4

Hydrogen Regulation in Latin America

From Promise to Production

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4.1 INTRODUCTION

Hydrogen is anticipated to play a central role in the global energy transition towards decarbonized economies.[1] With demand for clean hydrogen[2] projected to surge in the coming decades, particularly in Europe and north-east Asia,[3] Latin America finds itself well positioned to capitalize on this market opportunity.[4] With its vast energy resources, both proven and untapped, the region has the potential to become a production epicentre in the impending hydrogen economy.[5] This ability to produce large quantities of low-cost clean hydrogen and its derivatives can not only catalyse new export sectors for many Latin American countries; it can also contribute to their domestic decarbonization efforts.[6] Indeed, hydrogen's versatility as an energy carrier, storage medium and industrial feedstock makes it a vital component in addressing the challenges of hard-to-abate sectors like heavy industry and heavy-duty transport.[7]

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[1] IEA, 'Global Hydrogen Review 2022' (2022) 9, 12, 15 <https://iea.org/reports/global-hydrogen-review-2022> accessed 15 June 2024 (hereinafter: IEA 2022).

[2] For the purposes of this chapter, the terms 'clean hydrogen' and 'hydrogen' will be used interchangeably and encompass 'green hydrogen', 'blue hydrogen', 'renewable hydrogen' and 'low-carbon hydrogen'. See Hydrogen Science Coalition, 'Proposed Definition of "Clean" Hydrogen' (2023) <https://h2sciencecoalition.com/wp-content/uploads/2023/04/Clean-Hydrogen-Definition_4-April.pdf> accessed 15 June 2024.

[3] The EU aims to import 10 million tonnes of renewable hydrogen by 2030. By 2050, north-east Asian (including China) and European imports of low-carbon hydrogen combined could reach around 103 million tonnes per year. See European Commission, 'Hydrogen' (European Commission) <https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen_en#:~:text=The%20ambition%20is%20to%20produce,in%20energy-intensive%20industrial%20processes> accessed 15 June 2024, and Wood Mackenzie, 'The Blue Green Planet: How Hydrogen Can Transform the Global Energy Trade' (2021) <www.woodmac.com/horizons/the-blue-green-planet-how-hydrogen-can-transform-the-global-energy-trade/> accessed 15 June 2024.

[4] IRENA, 'Hydrogen Economy Hints at New Global Power Dynamics' (2022) <www.irena.org/News/pressreleases/2022/Jan/Hydrogen-Economy-Hints-at-New-Global-Power-Dynamics> accessed 15 June 2024.

[5] See generally IEA, 'Hydrogen in Latin America' (2021) <https://iea.org/reports/hydrogen-in-latin-america> accessed 15 June 2024 (hereinafter: Hydrogen in Latin America).

[6] Ibid. 9.

[7] IEA 2022, 57, 185.

This chapter examines the emerging policy and regulatory frameworks for hydrogen in Latin America by focusing on three regional leaders, Chile, Colombia and Brazil.[8] These countries, endowed with solar, wind, hydro and/or fossil fuel assets, all aim to become major clean hydrogen producers. To achieve this vision, they have each outlined ambitious hydrogen strategies, setting the stage for the industry's growth.[9] In order to keep pace with the increasing interest from policymakers and the private sector, their legal regimes are undergoing a period of significant transformation to scale the hydrogen value chain beyond scattered pilots. While Chile, Colombia and Brazil have made positive strides, as this chapter explores, critical regulatory challenges must be addressed before this promise of a thriving regional hydrogen market can fully materialize.

As a note to the reader, in view of the rapidly evolving nature of the hydrogen legal landscape, the information presented in this chapter is current as of 15 June 2024, unless otherwise noted.

4.2 FROM PROMISE TO POLICY: PARALLEL AMBITIONS, DIVERGENT APPROACHES

Seeking to harness clean hydrogen's power, Chile, Colombia and Brazil have each articulated important policy documents reflective of their ambitions. These documents, while providing insights into their strategic priorities and approaches to hydrogen development, also serve as the foundation for shaping their regulatory environments. In this regard, to properly contextualize the following regulatory discussions, this section will briefly explore some salient aspects of these policy initiatives.

4.2.1 *Kickstarting the Hydrogen Endeavour*

Chile's foray into hydrogen has been a comparatively recent affair, largely motivated by studies that highlighted the country's immense renewable potential.[10] Against this backdrop, swift decision-making coupled with international collaborations, notably with Germany,[11] led

[8] Numerous Latin American nations are actively engaging in hydrogen development, with several having released ambitious hydrogen strategies. However, to allow for a more focused analysis, this chapter concentrates on Chile, Colombia and Brazil, the three leading hydrogen countries in Latin American according to the latest H2LAC Index. See Hinicio & New Energy, 'H2LAC INDEX 2024 Results of the 4th Hydrogen Economy Index, Latin America & The Caribbean' (2024) <https://hinicio.com/wp-content/uploads/2024/06/Hinicio_H2LAC-Index-2024_Official-Results.pdf> accessed 15 June 2024. See also Hinicio, 'Hinicio and New Energy Present the Results of the H2LAC 2024 Index: Chile, Brazil, and Colombia Lead the Market' (Hinicio, 5 June 2024) <https://hinicio.com/hinicio-and-new-energy-present-the-results-of-the-h2lac-2024-index/> accessed 15 June 2024.

[9] Ministerio de Energía (Chile), 'Estrategia Nacional del Hidrógeno Verde: Chile, Fuente Energética para un Planeta Cero Emisiones' (2020) <https://energia.gob.cl/sites/default/files/national_green_hydrogen_strategy_-_chile.pdf> accessed 15 June 2024 (hereinafter: Chile's Strategy); Ministerio de Minas y Energía (Colombia), 'Hoja de Ruta del Hidrógeno en Colombia' (2021) <https://minenergia.gov.co/documents/5862/Colombias_Hydrogen_Roadmap_2810.pdf> accessed 15 June 2024 (hereinafter: Colombia's Roadmap); Ministério de Minas e Energia (Brazil), 'Plano de Trabalho Trienal PNH2' <https://gov.br/mme/pt-br/assuntos/noticias/PlanodeTrabalhoTrienalPNH2.pdf> accessed 15 June 2024 (hereinafter: Brazil's Work Plan).

[10] Ministerio de Energía (Chile), 'Hidrógeno Verde un Proyecto País' (2022) 6–7 <https://energia.gob.cl/sites/default/files/guia_hidrogeno_abril.pdf> accessed 15 June 2024. See, e.g., Christian Santana O et al., 'Energías Renovables en Chile: El Potencial Eólico, Solar e Hidroeléctrico de Arica a Chiloé' [Ministerio de Energía (Chile)/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2014] <https://4echile.cl/wp-content/uploads/2020/08/Energias-Renovables-en-Chile-El-potencial-eolico-solar-e-hidroele%CC%81ctrico-de-Arica-a-Chiloe.pdf> accessed 15 June 2024; Dominik Schlipf et al., 'CSP – Localization Potential: Analysis and Further Potential for Chile' (GIZ, 2014) <https://4echile.cl/wp-content/uploads/2020/08/CSP-localization-potential-Chile-GIZ-2014.pdf> accessed 15 June 2024.

[11] 4e Chile, 'Quiénes somos – 4e Chile' <https://4echile.cl/quienes-somos/#presentacion-programa> accessed 15 June 2024.

Chile to publish its National Green Hydrogen Strategy in 2020, the first of its kind in Latin America.[12] More recently, Chile released its Green Hydrogen Action Plan 2023–2030,[13] intended to serve as the actionable roadmap for the industry's development for the remainder of the decade.[14]

Colombia, for its part, saw potential in hydrogen as early as 2007, recognizing its capacity to transform the transportation sector.[15] Nonetheless, this interest only matured into a concrete plan with the publication of its Hydrogen Roadmap in 2021, under which the country similarly aims to exploit its natural resources for clean hydrogen production.[16] Unlike Chile's two-pronged approach, Colombia's Roadmap includes the several lines of work on which the different national and regional bodies will work over the current decade.[17]

As for Brazil, its hydrogen endeavour can be traced back to at least the 1990s, with early initiatives focused on exploring hydrogen's energy applications.[18] However, it was only in 2022 that these initiatives fully crystallized with the establishment of its National Hydrogen Programme.[19] As part of this programme, Brazil published its 2023–2025 Three-Year Work Plan, the country's short-term blueprint for its hydrogen ambitions.[20] Like its neighbours, it also plans on capitalizing on its extensive natural assets to become a major hydrogen producer.[21]

This overview reveals a unified vision amongst Chile, Colombia and Brazil to tap their natural resources for clean hydrogen production. Yet, as we will analyse next, their ultimate goals vary in fundamental ways, casting light on the strategic priorities of each country.

4.2.2 *Setting the Goals and Targets*

In the case of Chile, its Strategy outlines particularly ambitious goals. By 2025, the country aims to be the lead recipient of green hydrogen investments in Latin America with $5 billion, have 5 gigawatts (GW) of electrolysis capacity installed or under development, and produce

[12] Ministerio de Energía (Chile), 'Gobierno presenta la Estrategia Nacional para que Chile sea líder mundial en hidrógeno verde' (Ministerio de Energía, 3 November 2020) <https://energia.gob.cl/noticias/nacional/gobierno-presenta-la-estrategia-nacional-para-que-chile-sea-lider-mundial-en-hidrogeno-verde> accessed 15 June 2024. See generally Chile's Strategy. See also IEA, 'Latin America's Hydrogen Opportunity: From National Strategies to Regional Cooperation' (2020) <www.iea.org/commentaries/latin-america-s-hydrogen-opportunity-from-national-strategies-to-regional-cooperation> accessed 15 June 2026.

[13] Ministerio de Energía (Chile), 'Ministerio de Energía publica el Plan de Acción de Hidrógeno Verde 2023–2030' (Ministerio de Energía, 25 April 2024) <https://energia.gob.cl/noticias/nacional/ministerio-de-energia-publica-el-plan-de-accion-de-hidrogeno-verde-2023-2030> accessed 15 June 2026.

[14] Ministerio de Energía (Chile), 'Plan de Acción de Hidrógeno Verde 2023–2030' (2024) <https://energia.gob.cl/sites/default/files/documentos/plan_de_accion_hidrogeno_verde_2023-2030.pdf> accessed 15 June 2024 (hereinafter: Chile's Action Plan).

[15] Ministerio de Minas y Energía (Colombia), 'Plan Energético Nacional 2006–2025' (2007) 227 <www.upme.gov.co/Docs/PLAN_ENERGETICO_NACIONAL_2007.pdf> accessed 15 June 2024.

[16] See generally Colombia's Roadmap.

[17] Ibid. 28–49.

[18] Ministerio de Minas y Energía (Colombia), 'Programa Nacional do Hidrogenio: Directrices Propuestas' (2021) 5 <https://gov.br/mme/pt-br/assuntos/noticias/HidrognioRelatriodiretrizes.pdf> accessed 15 June 2024 (Proposed Guidelines).

[19] Serviços e Informações do Brasil, 'Brazil Publishes National Hydrogen Program' (gov.br, 29 August 2022) <www.gov.br/en/government-of-brazil/latest-news/2022/brazil-publishes-national-hydrogen-program> accessed 15 June 2024. See also Resolução CNPE No. 6, de 23 de junho de 2022, 23 June 2022, Diário Oficial da União, 4 August 2022 (Brazil) <https://gov.br/mme/pt-br/assuntos/conselhos-e-comites/cnpe/resolucoes-do-cnpe/2022/res_cnpe-6-2022.pdf> accessed 15 June 2024.

[20] See generally Brazil's Work Plan.

[21] Ibid. 13.

200 kilotons (kt) of green hydrogen a year.[22] By the end of the decade, Chile aspires to become the global leader in exporting green hydrogen and its derivatives ($2.5 billion), produce green hydrogen with the lowest levelized cost worldwide ($1.5/kg) and establish itself as the global leader in green hydrogen production through electrolysis (25 GW).[23] By mid-century, Chile aims to lower its levelized cost of hydrogen (LCOH) to $0.8/kg.[24]

Colombia's Roadmap also lays out ambitious goals, though comparatively smaller in scale. By 2030, Colombia aims to develop 1–3 GW of electrolysis backed by 1.5–4 GW of renewable energies, reach green hydrogen costs of $1.7/kg, and produce at least 50 kt of blue hydrogen via CO_2 capture.[25] Colombia's Roadmap also aims to deploy a fleet of 1,500 to 2,000 light-duty vehicles, 1,000 to 1,500 heavy-duty vehicles, as well as 50 to 100 hydrogen re-fuelling stations.[26] To achieve these goals, the country plans to mobilize $2.5–5.5 billion in investments over the decade, mainly from the private sector.[27]

Brazil's Work Plan contrasts with less defined goals and targets, perhaps owing to its nature as a triennial plan and not a long-term strategy. The main objectives set forth therein are to disseminate low-carbon hydrogen pilots nationally by 2025, become the most competitive global producer of low-carbon hydrogen by 2030 and to establish low-carbon hydrogen hubs by 2035.[28] However, the Plan stops short of specifying detailed figures for these objectives.[29]

When juxtaposed, the hydrogen strategies of these countries exhibit diverse (and even rival) goals and ambitions. Chile sets the bar high, aspiring to global leadership in green hydrogen production and export, as evidenced by its goal to achieve the world's lowest LCOH – a benchmark Brazil also aims to surpass. Colombia, in comparison, while also intent on becoming an important player in the hydrogen market, sets more modest but concrete goals. This includes, like Chile, specific targets for investment, electrolyser capacity and LCOH. Unique to Colombia's strategy, however, is the inclusion of detailed goals for the transport sector and blue hydrogen production. These distinctions not only illustrate the individual ambitions of Chile, Colombia and Brazil, but also hint at the unique policy choices underpinning their hydrogen initiatives, to which we will turn to next.

4.2.3 *Defining the Strategic Approach*

Chile's hydrogen policy distinctively focuses on 'green' hydrogen, bypassing mentions of 'blue' hydrogen or other variants.[30] This is not surprising if one considers that Chile imports nearly 98 per cent of the fossil fuels it uses, while it boasts an estimated renewable energy generation potential that exceeds 2,300 GW – seventy times its currently installed electrical capacity.[31]

In contrast to Chile's green-centric model, Colombia adopts a more inclusive approach which includes both 'blue' and 'green' hydrogen. Explicitly mentioning its abundant reserves of oil, natural gas and coal,[32] its Roadmap emphasizes the potential for harnessing these resources for

[22] Chile's Strategy 19.
[23] Ibid.
[24] Ibid. 11.
[25] Colombia's Roadmap 26.
[26] Ibid. 26–27.
[27] Ibid. 27.
[28] Brazil's Work Plan 20.
[29] Ibid.
[30] See generally Chile's Strategy.
[31] Chile's Action Plan 17.
[32] Colombia's Roadmap 8.

hydrogen production when coupled with carbon capture, utilization and storage (CCUS) technologies.[33] In this regard, while it recognizes green hydrogen's significance in the longer term, the strategy assigns blue hydrogen a key transitional role.[34]

Brazil's Work Plan, for its part, deviates from a previously heralded and even more eclectic 'rainbow' hydrogen approach, which included 'grey' hydrogen,[35] steering its strategy towards 'low-carbon' hydrogen production.[36] Interestingly, in opting for this terminology, Brazil forwent the traditional 'colour-book' classification, adopted by Chile and Colombia in their initiatives, echoing the preference of the International Energy Agency (IEA) for an emissions intensity-centric framework instead.[37] Under this classification, Brazil's Plan includes hydrogen derived from a wide variety of processes with low lifecycle emissions, including the equivalents of both 'green' and 'blue' hydrogen.[38]

While these documents reflect a unified movement towards integrating clean hydrogen into their national energy mix, Chile, Colombia and Brazil chart distinct strategic pathways reflective of their unique strengths and goals. The success of these ambitious policies hinges on the creation of enabling governance frameworks that keep pace with the momentum set. The following section examines the regulatory regimes of these countries, analysing how each is tackling the legal complexities of turning their hydrogen aspirations into tangible realities.

4.3 FROM POLICY TO REGULATION: STATUS QUO, CHALLENGES AND THE PATH AHEAD

Across the national strategies of Chile, Colombia and Brazil, a common theme threads the discourse: the need for a regulatory infrastructure that can enable the widespread deployment and commercialization of hydrogen technologies.[39] Hydrogen's multidimensional nature, straddling the lines between a fuel source, a storage medium and an industrial feedstock, necessitates a legal framework that can adapt to its unique characteristics and uses. Indeed, adequate regulation has been recognized as the primary enabler for the industry, providing the foresight and stability needed to invest and scale up hydrogen initiatives.[40] To this extent, the particularities of regulation are not merely peripheral considerations; they are central to the entire developmental narrative. As this section will examine, classifications, definitions, regulatory competences, safety protocols and certification procedures are all key facets that require precise legal crafting to adequately support the sector's growth.

[33] Ibid. 12–13.
[34] Ibid. 12–13, 17.
[35] Ministério de Minas e Energía (Brazil), 'Bases para a Consolidação da Estratégia Brasileira do Hidrogênio' (EPE, 2021) 24, 28 <www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-569/Hidroge%CC%82nio_23Fev2021NT%20(2).pdf> accessed 15 June 2024 (hereinafter: EPE Bases).
[36] Brazil's Work Plan 7.
[37] Ibid. 17. See IEA, 'Towards Hydrogen Definitions Based on Their Emissions Intensity' (2023) <https://iea.org/reports/towards-hydrogen-definitions-based-on-their-emissions-intensity> accessed 15 June 2024.
[38] Brazil's Work Plan 19.
[39] Chile's Strategy 26; Colombia's Roadmap 25; Brazil's Work Plan 21.
[40] DNV, 'Rising to the Challenge of a Hydrogen Economy: The Outlook for Emerging Hydrogen Value Chains, from Production to Consumption' (2021) 11 <https://dnv.com/Publications/rising-to-the-challenge-of-a-hydrogen-economy–203873> accessed 15 June 2024.

4.3.1 *Chile*

In Chile, significant efforts are underway to align its hydrogen regulatory framework with policy aspirations. Central to this task is the reassessment of hydrogen's legal classification.[41] Under Chilean law, molecular hydrogen has historically been (and continues to be) classified as a 'hazardous substance'.[42] As such, a suite of standards apply, including safety protocols for its storage and transportation, and occupational health rules.[43] Nevertheless, as hydrogen expands its applications beyond traditional industrial uses, these existing standards prove inadequate for its broader energy-related roles.[44] This discrepancy between legacy regulations and new applications emphasized the need for a more appropriate framework.

The call for a regulatory realignment to this effect found its legislative response through the enactment of Law 21,305 in 2021.[45] This legislation marked a significant turning point in hydrogen's governance by officially classifying it as a fuel, a measure aligned with Chile's Strategy.[46] In doing so, it conferred oversight of hydrogen to the Ministry of Energy, enabling it to pursue a regulatory agenda in line with hydrogen's new roles.[47] As part of this agenda, the development of safety standards across hydrogen's value chain has been a priority.[48]

This legislative progression has led to a regulatory conundrum: under Chilean law, hydrogen is recognized both as a hazardous substance and as a fuel.[49] While dual classifications are not inherently problematic, the practical implications in this case extend beyond theoretical discord.[50] As exemplified by the Ministry of Health's Supreme Decree 43/2016, they manifest in the potential for regulatory overlap and conflict.[51] In particular, this Decree sets forth safety requirements for hydrogen storage, mandating tank conditions, safety distances and maximum storage capacities.[52] However, it explicitly carves out 'liquid and gaseous fuels' from its scope of application.[53] This exclusion casts uncertainty over the operational parameters within which hydrogen must be managed: tanks storing hydrogen solely for industrial use might be subject to this Decree, whereas those for fuel purposes might not. This becomes more complex when

[41] Zainul Abdin et al., 'Hydrogen as an energy vector' (2020) 120 Renewable and Sustainable Energy Reviews 109620, 1–2 <http://dx.doi.org/10.1016/j.rser.2019.109620> accessed 15 June 2024.

[42] Ministerio de Salud (Chile), Aprueba el Reglamento de Almacenamiento de Sustancias Peligrosas, Decreto No. 43, 27 July 2015, Diario Oficial, 29 March 2016 (Chile) art. 2 <www.leychile.cl/Navegar?idNorma=1088802> accessed 15 June 2024 (Decree 43/2016) (hereinafter: Decree 43/2016). See also Centro de Energía UC et al., 'Proposición de Estrategia Regulatoria del Hidrógeno para Chile' (GIZ, 2020) 31 <https://energia.gob.cl/sites/default/files/proposicion_de_estrategia_regulatoria_del_hidrogeno_para_chile.pdf> accessed 15 June 2024 (hereinafter: Centro de Energía UC).

[43] Several other regulations address the management of hydrogen as a hazardous substance. For a more detailed analysis, see Centro de Energía UC 32.

[44] Ibid., 33–34.

[45] Sobre Eficiencia Energética, Ley No. 21305, 8 February 2021, Diario Oficial, 13 February 2021 (Chile) <https://bcn.cl/2nnoz> accessed 15 June 2024 (hereinafter: Law No. 21305).

[46] Ibid. art. 7; Chile's Strategy 30.

[47] Law No. 21305 art. 7; Chile's Strategy 29.

[48] Ministerio de Energía (Chile), 'Desarrollo Regulatorio de Hidrógeno' 18 (2021) <https://energia.gob.cl/sites/default/files/3_-_regulacion_de_seguridad_-_ma._de_los_angeles_valenzuela_min_energia.pdf> accessed 15 June 2024; Chile's Action Plan 108–110.

[49] Centro de Energía UC 61.

[50] Danitza Montserrat Eterovic Martí, 'Avances y desafíos en torno a la regulación del hidrógeno verde en Chile' (2022) (10) Revista Derecho Aplicado – LLM UC 33 <http://dx.doi.org/10.7764/rda.10.49971> accessed 15 June 2024 (hereinafter: Martí).

[51] Decree 43/2016.

[52] Ibid. arts. 152–153.

[53] Ibid. art. 3.

hydrogen's end use might span across both energy and non-energy domains. Considering that the risk profiles and mitigation strategies for hydrogen remain invariant throughout its lifecycle, regardless of its final application, this bifurcated governance paradigm risks disrupting regulatory consistency and sowing confusion.[54]

Despite this lack of clear and specific safety regulations for hydrogen installations, interest in pilot projects did not stall. To this extent, Chile introduced a support guide outlining the authorization procedure for hydrogen projects,[55] a requirement all energy facilities must fulfil.[56] This guide plays a crucial role in bridging the regulatory gap, allowing pilot projects to import safety standards dictated by foreign standardization institutes such as the American National Standards Institute (ANSI), the International Organization for Standardization (ISO) and the National Fire Protection Association (NFPA).[57] Since then, there have been attempts to approve an official set of safety regulations for hydrogen installations, which include safety requirements across design, construction, operation, maintenance, decommissioning and other stages.[58] However, despite the decree containing these regulations having been signed by former President Piñera in 2022, they have yet to enter into force.[59]

Another regulatory development in furtherance of Chile's Strategy has been the enactment of Law 21,505, which allowed for the inclusion of green hydrogen technologies into the country's electricity matrix.[60] This law formally recognized 'generation-consumption systems', a classification that includes green hydrogen production facilities.[61] Amongst other provisions, it allows these systems to both draw energy for electrolysis and contribute surplus power back to the grid.[62] This, in turn, allows green hydrogen to play a key role in optimizing the use of excess electricity from intermittent renewable sources, effectively managing power supply during peak demand periods.[63] Also noteworthy, the above classification explicitly extends to water desalination facilities,[64] of relevance as desalinated seawater is expected to be used in the hydrogen production process.[65] As Chile faces acute water scarcity challenges,[66] this inclusion reflects a

[54] Centro de Energía UC 60–61.

[55] Ministerio de Energía (Chile), 'Guía de Apoyo para Solicitud de Autorización de Proyectos Especiales de Hidrógeno' (2021) <https://energia.gob.cl/sites/default/files/guia_proyectos_especiales_hidrogeno_2021.pdf> accessed 15 June 2024 (hereinafter: Hydrogen Projects Support Guide).

[56] Deroga Decreto No. 20, de 1964, y lo Reemplaza por las Disposiciones Que Indica, Decreto con Fuerza de Ley No. 1, 22 September 1978, 14 February 1979 (Chile) art. 2 <www.leychile.cl/Navegar?idNorma=3383> accessed 15 June 2024.

[57] Hydrogen Projects Support Guide 2, 16–17.

[58] Aprueba Reglamento de Seguridad de Instalaciones de Hidrogeno e Introduce Modificaciones al Reglamento de Instaladores de Gas, Decreto Supremo 13, 22 February 2022 (Chile) <https://energia.gob.cl/consultas-publicas/reglamento-de-seguridad-de-instalaciones-de-hidrogeno> accessed 15 June 2024.

[59] Superintendencia de Electricidad y Combustibles (Chile), 'Instalaciones reguladas por el reglamento de seguridad de instalaciones de hidrógeno' <https://sec.custhelp.com/app/answers/detail/a_id/1319/kw/reglamento%20de%20seguridad> accessed 15 June 2024.

[60] Promueve el Almacenamiento de Energía Eléctrica y la Electromovilidad, Ley No. 21505 (Law 21505), 8 November 2022, Diario Oficial, 21 November 2022 (Chile) <www.leychile.cl/Navegar?idNorma=1184572> accessed 15 June 2024 (hereinafter: Law 21505). See also Martí 17.

[61] Law 21505 art. 7.

[62] Ibid.

[63] Martí 17.

[64] Law 21505 art. 7

[65] Martí 18; Friedrich-Ebert-Stiftung, 'Desafíos del Hidrógeno Verde: ¿Nueva Bonanza o Más de lo Mismo?' 40 (2023) <https://library.fes.de/pdf-files/bueros/mexiko/20738.pdf> accessed 15 June 2024.

[66] See generally Ariel A Muñoz et al., 'Water Crisis in Petorca Basin, Chile: The Combined Effects of a Mega-Drought and Water Management' (2020) 12(3) Water 648 <http://dx.doi.org/10.3390/w12030648> accessed 15 June 2024.

TABLE 4.1 *Chile's hydrogen regulatory agenda*

Area of focus	Period	Regulatory action
General regulatory enablement	2024–2030	Approve the Hydrogen Installation Safety Regulations
		Initiate studies for the regulatory proposal of hydrogen quality and hydrogen refuelling stations
		Present the regulatory strategy for hydrogen derivatives
		Enact the Law on the Use of Seawater for Desalination
Certification system	2024–2025	Develop a strategic proposal for establishing a sustainability certification system for hydrogen
	2025–2030	Strengthen the National Electric Coordinator's National Registry of Renewable Energies (RENOVA), which will serve as the main platform for hydrogen certification
Permitting system	2023–2025	Strengthen the dependencies that grant critical permits for the proper development of the hydrogen industry
	2023–2024	Update the Guide for the Submission of Hydrogen Projects to the Superintendency of Electricity and Fuels (SEC)
	2023–2026	Implement a comprehensive reform of sectoral permits
	2024–2026	Develop and establish the technical criteria for the environmental assessment of projects related to the value chain of green hydrogen and its derivatives
	2024–2030	Strengthen the Environmental Assessment Service (SEA) and the services involved in the environmental assessment process

Source: Author's own work based on Chile's Action Plan.

potential move towards sustainable water usage in hydrogen production in line with public concerns.[67]

While the above analysis demonstrates concrete progress, it simultaneously highlights the need for further legal refinement and comprehensiveness. For instance, in addition to the aspects previously described, Chile still has not formally defined what constitutes 'green hydrogen', nor has it established a system for certifying the sustainable pedigree of the hydrogen produced.[68] As the country positions itself to be a major exporter, addressing these issues is of paramount importance, particularly for hydrogen destined for the EU.[69]

In response to these and other concerns, and as part of its Action Plan, Chile has recently published the latest version of its hydrogen regulatory agenda, shown in Table 4.1.[70]

Simultaneously, Chilean lawmakers are actively pursuing legislative initiatives to address these gaps. Bill 14756-08 stands out amongst them, aimed at establishing a broad legal framework for promoting the production and use of green hydrogen in Chile.[71] Following the Strategy's green-centric approach, the bill only addresses 'green hydrogen', which it defines as hydrogen produced through renewable energy sources utilizing water electrolysis or other

[67] Ministerio de Energía (Chile), 'Hidrógeno Verde: Un Proyecto País' 90–91 (2022) <https://energia.gob.cl/sites/default/files/guia_hidrogeno_abril.pdf> accessed 15 June 2024.

[68] Chile's Action Plan 203–204.

[69] Janina Franco et al., 'Green Hydrogen for the Decarbonization of Chile: Certification as an Essential Step' (World Bank Blogs, 15 November 2022) <https://blogs.worldbank.org/latinamerica/green-hydrogen-decarbonization-chile-certification-essential-step> accessed 15 June 2024.

[70] Chile's Action Plan 107–121.

[71] Boletín No. 14756-08 'Impulsa la producción y uso del hidrógeno verde en el país' (Chile) <https://www.camara.cl/verDoc.aspx?prmID=14980&prmTIPO=INICIATIVA> accessed 15 June 2024.

approved technologies.[72] Also of importance, the bill incorporates provisions for establishing a hydrogen certification system, essential for verifying the renewable origins of green hydrogen.[73] As of the time of writing, Bill 14756-08 is, however, still in the early stages of consideration within its originating chamber.[74]

As this analysis shows, Chile finds itself in a transitional phase as regulations play catch-up to policy ambitions, displaying the inherent complexities in this hydrogen transition. Nevertheless, the country's regulatory environment is evolving steadily, as evidenced by the number of hydrogen regulations already enacted, those being developed and those planned for future development. Patient persistence in seeing these efforts through will determine whether Chile seizes the opportunities this new energy paradigm presents.

4.3.2 *Colombia*

Like its neighbour, Colombia is also deeply immersed in a regulatory overhaul. It too recently reclassified hydrogen, defining it as an energy vector suitable for energy storage, fuel or industrial applications.[75] This development, contained in the Ministry of Mines and Energy Decree 1476 of 2022, lays the groundwork for the creation of safety and technical standards better suited to its emerging roles.[76] Despite this reclassification, hydrogen continues to be regulated as a hazardous substance,[77] necessitating compliance with existing safety and technical regulations.[78] These, however, are considered insufficient and technologically outdated for hydrogen's new roles,[79] with Decree 1476 calling for their review and update, in particular those governing hydrogen transport.[80] As of the cut-off date, no updates have been announced. Regarding other elements of the hydrogen value chain, specific safety and technical standards remain undefined.[81]

Shifting focus from classifications to definitions, Colombia's legal delineation of 'green hydrogen' has undergone successive refinements that both expand opportunities and introduce complexity. Initially, Law 2099 of 2021 defined green hydrogen narrowly as produced exclusively from listed non-conventional renewable energy sources, such as wind, solar and biomass.[82] In 2022, this definition was de facto broadened by Decree 1476, which allows green hydrogen projects to also utilize grid-sourced electricity for their production processes, provided

[72] Ibid. art. 1(4).
[73] Ibid. art. 9.
[74] Cámara de Diputadas y Diputados (Chile), Actividad Legislativa Proyecto de Ley: Impulsa la producción y uso del hidrógeno verde en el país, Boletín No. 14756-08 <www.camara.cl/legislacion/ProyectosDeLey/tramitacion.aspx?prmID=15247&prmBOLETIN=14756-08> accessed 15 June 2024.
[75] Decreto 1476 de 2022, 3 August 2022 (Colombia) <https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=191408> accessed 15 June 2024 (hereinafter: Decree 1476).
[76] Colombia's Roadmap 32–33.
[77] Decreto 1496 de 2018, 6 August 2018 (Colombia) arts. 3–4 <www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=87910> accessed 15 June 2024.
[78] CMS Rodríguez-Azuero, 'Guía del Hidrógeno en Colombia' 11 (2024) <https://cms.law/es/media/local/cms-racla/files/publication/publication/guia-del-hidrogeno-en-colombia-2024?v=1> accessed 15 June 2024. See, e.g., Decreto 1609 de 2002, 31 July 2002 (Colombia) <https://funcionpublica.gov.co/eva/gestornormativo/norma.php?i=6101> accessed 15 June 2024.
[79] Colombia's Roadmap 32–33.
[80] Decree 1476 art. 2.2.7.1.8.
[81] Colombia's Roadmap 32–33.
[82] Ley 2099 del 2021, 10 July 2021 (Colombia) art. 5 <https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=166326> accessed 15 June 2024 (hereinafter: Law 2099).

the electricity is verified through bilateral contracts and renewable certificates.[83] Subsequently, Law 2294 of 2023 formally expanded the definition of Law 2099, introducing another layer to green hydrogen's evolving concept. According to this expanded definition, the green label can also be achieved by balancing a facility's self-generated renewable injections to the grid against any extracts for hydrogen production.[84] As long as injections meet or exceed production draws, the produced hydrogen retains its green designation.

Consequently, as it stands, three different definitions of green hydrogen coexist in Colombia's legal framework. While purely self-generated renewable energy serves as an unambiguous pathway for green hydrogen production, the differing grid-reliant models that have emerged introduce legal uncertainty in determining the compliance and sustainability credentials of green hydrogen projects. Creating further overlap, Decree 1476 also defined 'low-emission hydrogen', tying its designation to a to-be-determined emissions threshold.[85] As of the cut-off date, rules for the verification and operationalization of the two grid-based alternatives remained pending, as did the emissions threshold for 'low-emission hydrogen'.

In contrast to the multi-conceptualization of green hydrogen, the definition of 'blue hydrogen' under Colombian law is more straightforward. In particular, Law 2099 defines it as hydrogen produced from fossil fuels, incorporating a CCUS system within its production process.[86] This formal incorporation of both green and blue hydrogen into Colombia's legal regime represents a foundational step towards fulfilling its hydrogen commitments as outlined in its Roadmap. More recently, building upon this initial taxonomy, Colombia broadened its hydrogen narrative by also legally defining 'white hydrogen',[87] a move in line with its intention to explore for natural hydrogen deposits within the country's geology.[88]

Despite these advancements, important gaps remain in Colombia's regulatory framework, such as the absence of a hydrogen certification system and the lack of comprehensive technical and safety standards for the hydrogen value chain.[89] Addressing these and other challenges, however, is part of Colombia's regulatory agenda, outlined in Table 4.2.[90]

In line with this agenda, Colombian legislators have drafted several legislative proposals, including Bill 275/2022C. Designed as a comprehensive umbrella legislation, the bill's primary objective is to bridge existing regulatory voids while promoting the growth of, interestingly, 'low-emission' hydrogen.[91] In line with this taxonomy, the bill defines it as hydrogen produced from hydrocarbons with CCUS technologies, as well as from renewable energy sources, amongst other methods.[92] In all cases, however, it must meet the greenhouse gas (GHG) emission threshold set by the relevant ministries. This new emissions-based classification, however, does

[83] Decree 1476 art. 2.2.7.1.2.
[84] Ley 2294 de 2023, 19 May 2023 (Colombia) art. 235 <www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=209510> accessed 15 June 2024 (hereinafter: Law 2294).
[85] Decree 1476 art. 2.2.7.1.4.
[86] Law 2099 art. 5.
[87] Law 2294 art. 235.
[88] Lina Quiroga Rubio, 'ANH destinará $ 170.000 millones para buscar hidrógeno blanco en Colombia' (El Tiempo, 21 April 2023) <www.eltiempo.com/economia/sectores/anh-destinara-170-000-millones-para-buscar-hidrogeno-blanco-761498> accessed 15 June 2024.
[89] Colombia's Roadmap 31–33. See also Hinicio, 'Entregable 3 "Reporte Final de Recomendaciones"' (2022) <https://minenergia.gov.co/documents/8596/Recomendaciones_Certificacion_de_origen_hidrogeno.pdf> accessed 15 June 2024.
[90] Colombia's Roadmap 29–36.
[91] Proyecto de Ley 275 de 2022 Cámara, Gaceta del Congreso Año XXXIII, No. 298, 20 March 2024 (Colombia) <http://svrpubindc.imprenta.gov.co/senado/index2.xhtml?ent=Cámara&fec=20-3-2024&num=298> accessed 15 June 2024.
[92] Ibid. art. 2.

TABLE 4.2 *Colombia's hydrogen regulatory agenda*

Phase	Goal	Regulatory action
Phase 1	**Promote institutional articulation and assign responsibilities on hydrogen issues**	Establish working groups to identify and allocate institutional competencies amongst different ministries Articulate the Hydrogen Roadmap with the implementation instruments of the national climate change policy
	Establish the concepts of green and blue hydrogen in line with the national legal framework	Consolidate the definitions and taxonomy of green and blue hydrogen considering associated CO_2 emissions
	Design a system of guarantees of origin and certifications for hydrogen	Involve Colombia in international working groups Design a system of guarantees of origin through working groups with industry and other stakeholders Develop a monitoring tool for the system of guarantees of origin and certifications
	Develop and update technical and safety regulations for hydrogen	Review current national regulations through working groups and identify uses where new technical regulations need to be incorporated Adopt international standards in the technical regulation of hydrogen in Colombia
Phase 2	**Adapt regulation for new applications such as 'blending'**	Revise and update the Single Transport Regulation to allow for 'blending'
	Simplify and adapt administrative procedures	Review permits and procedures for the implementation of hydrogen projects including environmental aspects and land use Reduce the administrative red tape for low-emission hydrogen projects
	Adapt the regulation of the electricity system to better match hydrogen production	Analyse the participation of electrolysers in grid flexibility services Analyse electricity cost reduction in hydrogen production

Source: Author's own work based on Colombia's Roadmap.

not replace the current 'blue' and 'green' definitions, but rather explicitly covers them, potentially creating further definitional overlap.[93] Also of importance, the bill directs the relevant government bodies to establish the emissions threshold for low-emissions hydrogen, and to formulate regulations spanning technical specifications, safety protocols, certification systems and integration into the country's energy matrix, alongside other aspects.[94] Status-wise, Bill 275/2022C had been approved by the Chamber of Representatives in early 2024 and was awaiting treatment in the Senate.[95] However, the bill has since been shelved, requiring a complete restart of the legislative process.[96]

[93] Ibid.

[94] Ibid. arts. 4–5.

[95] Ibid. See also CMS Rodríguez-Azuero, 'Boletín Energético No. 21' 10–11 (2024) <https://cms.law/en/media/local/cms-racla/files/publication/publication/boletin-energetico-21?v=1> accessed 15 June 2024.

[96] Daniela Morales Soler, 'Proyecto de ley de hidrógeno tendrá nueva estrategia tras ser archivado en el Senado' (Portafolio.co, 13 June 2024) <www.portafolio.co/energia/proyecto-de-ley-de-hidrogeno-tendra-nueva-estrategia-tras-ser-archivado-en-senado-606707> accessed 15 June 2024.

As evidenced by the preceding analysis, Colombia's hydrogen governance is undergoing a period of important evolution, in many respects reflecting the process also underway in Chile. Colombia's path through this regulatory transformation thus far shows its commitment to seeing its policy ambitions through, as well as the challenges along the route towards maturation. While recent developments serve as crucial legal implementations of the country's Roadmap, the regulatory environment remains underdeveloped, with key areas still awaiting further definition and operationalization. Like Chile, continued efforts in addressing these gaps will be essential in establishing a robust hydrogen ecosystem in Colombia.

4.3.3 *Brazil*

Brazil's hydrogen regulatory framework, in a more nascent stage compared to Chile and Colombia, is marked by a dynamic parliamentary scene teeming with activity. As acknowledged by the Brazilian Energy Research Company (EPE), the country lacks adequate institutional and regulatory governance to support the deployment of hydrogen's diverse applications and usage scenarios.[97] This situation presents challenges in addressing concerns such as hydrogen's oversight, definitions and classifications, safety and technical standards, and certification processes.[98]

In this regard, under Brazilian law, hydrogen retains its traditional classification as a hazardous good, which encompasses both flammable gases and liquids.[99] This subjects hydrogen's handling to, inter alia, the Brazilian Norm NBR 14725:2023 and the resolutions issued by the National Land Transport Agency (ANTT).[100] Specifically, NBR 14725:2023 outlines hydrogen's labelling requirements in line with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS),[101] while ANTT Resolution 5998/2022 sets forth requirements for the identification, packaging, marking and documentation for the transport of hydrogen.[102] While these regulations provide a safety baseline consistent with its current uses, they fail to address the specialized needs of hydrogen's new applications across its value chain, mirroring the challenges that Chile and Colombia also face.

In view of these shortcomings, Brazil has outlined a broad regulatory agenda within its Three-Year Plan.[103] This agenda, as shown in Table 4.3, spans a wide spectrum of measures, ranging

[97] EPE Bases 22. See also Sabrina Macedo and Drielli Peyerl, 'Hydrogen: A Brazilian Outlook', Energy Transition in Brazil (Springer Nature Switzerland, 2023) 166 <http://dx.doi.org/10.1007/978-3-031-21033-4_10> accessed 15 June 2024.

[98] Ibid.

[99] Associação Brasileira de Normas Técnicas, NBR 14725:2023 'Produtos químicos – Informações sobre segurança, saúde e meio ambiente – Aspectos gerais do Sistema Globalmente Harmonizado (GHS), classificação, FDS e rotulagem de produtos químicos' (Brazil) (hereinafter NBR 14725:2023). See also Resolução No. 5.998, de 3 de novembro de 2022, 3 November 2022 <https://anttlegis.antt.gov.br/action/ActionDatalegis.php?acao=detalharAto&tipo=RES&numeroAto=00005998&seqAto=000&valorAno=2022&orgao=DG/ANTT/MI&codTipo=&desItem=&desItemFim=&cod_menu=5408&cod_modulo=161&pesquisa=true> accessed 15 June 2024 (hereinafter: Resolution 5.998).

[100] NBR 14725:2023; Lei No. 10.233 de 05/06/2001, Lei No. 10233, 5 June 2001, Diário Oficial da União, 6 June 2001 (Brazil) <https://legis.senado.leg.br/norma/552109> accessed 15 June 2024.

[101] NBR 14725:2023. See also UL Solutions, 'Brazil Implements Revision 7 of GHS' (UL Solutions, 6 July 2023) <www.ul.com/news/brazil-implements-revision-7-ghs> accessed 16 June 2024.

[102] See generally Resolution 5.998. See also Resolução No. 6.016, de 11 de maio de 2023, 3 May 2022 <https://anttlegis.antt.gov.br/action/ActionDatalegis.php?acao=detalharAto&tipo=RES&numeroAto=00006016&seqAto=000&valorAno=2023&orgao=DG/ANTT/MT&codTipo=&desItem=&desItemFim=&cod_menu=5408&cod_modulo=161&pesquisa=true> accessed 15 June 2024.

[103] Brazil's Work Plan 64–68.

TABLE 4.3 *Brazil's hydrogen regulatory agenda*

Goal	Regulatory action
Improve the institutional, legal and infra-legal frameworks	Draft regulation establishing the definition of low-carbon hydrogen
	Propose text amending Law 9.478/1997 in order to provide for activities related to low-carbon hydrogen and confer relevant competences on the National Agency of Petroleum, Natural Gas and Biofuels of Brazil (ANP)
	Draft report mapping the regulations that establish existing competences and gaps
Develop the codes, norms, standards and certifications in line with the timetable and development of international rules	Propose certification governance model
	Propose product coverage and scope
	Analyse and interact with international organizations for certification systems
Create carbon-intensity certification mechanisms for hydrogen and ethanol chains derivatives	Propose a certification standard for the carbon-intensity bands of the hydrogen and derivatives produced in Brazil
Foster interrelationships between sectors, and bolster harmonization and cooperation between government agencies	List governance instruments for interrelations between sectors, harmonization and cooperation to be improved or drawn up
	Propose new governance instruments and/or revise existing governance instruments between government agencies
	Study the possibility of blending hydrogen into the existing natural gas network
Enact additional safety standards	List additional safety standards or revisions to standards
	Propose new additional safety standards or revisions to standards
Develop regulations, codes, norms and standards for new hydrogen uses and technologies	Draft National Electricity Agency (ANEEL) normative resolution(s) for the insertion of storage systems in the grid, including via hydrogen
	Develop ANP technical note on international specifications for hydrogen as a transport fuel
	List regulations, codes, norms, standards for new uses and technologies
	Propose regulation, codes, norms, standards for new uses and technologies

Source: Author's own work based on Brazil's Work Plan.

from defining low-carbon hydrogen and assigning oversight to establishing adequate safety and technical norms for its novel applications.

In line with this plan, several concrete actions are already underway, such as studies on low-carbon hydrogen certification schemes.[104] In parallel, as mentioned, Brazilian lawmakers are currently drafting and deliberating upon various hydrogen bills aimed at legally enabling its policy ambitions. Amongst these, three proposals have garnered particular attention.

[104] Ibid. 30.

Bill 2308/2023, originating from Brazil's Chamber of Deputies, sets out to establish the legal framework for hydrogen in the country.[105] In line with Brazil's Work Plan, it focuses primarily on 'low-carbon hydrogen'.[106] Unlike the Plan, however, it defines it using a fixed emissions intensity threshold – four kilograms of carbon dioxide equivalent (CO_2e) per kilogram of hydrogen produced.[107] This numerical approach, while improving legal certainty in the short term, raises concerns about its adaptability to evolving market dynamics and technological advancements.[108] In fact, in line with the latest EU-delegated acts, the emissions threshold for hydrogen to be considered low-carbon is 3.38 kilograms of CO_2e per kilogram of hydrogen.[109] To this extent, Brazil's potential adoption of a higher threshold could impact its alignment with international standards, particularly as the EU moves towards more stringent GHG emission benchmarks.[110] The bill also refers to 'renewable hydrogen', a terminology not present in Brazil's Plan, defining it as hydrogen produced from listed renewable sources.[111] Also deviating from the Plan, the bill's latest amendment added the definition of 'green hydrogen', which covers hydrogen produced by electrolysis of water, from wind and solar energy sources.[112] Beyond definitions, the bill also includes risk management guidelines and seeks to establish a hydrogen certification system, amongst other aspects.[113] Regarding competences, it grants the ANP the authority to oversee hydrogen production activities.[114]

Bill 5816/2023, which comes from Brazil's Senate, likewise aims to lay certain regulatory foundations for hydrogen's development in the country.[115] To this extent, it also includes several important definitions, in particular those for 'low-carbon hydrogen' and, intriguingly, 'green hydrogen'.[116] In line with its counterpart from the Chamber of Deputies, it defines 'low-carbon hydrogen' using the same fixed carbon emission threshold, with the ensuing issues mentioned above.[117] 'Green hydrogen', on the other hand, is defined as hydrogen produced exclusively from listed renewable energy sources, and serves as this bill's equivalent to 'renewable

[105] Câmara dos Deputados, Projeto de Lei No. 2308, de 2023 (Brazil) <https://legis.senado.leg.br/sdleg-getter/documento?dm=9518494&ts=1718339679320&disposition=inline> accessed 15 June 2024 (hereinafter: PL 2308/2023).

[106] Ibid. art. 1.

[107] Ibid. art. 4.XII. See Brazil's Work Plan 19.

[108] EPBR, 'O que dizem os Projetos de Lei sobre Hidrogênio de Baixo Carbono?' (Agência epbr, 24 November 2023) <https://epbr.com.br/o-que-dizem-os-projetos-de-lei-sobre-hidrogenio-de-baixo-carbono/> accessed 15 June 2024.

[109] Gregor Erbach and Sara Svensson, 'EU rules for Renewable Hydrogen: Delegated Regulations on a Methodology for Renewable Fuels of Non-biological Origin' 6 (European Parliamentary Research Service, April 2023) <www.europarl.europa.eu/RegData/etudes/BRIE/2023/747085/EPRS_BRI(2023)747085_EN.pdf> accessed 15 June 2024. See also Thomas Boigontier et al., 'Low-Carbon Hydrogen Production in the EU: Are 2030 Targets Achievable?' 3 (2023) <https://hal.science/hal-04158824> accessed 15 June 2024.

[110] Rosa Oyarzabal et al., 'New Definitions for Blue and Green Hydrogen: The European Commission's Package on Hydrogen and Decarbonized Gas Markets' (Inside Energy & Environment, 7 January 2022) <www.?insideenergyandenvironment?.com/2022/01/new-definitions-for-blue-and-green-hydrogen-the-european-commissions-package-on-hydrogen-and-decarbonized-gas-markets> accessed 15 June 2024.

[111] PL 2308/2023 art. 4.XIII.

[112] Senado Federal (Brazil), Parecer (SF) No. 1, de 2024, 12 June 2024, amendment 17 modifying art. 4.XIV <https://legis.senado.leg.br/sdleg-getter/documento?dm=9634429&ts=1718339679869&rendition_principal=S&disposition=inline> accessed 15 June 2024.

[113] PL 2308/2023 arts. 10, 15.

[114] Ibid. art. 11 § 1º.

[115] Senado Federal (Brazil), Atividade Legislativa PL 5816/2023 <www25.senado.leg.br/web/atividade/materias/-/materia/161378#tramitacao_10637832> accessed 15 June 2024.

[116] Senado Federal (Brazil), Projeto de Lei No. 5816, de 2023 art. 4 <https://legis.senado.leg.br/sdleg-getter/documento?dm=9537460&ts=1704277318573&disposition=inline> accessed 15 June 2024 (hereinafter: PL 5816/2023).

[117] Ibid. art. 4.I.

hydrogen'.[118] By adopting this colour taxonomy, however, this bill deviates from the Work Plan's recommendations regarding hydrogen classifications as well.[119] Besides these definitional aspects, and similar to the previous proposal, Bill 5816/2023 also contains risk management guidelines and enables the creation of a hydrogen certification system, along with other measures.[120] As it relates to oversight, it bifurcates competences, assigning regulatory authority over hydrogen production to either the National Electricity Agency (ANEEL) or the ANP depending on the technological pathways.[121]

The third bill, the legislative initiative of the Brazilian Federal Government, also seeks to lay the groundwork for its hydrogen plans.[122] This bill exclusively addresses 'low-carbon emission hydrogen', with its definition adopting practically the same language as Brazil's Work Plan.[123] Namely, it defines it as hydrogen produced via technologies and energy sources with low lifecycle GHG emissions or utilizing carbon removal technologies – thus encompassing 'renewable', 'green' and 'blue' hydrogen.[124] While this approach circumvents the potential limitations of a fixed emission threshold, the bill does not otherwise define what constitutes 'low lifecycle emissions', requiring eventual clarification. Definitions aside, the bill also seeks to establish a hydrogen certification framework, with much of its text dedicated to this purpose.[125] Unlike the previous bills, however, it does not contain safety or risk management guidelines, nor does it assign regulatory competences over hydrogen production activities, except as it relates to naturally occurring hydrogen.[126]

In terms of legislative progression, Bill 2308/2023 represents the most advanced of the three. At the time of writing, the bill cleared the Chamber of Deputies, and is being analysed in the Senate.[127] Bill 5816/2023 has also made headway, securing approval from the relevant Senate commission and being consequently sent to the Chamber of Deputies for deliberation.[128] Trailing these proposals, the Federal Government's bill was presented to the Sustainable Economic and Social Council for further consideration.[129] As of the time of writing, it has yet to be formally submitted to the Brazilian Congress.

[118] Ibid. art. 4.II.
[119] Brazil's Work Plan 17.
[120] PL 5816/2023 arts 6–8.
[121] In particular, it authorizes the National Petroleum Agency (ANP) to govern the production of low-carbon hydrogen, and the National Electric Energy Agency (ANEEL) for electrolysis-based hydrogen production, PL 5816/2023 art. 9.
[122] Comitê Gestor do Programa Nacional do Hidrogênio (Brazil), Projeto de Lei do Hidrogênio art. 1 <https://gov.br/mme/pt-br/assuntos/noticias/mme-apresenta-proposta-de-projeto-de-lei-do-hidrogenio-ao-2018conselhao2019/20231030.Minuta_PLHidrognio_MMECogesPNH2.pdf> accessed 15 June 2024.
[123] Ibid. art. 5.X.
[124] Ibid.
[125] Ibid. arts 6–17.
[126] Ibid. art. 19.
[127] Senado Federal (Brazil), Atividade Legislativa Projeto de Lei no. 2308, de 2023 <www25.senado.leg.br/web/atividade/materias/-/materia/161391> accessed 15 June 2024. See also Agência Senado, 'Marco legal para a produção do hidrogênio verde vai a Plenário' (Agência Senado, 12 June 2024) <www12.senado.leg.br/noticias/materias/2024/06/12/marco-legal-para-a-producao-do-hidrogenio-verde-vai-a-plenario> accessed 15 June 2024; 'Câmara aprova marco legal para produção de hidrogênio verde, o combustível do futuro' (Portal da Câmara dos Deputados, 29 November 2023) <www.camara.leg.br/radio/programas/1021143-camara-aprova-marco-legal-para-producao-de-hidrogenio-verde-o-combustivel-do-futuro/> accessed 15 June 2024.
[128] Câmara dos Deputados (Brazil), Atividade Legislativa PL 5816/2023 <www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2416789> accessed 15 June 2024. See also Agência Senado, 'Comissão do Hidrogênio Verde aprova marco legal; texto segue para a Câmara' (Agência Senado, 14 December 2023) <www12.senado.leg.br/noticias/materias/2023/12/14/comissao-do-hidrogenio-verde-aprova-marco-legal-texto-segue-para-a-camara> accessed 15 June 2024.
[129] Agência Gov, 'MME apresenta proposta de Projeto de Lei do Hidrogênio ao "Conselhão"' (Agência Gov, 7 November 2023) <https://agenciagov.ebc.com.br/noticias/202311/mme-apresenta-proposta-de-projeto-de-lei-do-hidrogenio-ao-2018conselhao2019> accessed 15 June 2024.

As we can see, while Brazil lacks hydrogen regulations formally in force, it exhibits a flurry of legislative activity across chambers and ministries seeking to enable the industry's ascent. Still, it simultaneously reveals a universe of conflicting definitions, competences and paths towards certification systems, evidencing the complexity and diversity of views in the country. These varied proposals, each with its unique focus and regulatory approach, emphasize the dynamic and fragmented nature of Brazil's pursuit of a hydrogen economy. Until the fog of competing visions clears, the precise contours of Brazil's soon-to-be hydrogen legal framework will remain uncertain.

Overall, the regulatory environment for hydrogen in Chile, Colombia and Brazil reveals an evolving terrain. Each country, dealing with its unique complexities, has set out on a path to establish frameworks conducive to clean hydrogen development. While appreciable progress has been made, significant work remains ahead to truly match policy ambitions. Even so, as the following section will discuss, these regulatory imperfections have not stopped the number of clean hydrogen projects in Chile, Colombia and Brazil from growing considerably.

4.4 FROM REGULATION TO PRODUCTION: ON-THE-GROUND DEPLOYMENT UNDER EXISTING GOVERNANCE

Despite this evolving character of the hydrogen regulatory frameworks in Chile, Colombia and Brazil, the pace of on-the-ground project development is continuing. Developers are forging ahead, undeterred by the gaps and inadequacies in existing governance.[130] This section briefly explores these tangible developments, highlighting how, even amid a backdrop of regulatory uncertainty, the industry is making strides in turning policy visions into concrete projects.

This apparent paradox between incomplete regulation and robust project activity stems, at least in part, from these countries' constitutional provisions enshrining a principle of freedom of enterprise. Namely, in Chile, Colombia and Brazil, business activity can proceed freely absent explicit prohibition, thus requiring no prior authorizations or permits except as provided by law.[131] In this context, hydrogen-related activities across the value chain are, by default, free to be pursued and developed, provided they adhere to any applicable rules. This backdrop of flexibility has provided latitude for the hydrogen industry to advance even under transitional governance.

In this scenario, absent specific legal provisions, hydrogen ventures remain subject to the same permitting obligations and licensing protocols imposed universally across infrastructure projects. Thus, hydrogen undertakings, akin to hazardous chemical production plants in many respects,[132] require an array of permits to break ground and eventually become operational. This process typically entails adherence to a diverse range of mandates, including but not limited to

[130] Julián González Martínez and Fernando Cubillos, 'Green Hydrogen Is Picking Up Speed in Latin America and the Caribbean' (IDB Invest, 22 November 2022) <www.idbinvest.org/en/blog/energy/green-hydrogen-picking-speed-latin-america-and-caribbean> accessed 15 June 2024.

[131] Fija el Texto Refundido, Coordinado y Sistematizado de la constitucion politica de la Republica de Chile, Decreto No. 100, 17 September 2005, Diario Oficial, 22 September 2005 (Chile) art. 19.21 <www.leychile.cl/Navegar?idNorma=242302> accessed 15 June 2024; Constitución Política de Colombia 1991, 6 July 1991 (Colombia) art. 333 <https://dapre.presidencia.gov.co/normativa/normativa/Constitucion-Politica-Colombia-1991.pdf> accessed 15 June 2024; Constituição de 1988, Constituição, 5 October 1988 (Brazil) art. 170 <www.lexml.gov.br/urn/urn:lex:br:federal:constituicao:1988-10-05;1988> accessed 15 June 2024.

[132] GIZ et al., 'Identificación de aspectos ambientales, sectoriales y territoriales para el desarrollo de proyectos de hidrógeno verde en toda su cadena de valor' 36 (2020) <https://4echile.cl/wp-content/uploads/2021/09/Aspectos-ambientales-H2.pdf> accessed 15 June 2024.

site planning, construction compliance, environmental impact assessments, water resource management, waste disposal protocols and observance of health and safety guidelines.[133]

Pragmatically leveraging the existing frameworks, over 100 hydrogen projects across different phases have been logged across these countries as of late 2023, spanning from initial feasibility studies to fully operational plants.[134] More than half of these are in Chile, with at least three projects under construction and six already operational.[135] Amongst these, the Cerro Pabellón microgrid pilot project, operational since 2019, has been utilizing solar energy to generate 10 tonnes of green hydrogen per year.[136] Of larger scale, the Haru Oni demonstration plant is capable of producing 130,000 litres of e-fuels per year, making it the first operating e-fuels facility in the world.[137]

Colombia's hydrogen sector includes twenty-seven projects across various stages, with three in construction and four operational.[138] Notably, in early 2022, the Ecopetrol Group launched a three-month pilot project with the aim of producing 20 kg daily of high-purity green hydrogen for refinery usage. While small-scale, the pilot's objective was to assess the technical and environmental feasibility and performance of green hydrogen generation at the Cartagena Refinery.[139] Capitalizing on this experience, Ecopetrol is set to start the construction of two green hydrogen 'megaprojects' in 2024, expected to be amongst the largest in Latin America.[140]

Following closely behind, Brazil accounts for the remaining twenty-four projects, with two operational and a third under construction. In particular, White Martins has launched a green hydrogen production project with a yearly output of 156 tonnes destined for the local market.[141] Importantly, this project has been certified by TÜV Rheinland, making it the first plant in Latin America certified to produce green hydrogen.[142] The second operational undertaking is EDP Brazil's pilot project, part of a larger R&D initiative, which can produce 250 normal cubic metres of hydrogen gas per hour – operational hours determining annualized output.[143]

[133] Ibid.

[134] Although the number of projects varies by source and criteria, this chapter relies on the IEA's Hydrogen Production and Infrastructure Projects Database, last updated October 2023, available at IEA, 'Hydrogen Production and Infrastructure Projects Database' (2023) <www.iea.org/data-and-statistics/data-product/hydrogen-production-and-infrastructure-projects-database> accessed 15 June 2024 (hereinafter: IEA Project Database).

[135] Ibid.

[136] Hydrogen in Latin America 29.

[137] HIF, 'HIF Haru Oni Demonstration Plant' (HIF Global) <https://hifglobal.com/haru-oni> accessed 15 June 2024.

[138] IEA Project Database.

[139] Ecopetrol, 'El Grupo Ecopetrol inició la producción de hidrógeno verde en Colombia' (Ecopetrol, 18 March 2022) <www.ecopetrol.com.co/wps/portal/Home/es/noticias/detalle/Noticias+2021/el-grupo-ecopetrol-inicip-la-produccion-de-hidrogeno-verde-en-colombia> accessed 15 June 2024.

[140] Lina Quiroga Rubio, 'En 2024, Ecopetrol comenzará construcción de 2 megaproyectos de hidrógeno verde' (El Tiempo, 21 April 2023) <www.eltiempo.com/economia/empresas/ecopetrol-comenzara-construccion-de-2-megaproyectos-de-hidrogeno-verde-761523> accessed 15 June 2024.

[141] White Martins, 'White Martins produz o primeiro hidrogênio verde certificado do Brasil' (White Martins, 8 December 2022) <www.whitemartins.com.br/news/2022/white-martins-produz-o-primeiro-hidrogênio-verde-certificado-do-brasil> accessed 15 June 2024.

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[143] Robson Rodrigues, 'EDP inaugura primeiro projeto-piloto de hidrogênio verde do Brasil, no CE' (Um só Planeta, 22 January 2023) <https://umsoplaneta.globo.com/energia/noticia/2023/01/22/edp-inaugura-primeiro-projeto-piloto-de-hidrogenio-verde-do-brasil-no-ce.ghtml> accessed 15 June 2024.

This overview reveals a significant trend: although the regulatory structures may still be in a state of flux, they have not impeded the practical progression of hydrogen pilot projects. Still, reliance on (permitting) frameworks not specifically designed with the particularities of hydrogen projects in mind poses risks and increases stakeholder uncertainty. The varied nature of hydrogen undertakings, shaped by diverse technologies and processes, stresses the need for a tailored regulatory approach. This requires not only the adoption of hydrogen-specific regulations, as previously discussed, but also a thorough review and amendment of existing permitting structures in line with the characteristics of hydrogen projects. Recognizing this imperative, the strategies of Chile, Colombia and Brazil all include actions towards adapting their permitting procedures.[144] As the industry shifts from scattered pilots to widespread commercialization, these countries' continued regulatory efforts remain integral to realizing hydrogen's potential across the region.

4.5 CONCLUSION

The hydrogen landscape in Latin America, as exemplified by the endeavours of Chile, Colombia and Brazil, is marked by promise and challenge. Driven both by growing global demand and the motivation to decarbonize their economies, their initiatives represent a regional shift towards embracing clean hydrogen. These resource-rich countries have quickly progressed from articulating ambitious strategies to dealing with the complexities of designing enabling regulatory frameworks. While distinct in approach and execution, their policies converge on a common goal: to position themselves as major players in the impending hydrogen economy.

However, as their experiences reveal, the path from promise to production is fraught with challenges. Indeed, creating a regulatory environment that accommodates hydrogen's multidimensional nature is proving to be a demanding task, with governance structures struggling to match the pace of technological developments and market demands. Yet, despite these regulatory uncertainties, interest in clean hydrogen projects continues to grow, with pilot ventures forging ahead undeterred.

As Latin America looks to the future, the hydrogen promise appears compelling, even if exacting. The experiences and lessons emerging from Chile, Colombia and Brazil offer valuable insights for other countries, highlighting the critical role of coherent policy and regulatory frameworks in the transition towards a hydrogen future. While the full realization of Latin America's hydrogen potential remains to be seen, the current momentum offers reasons for optimism.

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