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Goal-Setting Approaches to the Regulation of Hydrogen Transport

A Case Study from France

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16.1 INTRODUCTION

16.1.1 *French Political Aspirations for Hydrogen*

In France, more than 900,000 tons of hydrogen are consumed each year for refining of petrol fuels, producing chemicals and ammonia for fertilizers as well as in the steel and cement industry and heavy transport.[1] Up to 98 per cent of that hydrogen is produced by fossil fuels (brown/grey hydrogen),[2] which adds 11.5 tonnes of carbon dioxide (CO_2) emissions in France.[3] Moreover, it is important to note that a part of this hydrogen is 'co-produced', meaning it is a side product of industrial processes and generated during the processing of oil cuts in refineries or the gasification of coal in steel factories or steam reforming of natural gas, making these industries in part self-sufficient.[4]

France prides itself on being one of the first countries to identify the full potential of hydrogen.[5] Already back in 2015, article 121 of the French Energy Transition Law (No. 2015-992)[6] identified hydrogen as a solution to climate change and put the obligation

The information and views set out in this chapter are those of the author and do not necessarily reflect the official opinion of the employer.

[1] France Hydrogène, 'Livre blanc pour l'élection présidentielle 2022: faire de la France un leader de l'hydrogène renouvelable ou bas-carbone' (2021), 7–8 <https://france-hydrogene.org/publication/livre-blanc-pour-lelection-presidentielle-2022-faire-de-la-france-un-leader-de-lhydrogene-renouvelable-ou-bas-carbone/> Accessed 20 December 2022.

[2] ADEME, 'Transition(s) 2050. Choisir maintenant. Agir pour le climat' (2021), 513 <https://transitions2050.ademe.fr/> Accessed 20 December 2022.

[3] Ministère de la Transition énergétique, 'Plan de déploiement de l'hydrogène pour la transition énergétique' (Ministry of Ecological and Solidarity Transition, 'Hydrogen deployment plan for the energy transition') (2018), 1. Translation by the author <https://ecologique-solidaire.gouv.fr/sites/default/files/Plan_deploiement_hydrogene.pdf> Accessed 21 December 2022.

[4] ADEME (2021), 513.

[5] Ministère de l'économie, des finances et de la souveraineté industrielle et numérique, 'Accélérer le déploiement de l'hydrogène, clé de voûte de la décarbonation de l'industrie – Dossier de Presse' (2023), 5 <https://presse.economie.gouv.fr/02022023-dossier-de-presse-accelerer-le-deploiement-de-lhydrogene-cle-de-voute-de-la-decarbonation-de-lindustrie/> Accessed 20 September 2023.

[6] Loi relative à la transition énergétique pour la croissance verte (TEPCV) (Law on Energy Transition for Green Development). Translation by the author <https://legifrance.gouv.fr/loda/id/JORFTEXT000031044385/> Accessed 31 December 2022.

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on the government to submit to Parliament a plan for the development of the storage of renewable energy using decarbonized hydrogen. Moreover, the law specifically asked for the deployment of an infrastructure of hydrogen distribution stations and the adaptation of regulations to enable the deployment of these new hydrogen applications, such as the conversion of electricity into gas.[7] This plan was finally published in June 2018, being the first official French hydrogen deployment plan.[8] Its aim is to support the development of low-carbon hydrogen with the purpose of decarbonizing the industrial sector, the transport sector (road, rail and so on) and to develop storage capacities and stabilize the energy networks.[9]

In September 2020, France published its National Hydrogen Strategy in which it announced over €7 billion up to 2030 for low-carbon hydrogen deployment, with €3.4 billion planned for the period 2020–2023.[10] In February 2022, almost €2 billion was added to the previous amount with the *France 2030 Plan*, bringing total government investment in hydrogen to €9 billion.[11] In November 2022, the revision of the French hydrogen strategy by the end of the first half of 2023 was announced, focusing on hydrogen hubs and expertise in hydrogen-related equipment, but nothing had been published by autumn 2023.[12]

The creation of France's national strategy on hydrogen has been a long-term project. The crucial investment decisions by France were based on the knowledge and experience gathered before 2018 by the hydrogen projects created all over the country with the support of the regions and industrial players. Since 2016, ADEME[13] has launched quite a few[14] calls for tenders relating to hydrogen,[15] while a new call under the 'Hydrogen Territorial Ecosystems' programme was launched in May 2023 with a budget of €175 million to finance the production and distribution of hydrogen and the deployment of vehicles.[16]

From all the above, the prospect of hydrogen for decarbonization and for achieving climate neutrality in France becomes clear. This chapter will focus on one of the important parameters needed for hydrogen deployment, namely the transport of hydrogen. Specifically, the aim is to determine whether or not the French legal system includes provisions aiming at accommodation and facilitation of the transport of hydrogen, which could help France with its ambition to achieve its energy transition goals. Transport of hydrogen plays a crucial role in the French

[7] Translation by the author.

[8] Ministère de la Transition énergétique, Plan de déploiement de l'hydrogène pour la transition énergétique (2018).

[9] Ibid, 9–14.

[10] Ministère de la Transition énergétique, 'Stratégie nationale pour le développement de l'hydrogène décarboné en France – Dossier de Presse' (Ministry of Energy Transition, 'National Strategy for the Development of Decarbonized Hydrogen in France – Press file') (2020), 7. Translation by the author <https://entreprises.gouv.fr/fr/strategies-d-acceleration/strategie-nationale-pour-developpement-de-l-hydrogene-decarbone-france#:~:text=Son%20souhait%20est%20de%20d%C3%A9velopper,'%C3%A9mergence%20d'%C3%A9nergies%20renouvelables> Accessed 27 December 2022.

[11] Anonymous, 'Pourquoi la France mise sur l'hydrogène' (Why is France betting on hydrogen?) (2022) French government's webpage. Translation by the author <https://gouvernement.fr/actualite/pourquoi-la-france-mise-sur-lhydrogene> Accessed 15 September 2023.

[12] Ministère de l'économie, 'Industrie: vers une nouvelle stratégie hydrogène pour la France' (Industry: towards a new French hydrogen strategy). Translation by the author <https://economie.gouv.fr/industrie-nouvelle-strategie-hydrogene-pour-la-france> Accessed 18 October 2023.

[13] The French Agency for Ecological Transition <https://ademe.fr/en/frontpage/> Accessed 18 January 2023/

[14] Engie, 'Appel à projets "Territoires Hydrogènes"' (2016) <https://engie.com/journalistes/communiques-de-presse/territoires-hydrogenes-france> Accessed 18 January 2023.

[15] France Relance/appel à projets Écosystèmes territoriaux Hydrogène (2021) <https://presse.ademe.fr/2021/04/france-relance-appel-a-projets-ecosystemes-territoriaux-hydrogene.html> Accessed 10 January 2023.

[16] Ministère de l'économie, 'Hydrogène: un nouvel appel à projets et 175 millions d'euros supplémentaires pour développer la filière' (2023) <https://economie.gouv.fr/hydrogene-un-nouvel-appel-projets-et-175-millions-deuros-supplementaires-pour-developper-la-filiere#> Accessed 18 October 2023.

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decarbonization plan as it can support innovation, ensure that all points of demand nationally are supplied, and also offers France a potentially central role in cross-border hydrogen trade.

16.1.2 *Rule- and Goal-Setting Approaches to Legislation*

Furthermore, the chapter aims to determine whether or not French authorities follow a rules-based or goal-based theory regarding the adopted legislation on hydrogen and specifically energy transport. When choosing the appropriate regulatory approach, various factors are taken into consideration, such as the desired allocation of risks, the incentives and behaviour of regulatees as well as enforcement approach and style, and the capacity and expertise of the regulator.[17] A rules-based approach to legislation is the classic way of establishing rules with the description of specific conduct that is desired or not.[18] This theory, regardless of the advantages that it may present – for example, predictability, stability, comfort in planning[19] – has been criticized as inflexible and restrictive. That led to the creation of an opposite regulatory trend, where instead of the rules, certain goals, outcomes, principles or standards are set without prescribing how regulatees need to achieve these goals and outcomes. Even though there is no common agreement on the term for this approach,[20] in this chapter, 'goal-setting approach' will be used.[21] The goal-setting approach is perceived by many as offering flexibility, shifting the focus away from a strict rule on the desired outcomes and a box-ticking mentality to a situation where regulatees are involved in considering the best way to achieve the outcome.[22] Which of the two regulatory approaches was followed when putting in place the rules for hydrogen transport in France will be considered in the following sections.

16.2 HYDROGEN IN FRANCE

16.2.1 *The Different Types of Hydrogen in France*

Internationally, a spectrum of colours (white to grey)[23] is used to provide information related to the energy sources and technical procedures used to produce hydrogen. In the French 'Hydrogen deployment plan for the energy transition', published in 2018, a first effort to differentiate the types of hydrogen in France can be seen. In this text, renewable hydrogen is defined as hydrogen produced via electrolysis without the use of fossil fuels, whereas decarbonized hydrogen is hydrogen produced from fossil methane with the CO_2 from the production procedure captured and stored underground.[24]

Ambiguity about what is considered to be renewable and decarbonized hydrogen under the French system vanished with the adoption of Ordinance No. 2021-167 of 17 February 2021 on

[17] C. Decker, *Goals-Based and Rules-Based Approaches to Regulation* – BEIS Research Paper No. 8 (2018), 5 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3717739> Accessed 30 January 2023.

[18] S. J. A. ter Borg and W. S. R. Stoter, "Is Goal-Based Regulation Consistent with the Rule of Law?" in M. Sellers and T. Tomaszewski (eds.), *The Rule of Law in Comparative* 57 *Perspective, Ius Gentium: Comparative Perspectives on Law and Justice* 3 (C Springer Science+Business Media B.V. 2010).

[19] Decker (2018), 22.

[20] Other terms used in bibliography: standards-based regulation; performance-based regulation; principles-based regulation; outcomes-focused regulation; goals-based regulation.

[21] Decker (2018), 14–16.

[22] Ibid, 21.

[23] N. Marchant, 'Grey, blue, green – why are there so many colours of hydrogen?' (2021) <https://weforum.org/agenda/2021/07/clean-energy-green-hydrogen/> Accessed 17 September 2023.

[24] Ministère de la Transition énergétique, Plan de déploiement de l'hydrogène pour la transition énergétique (2018).

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hydrogen.[25] Article L811-1 (as amended by article 81 of Law 2023-175) of Book VIII of the French Energy Code,[26] originally introduced by the Ordinance, defines three types of hydrogen: renewable, low-carbon and carbon-based hydrogen. These are distinguished by greenhouse gas emissions and by the primary energy source used for production.[27]

- Renewable hydrogen is 'produced either by electrolysis using electricity from renewable energy sources as defined in Article L. 211-2, or by any other technology using exclusively one or more of these same renewable energy sources and not conflicting with other uses allowing their direct recovery. This electricity may be supplied as part of an individual or collective self-consumption operation as defined in Articles L. 315-1 and L. 315-2. In all cases, its production process emits, per kilogram of hydrogen produced, a quantity of carbon dioxide equivalents less than or equal to a threshold'.
- Low-carbon hydrogen is hydrogen 'whose production process generates emissions less than or equal to the threshold for the qualification of renewable hydrogen, without being able, however, to receive this latter qualification, because it does not meet the other criteria'.
- Carbon-based hydrogen is 'hydrogen that is neither renewable nor low-carbon'.

From the above, it is clear that renewable hydrogen in France is considered to be hydrogen produced by using electricity from renewable energy sources via electrolysis and other production processes like steam reforming of biogas or the thermolysis of biomass. Therefore, going back to the colour spectrum, it can be deduced that French renewable hydrogen is mainly equivalent to *green* hydrogen. As far as the other categories are concerned, abiding by the same CO_2 threshold but also using non-renewable sources for production leads to the conclusion that yellow,[28] pink[29] and blue hydrogen are found under the low-carbon hydrogen definition in France. Lastly, hydrogen that does not conform to either of the first two categories is viewed as carbon-based (grey, brown and black), such as hydrogen produced by steam reforming of natural gas (around 11 $kgCO_2/kgH_2$), coal gasification (20 $kgCO_2/kgH_2$) or electrolysis using carbon-based electricity mixes.[30] It is important to note that this third category could potentially include hydrogen produced not only by fossil fuels but also by renewable sources if the emissions of their production process are above the $kgCO_2eq/kgH_2$ threshold. According to France Hydrogène,[31] an example could be hydrogen produced from biomass or biogas, depending on the nature of the inputs used and the associated carbon footprint, or depending on the methane leaks taken into account upstream.[32]

France Hydrogène drafted a table correlating the different 'colours' of hydrogen with the new definitions of the French legal system, which confirm those presented above.[33] Renewable is

[25] 'Ordonnance no. 2021-167 du 17 février 2021 relative à l'hydrogène', JORF (Governmental Gazette) No. 0042/18.02.2021 <www.legifrance.gouv.fr/jorf/id/JORFTEXT000043148001/> Accessed 20 December 2022.

[26] Code de l'énergie (2011), Version of 10 November 2023 (French Energy Code) <https://legifrance.gouv.fr/codes/texte_lc/LEGITEXT000023983208?etatTexte=VIGUEUR&etatTexte=VIGUEUR_DIFF> Accessed 19 September 2023.

[27] Article 5 of the Ordinance No. 2021-167.

[28] Hydrogen produced via electrolysis by the electricity of the grid which is considered a mix produced by renewables and fossil sources.

[29] Hydrogen produced via electrolysis by electricity produced from nuclear energy.

[30] France Hydrogène, 'Que faut-il retenir de l'ordonnance sur l'hydrogène? (What should we remember about the hydrogen ordinance?)' (2021). Translation by the author <https://france-hydrogene.org/press_release/que-faut-il-retenir-de-lordonnance-sur-lhydrogene/> Accessed 10 September 2023.

[31] Private organization with more than 450 members, bringing together the stakeholders of the French hydrogen sector across the entire value chain <https://france-hydrogene.org/en/qui-sommes-nous/> Accessed 7 September 2023.

[32] See France Hydrogène, 'Que faut-il retenir de l'ordonnance sur l'hydrogène?' (2021).

[33] France Hydrogène, 'PARLONS HYDROGÈNE! Tout savoir (ou presque) sur l'hydrogène' (We speak about Hydrogen! All (or almost all) you need to know on hydrogen) (2022), 5. Translation by the author <https://france-hydrogene.org/publication/parlons-hydrogene/> Accessed 15 September 2023.

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'green hydrogen', low-carbon is 'pink, yellow and blue hydrogen' and carbon-based is 'grey, brown and black hydrogen'. Lastly, it is interesting to note that the table includes no correlation for turquoise hydrogen. Turquoise hydrogen is usually produced via pyrolysis of natural gas using energy that was not produced by renewable sources together with solid black carbon.[34] Since the by-product, black carbon, can be used for purposes like enriching the soil or for the construction of other products such as tyres, its handling can be considered similar to carbon capture, utilization and storage (CCUS) of CO2 in the production of blue hydrogen and therefore turquoise hydrogen should be considered as low-carbon hydrogen. However, if the energy driving the pyrolysis is from renewable sources and/or the feedstock for the pyrolysis is biomethane and not natural gas, the production of turquoise hydrogen becomes zero-carbon and carbon-negative respectively,[35] making turquoise renewable hydrogen.

The threshold of the CO2 equivalent and the method of its calculation, were set via the relevant decree finally published in July 2024.[36] The greenhouse gas emissions threshold for qualifying hydrogen as renewable or low-carbon is set at 3.38 kg of CO2 equivalent per kg of hydrogen produced,[37] which corresponds to the benchmark of a 70% reduction in greenhouse gas emissions compared with a fossil equivalent[38] introduced by the recast Gas Directive (EU)2024/1788.[39]

For renewable hydrogen, greenhouse gas emissions from production, input supply, processing, transport, distribution, end use and carbon capture and geological storage are counted and they are determined in accordance with the rules for calculating greenhouse gas emissions from hydrogen set out in the Annex[40] to European Delegated Regulation 2023/1185,[41] whereas the methodology for low-carbon hydrogen is presented in the Annex of the French order,[42] but includes all the life-cycle steps listed also for renewable hydrogen. Lastly, from the above, we notice that pink hydrogen is considered low-carbon hydrogen, whereas the fact that the order includes for counting only emissions from the production that are stored geologically[43] and not others like captured and then used in industrial process, seems to exclude blue hydrogen from this category.[44]

34 Florence School of Regulation, 'Between green and blue: A debate on turquoise hydrogen' (2021) <https://fsr.eui.eu/between-green-and-blue-a-debate-on-turquoise-hydrogen/> Accessed 20 December 2022.

35 Ibid.

36 Arrêté du 1er juillet 2024 précisant le seuil d'émissions de gaz à effet de serre et la méthodologie pour qualifier l'hydrogène comme renouvelable ou bas-carbone, JORF (Governmental Gazette) n°0157/4-07-2024 (Order of 1 July 2024 specifying the greenhouse gas emission threshold and the methodology for qualifying hydrogen as renewable or low-carbon). <https://www.legifrance.gouv.fr/loda/id/LEGITEXT000049872383/2024-07-05/#LEGITEXT000049872383> Accessed: 25 July 2024

37 Ibid., article 1.

38 A. Hubert and Is. Smets, «Hydrogène bas carbone : une définition, quatre points de tension» (Low-carbon hydrogen: one definition, four points of tension). (2024) Contexte <https://www.contexte.com/article/energie/le-projet-de-definition-de-lhydrogene-bas-carbone-concocte-par-la-commission-europeenne_196659.html> Accessed: 24 August 2024.

39 Article 2(11) of the Directive (EU) 2024/1788 of the European Parliament and of the Council of 13 June 2024 on common rules for the internal markets for renewable gas, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/EC, OJ L, 2024/1788, 15.7.2024.

40 Ibid. 36, Article 2.

41 COMMISSION DELEGATED REGULATION (EU) 2023/1185 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels, JO L 157, 20.6.2023.

42 Ibid. 36, Article 3.

43 Ibid. 36, Annex par. 5.

44 Ph. Marcangelo-Leos, «Hydrogène renouvelable ou bas-carbone : le seuil de qualification et la méthodologie sont fixés», (2024). <https://www.banquedesterritoires.fr/hydrogene-renouvelable-ou-bas-carbone-le-seuil-de-qualification-et-la-methodologie-sont-fixes> Accessed 25 August 2024.

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16.2.2 *Transport of Hydrogen*

At a global level hydrogen can be transported mainly via three means: trucks, ships and pipelines.[45] The optimal form of transport depends on the end use and the targeted destination.[46] Usually, the use of the existing gas network, after being retrofitted (ensuring leakage prevention, for example), is the optimal choice for medium-distance transportation.[47] Away from pipeline grids, the supply of refuelling stations alongside major road arteries requires the use of alternative forms of transport, with trucks being the most popular option.

As mentioned before, France based its national hydrogen strategy on three pillars for which hydrogen is considered the solution for decarbonization: industry, the energy system and heavy transport. It becomes clear then that there will be a need to deliver massive production of renewable and low-carbon hydrogen throughout the country to the points of consumption. This is one of the main reasons why the transport of hydrogen in France must be looked into. Moreover, due to its geographical location (between the southern Europe producers/exporters and the northern importers), the existing gas infrastructure and interconnections with most of its neighbours, plus the availability (present and planned) of low-emission electricity, France can easily transition to become a hydrogen hub.[48] However, interestingly enough, regardless of the role that France can play in hydrogen transport across Europe and the cross-border hydrogen trade, French hydrogen plans have not included, at least not yet, specific measures for cross-border transport or hydrogen imports and focus mostly on internal production and industry hubs.[49] Nevertheless, transport of hydrogen is crucial for its plans for nationwide decarbonization and that is why it is examined.

Transport of Hydrogen (Road, Rail and Water Transport)

This section will present the rules applicable for the transport of hydrogen for road, rail and sea transport. In these cases, the French legal system is very clear, classifying hydrogen (regardless of means of production and end use) as a dangerous material and therefore imposing the rules that are applicable to other dangerous materials. Dangerous goods or hazardous materials are substances and articles the carriage of which is prohibited or is authorized only under specific conditions, due to health and safety reasons.[50]

The rules on the national or international transport of dangerous goods by road, rail and inland waterways in France can be found in the 'TMD Decree' (Arrêté Transports de Marchandises Dangereuses) (Decree of 29 May 2009 as amended).[51] Specifically, the TMD Decree deals with the application of the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), the Regulation for International Transport of Dangerous Goods by Railway (RID) and

[45] Hydrogen Council, McKinsey & Company, 'Hydrogen Insights 2021: A perspective on hydrogen investment, deployment and cost competitiveness' (2021), 19 <https://hydrogencouncil.com/en/hydrogen-insights-2021/> Accessed 10 January 2023.

[46] Ibid.

[47] Ibid.

[48] GRTgaz & Teréga. 'Hiver 2022–2023: Le système gaz français devrait faire face à la demande en s'appuyant sur la gestion prudente des stocks et la sobriété de tous les consommateurs. Communiqué de Presse' (Winter 2022–2023: The French gas system should be able to cope with demand thanks to prudent management of stocks and sobriety on the part of all consumers. Press release) (2022). Translation by the author <https://grtgaz.com/medias/communiques-de-presse/perspectives-systeme-gazier-hiver-2022> Accessed 5 October 2023.

[49] See Ministère de la Transition énergétique, 'Stratégie nationale pour le développement de l'hydrogène décarboné en France (2020).

[50] Definitions in ADR, RID and ADN Agreements and TMD Decree.

[51] Arrêté du 29 mai 2009 relatif aux transports de marchandises dangereuses par voies terrestres (dit 'arrêté TMD') (Decree of 29 May 2009 on the transport of dangerous goods by land (known as the 'TDG Decree')).

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the European Agreement on the International Carriage of Dangerous Goods by Inland Waterways (ADN).[52] These agreements follow a similar pattern. Each agreement contains a table that pairs the list of identified dangerous materials under their United Nations (UN) number with the requirements applied for the transport of this substance. This is a four-digit number that identifies dangerous goods, hazardous substances and articles (such as explosives, flammable liquids, toxic substances) in the framework of international transport, assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods.[53] Specifically for road transport, the ADR contains two Annexes, with Annex A laying down the packaging and labelling requirements and Annex B containing the conditions for the construction, equipment and operation of the vehicle carrying the dangerous good. The RID, which deals with the rail transport of dangerous goods, is appended (Appendix C) to the Convention concerning international transport by train (COTIF, Convention relative aux transports internationaux ferroviaires).

In these conventions, the following are most important in relation to the transport of hydrogen: UN 1049-Hydrogen compressed, UN-1966-Hydrogen liquified/refrigerated, UN 2034-compressed hydrogen and methane admixtures, UN 3166-Vehicle, flammable gas powered or vehicle, flammable liquid powered or vehicle, fuel cell, flammable gas powered or vehicle, fuel cell, flammable liquid powered and UN 3468-Hydrogen in a metal hydride storage device.[54] The TMD Decree establishes some general obligations for the transport of all dangerous goods, regarding labelling, packaging and documentation of the dangerous goods, the obligation to have a security adviser (article 6 of the TMD) and to provide special training to employees (L 4141-1 and following of the Labour Code).[55] Under the above UN numbers, hydrogen, whether in gaseous or liquid state, is categorized under class 2, with the principal characteristic as flammable. Each agreement has its own obligations, but they are largely similar regarding weight, packaging and labelling.

Concerning the distribution of hydrogen in refuelling stations, the provisions of ADR and RID, transposed via the TMD Decree, initially did not regulate products used as energy feedstock or fuel inside vehicles. This changed with the adoption of the ministerial decree of 22 October 2018[56] establishing new headings under the Installations Classified for

[52] Articles 3 and 4 TMD Decree.

[53] ADR (2023), Vol. 1, p. 52 <https://unece.org/transport/standards/transport/dangerous-goods/adr-2023-agreement-concerning-international-carriage> Accessed 2 October 2023.

[54] ADR (2023), 87–88, 100, 206, 208; RID (2011), 87 <https://otif.org/en/?page_id=172> Accessed 3 October 2023; ADN (2021), 229.

[55] Code du travail (French Labour Code) <https://legifrance.gouv.fr/codes/section_lc/LEGITEXT000006072050/LEGISCTA000006178070/#LEGISCTA000006178070> Accessed 29 January 2023.

[56] Arrêté du 22 octobre 2018 relatif aux prescriptions générales applicables aux installations classées pour la protection de l'environnement soumises à déclaration sous la rubrique n° 1416 (station de distribution d'hydrogène gazeux) de la nomenclature des installations classées et modifiant l'arrêté du 26 novembre 2015 relatif aux prescriptions générales applicables aux installations mettant en œuvre l'hydrogène gazeux dans une installation classée pour la protection de l'environnement pour alimenter des chariots à hydrogène gazeux lorsque la quantité d'hydrogène présente au sein de l'établissement relève du régime de la déclaration pour la rubrique no 4715 et modifiant l'arrêté du 4 août 2014 relatif aux prescriptions générales applicables aux installations classées pour la protection de l'environnement soumises à déclaration sous la rubrique no. 4802 (Decree of 22 October 2018 relating to the general requirements applicable to installations classified for the protection of the environment subject to declaration under heading 1416 (hydrogen gas distribution station) of the nomenclature of classified installations and amending the Order of 26 November 2015 on the general requirements applicable to installations using gaseous hydrogen in an installation classified for environmental for the protection of the environment to fuel gaseous hydrogen-powered trolleys when the quantity of hydrogen present in the establishment falls under the declaration regime for heading no. 4715 and amending the order of 4 August 2014 on the general requirements applicable to installations classified for the protection of the environment subject to declaration under heading No. 4802). Translation by the author <https://legifrance.gouv.fr/jorf/id/JORFTEXT000037519292> Accessed 15 January 2023.

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Environmental Protection (ICPE, Installations classées pour la protection de l'environnement) regulation (heading number 1416[57] on hydrogen distribution in refuelling stations for mobility applications).

The above shows that the rules on the transport of dangerous material have already been applicable to the transport of hydrogen outside pipelines for many years, without any specific adaptation or modification. The framework for the transport of dangerous goods is highly detailed and meticulous and explains to the regulatees in advance what actions are permissible, leaving almost no margin. The rules-based approach to legislation, that is clearly followed here, is a logical choice in cases such as the transport of dangerous goods legislation where safety with ex ante prohibition of certain actions is the only option.

Hydrogen Transport by Pipelines

The transport of hydrogen via grid connection is a key aspect of future hydrogen-based economies, especially for transport of large quantities.[58] The hydrogen can be integrated into the natural gas grid by injection as an admixture, by using it to produce synthetic methane to then be injected into the natural gas grid or by the creation of or conversion to 100 per cent hydrogen networks.[59] Synthetic methane is renewable synthetic gas produced by combining CO2 with hydrogen (methanation).[60] France, due to its geographical position, has a high incentive to secure proper hydrogen infrastructure that could be part of a pan-European network, since it would be able to export locally produced hydrogen to its neighbours but also import renewable hydrogen from other countries where its production is more economically advantageous (for example, Spain).[61]

The right of injection and transport of hydrogen in the gas grid was officially established with the adoption of Ordinance No. 2021-167/17.02.2021 and specifically part III of the newly established Book VIII of the French Energy Code, dedicated to the transport and distribution of hydrogen. Articles L831-1 and L832-1 of the Energy Code set a framework for the transport and distribution of hydrogen in autonomous transport networks, specially dedicated to hydrogen, and separate from those for natural gas. The idea behind the creation of dedicated hydrogen grids in France is that with the expected decline in demand for natural gas over the next decades, the existing, extensive natural gas grid could be used for the transport and distribution of hydrogen, after performing the necessary technical adjustments. The idea of using the existing infrastructure is financially attractive, a fact already well recognized; as Anthony Mazzenga, director for renewable hydrogen and gas of GRTgaz, recently declared: 'a grid adapted for hydrogen will cost 2 to 3 times less than a new grid dedicated to hydrogen'.[62] Western Europe

[57] ICPE, '1416. Stockage ou emploi d'hydrogène' <https://aida.ineris.fr/reglementation/1416-stockage-emploi-dhydrogene> Accessed 1 October 2023.

[58] M. Ball and M. Weeda, 'The hydrogen economy – vision or reality?' International Journal of Hydrogen Energy 40 (2015), 7910.

[59] Kantor, 'Assist the European Union Agency for the Cooperation of Energy Regulators in assessing the energy transition aspects as applicable to gas infrastructure – Possible regulation of hydrogen networks' (2021), 8 <https://acer.europa.eu/en/Gas/Documents/ACER%20H2%20Paper_%20vFinal_clean.pdf> Accessed 17 January 2023.

[60] Terega, 'What is synthetic methane?' <www.terega.fr/en/lab/what-is-synthetic-methane/> Accessed 25 January 2023.

[61] A. Wang, S. Yordanova and R. Capaldi, 'Competitiveness of France: Role of hydrogen transport and storage infrastructure' (2021), 21 <https://guidehouse.com/news/energy/2021/dedicated-hydrogen-infrastructure-in-france?lang=en> Accessed 29 January 2023.

[62] F. Gouty, 'Un réseau adapté à l'hydrogène coûte deux à trois fois moins cher qu'un réseau neuf' <https://actu-environnement.com/ae/news/hydrogene-anthony-mazzenga-grtgaz-adaptation-reseau-gaz-interview-39744.php4> Accessed 24 October 2022.

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already features a hydrogen-dedicated pipeline network of almost 2,000 km running through France, the Benelux and Germany.[63]

The right to use natural gas pipelines to transport hydrogen was established for the first time by Ordinance No. 2021-167/17.02.2021, which created articles L831-2 and L832-2 of the Energy Code. Specifically, these articles extend the obligations of gas network operators to include hydrogen transport: in the case of injection of hydrogen into natural gas transmission and distribution networks, they 'shall implement the necessary measures to ensure the proper functioning and balancing of the networks, the continuity of the natural gas transmission and delivery service and the safety of people and property'.[64]

These newly established articles strengthen the pre-existing right to access of other gases into gas systems, which was established a few years before. Originally, article 94 of Law No. 2018-938/30.10.2018[65] modified article L. 111-97 of the French Energy Code to establish the right of injection of biogas into the natural gas transport and distribution system.

The same article was amended again by article 49 of the Law on Energy and Climate (Law No. 2019-1147/8.11.2019) so that the scope of the article now also includes hydrogen and other renewable gases. It becomes clear from the report on the discussions of the French National Assembly[66] before the adoption of the Law on Energy and Climate that the extension of the right to access the gas network is important for the producers of renewable hydrogen and will further support the deployment of renewable and low-carbon hydrogen.[67]

The new wording of article L. 111-97 is:

> Subject to preserving the proper functioning and security level of natural gas infrastructures, a *right of access* to the natural gas transmission and distribution facilities and to liquefied natural gas (LNG) installations, including facilities providing ancillary services, is guaranteed by operators who use them for customers, to the *producers of renewable gases, low-carbon hydrogen*[68] and recovery gas as well as suppliers and their agents, under conditions defined by contract.[69]

Therefore, owners and/or operators of hydrogen production installations – since the term producers, which is used, does not distinguish between the two – gained the right to access the natural gas systems, which entails their right to use, in line with the ruling of the ECJ in the *Sabatauskas* case.[70] However, it is important to note that this right to use depends on the technical safety criteria imposed, determining the gas quality.[71] The connection will depend on the fulfilment of the technical standards needed for the injection and the capacity of the network, since no obligation to prioritize the hydrogen injection projects has been established (first come, first served system). Therefore, it can be deduced that the rules regarding the

[63] Terega, 'Transport d'hydrogène, comment Teréga organise son réseau?' <www.terega.fr/nos-activites/hydrogene/transport-dhydrogene-comment-terega-organise-son-reseau/> Accessed 30 January 2023.

[64] Amended articles L. 431-6-4 and L. 432-14 of the French Energy Code.

[65] Law No. 2018-938 of 30 October 2018 for the balance in the trade relations in the agriculture and food sector and healthy, sustainable and accessible food for all.

[66] Together with the Senate (Sénat), they constitute the two bodies of the French Parliament.

[67] A. Cellier, 'Rapport au nom de la commission des affaires économiques, sur le projet de loi relatif à l'énergie et au climat (nos 1908 et 2032) TOME III' (Report on behalf of the Committee on Economic Affairs, on the Draft Law on Energy and Climate (Nos. 1908 and 2032) – PART III) (2019), 266 <www.assemblee-nationale.fr/dyn/15/comptes-rendus/seance> Accessed 25 January 2023.

[68] Emphasis by the author.

[69] Translation by the author.

[70] ECJ C-239/07 Julius Sabatauskas and others (2008) ECR II-7253, 41–42.

[71] Ruven Fleming and Gijs Kreeft, 'Power-to-gas and hydrogen for energy storage under EU energy law' in Martha Roggenkamp and Catherine Banet (eds.) *European Energy Law Report XIII* (Insertia 2019) 119.

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injection of hydrogen into the natural gas grid establish a general guideline for preserving the proper functioning and safety of the grid without setting down a more detailed framework – following a goal-based regulatory approach, where the goal is the safe injection of hydrogen within the natural gas grid, but leaving the relevant actors to determine how exactly this will be succeeded.

Technical Conditions for Injecting Hydrogen into Natural Gas Networks

In accordance with articles L-433-13, L-453-4 and R-433-14 of the French Energy Code,[72] transmission system operators (TSOs) and gas distribution system operators (DSOs) issue and make public the guidelines concerning the technical conditions for safe injection that apply to pipelines and connections for gas transmission, distribution and storage facilities, which must be respected by actors in the gas market in order to ensure the safety of the grid.[73] GRTgaz and Teréga at the transmission level and GrDF at the distribution level issued their own codes where their rights and obligations are defined as well as the technical prescriptions applicable to their grids.[74] All three documents include articles on the technical rules that gases other than natural gas have to comply with (articles 7.1.2 and 5.1.2 respectively).[75] There are provisions on the level of impurities of the gas (concerning Hg, Cl, F, NH_3 and so on). The level of H_2 in the gas grid is set at 6 per cent (molar) admixture at most.[76] Moreover, the other gases must comply with the general technical conditions that are also imposed on natural gas – that is, Wobbe index, total sulphur content, density and others.[77] Interestingly, hydrogen injected into the gas grid was initially considered to be an impurity in the gas system,[78] which has changed recently.

The report produced by gas infrastructure operators to determine the technical and economic conditions for injecting hydrogen into the networks, based on measure 7 of the French hydrogen plan, shows that hydrogen blended at a rate of 6 per cent (volume) can be achieved in most networks, excluding cases where sensitive structures or installations are present at the customers' end.[79] However, to achieve a share of 10 per cent or even 20 per cent of hydrogen in the networks, significant investment is needed.[80] Moreover, the percentage of blended hydrogen cannot be the same nationally.[81] The volume of injectable hydrogen and the issues that this

[72] French Energy Code, L.433-13, L.453-4, R.433-14.

[73] French Energy Code, L. 111-97.

[74] For GRTgaz: Code operationnel de reseau-acheminement – piece A2 (Transmission Code) (2018) <https://grtgaz.com/vous-etes/client/expediteur/CORe> Accessed 28 October 2022.

For Teréga: Prescriptions techniques applicables au raccordement d'un ouvrage tiers au réseau de transport de gaz naturel de Teréga (Technical specifications applicable to the connection of a third-party facility to Teréga's natural gas transmission network) (2017) <https://assets.ctfassets.net/ztehsn2qe34u/65HfNcZoc63wtG9vOvXMz/2cd7e9c78966a5a0610c57b2ec1f8336/Annexe_1_-_Prescriptions_techniques_transport-TEREGA.pdf> Accessed 20 October 2023.

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[75] GRTgaz Transmission Code 2018, 8/Teréga technical prescriptions, 11–13 and technical prescriptions for the distributor GrDF, 8.

[76] Ibid.

[77] GRTgaz Transmission Code 2018, table at 8.

[78] EE Consultant, HESPUL and SOLAGRO, 'Etude portant sur l'hydrogène et la méthanation comme procède de valorisation de l'électricité excédentaire (ADEME 2014), 104 <www.actu-environnement.com/media/pdf/news-23161-etude-powertogs-ademe-grdf-grtgaz.pdf> Accessed 10 October 2022.

[79] P. Chambon et al., 'Conditions techniques et économiques d'injection d'hydrogène dans les réseaux de gaz naturel' (Rapport final Juin 2019), 21<https://francegaz.fr/conditions-techniques-et-economiques-dinjection-dhydrogene-dans-les-reseaux-de-gaz-naturel/> Accessed 11 October 2023.

[80] Ibid.

[81] Ibid.

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injection may cause depend, for example, on the specific characteristics of an area (sub-zone of the grid), the nature of pipelines, the presence or not of aquifer storage tanks, the gas quality and the possibility for proper metering, network equipment, network capacity and types of customers connected.[82]

The proportion of up to 6 per cent of pure hydrogen that may be injected into the grid provides an answer to the question whether or not it is allowed to admix gases in the grid which at the entry point do not fully comply with the technical gas specifications, but they become compliant at the exit point due to the mixing with the pre-existing gases in the gas grid. The GRHYD pilot project[83] was able to demonstrate that the injection of a gas mixture composed of up to 20 per cent hydrogen (by volume) into new natural gas distribution networks is technically possible, and Jupiter 1000[84] safely injected up to 1 per cent hydrogen (by volume) and could reach a theoretical limit of 6 per cent in the transport system.

Guarantees of Origin

Lastly, since France aims to use hydrogen to decarbonize many of its energy systems and processes, it is important to mention the provisions on traceability and guarantee mechanisms established by Ordinance No. 2021-167.[85] According to article 821-3 of the French Energy Code, a guarantee of origin is issued to attest the origin of the renewable or low-carbon hydrogen produced, if it is likely to be mixed with another type of hydrogen or gas between stages or if the guarantee issued during its production is likely to be sold independently of the hydrogen produced.[86] The system of guarantees of origin for hydrogen is modelled upon the existing system for biogas (article L. 445-3 and following the French Energy Code) and can play an important role in development and deployment of renewable and low-carbon hydrogen, even if mixed with other gases. However, the guarantee of traceability of article L-821-2 is issued for renewable or low-carbon hydrogen produced and not mixed with another type of hydrogen or gas and that has been physically delivered to the buyer or final consumer.

From the French Energy and Climate Law as well the National Hydrogen Strategy, there is a clear need to increase the deployment of renewable and low-carbon hydrogen for the decarbonization of the energy system and heavy transport. However, since there is no certainty on the exact technical conditions that need to be fulfilled, the French legislators opted to set the general goal of injecting hydrogen into the grid and leaving market players responsible for fulfilment, while keeping the network's security. Moreover, when setting the traceability and guarantee of origin system, the legislator is pretty precise regarding the system and how it should function, and even established a specific authority to handle and supervise the system (Chapter V of Book VIII of the French Energy code). The goal-setting approach that is followed in view of the right of injection of hydrogen is a good way to achieve the purpose of hydrogen integration into gas systems while ensuring system safety, for which there are still many uncertainties. The

[82] Ibid, 21.

[83] GRHYD (Gestion des Réseaux par l'injection d'HYdrogène pour Décarboner les energies – Network Management by injecting HYdrogen to Decarbonize energies) is one of the first French power-to-gas demonstrators, located at Dunkirk, where hydrogen produced by electricity from wind is injected in the natural gas distribution grid.

[84] Jupiter 1000 is the first French power-to-gas demonstrator at an industrial level, which aims at testing the injection of hydrogen and SNG into the natural gas transport system together with a carbon capture unit that provides for the CO2 needed for the methanation and SNG production. R. Boughriet, 'Jupiter 1000: la première installation de Power to gas est mise en service en France' (2020) Actu Environnment <https://actu-environnement.com/ae/news/jupiter-1000-grt-gaz-hydrogene-35040.php4> Accessed 14 October 2022.

[85] Title II of Book VIII of the French Energy Code.

[86] Art. 821-3 of the French Energy Code.

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goal-setting approach is arguably the best choice in facing technological change and can facilitate technological innovation by allowing regulatees the freedom to experiment,[87] as happened in the case of France with the development of numerous pilot projects.

16.3 CONCLUSION

The goal of this chapter was to examine how the existing French legal system accommodates the transport of hydrogen and to scrutinize the regulatory approach followed.

France finally took the first important step towards the establishment of a specific framework related to hydrogen with the adoption of Ordinance No. 2021-167/17.02.2021. Hydrogen (low-carbon and renewable) and the related technologies, such as power-to-gas have been at a central position in the future energy plan for France and have been viewed as important solutions for decarbonization by stakeholders in both the private and public sector. Even though there were some pre-existing elements concerning the regulation of hydrogen transport, they were largely confined to the general rules for transport of dangerous materials. For the hydrogen sector to blossom and to play the role that was envisioned for the French energy transition, some specific elements are needed for hydrogen (specific rules on the types of hydrogen, transport, sale and so on), which has been noted by the private sector over the years.

Besides the existing modes of transporting hydrogen (road, rail, water), France takes great interest in the injection of hydrogen – and especially of green hydrogen – into grids to transport the gas from the hubs of production. For the use of the existing gas network for hydrogen transport, it was concluded that a right to access for hydrogen and renewable gas to the gas grid was adopted a few years ago, opening the way for hydrogen and synthetic natural gas (SNG) injection. The adoption of Ordinance 2021-167 creates the legal leeway for both: a hydrogen-only transport and distribution system as well as the obligation for TSOs and DSOs to take the appropriate measures to ensure the proper functioning and balancing of the gas systems when hydrogen is injected. In terms of numbers, testing for injection of hydrogen admixed with natural gas up to 20 per cent yielded positive results. There now is the clear need to follow up on this quickly by changing the safety regulations and including this technical possibility into law by raising the amount of admissible hydrogen to the natural gas grid from 6 to 20 per cent.

From a regulatory techniques perspective, the approach followed in the case of hydrogen legislation in France is currently moving away from the prescriptive technical rules, such as the rules on the transport of dangerous goods, and towards the setting of important targets – that is, hydrogen injection with respect to the proper function and security of the grid. This latter approach leaves it to the market participants to determine, based on the individual characteristics, how safety in the grid can be achieved.

All in all, the analysis indicates that the decision on regulatory approaches is not a one-time decision: each time for every part of the system, which approach is most suited to reach a given regulatory objective must be considered. In case of hydrogen injection, the adoption of the goal-setting approach is considered a success for the French legislator as it provided leeway to each network operator to experiment based on their particularities. Even though there are still some important legal gaps in existing legislation and ambivalences that need to be resolved, France can be viewed as a positive example for how using a suitable regulatory approach can have a real effect on the quality and speed of adaptation of the legal system to a new energy carrier.

[87] Decker (2018), 21.

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