countries under assessment must refrain from operating such a facility. Furthermore, in neither of the three jurisdictions is an affirmative legal framework in place which allows system operators to operate a power-to-gas-to-power chain in support of their legal task to transport energy and maintain system integrity. *See* Table 4-1 at page 36.
	Current unbundling rules seem to be restrictive with regard to the combined operation of a power-to-gas installation and a gas storage facility. Although an evolutionary interpretation of the exemption for parts of storage facilities for production swings is in theory possible, this should be further clarified in legislation. *See* Table 4-1 at page 36.
Chapter 5: authorisation procedures	Power-to-gas installations are primarily considered as installations producing chemicals instead of being considered installations producing an energy commodity. As a result, authorisation procedures for power-to-gas installations may be more stringent than those for biogas production and upgrading installations which are considered as energy related activities under EU, German and Italian environmental legislation. *See* Table 5-1, at page 46.
	Chemicals producing installations are generally not differentiated on the basis of production capacity, so that small and large facilities fall under the same regime. Based on the outcome of the environmental analysis of the power-to-gas process within STORE&GO, it could be assessed whether arguments exist to differentiate power-to-gas installations from (other) chemical activities. *See* Table 5-1, at page 46.

	In neither of the three reviewed jurisdictions is a power-to-gas operator obliged to operate under a same permit as operators of natural gas production sites, as this does not involve the exploitation of mineral or natural resources. *See* Table 5-1, at page 46.
	Only Italy has introduced a comprehensive streamlined authorisation which also applies to power-to-gas installations, the SUAP procedure. *See* Table 5-1, at page 46.
Chapter 6: accommodating SNG in the natural gas network	Although privileges may be in place for SNG as biogas (Germany), biomethane (Italy), or renewable methane (Switzerland), the conditions related to the source of electricity and carbon source may vary. Furthermore, in neither of the jurisdictions is it clarified to what extent the renewable origin of the electricity can be demonstrated through the use of guarantees of origin. *See* Table 6-2 at page 64.
	Connection cost distribution mechanisms are in place in Germany and Italy, but only when the produced SNG is considered biogas or biomethane. *See* Table 6-2 at page 64.
	Germany and Switzerland and Switzerland allow for the injection of off-spec gases, in so far as the gas is delivered on-spec at the consumer exit-point. In Italy, such possibility only seems to exist for producers of natural gas. *See* Table 6-2 at page 64.
	Only Germany has introduced legal obligations for system operators to remedy capacity constraints at the distribution level through the instalment of overflow installations. *See* Table 6-2 at page 64.
Chapter 7: network tariffs, taxes, and other surcharges	Final consumers of electricity are required to pay for various cost components which are stacked on top of the electricity commodity price. The most common are network tariffs (so called "L-charges") and surcharges earmarked for the financing of support schemes. As this would mean that both the power-to-gas operator *and* the actual final consumer of the energy would have to pay such charges, the results is a double taxation of the same unit of energy. It is found in this chapter that exemptions from network tariffs for power-to-gas without reconversion to electricity only exist in Germany. In Italy and Switzerland such exemptions only exist for the power-to-gas-to-power scenario. The consequence of the current situation, which is especially advantageous for power-to-power storage, is that the transfer of renewable energy from the electricity system to other sectors is discouraged. *See* Table 7-2 at page 73.
	With regard to surcharges for the financing of support schemes, exemptions exist for the power-to-gas-to-power storage process, and possibly for the power-to-gas process as "energy intensive activity". *See* Table 7-2 at page 73.
Chapter 8: support schemes for the use of SNG	Electricity production from SNG is only supported in Germany. Through a mass balancing system, SNG, as so-called "storage gas", can then be transported from the power-to-gas installation through the gas network to a power generation unit at a different location. The incentive is equal to the amount for the initial electricity generation by the wind- or solar installation, less conversion losses. An additional flexibility premium as for installations using biogas is, however, not provided for. *See* Table 8-2 at page 90.
	Germany, Italy, and Switzerland all have taken power-to-gas and SNG into consideration in the design of one or more support schemes to increase the share of renewable energy in transportation. Support Schemes may, however, be conditioned on choice of carbon source. Under a recently adopted Italian support scheme for biomethane as transportation fuel SNG is only included when the carbon is of a biogenic nature. In Switzerland, a motion has been adopted to support vehicles which can be fuelled by SNG, but only when the carbon is supplied through ambient air capture. *See* Table 8-2 at page 90.

	With regard to the use of SNG for heating purposes, it is found that the German and Italian support schemes for renewable heat do not apply to SNG. This places SNG in a disadvantaged position compared to biomass-based gases, which are included under the respective schemes. In Switzerland, measures are proposed to decrease emissions from fossil sources used for heating in the building environment. Here it is discussed that SNG is not to be considered as a fossil fuel, and can thereby contribute to the Swiss ambition to decarbonise the heating sector.
	Statutory frameworks for guarantees of origin for SNG and other renewable gas are lacking. *See* Table 8-2 at page 90.

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Annex I - Questionnaire on Legal and Regulatory Affairs

National law applicable to Power-to-Gas

Details of respondent

STORE&GO site:

Name respondent:

Organization/partner:

Background

At the end of M20, Deliverable 7.2 has been published on European legislative and regulatory affairs relevant to Power-to-gas . Subsequently, Deliverable 7.3 will address national legislation in Germany, Italy, and Switzerland. Furthermore, this Deliverable will assess the authorisation procedures at the STORE&GO pilot sites. For this latter assessment your input is required.

Thank you for your cooperation!

Questions

Please answer the questions as detailed as possible

A. Operation

1. Who is the designated operator of the STORE&GO plant? If part of a group, please also name the holding/mother company.

2. Does the operator of the STORE&GO plant also operate one of the following assets? (please indicate in **bold**)

   - Gas storage facility
   - Biogas/biomethane production facility
   - Natural gas production/extraction facility
   - Electricity generation unit from solar or wind
   - Gas fired electricity generation unit
   - Electricity transmission or distribution network
   - Gas transmission or distribution network

B. Authorisation Requirements

1. Are the administrative procedures handled by one or multiple authorities? Please indicate which authorities.

2. Are the administrative procedures handled under a special streamlined/simplified procedure for (renewable) energy projects? Which authority coordinates this procedure?

3. Is your project perceived by the authorities to be an expansion of an earlier project? (e.g. Falkenhagen Windgas or INGRID) If so, please also provide information in the **EXCEL template** on the already obtained authorizations during the preceding project(s).

4. For information on the specific authorization procedures, please use the **EXCEL template.**

C. Public Participation

1. Has the public been consulted on their position regarding the deployment of the power-to-gas installation? If so, has this delayed the project?

2. Was this consultation voluntary or prescribed by law? Can you indicate which law?

3. Has any official protest or appeal been raised against the deployment of the power-to-gas installation? If so, has this delayed the project?

D. SNG Production and Grid Injection

1. How is the SNG classified under national legislation? E.g. biogas, biomethane, or other.

2. When the carbon is obtained from a biomass source, is this carbon certified in any way? E.g. certification for sustainable biomass or green carbon.

3. Have you encountered legal barriers with regard to grid injection? Can you describe the nature of this problem?

4. Are you exempted from paying network fees for the withdrawal of electricity and/or injection of gas?

E. Storage and Marketing

1. Will the (liquefied) SNG be stored before being marketed? If so, in what kind of facility and by who. Please indicate if this occurs before or after the SNG is injected into the gas grid.

2. Will the (liquefied) SNG be used for electricity production?

3. Will the installations be certified to receive guarantees of origin for the SNG produced? If yes, which authority or organization is responsible for issuing such guarantees of origin?

F. Other barriers

1. Please describe any legal barriers which you have encountered and which have not been addressed in this questionnaire

Annex II– Questionnaire Authorisation Procedures

Authorization Procedures STORE&GO Plants

Authorisation Requirement	Legal foundation/instrument	Classification of activity	Exemption for PtG installation as pilot/demonstration project	Status	Authority	Duration between application and approval	Delay?	Costs for application	Could apply digital?	Comments
Example: *Environmental impact assessement*	*Environmental Impast Assessement Act 2004*	*Integrated chemical installation*	*Yes, but after preliminary assessment*	*approved*	*Federal EIA Authority*	*Within 2 months*	*no*	*€100 administration fee*	*yes*	*Authorities had trouble clasifying the installation*