

North Sea Energy 3

Regulatory Framework: Legal Challenges and Incentives for Developing Hydrogen Offshore

D2.2 Analysis of the legal basis for offshore hydrogen planning, production, processing and transport in the North Sea and an overview of existing legal framework governing power-to-gas on the Dutch part of the continental shelf and some selected North Sea states

D2.3 Legal assessment of bottlenecks hampering the production, compression, transport and storage of hydrogen on the Dutch continental shelf and some selected North Sea states, and recommendations on how to stimulate these activities in the North Sea

Deliverables 2.2, 2.3

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List of Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
BAT	Best available techniques
CCS	Carbon capture and storage
CEN	European Committee for Standardisation
CfD	Contracts for Difference
CO₂	Carbon dioxide
CS	Continental Shelf
DEA	Danish Energy Agency
EC	European Commission
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
ETS	Emission Trading Scheme
EU	European Union
GEMA	Gas and Electricity Markets Authority
GW	Gigawatt
H-gas	High-calorific value gas
HSE	Health and Safety Executive
IED	Industrial Emissions Directive
IMO	International Maritime Organization
IPPC	Integrated pollution prevention and control
L-gas	Low-calorific value gas
MMO	Marine Management Organisation
MS LOT	Marine Scotland Licensing Operations Team
MWh	Megawatt hour
NGET	National Grid Electricity Transmission
NRA	National Regulatory Authority
NSA	North Sea Area
NSIP	Nationally significant infrastructure projects
Ofgem	Office of Gas and Electricity Markets
OFTO	Offshore transmission system operator
OGA	Oil and Gas Authority
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PtG	Power-to-gas
RED	Renewable Energy Directive
RES	Renewable energy sources
ROC	Renewable Obligations Certificates
SEA	Strategic environmental assessment
SNG	Synthetic natural gas
SO	System operator
SoS	Secretary of State
TEU	Treaty on the European Union
TFEU	Treaty on the Functioning of the European Union
TO	Transmission operator
TPA	Third party access
TSO	Transmission system operator
UK	United Kingdom
UNCLOS	United Nations Convention on the Law of the Sea

1. Executive Summary

The objective of work packages 2.2 and 2.3 is to address the legal challenges and drivers impacting the development of power-to-gas in the North Sea. From a regulatory perspective, several aspects governing power-to-gas in the North Sea require analysis. This report focuses on international, European Union (EU) and national law, governing the areas of: energy, environmental, and spatial planning, which may affect power-to-gas activities. The report seeks to explore the existing regulatory challenges concerning the development of power-to-gas offshore, and make recommendations on which legal changes are necessary to (i) overcome these legal challenges, and to (ii) stimulate the planning, production, transport and supply of 'green' hydrogen offshore.

This report analyses the sources of international law applicable to the development of power-to-gas facilities in the North Sea. Furthermore, it establishes the competence of some key coastal states (the Netherlands, the UK, and Denmark) to regulate power-to-gas activities in the North Sea. At the time of writing, these states are all members of the EU. Therefore, an analysis of the applicability of EU law offshore, particularly legislation relating to power-to-gas activities, is provided. Currently, a combination of EU electricity and gas market regulation govern power-to-gas. This report focuses on the applicability of both strands of regulation as well as the interplay between these regulations. Furthermore, the applicability of EU renewable energy law to the production and storage of hydrogen is analysed concerning, *inter alia*, support schemes and guarantees of origin. In addition, due to the interconnected nature of the energy system in the North Sea, the facilitation by EU maritime spatial planning law of the development of hydrogen activities offshore is analysed, particularly where the supply chain of hydrogen crosses national borders. Finally, as the production, transport, storage and supply of hydrogen offshore may involve significant risks, EU environmental and safety law are also analysed.

The successful development of power-to-gas in the North Sea requires national regulatory regimes facilitating such a deployment. This requires the allocation of adequate space in the North Sea, and the adoption of clear procedures on the authorisation of such facilities. Furthermore, such facilities require a connection to a source of electricity generated offshore to ensure the supply of electricity for the hydrogen conversion process. Access to hydrocarbon platforms for the conversion process, as well as to natural gas pipelines for the transport of hydrogen, must also be guaranteed. This report, therefore, provides an analysis of national regulatory regimes with regard to three main topics: (i) the construction of electricity cables and the connection of existing offshore hydrocarbon platforms to any part of the offshore electricity infrastructure, (ii) the authorisation procedure for the development and operation of offshore PtG facilities, and (iii) the transport and supply of hydrogen using existing natural gas infrastructure.

The analysis in this report demonstrates that none of the analysed national regulatory regimes provide the legal certainty necessary to sufficiently support the conversion of wind energy to hydrogen at sea. This conclusion can be made for three reasons: first, it is questionable whether it is legally permissible to establish a connection between any part of the offshore electricity infrastructure and an existing offshore hydrocarbon platform; secondly, there is no specific authorisation procedure in place regulating the construction and operation of an electrolyser on an existing offshore hydrocarbon platform; finally, strict blending concentrations of hydrogen in the existing natural gas networks have been imposed at the national level. The North Sea is increasingly characterised by new energy uses, which require the deployment of a wide range of installations. Currently, legislation in place governs *inter alia* offshore hydrocarbon installations and offshore wind farms. However, it is difficult to ascertain which rules apply to PtG installations.

2. Introduction

The North Sea Area (NSA) is of profound economic importance to its surrounding states.¹ The North Sea is one of the most heavily exploited marine environments in the world. There is fierce competition for space, with several important (economic) activities, including oil and gas production, wind energy generation, fisheries, sand and shell extraction, the shipment of goods, and recreational activities (such as cruises) taking place in the area. The existence of areas for military use, nature reserves add to the congestion, with each claiming part of the available space.² Hence, the NSA can be identified as being of huge economic importance to surrounding states, while also serving vital environmental functions.

Since the 1960's, the NSA has been used for the exploration and production of hydrocarbons. Today, oil and gas activities in the North Sea are in a mature phase, and as such will be confronted with rising extraction costs and diminishing proven reserves within the licence areas. In view of the depletion of the reservoirs, more and more platforms will cease their operations in the near future and will, therefore, need to be decommissioned. In the NSA, more than 600 platforms and the ancillary physical infrastructure will have to be removed in the coming decades. In the Dutch part of the North Sea alone, approximately 150 platforms will need to be decommissioned.³ Furthermore, the North Sea states face important challenges in implementing the Paris Agreement, with each needing to substantially reduce their own greenhouse gas emissions as part of the joint effort to limit global temperature increases.⁴ Consequently, a transition to a new energy system is necessary, *i.e.* shifting towards renewable and low carbon energy sources, and using energy in a more efficient and responsible manner.

The NSA will become a focal point in the transition to sustainable and low carbon energy. Currently, 13 gigawatts (GW) of offshore wind capacity have been installed in the North Sea.⁵ In the medium to long term, this installed capacity is projected to grow to 60 GW by 2030 and to approximately 180–250 GW by 2050.⁶ Thus, offshore wind installations are expected to make up a considerable portion of the total space utilised for offshore energy generation in the future. Extensive offshore wind deployment is challenging, as new landing points are difficult to realise, and in periods of intense wind electricity production the onshore grid cannot cope with high volumes of production. This is generally referred to as grid congestion.⁷ This may become an issue for several North Sea states with high levels wind energy production, even before 2030.⁸ The decreases in offshore oil and gas production and the growth of offshore wind are two important (but parallel) trends. Creating links between hydrocarbon and wind infrastructure offshore may allow these trends to align. This presents both challenges and opportunities.

The North Sea Energy Project emphasises offshore system integration as one option to bridge the aforementioned gap, through processes like platform electrification or offshore energy conversion and storage, such as *inter alia* power-to-hydrogen. However, planning, coordination and the active use of policy frameworks are necessary to ensure the efficient use of offshore space at a reasonable cost. Achieving

¹ The North Sea borders the coasts of Belgium, Denmark, Germany, the Netherlands, Norway and the United Kingdom.

² Mariene Strategie voor het Nederlandse deel van de Noordzee 2012-2020 (Marine Strategy for the Dutch part of the North Sea), 2012, Part I, p. 53.

³ Energiebeheer Nederland, 'Netherlands masterplan for decommissioning and re-use', 2016, p. 11.

⁴ Paris Agreement, 14 November 2016, No. 54113.

⁵ Wind Europe, 'Offshore Wind in Europe: key trends and statistics 2018', p. 19, available at <<https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2018.pdf>>

⁶ World Energy Council, 'Bringing North Sea Energy Ashore Efficiently', 2018, p. 6

⁷ Matthijsen, J., Dammers, E., Elzenga, H., 'The future of the North Sea – The North Sea in 2030 and 2050: a scenario study', PBL Netherlands Environmental Assessment Agency, no. 3193, 2018, available at <<https://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2018-the-future-of-the-north-sea-3193.pdf>>

⁸ Matthijsen, J., Dammers, E., Elzenga, H., 'The future of the North Sea – The North Sea in 2030 and 2050: a scenario study', PBL Netherlands Environmental Assessment Agency, no. 3193, 2018, available at <<https://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2018-the-future-of-the-north-sea-3193.pdf>>

system integration and the development of energy conversion offshore therefore requires a regulatory framework that facilitates such a development. This report analyses the current regulatory framework governing hydrogen activities offshore, with a focus on the planning, production, transport and supply of hydrogen in the NSA.

The choice of North Sea states, subject to the analysis contained in this report, is based on the combination of existing hydrocarbon activities offshore as well as the current and future wind potential offshore of the North Sea states. Furthermore, it is based on the level of national policies adopted with PtG prospects. The states chosen for the analysis of national regulatory regimes are the Netherlands, the UK and Denmark. The following sections focus on the logistics of PtG technology and its development offshore from a non-legal standpoint. Chapters 3 – 6 concern the regulatory framework governing hydrogen activities offshore.

2.1 Power-to-gas Technology

Unlike hydrocarbons, which are extracted from geological formations, hydrogen must be artificially produced. Hydrogen, a robust gas with several potential applications, can be produced from a large number of primary energy sources and through various technical processes.⁹

2.1.1 Hydrogen Production

The classification of hydrogen (*grey*, *blue* or *green*) is dependent on the method of production and the sources used for its production. Hydrogen is classified as *grey hydrogen* when it is produced using fossil fuels.¹⁰ At present, grey hydrogen is mainly produced by steam reforming of natural gas in which methane reacts with steam under pressure in the presence of a catalyst producing hydrogen, carbon monoxide and CO₂.¹¹ If the CO₂ – which is a by-product when hydrogen is produced using fossil fuels – is captured and permanently stored, the hydrogen produced is classified as *blue hydrogen*. Hydrogen can also be produced using PtG technology. PtG is the process through which electricity is used as an input for the production of hydrogen, through the decomposition of water molecules by electrolysis.¹² The by-product of this process is oxygen, which can be released into the atmosphere. If the electricity used as input is produced from renewable energy sources (RES), the hydrogen produced is classified as *green hydrogen*.¹³ Although PtG is generally considered a ‘green technology’, the hydrogen produced is only as green as the source of the electricity used for the electrolysis to produce the hydrogen. In summary, hydrogen produced from natural gas reforming or from non-renewable electricity is classified as *grey hydrogen*, whereas hydrogen produced from renewable electricity or other renewable sources, such as biomass-based hydrogen production,¹⁴ is classified as *green hydrogen*. The conversion of wind energy to green hydrogen offshore is the focal point of this report.

⁹ Gigler, J., Weeda, M., ‘*Contouren van een Routekaart Waterstof*’, TKI Nieuw Gas (2018), available in Dutch at <<https://www.topsectorenergie.nl/sites/default/files/uploads/TKI%20Gas/publicaties/20180307%20Routekaart%20Waterstof%20TKI%20Nieuw%20Gas%20maart%202018.pdf>>

¹⁰ International Energy Agency, ‘*Energy Technology Essentials Hydrogen Production and Distribution*’, 2007, no. 4, table 1.

¹¹ On a large industrial scale most hydrogen is produced through the steam reforming of natural gas. In this process methane reacts with steam under pressure in the presence of a catalyst to produce hydrogen, carbon monoxide and carbon dioxide (CO₂).

¹² Electrolysers (machines that perform electrolysis) can range in size from small, appliance-size equipment suited for small-scale distributed hydrogen production, to large-scale, central production facilities, with the potential to be tied directly to renewable or other non-greenhouse-gas-emitting forms of electricity production.

¹³ HyLaw, ‘*Hydrogen production from renewables*’, available at <<https://www.hydrogeneurope.eu/node/459>>

¹⁴ Biomass is classified as a renewable energy source since its inherent energy comes from the sun with the possibility to regrow in a relatively short time. Biomass is defined as “plant material and animal waste used especially as a source of fuel” in Merriam-Webster Dictionary, available at <<https://www.merriam-webster.com/dictionary/biomass>>

2.1.2 Hydrogen Application

The use of hydrogen – and the vision of a hydrogen economy – is not a new idea. Until the 1960s, hydrogen was used in many countries in the form of town gas for street lighting, as well as for home energy supply (cooking, heating, and lighting). The idea of a hydrogen-based energy system was also floated in the aftermath of the oil crisis in the 1970s.¹⁵ Hydrogen can be utilised in electricity generation and in transport (through fuel cell technology) or serve as a feedstock for industrial applications. Currently, hydrogen is an important chemical feedstock in the hydrogenation of crude oil or the synthesis of ammonia.¹⁶

Once hydrogen is produced, it can be used in the energy system in five ways. It can be: (i) fed directly into the natural gas network, (ii) stored,¹⁷ (iii) used to produce synthetic natural gas (SNG),¹⁸ (iv) used to upgrade biogas,¹⁹ or (v) used in power generation, heating, industry and mobility.²⁰ The first and second alternatives will be elaborated further in this report. The first alternative entails hydrogen being injected into the existing natural gas network. By injecting hydrogen into the natural gas network, hydrogen is mixed with natural gas, and is therefore used for the same purposes as natural gas. The second alternative, hydrogen storage, involves storing hydrogen in a reservoir so that it can be used later as a fuel source for different sectors. There are a variety of storage possibilities, such as compressed gas tanks, cryogenic compressed liquid tanks and underground storage. The storage would either take place at an on-site facility attached to the production plant, or it would involve the transportation of hydrogen via pipeline to a storage facility.²¹

2.1.3 Hydrogen in the Energy Sector

In future scenarios, hydrogen is likely to play a vital role in the energy sector.²² Although hydrogen can be utilised in different applications, the main focus of this deliverable is the usage of hydrogen in the energy sector. The most challenging task in the design of our future energy sector will be to integrating high levels of variable renewable energy sources while maintaining security of supply.²³ For renewable sources of electricity, solutions must be found to successfully offset the discrepancy between electricity generation from solar and wind and the levels of electricity demand.²⁴ Once in the system, the need to transport large amounts of electricity through the grid during peak load is expected to present further challenges for reliable grid operation, particularly in respect to network congestion and network stability.²⁵ Excess supply of electricity has already led to periods of negative prices in the EU, and has led some countries, like Denmark and Germany, to curtail the output of wind farms.²⁶ The North Sea Energy Project emphasises the urgency to address these challenges in light of the growing share of renewable energy available within the NSA

¹⁵ For a more comprehensive understanding see Ball, M., 'Why Hydrogen?' in Ball, M., Wietschel, M. (eds) *The Hydrogen Economy: Opportunities and Challenges* (Cambridge University Press 2009), p. 8-41.

¹⁶ Air Liquid, 'Hydrogen Applications', available at <<https://energies.airliquide.com/resources-planet-hydrogen/uses-hydrogen>>

¹⁷ Altfeld, K., Pinchbeck, D., 'Admissible hydrogen concentrations in natural gas systems', 2013(3) Gas for Energy, 2013, p. 4-5.

¹⁸ Synthetic natural gas is a type of gas that serves as a substitute for natural gas and is suitable for transmission in natural gas pipelines.

¹⁹ Graf, F., et al, 'Injection of biogas, SNG and hydrogen into the gas grid', 2011(2) Gwf-Gas Erdgas, 2011, p. 35.

²⁰ Gigler, J., Weeda, M., 'Contouren van een Routekaart Waterstof', TKI Nieuw Gas (2018), p. 31, available in Dutch at <<https://www.topsectorenergie.nl/sites/default/files/uploads/TKI%20Gas/publicaties/20180307%20Routekaart%20Waterstof%20TKI%20Nieuw%20Gas%20maat%202018.pdf>>

²¹ Lehner, M., Tichler, R., Steinmüller, H., Koppe, M., *Power-to-Gas: Technology and Business Models*, Springer Briefs in Energy (2014), p. 8.

²² For a comprehensive understanding see International Energy Agency, 'The Future of Hydrogen: Seizing today's opportunities', report prepared by the IEA for the G20, Japan, 2019.

²³ Lund, P.D, Lindgren, J., Mikkola, J. and Salpakari, J., 'Review of Energy System Flexibility Measures to enable High Shares of Variable Renewable Electricity', *Renewable and Sustainable Energy* (2015) 45, p. 785-807.

²⁴ For a comprehensive understanding see International Energy Agency, 'The Future of Hydrogen: Seizing today's opportunities', report prepared by the IEA for the G20, Japan, 2019.

²⁵ Huber, M., Dimkova, D., Hamacher, T., 'Integration of Wind and Solar power in Europe: Assessment of Flexibility Requirements', *Energy* (2014) 69, p. 236-246.

²⁶ Deutsches Bundesnetzagentur (German Federal Network Agency) (2014), *EEG in Zahlen 2014*.

power system. PtG can provide efficient solutions for the electricity system, such as grid balancing,²⁷ large-scale and long-term energy storage,²⁸ and hybrid grid infrastructure.²⁹

Alongside this, a rising trend of electrification is expected to emerge in final energy demand.³⁰ Nevertheless, the European Commission (EC) expects the share of gas in final energy consumption in 2050 to be at 22%.³¹ Given that the share of gas was 24% in 2010, the decline in gas consumption is expected to be modest. There is, therefore, complementing the *potential* to use hydrogen going forward, a demonstrable *need* for the 'greening' of gas molecules within the energy system, in order to accomplish a low-carbon EU energy economy.³² By replacing gas from traditional sources with hydrogen (or SNG), PtG can make a considerable contribution towards the decarbonisation of sectors that may be difficult or inefficient to electrify, such as mobile, high-temperature industrial applications, and dispatchable power generation.³³

2.2 The Development of Power-to-gas Offshore

Within the North Sea Energy Project, the synergy between wind energy and hydrogen production offshore is explored. Industry partners involved in the project have identified this as an option to re-use existing hydrocarbon infrastructure or to construct a sand-based island for the conversion process offshore.³⁴ Furthermore, it is recognised as a viable option to utilise the large share of wind-generated electricity offshore.³⁵ The following subsections provide an overview of the technical and socio-economic aspects of offshore PtG.

2.2.1 Rationale of Developing Hydrogen Offshore

As outlined previously, PtG technology is the process of converting electricity to hydrogen through electrolysis, by separating water molecules. Hydrogen can be produced both onshore and offshore, with the latter alternative entailing the installation of electrolyzers on offshore hydrocarbon platforms or sand-based offshore energy islands.³⁶ This report focuses on the production of hydrogen on existing offshore hydrocarbon platforms. The conversion of power to hydrogen requires that these platforms have access to electricity and water. The transport of the produced hydrogen to shore requires these platforms having access to offshore gas transport infrastructure.

²⁷ Dynamic operation of an electrolyser can provide both down- and upward balancing or ancillary services to the transmission or distribution system.

²⁸ In times of excess supply of generated electricity, the conversion of electrons into molecules allows for the large-scale and long-term storage of energy. Hydrogen is a high-density energy carrier, which can be stored in tanks, pipelines or underground storage facilities.

²⁹ An alternative to transporting electricity from generation to production locations is to transport the energy as hydrogen through the existing natural gas infrastructure. Such shifting between infrastructures for the transport of energy may partially defer or replace the need for cost-inefficient electricity grid expansions.

³⁰ World Energy Council, 'World Energy Scenarios 2019: Exploring Innovation Pathways to 2040', 2019, p.6, available at <https://www.worldenergy.org/assets/downloads/Scenarios_Report_FINAL_for_website.pdf>

³¹ European Commission, 'EU Reference Scenario 2016: Energy, transport and GHG emissions Trends to 2050', (2016) ISBN 978-92-79-52374-8.

³² See further Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas*, Store&Go, Deliverable 7.2, 2017, p. 17.

³³ Lehner, M., Tichler, R., Steinmüller, H., Koppe, M., *Power-to-Gas: Technology and Business Models*, Springer Briefs in Energy (2014).

³⁴ For a comprehensive understanding of hydrogen production on a sand-based offshore energy island see Pernot, E., Roggenkamp, M., *Legal assessment of the development of a sand-based offshore energy island*, North Sea Energy, Appendix Report, Deliverable D.3.8, 2020.

³⁵ See Section 2.1.3.

³⁶ For a comprehensive understanding of hydrogen production on a sand-based offshore energy island see Pernot, E., Roggenkamp, M., *Legal assessment of the development of a sand-based offshore energy island*, North Sea Energy, Appendix Report, Deliverable D.3.8, 2020.

Offshore hydrogen production requires an assurance that electricity is delivered to the platform. In principle, there are three options considered to transport electricity to platforms in the North Sea Energy Project. The first option requires an offshore platform being connected via cable to the onshore electricity grid.³⁷ The second option requires an offshore platform being connected to the offshore electricity grid.³⁸ The final option requires directly connecting a platform to an existing or future offshore wind farm.³⁹ In the North Sea Energy Project, the second and third options are of particular interest.⁴⁰

The output of hydrogen requires the transportation from the offshore platform (where it is produced) to shore (where it is consumed, stored, or reconverted). The North Sea Energy Project considers three options for the transport of offshore produced hydrogen to shore. The first of these options considers how platforms for the production of natural gas may be utilised for PtG. Hydrogen would be produced alongside natural gas, and then injected into the gas pipeline in place, *i.e.* admixed to the stream of natural gas. The second option involves utilising a disused natural gas pipeline connected to the platform, which can then be dedicated to exclusively transporting hydrogen. The final option requires constructing dedicated hydrogen pipeline infrastructure.⁴¹ From the perspective of re-use of existing infrastructure, the first and second options are of particular interest.

2.2.2 Socio-economic Benefits of Developing Hydrogen Offshore

Various reasons make PtG an interesting option for the future. Hydrogen will play a significant role as a low-carbon alternative in processes, such as the development of wind and solar energy, carbon capture and storage (CCS), the use of biomass, the use of existing infrastructure and the construction of new infrastructure, the need for system flexibility and storage etc.⁴²

The North Sea Energy project emphasises that the development of offshore PtG contributes to the extension of the economic lifetime of hydrocarbon platforms. In principle, it postpones the extensive decommissioning costs incurred by several North Sea states. Furthermore, where hydrogen can be technically and safely injected into the existing offshore gas pipeline system, it could extend the economic lifetime of the current pipelines and potentially avoid or at least reduce further investments in new offshore electricity cables. This is particularly important to consider, as prospective wind farms will be located far from shore. With PtG, the electricity produced by a wind farm could be turned into hydrogen. The World Energy Council estimates that the costs associated with decommissioning oil and gas assets in the North Sea, not accounting for the

³⁷ This option is mainly viable for offshore hydrocarbon platforms located close to the shore.

³⁸ In most North Sea countries it is the transmission system operator that is designated with the statutory task to develop an offshore grid dedicated to connect offshore wind farms to the onshore grids. In the United Kingdom it is instead third parties that compete for the ownership and operation of offshore transmission systems. This is explained for every North Sea country subject to analysis in this deliverable in Chapter 4.

³⁹ This option would entail the establishment of a connection between a hydrocarbon platform and the substation or the converter station of a wind farm. Such sub- or converter stations can either be a part of the offshore network or the wind farm dependent on the national regulatory regime in place. This is explained for every North Sea country subject to analysis in this deliverable in Chapter 5.

⁴⁰ North Sea Energy, 'The North Sea Energy Program: Project 1-3', available at <<https://www.north-sea-energy.eu/project.html>>; see also Synthesis paper NSE II, North Sea Energy Program, 'Hybrid offshore energy transition options – The merits and challenges of combining offshore system integration options', 2019, available at <<https://www.north-sea-energy.eu/results-nse2.html#synthesisReport>>

⁴¹ Offshore produced hydrogen can also be transformed on the platform to an identical chemical substance as natural gas, *i.e.* SNG, which could technically be transported through the existing gas infrastructure. Furthermore, hydrogen can be transported in a hydrogen tanker, which is a tank ship designed for transporting liquefied hydrogen. For a comprehensive understanding see further North Sea Energy, 'The North Sea Energy Program: Project 1-3', available at <<https://www.north-sea-energy.eu/project.html>>; see also Synthesis paper NSE II, North Sea Energy Program, 'Hybrid offshore energy transition options – The merits and challenges of combining offshore system integration options', 2019, available at <<https://www.north-sea-energy.eu/results-nse2.html#synthesisReport>>

⁴² Gigler, J., Weeda, M., 'Contouren van een Routekaart Waterstof', TKI Nieuw Gas (2018), available in Dutch at <<https://www.topsectorenergie.nl/sites/default/files/uploads/TKI%20Gas/publicaties/20180307%20Routekaart%20Waterstof%20TKI%20Nieuw%20Gas%20maart%202018.pdf>>

required investments in wind energy, will total between 390 and 690 billion Euros.⁴³ With hydrogen production taking place on existing hydrocarbon platforms, together with the optimisation of investment strategies in new assets, these costs are likely to be significantly postponed.⁴⁴ This is particularly relevant for the NSA, where the onshore and offshore natural gas infrastructure is well developed. In addition, the re-use of assets (such as platforms and pipelines) reduces environmental damage, which would otherwise have been inflicted when constructing new infrastructure.⁴⁵

Offshore hydrogen activities are likely to be beneficial for the energy system in various ways. Offshore wind deployment in the North Sea will face difficulties in realising new landing points, with a likelihood of the onshore grid becoming congested. Hydrogen production from offshore wind is beneficial in that it can be transported as molecules rather than electrons to shore. The integration of intermittent RES also creates challenges in balancing the energy system. Taking a holistic approach to the energy system, PtG can contribute to large-scale (renewable) energy storage, as it is easier to store energy as molecules rather than electrons.⁴⁶ Hence, excess electricity (produced by offshore wind farms) could be stored as hydrogen during times when electricity production exceeds demand, to be applied for industrial use or reconverted into electricity again when electricity demand exceeds (renewable) electricity production. Unlike electricity, hydrogen can easily be stored for a long period of time and can therefore offer buffering capacity for intermittent wind power. This increased flexibility facilitates the efficient operation of energy systems and contributes to a more robust and resilient energy supply system. From a commercial perspective, peak production from renewable sources may not coincide with peak consumption, resulting in an electricity market price characterised by substantial fluctuations. Temporal and spatial fluctuations of power generation by renewable sources demand both high-capacity systems and options to store electricity to abate intermittency, thus enabling a constant power output to the grid. Large-scale storage of electricity has long been a technical challenge, but PtG may present an interesting solution.

In seeking to decarbonise our energy system, it is not sufficient to decarbonise only electricity production. As explained above, molecules play an important role as energy carrier with energy storage potential – but molecules are also vital for sectors where electrification is challenging or simply impossible, such as transportation and heavy industry. Some industries require very high temperatures, which cannot be reached through electricity alone. Accordingly, green hydrogen provides a zero (or low-emission) source of energy, offering both the possibility to reduce dependence on fossil fuels and to enhance security of supply. Therefore, green hydrogen has the potential to benefit both society and the economy, provided it is not prohibitively expensive.⁴⁷

⁴³ World Energy Council, *'The North Sea Opportunity'*, London, May 2017, p. 8.

⁴⁴ Especially when considering offshore PtG technology together with other offshore system integration options, such as electrification of offshore hydrocarbon platforms and offshore carbon dioxide storage, see further Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 5-6.

⁴⁵ The postponement of the decommissioning of platforms also reduces negative impacts on the environment; see Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 6.

⁴⁶ North Sea Energy, *'The North Sea Energy Program: Project 1-3'*, available at <<https://www.north-sea-energy.eu/project.html>>; see also Synthesis paper NSE II, North Sea Energy Program, *'Hybrid offshore energy transition options – The merits and challenges of combining offshore system integration options'*, 2019, p. 13-14 available at <<https://www.north-sea-energy.eu/results-nse2.html#synthesisReport>>

⁴⁷ For a comprehensive understanding see further Mulder, M., Perey, P. L., Moraga, J. L. 'Outlook for a Dutch hydrogen market: economic conditions and scenarios', (CEER Policy Papers; No. 5). Groningen: Centre for Energy Economics Research, University of Groningen (2019).

2.3 Objectives and Scope

PtG is governed by *inter alia* international, EU and national energy, environmental, and planning law. This report seeks to establish how these legal frameworks apply to the various stages of the development of PtG offshore. While there are a substantial number of legal questions regarding PtG, this report focuses on the compatibility of PtG technology with the existing legal frameworks adopted at EU and national level. Furthermore, it scrutinises emerging regulatory trends for PtG. From a regulatory perspective, this report identifies some of the most urgent legal challenges impacting the development of PtG in the NSA.

PtG facilities in the NSA are subject to legislation originating from authorities at various levels, specifically at international, EU and national levels. The aim of this report is to provide an overview of the current status of EU and national law pertaining to hydrogen activities offshore. This can aid in the formulation of future legislative improvements as it provides policy makers with an overview of the existing legal framework in which they can enact legislation and the general objectives (stemming from EU law) to be followed. For stakeholders in PtG projects, this report provides guidance on the general legal framework applicable in the NSA. Moreover, it identifies the rights and duties – which can be derived from EU and national law – regarding hydrogen activities offshore.

Given the promotion of the internal energy market at the EU level, PtG is currently governed by both EU electricity and gas market regulation. This report focuses on the applicability and interactions between both strands of regulation. Given the possibility to use PtG to store large quantities of renewable energy, this report analyses the legal frameworks recently adopted by the EU in the 'Clean Energy Package'. Furthermore, as the production, storage and transport of hydrogen offshore may involve significant environmental and safety risks, a brief analysis of EU environmental and safety law is provided. Moreover, the interconnected nature of the North Sea energy system raises questions on the interaction between the legislation of the various North Sea states, for example where the supply chain of hydrogen crosses national borders. The analysis of national regulatory regimes is focused on the input of electricity, *i.e.* the possibility of connecting an offshore hydrocarbon platform to the offshore electricity network, or connecting it directly to a wind farm (*e.g.* through the converter or substation), and the output of hydrogen, *i.e.* the possibility to blend hydrogen with natural gas and transport it to shore using existing natural gas pipelines.

Clarification of the legal framework applicable to any technology is important from economic, technological and policy-making perspectives. Legal certainty allows for research and development of the technology to be promoted, as well as opening the doors to significant investment for business purposes. Given the benefits associated with PtG technology, it is important to expand the legal research regarding the use of hydrogen in the energy sector. Depending on the technology used (and the steps involved in the production of hydrogen), a multitude of potential legal issues may arise. This report therefore focuses specifically on the legislation applicable to *green hydrogen*. In part, the legislation applicable to *grey hydrogen* is also analysed. *Blue hydrogen* is however excluded from the scope of this report.

The North Sea Energy Project's focus on the re-use of the existing hydrocarbon infrastructure in the NSA distinguishes the legal analysis in this project from previous projects within the same field of research. The North Sea Energy Project has already dealt with legal barriers with regard to the re-use of existing hydrocarbon infrastructure in the previous report on the regulatory framework.⁴⁸ This report, therefore, focuses on the planning, production, transport and supply of hydrogen in the North Sea.

⁴⁸ For a more comprehensive analysis see Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018.

2.4 Structure of Deliverable

This chapter provided an introduction to the report, as well as outlining its objectives and scope. The subsequent chapter, chapter three, discusses very briefly the international legal aspects of offshore energy activities from the perspective of international law.⁴⁹ Chapter four analyses the applicable EU policy and legislation pertaining to PtG in general, and hydrogen activities offshore in particular. Chapter five provides a comparative analysis of the legal regimes pertaining to hydrogen activities offshore in the selected North Sea states. This involves an analysis of laws governing energy production; energy transmission and the re-use of current infrastructure; the construction of new infrastructure, such as national acts governing planning regimes for offshore energy activities and authorisation procedures for energy activities at sea, and; acts regulating offshore electricity and gas networks. Each chapter analyses the degree to which the current legal regimes create barriers to the development of hydrogen activities offshore, providing potential drivers in realising the production and transport of hydrogen offshore. Lastly, the conclusions are provided in chapter six.

⁴⁹ For a more comprehensive analysis see Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018.

3. International Law

3.1 Introduction

When discussing the legal aspects concerning the construction and operation of PtG facilities on offshore platforms, one should distinguish between onshore and offshore facilities. This is because the competences for states to regulate and enforce regulations governing onshore activities differ from offshore activities. This competence is termed jurisdiction.⁵⁰ While exercising jurisdiction over activities occurring onshore is an aspect of a state's sovereignty, the North Sea Energy Project is primarily concerned with offshore activities. A question therefore arises as to what extent states have the competence to regulate activities outside state sovereignty.

Rules regarding jurisdiction and sovereignty can be found in international law. As international law regulates the rights and duties of states at sea, it is of particular importance for the North Sea Energy Project. International law stands above EU and national law, and it is therefore wise to first assess relevant provisions in international law when one seeks to analyse the competences and legal basis for states' regulation of offshore activities. This section will first provide an overview of the key concepts of international law relevant to understanding the application of international law to offshore energy activities, before focusing on the main source of the international maritime law – the 1982 United Nations Convention on the Law of the Sea of (UNCLOS).⁵¹

3.2 Sources of International Law

Two sources of international law are particularly important: treaties between states, and customary international law. A treaty, once it has entered into force, is binding on all states that have signed and ratified it. A treaty can be concluded either by large groups of states or on a bilateral basis, with the aim of clarifying the legal situation between two states. Customary international law may be found to exist when states have adopted a certain practice or custom and perceive this custom or practice as a legal norm. It does not have to be explicitly noted down in legal frameworks to have legal effect.

In the context of offshore activities, UNCLOS is the most important source of international law. As such, this convention is referred to extensively in this section. There are numerous other conventions that create duties and obligations for coastal states in the NSA, including the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), and the London Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention). However, these conventions are not dealt with in depth in this report, as neither convention is decisive for determining the jurisdictional limits of coastal states.⁵²

⁵⁰ Jurisdiction entails the right of a State to govern over a certain territory, property or person. The concept of jurisdiction has traditionally had a strong link with the notion of sovereignty. Jurisdiction allows states to give effect to the sovereign independence, which entails the right of a state to legislate, to apply this legislation and to enforce it within a territory or over a particular subject. Jurisdiction only exists if there is an implicit or explicit basis for it. The most common forms of jurisdiction is the *territorial jurisdiction* whereby states enjoy jurisdiction over its territory and the treaty-based jurisdiction where states enjoy jurisdiction by virtue of an international treaty allocating this jurisdiction to states, see further Ryngaert, C., 'The Concept of Jurisdiction in International Law', Utrecht University, p. 1-2, available at <<https://unijuris.sites.uu.nl/wp-content/uploads/sites/9/2014/12/The-Concept-of-Jurisdiction-in-International-Law.pdf>>

⁵¹ United Nations Convention on the Law of the Sea (UNCLOS), Montego Bay, 1982.

⁵² For a more comprehensive analysis see Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018.

3.3 The Rights of Coastal States

In principle, coastal states enjoy sovereignty over their land territory, and as such have the jurisdiction to regulate activities taking place within their land territory. This sovereignty stretches from the heavens above to the depth of hell – *cuius est solum, eius est usque ad coelum et ad inferos* – and as such, understandably, includes natural resources embedded in the subsoil.⁵³ However, the extent to which coastal states have jurisdiction and sovereignty offshore is limited and regulated by international law.

The primary legal instrument dealing with the law of the sea in general, and with offshore jurisdiction in particular is UNCLOS, which is the successor to the 1958 Geneva Conventions, and has been ratified by all North Sea states.⁵⁴ UNCLOS divides the sea into four maritime zones: (i) the territorial sea, (ii) the Exclusive Economic Zone (EEZ), (iii) the continental shelf (CS), and (iv) the high seas. Each has its own characteristics in terms of coastal state jurisdiction and sovereignty (or sovereign rights). The following sections provide an overview of the rights of coastal states in these maritime zones.

3.3.1 Territorial Sea

The zone closest to shore is the territorial sea, comprising the water column, seabed and subsoil up to 12 nautical miles (22.2 kilometres) from shore, as illustrated in Figure 1.⁵⁵ Coastal states enjoy sovereignty over their territorial sea and, thus, have full jurisdictional power to regulate activities taking place within this zone.⁵⁶ Consequently, all national laws apply automatically. This entails that coastal states have the right to regulate the construction and operation of energy assets necessary for *inter alia* electricity production from wind, the conversion of electricity into hydrogen, and the transport of hydrogen from offshore installations to shore.⁵⁷

One important limitation to coastal states' sovereignty within their territorial sea is the right of innocent passage.⁵⁸ This is a key aspect of the concept of freedom of navigation by which coastal states must ensure that constructions in the territorial sea are not so extensive that they hamper the innocent passage of ships from other states. However, coastal states have right to regulate the innocent passage of ships in order to ensure *inter alia* safety of navigation and marine traffic, the protection of cables and pipelines, and the conservation of marine living resources.⁵⁹

3.3.2 Continental Shelf and Exclusive Economic Zone

The CS is a relatively shallow submarine terrace of continental crust forming the edge of a continental landmass. According to UNCLOS, the CS comprises the submerged prolongation of the land territory of the coastal State – the seabed and subsoil of the submarine areas that extend beyond its territorial sea to the

⁵³ As a rule of international customary law states enjoy permanent sovereignty over their natural resources. States have the right to for example dispose freely of the natural resource, to freely explore and exploit the natural resources, to use natural resources for national development, to manage natural resources pursuant to national environmental policy and to regulate foreign investment. United Nations Resolution 1803 (XVII) on the Permanent Sovereignty over Natural Resources on 14 December 1962.

⁵⁴ The 1958 Geneva Conventions include the Convention on the Territorial Sea and the Contiguous Zone, Geneva, 1958.; the Convention on the High Seas, Geneva, 1958.; the Convention on Fishing and Conservation of the Living Resources of the High Seas, Geneva, 1958.; and the Convention on the Continental Shelf, Geneva, 1958.

⁵⁵ Article 3 of the UNCLOS.

⁵⁶ Article 2 of the UNCLOS.

⁵⁷ The only limitations on a state's sovereignty to regulate in the territorial sea are other international legal commitments binding to the state and the right of innocent passage (Article 2(3) and Article 17-26 of the UNCLOS).

⁵⁸ Article 17 of the UNCLOS.

⁵⁹ Article 21(1) of the UNCLOS.

outer edge of the continental margin,⁶⁰ or to a distance of 200 nautical miles (370.4 kilometres) where the outer edge of the continental margin does not extend up to that distance, as illustrated in Figure 1.⁶¹ The North Sea largely consists of one geological CS and, given the overlap of the claims over the area held by various North Sea states, coastal states in the NSA have delimitedated their respective CSs in accordance with UNCLOS. Following customary international law, as codified in UNCLOS, coastal states may explicitly declare an EEZ – an area beyond the territorial sea ranging up to 200 nautical miles (370.4 kilometres) from the baseline, as illustrated in Figure 1.⁶² All states in the NSA have made such a declaration. Thus, the CSs and the EEZs of the North Sea states overlap.

When discussing the rights of coastal states offshore, it is necessary to note that ‘sovereignty’ and ‘sovereign rights’ are distinct concepts that must not be confused with one another. Whereas ‘sovereignty’ bestows full rights (or supreme authority) on a coastal state both onshore and within its territorial waters,⁶³ ‘sovereign rights’ are rights of specific functional purpose that are exclusively exercised by a coastal state in the EEZ and on the CS.⁶⁴ Thus, beyond territorial waters, coastal states have the right to merely perform particular sets of activities and functions specified under UNCLOS.⁶⁵ This translates into a ‘functional jurisdiction’, *i.e.* jurisdiction only for the purpose of regulating these particular activities/functions.⁶⁶

On the seabed and in the subsoil of their CS, coastal states enjoy sovereign rights for the purposes of natural resource exploration and exploitation.⁶⁷ The functional jurisdiction thus extends to the regulation of activities taking place with the aim of exploring and exploiting natural resources, such as oil and gas activities. In accordance with UNCLOS, coastal states are granted an exclusive right to construct and authorise (or regulate the construction and operation) of artificial islands and installations and structures with economic purposes.⁶⁸ Coastal states also have the right to regulate cables and pipelines located within their CS that are part of the energy infrastructure necessary for the exploration and exploitation of their natural resources.⁶⁹

The scope of sovereign rights enjoyed by states in the EEZ is broader than those enjoyed on the CS. Within the EEZ, coastal states have sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources and other activities for the economic exploitation and exploration of the zone – be they the fish in the sea, the water’s currents, the winds that blow through the area or the oil and gas lying beneath the earth’s surface.⁷⁰ As on the CS, coastal states have the exclusive right in their EEZ to construct and to authorise and regulate the construction and operation of artificial islands, and installations and structures for economic purposes.⁷¹

Coastal states therefore have the right to regulate the construction and operation of offshore energy assets necessary for, *inter alia*, electricity production from wind, the conversion of electricity into hydrogen, and the transport of hydrogen from offshore installations to shore – providing these activities serve an economic

⁶⁰ The continental margin consists of the seabed and subsoil of the shelf, the slope and the rise. It does not include the deep ocean floor with its oceanic ridges or the subsoil thereof.

⁶¹ Article 76(1) of the UNCLOS.

⁶² Article 57 of the UNCLOS.

⁶³ Article 2 of the UNCLOS. See further Section 3.3.1.

⁶⁴ Articles 56 and Article 77 of the UNCLOS.

⁶⁵ Articles 56 and Article 77 of the UNCLOS.

⁶⁶ Coastal states therefore have only limited rights to regulate such activities/functions, see further Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 8-10.

⁶⁷ Article 77(1) of the UNCLOS.

⁶⁸ Articles 60 and 80 of the UNCLOS.

⁶⁹ Article 79(4) of the UNCLOS.

⁷⁰ Article 56(1)(a) of the UNCLOS.

⁷¹ Article 60(1) of the UNCLOS.

purpose. Given that coastal states only have sovereign rights in their EEZ and on the CS, they may only exercise a functional jurisdiction, and national laws will therefore only apply to such activities where coastal states expressly decide that they ought to.

3.3.3 High Seas

The last maritime zone, the high seas, consists of all parts of the world's seas and oceans that are not part of the EEZ, the territorial sea or the internal waters of a state.⁷² No state has sole jurisdictional power over these areas, and thus they are open to all states whether coastal or land-locked.⁷³ Freedom of the high seas is exercised under the conditions laid down by UNCLOS "and other rules of international law".⁷⁴ Article 87 of UNCLOS comprises, *inter alia*, the freedom of navigation and overflight, the freedom to lay submarine cables and pipelines, and the freedom to fish (subject to certain conditions).⁷⁵

In the EEZ, all states, coastal or land-locked enjoy, subject to the relevant provisions of UNCLOS, the freedoms referred to in Article 87.⁷⁶ This principle is referred to as the 'freedom of the sea', which is relevant across all the previously mentioned maritime zones.⁷⁷ Coastal states must therefore accept the laying of cables and pipelines within their EEZ and on their CS.⁷⁸ The delineation of the laying of such cables and pipelines is, however, subject to consent of the state concerned, as coastal states enjoy jurisdiction over the spatial planning of cables and pipelines.⁷⁹ Furthermore, coastal states enjoy jurisdiction over environmental aspects, and retain the jurisdiction to take reasonable measures to protect and preserve the marine environment.⁸⁰ Under UNCLOS, coastal states must adopt measures necessary to ensure that activities under their jurisdiction or control are conducted as not to cause damage, and to this end must adopt measures to limit pollution from pipelines.⁸¹

⁷² Article 86 of the UNCLOS.

⁷³ Article 87 of the UNCLOS.

⁷⁴ Article 87(1) of the UNCLOS.

⁷⁵ In accordance with Article 116 of UNCLOS all states have the right for their nationals to engage in fishing on the high seas subject to: (a) their treaty obligations, (b) the rights and duties as well as the interest of coastal states, and (c) the provisions of section 2 of the UNCLOS.

⁷⁶ Article 58 of the UNCLOS.

⁷⁷ Referred to as '*mare liberum*'.

⁷⁸ Article 58(1) in conjunction with Article 79(1) and (2) of the UNCLOS; see Article 87 of the UNCLOS.

⁷⁹ Article 79(3) and (4) of the UNCLOS.

⁸⁰ Article 56(b) of the UNCLOS.

⁸¹ Article 194 of the UNCLOS.

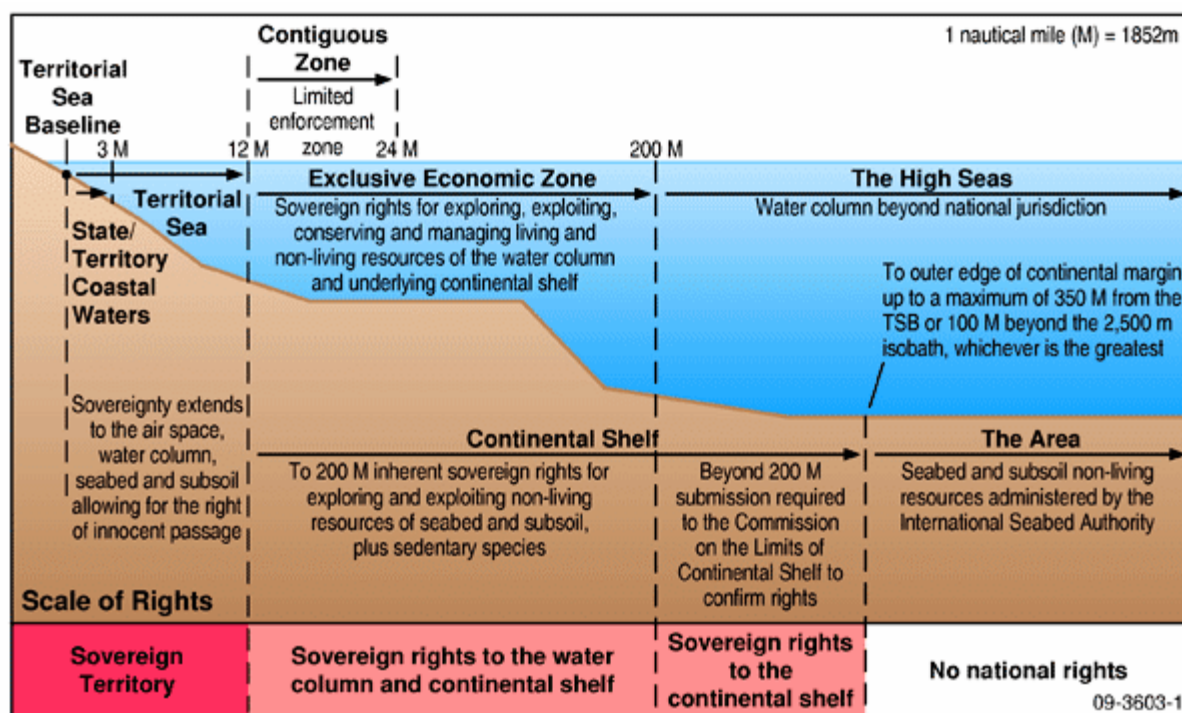


Figure 1: International maritime zones (image by National Oceanic and Atmospheric Administration)

3.4 Offshore Infrastructure

This section provides an analysis of coastal states' sovereign rights to develop offshore installations and structures (hereafter 'infrastructure'), focusing particularly on the international rules pertaining to hydrogen activities offshore. The construction and use of such infrastructure offshore must be balanced with other uses of the sea, such as shipping and navigation. To integrate and balance the various uses and users of the sea, UNCLOS provides guidelines on the construction and decommissioning of offshore infrastructure, such as platforms, wind turbines, submarine cables and pipelines. Given that the previous report on the regulatory framework in the North Sea Energy Project dealt with this in depth, only a brief analysis of this subject matter is provided in this report.⁸²

3.4.1 Construction of Offshore Infrastructure

Coastal states enjoy sovereign rights to authorise and regulate the construction, operation and use of infrastructure for economic purposes in the EEZ and on the CS.⁸³ Since the construction of a PtG facility (and the submarine cables and pipelines connected to it) are economic activities, such development falls under the functional jurisdiction of coastal states. When coastal states have the jurisdiction to regulate a particular activity, they can adopt national laws regulating the construction of the infrastructure necessary for that activity, the operation of such infrastructure and, at end-of-life, the removal of such infrastructure.⁸⁴ The degree to which coastal states must take into consideration other users of the sea when drafting national laws differs across each maritime zone.

⁸² Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 6-15.

⁸³ Article 60(1)(b) and Article 80 of the UNCLOS.

⁸⁴ See Sections 3.3.1-3.3.2.

In the territorial sea, coastal states are entitled to manage the construction of infrastructure, provided they exercise their jurisdiction in accordance with the rules of UNCLOS “and other rules of international law”.⁸⁵ In the EEZ, coastal states have the right to permit the construction of offshore infrastructure for economic purposes, but this right is limited by the duty to have due regard to the rights and duties of other states.⁸⁶ Article 58 of UNCLOS details these rights, and includes, *inter alia*, the right of navigation and the right to lay pipelines and submarine cables.⁸⁷ The same regime applies to the CS, where states can exercise their jurisdiction provided that it does not result in any unjustifiable interference with navigation, or unjustifiably interfere with other rights and freedoms of other states.⁸⁸

3.4.2 Decommissioning of Offshore Infrastructure

Although UNCLOS gives states the right to construct infrastructure offshore, there is an associated duty relating to the removal of abandoned or disused infrastructure.⁸⁹ Offshore infrastructure may hamper the rights of other parties or states to fully exercise their rights and freedoms, and as such, UNCLOS requires the removal of any abandoned or disused installations and structures.⁹⁰ The terms ‘installations’ and ‘structures’ are not defined in UNCLOS, but it is generally accepted that these terms cover large physical infrastructure, such as hydrocarbon platforms. Once abandoned or disused, such infrastructure must therefore be removed. Given the explicit reference to safety and navigation in Article 60(3) of UNCLOS, it can be argued that cables and pipelines are not covered by this removal obligation. However, this is only the case for cables and pipelines that are not seen as an integral part of the installation to which they are connected.⁹¹

The form that the obligation to remove abandoned or disused infrastructure takes is also based on “international standards established [...] by the competent international organization”.⁹² These standards can be found in the 1989 Resolution by the International Maritime Organization, namely, ‘the 1989 Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone’ (hereafter ‘IMO Guidelines’).⁹³ Also relevant for infrastructure in the North Sea and the North East Atlantic are the ‘OSPAR Decision on Disposal of Disused Offshore Installations’,⁹⁴ the ‘1972 London Convention’,⁹⁵ and its 1996 protocol.⁹⁶

⁸⁵ Article 2 (3) of the UNCLOS; see also Section 3.3.1.

⁸⁶ Article 66 (2) of the UNCLOS.

⁸⁷ Article 58 (1) of the UNCLOS.

⁸⁸ Article 78 (2) of the UNCLOS.

⁸⁹ Article 60 (3) of the UNCLOS.

⁹⁰ Article 60 (3) of the UNCLOS.

⁹¹ In general, cables and pipelines are seen as separate activities in UNCLOS. Cables and pipelines, that is an integral part of an energy production installation, to which they are connected, are however generally included under the removal obligation in Article 60(3) of the UNCLOS. See further Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 15.

⁹² Article 60 of the UNCLOS. The obligation to remove abandoned or disused offshore installations and structures is further based on the following Conventions, Protocols and Guidelines: International Maritime Organization Assembly resolution 672(16) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone (IMO Guidelines), 1989, London; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 [1972 London Convention]; 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter; Convention for the Protection of the Marine Environment of the North-East Atlantic [OSPAR Convention], 1992, Paris; OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations (OSPAR Decisions 98/3), 1998, Sintra.

⁹³ IMO, Resolution A. 672 (16), Adopted by the International Maritime Organization on 19 October 1989.

⁹⁴ OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations.

⁹⁵ Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 [1972 London Convention].

⁹⁶ 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

3.4.3 Re-use of Existing Offshore Infrastructure

The decommissioning of offshore hydrocarbon infrastructure is of particular relevance to the North Sea Energy Project. The project proposes re-using existing North Sea hydrocarbon infrastructure for the production and transport of hydrogen offshore, rather than removing the infrastructure. It is therefore crucial to take into consideration existing legislation pertaining to the physical removal of offshore infrastructure when analysing whether hydrogen-related activities may be performed offshore.

In contrast to the '1958 Geneva Convention on the Continental Shelf', the current regime no longer requires a 'complete removal', but merely a 'removal' of abandoned or disused installations or structures.⁹⁷ In addition to the removal obligation in Article 60 of UNCLOS, recommendations on how and when installations and structures must be removed are further provided by the IMO guidelines.⁹⁸ As a general rule, these guidelines provide that abandoned or disused installations and structures should be removed.⁹⁹ However, the IMO guidelines list the following exemptions to this general rule: (i) when the installation or structure will serve a new use, (ii) when the installation or structure can be left in place without causing unjustifiable interference with other uses of the sea, or (iii) when entire removal is not technically feasible or would involve extreme costs, or an unacceptable risk to personnel or the marine environment.¹⁰⁰ However, the two latter exemptions, do not apply to 'lightweight platforms standing in shallow waters'.¹⁰¹ Thus, only re-use can provide a valid reason for leaving such platforms in place when they after oil or gas production have ceased.¹⁰²

Furthermore, the OSPAR Convention stipulates that no disused installations offshore shall be left in place without a permit from the competent authority of the contracting parties.¹⁰³ In contrast to UNCLOS and the IMO Guidelines, OSPAR Decision 98/3 provides a definition for 'disused offshore installations'.¹⁰⁴ The definition specifies that an installation that serves another legitimate purpose in the maritime area should not be considered a 'disused installation'. However, this exemption only applies if the installation has been authorised or regulated by the competent authority of the relevant contracting party.¹⁰⁵ Thus, such installations need not be removed.

Consequently, a reading of international conventions and guidelines makes clear that, in principle, all hydrocarbon platforms in the NSA ought to be removed once they become disused. The term 'disused', however, seems to leave room for the repurposing of platforms for the production of hydrogen.¹⁰⁶

3.5 Protection of the Marine Environment

UNCLOS provides a comprehensive framework for international cooperation to protect the marine environment,¹⁰⁷ and imposes on its ratifying parties minimum requirements for the protection and

⁹⁷ Article 60 of the UNCLOS.

⁹⁸ The 1989 Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone', Resolution A. 672 (16), Adopted by the International Maritime Organization on 19 October 1989.

⁹⁹ Article 1.1 of the IMO Guidelines.

¹⁰⁰ Articles 3.4 and 3.5 of the IMO Guidelines.

¹⁰¹ Article 3.1 and 3.2 of the IMO Guidelines.

¹⁰² For a more comprehensive analysis see Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 10-12.

¹⁰³ Annex III, Article 5.1 of the OSPAR Convention.

¹⁰⁴ Article 1 of the OSPAR Convention.

¹⁰⁵ Article 1 of the OSPAR Convention.

¹⁰⁶ For a more comprehensive analysis see Drankier, D., Roggenkamp, M., *North Sea Energy II Regulatory Framework: Barriers or Drivers for Offshore System Integration*, North Sea Energy, Deliverable B.1, 2018, p. 11-13.

¹⁰⁷ Part XII of the UNCLOS, see also Article 145 of the UNCLOS.

preservation of the marine environment.¹⁰⁸ Although states have sovereign rights to exploit their natural resources, this must be carried out pursuant to their environmental policies, and in accordance with their duty to protect and preserve the marine environment.¹⁰⁹ Coastal states are therefore required to take, individually or jointly, all 'necessary measures' with respect to offshore activities in order to guarantee the effective protection of the marine environment from harmful effects, which may occur as a result of such activities.¹¹⁰

The provisions relating to the protection and preservation of the marine environment emphasise the need for states to undertake surveillance of activities that they permit to engage in, in order to determine whether these activities are likely to have significant adverse impacts on the marine ecosystem and its various components.¹¹¹ This includes the prevention and reduction of pollution and other hazards, the protection and conservation of natural resources, and the prevention of damage to flora and fauna.¹¹²

3.6 Interim Conclusions

Each North Sea state exercises full jurisdiction in its territorial sea and has sovereign rights beyond the territorial sea. Accordingly, the North Sea states may exercise a functional jurisdiction in their EEZs and on their CSs. Whereas national law applies automatically in the territorial sea, North Sea states must explicitly declare whether national laws are applicable in the EEZ and on the CS. In the exercise of their rights, coastal states must always have due regard to other obligations under international law, such as those that serve the rights and freedoms of third states. Moreover, coastal states must comply with rules on the protection of the marine environment when constructing and operating offshore energy facilities. Although North Sea states have a duty to remove abandoned or disused hydrocarbon platforms, international conventions and guidelines seem to provide for the possibility to repurpose platforms for the production of hydrogen.

¹⁰⁸ Article 192 of the UNCLOS.

¹⁰⁹ Article 193 of the UNCLOS.

¹¹⁰ Article 145 of the UNCLOS.

¹¹¹ Article 204 of the UNCLOS.

¹¹² Article 145(a) and (b) of the UNCLOS.

4. EU Policy Frameworks and Legislation

4.1 Introduction

At the time of writing, the North Sea states analysed in this report are all members of the EU, which means that EU policy and legislation apply to these states. The future applicability of EU legislation in the UK, however, depends on the outcome of the Brexit process and the content of any potential trade agreement between the EU and the UK. As the implementation of EU directives and regulations affect policy and legislation at the national level, it is necessary to look at the sources of EU law and the extent of the EU's competence to regulate. This is covered in Section 4.2 of this report. In light of the planned production of hydrogen on offshore platforms, this section focuses predominantly on the applicability of EU law at sea.

PtG is a relatively new technological development, as is the use of hydrogen in the energy sector. Section 4.3, presents the most important energy and climate policy frameworks supporting the development of PtG and energy storage technologies in the electricity system. As there is no hydrogen-specific legislation regulating the conversion of electricity to hydrogen, Section 4.4 analyses the applicability of the EU energy legislation to PtG technology generally.

The recently adopted EU energy legislation includes provisions on energy storage and renewable gases. Sections 4.4.1 – 4.4.2 analyses the applicability of EU electricity and gas legislation to activities involving green and grey hydrogen, discussing the importance of PtG's potential classification as an energy storage or as a production activity, and looking at the significance any decision on this matter will have in the ownership of PtG facilities. Subsequently, Section 4.4.3 examines the incorporation of green hydrogen into the EU renewable energy legislation, with the section containing an evaluation of the incentives available to states to boost the development of PtG facilities.

Furthermore, Section 4.5 analyses the applicability of EU climate, environmental and safety law to offshore PtG facilities generating green and grey hydrogen. This is a necessary step in determining the conditions that must be fulfilled by a PtG developer, *i.e.* whether it is necessary to carry out an impact assessment before constructing PtG facilities and whether developers must obtain certain permits for the development and operation of such facilities. Moreover, Section 4.6 analyses EU legislation on maritime spatial planning, and aims to identify the considerations Member States must make when planning offshore energy activities, including the generation of green and grey hydrogen offshore. Finally, Section 4.7 contemplates the legal barriers that may hamper the development of PtG offshore and impede the adoption of hydrogen in the energy sector.

4.2 Competences under EU Law and the Sources

The following Section provides a very brief account of the sources of EU energy law. The main sources of EU primary legislation are the Treaty on the European Union (hereinafter TEU)¹¹³ and the Treaty on the Functioning of the European Union (hereinafter TFEU).¹¹⁴ Of particular importance to the energy sector are the TFEU rules on free movement, competition, state aid and the energy-specific rules further discussed below. Secondary legislation in the EU is based on the Treaties and is valid only insofar as it is consistent with these instruments. The limits of the EU competences are governed by the principle of conferral, which is enshrined in Article 5(1) of the TEU, and provides that the EU can only act within the limits of the competences conferred upon it by the Member States.

¹¹³ Consolidated version of the Treaty on the European Union, OJ C 326, 26.10.2012.

¹¹⁴ Consolidated version of the Treaty on the Functioning of the European Union, OJ C 326, 26.10.2012.

4.2.1 Competences to Regulate Power-to-gas

As stated above, the EU may act only within the limits of the competences conferred upon it by its Member States in the Treaties, and only to the extent necessary to attain the objectives provided therein. The decision-making procedure is different under each measure and depends on the legal basis. The EU institutions do not have unlimited competences, and it is essential to establish the legal basis by which the extent of each competence is determined. Furthermore, the choice of legal basis affects the extent to which Member States can adopt measures, which may be based on the principles of maximum or minimum harmonisation.¹¹⁵ There are three categories of competence for the EU in the TFEU: exclusive competences,¹¹⁶ shared competences¹¹⁷ and competences to support, coordinate and supplement the action of Member States.¹¹⁸ The subsidiarity principle establishes that the EU can only act if the objectives of the proposed action cannot be sufficiently achieved by the Member States acting alone, and if the proposed action can be better achieved through joint action at the EU level.¹¹⁹ This essentially means that the EU must meet two separate criteria in order for EU-level legislation in that area to be justified. Pursuant to Article 4(2) of the TFEU, the EU has shared competence to regulate energy matters, which implies that the EU and the Member States may legislate and adopt legally binding acts regulating energy matters. However, the Member States are limited to exercise their competence to the extent that the EU has not exercised or ceased to exercise its competence.¹²⁰

Article 194 of the TFEU sets out the goals of EU energy law and contains a legal basis for further action. Moreover, it confirms the existing division of competences (shared).¹²¹ It stipulates that:

"in a spirit of solidarity between Member States" and "in the context of the establishment and functioning of the internal market, and with regard for the need to preserve and improve the environment", the EU policy on energy must aim to: "(a) ensure the functioning of the energy market; (b) ensure security of supply in the Union; (c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and (d) promote the interconnection of energy networks."¹²²

Given that Article 194 of the TFEU is the basis for a large number of legislation adopted in the energy sector, it is likely that this will be the legal basis for further legal action in the energy sector.¹²³ Of relevance is also Article 114 of the TFEU, which empowers the EU to adopt legislation to harmonise national laws that may hamper the establishment and functioning of the EU internal market. Furthermore, Article 170 – 172 of the TFEU provides the legal basis for trans-European networks, by which the EU contributes to the establishment and development of trans-European networks in the area of energy. Another necessary element is the competence of the EU with regard to environmental matters, which is elaborated on in Article 191–193 of the TFEU. Legislation with the goal to preserve, protect and improve the environment is based on these articles.

¹¹⁵ Jans, J.H., Vedder, H., *European Environmental Law, After Lisbon*, (4th ed.), Europa Law Publishing, p. 13.

¹¹⁶ Article 2(1) of the TFEU.

¹¹⁷ Article 2(2) of the TFEU.

¹¹⁸ Article 2(3) of the TFEU.

¹¹⁹ Article 5(3) of the TFEU.

¹²⁰ Craig, P., De Búrca, G., *European Law: Text, Cases, and Materials* (6th ed.), Oxford University Press, 2015, p. 95.

¹²¹ Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., 'EU Energy Law' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 195.

¹²² In reality, Article 194 of the TFEU overlaps with the content of several other rules of the Treaty, such as Article 114 of the TFEU, Article 191 and 192 of the TFEU, and Article 122 of the TFEU. For a comprehensive understanding see Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., 'EU Energy Law' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 196.

¹²³ The legislative frameworks adopted under the 'Clean Energy for all Europeans' package all have Article 194 of the TFEU as the legal basis, except for the Governance of the Energy Union, which has a joint legal basis of Article 192(1) and 194(2) of the TFEU.

4.2.2 Applicability of EU Law at Sea

The applicability of EU law for activities taking place at sea depends on the nature and geographic location of the activity, as well as on the formulation of the scope of the legal instrument governing such activity. Article 52 of the TEU and Article 355 of the TFEU provide that EU law is applicable to the territory of the EU Member States. However, it is not evident to what extent EU law is applicable at sea, or more specifically, to the North Sea. Given that territorial waters fall under the territory of a coastal state,¹²⁴ EU law is applicable to the territorial waters of its Member States. It is more difficult to determine the applicability of EU law in the EEZ and on the CS as the jurisdiction is limited to a functional jurisdiction.¹²⁵ The EU Treaties provide no clarity on this matter, but from the wording of the Treaties it is likely that EU law is applicable only where Member States have jurisdiction, as they may only transfer their competence to legislate to the EU in a particular field if they have jurisdiction.¹²⁶

EU Treaties and secondary legislation generally dictate the geographic scope of their applicability. The extent to which the EU has the right to adopt legislation pertaining to the different maritime zones is, however, unclear. With increasing activity at sea, the European Court of Justice has been confronted with questions on the applicability of secondary legislation at sea. In fact, the Court has, in a number of cases, already addressed the applicability of secondary EU law to activities at sea beyond territorial waters. In several of these cases, the Court established that secondary legislation applies in principle to the same geographical areas that are specified in Article 52 of the TEU and Article 355 of the TFEU, unless the secondary legislation contains provisions specifically providing otherwise.¹²⁷ This means that secondary legislation is only applicable to the territory of the EU Member States and thus not outside their territorial waters, unless otherwise specified. Therefore, where relevant, one may expect that the geographical scope of the relevant secondary legislation to be explicitly mentioned – however, such reference is often missing.¹²⁸

There are several relevant cases from the European Court of Justice concerning the applicability of EU law at sea, with two of particular importance being *Poulsen*¹²⁹ and the *Habitats* case.¹³⁰ In the first case, *Poulsen*, the European Court of Justice ruled on the extent to which EU law applied to the Danish EEZ. The court concluded that the EU has the competence to legislate matters related to fisheries in the EEZ, as a result of Denmark's functional jurisdiction.¹³¹ In the second case, the *Habitats* case, the European Court of Justice ruled on the applicability of the Habitats Directive in the EEZ and on the CS of the UK. The Court argued that, as the UK exercises its sovereign rights beyond the territorial waters, the Directive should also apply there, insofar as the UK exercises its sovereign rights.¹³² Thus, the Court confirmed its earlier stance that EU law applies where coastal Member States have any degree of national sovereignty.¹³³ In summary, EU case law implies that when the activity falls under a coastal Member State's functional jurisdiction – and the coastal Member State's sovereign rights – then also EU law applies as far as that activity is concerned.¹³⁴

¹²⁴ See Section 3.3.1.

¹²⁵ See Section 3.3.2.

¹²⁶ See Section 4.2.1.

¹²⁷ *Commission v Ireland* (Case C-61/77) [1977] ECLI:EU:C:1977:88, para 46; *Hansen & Balle* (Case C-148/77) [1978] ECLI:EU:C:1978:173, para. 11.

¹²⁸ For a more comprehensive understanding see Müller, H.K., *A Legal Framework for a Transnational Offshore Grid in the North Seas*, Intersentia, 2016, p.67-98.

¹²⁹ *Anklagemyndigheden v Poulsen* (Case C-286/90) [1992] ECR I-6019.

¹³⁰ *Commission v United Kingdom* (Case C-6/04) [2005] ECR I-9017.

¹³¹ *Anklagemyndigheden v Poulsen* (Case C-286/90) [1992] ECR I-6019, para. 24, 25.

¹³² *Commission v United Kingdom* (Case C-6/04) [2005] ECR I-9017, para. 115, 117.

¹³³ For a more comprehensive understanding see Waverijn, J., Nieuwenhout, C.T., 'Swimming in ECJ case law: The rocky journey to EU law applicability in the continental shelf and Exclusive Economic Zone' (2019) 56 Common Market Law Review, Issue 6, p. 1623–1648.

¹³⁴ *Herbert Weber v Universal Ogden Services Ltd.* (Case C-37/00) [2002] ECLI:EU:C:2002:122.

4.2.3 Sources of EU Law

In an analysis of EU policies and legislation, it is essential to understand the legal acts that the EU can adopt, and the binding nature of these acts. Article 288(1) of the TFEU sets out the different types of legal acts that may be adopted, which includes regulations, directives, decisions, recommendations and opinions. It stipulates that only regulations, directives and decisions are legally binding. Whereas a 'regulation' has general application and is directly applicable in a Member State, a 'directive' must be implemented in national legislation but leaves the choice of form and method to the Member States. Under the category of non-binding 'opinions' and 'recommendations', other instruments are included, such as communications and strategies, which are used by the European Commission (EC) to propose and subsequently agree on objectives and strategies. These measures are of great importance as they provide guidance as to the interpretation and content of EU law.

4.3 EU Policy Frameworks

EU energy and climate policies, and eventually legislation, are founded on the main energy objectives of the EU: sustainability, competition and affordability, and security of supply.¹³⁵ This section lists some of the key EU policy frameworks that promote PtG technology in the energy sector. The choice of policy frameworks is not exhaustive, as it merely reflects the EU's position on the use of hydrogen in the energy sector. They create the signals for future legislation on PtG at the EU level and, thus, the regulation of hydrogen activities.

4.3.1 Energy and Climate Targets

The setting of quantitative targets in the EU requiring a reduction of greenhouse gas emissions – and a higher share of energy from renewables – are crucial for the development of clean technologies such as PtG. The 20-20-20 package, adopted by the European Council in 2007, is a set of binding provisions to ensure that the EU meets its climate and energy targets for the year 2020.¹³⁶ The package sets three key targets: (i) a 20% cut in greenhouse gas emissions (from 1990 levels), (ii) 20% of EU energy to come from renewables, and (iii) a 20% improvement in energy efficiency.¹³⁷ These targets are achieved through the setting of binding national targets, with some Member States needing to take greater steps than others. A 2017 analysis of data and information reported by EU Member States indicates that the EU is on course to meet each of its 2020 targets. The greenhouse gas emission target was, in fact, surpassed in 2014.¹³⁸ Although the EU and its Member States are making good progress towards their short-term climate and energy goals, efforts need to be redoubled if the more ambitious long-term targets are to be met.

The 2030 climate and energy framework sets EU-wide targets and policy objectives for the period 2021–2030.¹³⁹ The European Council adopted its framework in October 2014, with the key targets being: (i) at least a 40% reduction in greenhouse gas emissions (from 1990 levels), (ii) at least a 32% share for

¹³⁵ European Commission, 'A policy framework for climate and energy in the period from 2020 to 2030', (Communication) COM(2014) 15 final.

¹³⁶ These climate and energy targets are enacted in legal documents, see further European Commission, '2020 climate & energy package' <https://ec.europa.eu/clima/policies/strategies/2020_en>

¹³⁷ European Commission, '2020 by 2020: Europe's Climate Change Opportunity', COM(2008) 30 final.

¹³⁸ European Environment Agency, 'Overall progress towards the European Union's '20-20-20' climate and energy targets', 2018, available at <<https://www.eea.europa.eu/themes/climate/trends-and-projections-in-europe/trends-and-projections-in-europe-2017/overall-progress-towards-the-european#1-1-progress-of-the-european-union-towards-its--20-20-20--climate-and-energy-targets>>

¹³⁹ European Commission, '2030 climate & energy framework' <https://ec.europa.eu/clima/policies/strategies/2030_en>

renewable energy, and (iii) at least a 32.5% improvement in energy efficiency.¹⁴⁰ According to the new rules on governance of the European Energy Union, Member States are required to develop integrated national energy and climate plans, in which they need to report national objectives and targets to reduce greenhouse gas emissions; increase the share of renewable energy; ensure energy efficiency improvements; safeguard security of supply; guarantee the progress in the internal energy market, and; enhance competitiveness, research and innovation for the period up to 2030.¹⁴¹

In the long term, the EU has set itself a goal by 2050 in its Energy Roadmap to reduce greenhouse gas emissions by 80–95% compared to 1990 levels.¹⁴² The Roadmap stresses the importance to reduce greenhouse gases, while guaranteeing competitiveness and security of supply in the energy sector. In the 2050 Roadmap, energy storage is explicitly included, with one of the conditions being that: “a new sense of urgency and collective responsibility must be brought to bear on the development of new energy infrastructure and storage capacities across Europe and with neighbours”.¹⁴³ Furthermore, it stresses that:

“alternative fuels must be supported at the EU level by regulatory developments, standardization, infrastructure policy and further research and demonstration efforts, particularly on [...] hydrogen, which together with smart grids can multiply the benefits of electro-mobility both for decarbonisation of transport and development of renewable energy.”¹⁴⁴

Among all forms of energy, electricity plays an increasingly central role in the EU – due in part to the electrification of the building environment and the transportation sector. The challenge of integrating intermittent and variable RES is that one cannot be sure that the sources are available when needed.¹⁴⁵ The need to ensure flexibility mechanisms to maintain a high level of security of supply is, therefore, recognised by the EU. While energy security has been one of the main pillars of energy policy in the EU, recent concerns regarding climate change are becoming more important in shaping energy policy. Policy makers must develop cost-effective policies to ensure the security of the energy system, while at the same time reducing greenhouse gas emissions. Hydrogen offers a range of benefits as a clean energy carrier, which is receiving ever-greater attention as a policy priority.¹⁴⁶ The use of green hydrogen in energy systems offers effective solutions to both emission reductions and security of energy supply.¹⁴⁷

4.3.2 Policy Documents Promoting Power-to-Gas

The need for flexibility within the energy system to address the integration of higher shares of intermittent RES prompted the EC to initiate multiple reviews in 2013.¹⁴⁸ Following these reviews, the EC initiated a public consultation on a new energy market design in 2015, titled ‘Launching the public consultation process

¹⁴⁰ European Commission, ‘A policy framework for climate and energy in the period from 2020 to 2030’, (Communication) COM(2014) 15 final.

¹⁴¹ European Commission, ‘*National Energy and Climate Plans (NECPs)*’, available at

<<https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/governance-energy-union/national-energy-climate-plans>>

¹⁴² European Commission, ‘Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Energy Roadmap 2050’ COM(2011) 885 final.

¹⁴³ European Commission, ‘Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Energy Roadmap 2050’ COM(2011) 885 final, section 4(7).

¹⁴⁴ European Commission, ‘Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Energy Roadmap 2050’ COM(2011) 885 final, section 3(f).

¹⁴⁵ For a more comprehensive analysis see Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas*, Store&Go, Deliverable 7.2, 2017, p. 18-22.

¹⁴⁶ European Commission, ‘A policy framework for climate and energy in the period from 2020 to 2030’ (Communication) COM(2014) 15 final; European Commission, ‘Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Energy Roadmap 2050’ COM(2011) 885 final.

¹⁴⁷ For the Impact of governmental intervention with regard to energy security in case of market failures associated with the usage of hydrogen in the energy system, see further discussion in van Schot, M., *A vision on hydrogen potential from the North Sea*, North Sea Energy, Deliverable D.1.5, 2020.

¹⁴⁸ European Commission Joint Research Centre, *Assessing Storage Value in Electricity Markets*, (2013) ISBN 978-92-79-32362-1.

on a new energy market design'.¹⁴⁹ It was emphasised that the integration of energy storage in the electricity market would further increase the necessary flexibility of the electricity system.¹⁵⁰

In early 2017, the EC published an internal staff working paper providing insight into its vision on energy storage and sectoral integration.¹⁵¹ In the document, entitled 'Energy Storage – the Role of Electricity', the EC acknowledged the potential functions and benefits of energy storage. Cited below are paragraphs of the document that directly reference the benefits of energy storage and/or the sectoral integration that PtG entails:

- (i) "Energy storage brings benefits to the electricity system in a similar way as demand response, flexible generation and grid extension (including interconnections): it helps shave the peaks and provides flexibility solutions to market participants. Furthermore, storage can help reduce emissions from the conventional electricity generation: on the one hand by facilitating a more efficient use of the existing assets, on the other hand by reducing the carbon content of the fuels (e.g. blending of the natural gas with renewable hydrogen and synthetic methane)."¹⁵²
- (ii) "Large amounts of fossil fuels are used to produce industrial feedstock like hydrogen, ammonia and methanol. These feedstocks could be produced from variable RES by converting it to hydrogen and potentially further to other chemicals. The variable RES produced hydrogen, and derived chemicals, could also be used in agriculture and transport. These solutions would also promote innovation within European manufacturing industries and contribute to a [European global leadership] within the hydrogen industry, for which a regulatory framework may need to be further developed."¹⁵³
- (iii) "Chemical storage and innovative sectoral integration could absorb almost all excess variable RES even in a high variable RES scenario [...] and cover large shares of the longer term flexibility needs in the new electricity system."¹⁵⁴
- (iv) "Chemical storage could ensure the stability of the electricity system over longer periods [...] similar to what natural gas storages and gas power plants have done historically."¹⁵⁵

In summary, the policy document promotes energy storage technologies and the potential for sector integration, and introduces principles to ensure the successful commercialisation of energy storage in the electricity sector.¹⁵⁶ Although the EC included PtG under the concept of energy storage in the integrated sectoral review of the future EU energy system,¹⁵⁷ no clear classification of this conversion technology has been adopted in law.

4.4 EU Energy Law

Due to the fact that the usage of PtG in the energy sector is a relatively recent development, it is unsurprising that there is no hydrogen-specific law in place and that there is no clear classification of this

¹⁴⁹ European Commission, 'Communication: Launching the Public Consultation Process on a New Energy Market Design' COM(2015) 340 final.

¹⁵⁰ The European Commission emphasised that electricity should be stored when there is a surplus and prices are low and released when generation is scarce and prices are high.

¹⁵¹ European Commission Staff Working Document, 'Energy Storage – The Role of Electricity' SWD(2017) 61 final.

¹⁵² European Commission Staff Working Document, 'Energy Storage – The Role of Electricity' SWD(2017) 61 final, p. 7.

¹⁵³ European Commission Staff Working Document, 'Energy Storage – The Role of Electricity' SWD(2017) 61 final, p. 18.

¹⁵⁴ European Commission Staff Working Document, 'Energy Storage – The Role of Electricity' SWD(2017) 61 final, p. 12.

¹⁵⁵ European Commission Staff Working Document, 'Energy Storage – The Role of Electricity' SWD(2017) 61 final, p. 24.

¹⁵⁶ See further discussion in Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas, Store&Go*, Deliverable 7.2, 2017, p. 20-21.

¹⁵⁷ This is due to the fact that large amounts of variable RES can be stored in the form of gas (e.g. hydrogen), which can provide significant flexibility to the electricity system and decarbonise other sectors.

conversion activity in existing EU law. The existing legal instruments that are likely to shape this domain of EU law are assessed below.

It was not until the 1988 publication of 'Towards an Internal Energy Market' that special attention was given to the electricity and gas markets, which at the time were dominated by integrated monopolistic companies that combined production, transportation and supply within the same entity.¹⁵⁸ The need to regulate and liberalise the European electricity and gas markets eventually led to sector specific legislation in the internal energy market. The first Directives appeared 1996 (electricity)¹⁵⁹ and 1998 (gas).¹⁶⁰ In 2003, new Directives on the internal market for electricity and gas replaced these Directives.¹⁶¹ These Directives were accompanied by the 2003 Electricity Regulation¹⁶² and the 2005 Gas Regulation,¹⁶³ specifically focused on cross-border trade in electricity and gas. The 2003 Electricity and Gas Directives sought to complete the internal market in electricity and gas by increasing the freedom for consumers to choose their supplier, and by further unbundling network activities from energy production and supply activities.

As the 2003 legislation was considered inadequate to realise sufficiently liberalised, competitive and integrated internal electricity and gas markets, new legislation was again introduced 2009 in the 'Third Energy Package'.¹⁶⁴ The following pieces of legislation from the legislative package are of relevance to this report: the 2009 Electricity Directive,¹⁶⁵ the 2009 Electricity Regulation,¹⁶⁶ the 2009 Gas Directive,¹⁶⁷ the 2009 Gas Regulation¹⁶⁸ and the 2009 Renewable Energy Directive.¹⁶⁹ The Electricity and Gas Directives and Regulations all aimed at increasing competitiveness and market integration.¹⁷⁰ The directives established common rules for the generation, transmission and distribution of electricity and gas. Specific rules for cross-border trade in electricity and gas were included in their respective regulations. Furthermore, the Renewable Energy Directive laid down rules promoting the use of RES.

In late 2016, the EC proposed a new legislative package, the 'Clean Energy for All Europeans' package.¹⁷¹ This legislative package provides an update to facilitate the transition away from fossil fuels and towards

¹⁵⁸ European Commission, 'The Internal Energy Market' COM(88) 238 final.

¹⁵⁹ Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity, [1997] OJ L27/20.

¹⁶⁰ Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas, [1998] OJ L204/1.

¹⁶¹ Directive 2003/54/EC of the European Parliament and the Council of 26 June 2003 concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC, [2003] OJ L176/37; Directive 2003/55/EC of the European Parliament and the Council of 26 June 2003 concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC, [2003] OJ L176/57.

¹⁶² Regulation (EC) 1228/2003 of 26 June 2003 on conditions for access to the network for cross-border exchanges in electricity [2003] OJ L 176/1.

¹⁶³ Regulation (EC) 1775/2005 of 28 September 2005 on conditions for access to the natural gas transmission networks [2005] OJ L 289/1.

¹⁶⁴ Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., 'EU Energy Law' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 187-366.

¹⁶⁵ Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC [2009] OJ L 211/55.

¹⁶⁶ Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003 [2009] OJ L 211/15.

¹⁶⁷ Directive 2009/73/EC of the European Parliament and the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC [2009] OJ L211/94.

¹⁶⁸ Regulation (EC) 715/2009 of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) 1775/2005 [2009] OJ L 211/36.

¹⁶⁹ Directive 2009/28/EC of the European parliament and of the council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing directives 2001/77/EC and 2003/30/EC [2009] OJ L 140/16.

¹⁷⁰ Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., 'EU Energy Law' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 187-366.

¹⁷¹ European Commission, 'Clean Energy for all Europeans package', 2019 <<https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans>>

cleaner energy, and marks a significant step towards the implementation of the Energy Union Strategy.¹⁷² Of particular relevance to this report are the 2019 Electricity Directive,¹⁷³ which replaced the 2009 Electricity Directive; the 2019 Regulation on Electricity,¹⁷⁴ which replaced the 2009 Electricity Regulation; and the 2018 Renewable Energy Directive (RED),¹⁷⁵ which replaced the 2009 Renewable Energy Directive.

Furthermore, in 2019, amendments were made to the 2009 Gas Directive. These amendments came through the 2019 Gas Directive,¹⁷⁶ and had the goal of ensuring that “the rules governing the EU’s internal gas market apply to gas transmission lines between a member state and a third country”.¹⁷⁷ The new legislation, however, does not pertain to the development of PtG in the North Sea. As this new legislation only amended (and did not completely replace) the 2009 Gas Directive, both the 2009 Gas Directive and the 2009 Gas Regulation from the Third Energy Package remain applicable. The EC is expected to propose a new legislative package containing more widespread reforms for the gas sector in 2020.¹⁷⁸ As this is not yet final, this report does not engage in any further analysis on this subject matter.

As there is no EU law devoted solely to hydrogen, the pieces of legislation subject to analysis are those legislative acts adopted under the Clean Energy Package and the Third Energy Package. At present, the question is whether PtG is considered an electricity activity or a gas activity. Sections 4.4.1 and 4.4.2 therefore analyse the applicability of EU electricity and gas legislation, respectively, to *green and grey hydrogen*. Of particular importance are the 2019 Electricity Directive and the 2019 Electricity Regulation, which governs energy storage in the electricity system, and the 2009 Gas Directive and 2009 Gas Regulation, which govern the blending of hydrogen into the natural gas system. Moreover, due to the inclusion of renewable gases in the scope of the 2018 RED, Section 4.4.3 examines its applicability to *green hydrogen*.

4.4.1 EU Electricity Laws Governing Hydrogen

Energy storage in support of the electricity system was not an important issue during the adoption of the Third Energy Package in 2009, with the then adopted legal framework containing no references to such energy storage.¹⁷⁹ This changed following the introduction of the Clean Energy package. Due to the adoption of a definition of energy storage in the 2019 Electricity Directive,¹⁸⁰ PtG activities are likely to fall within the scope of the Electricity Directive. This section, therefore, focuses on the applicability of EU electricity law to green and grey hydrogen.

¹⁷² European Commission, ‘Clean Energy for all Europeans package’, 2019 <<https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans>>

¹⁷³ Directive (EU) 2019/944 of the European Parliament and the Council of 5 June 2019 concerning common rules for the internal market in electricity and repealing Directive 2012/27/EU, [2019] OJ L 158/125.

¹⁷⁴ Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity [2019] OJ L 158/54.

¹⁷⁵ Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources [2018] OJ L328/82.

¹⁷⁶ Directive (EU) 2019/692 of the European Parliament and of the Council of 17 April 2019 amending Directive 2009/73/EC concerning common rules for the internal market in natural gas [2019] OJ L 117/1.

¹⁷⁷ Council of the European Union, ‘Council adopts gas directive amendment: EU rules extended to pipelines to and from third countries’, press release 15 April 2019, available at <<https://www.consilium.europa.eu/en/press/press-releases/2019/04/15/council-adopts-gas-directive-amendment-eu-rules-extended-to-pipelines-to-and-from-third-countries/>>

¹⁷⁸ Olczak, M., Piebalgs, A., ‘What to Expect from the 2020 Gas Package’ (2019) vol. 7, issue 1, Politics and Governance, p. 165-169.

¹⁷⁹ *E contrario* the 2009 Electricity Directive.

¹⁸⁰ Article 2(59) of the 2019 Electricity Directive.

4.4.1.1 Application of the Electricity Directive

The subject matter of the Electricity Directive is provided in Article 1, which states that the “Directive establishes common rules for the generation, transmission, distribution, energy storage and supply of electricity”. ‘Energy storage’ is defined in Article 2(59) of the Electricity Directive:

“[...] in the electricity system, deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier”.

The definition therefore applies to any process through which electrical energy is converted into a ‘form of energy’ before subsequently being reconverted into electrical energy or used itself as an energy carrier. ‘Energy carrier’ (not itself defined in the Electricity Directive), is a technical term, usually understood as being a “substance or phenomena that can be used to produce mechanical work or heat, or to operate chemical or physical processes”.¹⁸¹ Electricity, natural gas and hydrogen may each be considered energy carriers under this definition.

The reference to ‘use’ within the definition of energy storage, however, is more troubling, and it is not immediately obvious what the legislator meant by ‘use’ in this context, *i.e.* does it only apply where another energy carrier is used for storage purposes, or does it also apply where the energy carrier is used to supply consumers?

Article 2(59) of the Electricity Directive refers only to the conversion of electrical energy into a form of energy that can be *stored*. The Directive therefore refers merely to the input of electricity, irrespective of the source used for the generation of the electricity used to produce the energy, which can be stored. Hence, the Directive applies to both green and grey hydrogen.¹⁸²

4.4.1.2 Classification of Power-to-Gas

Hydrogen is a good solution for long-term seasonal storage of electricity, as it can be stored in compressed gas tanks; cryogenic compressed liquid tanks; and underground in salt domes, caverns, and even depleted oil and gas fields.¹⁸³ Hydrogen storage facilities would either be located on-site (attached to the PtG facility), or would involve the transportation of hydrogen via pipelines to a storage facility.¹⁸⁴

The adoption of a broad definition of ‘energy storage’ in the Electricity Directive means that PtG is likely to be classified as an energy storage technology. Conceptually, PtG is capable of ticking each of the necessary boxes to be considered an energy storage technology, and a PtG facility an ‘energy storage facility’ (‘a facility where energy storage occurs’).¹⁸⁵ This interpretation of PtG as an energy storage technology is supported by communications and reports published by the EU institutions, various stakeholder papers and academic publications.¹⁸⁶ However, as set out in the previous subsection, while the definition of energy storage allows for electricity to be converted into hydrogen (an energy carrier and a ‘storable form of energy’), there is a lack of clarity regarding the purposes for which this energy may then be used. It is this lack of

¹⁸¹ International Organization for Standardization, ISO 16818:2008, ‘3.75 energy carrier’, available at <<https://www.iso.org/obp/ui/#iso:std:iso:16818:ed-1:v1:en>>

¹⁸² For a more comprehensive understanding see Section 2.2.1.

¹⁸³ Hydrogen Europe, ‘Hydrogen storage’, available at <<https://hydrogeneurope.eu/hydrogen-storage>>

¹⁸⁴ Roby, H., ‘Hydrogen Storage: A supplementary Dictionary of Renewable Energy and Sustainability’ (2013) Oxford University Press.

¹⁸⁵ Article 2(60) 2019 Electricity Directive

¹⁸⁶ Kreft, G., *European Legislative and Regulatory Framework on Power-to-Gas, Store&Go*, Deliverable 7.2, 2017, p. 26.

clarity that causes issues in ascertaining whether the term 'energy storage' can be applied to PtG facilities that do not seek to reconvert the energy carrier into electrical energy.

It is therefore necessary to consider the purpose for which the activity is carried out, as this may impact whether the Electricity Directive is applicable to such facilities (and to the storage of hydrogen). In instances where electricity is withdrawn from the electricity grid, converted into hydrogen, temporarily stored as hydrogen, reconverted into electricity, and then injected into the electricity grid, it is inarguable that the purpose of the activity is to provide a storage medium in the electricity system.¹⁸⁷ Therefore, it is justifiable to regard the PtG process (in this instance) as an electricity activity, falling entirely within the scope of the Electricity Directive.

However, as alluded to previously, classifying the PtG process as falling within the scope of the Electricity Directive when a PtG facility is directly connected to the natural gas network, or indirectly connected through a hydrogen storage facility connected to the natural gas network, is far more complex. Such PtG facilities are more likely to fall within the scope of EU gas law. This is further elaborated in Section 4.4.2.2, which analyses the applicability of EU gas law to PtG and hydrogen.

Generators of electricity may then be able to utilise PtG to remedy the intermittent production patterns of RES. Indeed, it is probable that electricity systems operators would like to operate electrolyzers in order to resolve imbalances or congestion in the electricity system.¹⁸⁸ This section therefore analyses the rules in the Electricity Directive on ownership and operation of storage facilities, and the tariffs applicable to such facilities.

4.4.1.3 Ownership and Operation of Storage Facilities

Article 2(60) of the Electricity Directive defines an energy storage facility as a facility where energy storage occurs in the electricity system. Energy storage is considered a commercial activity, and against this background, Recital 62 of the Electricity Directive prescribes that system operators should not own, develop, manage or operate such facilities. These restrictions are intended to eliminate the risk of discrimination, ensure fair access to energy storage services to all market participants, and to foster effective and efficient use of energy storage facilities beyond the operation of the distribution and transmission system.

Articles 36 and 54 of the Directive respectively provide the general rule that transmission and distribution system operators are not allowed to own, develop, manage or operate energy storage facilities.¹⁸⁹ Member States are however allowed to derogate from this general rule provided that the storage facility is a fully integrated network component,¹⁹⁰ and that the regulatory authority has granted its approval – or in situations where all of the following conditions are fulfilled:

- (i) following an open and transparent tender procedure, other market participants have not expressed their interest in owning or controlling a storage facility;

¹⁸⁷ For a more comprehensive understanding see Fleming, R., Kreeft, G., 'Power-to-Gas and Hydrogen for Energy Storage under EU Energy Law' in Roggenkamp, M., Banet, C. (ed.) *European Energy Law Report XIII* (Intersentia 2020), p. 111-114.

¹⁸⁸ European Commission, Directorate-General for Energy, *DG ENER Working Paper: The future role and challenges of Energy Storage*, p. 9, available at <https://ec.europa.eu/energy/sites/ener/files/energy_storage.pdf>

¹⁸⁹ See Section 4.4.2.3 on ownership and operation of gas storage facilities. The principle that transmission and distribution system operators are not allowed to own, manage or operate is the same.

¹⁹⁰ 'Fully integrated network components' means "network components that are integrated in the transmission or distribution system, including storage facilities, and that are used for the sole purpose of ensuring a secure and reliable operation of the transmission or distribution system, and not for balancing or congestion management" (Article 2(51) of the Electricity Directive).

- (ii) the deployment of a storage facility is *necessary* for a system operator to fulfil its obligations under the Electricity Directive for the efficient, reliable and secure operation of the system, and the facility is not used to buy or sell electricity in the electricity market, and;
- (iii) the national regulatory authority has assessed the necessity of a derogation while taking into account the first two paragraphs and has granted its approval.¹⁹¹

For the transmission level two additional criteria are prescribed:

- (iv) the regulatory authority has carried out an *ex ante* review of the applicability of a tendering procedure, and;
- (v) the decision to grant the derogation is notified to the EC and the Agency for the Cooperation of Energy Regulators (ACER), with relevant information presented regarding the request, and reasons for granting the derogation.¹⁹²

The possibility of derogating from the unbundling rule allows system operators to make use of the benefits associated with owning and operating storage facilities in the electricity system. Nevertheless, ownership of storage facilities by system operators is possible only in certain cases, and must follow a transparent market procedure in which regulatory approval is required, with other market parties uninterested in providing such storage services.¹⁹³ The outcome of any decision regarding the ownership of a storage facility by a system operator is therefore likely to depend on how lenient the national regulatory authorities (NRAs) interpret 'necessity', as referred to in point (ii). At the transmission level, this is at least monitored by the EC and ACER, which can develop guidelines in the future to ensure a homogenous implementation of the ownership regime on energy storage under the Electricity Directive.¹⁹⁴

Given that energy storage in the electricity system is a new concept, it is difficult to ascertain whether other market participants have an interest in owning or controlling such storage facilities. The rules on the ownership of energy storage facilities in the Electricity Directive therefore allow TSOs and DSOs to own and control hydrogen storage facilities, provided that there is a lack of interest from other market participants and it is necessary in order for them to fulfil their obligations under the Electricity Directive.

4.4.1.4 Double Charging of Network Tariffs for Energy Storage Facility Operators

Producers and customers connected to the transmission or distribution networks are required to pay charges for access to those networks (transportation service tariffs), as well as charges for obtaining a connection thereto (connection tariffs).¹⁹⁵ Likewise, operators of electricity storage facilities, which are connected to the transmission or distribution system, must pay tariffs as system users.¹⁹⁶ Under the current regulation, hydrogen storage facilities would therefore be treated both as final end-users (requiring the storage operators to pay tariffs when withdrawing electricity from the network) and as generation assets (requiring the storage operators to pay tariffs a second time when re-injecting electricity into the network).¹⁹⁷ Hydrogen storage facilities would therefore be subject to double charging.¹⁹⁸ The input of electricity as a feedstock in

¹⁹¹ Articles 36(2) and 54(2) of the Electricity Directive.

¹⁹² Article 54(3) of the Electricity Directive.

¹⁹³ See further Articles 34 and 56 of the Electricity Directive.

¹⁹⁴ Article 54(3) of the Electricity Directive.

¹⁹⁵ Article 18 of the Electricity Regulation.

¹⁹⁶ Article 18 of the Electricity Regulation. See also Recital 39 of the Electricity Regulation.

¹⁹⁷ This same principle would apply when storage operators withdraw electricity from the grid, store it in the form of hydrogen, and then inject the previously stored hydrogen into the natural gas network. See Article 13 of the Gas Regulation.

¹⁹⁸ Hydro pumped storage is also subject to double charges in some countries, see further Eurelectric, 'Europe Needs Hydro Pumped Storage: Five Recommendations, A Eurelectric Briefing Paper, 2012, available at <https://www3.eurelectric.org/media/27210/eurelectric_5_recomm-pumped_storage-final_draft_clean-for_upload-2012-160-0002-01-e.pdf>

the production of hydrogen through water electrolysis means that network tariffs are charged on top of the wholesale price of electricity, which in turn influences overall production costs. At the end of the supply chain, end-users would pay charges again for the previously-stored electricity or gas.

Although the EC adopted a network code on harmonised transmission tariff structure for gas in 2017, no similar network code has been adopted for electricity.¹⁹⁹ This network code prescribes that a 50% discount is awarded on capacity-based transmission tariffs at entry and exit points of gas storage facilities connected to the network of one transmission system, allowing for the avoidance of double charging for the transportation of gas to and from storage facilities.²⁰⁰ The elimination of double charging provides the type of financial incentive necessary to develop gas storage facilities. Furthermore, it can be argued that it reinforces the importance of the role of gas storage facilities in enhancing system flexibility and security of supply.

While the Electricity Regulation prescribes in Recital 39 that network tariffs “should not discriminate against energy storage”, it does not positively abolish double charging. This means that it is at the discretion of the Member States to abolish double charges, or to provide discounts to storage facilities in the electricity system. It was suggested in the proposal of the 2019 Electricity Regulation to allow the EC to adopt guidelines that would determine appropriate rules for the charges applied to energy storage.²⁰¹ However, this proposal was not incorporated in the Electricity Regulation. Rules regarding harmonised electricity transmission tariff structures were identified as a priority matter by the EC in 2015.²⁰² Following this, the EC formally asked ACER to prepare a guideline for a framework.²⁰³ Given that the EC has not yet adopted harmonised rules for tariffs applied to storage facilities in the electricity system, it is questionable whether the EC has any intention to prohibit the double charging of energy storage facilities, or whether it will continue to allow Member States to decide individually.

4.4.2 EU Gas Laws Governing Hydrogen

Hydrogen was a major component in ‘town gas’, which was used widely in a number of European cities before the discovery of the Groningen gas field and of North Sea gas in the 1960s.²⁰⁴ As a consequence, town gas (hydrogen) was substituted by natural gas, with today's gas infrastructure dedicated to the transport and supply of natural gas. Although dedicated hydrogen networks still exist, they mainly supply refineries.²⁰⁵

¹⁹⁹ Commission Regulation (EU) 2017/460 of 16 March 2017 establishing a network code on harmonised transmission tariff structures for gas [2017] OJ L 72/29.

²⁰⁰ Article 9 of the Network Code on Harmonised Transmission Tariff Structures for Gas.

²⁰¹ Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity [2019] OJ L 158/54.

²⁰² Agency for the Cooperation of Energy Regulators, ‘*Harmonised transmission tariff structures*’, 2019 <https://acer.europa.eu/en/Electricity/FG_and_network_codes/Pages/Harmonised-transmission-tariff-structures.aspx>

²⁰³ Pursuant to Article 8(6) of the Regulation (EC) 714/2009 of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) 1228/2003 [2009] OJ L 211/15 and following European Commission Decision 2014/713/EU on the establishment of the annual priority lists for the development of network codes and guidelines for [2014] OJ L 296/28; see further Agency for the Cooperation of Energy Regulators, ‘*Scoping towards potential harmonisation of electricity transmission tariff structures: conclusions and next steps*’, 2015, available at <https://acer.europa.eu/en/Electricity/FG_and_network_codes/Documents/Scoping%20conclusions%20for%20harmonised%20Transmission%20Tariff%20Structures%20in%20Electricity.pdf>

²⁰⁴ Ball, M., Weindort, W., Bünger, U., ‘Why Hydrogen?’ in Ball, M., Wietschel, M. (eds) *The Hydrogen Economy: Opportunities and Challenges* (Cambridge University Press 2009), p. 34.

²⁰⁵ HyLaw, ‘*Hydrogen transport and distribution*’, available at <<https://hydrogeneurope.eu/hydrogen-transport-distribution>>; see also CertifHy, ‘*Overview of the market segmentation for hydrogen across potential customer groups, based on key application areas*’, deliverable no. 1.2, 2015, p.3, available at <https://www.fch.europa.eu/sites/default/files/project_results_and_deliverables/D%201.2.%20Overview%20of%20the%20market%20segmentation%20for%20hydrogen%20across%20potential%20customer%20groups%20based%20on%20key%20application%20areas.pdf>

Hydrogen is once again a prominent topic in the debate on the future design of the energy sector, and the blending of hydrogen in natural gas networks and storage of hydrogen in gas storage facilities are discussed. Given the large expenses associated with the construction of new gas infrastructure, it is more cost-effective to re-use the existing natural gas infrastructure to transport and supply hydrogen, *i.e.* blending hydrogen in natural gas networks or repurposing natural gas networks for the transport and supply of hydrogen.²⁰⁶

As PtG is deemed to be a cross-energy vector technology functioning as a linkage between the electricity and gas sectors, it is of relevance to consider the extent to which EU gas legislation is applicable when the energy is no longer carried by electrons but by hydrogen molecules.²⁰⁷ Especially when one considers blending hydrogen into the natural gas system, as this falls under the scope of EU gas law. Similarly to natural gas, hydrogen is a gaseous energy carrier, which can be compressed and stored in gas tanks, and underground in salt domes, caverns, and depleted oil and gas fields.²⁰⁸ Against this background, this section explores the extent to which EU natural gas legislation applies to green and grey hydrogen.

4.4.2.1 Application of the Gas Directive

Article 1(1) of the Gas Directive establishes the scope of the Directive as providing common rules for the transmission, distribution, supply and storage of natural gas. The Directive lays down the rules relating to the organisation and functioning of the natural gas sector, access to the market and criteria applicable to the granting of authorisations of transmission, distribution, storage, and supply of natural gas.²⁰⁹ The Directive, however, contains no definition of PtG, nor does it contain any provisions specifically for hydrogen. Although the title and the scope of the Directive indicate that it applies to natural gas, Article 1(2) of the Directive establishes that the rules of the Directive “shall also apply in a non-discriminatory way to biogas and gas from biomass or other types of gas”. The inclusion of ‘other types of gas’ suggests that the Directive is also applicable to hydrogen. At the time of writing, there is no European Court of Justice jurisprudence determining what is to be understood with ‘other types of gas’, and the regime applicable to such gases. Given the lack of clarification of ‘other types of gas’, it is uncertain under what circumstances hydrogen is subject to the rules of the Gas Directive.

However, a continued reading of the provision clarifies that ‘other types of gas’ will be subject to the Directive if they can be “technically and safely injected into, and transported through, the natural gas system”.²¹⁰ In other words, “the technical and safety standards applicable to the injection and transportation of gas through the natural gas system, including gas quality standards, form the benchmark with which other gases need to comply.”²¹¹ Thus, if other gases are equivalent to that of natural gas, it can be argued that the rules of the Gas Directive applies to the injection into, and the transport through, the natural gas system. This means that the rules apply to the injection of hydrogen into the natural gas system, insofar as the legal standard for the maximum allowed volume of hydrogen is not exceeded.

Moreover, the Gas Directive does not refer to the technical and safe injection of other gases into natural gas *networks*, but into the natural gas *system* – therefore, it is crucial to assess whether the Gas Directive also applies to the storage of hydrogen. ‘System’ is defined in Article 2(13) of the Gas Directive as “any transmission networks, distribution networks, LNG facilities and/or storage facilities [...]”. Storage is thus part

²⁰⁶ Fuel Cells and Hydrogen Joint Undertaking (FCH 2 JU), Annual Work Plan and Budget, 2018, available at <https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/jtis/h2020-wp18-fch_en.pdf>

²⁰⁷ Fleming, R., Kreeft, G., ‘Power-to-Gas and Hydrogen for Energy Storage under EU Energy Law’ in Roggenkamp, M., Banet, C. (ed.) *European Energy Law Report XIII* (Intersentia 2020), p. 109.

²⁰⁸ Hydrogen Europe, ‘Hydrogen storage’, available at <<https://hydrogeneurope.eu/hydrogen-storage>>

²⁰⁹ Article 1(1) of the Gas Directive.

²¹⁰ Article 1(2) of the Gas Directive.

²¹¹ Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas, Store&Go*, Deliverable 7.2, 2017, p. 24.

of the system. It can be argued then that the Gas Directive applies where hydrogen is admixed into the natural gas system and then stored (as a blended gas) in natural gas storage facilities.

The Gas Directive makes no distinction for its application to different types of gases based on the production method or the sources used to produce the gas. It merely limits its application to gases that can be technically and safely injected into, and transported through, the natural gas system. This entails that where the rules of the Gas Directive apply to hydrogen, both green and grey hydrogen falls within its scope.

4.4.2.2 Classification of Power-to-Gas

The possibility that EU electricity law regulates PtG facilities and the storage of hydrogen has previously been considered in Section 4.4.1.2. However, as the analysis in that section demonstrates, this may only be the case when the purpose of PtG is to produce hydrogen as a storage medium in the electricity system. It therefore becomes complex when one considers the regulation of PtG facilities directly, or indirectly, connected to the natural gas system. If the purpose is to inject the produced hydrogen into, and transport it through, the natural gas system, it can be argued that EU gas law should apply to such facilities.

Although the title and the scope of the Gas Directive indicate that it applies to natural gas, Article 1(2) of the Directive establishes that the rules of the directive “shall also apply in a non-discriminatory way to biogas and gas from biomass or other types of gas”. The extraction of gas from natural reservoirs and the production of biogas through anaerobic digestion of biomass are considered gas production activities, and the Gas Directive governs the injection of these gases into the natural gas system. The question is therefore whether the decomposition of water molecules by electricity into hydrogen is classified as a gas production activity. The term ‘gas production’ is not defined under EU gas law. Instead, one must seek guidance in the general definition of ‘production’. The Oxford Dictionary defines ‘production’ as: “the action of making or manufacturing from components or raw materials, or the process of being manufactured”.²¹² Similarly, the Cambridge Dictionary defines ‘production’ as: “the process of making [...] something”.²¹³ Based on these definitions, one can consider the decomposition of water molecules (‘raw material’) through electrolysis (‘manufacturing’ or ‘making’ process) into hydrogen (‘product’) to be a ‘production’ activity.

Another crucial question is whether a hydrogen storage facility connected to the natural gas network can be classified as a gas storage facility under the Gas Directive. Article 2(9) of the Gas Directive defines a ‘gas storage facility’ as: “a facility used for the stocking of natural gas and owned and/or operated by a natural gas undertaking [...]”. As it is technically feasible and safe to inject hydrogen into salt caverns and depleted oil and gas fields one can argue that a hydrogen storage facility should be classified as a gas storage facility.²¹⁴ It is therefore crucial to establish which entities may own PtG facilities, and is thus able to carry out the activity under the Gas Directive. It must also be examined whether there is a certain authorisation procedure in place to construct and operate such facilities, and the circumstances under which hydrogen can be blended into the natural gas system.

²¹² See Oxford Dictionary, ‘Production’, available at <<https://www.lexico.com/en/definition/production>>

²¹³ See Cambridge Dictionary, ‘Production’, available at <<https://dictionary.cambridge.org/dictionary/learner-english/production>>

²¹⁴ For a more comprehensive understanding see Fleming, R., Fershee, J.P., ‘The ‘Hydrogen Economy’ in the United States and the European Union, Regulating Innovation to Combat Climate Change’ in Roggenkamp, M., Zillman, D., Paddock, L., Gordon, L., (eds.) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press 2018), p. 149.

4.4.2.3 Ownership and Operation of Power-to-Gas Facilities and Hydrogen Storage Facilities

The Gas Directive prescribes that ownership and operation of natural gas networks must be unbundled from production and supply activities.²¹⁵ Without effective separation of networks from activities of production and supply, there is a risk of discrimination not only in the operation of the network, but also in the incentives for vertically integrated undertakings to invest adequately in their networks.²¹⁶ With regard to the separation of gas transmission activities from production and supply activities, Article 9 of the Gas Directive provides that Member States can choose between three unbundling options: strict ownership unbundling,²¹⁷ independent system operator²¹⁸ and independent transmission system operator.²¹⁹ At the distribution level, there exist no prohibition of combined ownership/control by the same legal person over a production or supply undertaking and over a distribution system or system operator.²²⁰ However, where the distribution operator “is part of a vertically integrated undertaking, it shall be independent at least in terms of its legal form, organisation and decision making from other activities not relating to distribution [...]”.²²¹ Thus, where PtG is classified as a gas production activity, the unbundling rules of the Gas Directive prohibit transmission and distribution system operators to own and operate such facilities.

Furthermore, the Gas Directive imposes rules on ownership and operation of gas storage facilities. Article 15 of the Gas Directive requires storage system operators, which are part of a vertically integrated undertaking, to be legally and functionally unbundled from other activities not related to transmission, distribution, and storage. We can thus conclude that a fully ownership unbundled storage system operator (which is at the same time the owner of the storage facility) is compliant, irrespective of whether it is the same company as the fully ownership unbundled TSO or a separate one. However, when a PtG facility is classified as a gas production facility, a gas storage system operator is not allowed to operate such a facility.²²² If a gas undertaking would like to operate a PtG facility, it must therefore structure the operation of such a facility under different subsidiaries.

4.4.2.4 Authorisation Procedure

The Hydrocarbons Directive prescribes the conditions for granting authorisations for the production of hydrocarbons, such as natural gas.²²³ Given that hydrogen is not a hydrocarbon resource located in the subsoil, the Hydrocarbons Directive does not apply to the production of hydrogen.²²⁴ The Gas Directive provides limited guidance on the authorisation procedure for the production of gas, as the scope of the Directive is limited to the establishment of common rules for the transmission, distribution, supply and storage of natural gas.²²⁵

²¹⁵ Article 9 of the Gas Directive.

²¹⁶ Recital 6 of the Gas Directive.

²¹⁷ No supply or production company can own network companies, see further European Commission, ‘Market legislation’, available at <<https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation>>

²¹⁸ Energy supply companies may still formally own gas or electricity networks but must leave the entire operation of the network to a designated ISO, see further European Commission, ‘Market legislation’ <<https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation>>

²¹⁹ Energy supply companies may still own and operate gas or electricity networks but must do so through a subsidiary subject to strict rules to prevent interference from the supply and production divisions in the running of the network, see further European Commission, ‘Market legislation’ <<https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation>>

²²⁰ Recital 25 of the Gas Directive.

²²¹ Article 26 of the Gas Directive.

²²² Storage operators that are part of vertically integrated undertakings with transmission activities must be legally and organisationally unbundled from supply activities.

²²³ Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorisations for the prospecting, exploration and production of hydrocarbons [1994] OJ L 164/3.

²²⁴ Article 2 of the Hydrocarbons Directive.

²²⁵ Article 1(1) of the Gas Directive.

Nevertheless, Article 4 of the Gas Directive prescribes that “in circumstances where an authorisation (for example, licence, permission, concession, consent or approval) is required for the construction or operation of natural gas facilities, the Member States or any competent authority [...] shall grant authorisations to build and/or operate such facilities [...]”. This provision does not impose an obligation on the Member States to establish a specific authorisation procedure, but merely provides them with the discretion to choose whether they want to enforce such an authorisation procedure in addition to their national environmental, safety and spatial planning rules. If a Member State chooses to impose a specific authorisation procedure to construct and operate such facilities, it must ensure that objective and transparent criteria are set.²²⁶

The rules on authorisation procedure in the Gas Directive refer explicitly to the construction and operation of natural gas facilities, pipelines and associated equipment. The question is therefore whether Article 4 of the Gas Directive also applies to the construction and operation of PtG facilities producing hydrogen? Some have advocated for the extension of the authorisation procedure in the Gas Directive to include the construction and operation of biogas facilities.²²⁷ It can thus be argued that these rules should apply also to other comparable gas facilities, such as PtG facilities.

4.4.2.5 Blending of Hydrogen in the Natural Gas Networks

Article 1(2) of the Gas Directive acknowledges the possible injection into, and transportation of, other gases through the natural gas network – provided it is technically feasible and safe, and system integrity is guaranteed. The blending of hydrogen in the natural gas network is therefore a challenge, as hydrogen and natural gas have different physical and chemical properties, such as *inter alia* density, calorific value, and burning velocity.²²⁸ As such, the admixture of hydrogen impacts the integrity of the network and the functioning of end-use appliances connected to the network.²²⁹

Gas quality requirements are set under gas quality standards, which establish the maximum and minimum acceptable levels for individual parameters and components of gas.²³⁰ The gas parameters include descriptive properties, such as Wobbe Index (or Wobbe number); physical properties, such as density; compositional properties, such as methane content; and conceptual properties, such as odour.²³¹ Admixing hydrogen with natural gas changes the Wobbe Index of the gas – the most important indicator of gas interoperability used in the EU.²³² A Wobbe Index indicates the “ability to substitute one gaseous fuel for another in a combustion application without materially changing the operational performance of the application (its safety, emissions and efficiency)”.²³³

²²⁶ The non-discriminatory criteria and procedures for granting of authorisations must be made available to the public, see Article 4(2) and (3) of the Gas Directive.

²²⁷ Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I., ‘Introduction’ in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 39.

²²⁸ Altfeld, K., Pinchbeck, D., ‘Admissible Hydrogen Concentrations in Natural Gas Systems’, Gas for energy No. 3 (2013), *GERG study*, p. 36-47.

²²⁹ NaturalHY, ‘Using the Existing Natural Gas System for Hydrogen: preparing for the Hydrogen Economy by Using the Existing Natural Gas System as a Catalyst’, No. SES6/CT/2004/502661, 2009, p. 10.

²³⁰ Tempelman, D., ‘Harmonising Gas Quality: Obstacles and Challenges in an Internal Energy Market’ in Roggenkamp, M., Bjerneby, H. (eds.) *European Energy Law Report X* (Intersentia 2014), p. 88-89.

²³¹ Van Stiphout, M., ‘Gas Quality Standards in the European Union: the need to develop European gas quality standards to achieve market integration and a competitive gas appliance market’, DG Energy and Transport, European Commission, available at <<http://members.igu.org/html/wgc2009/papers/docs/wgcFinal00785.pdf>>

²³² Tempelman, D., ‘Harmonising Gas Quality: Obstacles and Challenges in an Internal Energy Market’ in Roggenkamp, M., Bjerneby, H. (eds.) *European Energy Law Report X* (Intersentia 2014), p. 88-89.

²³³ International Gas Union and BP, ‘Guidebook to Gas Interchangeability and Gas Quality’, 2011, p.13.

The national laws of EU Member States specify the Wobbe Index range applicable to the national gas networks, and it is the responsibility of the Member States to ensure that the necessary gas quality requirements are taken into account in the natural gas system.²³⁴ Thus, the Wobbe Index differs between Member States. The reason for heterogeneous gas quality standards in the EU is that Member States prescribed their own national gas quality standards. This was a natural result of production fields (which may each have their own gas quality level) or main sources of supplies often being used to determine the gas composition in a country, with national gas quality standards adjusted accordingly.²³⁵ Commonly, Member States that exclusively import gas or produce very little themselves have a wider range of Wobbe Index than Member States producing large quantities of gas themselves, as the former need to be more flexible to facilitate imports.²³⁶

Gas quality differs from one gas field to another. For example, gas from the Groningen field is of low-calorific value (L-gas), whilst most gas from the fields in the North Sea is of high-calorific value (H-gas).²³⁷ As a result of the liberalisation of the European gas market, trade in gas between Member States increased, resulting in gas flows between Member States with varying gas quality specifications. To ensure safe and secure delivery and use of gas between Member States, the EC issued a mandate to the European Committee for Standardisation (CEN) to draw up harmonised standards for gas quality in the EU.²³⁸

The EC mandated the CEN to develop an appropriate high calorific gas standard, specifying the characteristics and requirements for gases entering H-gas networks (M/400 Mandate).²³⁹ The purpose of the mandate was to develop standards that define “a minimum range for gas quality parameters for High calorific gas”.²⁴⁰ This harmonised EU standard instructs the CEN to aim for gas quality standards that are as broad as possible – featuring an extensive variation of gas quality – without causing reasonable costs to be incurred.²⁴¹ However, the EC explicitly excluded hydrogen from the scope of the work of the CEN under this Mandate, remarking that gas flows at that time did not contain any hydrogen. Therefore, it was concluded that the injection of hydrogen into the natural gas grids was not yet an issue for the gas market.²⁴² As of today, the M/400 Mandate contains an informative Annex referencing hydrogen, but it does not require the CEN to prescribe the admissible concentration of hydrogen admixture.²⁴³

In July 2015 and December 2016 respectively, the CEN issued two standards, thereby creating a EU-wide standard for gas quality in the transmission and distribution systems – ‘EN 16723-1’²⁴⁴ (under Mandate

²³⁴ Recital 41 of the Gas Directive, see further Tempelman, D.G., ‘Harmonising Gas Quality Standards: Obstacles and challenges in an internal market’ in Roggenkamp, M., Bjørneby, H., (eds) *European Energy Law Report X* (Cambridge 2014), p. 89.

²³⁵ Tempelman, D.G., ‘Harmonising Gas Quality Standards: Obstacles and challenges in an internal market’ in Roggenkamp, M., Bjørneby, H., (eds) *European Energy Law Report X* (Cambridge 2014), p. 88.

²³⁶ Tempelman, D.G., ‘Harmonising Gas Quality Standards: Obstacles and challenges in an internal market’ in Roggenkamp, M., Bjørneby, H., (eds) *European Energy Law Report X* (Cambridge 2014), p. 89.

²³⁷ Calorific value (CV) is a measure of heating power and is dependent upon the composition of the gas. It refers to the amount of energy released when a known volume of gas is completely combusted under specified conditions, see further National Grid, ‘*Calorific value (CV)*’, available at <<https://www.nationalgridgas.com/data-and-operations/calorific-value-cv>>

²³⁸ European Commission, ‘*Gas quality harmonisation*’, 2019, available at <<https://ec.europa.eu/energy/en/topics/markets-and-consumers/wholesale-market/gas-quality-harmonisation>>

²³⁹ Mandate M/400 EN from the European Commission to CEN for standardisation on the field of gas qualities, 16 January 2007, Brussels.

²⁴⁰ Mandate M/400 EN from the European Commission to CEN for standardisation on the field of gas qualities, 16 January 2007, Brussels, p. 2.

²⁴¹ Mandate M/400 EN from the European Commission to CEN for standardisation on the field of gas qualities, 16 January 2007, Brussels, p. 1.

²⁴² Mandate M/400 EN from the European Commission to CEN for standardisation on the field of gas qualities, 16 January 2007, Brussels, p. 7.

²⁴³ Annex 2 of the Mandate M/400 EN from the European Commission to CEN for standardisation on the field of gas qualities, 16 January 2007, Brussels.

²⁴⁴ European Committee for Standardization, Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 1: Specifications for biomethane for injection in the natural gas network, 2016, EN 16723-1.

M/400) and 'EN 16726'²⁴⁵ (under Mandate M/475). Neither of these standards included hydrogen within their scope – something attributable to the exclusion of hydrogen from the scope of each overarching mandate. As such, on the question of hydrogen-admixture, the CEN stated only that: “it is not possible to specify a limiting value which would generally be valid for all parts of the European gas infrastructure”.²⁴⁶ Nevertheless, Annex E of standard 'EN16726' establishes that the study of the European Gas Research Group “show[s] that an admixture of up to 10% by volume of hydrogen to natural gas is possible in some parts of the natural gas system”.²⁴⁷ Furthermore, the EC suggests in an internal working document from 2017 that hydrogen could be blended in the natural gas system up to a certain percentage, between 5vol% and 20vol%, as demonstrated by the EC's research project NaturalHy.²⁴⁸

While the business plan of CEN/TC 234²⁴⁹ – the technical body behind EN 16726 – failed to explicitly mention hydrogen, there are indications that there may be more certainty regarding hydrogen injection in the near future:

“CEN/TC 234 aims at elaborating and maintaining the complete and coherent suite of functional standards for the gas sector. It covers all parts of the gas infrastructure system from the input of gas to the transmission system up to the inlet connection of the gas appliances, whether for domestic, commercial or industrial purposes. This includes transmission, distribution, storage, compression, regulation and metering, installation, injection of non-conventional gases, gas quality issues and others.”²⁵⁰

Decision 03/2016, taken by CEN/TC 234 in Paris, confirmed the ‘clear intention’ of the technical committee “to define the appropriate requirements for H₂NG (Hydrogen into natural gas) related to gas quality”.²⁵¹ The commitment of the technical committee to achieve this goal may be evidenced by the explicit reference to CEN/TC 234's work on this issue in the *CEN-CENELEC Work Programme 2020*. In the work programme, CEN-CENELEC confirmed that Committee CEN/TC 234 “will progress on the development of a Technical Report that will investigate the consequences of hydrogen in the natural gas infrastructure (as well as a standardisation roadmap for TC 234)”.²⁵²).²⁵³ If CEN/TC 234 is able to deliver on their aims, the work programme/portfolio may be amended and, as such, provide a concentration level of hydrogen blend in the natural gas system.

The admixture of hydrogen into the natural gas system also affects end-appliances connected to the network. As L-gas and H-gas are not interchangeable, transport must take place in separate networks, with end-appliances adapted to the allowable calorific value of the network.²⁵⁴ The condition determining a maximum hydrogen blend level – which does not pose risks to the safe operation of end-appliances – varies significantly, and depends on the composition of the natural gas, the type of appliance and the age of the appliance.²⁵⁵ The acceptable ranges of hydrogen-admixture for end-use appliances noted as being

²⁴⁵ European Committee for Standardization, Gas Infrastructure – Quality of Gas – Group H, 2015, EN 16726:2015. 

²⁴⁶ European Committee for Standardization, Gas Infrastructure – Quality of Gas – Group H, 2015, EN 16726:2015, p. 4.

²⁴⁷ Annex E of the European Committee for Standardization, Gas Infrastructure – Quality of Gas – Group H, 2015, EN 16726:2015.

²⁴⁸ European Commission Staff Working Document, 'Energy Storage – The Role of Electricity' SWD(2017) 61 final, p. 20.

²⁴⁹ European Committee for Standardization, CEN/TC 234 Business Plan Gas Infrastructure, 7 August 2014, available at <<https://standards.cen.eu/BP/6215.pdf>>

²⁵⁰ European Committee for Standardization, CEN/TC 234 Business Plan Gas Infrastructure, 7 August 2014, p. 6, available at <<https://standards.cen.eu/BP/6215.pdf>>

²⁵¹ Decision 03/2016 taken by CEN/TC 234 on 19-20 of April 2016 in Paris, CEN/TC 234 approach Hydrogen into natural gas, available via SFEM WG Hydrogen at <https://ec.europa.eu/jrc/sites/jrcsh/files/CEN_TC%20234%20for%20SFEM%20WG%20H2%202016-05-04.pdf>

²⁵² European Committee for Standardization and European Committee for Electrotechnical Standardization, 'Work Programme 2020', p. 35, available at <https://www.cenelec.eu/News/Publications/Publications/CEN-CENELEC_WP_2020_EN.pdf>

²⁵³ European Committee for Standardization and European Committee for Electrotechnical Standardization, 'Work Programme 2020', p. 35, available at <https://www.cenelec.eu/News/Publications/Publications/CEN-CENELEC_WP_2020_EN.pdf>

²⁵⁴ National Grid, 'Calorific value (CV)' <<https://www.nationalgridgas.com/data-and-operations/calorific-value-cv>>

²⁵⁵ Fleming, R., 'Regulating Power-to-Gas in the Energy Union' (2019) OGEL, p. 8-9.

acceptable generally falls within the 5vol%–20vol% range.²⁵⁶ In 2019, the EC submitted a standardisation request to CEN and CENELEC. It is a joint commitment of the EC and the industry to provide the appropriate and aligned standards for hydrogen deployment.²⁵⁷

The compliance with the standards analysed above is voluntary, with each standard merely constituting recommendations for Member States.²⁵⁸ An attempt to make these standards legally binding was unsuccessful due to a lack of public support during the consultations at the 29th Madrid Forum.²⁵⁹ As such, the injection of hydrogen into the natural gas network requires assurances on a case-by-case basis that the Wobbe Index of the blending mixture does not contravene the safety margins of the relevant natural gas network. Although some Member States in the EU allow for hydrogen-admixture in their natural gas networks, the percentage considered technically feasible and safe varies considerably.²⁶⁰ This is clearly an obstacle to the creation of the internal gas market, and it would be beneficial to adopt unified standards or at least provide guidelines on whether Article 1(2) of the Gas Directive in fact applies to the injection of hydrogen into natural gas networks. One alternative to circumvent the legal uncertainties concerning the applicability of the Gas Directive would be to upgrade hydrogen to SNG and feed it directly into the natural gas network.²⁶¹

4.4.2.6 Non-discriminatory Access to Transmission and Distribution Systems and Storage Facilities

The rules on technical and safe injection of gas into the natural gas system can relate either to ‘access’ or ‘connection’ to the system.²⁶² In the *Sabatauskas* case, the European Court of Justice established the difference between the terms ‘access’ and ‘connection’.²⁶³ Whereas the former is linked to the actual supply, the latter is referred to in technical terms as the actual physical connection to the network.²⁶⁴ The difference between these terms is of importance; as the right to access the natural gas network, does not mean that one also have the right to be connected to the network. This section focuses on access to the natural gas system, *i.e.* access to transmission and distribution systems,²⁶⁵ and to gas storage facilities.²⁶⁶ The main principle laid down in the Gas Directive is that system operators are prohibited from discriminating between persons who wish to inject gas into the natural gas system.²⁶⁷

With regard to the transmission and distribution system, it is the responsibility of Member States to ensure that all system users are awarded an equal access to such infrastructure.²⁶⁸ This is referred to as the TPA regime. Member States must ensure that access tariffs, or the methodology underlying their calculation, are

²⁵⁶ Melaina, M.W., Antonnia, O., Penev, M., ‘*Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues*’, National Renewable Energy Laboratory Prepared under Task No. HT12.2010, 2013, p. vii.

²⁵⁷ For a more comprehensive understanding see de Jong, F., Schülken, H., ‘*Towards a roadmap for hydrogen standardisation*’, CEN, Madrid Forum 2019-10-24, available at <https://ec.europa.eu/info/sites/info/files/02.c.04_mf33_presentation_-_cen_-_towards_h2_standardisation_-_schulken_dejong.pdf>

²⁵⁸ See further European Commission, ‘*Standardisation policy*’, available at <https://ec.europa.eu/growth/single-market/european-standards/policy_en>

²⁵⁹ Conclusion of the 29th of the Madrid Forum, 6-7 of October 2016, available at <<https://ec.europa.eu/energy/en/topics/markets-and-consumers/wholesale-market/gas-network-codes/madrid-forum-meetings>>

²⁶⁰ Fleming, R., Fershee, J.P., ‘The ‘Hydrogen Economy’ in the United States and the European Union, Regulating Innovation to Combat Climate Change’ in Roggenkamp, M., Zillman, D., Paddock, L., Gordon, L., (eds) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* (Oxford University Press 2018), p. 149.

²⁶¹ The methanation of hydrogen is an additional and optional step in a PtG facility. The chemical process is rather straightforward: hydrogen and CO₂ synthesise to methane, either by a chemically or biologically catalysed reaction.

²⁶² See Articles 8 and 32 of the Gas Directive.

²⁶³ *Julius Sabatauskas and Others* (Case C-239/07) [2007] ECR, II-7523.

²⁶⁴ *Julius Sabatauskas and Others* (Case C-239/07) [2007] ECR, II-7523, para 40, 41.

²⁶⁵ Article 32 of the Gas Directive.

²⁶⁶ Article 33 of the Gas Directive.

²⁶⁷ Article 1(2) of the Gas Directive.

²⁶⁸ Article 32 of the Gas Directive.

approved by the NRA.²⁶⁹ The Directive establishes that tariffs must be objective, non-discriminatory and cost-reflective.²⁷⁰ Further requirements, on access tariffs, were adopted in the Regulation on Gas, which requires tariffs for access to be transparent, taking network security into consideration and reflecting actual costs incurred.²⁷¹ Member States must thus ensure the implementation of a regulated TPA to the transmission and distribution system based on published tariffs applicable to all eligible customers, including gas supply undertakings, and applied objectively and without discrimination between system users. Nonetheless, the Gas Directive makes it possible to treat different groups of network users differently, provided network users within a group are treated equally.²⁷² System operators can therefore discriminate between classes of system users, as long as such discriminatory treatment is based on objective criteria. Such objective criteria can be found in the technical safety criteria, which are aimed at ensuring the integrity of the gas system, including gas quality standards.²⁷³

Article 33 of the Gas Directive is the core provision as far as the regulatory framework for operating gas storage facilities is concerned. It establishes the right of access to gas storage facilities “when technically and/or economically necessary [...] for the supply of customers”, while leaving it to the Member States to determine whether a negotiated or regulated access regime should be implemented.²⁷⁴ Whether Member States choose either or both of these procedures, they must ensure that those procedures operate in accordance with objective, transparent and non-discriminatory criteria.²⁷⁵ It should be noted that the definition of ‘storage facility’, as provided in Article 2(9) of the Gas Directive, restricts the scope of the application of the Directive’s provisions on access to storage facilities. This concerns storage facilities that are exclusively reserved for TSOs to carry out their functions²⁷⁶ and the portion of storage facilities used for production operations.²⁷⁷ In the case of regulated access, Member States (or the NRAs where Member States have provided so) must take necessary measures to give natural gas undertakings and eligible customers the right to access gas storage facilities on the basis of published tariffs and/or terms and obligations for the use such storage.²⁷⁸ The NRAs are responsible to monitor and review the access conditions.²⁷⁹ In the case of negotiated access, Member States (or the NRAs where Member States have provided so) must take necessary measures for natural gas undertakings and eligible customers to be able to negotiate access to gas storage facilities.²⁸⁰ The NRAs do not have the power to review the tariffs for such storage.²⁸¹ They are however required to ensure compliance with the general principle of non-discrimination, including as regards tariff setting. This derives *inter alia* from Article 15 of the Gas Regulation, according to which the same service must be offered to different customers under equivalent terms and conditions.²⁸²

²⁶⁹ Article 32 of the Gas Directive in conjunction with Article 41(1) and 41(6) of the Gas Directive.

²⁷⁰ Article 32 of the Gas Directive; see also Recital 31 of the Gas Directive.

²⁷¹ Article 13 of the Gas Regulation.

²⁷² Kruimer, H., ‘The Non-Discrimination Obligation of Energy Network Operators: European Rules and Regulatory Practice’ (2014) Energy Law Series 15, p. 4.

²⁷³ See Section 4.4.2.5.

²⁷⁴ Article 33(1) of the Gas Directive. See also Article 33(3) and (4) of the Gas Directive.

²⁷⁵ Article 33(1) of the Gas Directive.

²⁷⁶ See Article 2(9) of the Gas Directive. The operation of the transmission system, which is listed as one of the functions of the TSOs in Article 2(4) of the Gas Directive, can reasonably involve the use of storage.

²⁷⁷ See Article 2(9) of the Gas Directive. The Directive excludes from the definition those (portions of) storages that serve a function as part of production operations. Producers may need to resort to portions of storages for their exclusive use in order to smooth production swings. For a more comprehensive understanding see Commission Staff Working Paper, Interpretative note on Directive 2009/73/EC concerning common rules for the internal market in natural gas, ‘Third party access to storage facilities’, 2009, available at <https://ec.europa.eu/energy/sites/ener/files/documents/2010_01_21_third-party_access_to_storage_facilities.pdf>

²⁷⁸ Article 33(4) of the Gas Directive.

²⁷⁹ Article 41(1)(n) of the Gas Directive.

²⁸⁰ Article 33(3) of the Gas Directive.

²⁸¹ Article 41(1)(n) of the Gas Directive.

²⁸² With respect to transparency requirements, only Article 33(4) of the Gas Directive expressly requires tariffs to be published. Nonetheless, in the case of negotiated TPA, the obligation to publish “main commercial conditions” pursuant to Article 33(3) of the Gas Directive includes at least the publication of prices for standard services. For a more comprehensive understanding see Commission Staff Working Paper, Interpretative note on Directive 2009/73/EC concerning common rules for the internal market in natural gas, ‘Third

To conclude, when one seeks access to natural gas networks or gas storage facilities, it may be done so only on the condition that technical and safety rules are complied with. This is explicitly stipulated in Recital 41 of the Gas Directive:

“Member States should ensure that, taking into account the necessary quality requirements, [...] other types of gas are granted non-discriminatory access to the gas system, provided such access is permanently compatible with the relevant technical rules and safety standards”.

Natural gas undertakings and eligible customers must therefore adhere to gas quality standards in order to be granted non-discriminatory access to the natural gas system.

4.4.2.7 Access to Upstream Pipelines

The North Sea Energy Project proposes to produce hydrogen on offshore hydrocarbon platforms and islands,²⁸³ and transport it via the existing natural gas pipelines to the transmission network onshore. This report focuses on the production of hydrogen on existing hydrocarbon platforms. The Hydrocarbons Directive, which regulates the exploration and exploitation of oil and gas, does not govern pipelines bringing gas from production facilities to shore.²⁸⁴ Such pipelines fall within the scope of the Gas Directive and are referred to as ‘upstream pipelines’.²⁸⁵ Article 2(2) of the Gas Directive defines an ‘upstream pipeline network’ as: “any pipeline or network of pipelines operated and/or constructed as part of an oil or gas production project, or used to convey natural gas from one or more such projects to a processing plant or terminal or final coastal landing terminal”.

The origin and ownership structure of these pipelines differs from the transmission and distribution networks.²⁸⁶ These pipelines are usually owned and operated by oil and gas companies, and the regulatory regime is different. Contrary to transmission and distribution pipelines, upstream pipelines are not subject to a regime of regulated TPA. The Gas Directive merely prescribes that Member States must take the necessary measures to ensure that third parties are able to obtain access to upstream pipelines.²⁸⁷ In order to obtain access, third parties must negotiate with the owner of the pipeline and such negotiations are not based on indicative tariffs.²⁸⁸

To guarantee open and fair access to upstream pipelines Member States must prohibit any abuse of dominant market position, taking into account regularity of supplies, the extent to which capacity can reasonably be made available, and the need for environmental protection.²⁸⁹ The right for the owner of the upstream pipeline to refuse access include, but is not limited to, incompatibility of technical specifications, difficulties affecting the efficient, current and planned future production of gas, and the duly substantiated

party access to storage facilities’, 2009, available at <https://ec.europa.eu/energy/sites/ener/files/documents/2010_01_21_third-party_access_to_storage_facilities.pdf>

²⁸³ For a more comprehensive understanding of hydrogen production on a sand-based offshore energy island see Pernot, E., Roggenkamp, M., *Legal assessment of the development of a sand-based offshore energy island*, North Sea Energy, Appendix Report, Deliverable D.3.8, 2020.

²⁸⁴ Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorizations for the prospecting, exploration and production of hydrocarbons [1994] OJ L 164/3.

²⁸⁵ Article 2 of the Gas Directive.

²⁸⁶ Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., ‘EU Energy Law’ in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 292.

²⁸⁷ Article 34(1) of the Gas Directive.

²⁸⁸ Article 34(2) of the Gas Directive.

²⁸⁹ Article 34(2) of the Gas Directive.

reasonable needs of the owner or operator of the upstream pipeline for the transport and processing of gas.²⁹⁰

The abovementioned rights for the owners of upstream pipelines to refuse access to their pipelines, suggests that EU legislators consider upstream pipelines as essential facilities.²⁹¹ An evaluation of the character of a facility (essential vs. non-essential), and of whether the owner ought to provide access to its competitors, was made by the European Court of Justice in *Bronner*.²⁹² For a facility to be considered essential (indicating that the facility owner holds a dominant position) it must be indispensable – “a facility or infrastructure without which the [owner’s] competitors are unable to offer the services to customers”.²⁹³ To be considered an abuse of dominant position, it must be established that the refusal to provide access is likely to eliminate all competition.²⁹⁴ The decision is based on Article 102 of the TFEU on abuse of dominant position. The Court established that refusal to grant access to an essential facility by a dominant undertaking may only be justified by objective reasons, such as a lack of capacity and legitimate business reasons.²⁹⁵

The fact that third parties must be able to negotiate access to upstream pipelines has remained unchanged since 1998, and entails the *ex post* control of the conditions for access and the tariffs.²⁹⁶ For this reason, the Directive also prescribes that Member States need to have in place a dispute settlement arrangement in conjunction with an independent authority, which may expeditiously settle any disputes concerning access to upstream pipelines.²⁹⁷ Regardless of the different access regimes for upstream pipelines and downstream pipelines, the former are connected to the onshore transportation network, and account must therefore also be taken to the gas quality standards applying to the onshore network. Pursuant to the Gas Directive, all gas fed into the onshore gas transport network must adhere to certain quality standards.²⁹⁸

4.4.3 EU Law Promoting Green Hydrogen

Member States must collectively ensure that the share of energy from renewable sources in the Union’s gross final consumption of energy in 2030 is at least 32%.²⁹⁹ In order to promote the use of energy from renewable sources, the Directive contains rules on *inter alia* financial support, guarantees of origin and integration of gas from renewable sources. Considering that green hydrogen is produced from renewable sources, it is relevant to examine some of the tools and mechanisms in the RED to achieve a higher share of RES, as this could also support an accelerating deployment of green hydrogen in the energy sector.

²⁹⁰ Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., ‘EU Energy Law’ in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 293; See further Article 34 of the Gas Directive.

²⁹¹ Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., ‘EU Energy Law’ in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 293.

²⁹² *Bronner v Mediaprint Zeitungs- und Zeitschriftenverlag GmbH* (Case C-7/97) [1998] ECR I-7791.

²⁹³ European Commission Decision 94/119/EC concerning a refusal to grant access to the facilities of the Port of Rødby (Denmark) [1994] OJ L55/52; Evrard, S.J., ‘Essential Facilities in the European Union’ (2004) *European Law* 10, p. 8.

²⁹⁴ Evrard, S.J., ‘Essential Facilities in the European Union’ (2004) *European Law* 10, p. 17.

²⁹⁵ *Bronner* (Case C-7/97) [1998] ECR I-7791, para. 41.

²⁹⁶ See further Roggenkamp, M., Vedder, H., Rønne, A., Del Guayo, I., ‘EU Energy Law’ in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 293.

²⁹⁷ Article 34(3) of the Gas Directive.

²⁹⁸ Article 1(2) and Recital 41 of the Gas Directive; see further Section 4.4.2.5.

²⁹⁹ Article 3(1) of the RED.

4.4.3.1 Application of the Renewable Energy Directive

The RED establishes a common framework for the promotion of energy from renewable sources.³⁰⁰ Article 2(1) of the RED defines energy from renewable sources as “non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas.” Green hydrogen is derived from wind, solar, hydropower, biomass or biogas, and therefore falls under that definition. The inclusion of green hydrogen, into the scope of the RED, is explicitly recognised in Recital 59, which states that hydrogen is considered a renewable gas. Furthermore, green hydrogen is also considered for the purpose of calculating the share of gross final consumption of energy from renewable sources.³⁰¹

4.4.3.2 Financial Support

Costs from commercially available renewable energy production technologies have declined in recent years. Technologies such as onshore wind and solar PV power are now frequently less expensive than any fossil fuel option, without financial support.³⁰² On the other hand, the cost of producing energy from renewable sources with relatively new technology, such as PtG, is generally higher than the cost of producing energy from fossil fuels.³⁰³ Investors may therefore be unwilling to invest in such renewable energy technologies, as there is no guarantee to that the investment will be recouped through energy sales alone.³⁰⁴

It is recognised by the EU that external financial support for renewable energy development is necessary in order to realise a higher share of energy from lower carbon sources.³⁰⁵ Accordingly, Member States of the EU have attempted to overcome the lack of cost competitiveness for renewable energy with fossil fuels. The RED recognises that a financial framework facilitating investments in renewable energy projects is necessary in order to support Member States' ambitious contributions to the Union-wide target on the use of RES. Article 4 of the RED establishes that Member States may apply support schemes to reach or exceed the Union target of energy from renewable sources in the gross final consumption.³⁰⁶ The definition of 'support schemes' is provided in Article 2(5):

“[...] any instrument, scheme or mechanism applied by a Member State, or a group of Member States, that promotes the use of energy from renewable sources by reducing the cost of that energy, increasing the price at which it can be sold, or increasing, by means of a renewable energy obligation or otherwise, the volume of such energy purchased, including but not restricted to, investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct price support schemes including feed-in tariffs and sliding or fixed premium payments”

If (or when) Member States decide to implement a system to support PtG technology, and the integration of green hydrogen in the energy sector, such support should be provided in a form that does not overtly distort the functioning of the internal energy market. While Recital 20 of the RED emphasises the importance of providing sufficient support to integrate ever-increasing levels of variable renewable energy, Member States

³⁰⁰ Article 1 of the RED.

³⁰¹ Article 7(1) of the RED.

³⁰² IRENA, 'Renewable Power Generation Costs in 2018', report by International Renewable Energy Agency, 2019, available at <https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf>

³⁰³ This is in part due to subsidies for fossil fuels and the failure to take into account the external effects on health and the environment in pricing of fossil fuels, see further Ottinger, R.L., Matthews, L., Czachor, 'Renewable Energy in National Legislation: Challenges and Opportunities' in Zillman, D.N., et al (eds) *Beyond the Carbon Economy* (Oxford University Press 2008) p. 186-188.

³⁰⁴ European Commission, European Commission guidance for the design of renewable support schemes – Accompanying the document Communication from the Commission: Delivering the internal market in electricity and making the most of public intervention, SWD(2013) 439 final, p. 3.

³⁰⁵ Recital 16 of the RED.

³⁰⁶ Article 3 of the RED.

must ensure that such systems are compatible with EU state aid rules set forth in Article 107 of the TFEU.³⁰⁷ The EC assists Member States in designing measures that do not contravene constraints on state aid. It does this by producing guidelines indicating the types of measures that are likely to be regarded as compatible with the internal energy market. These guidelines are not legally binding, but ultimately they have strong influence on the form of Member States' support schemes in view of the EC's role in approving their compatibility with state aid rules.³⁰⁸ Guidelines on state aid, in the field of energy and environment, took effect in 2014.³⁰⁹ These guidelines provide no specific conditions for support schemes for PtG technology. Nonetheless, some conditions could apply analogously and serve as a benchmark for Member States when evaluating national support schemes for PtG, e.g. aid per unit of energy.³¹⁰

4.4.3.3 Guarantees of Origin

Guarantees of origin are used to confirm that a given share or quantity of energy was produced from renewable sources.³¹¹ Their role under the RED is thus to support the establishment of a 'green' energy market.³¹² It is important to distinguish between green certificates used for support schemes and guarantees of origin, as the possibility of benefitting from national support schemes cannot be derived from the latter.³¹³

Member States must ensure that the origin of energy from renewable sources can be guaranteed in accordance with objective, transparent and non-discriminatory criteria.³¹⁴ To that end, Member States must ensure that a guarantee of origin is issued in response to a request from a producer of energy from renewable sources.³¹⁵ The sub clauses of Article 19 of the RED provide guidance on the administrative arrangements, which should be put in place to enable the issuance and cancellation of guarantees of origin and the information that they should contain. Time limits and other criteria for the validity of guarantees of origin are also specified, as this helps prevent the misuse and the double counting of certificates for RES.

Recital 59, in conjunction with Article 19 of the RED, extends the scope of the RED to hydrogen, as guarantees of origin shall be issued for renewable gases. Article 19(7)(b)(ii) stipulates that a guarantee of origin shall specify whether it relates to gas, including hydrogen. Under the previous Directive, each Member State had to be able to guarantee the origin of electricity, but in the new RED, 'electricity' has been exchanged for 'energy', which further confirms that green hydrogen is included.

Although this is a positive development for green hydrogen, the RED does not provide further clarification on how guarantees of origin interact when one form of energy is converted into another, *i.e.* when electricity generated from renewable sources is converted into green hydrogen. To avoid double counting the CertifHy Consortium³¹⁶ – developing the first EU-wide guarantee of origin scheme for green hydrogen and low-carbon hydrogen – specifies in its core principles that no more than one CertifHy guarantee of origin “[...] or any

³⁰⁷ Article 107(1) of the TFEU stipulates that any aid granted by a Member States or through state resources in any form that distorts, or is likely to distort, competition by favouring certain undertakings or production of certain goods (if it affects trade between Member States) is incompatible with the internal market.

³⁰⁸ Article 107 of the TFEU.

³⁰⁹ European Commission, Guidelines and State aid for environmental protection and energy 2014-2020, 2014/C, OJ C200/01.

³¹⁰ For a more comprehensive understanding see Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas*, Store&Go, Deliverable 7.2, 2017, p. 61.

³¹¹ Article 19 of the RED.

³¹² Recital 55 of the RED.

³¹³ Recital 55 of the RED.

³¹⁴ Article 19(1) of the RED.

³¹⁵ Article 19(2) of the RED.

³¹⁶ See further Fuel Cells and Hydrogen Joint Undertaking (FCH), CertifHy – Designing the first EU-wide green hydrogen guarantee of origin for a new hydrogen market, available at <<https://www.fch.europa.eu/page/certifhy-designing-first-eu-wide-green-hydrogen-guarantee-origin-new-hydrogen-market>>

other transferrable certificate with a purpose of disclosure of sustainability attributes shall be issued and subsequently cancelled in respect of the same unit of output”.³¹⁷ Nevertheless, it would be helpful if the EU harmonise the systems for guarantees of origin providing guidelines on the interaction referred to above. Another issue requiring attention is the time of validity for guarantees of origin. Article 19(3) of the RED states that “guarantees of origin shall be valid for 12 months after the production of the relevant energy unit”, which could potentially affect seasonal storage, such as hydrogen storage.

4.4.3.4 Integration of Gas from Renewable Sources

Successful integration of PtG in the energy sector requires the necessary infrastructure to accommodate the transportation of hydrogen from PtG facilities to its end-use. In accordance with Article 20 of the RED, Member States must assess, where relevant, “the need to extend existing gas network infrastructure to facilitate the integration of gas from renewable sources”. As green hydrogen is a gas produced from renewable sources, Member States must evaluate the need to expand their current gas transportation network to ensure its integration. To further facilitate the integration of gas from renewable sources into the gas grid,³¹⁸ Article 20(2) requires TSOs and DSOs to publish technical rules pursuant to Article 8 of the Gas Directive, in particular regarding network connection rules, including gas quality and gas pressure requirements. System operators are required to publish connection tariffs to connect gas from renewable sources based on objective, transparent and non-discriminatory criteria.³¹⁹

4.5 EU Climate, Environmental and Safety Laws Governing Hydrogen

Hydrogen activities are subject to a significant number of requirements at the EU level. Despite being transposed into national laws, the source of most of these requirements can be directly traced to EU Directives. There are several EU Directives, which are particularly relevant when one examines the requirements applicable to hydrogen activities.³²⁰ These are: the Emissions Trading Directive,³²¹ the Industrial Emissions Directive,³²² the Environmental Impact Assessment Directive,³²³ and the SEVESO Directive.³²⁴ These Directives aim to prevent or limit the adverse effects of certain activities on the climate, environment and human health by imposing general obligations on developers and operators of such activities.

Hydrogen is explicitly included within the scope of each Directive. However, an analysis of these particular Directives will make clear that none of these Directives explicitly distinguish between green and grey hydrogen. In theory, this means that these Directives regulate hydrogen, regardless of the production method or sources used for its production. Hence, the following Sections look at the permitting and safety requirements, and requirements in terms of environmental and risk assessment, applicable to both green and grey hydrogen.

³¹⁷ CertifHy, *CertifHy Scheme*, 2019, p. 5, available at

<https://www.certifhy.eu/images/media/files/CertifHy_2_deliverables/CertifHy_Scheme-Documents_V1-0_2019-03-11_endorsed.pdf>

³¹⁸ Recital 60 of the RED:

³¹⁹ Article 8 of the Gas Directive.

³²⁰ For a more comprehensive list of requirements pertaining to the production, storage, transport and distribution of hydrogen see Floristean, A., ‘EU regulations and directives which impact the deployment of FCH technologies’, HyLAW Project, Deliverable 4.4, 2019, p. 3-8.

³²¹ Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC [2003] OJ L 275/32.

³²² Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [2010] OJ L 334/17.

³²³ Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment [2011] OJ L 26/1.

³²⁴ Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accidents hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC [2012] OJ L 197/7.

4.5.1 Emissions Trading Directive

The EU emissions trading scheme is a cornerstone of the EU's policy to combat climate change, and it is the key tool for reducing greenhouse gas emissions in a cost-effective manner.³²⁵ The rules under which the trading scheme operates are provided for in the EU Emission Trading Scheme Directive (EU ETS Directive).³²⁶ The EU ETS is a cap-and-trade system; wherein a cap on annual emissions for covered installations is imposed.³²⁷ For each tonne of CO₂ equivalent, an installation operator must possess one 'allowance'.³²⁸ Operators of stationary installations that result in emissions specified in relation to the activity that they carry out must hold a greenhouse gas emission permit.³²⁹ In order to determine whether operators of PtG facilities (installations) must obtain a permit under the EU ETS Directive, it must be established whether such facilities fall under any of the categories of activities listed in Annex I.³³⁰ Among the activities listed in Annex I are: "Production of hydrogen (H₂) and synthesis gas by reforming or partial oxidation with a production capacity exceeding 25 tonnes per day".

As PtG facilities produce hydrogen, Annex I advocates that operators of such facilities are obliged to apply for a greenhouse gas emission permit. Although the Directive refers to the 'production of hydrogen by reforming or partial oxidation', the list of production methods is non-exhaustive. Furthermore, no distinction is made between the sources used for its production. A reading of Annex I therefore suggests that operators of PtG facilities are subject to the rules of the Directive, regardless of whether the electricity used in the process is generated from renewable sources or from fossil fuels. Even if that is the case, Article 4 provides that the Directive's rules apply only to stationary installations, which emit greenhouse gases from the activities in which they are mainly engaged. Where the Directive refers to hydrogen, it prescribes that hydrogen production must emit CO₂. But because the production of green hydrogen does not emit CO₂, the Directive cannot cover the production of green hydrogen within its scope.³³¹ This interpretation is also consistent with the overall objective of the Directive to reduce greenhouse gas emissions, as it would go against the intention of the Directive to oblige operators of activities that do not emit greenhouse gases to apply for a permit under the Directive. As a result only operators of PtG facilities producing hydrogen from fossil fuels fall under the cap-and-trade system, and are therefore obliged to acquire allowances.

4.5.2 Industrial Emissions Directive

Industrial production processes account for a considerable share of the overall pollution in Europe due to their emission of air pollutants and discharges of wastewater. The Industrial Emissions Directive (IED)³³² is

³²⁵ European Commission, 'EU Emission Trading System (EU ETS)', available at <https://ec.europa.eu/clima/policies/ets_en>

³²⁶ Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC [2003] OJ L 275/32.

³²⁷ Recital 11 of the EU ETS Directive; for a more comprehensive understanding see European Commission, 'EU Emission Trading System (EU ETS)', available at <https://ec.europa.eu/clima/policies/ets_en>

³²⁸ Articles 3(a) of the EU ETS.

³²⁹ Article 4 of the EU ETS Directive.

³³⁰ Article 3(1) of the EU ETS Directive. See furthermore Entry I of Annex I, which excludes from the scope of the Directive installations or parts of installations that are used for research, development and testing of new products.

³³¹ This is also the case when biomass is used as a source for hydrogen production (see Section 2.1.1). The introduction of a 'zero emission factor' for biomass emissions in Annex IV of the EU ETS Directive entails that emissions from biomass do not need to be covered by ETS allowances. This exemption is a financial incentive in support of the consumption of biomass and related gases such as biogas and biofuels, see further Recital 2 and Article 38 of the Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council [2012] OJ L 181/30 (MRG Regulation).

³³² Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [2010] OJ L 334/17.

the main EU instrument regulating pollutant emissions from industrial installations.³³³ The Directive aims to achieve a high level of protection of human health and the environment as a whole by reducing harmful industrial emissions across the EU, particular through better application of the Best Available Techniques.³³⁴ The industrial activities listed in Annex 1 of the IED are required to operate in accordance with a permit (granted by authorities in the Member States).³³⁵

Industrial activities fall under the scope of the IED if they are referred to in Chapters II to IV of the Directive.³³⁶ The IED excludes from its scope “research activities, development activities or the testing of new products and processes”.³³⁷ According to Article 10 of the IED, Chapter II applies to those activities that are listed in Annex I. Activities listed under Annex I includes the ‘production of hydrogen’ and ‘re-electrification’. The ‘production of hydrogen’ is included under 4.2 of Annex I as “Production of inorganic chemicals, such as: a) gases [...] such as hydrogen” and ‘re-electrification’ is included under 1.1 of Annex I as “Combustion of fuels in installations with a total rated thermal input of 50MW or more”.

Section 4 of Annex I stipulates that “production within the meaning of the categories of activities contained in this section means the production on an industrial scale by chemical or biological processing of substances or groups of substances listed in points 4.1 to 4.6”, with hydrogen included under point 4.2. In accordance with Annex I, it is the responsibility of the EC to determine what is to be understood by ‘industrial scale’ – but no such definition has yet been provided by the EC.³³⁸ However, guidance is provided in the predecessor to the IED, namely the IPPC Directive, which states:

“the scale of chemical manufacture can vary from a few grams of a highly specialised product to many tonnes of a bulk chemical product, yet both scales may correspond to “industrial scale” for that particular activity. If the activity is carried out for “commercial purposes”, it should be considered as production on an industrial scale”.³³⁹

In conclusion, the IED applies to the production of hydrogen for commercial purposes. One could, however, question whether the Directive applies to both the production of green and grey hydrogen. At present, the Directive only refers to the “production of inorganic chemicals such as [...] hydrogen”,³⁴⁰ without specifically mentioning the method used for its production. Furthermore, the Directive makes no distinction between the sources used for its production, which indicates that the rules of the Directive apply to hydrogen irrespective of whether it is produced from renewable sources or fossil fuels. However, it could be argued that operators of facilities producing green hydrogen should not be required to obtain such a permit, as it can be considered against the Directive’s intention to require operators to obtain a permit when not contributing to pollutant emissions, which to some extent is true for green hydrogen, but not for grey hydrogen. Nevertheless, PtG facilities (whether the input of electricity is generated from renewable energy or fossil fuels) emit substances such as brine (from water purification), oxygen, trace materials, and in some cases solid waste in form of

³³³ It was adopted in 2010 and is based on a Commission proposal recasting 7 previously existing directives including in particular the IPPC Directive following an extensive review of the policy; see Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control [2008] OJ L 24/8.

³³⁴ Preamble 12 and 13 of the EID.

³³⁵ European Commission, ‘*The Industrial Emissions Directive*’, 2019
<<https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm>>

³³⁶ Article 2(1) of the IED.

³³⁷ Article 2(2) of the IED.

³³⁸ Floristean, A., ‘*EU regulations and directives which impact the deployment of FCH technologies*’, HyLAW Project, Deliverable 4.4, 2019, p. 6.

³³⁹ European Commission, ‘*Guidance on Interpretation and Implementation of the IPPC Directive*’, available at
<https://ec.europa.eu/environment/archives/air/stationary/ippc/general_guidance.htm>

³⁴⁰ See Point 4.2 of Annex 1 of the IED.

spent stacks, which may be held to be within the scope of the Directive.³⁴¹ Until further clarified by the EU legislators, it seems likely that both green and grey hydrogen is covered by the rules of the Directive.

Although there is no direct reference with regard to the applicability of the IED offshore, a clarification of the applicability offshore can be found in the subject scope in Article 1(2) of the IED, which specifies that the Directive provide rules to prevent and reduce emissions into air, water and land “to achieve a high level of protection of the environment as a whole”. It can thus be interpreted as to include not only industrial activities on land, but also industrial activities taking place offshore. The Directive also explicitly prescribes that it is applicable to certain activities taking place at ‘sea’.³⁴² Furthermore, EU case law supports the claim that the Directive applies to activities taking place in the EEZ and on the CS.³⁴³

4.5.3 Environmental Impact Assessment Directive

An environmental impact assessment is a procedural device deployed to ensure that the environmental implications of a decision are considered before the commencement of a project. Environmental assessments can be undertaken for individual projects on the basis of Directive 2011/92/EU Environmental Impact Assessment (EIA Directive),³⁴⁴ or for public plans or programs on the basis of Directive 2001/42/EC Strategic Environmental Assessment (SEA Directive).³⁴⁵ Each Directive works to ensure that plans, programs and projects likely to have significant effects on the environment by virtue, *inter alia* due to their size or location, should be made subject to an environmental assessment prior to their approval or authorisation.³⁴⁶ The EIA Directive aims to provide a high level of protection for the environment, while contributing to the integration of environmental considerations into the preparation of projects, plans and programs, with a view to reducing their environmental impact.³⁴⁷

Article 2(1) of the EIA Directive sets out which projects require development consent and an assessment to be conducted with regard to their effects on the environment. Article 2(4) of the EIA Directive provides that Member States in exceptional cases may exempt a specific project, in whole or in part, from the provisions in the Directive. In the event of an exemption, Member States shall consider whether another form of assessment is appropriate and ensuring that the necessary information relating to this assessment is available. Furthermore, Member States must inform the EC prior to granting their consent and the reasons justifying the exemption granted.³⁴⁸

In accordance with Article 4(1) of the EIA, subject to Article 2(4), projects listed in Annex I are always subject to an assessment according to Articles 5–10 of the EIA Directive.³⁴⁹ For projects qualifying under Annex II, Member States have the discretion to determine whether these projects shall be subject to an assessment following Articles 5–10.³⁵⁰ Member States can determine this either on a case-by-case basis or based on pre-determined thresholds and criteria. These criteria include: the size and design of the installation, use of

³⁴¹ See Article 3(1), (2) and (4) of the IED.

³⁴² See *inter alia* Article 67 of the IED, which prohibits the disposal of waste “into any water body, sea or ocean”.

³⁴³ For a more comprehensive understanding see Section 4.2.2.

³⁴⁴ Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public private projects on the environment [2011] OJ L 26/1; Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014, amending Directive 2011/92/EU on the assessment of the effects of certain public private projects on the environment [2011] OJ L 124/1.

³⁴⁵ Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment [2001] OJ L 197/30.

³⁴⁶ Article 2 of the EIA Directive.

³⁴⁷ Recital 7 of the EIA Directive.

³⁴⁸ Article 2(4) of the EIA Directive.

³⁴⁹ For certain projects that listed under Annex I, quantitative thresholds are provided.

³⁵⁰ Article 4(2) of the EIA Directive.

natural resources, waste production, pollution and nuisance, risk of major accidents, risk of human health, ecological effects, and density of the population in the area.³⁵¹

The production of hydrogen is listed in Entry 6(a) of Annex II under “treatment of intermediate products and production of chemicals”. Furthermore, the storage of hydrogen is listed in Entry 3(d) of Annex II: “Underground storage of combustible gases”, and Entry 6(c) of Annex II: “Storage facilities for [...] chemical products”. Given that the production and storage of hydrogen falls within the projects listed in Annex II, it is for the Member States to determine whether such projects should be made subject to an impact assessment or not.³⁵² It is important to note that the Directive makes no distinction between green and grey hydrogen, as it merely refers to hydrogen as a chemical and/or combustible gas, irrespective of the production method and the sources used for its production.

It becomes more complicated when trying to determine whether a PtG project should be considered a project according to Annex I or II. ‘Project’ is defined in the Directive as: “[...] the execution of construction works or of other installations or schemes” and “[...] other interventions in the natural surroundings and landscape”.³⁵³ The term ‘project’ must be interpreted widely and includes the cumulative effects of related projects.³⁵⁴ This holistic approach means that projects that consist of several linked processes or subprojects are considered as one singular project.³⁵⁵ PtG projects consist of several related projects, which fall within the scope of the Directive. Besides the production and storage of hydrogen, construction of overhead electrical power lines with a voltage of 220 kV or more and a length of more than 15 km” is covered in Entry 30 of Annex I. Furthermore, Entry 16 of Annex I lists “Pipelines with a diameter of more than 800 mm and a length of more than 40 km” for the transportation of gas, oil and chemicals. Moreover, Entry 3(b) of Annex II includes “Industrial installations for carrying gas [...]”. Several processes, linked to the construction of a PtG facility, are thus listed in Annex I and II of the EIA Directive.

The main question is therefore whether a PtG installation is considered an “integrated chemical installation” under Article 6(a) and (b) of Annex I, or a “chemical industry” under Article 6(a) of Annex II.³⁵⁶ This classification is crucial as it determines whether Member States are required to perform an environmental impact assessment of such installations, or whether they have the discretion to exempt such installations. An ‘integrated chemical installation’ is defined in Article 6 of Annex I as “those installations 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 [...]”. The European Court of Justice expressed in *EC v Belgium* that the term ‘integrated chemical installations’ should not be interpreted narrowly, and that it does not depend on its processing capacity or on the type of chemical substances processed in it, but “on the existence of [*interlinked production units*] constituting in terms of their operation a single production unit.”³⁵⁷ An electrolyser in a PtG facility most likely does not fall under this definition given the absence of interlinked production units.³⁵⁸ It is therefore likely that it is for Member States to decide whether an environmental impact assessment is required for the installation of an electrolyser, in accordance with Entry 6 of Annex II.

³⁵¹ Annex III of the EIA Directive.

³⁵² In some countries, storage of 5 tons of hydrogen or more falls within the scope of the Directives, see further Alexandru Floristean, ‘EU regulations and directives which impact the deployment of FCH technologies’, HyLAW Project, Deliverable 4.4, 2019, p. 7.

³⁵³ Article 1(2) of the EIA Directive.

³⁵⁴ Commission v Ireland (Case C-392/96) [1999] ECR I-5901.

³⁵⁵ European Commission, ‘Interpretation of Definition of Project Categories of Annex I and II of the EIA Directive’ (2015); see further Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas*, Store&Go, Deliverable 7.2, 2017, p. 69.

³⁵⁶ For a more comprehensive understanding see Floristean, A., ‘EU regulations and directives which impact the deployment of FCH technologies’, HyLAW Project, Deliverable 4.4, 2019, p. 3-8; Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas*, Store&Go, Deliverable 7.2, 2017, p. 69.

³⁵⁷ European Commission v Kingdom of Belgium (Case C-133/94) [1996] ECLI:EU:C:1996:181, para. 27.

³⁵⁸ There are however possible synergies when linking green and blue hydrogen production, which would entail interlinked production units (linking heat and oxygen production from green hydrogen production). For a more comprehensive understanding see Hauck, M., *Life cycle assessment of grey, blue and green hydrogen*, North Sea Energy, 2020.

However, until the EIA Directive explicitly categorises PtG projects as falling under Annex I or II, it is uncertain whether an environmental impact assessment is mandatory or whether it is the decision of Member States to impose such an assessment.

Regarding electric cables necessary for the operation of PtG facilities, the EIA Directive references only overhead electric cables, with further references to underground or sub-sea cables in the Annexes not provided.³⁵⁹ Although the EC proposed that the EIA Directive should apply to sub-sea cables in a working document, it did not result in any amendments to the EIA Directive.³⁶⁰ Therefore, it is at the discretion of the Member States to require EIAs on (offshore) underground electricity cables. As previously discussed, there is also no explicit reference of the applicability of the EIA Directive to the construction of a PtG facility, and its connected electricity cables and pipelines at sea. Where such an activity in fact is listed in Annex I - and the specific activity takes place within territorial waters - the Directive requires an EIA. EU case law further supports that this is the case even if such an activity takes place in the EEZ and CS.³⁶¹

4.5.4 Seveso Directive

The Seveso-III-Directive (Seveso Directive)³⁶² aims first to prevent major accidents, but acknowledging that accidents will still occur, it seeks also to limit any ensuing damage to human and environmental health.³⁶³ The Directive covers situations where dangerous substances may be present (e.g. during processing or storage) in quantities exceeding certain thresholds.³⁶⁴ Annex I classifies hydrogen as a dangerous substance, listing the quantity threshold for the application of lower-tier requirements (under 5 tonnes) and for upper-tier requirements (more than 50 tonnes). Thus, for quantities of less than 5 tonnes of hydrogen, none of the obligations established in the Directive applies. As the Directive classifies hydrogen as a dangerous substance regardless of production method or the sources used for its production both green and grey hydrogen is subject to the provisions of the Directive.³⁶⁵ Operators of installations exceeding the thresholds in the Annex are obliged to notify the competent authority on *inter alia* the form and amount of substance, the activity and the surrounding environment of the concerned establishment.³⁶⁶

Member States must ensure that the competent authority exert control of the siting of new establishments, including transport routes, locations of public use and residential areas in the vicinity of the establishment.³⁶⁷ The Directive thus affects the choice of the location of a project producing hydrogen (e.g. PtG facilities) or storing hydrogen, as considerations for potential harm have to be included when selecting the location of the project. The geographical application of the Directive is not specifically mentioned, but Article 1 states that the rules apply throughout the EU. Article 2 of the Directive furthermore indicates that the Directive applies to activities occurring both on and offshore.³⁶⁸ Nonetheless, EU case law implies that the Directive applies to activities taking place in the EEZ and on the CS.³⁶⁹

³⁵⁹ Entry 20 of Annex I of the EIA Directive.

³⁶⁰ Report from the European Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on the application and effectiveness of the EIA Directive (Directive 85/337/EEC, as amended by Directives 97/11/EC and 2003/35/EC), COM(2009) 378 final, p. 3.^[1]^[2]^[3]^[4]^[5]

³⁶¹ For a more comprehensive understanding see Section 4.2.2.

³⁶² Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accidents hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC [2012] OJ L 197/7.

³⁶³ European Commission, 'Major accident hazards', 2019, available at <<https://ec.europa.eu/environment/seveso/legislation.htm>>

³⁶⁴ Article 1 of the Seveso Directive.

³⁶⁵ The Seveso Directive is well integrated with other EU policies, thus avoiding double regulation or other administrative burden. This includes related policy areas such as *inter alia* safety of offshore oil and gas operations, see further European Commission, 'Offshore oil and gas safety', available at <<https://ec.europa.eu/energy/en/topics/energy-security/offshore-oil-and-gas-safety/overview>>

³⁶⁶ Article 5 of the Seveso Directive; Article 7 of the Seveso Directive.

³⁶⁷ Article 13 of the Seveso Directive.

³⁶⁸ See especially subparagraphs (c) and (f) of Article 2(2) of the SEVESO Directive.

³⁶⁹ For a more comprehensive understanding see Section 4.2.2.

4.6 Offshore Planning of Energy Infrastructure at the EU Level

Whereas the previous sections focussed on EU laws applicable to PtG and hydrogen activities, this Section focuses more specifically on EU laws governing the offshore planning of such infrastructure. EU Directives impose obligations on the Member States to coordinate the planning of energy infrastructure offshore, taking into consideration the scarcity of space and the potential environmental impact in a cross-border context. These Directives provide guidance on the offshore planning and location of energy projects. There are several Directives, which are particularly relevant to the development of PtG facilities and hydrogen activities offshore. These are: the Maritime Spatial Planning Directive,³⁷⁰ the Marine Strategy Directive,³⁷¹ and the Habitats Directive.³⁷² These Directives play an important role when governments allocate space at sea for activities such as PtG projects.

4.6.1 Maritime Spatial Planning Directive

Maritime spatial planning is the coordination of practices and policies affecting spatial organisation in the offshore area. The competence for maritime spatial planning lies at the national or even sub-national or local level.³⁷³ Although the EU has no general competence assigned with regard to spatial planning,³⁷⁴ it has adopted the Maritime Spatial Planning Directive³⁷⁵ to coordinate maritime spatial planning between Member States and to ensure that the environmental standards of the EU's marine waters are maintained.³⁷⁶

Competition for maritime space has highlighted the need to manage the waters more coherently, and the Directive works across borders and sectors to ensure that activities at sea take place in an efficient, safe and sustainable way.³⁷⁷ The main benefits of maritime spatial planning are the reduction of conflicts between sectors, the creation of synergies between different activities (e.g. system integration offshore),³⁷⁸ the creation of clearer rules to encourage investment offshore,³⁷⁹ and the facilitation of cross-border cooperation.³⁸⁰ Member States are obliged to establish an authority responsible for the implementation of the Directive through the drafting of maritime spatial plans and the submission of these plans to the EC.³⁸¹ Moreover, they need to facilitate the sharing of best available data with neighbouring Member States.³⁸² These measures should lead to a reduction of conflicts in maritime spatial planning, possibly allowing for the realisation of synergies across national borders.

As the Directive was only adopted in September 2014, and had to become law in the Member States by September 2016, some of the proposed mechanisms are not yet in place. The deadline for the national authorities (responsible for drafting maritime spatial plans) to adopt the first maritime spatial plan is

³⁷⁰ Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning [2014] OJ L 257/135.

³⁷¹ Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy [2008] OJ L164/19.

³⁷² Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and or wild fauna and flora [1992] OJ L 206/7.

³⁷³ Spatial planning at the national level is further presented in chapter 4.

³⁷⁴ *E contrario* Article 4 of the TFEU.

³⁷⁵ Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning [2014] OJ L 257/135.

³⁷⁶ Article 1 of the Maritime Spatial Planning Directive.

³⁷⁷ See Recitals 2 and 3 of the Maritime Spatial Planning Directive.

³⁷⁸ Recital 19 of the Maritime Spatial Planning Directive.

³⁷⁹ Recital 5 of the Maritime Spatial Planning Directive.

³⁸⁰ Article 1 of the Maritime Spatial Planning Directive.

³⁸¹ Article 13 of the Maritime Spatial Planning Directive.

³⁸² Article 11 of the Maritime Spatial Planning Directive.

September 2021.³⁸³ However, some Member States, for example the Netherlands, already have such plans in place.³⁸⁴ In their national maritime spatial plans, Member States should take into account “economic, social and environmental aspects to support sustainable development and growth in the maritime sector”.³⁸⁵ The Directive lists minimum requirements for activities and uses of marine waters in Article 6. One requirement of particular importance to hydrogen activities offshore is the requirement to ensure transboundary cooperation between Member States. This could be especially relevant in the context of offshore spatial planning for hydrogen activities and the connected pipelines and cables, as it could ensure coordination between the Member States in the marine area.

4.6.2 Marine Strategy Framework Directive

The aim of the Marine Strategy Directive³⁸⁶ is to protect more efficiently the marine environment across Europe, including the North Sea.³⁸⁷ The aims are to achieve a ‘good environmental status’ for the EU’s marine waters by 2020, and to protect the resources based upon which marine-related economic and social activities depend. These aims are enshrined in Article 1 of the Directive. The Directive utilises the ‘ecosystem approach’ to the management of human activities impacting the marine environment, integrating the concepts of environmental protection and sustainable use.³⁸⁸

In order to achieve its goals, the Directive establishes European marine regions and sub-marine regions on the basis of geographical and environmental criteria. The following regions have been established: the Baltic Sea, the North-east Atlantic Ocean, the Mediterranean Sea and the Black Sea. These regions located within the geographical boundaries of the existing Regional Sea Conventions, such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR).³⁸⁹ Cooperation between Member States in one marine region and with the neighbouring countries sharing the same marine water already takes place through these Regional Sea Conventions.³⁹⁰ The Directive, as well as the OSPAR Convention, requires that Member States take measure to preserve the marine environment, and to draft strategies for their marine waters.³⁹¹ The Marine Strategy includes *inter alia* an initial assessment of the current environmental status of national marine waters, the establishment of environmental targets, and a monitoring program for the on-going assessment.³⁹²

A ‘good environmental status’ does not preclude the construction and operation of PtG facilities offshore, but such facilities should not adversely affect the marine environment, which can be determined by the qualitative descriptors of Annex I of the Marine Strategy Directive. However, if an activity must take place because of overriding public interest and these interests cannot be achieved without the particular activity, the EC can exempt the activity from the Directive. It could be argued that the development of PtG facilities in the marine environment is an overriding public interest, given its importance as a potential keystone in a low-carbon energy system, and in meeting climate targets. Although PtG facilities could be exempted, Member States should take appropriate ad-hoc measures to limit pollution, pursuing the targets set to achieve a ‘good

³⁸³ European Commission, ‘Maritime spatial planning’ <https://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning_en>

³⁸⁴ Noordzeeloket, ‘Nationaal Waterplan’, available in Dutch at <<https://www.noordzeeloket.nl/beleid/noordzeebeleid/nationaal-waterplan/>>

³⁸⁵ Article 5(1) of the Maritime Spatial Planning Directive.

³⁸⁶ Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy [2008] OJ L164/19.

³⁸⁷ Article 4(1) and 4(2) of the Marine Strategy Directive.

³⁸⁸ Article 1(3) of the Directive.

³⁸⁹ Article 4 of the Marine Strategy Directive.

³⁹⁰ European Commission, ‘Legislation: the Marine Strategy Framework Directive’, 2019 <https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm>

³⁹¹ Article 1 of the Marine Strategy Directive.

³⁹² Article 5 of the Marine Strategy Directive.

environmental status' of the area.³⁹³ Besides an environmental impact assessment, which requires project developers to reduce pollution and take far-reaching measures to ensure a good environment,³⁹⁴ the Marine Strategy Directive adds that Member States should also adopt such measures in their Marine Strategies.

4.6.3 Habitats Directive

The Habitats Directive³⁹⁵ could limit the choice of location for a PtG project offshore. The Directive provides measures for the protection of both 'special areas of conservation' and certain animal species. Article 3 of the Habitats Directive specifies that the aim is to set up a coherent European ecological network of so called 'Natura 2000' areas. PtG projects planned within a designated area of conservation require prior approval by the competent authority. Approval is based on an assessment, which must establish with certainty that the project will not adversely affect the area.³⁹⁶ If the assessment reveals adverse effects, but there are important reasons for a project to be sited in a Natura 2000 area, the negative impact can be compensated by expanding or improving habitats elsewhere.³⁹⁷ If the developer of the PtG facility is obliged to perform an impact assessment under both the Habitats Directive and the EIA Directive, the competent authorities must streamline the assessments.³⁹⁸ The ruling by the European Court of Justice in the *Habitats Case* confirms the applicability of the Directive in the EEZ and on the CS.³⁹⁹

4.7 Interim Conclusions

This chapter of the deliverable sought to provide an overview of the substantive EU law that is (potentially) applicable to offshore hydrogen activities. Whether the EU has the competence to regulate over a certain matter depends on whether Member States have explicitly given the EU such a competence in the founding treaties. Due to the competence conferred on the EU to adopt legally binding acts that regulate the energy sector in general, it can be argued that there is a competence for the EU to adopt secondary law that would regulate PtG. As regards the application of secondary legislation at sea, EU case law advocates that when an activity falls under a coastal Member State's functional jurisdiction – and the coastal Member State's sovereign rights – then also EU law applies as far as that activity is concerned.

Following the incorporation of a definition on 'energy storage' in the Electricity Directive, it can be argued that PtG, as an *energy storage activity*, is governed exclusively under EU electricity legislation. This is, however, contingent on the word 'use' being interpreted broadly within the directive's definition. If interpreted narrowly, the Electricity Directive concerns itself with PtG facilities only if the storage medium is to be reconverted into electricity. However, the analysis contained within this report indicates that PtG may also be classified as a *gas production activity*. If so, it can be argued that the rules of the Gas Directive apply to a PtG facility. The subsequent storage of hydrogen can thus either be conducted under the Electricity Directive, or the Gas Directive. Whereas the analysis suggests that the Electricity Directive applies where hydrogen is stored in a specific (separate) location and *then* either reconverted into electricity or injected into a dedicated hydrogen network, the Gas Directive applies where hydrogen is injected into the natural gas system. Nevertheless, the interplay between the Electricity Directive and the Gas Directive is still ambiguous, especially regarding definitions. It is particularly important to clarify this interplay in order to determine the rules that apply to the

³⁹³ Article 14 of the Marine Strategy Directive.

³⁹⁴ For a more comprehensive understanding see Section 4.6.1.

³⁹⁵ Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and or wild fauna and flora [1992] OJ L 206/7.

³⁹⁶ Article 6 of the Habitats Directive.

³⁹⁷ Article 6(3) of the Habitats Directive.

³⁹⁸ Kreeft, G., *European Legislative and Regulatory Framework on Power-to-Gas, Store&Go*, Deliverable 7.2, 2017, p. 74.

³⁹⁹ *Commission v United Kingdom* (Case C-6/04) [2005] ECR I-9017, para. 115, 117.

ownership and operation of PtG facilities, and hydrogen storage facilities. These issues should be dealt with during the proposal to adopt new EU gas legislation.

Producers and customers connected to the electricity transmission and distribution system are required to pay charges for their access to the system. Since storage facility operators are treated both as final end-users (requiring the storage operators to pay tariffs when withdrawing electricity from the network) and as generation assets (requiring the storage operators to pay tariffs a second time when re-injecting electricity into the electricity network), they must pay double charges. This financial barrier to the deployment of hydrogen storage in the electricity system could be avoided if the EC adopts a network code explicitly providing for a discount at entry and/or exit points, avoiding double charging for the transport of electricity to and from storage facilities. However, it currently remains as the responsibility of the Member States to curtail this financial barrier.

Access to the natural gas system for the injection of hydrogen is conditioned by technical and safety rules, including gas quality standards. Although different rules apply to upstream and downstream natural gas pipelines, any quantity of gas that is transported from an offshore location (upstream pipelines) to the onshore transmission network (downstream pipelines) will have to be treated in such way that it meets the criteria upon injection into the onshore transmission network. Standardisation at the EU level has not yet resulted in consensus on a common Wobbe Index range or limit on hydrogen admixture in the existing natural gas system. Current gas quality standards, including the Wobbe Index range, are of a heterogeneous nature. If there is too much discrepancy between Member States in their standards, this may hamper the introduction of more sustainable gases, such as green hydrogen. Hence, the absence of rules permitting hydrogen injection into the existing natural gas network and the fragmentation of approaches (with differing admissible hydrogen concentration levels) makes evident the need to harmonise current gas quality standards.

The incorporation of renewable gases (including green hydrogen) in the RED is an important stepping-stone to the 'greening' of the EU energy sector. The Directive establishes that Member States may apply support schemes to reach or exceed the EU target share of energy from renewable sources, but only if such support does not distort the functioning of the internal energy market. To prevent PtG support schemes from falling foul of EU rules on state aid, the EC could adopt conditions for such support in their guidelines on state aid. Furthermore, the RED extends the scheme of guarantees of origin to hydrogen produced from renewable sources. Although green hydrogen is now included in the scheme, there is a lack of clarification as to how such guarantees interact when one form of energy is converted into another. Moreover, such guarantees are only valid for a period of 12 months after production, which may affect seasonable storage of hydrogen.

In reviewing the applicable EU climate, environmental and safety laws, it follows that hydrogen activities are subject to permitting and safety requirements, as well as requirements pertaining to environmental- and risk assessments. These requirements are incorporated in various EU Directives, including, *inter alia*, the EU ETS Directive, the IED, the EIA Directive and the SEVESO Directive. Each directive explicitly includes the production of hydrogen within its scope, without distinguishing between the different production methods and sources of its production. These Directives therefore apply to the production of both green and grey hydrogen, with the only clear exception being the EU ETS Directive, which applies only to the production of grey hydrogen. Although these Directives refer to hydrogen activities, there is no direct reference to PtG activities. In order to clarify the provisions applicable to the development and operation of PtG facilities, such facilities should be included within the scope of these Directives.

5. National Policy Frameworks and Legislation

5.1 Introduction

This report is primarily focused on the conversion of wind energy to hydrogen on existing hydrocarbon platforms in the North Sea.⁴⁰⁰ A successful launch of hydrogen activities offshore would require national law to facilitate such developments. Hydrogen is not currently produced in the North Sea.⁴⁰¹ Hence, it is important to first investigate which national laws of North Sea states might apply to PtG developments. The extent to which existing national laws, if any, regulate the development of PtG activities on existing hydrocarbon platforms must therefore be ascertained. From this, an assessment can be made as to whether these laws should be amended, or whether new laws must be adopted in order to support such developments on existing platforms. This section therefore examines the national laws and regulations pertaining to offshore PtG activities of three North Sea states: the Netherlands, the UK and Denmark. This involves an assessment of national policies, regulations and standards, as well as a literature review related to country-specific conditions.

The development of the production and transport of hydrogen offshore can be divided into three main stages (as illustrated by Figure 2 below), each of which is relevant for the analysis of national legislation in this report. Stage one involves the construction of a cable between an offshore wind farm or the offshore electricity grid and an existing hydrocarbon platform, supplying the platform with electricity. In the second stage, an electrolyser must be constructed and installed on the platform to convert this electricity into hydrogen. As the produced hydrogen must be transported to shore, step three requires either the injection of hydrogen into the existing gas pipelines already connecting the platform to the onshore gas transmission network, or injection of hydrogen into dedicated pipelines constructed for the purpose of transporting hydrogen to shore. The former category of gas pipelines – existing gas pipelines – is the subject of this analysis. This Section explores which national laws in the Netherlands, the UK and Denmark might be applicable to these three main stages of the offshore PtG process. A more elaborate description of each stage in the PtG process is explained in the following sections, further outlining what is necessary to consider from a legal perspective to promote the development of hydrogen activities in the North Sea.

5.1.1 Electricity Input for Hydrogen Conversion

In order to convert electricity to hydrogen on a hydrocarbon platform, electricity must be supplied thereto. To facilitate the supply of electricity generated from wind, one must construct an electricity cable between an offshore wind farm, or the offshore electricity grid connected to an offshore wind farm, and an offshore platform (as illustrated by Figure 2 below). From a legal perspective, it is necessary to determine whether national law facilitates the construction of such an electricity cable and the transport of electricity from a wind farm (or the offshore electricity grid) to a platform.

The primary legal issue is how to define the cable transporting electricity from an offshore wind farm (or the offshore electricity grid) to a platform. Would such a cable be classified under national law as a 'transmission

⁴⁰⁰ For a comprehensive understanding of the conversion of wind energy to hydrogen on a sand-based offshore energy island see Pernot, E., Roggenkamp, M., *Legal assessment of the development of a sand-based offshore energy island*, North Sea Energy, Appendix Report, Deliverable D.3.8, 2020.

⁴⁰¹ This will change in the near future after Neptune Energy's announcement that they will participate in a pioneering pilot project to create the first offshore hydrogen facility in the Dutch sector of the North Sea, see further Section 5.2.1.

line' or a 'direct line'?⁴⁰² One must also then determine who is responsible to construct such a cable. Is it the TSO, the wind farm developer, or the developer of the electrolyser? This Section seeks to address these issues by analysing the relevant national laws pertaining to the construction of offshore electricity cables, and the transport of electricity offshore.

5.1.2 Hydrogen Conversion

The next step in the offshore PtG process is the construction and installation of an electrolyser on an existing offshore hydrocarbon platform (as illustrated by Figure 2 below). It is necessary to determine the national law applicable to the construction of an electrolyser and the subsequent production of hydrogen from an existing platform in order to assess the legal effects of this. There are two scenarios which are foreseen by the author: (i) the electrolyser is installed on a hydrocarbons platform, which still produces natural gas, or (ii) the electrolyser is installed on a hydrocarbons platform, which is no longer producing natural gas. Both scenarios raise their own legal issues.

In the first scenario, one must consider that the hydrocarbons platform already operates under a gas production (hydrocarbons) licence. The question is therefore whether the production of hydrogen could be considered an ancillary service to the production of natural gas or a production activity in and of itself? If it would be classified as an ancillary service, one must consider whether the national laws applicable to the production of natural gas also apply to the production of hydrogen. If it is considered a production activity in and of itself, one should then investigate whether there are other national laws governing the hydrogen conversion process on an existing offshore hydrocarbon platform.

In the second scenario, one must also consider that the hydrocarbons platform was once constructed and operated under a hydrocarbons licence. However, as the production of natural gas on the platform has ceased in this scenario, there is a need to explore the possibility to re-use the platform for a purpose other than what it was initially developed for. The question is therefore whether another permit or licensing regime in national law might be applicable to the construction and operation of an electrolyser offshore. This section seeks to address these issues by analysing the relevant national laws pertaining to the construction and operation of an electrolyser on an existing hydrocarbon platform.

5.1.3 Hydrogen Transport

In the final step of the offshore PtG process, the produced hydrogen must be transported from the offshore hydrocarbons platform to shore, where it is consumed, stored or reconverted (as illustrated by Figure 2 below). Since existing platforms are already connected to a pipeline, which in turn is connected to the gas transmission network onshore, the North Sea Energy project envisages the re-use of these pipelines to transport the offshore produced hydrogen. The characteristics of the gas transported through the pipeline changes when hydrogen is blended with natural gas. Hence, the primary issue arising therefrom is whether national law grants the blending of hydrogen into the existing natural gas pipelines. The regulation of upstream pipelines is limited, and there is no regulation pertaining to these networks on standards, including gas quality standards.⁴⁰³ However, as these pipelines are connected to the onshore transmission network, one must also consider the gas quality standards applying to the onshore network. The primary question is therefore whether national laws allow for the admixture of hydrogen into the national transmission network.

⁴⁰² A 'direct line' is defined in Article 2(41) of the EU Electricity Directive as "an electricity line linking an isolated generation site with an isolated customer or an electricity line linking a producer and an electricity supply undertaking to supply directly their own premises, subsidiaries and customers".

⁴⁰³ For a more comprehensive understanding see Sections 4.4.2.5 – 4.4.2.7.

As this report seeks to provide an overview of the legal framework surrounding the re-use of existing platforms and the pipelines connecting them to the onshore transmission network, there is no need to analyse national laws that govern the construction of new platforms and pipelines. Nevertheless, it is imperative that hydrogen producers have access to the existing pipelines, in order to inject the produced hydrogen and transport it to shore. This access can only be granted if the injection of hydrogen adheres to the gas quality standards specified for the relevant pipeline. This section seeks to address these issues by analysing the relevant national laws pertaining to the injection of hydrogen into the natural gas network.

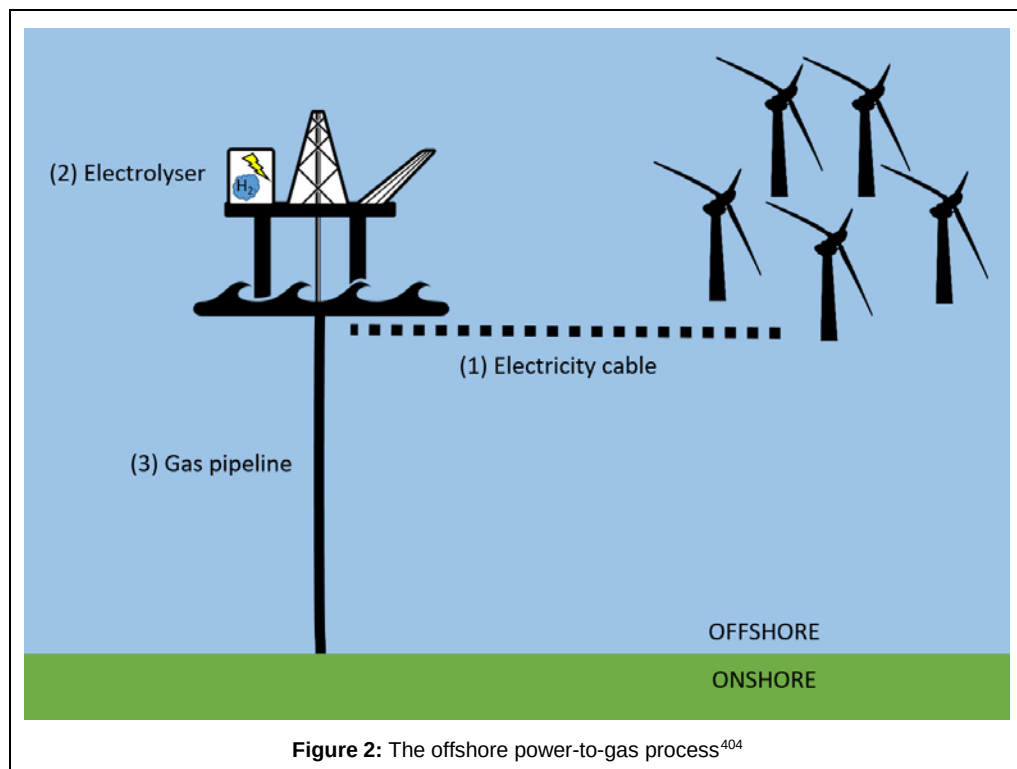


Figure 2: The offshore power-to-gas process⁴⁰⁴

5.2 The Netherlands

5.2.1 Introduction

In the Netherlands, energy supply is characterised at present by the large-scale production of natural gas. The share of renewable electricity production is, despite increased wind energy utilisation, relatively small – due in part to the large-scale penetration of natural gas in the energy supply market. However, in order to meet CO₂ emission reduction targets and secure long-term energy supplies, the use of alternative energy sources is unavoidable. The Dutch 'Energieakkoord' prescribes that 14% of energy must come from RES by 2020 and 16% in 2023.⁴⁰⁵ Further to the general targets for renewable energy, this agreement includes a specific capacity goal of 4.5 GW for offshore wind in 2023.⁴⁰⁶ Currently, the Netherlands has an installed

⁴⁰⁴ By author's illustration, 'the offshore PtG process': (1) transport of electricity from a wind farm, or the offshore electricity grid connected to a wind farm, to a platform: (2) installation of an electrolyser on an existing platform for the hydrogen conversion process: (3) transport of hydrogen through existing pipelines connected to the onshore gas transmission network.

⁴⁰⁵ Energy Agreement for Sustainable Growth (*Energieakkoord voor Duurzame Groei*), 2013, p. 17.

⁴⁰⁶ Energy Agreement for Sustainable Growth (*Energieakkoord voor Duurzame Groei*), 2013, p. 70.

capacity of 957 MW for offshore wind.⁴⁰⁷ The 2017 coalition agreement (the basis for action brought forward by the current government) foresees the development of a new national climate and energy strategy, though no such strategy has yet been published.⁴⁰⁸ Under this new strategy, the national climate targets will be incorporated into law, and by 2030, CO₂ emissions should be cut to 49% of 1990 levels.⁴⁰⁹ The 2017 coalition agreement emphasises that more sections of the North Sea will be earmarked for wind farms, and that all coal-fired power stations will be closed by 2030.⁴¹⁰ Offshore sustainable energy, predominantly offshore wind, will therefore play an important role in the accelerated growth of a low carbon and sustainable energy supply in the Netherlands.

The 'North Sea 2050 Spatial Agenda' lays down the objectives for the Dutch part of the North Sea until 2050.⁴¹¹ The agenda focuses on five themes: (i) building with North Sea nature, (ii) energy transition at sea, (iii) multiple/multi-functional use of space, (iv) connection between land and sea, and (v) accessibility/shipping. These themes are also incorporated in the 'Policy Document on the North Sea 2016-2021', which describes the current situation on the North Sea, maps out the developments for the years to come, and records the policy choices for the upcoming planning period.⁴¹² The aim is to prevent fragmentation and to promote the efficient use of space, while giving market players the scope to develop initiatives and make spatial choices within certain limits.⁴¹³ A review of the Dutch marine spatial plan, however, indicates that the conversion of wind energy to hydrogen at sea is (for the time being at least) excluded from the future policy strategy of its marine area.

The option to produce hydrogen offshore, linking wind farms and platforms, is a promising means of achieving the aforementioned targets. The concept of producing hydrogen offshore with wind energy is a newer one, and there is not currently any such production taking place in the Dutch part of the North Sea. This will change in the near future, however, after Neptune Energy's announcement that they will participate in a pioneering pilot project to create the first offshore hydrogen facility in the Dutch sector of the North Sea.⁴¹⁴ Hydrogen in the Netherlands is mainly used as a feedstock, and in recent years also as an energy carrier.⁴¹⁵ The quantities are large, and several production centres onshore are connected to dedicated hydrogen pipelines. Most Dutch hydrogen is produced from natural gas, a practice set to be challenged by the objective of producing hydrogen from RES. Awareness of the role of carbon neutral hydrogen as a part

⁴⁰⁷ CBS StatLine, 'Windenergie; elektriciteitsproductie, capaciteit en windaanbod, 2002 – 2019', available in Dutch at <<https://opendata.cbs.nl/statline/#/CBS/nl/dataset/70802NED/table?fromstatweb>>

⁴⁰⁸ Coalition Agreement, 'Confidence in the Future: 2017-2021 Coalition Agreement', 10 October 2017, available in English at <<https://www.government.nl/documents/publications/2017/10/10/coalition-agreement-confidence-in-the-future>>

⁴⁰⁹ For an update on the timeline of the Climate Agreement in the Netherlands see Government of the Netherlands, 'Climate Policy', available at <<https://www.government.nl/topics/climate-change/climate-policy>>

⁴¹⁰ Energy Agreement for Sustainable Growth (*Energieakkoord voor Duurzame Groei*), 2013, p. 97.

⁴¹¹ Rijksoverheid, 'North Sea 2050 Spatial Agenda: The report of joint research into the long-term potential of sea and coastal areas, translated into a vision, series of ambitions, opportunities, points of action and maps', 2014, available at <<https://www.government.nl/documents/policy-notes/2014/07/28/north-sea-2050-spatial-agenda>>

⁴¹² Rijksoverheid, 'Policy Document on the North Sea 2016-2021', 2015, available at <<https://www.government.nl/documents/policy-notes/2015/12/15/policy-document-on-the-north-sea-2016-2021-printversie>>

⁴¹³ See further Kafas, A., et al, *Status quo report on offshore energy planning provisions in the North Sea region: Annex 2 National marine spatial planning and licencing frameworks in North Sea countries and links to offshore renewable developments*, NorthSEE, WP.5, 2019, p. 21, available at <<https://northsearegion.eu/media/4932/annex-2-marine-planning-licensing-frameworks-northsee-offshore-energy-status-quo-report-final-with-intro-120418.pdf>>

⁴¹⁴ The pilot is commissioned by NexStep, the Dutch Association for Decommissioning and Re-Use, and TNO, the Netherlands Organisation for applied scientific research in close collaboration with the industry. A megawatt electrolyser will be placed within a sea container and installed on Neptune's Q13a platform, located near the Dutch coast. The pilot – due to begin production later in 2020 – will provide the participants with the opportunity to develop their experience of producing hydrogen in an offshore environment. For more information see Neptune Energy, 'Neptune Energy Selected For Offshore Hydrogen Pilot', 2019, available at <<https://www.neptuneenergy.com/news/neptune-energy-selected-for-offshore-hydrogen-pilot/>>

⁴¹⁵ Centralised production, i.e. at one location, in quantities to cover the needs of hydrogen over a relatively large geographic area for a relatively large number of points of use (implying hydrogen transport), see further HyLaw, Piet van der Meer, J., Perotti, R., de Jong, F., *National Policy Paper – Netherlands*, available at <https://www.hylaw.eu/sites/default/files/2019-03/HyLAW_National%20Policy%20Paper_Netherlands.pdf>

of the future energy mix seems to be growing strongly, with issues typically discussed ranging from “how strong a role will hydrogen play in the future Dutch energy system?”, to “under what conditions can green hydrogen compete with grey hydrogen and comparable carriers/feedstock?”, and “what policies and measures are needed to ‘green’ the energy molecules and introduce hydrogen in various economic sectors?”.⁴¹⁶

5.2.2 Electricity Input for Hydrogen Conversion

The Wind Energy at Sea Act (*Wet windenergie op zee*)⁴¹⁷ applies to the development of wind farms offshore. Within the meaning of the Act, wind farms include the facilities necessary to produce electricity from wind energy, the connections between these facilities, and the connection of these facilities to the electricity network.⁴¹⁸ The Ministry of Economic Affairs and Climate determines which parts of an identified location will form separate wind energy plots.⁴¹⁹ When the Ministry is of the opinion that a particular area should be turned into a wind energy plot, a plot decision is taken.⁴²⁰ This plot decision specifies the location of the cables connecting the wind farm to the electricity network.⁴²¹ The Wind Farm Zone Decision (*Kavelbesluit*) fills in the exact coordinates of an offshore wind farm, and includes the cable trajectory of the network at sea until the onshore connection point to which the offshore wind farm will be connected.⁴²²

Prior to the most recent legislative changes in the Netherlands, developers of wind farms offshore were responsible for the construction of the cable from the wind farm to shore, where the grid connection took place.⁴²³ Under the previous regime, the wind farm developer therefore needed to construct and operate this cable.⁴²⁴ This changed following legislative changes made in 2016, through which a more coordinated grid planning approach at sea was adopted. The grid connection now takes place at sea at the converter station, and the responsibility for the construction of the converter station and the cable from the converter station to shore has been shifted from the wind farm developer to the TSO.⁴²⁵ Since September 2016, TenneT is certified as the TSO at sea by the national regulatory authority.⁴²⁶

In accordance with Article 15a of the Electricity Act (*Elektriciteitswet*),⁴²⁷ the offshore electricity network comprises the networks intended for the transport of electricity connecting one or more offshore wind farms to the national transmission network. The sole purpose of the offshore electricity network is to transport electricity generated offshore to the onshore transmission network. It is therefore not intended to facilitate offshore electricity supply and consumption, and it is unlikely that it will be legally permissible to establish a connection between the offshore electricity network and a platform. The odds of legally establishing such a

⁴¹⁶ Jepma, C., Spijker, E., Hofman, E., *The Dutch Hydrogen Economy in 2050: An explanatory study on the socio-economic impacts of introducing hydrogen into the Netherlands energy system*, New Energy Coalition, 2019, available at <https://www.vnoncw.nl/sites/default/files/the_dutch_hydrogen_economy_in_2050_march_2019.pdf>

⁴¹⁷ Wind Energy at Sea Act (*Wet windenergie op zee*) of 24 June 2015.

⁴¹⁸ Article 1 of the Wind Energy at Sea Act.

⁴¹⁹ Article 3(3) of the Wind Energy at Sea Act.

⁴²⁰ This contains information on the physical characteristics of the plot, the measures taken to limit the environmental impact of the wind farm, a time frame for the future wind energy permit, and the rights of third parties pertaining to the plot, see Article 4 of the Wind Energy at Sea Act.

⁴²¹ Article 3(2) of the Wind Energy at Sea Act.

⁴²² Article 1 of the Wind Energy at Sea Act.

⁴²³ Müller, H.K., *A Legal Framework for a Transnational Offshore Grid in the North Seas*, Intersentia, 2016, p. 148.

⁴²⁴ The reason for this was that the Electricity Act of 1998 was not applicable to the EEZ, except for the provision regarding electricity production.

⁴²⁵ Article 16(2)(n) of the Electricity Act. For a more comprehensive understanding see Nieuwenhout, C.T., *Legal Framework and Legal Barriers to an Offshore HVDC Electricity Grid in the North Sea*, PROMOTioN, Deliverable 7.1, 2017, p. 95.

⁴²⁶ TenneT is certified as the TSO at the sea for the coming 10 years, see Article 10.3 of the Electricity Act. The certification decision is available in Dutch at <<https://www.acm.nl/nl/publicaties/publicatie/16048/Besluit-certificering-TenneT-als-netbeheerder-van-het-net-op-zee>>

⁴²⁷ Electricity Act (*Elektriciteitswet*) of 2 July 1998.

connection are further diminished by the nature of the plot decisions issued by the Ministry of Economic Affairs and Climate.⁴²⁸ As outlined earlier, a plot decision only considers connections between the offshore wind farm and the offshore electricity network. Another obstacle to the connection of offshore platforms to the offshore electricity network is the support schemes applied to offshore wind farms. The Dutch support scheme system, SDE+ (*Besluit stimulerende duurzame energieproductie*)⁴²⁹ is based on a remuneration per kWh, fixed by a procedure in which project developers can participate on a first-come-first-served basis in different subsidy rounds.⁴³⁰ A project developer that wins a tender for an offshore wind farm enters into an agreement with the state in order to receive the subsidy, and the compensation per kWh requires that the offshore-produced electricity is fed into the onshore transmission network. In recent times, zero subsidy bids have been favoured for offshore wind development, due to current market conditions making such projects economically feasible.⁴³¹ Hence, the impact of the subsidy regime may be less of an issue for the connection of offshore platforms to the offshore electricity infrastructure in the near future.⁴³²

Further, one must consider whether the proposed cable connecting an offshore wind farm to an offshore platform is to be considered a transmission line (*i.e.* part of the transmission network), or whether such a cable can be distinguished and considered a 'direct line'. This distinction may be made, as the cable does not bring electricity from a wind farm to shore, instead only transmitting electricity from a wind farm to a platform. It is, thus, questionable whether such a cable should be considered part of the offshore transmission network, or whether it should be considered a 'direct line', entirely distinct from the transmission network. Per the first sub-paragraph of Article 1(1) of the Electricity Act, a 'direct line' is one or more connection for the transport of electricity linking an isolated generation site with an isolated customer. For this definition to apply to a cable, the provision indicates that neither generator nor final customer may be connected to the transmission grid (or another connection for the transport of electricity). As a connection may only be considered a 'direct line' if both nodes are remote, any installation that is deemed to be connected in some way to another electricity network is likely incapable of being part of a 'direct line'. If one therefore establishes a connection via an electricity cable between: (i) a wind farm, which is also connected to the electricity transmission network, and (ii) a platform, it may be that the electricity cable connecting the wind farm and the platform falls outside the definition of a 'direct line' under Dutch law. If, however, the wind farm is not itself connected to the electricity transmission network – and therefore considered an 'isolated generation site' – it is more likely that the electricity cable connecting the wind farm in question to a platform falls within the definition of a 'direct line'. Nonetheless, the provisions of the Electricity Directive regulating direct lines are not applicable in the EEZ.⁴³³ There is thus no classification of such an electricity cable offshore in Dutch law.

In 2018, the Ministry of Economic Affairs and Climate opened a consultation for an Act amending the Wind Energy at Sea Act, which proposes major revisions of the current regime for offshore wind.⁴³⁴ The amending Act broadens the scope of the Wind Energy at Sea Act, changing it from being one with an exclusive focus on the generation of electricity, to one concerned with the broader concept of producing wind energy, which

⁴²⁸ Articles 1 and 4 of the Wind Energy at Sea Act.

⁴²⁹ Decision on Stimulation of Sustainable Energy Production (*Besluit Stimulerende duurzame energieproductie*) of 16 October 2017.

⁴³⁰ Article 19 of the Decision on Stimulation of Sustainable Energy Production.

⁴³¹ Ministerial Order issued by the Minister of Economic Affairs and Climate Policy on 13 December 2019, no. WJZ/19201387, containing specific rules for permitting of offshore wind energy for Hollandse Kust (noord) Wind Farm Site V (Ministerial Order for the permitting of Offshore Wind Energy Hollandse Kust (noord) Wind Farm Site V), p. 13, available at <<https://english.rvo.nl/sites/default/files/2019/12/Translation%20Ministerial%20Order%20for%20Permitting%20Offshore%20Wind%20Energy%20Hollandse%20Kust%20noord%20V.pdf>>

⁴³² Market conditions for the development of offshore wind farms may however change in the future given that offshore wind farms may need to be developed further offshore. The development of offshore wind farms at a distance further from shore will increase costs and subsidies may be needed to support such development.

⁴³³ See Article 1(5) of the Electricity Act.

⁴³⁴ Act amending the Wind Energy at Sea Act (*Wijziging van de Wet windenergie op zee*) of 28 November 2018, Kamerstuk 35092 no. 3, available at <<https://zoek.officielebekendmakingen.nl/kst-35092-3.html>>

includes any energy carrier based on the conversion of wind energy.⁴³⁵ The explanatory note refers explicitly to hydrogen as an energy carrier.⁴³⁶ To facilitate the production of energy carriers, such as hydrogen, the amending Act replaces the concept of a network connection with the concept of a 'connection point'. The memorandum provides three examples of such connection points: (i) the connection of an electricity cable to a hydrogen facility (onshore or offshore), (ii) the connection of a hydrogen pipeline to an installation where the hydrogen is distributed over various means of transport, and (iii) the connection of a hydrogen pipeline to an installation where electricity is produced from hydrogen.⁴³⁷ The proposed amendments to the Wind Energy at Sea Act promote the possibility of connecting wind farms to offshore electricity users (e.g. energy conversion installations) through the introduction of an alternative connection.⁴³⁸ However, despite the introduction of these alternative connections, there is no clarification in the proposed amendment regarding how the electricity cable (establishing the connection) would be defined or classified by law. Furthermore, such a change in the law must also be adapted to the current support system applicable to wind farms, as a means of ensuring the feasibility of such alternative connections.

5.2.3 Hydrogen Conversion

The extraction of subsoil resources onshore and offshore in the Netherlands is regulated by the Mining Act (*Mijnbouwwet*).⁴³⁹ The Mining Act prohibits the extraction of natural gas without a licence, and governs equipment and installations (e.g. platforms) for the production of natural gas.⁴⁴⁰ Given that hydrocarbon platforms that still produce natural gas are governed by the rules prescribed in the Mining Act, one must consider whether the installation and subsequent production of hydrogen on such a platform is to be considered an ancillary service, and thus falling under the Mining Act. For a service to be considered an ancillary service, it must be necessary to support the production of natural gas from the installation.⁴⁴¹ It would appear that the production of hydrogen through electrolysis not likely clear this bar, and thus it can safely be assumed that hydrogen production would not be considered an ancillary service. Furthermore, it is questionable whether the production of hydrogen requires a licence under the Mining Act in the first place, as the definition of 'mineral' within the legislation is narrow enough to exclude hydrogen from the Mining Act's scope.⁴⁴² As a result, it is unlikely that hydrogen conversion can be carried out on a platform under the existing hydrocarbon production licence applicable to the platform in question.

The possibility of installing and operating an electrolyser on a hydrocarbon platform following the cessation of natural gas production must also be considered, with position under international law analysed in Sections 3.4.2 – 3.4.3. While allowing existing installations to be reused may allow for benefits to be realised, Article 44 of the Dutch Mining Act appears fatal to any hopes of installation repurposing in the Netherlands. The existence of an explicit removal obligation, which takes effect once a mining installation is no longer used, makes it difficult to envisage how re-use could occur. However, courtesy of the draft proposal of a bill seeking to amend the rules on the removal of disused mining installations, there may soon be some clarification on this matter.⁴⁴³ The bill proposes to provide the Minister of Economic Affairs and Climate with the authority to grant exemptions from the obligation to remove installations, arguing that removal under certain conditions should be postponed if installations can be reused for *inter alia* CCS, hydrogen production

⁴³⁵ Article 1(a) of the Act amending the Wind Energy at Sea Act.

⁴³⁶ Para. 2.1.2 of the Act amending the Wind Energy at Sea Act.

⁴³⁷ Para. 2.1.2 of the Act amending the Wind Energy at Sea Act.

⁴³⁸ The term 'alternative connection' refers to a connection point, which is not yet incorporated in law.

⁴³⁹ Mining Act (*Mijnbouwwet*) of 31 October 2002, see Articles 1(a) and 6.

⁴⁴⁰ Article 1(n) and (o) of the Mining Act.

⁴⁴¹ See Article 1(n) and (o) of the Mining Act in conjunction with Article 2 of the Mining Decree (*Mijnbouwbesluit*) of 6 December 2017.

⁴⁴² Article 1(a) of the Mining Act

⁴⁴³ For all documentation see <<https://www.internetconsultatie.nl/mijnbouwwerken>>

or any other offshore energy related activities.⁴⁴⁴ Nevertheless, a reading of international conventions and guidelines seems to leave room for the repurposing of platforms for the production of hydrogen.⁴⁴⁵

It must, therefore, be examined whether the construction of an electrolyser on an offshore hydrocarbon platform and the production of hydrogen are governed by other legislation. The Water Act (*Waterwet*)⁴⁴⁶ provides a general framework governing all activities occurring in water systems to the extent that such activities are not regulated by specific legislation.⁴⁴⁷ Given then that neither the Mining Act (as explored above) nor the Wind Energy at Sea Act applies to the production of hydrogen, it is necessary to determine whether the Water Act applies to the construction of an electrolyser offshore.

The Water Act regulates the spatial planning for all water areas in the Netherlands and is applicable to the Dutch territorial waters and to its EEZ.⁴⁴⁸ Article 6.5 of the Water Act lists certain activities that may be prohibited in national waters without possession of a water permit, as awarded by the Ministry of Infrastructure and Environment.⁴⁴⁹ Article 6.13 of the Ministerial Water Decree (*Waterbesluit*)⁴⁵⁰ prescribes that it is forbidden to use the North Sea for certain specified activities without permission from the Ministry, as referred to in Article 6.5 of the Water Act; subsection (c) specifically prohibits the installation or laying down of installations or cables and pipelines, or leaving them in place; while subsection (d) specifically prohibits construction activities. The development of an electrolyser offshore thus falls under both subsections (c) and (d), and so a water permit must be obtained by the project developer pursuant to the Water Act.⁴⁵¹ Per Article 6.12 of the Water Regulation (*Waterregelingen*),⁴⁵² an activity may be carried out without a water permit providing the activity, due to its nature, limited size, or short duration, has no adverse influence on the water management. This is probably not the case for the construction of a permanent electrolyser offshore. The award of a water permit is not competitive, and involves an actor requesting the permit for a particular usage of an area of the concerned water body.⁴⁵³

It must be considered, however, that this report looks at the construction of an electrolyser on an existing hydrocarbon platform, which means that no 'new installation' will be introduced in the water body. The Water Act does not contain any provisions applicable to the construction of additional infrastructure on an existing installation, which is licensed under a different regime (e.g. a hydrocarbon platform under the Mining Act). At present, it is unclear whether such an activity falls within the scope of the Water Act.

The intention of the Government to simplify and merge spatial development rules in the Netherlands is particularly important for future offshore hydrogen activities. The forthcoming Environment Act

⁴⁴⁴ The Council of State provided its advice on the bill, which is now pending to be sent to parliament. The advice was sent to the Minister on the 18 of December 2019, but the advice is still confidential.

⁴⁴⁵ For a more comprehensive understanding on re-use of offshore installations and structures see Section 3.4.3.

⁴⁴⁶ Water Act (*Waterwet*) of 29 January 2009.

⁴⁴⁷ If two laws govern the same factual situation, a law governing a specific subject matter (*lex specialis*) overrides a law governing general matters (*lex generalis*).

⁴⁴⁸ Articles 1.2 and 1.4 of the Water Act.

⁴⁴⁹ Article 6.5 of the Water Act applies to the construction and operation of a PtG facility on an offshore platform. See Article 6.5(a) recharge of water into or extraction from a body of surface water, and Article 6.5(c) making use of a water management structure or an associated protection zone by carrying out activities, erecting or maintaining structure or dumping, placing, laying or leaving solid substances or objects in, on, above or under it, unless such use is consistent with its function.

⁴⁵⁰ Ministerial Water Decree (*Waterbesluit*) of 30 November 2009.

⁴⁵¹ The 'function of the North Sea' referred to in Article 6.13 of the Ministerial Water Decree is to be interpreted narrowly according to the commentary, see further S. Handgraaf Milieurecht Totaal, commentaar op art. 6.5 Wtw, aant. 1.

⁴⁵² Water Regulation (*Waterregelingen*).

⁴⁵³ This request is assessed against the general purposes of the Act and only when the proposed project is incompatible with these purposes can the Minister of Transport, Public Works and Water Management refuse the request (Article 6.1 of the Water Act); Article 2.1 of the Water Act stipulates that the purpose of the Water Act is to (a) prevent flooding and water scarcity, (b) assure and improve the chemical and ecological quality of water systems, and (c) ensure the performance of the societal functions of the water systems.

(*Omgevingswet*)⁴⁵⁴ will bundle 26 existing laws pertaining to activities including, *inter alia*, construction, environment, water, spatial planning and nature. Interestingly, improved facilitation of construction projects is an important purpose of the Environment Act.⁴⁵⁵ The new legislation is expected to enter into force in 2021, and will replace large parts of the Water Act.⁴⁵⁶ At present, however, it is unclear whether changes to the rules governing water permits will be made and if so, what such changes will entail.

5.2.4 Hydrogen Transport

The Dutch Gas Act (*Gaswet*)⁴⁵⁷ regulates the transport of natural gas in the land territory of the Netherlands, the territorial sea, the EEZ and the CS.⁴⁵⁸ Whether the Gas Act is applicable to hydrogen is contingent on the definition of 'gas'.⁴⁵⁹ Since 2012, the Act explicitly states that the term gas covers natural gas and other substances to the extent that these substances meet a set of specifications concerning the production method and the chemical state of the substance when held under a particular temperature and under a particular pressure.⁴⁶⁰ One important requirement pertaining to the chemical state of gas injected into the natural gas network is that the substance should primarily consist of methane or another substance equivalent to methane in terms of characteristics.⁴⁶¹ In accordance with Chapter 2 of the Gas Act, the main requirement is that the gas can be transported safely through the natural gas network. However, no further guidance on the meaning of safe transport is provided. Article 11 of the Gas Act specifies that the requirements that the gas must meet before it is fed into the natural gas network are listed in the Ministerial Decree on Gas Quality (*Regeling Gaskwaliteit*).⁴⁶² The requirements listed in the Annexes of the Decree only permit a very low concentration of hydrogen admixed into the natural gas network.⁴⁶³

Producing hydrogen on offshore platforms entails the hydrogen produced being transported to shore through (offshore) upstream pipelines. Whereas the Mining Act (*Mijnbouwwet*)⁴⁶⁴ regulates the safety and the environmental aspects of (offshore) upstream gas pipelines, the Gas Act provides the rules on the usage of (offshore) upstream pipelines. Access to such pipelines is based on negotiations with the owner or operator of the pipelines, which may refuse access where there is an incompatibility with technical specifications.⁴⁶⁵ Where upstream pipelines are still used to transport natural gas, producers of hydrogen wishing to use the same pipelines must adhere to the specific technical rules applicable to these pipelines.⁴⁶⁶ In cases where the owners or operators of upstream pipelines abuse their dominant position, a complaint can be submitted to the Dutch Competition Authority.⁴⁶⁷

Although individual technical specifications are set for upstream pipelines, these pipelines are connected to the onshore gas transmission network. Pursuant to the Gas Act, all gas fed into the onshore gas

⁴⁵⁴ Environment Act (*Omgevingswet*) of 26 April 2016, see also Rijksoverheid, 'Voorbeeldprojecten toekomstige Omgevingswet', available at <<https://www.rijksoverheid.nl/onderwerpen/omgevingswet>>

⁴⁵⁵ Rijksoverheid, 'Nieuwe omgevingswet maakt omgevingswet eenvoudiger', available at <<https://www.rijksoverheid.nl/onderwerpen/omgevingswet/vernieuwing-omgevingsrecht>>

⁴⁵⁶ Ministerie van Infrastructuur en Milieu, *Omgevingswet: 'Ruimte voor ontwikkeling, waarborgen voor kwaliteit'*, available at <<https://www.rijksoverheid.nl/onderwerpen/omgevingswet/documenten/publicaties/2014/06/17/ienm-factsheet-omgevingswet>>

⁴⁵⁷ Gas Act (*Gaswet*) of 22 June 2000.

⁴⁵⁸ Article 1.3 of the Gas Act.

⁴⁵⁹ See Article 1.1 (b) of the Gas Act.

⁴⁶⁰ Article 1 (b) of the Gas Act.

⁴⁶¹ See Article 1(b) of the Gas Act and the Ministerial Decree on Gas Quality.

⁴⁶² Ministerial Decree on Gas Quality (*Regeling Gaskwaliteit*) of 11 July 2011.

⁴⁶³ See the Annexes of the Ministerial Decree on Gas Quality, which excludes the transport of pure hydrogen in the existing natural gas networks.

⁴⁶⁴ Mining Act (*Mijnbouwwet*) of 31 October 2002.

⁴⁶⁵ See Article 34 of the EU Gas Directive; for a more comprehensive understanding see Section 4.4.2.7.

⁴⁶⁶ The Gas Act limits the freedom of gas production network operators to determine their own network tariffs and access conditions, as the Competition Act (*Mededingingswet*) of 22 May 1997 applies to the Dutch continental shelf.

⁴⁶⁷ Article 17 of the Gas Act.

transmission network must adhere to certain quality standards.⁴⁶⁸ As such, gas fed into the onshore gas transmission network should consist primarily of methane or equivalent substances and comply with the requirements provided in the Ministerial Decree on Gas Quality. In 2016, the Minister updated the gas quality requirements and detailed the prerequisites to admixing hydrogen into the natural gas stream. The pipeline network of particular importance is the pipeline network transporting H-gas, as most offshore gas fields in the Netherlands are connected to this.⁴⁶⁹ The maximum content level of hydrogen in H-gas is 0.02mol%,⁴⁷⁰ with no distinction made between different types of H-gas networks.⁴⁷¹ Although the pipeline network carrying L-gas is of less importance in this report, it can be stated for the purpose of comparison that the maximum content level of hydrogen in some parts of the L-gas network is 0.5mol%.⁴⁷² The exact composition of the mixture may, however, change over the years as the volumes of natural gas in existing natural gas pipelines will decrease due to ceased extraction of natural gas.⁴⁷³ Thus, some room exists for the injection of hydrogen into the onshore natural gas network.

Any quantity of gas that is transported from an offshore location to the onshore transmission network will have to be treated in such way that it meets the criteria upon injection into the onshore network. In practice, this means that hydrogen produced offshore will have to be fed into offshore pipelines in such a way that it meets the criteria of the receiving equipment onshore. Then, if the concentration of hydrogen exceeds the predetermined hydrogen limit applicable to the onshore transmission network, it will have to be treated (e.g. separated) prior to injection. Several projects in the Netherlands are looking at the possibility of transporting hydrogen through the existing natural gas network. Gasunie suggests that a hydrogen network out of the current L-Gas network could be ready by 2030, which would link the five large industrial clusters and other potential clusters in the Netherlands (which may also be linked with Germany).⁴⁷⁴ This hydrogen backbone could be realised largely by using existing natural gas pipelines that will be freed up, as these are suitable for transportation of hydrogen.⁴⁷⁵ The accomplishment of such development, however, requires a change in the current legislation to facilitate higher blending levels of hydrogen in the existing natural gas networks.

5.3 The UK

5.3.1 Introduction

The UK is rich in renewable sources, and the importance of RES continues to increase.⁴⁷⁶ The UK boasts the highest installed offshore wind generation capacity in the North Sea (9,945 MW).⁴⁷⁷ Still, there are no

⁴⁶⁸ Article 11 of the Gas Act.

⁴⁶⁹ See Section 4.4.2.5 specifying that gas quality differ from one gas field to another. For example, gas from the Groningen field is of low-calorific value (L-gas), whilst most gas from the fields in the North Sea is of high-calorific value (H-gas).

⁴⁷⁰ High-calorific natural gas or natural gas with a high calorific value. This gas contains relatively large proportions of higher hydrocarbons and consequently has more energy than low-calorific value, see further Gasunie, 'H-Gas' <<https://www.gasunie.nl/en/glossary/h-gas>>

⁴⁷¹ Article 2.1 and 2.3 of the Ministerial Decree on Gas Quality, Annexes 1 and 3 of the Ministerial Decree on Gas Quality.

⁴⁷² This is however only the case for gas transportation networks that are not managed by the network operator of the national gas transport network. For the high-pressure networks, the admixing limitation of hydrogen for L-gas networks is 0.02mol%; see further; Article 2.2 and 2.4 of the Ministerial Decree on Gas Quality, Annexes 2 and 4 of the Ministerial Decree on Gas Quality.

⁴⁷³ EBN indicated a limitation of maximum 15vol% of hydrogen in the natural gas mix due to the onshore receiving equipment, such as for example gas plants onshore. Nonetheless, the maximum content level of hydrogen in the onshore H-gas networks is 0.02mol% and in parts of the onshore L-gas networks 0.05mol%. For a more comprehensive understanding see New Energy Coalition, Bonetto, J., Jepma, C., Renz, M., van Schot, M., *Offshore Reuse Potential for Existing Gas Infrastructure in a Hydrogen Supply Chain: As part of the project "Gas Infrastructure Opportunities for a Hydrogen Supply Chain"*, Deliverable WP1, 2019, p. 15.

⁴⁷⁴ Gasunie, 'Networks for sustainability', Annual report 2018, p. 11

⁴⁷⁵ Gasunie, 'Gas infrastructure helps accelerate energy transition', 2018, available at <<https://www.gasunie.nl/en/news/gas-infrastructure-helps-accelerate-energy-transition>>

⁴⁷⁶ Although relatively rich in energy sources, the UK's once-great coal industry has largely disappeared. Offshore oil and gas has risen to more or less take its place, but is now itself in a period of gradual decline, see further Gordon, G., McHarg, A., Paterson, J., 'Energy

specific long-term (offshore) wind energy targets in the UK, as it is for the market to 'decide' what types of RES that will be developed and on what scale.⁴⁷⁸ The Government has committed to meeting 15% of the UK's energy demand from RES by 2020, with an indicative target of 30% for renewable electricity.⁴⁷⁹ The Climate Change Act of 2008⁴⁸⁰ outlines the advancement in the UK's energy policy by imposing upon the Secretary of State (SoS) the duty to secure an 80% reduction on 1990 levels of the UK's carbon account by 2050. Contrary to many other European countries, the UK lacks the kind of formal cross-party mechanisms to encourage long-term energy planning.⁴⁸¹ The UK's approach to energy policy has been summarised as follows: "It is difficult to discern a comprehensive energy policy in the UK; the policy has been to provide an independent regulatory framework within which the market may make decisions. There are discernible sectoral policies, but no overall strategy."⁴⁸² One development of particular importance in the UK is though the introduction of the 'Strategy and Policy Statement' under the Energy Act of 2013.⁴⁸³ This imposes a duty upon the SoS to place before parliament a regularly updated statement of the government's energy policy priorities for the UK, outlining the roles and responsibilities of the various actors involved in its implementation.⁴⁸⁴

The 'Marine Policy Statement' is the framework, which forms the basis for 'marine plans' and decisions that affect the marine environment in England, Scotland, Wales and Northern Ireland.⁴⁸⁵ These plans set forth the relevant authorities' policies⁴⁸⁶ and activity-specific objectives⁴⁸⁷ for the sustainable development of UK marine areas. It also sets the direction for marine licensing and other decisions affecting the marine environment.⁴⁸⁸ Most plans are still being drafted, but some are already available to the public.⁴⁸⁹ The concept of producing hydrogen offshore from wind energy is, however, new, and is not yet taking place in the UK's part of the North Sea. Producing hydrogen offshore by linking wind farms and platforms may help the UK achieve its aforementioned climate targets. However, references to the conversion of wind energy to hydrogen at sea are notably absent from any of the UK's marine spatial plans.

The UK was an early proponent in the research, system development, production, manufacturing and deployment and use of hydrogen and fuel cell technologies across multiple portable, transport and stationary

Law in the United Kingdom' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 1054-1055.

⁴⁷⁷ WindEurope, 'Offshore Wind in Europe: Key Trends and Statistics 2018', p. 15, available at <<https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2018.pdf>>

⁴⁷⁸ Müller, H.K., *A Legal Framework for a Transnational Offshore Grid in the North Seas*, Intersentia, 2016, p. 176.

⁴⁷⁹ See further Department of Energy & Climate Change, 'UK Renewable Energy Roadmap', 2011, available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48128/2167-uk-renewable-energy-roadmap.pdf>

⁴⁸⁰ Climate Change Act 2008 (2008 c. 27), available at <<http://www.legislation.gov.uk/ukpga/2008/27/contents>>

⁴⁸¹ See further discussion in Gordon, G., McHarg, A., Paterson, J., 'Energy Law in the United Kingdom' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 1056.

⁴⁸² Dow, S., 'Energy Law in the UK' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (2nd edn, Oxford 2007), p. 1177; Gordon, G., McHarg, A., Paterson, J., 'Energy Law in the United Kingdom' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 1055.

⁴⁸³ Energy Act 2013 (2013 c. 32), available at <<http://www.legislation.gov.uk/ukpga/2013/32/contents/enacted>>

⁴⁸⁴ Part 5 of the Energy Act.

⁴⁸⁵ Section 49(1) of the Marine and Coastal Access Act.; see further Part 3, Chapter 2 of the Marine and Coastal Access Act.

⁴⁸⁶ Section 51(3)(b) of the Marine and Coastal Access Act.

⁴⁸⁷ Section 44(1) of the Marine and Coastal Access Act. The marine policy statement is available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf>

⁴⁸⁸ HM Government, 'UK Marine Policy Statement', 2011, p. 3, available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf>

⁴⁸⁹ Marine Plans of the different marine regions of the UK is available at <<https://www.gov.uk/topic/planning-development/marine-planning>>

power applications.⁴⁹⁰ An increasing number of industries in the UK are now formulating strategies to integrate the use of fuel cell technologies for a spectrum of applications. A report by the Committee on Climate Change⁴⁹¹ assessed the potential role of hydrogen in the UK's low carbon economy, concluding that it is a credible option to assist in the decarbonisation of the UK's energy system.⁴⁹² Furthermore, it stressed that hydrogen could replace natural gas in parts of the energy system where electrification is not feasible or is prohibitively expensive.⁴⁹³ By 2030, the UK is likely to have a very low-carbon electricity system, with renewables backed up mainly by natural gas plants. There is, therefore, an opportunity for hydrogen to replace natural gas cost-effectively in this back-up role.⁴⁹⁴

It must be emphasised that the legal system of the UK – a common-law system – is fundamentally different to the civil-law legal systems of the Netherlands and Denmark. The main difference between the two systems is that in common law countries, case law — in the form of published judicial opinions — is of primary importance, whereas in civil law systems, codified statutes predominate.⁴⁹⁵ UK energy law is however to a large extent based on EU law, which is implemented in the UK. The future applicability of EU legislation in the UK, however, depends on the outcome of the Brexit process and the content of any potential trade agreement between the EU and the UK. The analysis of UK law focuses on the laws adopted in England and Scotland, as these countries border the North Sea.

5.3.2 Electricity Input for Hydrogen Conversion

The UK has a distinct regime governing electricity grid planning, with the function of the TSO split between system operator (SO) functions and transmission operator (TO) functions.⁴⁹⁶ Offshore wind farm cables are, however, not the responsibility of any of these TOs or SOs. Instead, separate actors – referred to as Offshore Transmission System Operators (OFTOs) – are appointed for the management such cables.⁴⁹⁷ The Electricity Act 1989 provides that all cables connecting wind farms to the onshore electricity network are classified as 'offshore transmission', and require an 'Offshore Transmission Licence'.⁴⁹⁸ A competitive tender procedure is used to decide which party will be awarded such a licence for a particular connection.⁴⁹⁹

Developers of wind farms are free to choose between either constructing the transmission assets themselves ('generator build model') or to transfer this responsibility to another party ('OFTO build model'). Under the 'generator build model', the developer informs the Office of Gas and Electricity Markets (Ofgem) when finalising the construction of the cable bringing electricity from the wind farm to the shore. Ofgem then

⁴⁹⁰ Hayter, D., *Hydrogen Law and removal of legal barriers to the deployment of fuel cells and hydrogen applications*, HyLaw, available at <https://www.hylaw.eu/sites/default/files/2019-01/HyLaw%20UK%20Policy%20Paper_Final_December%202018.pdf>

⁴⁹¹ The Committee on Climate Change is an independent non-departmental public body, formed under the Climate Change Act 2008 to advise the UK and devolved Governments and Parliaments on tackling and preparing for climate change.

⁴⁹² Committee on Climate Change, *Hydrogen in a low-carbon economy*, 2018, available at <<https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf>>

⁴⁹³ Committee on Climate Change, *Hydrogen in a low-carbon economy*, 2018, available at <<https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf>>

⁴⁹⁴ Committee on Climate Change, *Hydrogen in a low-carbon economy*, 2018, available at <<https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf>>

⁴⁹⁵ See further the definition of 'common law' by Merriam-Webster, available at <<https://www.merriam-webster.com/dictionary/common-law>>

⁴⁹⁶ There is a single system operator for the UK – National Grid Electricity Transmission plc (NGET) – but three separate transmission operators – NGET in England, the Scottish Power Transmission Limited in southern Scotland, and the Scottish Hydro Electric Transmission for parts of northern Scotland (including the Highlands and Islands), see further in Gordon, G., McHarg, A., Paterson, J., 'Energy Law in the United Kingdom' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 1101.

⁴⁹⁷ See further Gazendam, J., 'Het Britse regime voor elektriciteitsnetten op zee: veilen voor efficiency', *Nederlands Tijdschrift voor Energierecht*, No. 3, 2018.

⁴⁹⁸ Section 6A-6D of the Electricity Act; see further Chapter 2, Section 89-94 of the Energy Act 2004 (2004 c.20), available at <<http://www.legislation.gov.uk/ukpga/2004/20/contents>>

⁴⁹⁹ Müller, H.K., *A Legal Framework for a Transnational Offshore Grid in the North Seas*, Intersentia, 2016, p. 183.

organises a tender round, including one or multiple offshore wind farms, and the transmission licence is transferred to the winner of the tender procedure. In the 'OFTO build model', the licensee is responsible for all stages of pre-construction and construction.⁵⁰⁰ The construction of offshore electricity cables requires a marine licence.⁵⁰¹

From Tender Round 3, which started in February 2014, all offshore wind farm projects are required to connect through the national transmission network.⁵⁰² Therefore, the OFTO regime itself is not intended to facilitate any form of connection other than the connection to the national onshore transmission network. There is thus no provision in law facilitating a connection between the offshore electricity network and an offshore platform. Another obstacle to establish such an alternative connection is the support scheme applicable to the development of offshore wind farms. The condition to receive the necessary support for offshore wind energy is that the produced electricity is fed into the onshore electricity network.⁵⁰³

Furthermore, one must consider the possibility of connecting an offshore wind farm to an offshore platform. As such an electricity cable would not be a part of the offshore transmission network, it must be determined whether the cable in question could be classified as a 'direct line'. While a note on the transposition of the EU Electricity Directive into UK law states that the "distribution licence exemption system allows producers to supply via direct lines",⁵⁰⁴ the distribution licence exemption regime in the Electricity Act 1989 contains no definition of a 'direct line'. It is therefore necessary to seek guidance in the EU Electricity Directive. The Electricity Directive defines a 'direct line' as "either an electricity line linking an isolated generation site with an isolated customer or an electricity line linking an electricity producer and an electricity supply undertaking to supply directly their own premises, subsidiaries and eligible customers".⁵⁰⁵ This definition suggests that an electricity cable falls outside the definition of a 'direct line' if it connects a wind farm, which is already connected to the electricity transmission network, and a platform. However, it is more likely that the definition will apply to a cable linking a wind farm and a platform, if the wind farm is not itself connected to the transmission network. Regardless of whether such electricity cables fall under the definition, it is still unclear whether the rules pertaining to 'direct lines' even apply in the UK offshore area.

5.3.3 Hydrogen Conversion

The Petroleum Act 1998⁵⁰⁶ sets out the regulatory regime applying to petroleum production onshore and offshore in the UK. The Act vests all rights to petroleum in the Crown, but permits the Oil and Gas Authority (OGA) to grant licences to conduct drilling and development work within, and production from, a defined area (referred to as a 'petroleum production licence').⁵⁰⁷ 'Petroleum' is defined in Section 1(a) of the Petroleum Act 1998 as "any mineral oil or relative hydrocarbon and natural gas existing in its natural condition in strata".

⁵⁰⁰ Ofgem, 'Offshore Transmission: An Investor Perspective – Update Report', prepared for the Gas and Electricity Markets Authority under Con/Spec/2011-99A, 2012, p. 12, available at <<https://www.ofgem.gov.uk/ofgem-publications/85943/offshoretransmission-aninvestorperspective-updatereport.pdf>>

⁵⁰¹ For a more comprehensive understanding of marine licensing see Section 5.3.3; see also Section 66 of the Marine and Coastal Access Act; Section 21 of the Marine (Scotland) Act.

⁵⁰² Ofgem, 'Offshore Transmission: An Investor Perspective – Update Report', prepared for the Gas and Electricity Markets Authority under Con/Spec/2011-99A, 2012, p. 13, available at <<https://www.ofgem.gov.uk/ofgem-publications/85943/offshoretransmission-aninvestorperspective-updatereport.pdf>>; see further Ofgem, 'Tender Round 3', 2019, available at <<https://www.ofgem.gov.uk/electricity/transmission-networks/offshore-transmission/offshore-transmission-tenders/tender-round-3>>

⁵⁰³ See further 'Contracts for Difference', Commissioned by the Scottish Government and Energy Saving Trust, Produced by Ricardo-AEA Ltd, 2015, available at <<https://www.localenergy.scot/media/82522/CARES-Briefing-Paper-Contracts-for-Difference-V1.pdf>>

⁵⁰⁴ Annex 1 EU Third Energy Package – Transposition Note – Great Britain: Electricity Directive (2009/72/EC), p. 23, available at <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48156/2573-eu-third-package-trans-note-directive-2.pdf>

⁵⁰⁵ Article 2(15) of the EU Electricity Directive.

⁵⁰⁶ Petroleum Act 1998 (1998 c.17), available at <<http://www.legislation.gov.uk/ukpga/1998/17/contents>> essentially continues the Petroleum (Production) Act 1934 (1934 c.36), available at <<http://www.legislation.gov.uk/ukpga/Geo5/24-25/36/enacted>>

⁵⁰⁷ Sections 2-3 of the Petroleum Act 1998.

This ensures a general prohibition against the extraction of natural gas without a licence to do so, and means that offshore natural gas production platforms must operate under such a licence. It must, therefore, be considered whether the development of an electrolyser on an offshore platform (with ongoing petroleum activities) could be considered an ancillary service to this activity. An ancillary service must necessarily support the production of hydrocarbons from the installation. As the development of an electrolyser is not a necessary step for the extraction of natural gas, the installation of an electrolyser is unlikely to be considered such a service. Furthermore, the production of hydrogen does not require a licence under the Petroleum Act 1998, as it is not considered to be 'petroleum',⁵⁰⁸ and thus falls outside the scope of the legislation. As a result, it is unlikely that hydrogen conversion can be carried out under the existing petroleum production licence applicable to the platform in question.

The possibility of installing and operating an electrolyser on a platform following the cessation of natural gas production must also be considered, with position under international law analysed in Sections 3.4.2 – 3.4.3. As discussed it is uncertain to what extent international law allows for the re-use of offshore installations. Therefore, it is necessary to assess the UK stance on the re-use of disused offshore installations. On this matter, the Petroleum Act 1998 requires petroleum installations, once out of use, to be removed.⁵⁰⁹ The Act contains no specific provisions on the re-use of such installations. Nevertheless, a reading of international conventions and guidelines seems to leave room for the repurposing of platforms for the production of hydrogen.⁵¹⁰

A dive into the general framework governing offshore activities sheds a little more light on PtG governance in the UK. The Marine and Coastal Access Act 2009 (for England) and the Marine (Scotland) Act 2010 (for Scotland) provide that certain activities carried out in and around the English and Scottish marine areas require a marine licence.⁵¹¹ The activities requiring a marine licence in English marine waters are specified in Section 66(1) of the Marine and Coastal Access Act 2009, and in Scottish marine waters in Section 21(1) of the Marine (Scotland) Act 2010.⁵¹² The development of an electrolyser offshore falls under subparagraphs 7 and 5 of these sections respectively. It is stipulated that the construction, alteration or improvement of any works within the English and Scottish marine licensing area, in or under the sea, or on or under the seabed, require a marine licence. This includes the laying of cables and the maintenance, alteration or improvement of existing structures and assets.⁵¹³ Whereas the responsible authority for marine licences in English waters is the Marine Management Organisation (MMO),⁵¹⁴ the Marine Scotland Licensing Operations Team (MS LOT) is a one-stop-shop for consenting process for all marine licence applications in Scottish waters.⁵¹⁵

Some activities may be exempted from marine licence requirements, provided they fall within one of the grouped themes, and meet the relevant qualifying criteria and conditions set out in Part 4 Chapter 2 of the Marine and Coastal Access Act 2009 or sections 32-34 of the Marine (Scotland) Act 2010.⁵¹⁶ The

⁵⁰⁸ Section 1(a) of the Petroleum Act 1998.

⁵⁰⁹ Section 29(1) of the Petroleum Act 1998 as amended by the Energy Act 2008; see further Department of Energy and Climate Change, 'Guidance Notes on the Decommissioning of Offshore Oil and Gas Installations and Pipelines', March 2011, available at <https://webarchive.nationalarchives.gov.uk/20111122073803/https://www.og.decc.gov.uk/regulation/guidance/decomm_guide_v6.pdf>

⁵¹⁰ For a more comprehensive understanding on re-use of offshore installations and structures see Section 3.4.3.

⁵¹¹ Part 4 of the Marine and Coastal Access Act 2009 (2009 c.23), available at <<http://www.legislation.gov.uk/ukpga/2009/23/contents>>; Part 4 of the Marine (Scotland) Act 2010 (2010 asp.5), available at <<http://www.legislation.gov.uk/asp/2010/5/contents>>

⁵¹² Marine (Scotland) Act 2010 (2010 asp.5), available at <<http://www.legislation.gov.uk/asp/2010/5/contents>>

⁵¹³ UK Government, 'Do I need a marine licence? Guidance on activities that may require a marine licence', 2018, <<https://www.gov.uk/guidance/do-i-need-a-marine-licence#activities-that-may-need-a-marine-licence>>

⁵¹⁴ Section 67 of the Marine and Coastal Access Act; see further UK Government, 'Do I need a marine licence? Guidance on activities that may require a marine licence', 2018, <<https://www.gov.uk/guidance/do-i-need-a-marine-licence#activities-that-may-need-a-marine-licence>>

⁵¹⁵ Scottish Government, 'Marine Licensing in Scotland', 2019, available at <<https://www2.gov.scot/Topics/marine/Licensing/marine>>

⁵¹⁶ This includes *inter alia* removal of marine litter, the deposit of scientific instruments or equipment, maintenance of harbour works or dredging for harbour authorities see further UK Government, 'Marine licensing exempted activities', 2019, <<https://www.gov.uk/government/publications/marine-licensing-exempted-activities>>

development of an electrolyser offshore does not fall under any of the exempted activities specified in these pieces of legislation.⁵¹⁷

It must be considered, however, that this report looks at the construction of an electrolyser on an existing hydrocarbon platform, which entails that no 'new installation' will be introduced in the water body. The Marine Coastal Access Act 2009 and the Marine (Scotland) Act 2010 do not contain any provisions applicable to the construction of a new installation on an existing installation, which is licensed under a different regime (e.g. a hydrocarbon platform under the Petroleum Act 1998). Although both the Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 require a marine licence before any 'maintenance, alteration or improvement can be carried out for existing structures and assets', it is likely that this provision pertains only to structures and assets that have been permitted under the scope of these pieces of legislation. At present, it is therefore unclear whether the construction of an electrolyser on an existing offshore hydrocarbon platform would be subject to the marine licensing regime under the Marine and Coastal Access Act 2009 or the Marine (Scotland) Act 2010.

5.3.4 Hydrogen Transport

The primary legal sources regulating the transport and supply of gas in the UK are the Gas Act 1986,⁵¹⁸ the Utilities Act 2000,⁵¹⁹ the Energy Act 2011,⁵²⁰ the Pipelines Safety Regulations 1996,⁵²¹ and the Gas Safety (Management) Regulations 1996.⁵²² These Acts and Regulations govern the transport of gas in both downstream and upstream pipelines, or exclusively the transport and supply of gas in downstream pipelines. Participation in the gas market is subject to a licencing regime and the transport and supply of gas are licensable activities.⁵²³

Producing hydrogen on offshore platforms entails the hydrogen produced being transported to shore through (offshore) upstream pipelines. Access to such pipelines is based on negotiations with the owner or operator of the pipelines,⁵²⁴ which publish annually the commercial conditions for access to their pipelines. On the basis of these terms and conditions, third parties seeking access negotiates directly with the owners or operators.⁵²⁵ Where the parties cannot agree on rights of access, the party seeking access can apply to the OGA for a notice granting the relevant rights in accordance with Chapter 3 of the Energy Act 2011 (heavily amended by the Energy Act 2016).⁵²⁶ This clause is only to be used when the parties have been unable to agree on the terms for access.⁵²⁷ Although individual technical specifications are set for upstream pipelines, these pipelines are connected to the onshore transportation network. Account must therefore be taken of the gas quality standards applying to the onshore natural gas network.

⁵¹⁷ Part 4 Chapter 2 of the Marine and Coastal Access Act; Sections 32-34 of the Marine (Scotland) Act; See also Marine Licensing Order 2011, available at <<http://www.legislation.gov.uk/ukxi/2011/409/contents>>

⁵¹⁸ Gas Act 1986 (1986 c.44), available at <<http://www.legislation.gov.uk/ukpga/1986/44/contents>>

⁵¹⁹ Utilities Act 2000 (2000 c.27), available <<http://www.legislation.gov.uk/ukpga/2000/27/contents>>

⁵²⁰ Energy Act 2011 (2011 c.16), available at <<http://www.legislation.gov.uk/ukpga/2011/16/contents/enacted>>

⁵²¹ The Pipelines Safety Regulation 1996 (1996 No. 825), available at <<http://www.legislation.gov.uk/ukxi/1996/825/contents/made>>

⁵²² Gas Safety (Management) Regulations 1996 (1996 No. 551), available at <<http://www.legislation.gov.uk/ukxi/1996/551/contents/made>>

⁵²³ Section 5 of the Gas Act (as amended); see further Part V of the Utilities Act 2000 (2000 c.27) available at <<http://www.legislation.gov.uk/ukpga/2000/27/contents>>

⁵²⁴ Gordon, G., McHarg, A., Paterson, J., 'Energy Law in the United Kingdom' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 1072.

⁵²⁵ See the Statutory Annotations to Section 82 of the Energy Act 2011, Government's Explanatory Note 214 to the Bill, available at <<http://www.legislation.gov.uk/ukpga/2011/16/notes/division/5/2/3/1>>

⁵²⁶ Energy Act 2016 (2016 c.20), available at <<https://www.legislation.gov.uk/ukpga/2016/20/contents>>

⁵²⁷ Gordon, G., McHarg, A., Paterson, J., 'Energy Law in the United Kingdom' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 1073.

Under the Utilities Act, the Gas and Electricity Markets Authority (GEMA) has the power to adopt secondary legislation regulating the quality of gas that may be transported to premises or to pipeline systems operated by other gas transporters. Such legislation relates to pressure, purity, and other standards with respect to the properties, conditions and composition of the gas conveyed.⁵²⁸ The exercise of this power by GEMA is subject to the consent of the SoS.⁵²⁹ The transport of natural gas through pipelines to domestic and other customers is dealt with by the Gas Safety (Management) Regulations,⁵³⁰ which requires gas transporters to prepare a safety case for approval by the Health and Safety Executive (HSE).⁵³¹ The HSE is entrusted with the power to regulate gas quality insofar as safety may be affected.⁵³² In accordance with Regulation 2(8), gas may not be transported in a network unless it conforms with the requirements set forth in Schedule 3 of the Regulations.⁵³³

The Regulation provides a limit of 0.1mol% admixture of hydrogen.⁵³⁴ Although a predetermined limit is set forth in the Regulations, the HSE must approve the concentration of hydrogen to be delivered before any hydrogen can be blended with natural gas in the network. Such approval is, therefore, an exemption to the gas quality requirements in the Gas Safety (Management) Regulations. In order to be granted an approval, the admixture of hydrogen must be considered as safe to use as natural gas, and meet the gas quality requirements specified in Schedule 3 of the Regulations. If the HSE approves the requested concentration level of hydrogen to be blended with natural gas, hydrogen production units can be installed and connected to the network and an extensive trial programme undertaken.⁵³⁵ Although some room exists for the injection of hydrogen into the onshore natural gas network, the admixture limitation is considerably low, and prior approval by the HSE is required. Although a higher admixture limitation of hydrogen to the upstream gas pipelines may be provided these pipelines are connected to the onshore transportation network. Consideration must therefore be given to the gas quality standards applying to the onshore network. In practice, this means that hydrogen must either be fed into the offshore pipelines in such a way that it meets the onshore criteria, or it will have to be treated onshore prior to injection into the natural gas network. Hence, there is limited scope to blend offshore produced hydrogen with the natural gas transported to the onshore network.⁵³⁶

Although the UK has production sites for hydrogen via electrolysis onshore, none of them inject hydrogen into the existing natural gas network.⁵³⁷ This is likely to change in the near future, however, with the HyDeploy Project (funded by Ofgem) working hard to discover the hydrogen tolerance of the existing natural

⁵²⁸ Section 101(1) of the Utilities Act; see further the Statutory Annotations to Section 101 of the Utilities Act 2000, Government's Explanatory Note 159 to the Bill, available at <<http://www.legislation.gov.uk/ukpga/2000/27/notes/division/4/5/5>>

⁵²⁹ Section 101(1) of the Utilities Act.

⁵³⁰ Gas Safety (Management) Regulations 1996 (1996 No. 551), available at <<http://www.legislation.gov.uk/uksi/1996/551/contents/made>>

⁵³¹ See further Health and Safety Executive available at <<https://www.hse.gov.uk>>

⁵³² Explanatory Note 161 of the Utilities Act.

⁵³³ See further Schedule 3, Part I(1) of the Gas Safety (Management) Regulations

⁵³⁴ Schedule 3, Part I(1) of the Gas Safety (Management) Regulations; see further Health and Safety Executive, 'A Guide to the Gas Safety (Management) Regulations 1996', 2nd ed., 2007, p. 49, available at <<http://www.hse.gov.uk/pubns/priced/l80.pdf>>

⁵³⁵ See further HyDeploy, 'HyDeploy Project: Gas Network Innovation Competition', 2018, p. 2, available at <https://hydeploy.co.uk/app/uploads/2018/12/15055_HD_PH2_PROJECT_REPORT_v2.pdf>

⁵³⁶ Although the blending concentration of hydrogen in natural gas pipelines in the UK is relatively low, one must consider that the UK has a large network of natural gas pipelines with considerable gas transportation volume. If all pipelines, or a large share of all pipelines, were to be used to also transport hydrogen, it would entail that quite large volumes of hydrogen could be admixed to the natural gas network despite the low admissible concentration levels of hydrogen admixture applicable to the gas transportation network in the UK. For pilot and demonstration projects, this is probably not a problem, but when developing offshore hydrogen production on a large scale such limitations will pose a problem.

⁵³⁷ See further 'The effects of Hydrogen injection in natural gas networks for the Dutch underground storages', Commissioned by the Ministry of Economic Affairs, 2017, p. 55, available at <<https://www.rvo.nl/sites/default/files/2017/07/The%20effects%20of%20hydrogen%20injection%20in%20natural%20gas%20networks%20for%20the%20Dutch%20underground%20storages.pdf>>

gas networks.⁵³⁸ The results of the project are expected by 2020. The project aims to demonstrate that natural gas containing levels of hydrogen beyond the specifications set forth in the Gas Safety (Management) Regulations can be distributed and utilised safely and efficiently in a representative section of the UK natural gas networks.⁵³⁹ The work via HyDeploy takes a private natural gas network up to a maximum blend of 20mol% of hydrogen.⁵⁴⁰ Future thresholds of hydrogen admixture in the public natural gas transportation network will likely depend on the outcome of this project.

5.4 Denmark

5.4.1 Introduction

Danish energy demands are met primarily through domestic oil and natural gas resources and domestic renewable energy sources such as waste, wind and biogas.⁵⁴¹ In November 2011, the Danish Government published its plan, 'Our Future Energy',⁵⁴² with the main objective being to convert the country to 100% renewable energy uses by 2050. The strategy presents specific measures to fulfil the goal to stimulate green growth. Wind energy is projected to cover 50% of electricity use by 2020, and all electricity and heating should be based on renewables by 2035.⁵⁴³ It is estimated that these initiatives will result in Denmark's greenhouse gas emissions being cut by 40% by 2020 compared to 1990 levels.⁵⁴⁴ The ambition to be independent from fossil fuels by 2050 will require substantial investments in renewable energy, and several concrete measures are specified to reach this goal.⁵⁴⁵ Currently, Denmark has a cumulative installed capacity of 1,703 MW of offshore wind, but no goals for the total amount of offshore wind energy to be deployed in the long-term have been specified by the Government.⁵⁴⁶

Denmark is yet to adopt a comprehensive marine spatial plan for its sea area. While a proposal for a Danish marine spatial plan has been tabled, it contains no specific reference to the development of wind energy for the production of hydrogen at sea. The concept of producing hydrogen offshore from wind energy is new, and is not yet taking place in Denmark. The potential for such development is promising, provided that the electricity needed is sourced largely from offshore wind farms. Moreover, the production of oil and gas offshore in Denmark is declining, and it is anticipated that Denmark will be self-sufficient only until the end of the 2020s.⁵⁴⁷ Following forty years of hydrocarbon production, the Danish part of the North Sea can be termed a 'mature area', with a primary focus on optimising the current production and maintenance of the existing installations.⁵⁴⁸ Adopting offshore PtG may allow Denmark to more easily meet its emission reduction and energy security targets.

⁵³⁸ See further HyDeploy, 'Hydrogen is vital to tackling climate change', 2019, available at <<https://hydeploy.co.uk>>

⁵³⁹ Isaac, T., 'HyDeploy: The UK's First Hydrogen Blending Deployment Project', (2019) 3 Clean Energy 2, p. 114-125.

⁵⁴⁰ HyDeploy, 'HyDeploy Project: Gas Network Innovation Competition', 2018, p. 2, available at <https://hydeploy.co.uk/app/uploads/2018/12/15055_HD_PH2_PROJECT_REPORT_v2.pdf>

⁵⁴¹ IEA, 'Denmark: Key energy statistics', 2018, available at <<https://www.iea.org/countries/denmark>>

⁵⁴² Ministry of Climate, Energy and Utilities, *Our Future Energy* (November, 2011). The Danish Government, *Together For the Future, Government Platform*, June 2015, p. 23.

⁵⁴³ Ministry of Climate, Energy and Utilities, *Our Future Energy* (November, 2011). The Danish Government, *Together For the Future, Government Platform*, June 2015, p. 23.

⁵⁴⁴ Rønne, A., 'Energy Law in Denmark' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 406.

⁵⁴⁵ One of the measures specified is for example tendering 600MW at Kriegers Flak; see further Ministry of Climate, Energy and Utilities, *Our Future Energy* (November, 2011). The Danish Government, *Together For the Future, Government Platform*, June 2015, p. 104.

⁵⁴⁶ WindEurope, 'Offshore Wind in Europe: Key Trends and Statistics 2018', p. 15, available at <<https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2018.pdf>>

⁵⁴⁷ Rønne, A., 'Energy Law in Denmark' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 417.

⁵⁴⁸ Rønne, A., 'Energy Law in Denmark' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 417.

Hydrogen technologies have been supported at the national level in Denmark for decades and have taken many shapes and forms.⁵⁴⁹ In the 1990s and 2000s, the Danish focus on hydrogen was based mainly on research, development and production of fuel cells. In the same era, Denmark began to convert its energy sources from fossil fuels to greener alternatives, which primarily resulted in heavy investment in wind energy to produce more green electricity.⁵⁵⁰ The availability of larger amounts of intermittent electricity resulted in a shift in energy policy regarding the use of hydrogen.⁵⁵¹ The new focus is on how to use the newly acquired green energy for transportation purposes, which means a larger focus on the conversion of green electricity to hydrogen through electrolysis.⁵⁵² To exploit these capabilities, the political focus has shifted towards the storage of hydrogen and the possibility of linking the hydrogen sector with other energy sectors, *i.e.* sectoral integration.⁵⁵³

5.4.2 Electricity Input for Hydrogen Conversion

Current operational offshore wind farms in Denmark are established under the government-led tender as organised by the Danish Energy Agency (DEA). For tendered offshore wind farms, Energinet⁵⁵⁴ is responsible for connecting the offshore wind farm to the offshore electricity grid and, therefore, constructs, owns and maintains both the converter station and the underwater cable that carries the electricity to shore.⁵⁵⁵ The establishment of offshore wind farms can also follow an 'open-door procedure'. In this procedure, the project developer takes the initiative to establish an offshore wind farm in a particular area, which is done by submitting an unsolicited application for a licence to carry out preliminary investigations in a given area (outside areas that are already designated wind energy areas specified in the spatial planning process).⁵⁵⁶ The grid connection takes place onshore and it is the developer of the wind farm that has the responsibility to construct and operate the cable that is necessary to bring the offshore produced electricity to the shore.⁵⁵⁷ The cable is therefore part of the offshore wind farm, and the responsibility passes to Energinet at the onshore connection point.⁵⁵⁸

Establishment of new transmission networks in the territorial sea and in the EEZ can only be made after prior approval by the Ministry of Energy, Utilities and Climate, and the approval is subject to conditions regarding *inter alia* the location and layout of the cables.⁵⁵⁹ For the construction of sub-sea electricity cables by the wind farm developer, it is necessary to obtain a permit from the same Ministry, in accordance with Section

⁵⁴⁹ Partnerskabet Brint og Brændselsceller, *Elektrolyse i Danmark: Strategi for F,U&D 2010-2018*, available at <<http://ieahydrogen.org/Activities/National-Documents/Task-18/DK-electrolyse-strategi-2009.aspx>>

⁵⁵⁰ Ministry of Climate, Energy and Utilities, Energy Agreement (*Energiaftale*) of 29 June 2018, available in Danish at <<https://efkm.dk/media/12222/energiaftale2018.pdf>>; HyLaw, Jensen, T.L., Møller Husted, E., *National Policy Paper – Denmark*, available at <<https://www.hylaw.eu/sites/default/files/2018-10/National%20Policy%20Paper%20-%20Danmark%20%28DK%29.pdf>>

⁵⁵¹ Danish Energy Agency, *Denmark's Energy and Climate Outlook 2017*, p. 26, available at <https://ens.dk/sites/ens.dk/files/Analyser/denmarks_energy_and_climate_outlook_2017.pdf>

⁵⁵² HyLaw, Jensen, T.L., Møller Husted, E., *National Policy Paper – Denmark*, available at <<https://www.hylaw.eu/sites/default/files/2018-10/National%20Policy%20Paper%20-%20Danmark%20%28DK%29.pdf>>

⁵⁵³ HyLaw, Jensen, T.L., Møller Husted, E., *National Policy Paper – Denmark*, available at <<https://www.hylaw.eu/sites/default/files/2018-10/National%20Policy%20Paper%20-%20Danmark%20%28DK%29.pdf>>

⁵⁵⁴ Energinet is the Danish national transmission system operation for electricity see Act on Energinet (*Energinetloven*) no. 997 of 27 June 2018.

⁵⁵⁵ Section 2(2) of the Act on Energinet (*Energinetloven*) no. 997 of 27 June 2018; see further Danish Energy Agency, *Danish Experiences from Offshore Wind Development*, p. 20, available at <https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_development_0.pdf>

⁵⁵⁶ Danish Energy Agency, *Danish Experiences from Offshore Wind Development*, p. 27, available at <https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_development_0.pdf>

⁵⁵⁷ See Chapter 4 of the Promotion of Renewable Energy Act (*Energifremmeloven*) no. 356 of 4 April 2019.

⁵⁵⁸ Müller, H.K., *A Legal Framework for a Transnational Offshore Grid in the North Seas*, Intersentia, 2016, p. 172.

⁵⁵⁹ Section 4a of the Act on Energinet.

22a of the Electricity Supply Act (*Elforsyningsloven*).⁵⁶⁰ This provision applies to all offshore electricity cables except the inter-array cables of the offshore wind farm.⁵⁶¹

Neither the construction licence for sub-sea electricity cables nor the electricity production licence or the grid extension plan seems to allow for the establishment of an alternative connection point, such as between an offshore platform and the offshore electricity network (or directly to an offshore wind farm). These licences and plans merely refer to a grid connection for the purpose of bringing electricity from an offshore wind farm to the national transmission network onshore. Another obstacle to establish such an alternative connection is the requirement, under the national subsidy regime, to feed electricity produced from offshore wind farms into the national transmission network.⁵⁶² The winning applicant of a wind farm tender can only profit from the support scheme from the moment the wind farm is connected to the onshore transmission network.⁵⁶³ Similarly, in the open-door procedure, offshore wind farms profit from the support scheme after the connection to the onshore transmission network.⁵⁶⁴

'Transmission networks' is defined in Section 5(19) of the Electricity Supply Act as "a collective electricity supply network, which is intended to transport electricity from production sites to central centres of the distribution network or to connect it to other connected electricity supply networks". An electricity cable connecting a wind farm to a platform is thus not covered by this definition. A determination must therefore be made of whether such an electricity cable could be classified as a 'direct line' under the Electricity Supply Act. Section 5(4) defines a 'direct electricity supply network' as an electricity supply network intended for the supply of electricity from one electricity generating undertaking to another electricity generating undertaking, or to specific customers; and which replaces the use of the public electricity supply network in whole or in part. Given that the Electricity Supply Act applies to the EEZ, it would therefore also apply to the establishment of a 'direct electricity supply network' offshore.⁵⁶⁵ The definition provided by the Act thus appears to be applicable to an offshore electricity cable connecting an offshore wind farm (electricity generating asset) and an offshore platform (customer). As this definition refers to the replacement of the use of the public electricity supply network in whole or in part, it is likely that connections between wind farms and platforms qualify as 'direct lines', even where such wind farms are connected to the transmission network. The construction of direct lines requires a permit;⁵⁶⁶ however, the relevant permit may only be issued if the applicant has previously been denied permission to transport electricity through the collective electricity supply network, and it has been impossible to find a solution to the problem by submitting it to the DERA.⁵⁶⁷

5.4.3 Hydrogen Conversion

The Subsoil Act (*Undergrundsløven*)⁵⁶⁸ is the principle legislation in Denmark governing the extraction of oil and natural gas onshore and offshore.⁵⁶⁹ Per the Subsoil Act, oil and natural gas belong to the state, and can only be recovered by others after a combined exploration and production licence has been granted by the Minister of Climate, Energy and Supply, authorising all activities necessary for the exploration for and

⁵⁶⁰ Electricity Supply Act (*Elforsyningsloven*) no. 840 of 15 August 2019.

⁵⁶¹ Section 22a(3) of the Electricity Supply Act; Section 25(1) of the Promotion of Renewable Energy Act; Section 4(a) of the Act on Energinet.

⁵⁶² See chapter 6 of the Promotion of Renewable Energy Act.

⁵⁶³ Section 37(4) of the Promotion of Renewable Energy Act.

⁵⁶⁴ Section 39(3) of the Promotion of Renewable Energy Act; see further See further Danish Energy Agency, *Procedures and Permits for Offshore Wind Parks*, available at <<https://ens.dk/en/our-responsibilities/wind-power/offshore-procedures-permits>>

⁵⁶⁵ Section 2(2) of the Electricity Supply Act.

⁵⁶⁶ Section 23(1) of the Electricity Supply Act.

⁵⁶⁷ Section 23(2) of the Electricity Supply Act.

⁵⁶⁸ The Subsoil Act (*Undergrundsløven*) no. 1533 of 16 December 2019.

⁵⁶⁹ Section 1 of the Subsoil Act.

production of hydrocarbons.⁵⁷⁰ It is thus prohibited to extract natural gas without a licence to do so. Installations needed for hydrocarbon production must be approved as part of the development prior to production beginning.⁵⁷¹ It is necessary to consider whether the installation and operation of an electrolyser on an offshore platform with ongoing hydrocarbon activities could be considered an ancillary service to this activity. For a service to be considered an ancillary service, it must be necessary to support the installation's main activity. Given that the Subsoil Act only applies to hydrocarbons extracted from the subsoil, with the licence only covering installations necessary for the production of hydrocarbons, it is unlikely that the installation of an electrolyser and the subsequent production hydrogen will be considered ancillary to the main function. If that is the case, it will likely not be possible to carry out the new function under the platform's existing hydrocarbon licence.

The possibility of installing and operating an electrolyser on a hydrocarbon platform following the cessation of natural gas production must also be considered, with position under international law analysed in Sections 3.4.2 – 3.4.3. While allowing existing installations to be reused may allow for benefits to be realised, Section 33 of the Subsoil Act appears fatal to repurposing of such installations in Denmark. The provision places an obligation on the license holder to remove an offshore installation after it ceases to be used for its original purpose. It appears that little consideration was given for the potential re-purposing of existing hydrocarbon platforms, with no mention within the Subsoil Act for how it may occur. Nevertheless, a reading of international conventions and guidelines seems to leave room for the repurposing of platforms for the production of hydrogen.⁵⁷²

Marine activities in Denmark are regulated by a large number of sectoral laws including, *inter alia*, the Marine Environment Protection Act (*Lov om beskyttelse af havmiljøet*),⁵⁷³ the Raw Materials Act (*Lov om råstoffer*),⁵⁷⁴ the Subsoil Act (*Undergrundsloven*),⁵⁷⁵ the Continental Shelf Act (*Lov om kontinentalsoklen og visse rørledningsanlæg på søterritoriet*)⁵⁷⁶ and the Electricity Supply Act (*Elforsyningsloven*).⁵⁷⁷ There are, therefore, several authorities responsible for the marine area and various levels of administrative decision-making. With the exception of the Marine Environment Protection Act (which aims to limit and prevent the negative effects of activities taking place in the marine area), none of the previously mentioned laws govern either the installation of an electrolyser on an existing offshore hydrocarbon platform or the subsequent production of hydrogen.

The Act on Maritime Spatial Planning (*Lov om maritim fysisk planlægning*),⁵⁷⁸ which introduces sector-specific plans for the marine area, provides some clarity. Various sectors are included in the legislation, such as *inter alia* offshore energy, maritime transport, the extraction of raw materials, and the preservation, protection and improvement of the environment.⁵⁷⁹ The Ministry of Industry, Business and Financial Affairs is tasked with determining the physical and temporal distribution of existing and future activities and uses in the national marine spatial plan.⁵⁸⁰ The Ministry, however, does not grant any licences or permits on the basis of this Act, as it merely provides the current and future policy strategy of the marine area.

⁵⁷⁰ Section 2 of the Subsoil Act; see further Chapter 3 of the Subsoil Act.

⁵⁷¹ See Section 10 of the Subsoil Act.

⁵⁷² For a more comprehensive understanding on re-use of offshore installations and structures see Section 3.4.3.

⁵⁷³ Marine Environment Protection Act (*Lov om beskyttelse af havmiljøet*) no. 116 of 26 January 2017.

⁵⁷⁴ Raw Materials Act (*Lov om råstoffer*) no. 1218 of 28 September 2016.

⁵⁷⁵ Subsoil Act (*Undergrundsloven*) no. 960 of 13 September 2011.

⁵⁷⁶ Continental Shelf Act (*Lov om kontinentalsoklen og visse rørledningsanlæg på søterritoriet*) no. 1101 of 18 November 2005.

⁵⁷⁷ Electricity Supply Act (*Elforsyningsloven*) no. 840 of 15 August 2019.

⁵⁷⁸ Act on Maritime Spatial Planning (*Lov om maritim fysisk planlægning*) no. 615 of 8 June 2016.

⁵⁷⁹ Section 5(2) of the Maritime Spatial Planning Act, see further Marine Policy and Regional Coordination Section, *Denmark* <<http://msp.ioc-unesco.org/world-applications/europe/denmark/>>

⁵⁸⁰ Section 7 of the Maritime Spatial Planning Act.

Given that activities taking place offshore are governed by specific legislation, there is no general legislation governing all other activities falling outside the scope of such legislation. There is thus no general 'licensing' or 'permitting' regime for activities not covered by specific legislation. In theory, however, this does not prevent a project developer from approaching the Ministry to request a permit to make use of a specific marine area to carry out a certain activity. Nonetheless, it is extremely difficult to ascertain which rules would apply to such an activity. The lack of a general licensing or permitting regime for activities not covered by specific legislation evidently demonstrates that there is a gap in the current legislation.

5.4.4 Hydrogen Transport

The Gas Supply Act (*Naturgasforsyningsloven*)⁵⁸¹ regulates the transport of natural gas on the territory of Denmark, the territorial sea, the EEZ and the CS.⁵⁸² The Act is applicable to the transmission, distribution, supply and storage of natural gas as well as adjacent natural gas systems.⁵⁸³ Furthermore, the Act is applicable to biogas, biomass and other types of gases, insofar as such gases can be technically and safely injected into and transported through the natural gas system.⁵⁸⁴

The proposal to produce hydrogen on offshore platforms entails that the produced hydrogen is transported via upstream pipelines to shore. Section 16(5) of the Subsoil Act (*Undergrundsløven*)⁵⁸⁵ obliges owners and operators in a dominant position to negotiate with parties seeking access to their pipelines in order to ensure that they do not possess an advantage at the expense of third parties. Any refusal of access must be justified, with the owner or operator of an upstream pipeline only able to refuse access out of necessity, due to *inter alia* different technical specifications.⁵⁸⁶ Although, there is no regulation on technical standards (e.g. gas quality) for such networks⁵⁸⁷ these pipelines are connected to the onshore transportation network and account must therefore be taken of the gas quality standards applying to the onshore natural gas network.

Under the Gas Supply Act, all gas fed into the onshore transportation network must adhere to certain quality standards.⁵⁸⁸ In accordance with Section 12(2) and Section 14(2) of the Gas Supply Act, the TSO and the DSO are responsible for ensuring that the quality of the gas supplied through the transmission and distribution networks, respectively, adhere to the standards set forth in the in the Executive Order on Gas Quality (*Bekendtgørelse om gaskvalitet*).⁵⁸⁹ The Order is issued pursuant to the Gas Safety Act (*Gassikkerhedsloven*)⁵⁹⁰ and a number of underlying regulations, all of which relate to gas safety, are issued under this Act.⁵⁹¹ Executive Orders are administrative regulations, which is a form of secondary legislation. The Ministry concerned can therefore change them without prior approval by Parliament. This means that the Executive Order on Gas Quality can be changed relatively easy if such changes fall within the authority of the Ministry concerned and it is necessary due to changed circumstances (for example the need for rules regarding hydrogen injection into the natural gas networks). Distribution networks for the supply of natural gas and biogas and transmission networks for the transport of natural gas are excluded from the scope of

⁵⁸¹ Gas Supply Act (*Naturgasforsyningsloven*) no. 1127 of 5 September 2018.

⁵⁸² Section 2(1) and (3) of the Gas Supply Act.

⁵⁸³ Section 2 of the Gas Supply Act.

⁵⁸⁴ Section 2(2) of the Gas Supply Act.

⁵⁸⁵ Subsoil Act (*Undergrundsløven*) no. 1190 of 21 September 2018.

⁵⁸⁶ Rønne, A., 'Energy Law in Denmark' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 432, 453.

⁵⁸⁷ See Section 1(3) of the Gas Safety Act (*Gassikkerhedsloven*) no. 61 of 30 January 2018.

⁵⁸⁸ Rønne, A., 'Energy Law in Denmark' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 438.

⁵⁸⁹ Executive Order on Gas Quality (*Bekendtgørelse om gaskvalitet*) no. 230 of 21 March 2018.

⁵⁹⁰ Gas Safety Act (*Gassikkerhedsloven*) no. 61 of 30 January 2018.

⁵⁹¹ For an overview of the regulations see Retsinformation.dk, available in Danish at <<https://www.retsinformation.dk/Forms/R0910.aspx?id=198294&rg=8>>

the Executive Order on Gas Quality, but the Order still applies to the quality of the gas transported through these networks.⁵⁹²

One important requirement pertaining to the chemical state of the gas injected into the existing natural gas network is that the substance should mainly consist of methane or another substance equivalent to methane.⁵⁹³ For example, biogas must be of quality similar to that of natural gas before being injected into the natural gas network.⁵⁹⁴ Biogas must therefore be upgraded to natural gas quality at upgrading facilities, and only then can it be traded in the same way as natural gas.⁵⁹⁵ At present, there is no legislated maximum injection concentration of hydrogen for the natural gas network defined in the Executive Order on Gas Quality.⁵⁹⁶ There is therefore little room for the injection of hydrogen into the onshore natural gas network in Denmark. In practice, it would only be possible to admix hydrogen into the natural gas network after prior approval by the Danish Safety Authority,⁵⁹⁷ and such permission is likely to be provided only if the admixture of hydrogen does not excessively change the quality of the natural gas.⁵⁹⁸ Although these rules do not apply to the gas transported through the offshore upstream network, any quantity of gas transported from an offshore location to the onshore transmission network will have to be treated in such a way that it is able to meet the criteria upon injection into the onshore network. In practice, this means that it will have to be treated onshore prior to injection into the natural gas network. Hence, the possibility to blend hydrogen in offshore natural gas networks and transport it to the onshore transmission network is greatly limited.

Major studies are being carried out in Denmark on the possibility of using the current gas infrastructure to transport hydrogen, in which Energinet actively participates – but further studies are required before a consolidated hydrogen acceptance limit can be implemented in the gas quality specifications.⁵⁹⁹ Energinet is currently conducting a demonstration project where the effects of injecting up to 15vol% of hydrogen into the natural gas network is tested, and the results of this is expected to act as a basis to develop national standards.⁶⁰⁰ Furthermore, one methanation plant in Denmark is permitted to inject up to 20vol% of hydrogen into the distribution grid.⁶⁰¹ The Executive Order on Gas Quality should specify maximum volume of hydrogen admixture when hydrogen is introduced in natural gas networks. Similar to the rules applicable to the injection of biogas into the natural gas networks, it seems likely that hydrogen can only be injected into natural gas networks without prior approval if upgraded to natural gas quality, hence, SNG.⁶⁰² Finally, Denmark is working on a political strategy regarding green gases, with rules on admixture limitations of hydrogen expected to be announced in the near future.⁶⁰³

⁵⁹² Section 1(2) and (3) of the Gas Safety Act.

⁵⁹³ Section 2(3), (4) and (6) of the Executive Order on Gas Quality. See further definition of hydrogen in Section 2(8) of the Executive Order on Gas Quality.

⁵⁹⁴ Chapter 6 of the Executive Order on Gas Quality.

⁵⁹⁵ Rønne, A., 'Energy Law in Denmark' in Roggenkamp, M., Redgewell, C., Rønne, A., Del Guayo, I. (eds) *Energy Law in Europe: National, EU and International Regulation* (3rd edn, Oxford 2016), p. 438.

⁵⁹⁶ Section 27(1) of the Executive Order on Gas Quality merely prescribes the quality of the hydrogen to be injected into the natural gas distribution network and Section 27(2) of the Executive Order on Gas Quality requires an approval by the Danish Safety Authority before one may inject hydrogen into the natural gas distribution network.

⁵⁹⁷ See Section 27(2) of the Executive Order on Gas Quality.

⁵⁹⁸ See Section 2(3) and (4) of the Executive Order on Gas Quality.

⁵⁹⁹ Danish Energy Agency, '*Den fremtidige anvendelsen af gasinfrastrukturen*', 2014, p. 83, available in Danish at <https://ens.dk/sites/ens.dk/files/EnergiKlimapolitik/gasinfrastrukturen_-_analyse_2014_web.pdf>

⁶⁰⁰ Bruun, J., et al, '*Energy Storage – Hydrogen injected into the Gas Grid via electrolysis field test*', 2018; Energinet, '*Danish gas system able to store wind energy*', 2019, available at <<https://en.energinet.dk/About-our-news/News/2019/05/21/Danish-gas-system-able-to-store-wind-energy>>

⁶⁰¹ See further the BioCat Project available at <<http://biocat-project.com/about-the-project/>>

⁶⁰² See further discussion in Partnerskabet for brint og brændselsceller, '*Brint og brændselsceller bidrager til at løse Danmarks store udfordringer*', 2012, p. 4, available in Danish at <<https://www.ft.dk/samling/2011/almindel/KEB/bilag/139/1064118.pdf>>

⁶⁰³ Regeringen, '*Sammen om en grønnere fremtid*', available in Danish at <<https://www.regeringen.dk/nyheder/miljoe-og-klimaudspil/>>

5.5 Comparative Analysis and Recommendations

This section provides an overview of the findings from the analysis of the legal regimes pertaining to hydrogen activities offshore in the Netherlands, the UK and Denmark in relation to the three stages of the PtG process: (i) electricity input for hydrogen conversion, (ii) hydrogen conversion, and (iii) hydrogen transport.

5.5.1 Electricity Input for Hydrogen Conversion

Various forms of networks exist for the transportation of electricity. However, unlike the oil and gas sector, there is no separate category for 'upstream' electricity networks. Instead, three distinct regulatory models can be identified from the analysis of the Dutch, British and Danish regimes governing the offshore electricity network and the connection of offshore wind farms to the onshore electricity network. The first is the 'TSO model', in which the appointed TSO is responsible for connecting offshore wind farms to the electricity network. This model is used for wind farms developed after 2016 in the Netherlands, and for tendered wind farms in Denmark. The second model is the 'wind farm developer model', in which offshore wind farm developers are responsible for the construction of the cable and for the connection of the offshore wind farm to the onshore transmission network. This model was used for wind farms developed offshore before 2016 in the Netherlands and before 2009 in the UK – and is still the model for wind farms established under the open-door procedure in Denmark. The third model is the 'third-party-model', currently applied in the UK, which involves a tendering process for the connection of the offshore wind farm to the onshore transmission network. This model utilises third party ownership and operation of the offshore electricity assets. Considering these regulatory models, it must be determined whether an offshore hydrocarbon platform can be connected via an electricity cable to (i) the offshore electricity network, or (ii) an offshore wind farm.

The offshore electricity network developed by TenneT in the Netherlands (defined in the Dutch Electricity Act) and by Energinet in Denmark (defined in the Danish Electricity Supply Act) is only intended for the transport of electricity from one or more wind farms to the onshore transmission network in each respective country. Similarly, in the UK, it is explicitly stated in the third tender round for wind farms that all wind farm projects are required to connect through the national transmission network onshore. The purpose of these networks is, therefore, not to facilitate offshore electricity supply and consumption, but to bring to shore electricity produced offshore. Neither the TSOs nor the OFTOs have been assigned the responsibility to enable this form of connection offshore. As a result, there is no explicit regulation in the countries facilitating a connection between the offshore electricity grid and an offshore platform.

Little guidance is also provided in national legislation regarding the connection of an offshore wind farm to an offshore platform via an electricity cable. The analysis of the Dutch, British and Danish definitions of 'transmission network' demonstrates that such an electricity cable falls outside the prescribed definitions. While the concept of a 'direct line' (as provided in the EU Electricity Directive) may be able to provide some legal certainty to the development of these cables, this potential utility is to some extent hampered by the fact that – of the three jurisdictions considered – only the Danish definition of 'direct line' seems broad enough to encompass a cable connecting an offshore wind farm (which is itself connected to the national transmission network) to an offshore platform. The case is, however, clearer when the wind farm in question is not connected to the transmission network or any other network for the transport of electricity. In this case, the electricity cable connecting such a wind farm to a platform is likely to be defined as a 'direct line' in all three jurisdictions. Even when such a cable would be classified as a 'direct line' under the Dutch legislation, one must consider that provisions governing 'direct lines' in the Netherlands are not applicable offshore. In comparison, it is uncertain whether the rules on 'direct lines' apply offshore in the UK. In order to facilitate hydrogen conversion on offshore platforms, it should be clarified whether an offshore electricity cable connecting an offshore wind farm and an offshore platform is to be defined as a 'direct line', meaning that it

would not be considered part of the transmission network. If not, a definition, and possibly a separate legal regime governing such cables, must be adopted.

In conclusion, an alternative connection between an offshore wind farm and an offshore platform is not explicitly included in any of these countries' legislation. Proposed amendments to the Dutch Wind Energy at Sea Act, however, seem to promote the possibility of connecting wind farms to offshore consumers (e.g. energy conversion installations) through the introduction of a new type of connection. There is, however, no clarification in this amendment as to how the cable establishing such a connection should be classified. Furthermore, to facilitate this type of connection, one must also consider the legal arrangements of the support schemes in the Netherlands, the UK and Denmark. One of the most prominent requirements of such support schemes is that the electricity produced by offshore wind farms must be fed into the national transmission network. This means that offshore wind farms would become ineligible for the subsidy should the electricity produced be utilised offshore. However, subsidies for developing offshore wind farms in the Netherlands and Denmark have decreased or are no longer needed, making the relevance of this issue more or less redundant under current market conditions. Nevertheless, one should not ignore that the legal barriers addressed in this Section must be removed before offshore platforms are connected to any part of the offshore electricity infrastructure.

5.5.2 Hydrogen Conversion

There is no specific legislation regulating the installation of an electrolyser and the subsequent production of hydrogen from an existing hydrocarbon platform. One commonality between the three jurisdictions analysed is that, in all cases, it is extremely unlikely that the natural gas production licence covers the construction and operation of an electrolyser on a platform, even if the platform is already in possession of such a licence. Indeed, this is the case regardless of whether the electrolyser will be installed on a platform still producing natural gas, or on a platform that has ceased natural gas production. In the latter case, it is also unclear whether it is possible to install an electrolyser at all, as all countries in this assessment presently require disused platforms to be removed. Nevertheless, a reading of international conventions and guidelines seems to leave room for the repurposing of platforms for the production of hydrogen.

The analysis of legislation applicable to the development of activities offshore in these countries indicates that the construction of an electrolyser offshore (and the subsequent production of hydrogen) falls outside the scope of legislation governing specific offshore activities, such as *inter alia* legislation governing the extraction of hydrocarbons and the generation of electricity. In the Netherlands and the UK, there is a general framework in place to govern all activities in water systems and regulate activities in the marine area that are not covered by specific legislation. Each of the Water Act, the Marine Coastal Access Act and the Scottish Marine Act contain provisions applicable to the construction of an electrolyser offshore, requiring a developer first to obtain a water permit or a marine licence respectively. By contrast, Denmark has not adopted a general framework. Instead, actors planning to construct or change infrastructure offshore must communicate this with the relevant authority. Without a general framework, and without specific legislation applying to the construction of electrolyzers offshore, it is unclear what rules would be applied.

Moreover, the Water Act and the Marine Coastal Access Act, and the Scottish Marine Act merely require a permit or a licence, respectively, for the construction of an installation offshore. Where it is established that the developer of an electrolyser offshore must obtain a water permit (the Netherlands) or a marine licence (the UK), there are no rules governing the operation of such an electrolyser. The absence of even a more generalist piece of legislation in Denmark creates even greater legal uncertainty regarding the rules applicable to the operation of an electrolyser.

Furthermore, it is necessary to re-state that the construction of an electrolyser on an existing hydrocarbon platform does not refer to construction of a completely 'new installation' offshore. Instead, the electrolyser will be constructed on an existing installation, which is already licensed under a different regime. It is, therefore, necessary to clarify whether the Water Act, the Marine Coastal Access Act and the Scottish Marine Act apply to already existing installations. If so, the interplay between the hydrocarbon production licence and the water permit/marine licence (when an electrolyser is constructed on an existing hydrocarbon platform still extracting natural gas) must be clarified. Where the electrolyser is constructed on a platform which no longer produces natural gas, it is necessary to clarify whether the water permit and the marine licence apply to the whole platform, or just to the construction of the electrolyser. Lastly, it is necessary to clarify the rules applicable to the operation of an electrolyser, and to the hydrogen conversion process.

5.5.3 Hydrogen Transport

The analysis of national gas legislation showcases the lack of certainty regarding the transport and supply of hydrogen – specifically whether the legislation governing the transport and supply of natural gas automatically carries over. The applicability of gas legislation to the injection of hydrogen into natural gas networks in the Netherlands, the UK and Denmark depends on how the term 'gas' is defined. One common requisite pertaining to the chemical state of the gas injected into the natural gas network of these countries is that the gas (substance) to be injected consists primarily of methane, or of another substance equivalent to methane in terms of its characteristics. Provided that the characteristics of natural gas and hydrogen are different, it may well be argued that gas legislation in these countries does not apply to the injection of hydrogen into natural gas networks. It is, however, prescribed in these countries' gas legislation that the legislation in question is applicable to the injection of other gases into the natural gas network, in so far as it is technically feasible and safe to inject such gases. It is thus necessary to seek guidance in national gas quality rules in order to determine the admissible concentration levels of hydrogen admixture into natural gas networks. Establishing the admissible concentration levels is of paramount importance when determining whether the hydrogen produced offshore can be injected into the existing national gas transmission network onshore. Although it is outside the scope of this report, it should be noted that this is not relevant to consider when injecting pure hydrogen into new offshore and onshore pipelines developed for the purpose of dedicated hydrogen transport.

The amount of hydrogen that can be blended in the natural gas network depends on local network conditions and the legislation governing admixture levels differs between the countries in this assessment. Although it may be technically feasible and safe to blend hydrogen in natural gas networks, neither the Netherlands nor the UK permit very high admixture levels. Furthermore, no admixture concentration level of hydrogen injection is prescribed in Denmark. This is attributable to safety concerns and the fact that the necessary technology has not yet been installed. An analysis of the legislation governing gas quality demonstrates that the Dutch legislation allows for the highest admixture level of 0.5mol% in certain parts of its natural gas network, while the British legislation allows for 0.1mol% in certain parts of its natural gas network. However, ongoing projects in these countries indicate that it is technically feasible and safe to raise the permitted concentration level of hydrogen injection beyond the current limits. In order to introduce hydrogen into the existing natural gas system, it is important to adapt these admixing restrictions to the levels proven to be technically feasible and safe in practice. Over the next decade, gas in Europe will come from more diverse sources and may, therefore, be characterised by a wider range of gas quality. This may mean that, in the future, gas in certain countries may be incompatible with gas quality standards in other countries. Hence, it may be necessary to take action to alter the gas quality standards sooner rather than later, to ensure that these standards safeguard a higher share of green gases such as hydrogen.

In contrast to Dutch legislation, UK and Danish legislation require approval from the relevant authority before hydrogen can be injected into a specific part of the onshore natural gas network. Arguments can be made

both for and against such a procedure. On the one hand, an approval for hydrogen injection on a case-by-case basis safeguards the integrity and interoperability of the specific gas network. On the other hand, such a procedure creates a competitive disadvantage for hydrogen producers relative to natural gas producers, as it creates a barrier for the former to enter the gas market. This is especially the case if the approval procedure is complex, as it is likely to increase the costs for the hydrogen producer. In practice, pre-determined rules on the restrictions of hydrogen admixture for specific parts of natural gas networks create legal certainty for hydrogen producers, which is currently the case in the Netherlands.

5.6 Interim Conclusions

It should be stressed that the development of PtG activities offshore is contingent on each country's overall national policy strategy for the marine area. The Netherlands, the UK and Denmark have all transposed the EU Maritime Spatial Planning Directive into national law, and, as such, must each draft their own marine spatial plans determining the physical distribution of existing and future activities in their marine areas. However, the conversion of wind energy to hydrogen at sea is excluded from these countries' marine spatial plans (or proposed marine spatial plans). The successful development of hydrogen conversion activities in the North Sea requires that coastal states ensure that hydrogen is a part of their national policy strategy, as only then may hydrogen conversion be considered an 'eligible activity' when allocating the use of space for offshore activities in the North Sea.

The establishment of a connection between any part of the offshore electricity infrastructure and an offshore hydrocarbon platform – necessary to provide electricity supply for the conversion process – represents one of the most prominent legal challenges to the successful production of hydrogen on such a platform. Currently, national legislation pertaining to the construction of electricity cables and the transport of electricity offshore inhibits the establishment of a connection between the offshore electricity network and an offshore platform. The possibility of connecting an offshore wind farm to an offshore platform also requires consideration; however, this is difficult given the ambiguities in national legislation regarding how such electricity cables are defined. It may well be that such a cable could be classified as a 'direct line', and thus subject to a different set of rules to those that regulate the transmission network. This report's analysis, however, indicates that it is uncertain as to whether this definition applies to the electricity cables in question. Moreover, no guidance is provided in national legislation regarding who ought to be responsible for the construction and connection of these electricity cables. In order to facilitate hydrogen conversion on offshore platforms, a definition, and possibly a separate legal regime governing these electricity cables must be adopted in national law.

There is no specific legislation regulating the construction of an electrolyser and the subsequent production of hydrogen from an existing hydrocarbon platform. This report's analysis shows that it is highly unlikely that the construction and operation of an electrolyser on a hydrocarbon platform can be carried out under the gas production licence applicable to the platform in question. This assumption is independent of whether the platform still produces natural gas, or whether the platform has ceased production. When the relevant platform no longer produces natural gas, issues surrounding decommissioning emerge, as each of the jurisdictions analysed in this report currently require the removal of such infrastructure. It is thus uncertain which national legislation applies to the construction and operation of electrolysers on existing hydrocarbon platforms. Although, the Netherlands and the UK have adopted underlying permitting and licensing regimes governing the development of activities in the marine area, it is unclear whether even these general frameworks apply to activities taking place on installations that have already been licensed under a different regime. Even where such legislation actually applies to the construction of an electrolyser, there are currently no rules concerning its operation.

Blending hydrogen in existing natural gas networks would avoid the significant capital costs incurred through developing new gas transportation infrastructure. Although it may be technically feasible and safe to blend hydrogen into natural gas networks, neither the Netherlands nor the UK permit high admixture levels. Furthermore, no admixture concentration level of hydrogen injection is prescribed in Denmark. Currently, there is little scope for network operators to assume a larger role in the transport and supply of hydrogen. As hydrogen can be transported and supplied in the same way as natural gas, regulation governing the blending of hydrogen is necessary in order to realise the potential of hydrogen.

6. Conclusions

This report elaborates on the legal framework governing offshore hydrogen activities at international, EU, and national levels. In the absence of specific rules or documents providing legal guidance on the concept of offshore PtG, the conclusions are based on related legislative frameworks and a reasoned interpretation. This report shows that existing, related legal frameworks must be adapted to be made applicable to PtG if the development of PtG facilities offshore is to be facilitated.

Under international law, the North Sea states have full jurisdictional rights (and full sovereignty) in their territorial sea, and a functional jurisdiction (and sovereign rights) over their EEZ and CS. States must, however, seek to strike a balance between the execution of their rights and the rights of other users of the sea. Whereas national laws apply automatically in the territorial sea, North Sea states must explicitly state whether such laws are also applicable in their EEZ and on their CS. The right of the EU to legislate in maritime areas hypothetically extends as far as the Member State's own right to legislate, though is dependent on the EU being granted the relevant competences in the founding treaties. As this report demonstrates, the EU possesses the requisite competences to adopt legally binding acts governing the production, transport and supply of hydrogen at sea.

The use of hydrogen in the energy sector is not incorporated in substantive EU law. Despite the adoption of a definition for energy storage in the Electricity Directive, it is still unclear whether PtG is governed by electricity legislation or gas legislation. It is, therefore, crucial to establish whether PtG is classified as a storage technology or a production technology. If classified as a storage technology, PtG would be governed under EU electricity legislation, while the latter classification would see PtG instead governed under gas legislation. Drafting a clear definition for PtG, and more generally addressing the terminological mismatch between the Electricity Directive and Gas Directive, should be prioritised by EU legislators: doing so would provide clarification as to which framework applies to technologies which, like PtG, sit uncomfortably between both strands of legislation. The proposed new Gas Directive provides the perfect opportunity to address this. To ensure the successful integration of green gases (such as hydrogen) in the EU energy sector, it is essential to harmonise EU gas quality standards by specifying homogenous blending levels of hydrogen in the existing natural gas networks. Furthermore, it is important to clarify in the RED how guarantees of origin interact when one form of energy is converted into another. From a financial perspective, the development of PtG may require that the EU include this concept in its guidelines on state aid. Finally, it can be argued that the EU should include explicit references to PtG in its environmental and safety laws, in order to clarify whether impact assessments are mandatory for the development of such facilities, and whether the developers must obtain certain permits.

Regarding national law, several legal issues relating to the development of PtG offshore become apparent when observing the Netherlands, the UK and Denmark. Differences exist between the national legal regimes of these countries, and the choice of a certain legal framework can affect whether the development of offshore PtG is facilitated or impeded. Therefore, this report looked at national legal frameworks, comparing them to determine the different options utilised, and analysing how they influence the development of PtG. The three main stages of the PtG process offshore were analysed: (i) electricity input for hydrogen conversion, (ii) hydrogen conversion, and (iii) hydrogen transport. From this analysis, it can be concluded that none of the analysed national regulatory regimes provide the legal certainty necessary to sufficiently support the conversion of wind energy to hydrogen at sea. This conclusion can be made for three reasons: first, it is questionable whether it is legally permissible to establish a connection between any part of the offshore electricity infrastructure and an existing offshore hydrocarbon platform; secondly, there is no specific authorisation procedure in place regulating the construction and operation of an electrolyser on an existing hydrocarbon platform; finally, strict blending concentrations of hydrogen in the existing natural gas networks have been imposed at the national level. Some developments at the national level indicate that the countries

assessed are making efforts to promote (or even regulate) PtG activities offshore – the Dutch proposal to amend the current law to enable connections between platforms and electricity infrastructure at sea is a good example of this. Ongoing projects in the Netherlands, the UK and Denmark to bring about higher admissible blending levels of hydrogen in their natural gas infrastructure also show a desire to support PtG.

The North Sea is increasingly characterised by new energy uses, which require the deployment of a wide range of installations. Currently, legislation in place governs *inter alia* offshore hydrocarbon installations and offshore wind farms. However, it is difficult to ascertain which rules apply to PtG installations. One important question for further research is therefore whether it would be more beneficial to have separate laws governing each category of installation, or whether a more holistic approach (including the adoption of an underlying offshore legal framework) is necessary. This may also raise broader questions regarding whether the strategies and legal frameworks promoting PtG initiatives should be harmonised at the EU level, rather than being addressed separately by individual Member States. To that end, this report invites policy makers, stakeholders and researchers to engage in further dialogue on the future regulatory framework governing the planning, production, transport and supply of hydrogen.