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Conclusion

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21.1 INTRODUCTION

Ten years ago, Werner Franz, the fourteen-year-old cabin attendant on the airship Hindenburg,[1] died on 13 August 2014 at the age of ninety-two. According to his widow, he lived a long and 'very fulfilled'[2] life after the Second World War. Franz had been traumatized by the events of 1937, but still took pleasure in sharing his knowledge about hydrogen as he guided visitors through a Zeppelin Hall for the airship shipping company after the disaster.[3]

Just as in the life of Franz, the relationship between hydrogen and mankind intertwines in a complex weave. This is particularly true for the relationship between hydrogen and the law, which transcends mere legal frameworks; it embodies a convergence of technological advancement, environmental stewardship, and socio-economic imperatives. As we delved deeper into this relationship, chapter by chapter, it became evident that the legal landscape plays a pivotal role in shaping the trajectory of hydrogen's journey towards becoming a cornerstone of our sustainable future.

At its core, the interplay between hydrogen and the law revolves around the regulation, promotion, and integration of hydrogen technologies into existing socio-economic structures. Legislative bodies worldwide seem to have embarked on a journey to formulate first, tentative frameworks that, at best, address the multifaceted dimensions of hydrogen production, transmission, and utilization. From incentivizing research and development to establishing safety standards and fostering international collaboration, legal instruments have served as catalysts for unlocking hydrogen's transformative potential.

One of the primary drivers behind the surge in hydrogen-related legislation is the imperative to mitigate climate change and reduce greenhouse gas emissions. As nations grapple with the pressing need to transition towards low-carbon energy systems, hydrogen can function as a versatile ally in this quest for sustainability. We will now go on to create an inventory of key findings of this book concerning the relationship between hydrogen and the law.

[1] His role is discussed in the introduction to this book (Chapter 1).

[2] 'Letzter Überlebender der "Hindenburg"-Katastrophe gestorben', *Der Spiegel* (29 August 2014), available at <https://spiegel.de/panorama/hindenburg-katastrophe-letzter-ueberlebender-werner-franz-gestorben-a-988852.html> accessed 19/February 2024.

[3] Ibid.

21.2 KEY FINDINGS AND FUTURE DIRECTIONS

The intersection of hydrogen and the law extends beyond domestic jurisdictions, encompassing regional collaborations and future international agreements. Given the global nature of climate change and energy transition, cooperation among nations is imperative to harness the full potential of hydrogen as a clean energy vector. Progress, however, differs from region to region and the question of how best to create a hydrogen economy seems to have split the world. (At least) two different approaches have been identified in this book: either starting with the establishment of a legal framework and then looking for investments or securing investments first, with a legal framework growing thereafter.

The first approach is epitomized, inter alia, by the EU. In Chapter 2, Hancher and Suciu describe how the EU is currently working to establish a comprehensive legal framework on hydrogen and establishing clear rules for EU Member States. However, the focus is different in other parts of the world and an alternative approach is taken there. In Chapter 3, Attanasio and Briggs explain the approach of the United States. Here, the focus is on a massive stimulation effort to bring billions of dollars of private investments to the hydrogen sector, while regulatory uncertainty is still looming large. The approach of first securing investments for hydrogen has also been taken in the Middle East and North Africa (MENA) region, as Olawuyi and Aryanpour report in Chapter 6. However, the focus here lies with the creation of export opportunities, for example, for green ammonia, including huge state investments in export infrastructure specifically.

A similarly dynamic development can be seen in Latin America. Chile, Colombia, and Brazil, aiming to capitalize on their abundant (renewable) resources, have moved to outline ambitious hydrogen strategies and legislation. But Foy argues in Chapter 4 on Latin America that the speed of legislative movements is not sufficient to keep pace with the developers that are continuing to forge ahead, undeterred by the gaps and inadequacies in existing governance. Even amidst a backdrop of regulatory uncertainty, the industry is making strides in turning policy visions into concrete projects. Foy attributes this paradox between incomplete regulation and robust project activity to these countries' constitutional provisions, which enshrine a principle of freedom of enterprise. Namely, in Chile, Colombia, and Brazil, business activity can proceed freely absent explicit prohibition, requiring no prior authorizations or permits except as provided by law and that, according to Foy, has benefitted the hydrogen sector in its development.

The export of hydrogen is also a key driver of legal developments concerning hydrogen in Oceania. While New Zealand seems to lag behind a bit in its development, Australia recently embraced the opportunities of hydrogen. In Chapter 5, Taylor argues, however, that export requires hydrogen production capacities in the first place. While Australia has plenty of sunshine and wind to produce green electricity for green hydrogen, the legal governance of land use is an issue, according to Taylor. While the complicated system of pastoral leases developed into diversification leases in some parts of Australia, which will permit hydrogen development on pastoral land, the developments and impacts differ from one region to another. Taylor argues that many crucial aspects of the future renewable hydrogen supply chain and licensing systems will be regulated by states and territories. In practical terms, this requires measurable national strategies aligned with state and territory planning systems to design regulatory frameworks. Principles for renewable hydrogen development are crucial to guide and develop consistent and coherent licensing and planning regulatory regimes.

In Chapter 7, surveying the situation in Southeast Asia, Eiamchamroonlarp pays attention to a clear and mutual understanding of what green or renewable hydrogen is to create export and trade opportunities. He points towards a development in Southeast Asia that differs from many other parts of the world, where electrolysis will be used as the method of choice to produce green hydrogen. As opposed to this, in Southeast Asia, a traditionally agricultural region, a different path is being pursued, namely steam reforming from biofuels to produce green hydrogen. Accordingly, the legal frameworks in Southeast Asian countries focus more on the traditional regulation of industrial power plants and factories. Eiamchamroonlarp argues that this approach to regulation also makes sense to produce green hydrogen from steam reforming of biofuels, as there will be a considerable number of hydrogen power plants in that region using this technology in the future. However, ASEAN countries are at the initial stages of hydrogen production.

What green or renewable hydrogen is, also seems to be a key debate in other parts of the world. For the EU, the discussion boils down to the question of sustainability criteria for hydrogen against which imports from other regions are benchmarked. In Chapter 10, Mauger, Villavicencio-Calzadilla, and Fleming explain how just copy-pasting known sustainability criteria that exist for bioenergy might not be an ideal way forward. They do not sufficiently include considerations of water consumption in water-scarce areas and the social impacts.

Social impacts are also a key driver behind the democratization of energy through hydrogen, which can hold the promise of empowering communities and fostering inclusive development. By decentralizing energy production and enabling local energy generation through technologies such as electrolysers and fuel cells, hydrogen can transcend geographical constraints and empower communities to become energy self-sufficient. The role of local authorities in this should not be underestimated, as Chapter 9 by Nieuwenhout aptly demonstrates. If clear political will exists, municipalities and small regions can create a 'bottom-up' approach to the introduction of hydrogen in our energy systems in at least three ways. First, they can bring parties together and position the specific region as a hydrogen hotspot. Second, they can create local demand through the public procurement of public transport services and/or maintenance vehicles, also in areas where there is no industrial demand for hydrogen (yet). Third, local and regional authorities can also play a role in system integration.

For this development to succeed, however, the active participation of citizens in hydrogen developments and legal frameworks is required, as Squintani and Schouten argue in Chapter 11. Currently, however, this is not guaranteed in effective ways by the legal framework, as they demonstrate, with EU and Member States as well as local legal frameworks serving as examples. According to Squintani and Schouten, the lack of explicit requirements on public participation in the EU regulatory framework for renewable energy, in general, and energy production and transport is echoed by the lack of a participatory process for the establishment of the National Hydrogen Programme and related National Roadmap. Also at a regional level, the retrieved policies, plans, and programmes for the development of the hydrogen economy do not show the presence of public participation.

However, amidst the myriad opportunities presented by hydrogen, it is essential to navigate the associated challenges judiciously. The creation of hydrogen markets, as Mulder argues in Chapter 8, can be achieved via several routes, but a clear legal framework is crucial to protect and ease transactions. Looking into the entire hydrogen supply chain from production to end use through an economic lens shows, according to Mulder, that certain regulatory strategies that worked in the natural gas and particularly the electricity sector should be used for the regulation

of hydrogen markets, while other aspects, like environmental externalities of production, require a different type of regulation.

The fact that certain aspects of the hydrogen supply chain might require different regulation is evident from Andreasson's Chapter 12 on offshore production and transport of green hydrogen in Denmark and the Netherlands. She identifies the lack of legislation that specifically addresses the permitting procedure for offshore hydrogen production as a key legal barrier and, coming back to the theme identified earlier in these conclusions of what should come first, investments or legal framework, takes a clear stance for the offshore area. She argues that a robust and enabling legal framework is needed to facilitate the development of offshore hydrogen infrastructure. Without such a framework, investments will not be made and new developments, such as offshore electrolysers, will not be deployed.

As opposed to offshore, in Chapter 13, Tissari gives an example of the development of onshore electrolysers. Her scrutiny of the Finnish permitting regime unearths a regime that was initially designed around many individual permits that may, however, be applied for online in most cases. But there are recent efforts to streamline the regime and make it easier for the user via the so-called accelerated permission procedure for green transition projects. Tissari explains that it will significantly shorten the processing time for permit handling to a maximum of twelve months. With this trend, Finland stands as an example for many other countries that are currently investigating permitting regimes for hydrogen production facilities and are eager to create one-stop shops for users, or at least streamline the process.

When it comes to hydrogen production, it can be observed that many permitting regimes are centred around environmental aspects like water, wastewater, and air quality. Campion adds to that list in Chapter 14, but also makes clear that the way in which we look at the regulation of these elements as such might need to be reconsidered in the context of hydrogen. New Zealand is currently wrestling with the question of how to incorporate indigenous perspectives into the consenting regimes. Campion argues for the establishment of a hydrogen-specific permitting framework in New Zealand that takes indigenous perspectives into account better – a point that may also be of interest to other parts of the world when contemplating future legal and regulatory frameworks on hydrogen.

Once the hydrogen production facility – for example, an electrolyser – obtains the necessary permits, the hydrogen produced needs to be transported to the end users. In Chapter 15, Jansen provides a case study on Germany which illustrates that a whole set of permits is required to build and/or operate the transport infrastructure. Jansen compares the erection of new hydrogen pipelines and storage with the required permits for the conversion of existing gas pipelines and storage to hydrogen and concluded that the latter is particularly supported by the German system. Several procedural privileges have been specifically designed to make the reuse of natural gas infrastructure for hydrogen purposes attractive from a legal point of view. This is particularly the case because the German regulator is currently in the process of issuing permission to a so-called hydrogen core grid, which will just fall short of 10,000 kilometres, and the reuse of existing pipeline infrastructure will provide the majority (around 60 per cent) of that core grid. Thus, Jansen concludes that the government's recent decision to construct a hydrogen core grid, accompanied by an acceleration law, sets the right course.

A similar approach to hydrogen infrastructure regulation has been taken in the Netherlands, as discussed by Broersma, Jäger, and Holwerda in Chapter 17. The country also aims to create a national hydrogen network mainly consisting of reused natural gas pipelines, as studies have shown this to be a more cost-effective alternative to new hydrogen pipelines. This needs to be accommodated for in legal terms, as there might, as a result, be times when a mingled or

blended stream will be in the main networks. Given the fact that current regulation in the Netherlands effectively sees hydrogen as an impurity to the natural gas stream and only allows a very small percentage of hydrogen in the pipelines, this will require a fundamental rethinking of legislative perspectives. Luckily, changes to the existing framework are on their way. One of the key challenges that remains, however, is how to regulate the access of others to the hydrogen network. Broersma, Jäger and Holwerda argue that opening access to hydrogen infrastructure components on a regulated third-party access (TPA) basis might be counterproductive to the speed and scale of the rollout of the hydrogen economy.

The general issue of a lack of an existing legal framework for hydrogen transportation may also be encountered in other countries. Zerde argues in Chapter 16 on the French legal regime, however, that this has been identified and tackled by the legislator. The adoption of a specific chapter in the French energy code that also includes provisions on the transport of renewable hydrogen in natural gas pipelines and autonomous transport networks has been a positive move in the right direction. Zerde characterizes the regulatory technique followed in the case of hydrogen legislation in France as moving away from prescriptive technical rules. Instead, it is moving 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 individual characteristics, how safety can be achieved.

The safe transport of hydrogen is needed for several end-use sectors. One of the early adopters of hydrogen is the heavy-duty transport sector. In Chapter 18, Cocciolo thus focusses particularly on the regulation of hydrogen road refuelling infrastructure, where safety issues also play a vital role. Using the example of European legislation, Cocciolo demonstrates how the deployment of hydrogen refuelling stations requires a careful analysis of the various legal barriers that affect the value chain of hydrogen. In this sense, he calls for a holistic approach to the identification and resolution of legal hurdles. Cocciolo poses that the actual rollout of the hydrogen refuelling infrastructure should reflect other, broader goals and align with them, namely social/societal benefits, and environmental sustainability.

Societal benefits and the furtherance of environmental sustainability also lie at the heart of the idea of using hydrogen in a different sector – for the storage of electricity. In Chapter 19, Huhta and Sairanen analyse the legal questions that emerge in using hydrogen as a storage medium to balance the intermittency of renewable energy sources in the low-carbon energy transition. They find that, much as with the debate about the definition of the different colours of hydrogen, the questions surrounding the existing legislative framework for hydrogen storage are often definitional: they hinge on whether, or to what extent, the existing rules on natural gas, electricity, and renewable energy apply to hydrogen storage.

As opposed to these definitional issues, where the general direction and political will are clear, Jansen and Reins conclude the book with Chapter 20 on the regulation of hydrogen in heating markets. Whether or not hydrogen should be used in heating is already subject to political debate. With the help of a case study, hydrogen heating regulation in the Netherlands, Jansen and Reins make the case for using hydrogen to abate the greenhouse gas (GHG) emissions of the heating sector. However, they bemoan the lack of a coherent and comprehensive legal framework for hydrogen in the heating market in the Netherlands and have little hope concerning the new and upcoming Dutch Energy Act. In the short to medium term a temporary framework, drawn up by the energy regulator in the Netherlands provides some relief to market players, but this cannot be a long-term solution, according to Jansen and Reins.

21.3 CONCLUSION

What all these fascinating glimpses into the world of hydrogen regulation have taught us is that legal frameworks, which promote transparency, accountability, and stakeholder engagement, are essential in fostering a just transition towards a hydrogen-based economy. Furthermore, the transition to a hydrogen economy necessitates a holistic approach that transcends siloed thinking and embraces interdisciplinary collaboration. Lawyers, policymakers, scientists, engineers, and stakeholders from diverse backgrounds must come together to navigate the complex terrain of hydrogen deployment effectively. Interdisciplinary research and industry implementation can facilitate synergies between legal, technical, and socio-economic perspectives, enabling informed decision-making and policy formulation.

In conclusion, the nexus of hydrogen and the law embodies a convergence of technological innovation, environmental imperatives, and socio-economic dynamics. Legal frameworks serve as enablers, catalysts, and guardians in shaping the trajectory of hydrogen's journey towards sustainability and resilience. By fostering innovation, ensuring safety, facilitating international cooperation, and promoting inclusive development, the law plays a pivotal role in unlocking the transformative potential of hydrogen as a cornerstone of our sustainable future.

It has become clear from this conclusion that the current regulation of hydrogen around the globe and along the entire hydrogen value chain is not yet sufficiently developed and there are several areas that require attention and improvement. In some respects, this result does not come as a surprise, as the idea of regulating hydrogen is relatively new to lawmakers and lawyers. However, driven by the current rate of investments and high-level policy plans, the dynamics are highly promising and the scale of developments is breathtaking. Ten years ago, it was common to discuss future electrolyser projects at the scale of some kilowatts (kW) and up to 10 megawatts (MW) (with the latter being considered very big).[4] In 2024, however, we are frequently discussing electrolysers of 320 MW capacity and more.[5] Legal frameworks will have to keep pace with these rapid developments and much further research into the legal frameworks is required in the coming years to trace developments and identify regulatory and legislative trends. This book has merely created a first, tentative inventory that will soon require substantive updates in many respects.

This is no small enterprise and may even seem daunting at times. It is important for legal scholars and everybody working on hydrogen issues to remember a thought that should comfort us as we navigate the complexities of the hydrogen economy. Ultimately, it is incumbent on all of us to harness the power of the law to steer towards a future where energy is clean, equitable, and abundant for all.

[4] See for example EU Horizon 2020 'STORE & GO Deliverable 7.2 European Legislative and Regulatory Framework on Power to Gas', available at <https://storeandgo.info/fileadmin/downloads/20171030_STOREandGO_D7.2_RUG_submitted.pdf> accessed 26/February/2024, at 13.

[5] See for example for Germany, the EWE, 'Clean Hydrogen Coastline', available at <https://clean-hydrogen-coastline.de/de/projekte/ipcei-elektrolyse-ostfriesland> accessed 26/February/2024.