Hydrogen development in the European Union and in Italy Legislative barriers and potential solutions

Simona Capozza, Luigi Crema, Cristina Maggi, Matteo Testi, Martina Trini*

Abstract: Climate change is a touchable phenomenon and hydrogen has become an attractive solution for experts and for policymakers. However, in order to understand the environmental impact of an energy vector, it is necessary to consider its entire value chain and not simply the end uses. Hydrogen is really "clean" when produced by the exploitation of renewable sources (so-called "green hydrogen") or (at most) when produced by fossil fuels using technologies able to impede the release of greenhouse gases emissions in the atmosphere (so-called "blue hydrogen"). The major potential of hydrogen consists into the increase of renewable sources' integration into the energy system, addressing two major challenges of renewable energy: intermittency and non-programmability. Hydrogen produced by RES can be transported over long distances, injected into the natural gas grid, stored and reconverted into electricity as needed, so that the Hard-To-Abate sector gets electrified. Nevertheless, the need for timely review of regulation strongly emerges from legislative gaps concerning both the energy vector and the existing regulation, which imply barriers that can actively interfere with the development of the hydrogen supply chain. As the European Union has seen a great intrinsic potential in hydrogen development, also Italy is trying to bring to action the European pathways together with their customization. This article analyses some of the barriers and gaps of the current legislation, namely: the need for a Guarantee of Origin system; on the goal of sector coupling, which consists in the realization of an integrated energy system based on the exploitation of green energy; on one of the cleanest hydrogen production technology, the "power-to-gas", and its role inside the integrated energy system. The analysis starts from the European Union and then deepens the Italian context with the purpose of understanding peculiarities and possibilities.

Keywords: Hydrogen; Energy Transition; Energy regulation; Sector Coupling; Power-to-gas.

1. Introduction

The idea of utilizing hydrogen as a clean energy vector is not new, but it was neither ever considered as a feasible option. However, today hydrogen is living an important momentum, since technology has known severe improvement and it is no longer immature, costly, and inefficient for implementing new energy solutions.

Nowadays, the hydrogen sector is just waiting for concrete and coherent initiatives to develop its usage on a large scale. Even green hydrogen, if still not competitive, recently has seen a great cost reduction[1]. Globally, the political will seems to aim at creating the so-called

*Simona Capozza is currently working at iLStudio Engineering & Consulting and at Studio Legale Gurrado, Simona Capozza is an alumna of the University of Trento, who also studied at the Universidade Catòlica Portuguesa and at the Vermont Law School. She was a trainee at Fondazione Bruno Kessler and collaborated with H2IT.

Luigi Crema is the director of the Sustainable Energy Center at Trento based Fondazione Bruno Kessler. He is the vice president of the Italian Hydrogen Association and a member of the Board of Hydrogen Europe Research of the Clean Hydrogen European partnership.

Cristina Maggi is an energy engineer graduated at Politecnico di Milano, she has been involved in hydrogen projects since 2017 and since 2018 she is the Director of H2IT Italian hydrogen and fuel cells Association.

"hydrogen economy"[2], which means that hydrogen will be used to transport energy over long distances and to store it in large amounts[3], finding many different applications in lots of economic sectors (e.g. industry, transport, buildings).

Moreover, the current energy and climate policies (both at the European and at the national level) are promoting the use of electricity from renewable sources, though these are intermittent and non-programmable. Therefore, new storage solutions are needed and hydrogen may represent one: overproduction from renewable electricity generation could be used to produce hydrogen that can be stored and then re-converted into electricity on demand. In this way, renewable electricity would generate the so-called "green hydrogen", through the electrolysis process and the electricity would be used to separate water into hydrogen and oxygen: the latter would be the only element released in the atmosphere (if not stored for other uses), while hydrogen would be stored for later use (Figure 1)[4].

Dr. Matteo Testi holds a PhD in Physics at the University of Trento on the novel materials and methods for solid state hydrogen storage technologies and has a master degree in Materials Science at Università Cà Foscari of Venice. He is involved in many different European projects of FCH JU.

Martina Trini is Hydrogen Technology Manager. She got a PhD in Energy Conversion and Storage at the Technical University of Denmark on Solid Oxide Electrolysis and Fuel Cells. She carried out research activity at Fondazione Bruno Kessler in the Applied Research on Energy Systems (Sustainable Energy Centre from 2021).

1. Thijs Van de Graaf, et al, *The new oil? The geopolitics and international governance of hydrogen*, 70 Energy Research & Social Science, at 2-4 (2020).

2. Donald Zillman, et al, *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions* at 137 (Oxford University Press 2018).

3. John O. Bockris, *Environmental Chemistry,* in Bockris J.O. (eds), *Environmental Chemistry* at 1-18 (Springer, Boston, MA 1977).

4. Ruven Fleming, *Clean or renewable - hydrogen and power-to-gas in EU energy law*, 39 Journal of Energy & Natural Resources Law 43 at 4 (2021). See also Hydrogen Council, *Path to Hydrogen Competitiveness: A cost perspective* at 20 (2020), available at https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf (last visited November 20, 2021). For a general explication on hydrogen, see SNAM, *L'idrogeno* (September 22, 2020), available at https://www.snam.it/it/transizione_energetica/idrogeno/idrogeno/ (last visited November 20, 2021).

Therefore, renewable energy would always be available for periods of demand peaks, ensuring flexibility and resilience to the entire electric network[5].

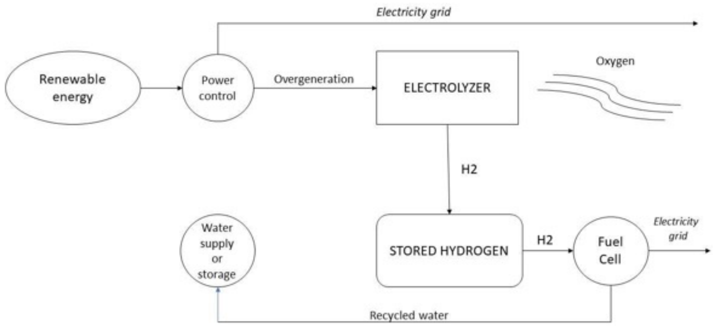

Figure 1 - Hydrogen production from renewable electricity overgeneration. *Author*: Simona Capozza

Furthermore, hydrogen could help renewable electricity to reach all the economic sectors, among which there are the so-called

5. Fuel Cells and Hydrogen Energy Association, *Road Map to a US Hydrogen Economy: Reducing emissions and driving growth across the nation* (2020), available at http://www.fchea.org/us-hydrogen-study (last visited November 20, 2021). See also Marco Alverà, *Rivoluzione Idrogeno: La piccola molecola che può salvare il mondo* at 86-88 (Mondadori Electa 2020).

"hard-to-abate" ones[6] (e.g. steelworks[7], refineries[8], aviation[9]) since they cannot be electrified, as well as distant consumers.

For these reasons, the interest in hydrogen has grown exponentially, considering the objectives both of decarbonizing economy and society, and of the energy transition towards an interconnected and sustainable energy system. Indeed, the decarbonization process aims at reducing the carbon intensity of the power sector that supports the economy and, consequently, the entire society[10] to realize an energy sustainable transition.

This article will identify some of the most critical legislative issues concerning hydrogen production, namely: the development of a Guarantee of Origin (GO) system and the regulative barriers that impede the deployment of Power-To-Gas (P2G) technology on a large scale. Particular attention will be paid to the need for a clear vision regarding hydrogen transportation and the hydrogen role in the creation of sector coupling (SC).

These are essential issues that need to be addressed to ensure clean hydrogen access to energy markets and, consequently, to foster the creation of an energy system which is free from fossil fuels' exploitation.

---

6. See SNAM, The European House - Ambrosetti, *H2 Italy 2050: Una filiera nazionale dell'idrogeno per la crescita e la decarbonizzazione dell'Italia* at 112-115, 117, 120, 122, 125, 146-150, 172-189 (2020), available at https://www.snam.it/export/sites/snam-rp/repository/file/Media/news_eventi/2020/H2_Italy_2020_ITA.pdf (last visited November 20, 2021).

7. See Fuel Cells and Hydrogen Energy Association, *Road Map to a US Hydrogen Economy* at 9 (cited in note 5).

8. See International Energy Agency, *Decarbonizing Industry with Green Hydrogen* (November 17, 2020), available at https://www.iea.org/articles/decarbonising-industry-with-green-hydrogen (last visited November 20, 2021).

9. See AIRBUS, *Hydrogen in Aviation: How Close is it? Understanding the challenges to widespread hydrogen adoption* (October 8, 2020), available at https://www.airbus.com/en/newsroom/stories/2020-10-hydrogen-in-aviation-how-close-is-it (last visited November 20, 2021).

10. The London School of Economics and Political Science, *What is "decarbonization" of the power sector? Why do we need to decarbonize the power sector in the UK?*, (January 29, 2020), available at https://www.lse.ac.uk/granthaminstitute/explainers/what-is-decarbonisation-of-the-power-sector-why-do-we-need-to-decarbonise-the-power-sector-in-the-uk/ (last visited November 20, 2021).

2. The need of a Guarantee of Origin scheme

2.1. The functionality and relevance of a GO scheme

A Guarantee of Origin, hereafter GO, consists in «an electronic document which has the sole function of providing evidence to a final consumer that a given share or quantity of energy was produced from renewable sources»[11]. In other words, a GO permits a renewable energy producer to monetize the energy value towards a consumer who is willing to pay a premium for that energy.

Energy vectors, such as hydrogen, need complex infrastructures to be transported and it is difficult to create specific ones that can properly value all their characteristics (as it is for renewable vectors). Considering this, GOs have been created, so they can be exchanged separately from the physical energy vector (which is exchanged using the traditional infrastructure) and ensure the renewable origin of it.

In general, a GO system has three essential elements: (i) there is a public or private authority authorized to release the GOs to producers and which has the task to monitor them, through their punctual registration; (ii) every time a final consumer affirms that he has consumed all the certified energy, the GO he has must be cancelled; (iii) every exchange of GOs must be noted in the respective registry until they are cancelled.

Currently, there is not a binding GO scheme for hydrogen, neither at the Italian level, nor at the European or international one. Nevertheless, the boost to create an energy sector able to host green hydrogen in Italy is a crucial issue to address. In this regard, particular attention should be paid to the impellent necessity of incrementing public awareness about hydrogen potential. To this respect, a non-binding certification system has been developed by private initiative, which is the CertyfHy Guarantee of Origin Scheme[12].

11. Art. 2, para 2 (12), EU Dir 11 December 2018, no 2001.

12. See CertifHy, *Recommendations on the establishment of a well-functioning EU hydrogen GoO system* at 5, 10-11, 20-22, 25-27, 33-36 (January 31, 2016), available at https://www.certifhy.eu/images/project/reports/D3.3_Recommendations_on_the_establishment_of_a_well_functioning_EU_hydrogen_GO_system.pdf (last visited November 20, 2021).

2.2. The vision of the European Union

The European Union has explicitly invited Members to consider systems ensuring the origin of gases, including hydrogen, as it has already been done for renewable electricity[13].

To foster the creation of a system certifying the origin, the Directive charges the European Standard Organizations, the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC)[14] to revise the EN 16325 standard[15] (the standard regarding the renewable electricity GO scheme), with the aim of defining a European common system for the certification of hydrogen.

More specifically, the CertifHy Guarantee of Origin Scheme has been considered as a guideline in the reviewing process[16]. The CertifHy Project has been promoted by the Fuel Cells and Hydrogen Joint Undertaking in order to elaborate an origin certification system dedicated to hydrogen.

This scheme provides a GO system for hydrogen, consenting its labelling and traceability. The CertifHy includes also the possibility of certifying hydrogen produced using fossil fuels with carbon capture, usage and storage (CCUS) technologies (so-called "blue hydrogen"). More precisely, considering emissions at the production point (and not considering subsequent emissions), hydrogen can be labelled as "CertifHy Green Hydrogen", when produced using renewable energy and meeting the sustainability criteria stated by the RED II[17]; or as "CertifHy Low-greenhouse gas (GHG) Hydrogen", when emissions are lower than the threshold defined by the CertifHy

---

13. See Art. 19, para (7) (b), EU Dir. 11 December 2018, no. 2001.

14. More information about CEN and CENELEC are available at https://www.cencenelec.eu/ (last visited November 20, 2021).

15. See European Standard CEN - EN 16325 Guarantees of Origin related to energy - Guarantees of Origin for Electricity, (Engineering360, Standards Library), available at https://standards.globalspec.com/std/9969735/EN%2016325 (last visited October 27, 2021).

16. See CertifHy, Fuel *Cells and Hydrogen Joint Undertaking*, available at https://www.certifhy.eu/ (last visited November 20, 2021).

17. See European Commission, *Sustainability Criteria* (March 16, 2020), available at https://ec.europa.eu/energy/topics/renewable-energy/biofuels/sustainability-criteria_en (last visited November 20, 2021).

low-GHG-emissions and it is produced in a facility where the average intensity of emissions from the production of non-CertifHy Low-GHG hydrogen does not exceed the intensity of the emissions of the reference process[18].

Furthermore, in 2021, the European Commission should propose an adjustment of the Emission Trading System (ETS): due to the latest policies in favor of hydrogen development, a new great part of industry could be subjected to the ETS. Particularly, lots of these industries are potential consumers of clean hydrogen and, consequently, their subjection to the ETS would increase the demand for the renewable gas. Green and blue hydrogen could substitute gray hydrogen as a feedstock while reducing GHG emissions from the industrial sector.

To summarize, there is the need for an instrument that can recognize the value of clean hydrogen and that can be used to demonstrate the meeting of the allowances released: GOs show the potential to become such an instrument. Obviously, to do so GOs should also report the information about GHG content[19].

3. Sector Coupling and the role of hydrogen

3.1. What it is and why it is relevant

Aiming at the energy transition, it is essential to look at the energy system as a whole and not to consider all the different sectors as independent. The decarbonization of the energy system requires a comprehensive solution that makes it possible to replace traditional fossil fuels with renewable energy.

The coordination of all the energy sectors in one interconnected energy system goes under the name of "sector coupling" (SC). The SC aims at getting together different energy sectors such as production, transportation, and final uses, to increase the growing share of

18. See CertifHy, *Technical Report on the Definition of "CertifHy Green Hydrogen* at 5, para 1.3 (26 October 2015).

19. See Andris Piebalgs and Christopher Jones, *A proposal for a Regulatory Framework for Hydrogen Guarantees of Origin*, 37 Robert Schuman Centre - Policy Brief 5 (2020).

renewable energy sources in the energy system[20]. Therefore, an energy conversion process takes place, through which the energy can be preserved outside of the electricity network (e.g. hydrogen storage), consumed in other sectors, and transported (when transportation outside the network is more convenient)[21].

Hence, hydrogen could be one of the instruments the energy system needs to allow the increasing integration of renewables inside a system which results from the coupling of networks (Figure 2).

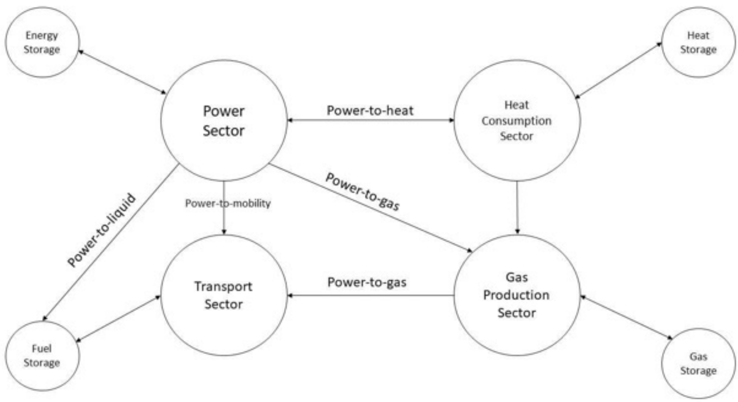

Figure 2 - The Sector Coupling. *Author*: Simona Capozza

Article 20 of the RED II states that Member States should address the issue of the infrastructure extension to help the integration of renewable gases inside the energy system. Also, the Transmission System Operators (T.S.O.s) should support the national regulatory authorities in the elaboration of common Network Development Plans showing all the infrastructure goals set for the short and long-term.

20. See IRENA, *Global Energy Transformation: A Roadmap to 2050* at 70 (2018), available at https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_Report_GET_2018.pdf (last visited November 20, 2021).

21. See ETIP SNET, *Sector Coupling: Concepts, State-of-the-art and Perspectives* at 12, 33, 39, 42-43 (January 2020), available at https://www.etip-snet.eu/wp-content/uploads/2020/02/ETIP-SNEP-Sector-Coupling-Concepts-state-of-the-art-and-perspectives-WG1.pdf (last visited November 20, 2021).

Various options able to give flexibility to the energy system should be considered: Power to Gas (P2G) systems, injection at the distribution level, hydrogen blending, demand response strategies, etc. In this regard, guidelines from policymakers and regulators are needed[22] for the T.S.O.s to guarantee an adequate environment for operation.

In accordance with all these considerations, a GO scheme appears to be crucial, since it is ideal to use only green (and blue) hydrogen, enabling also its storage for later use[23]. This can be further validated by looking at the goals stated by the European Green New Deal (which states the achievement of climate neutrality by 2050), since they can be pursued only with the maximum integration of renewables inside the entire energy system.

Multiple options are available for infrastructure to transport hydrogen; however, one of the most suitable seems to be the use of pipelines. The transport could be carried out through the existing pipelines for natural gas (NG) that could be used to transport a mixture of NG and hydrogen, or, alternatively, through new pipelines, purposely built for hydrogen.

At the moment, both at the European and Italian level, there is no regulation that contemplates in a harmonized and complete way how to treat hydrogen for its injection into the gas network.

3.2. The role of power-to-gas (P2G) in the energy transition and in the sector coupling

The technology able to permit the deployment of hydrogen use on a large scale together with the maximum integration of renewables in the energy system is P2G (Power-To-Gas): using the electrolysis of water, the surplus of clean electricity could be used to produce green hydrogen (Figure 3) depending by the electricity source.

---

22. See European Commission, *Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure* at 16-18 (April 2020), available at https://op.europa.eu/en/publication-detail/-/publication/10e93b15-8b56-11ea-812f-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search (last visited November 20, 2021).

23. See Alverà, *Rivoluzione Idrogeno* at 86-88 (cited in note 5).

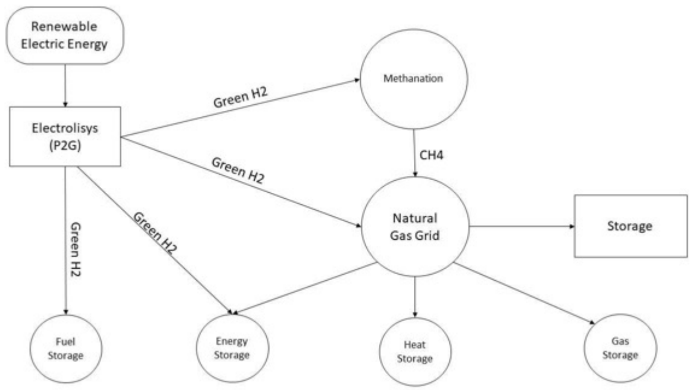

Figure 3 - The potential role of power-to-gas in an integrated energy system. *Author*: Simona Capozza

This procedure responds to the Italian, European and international climate targets of incrementing the renewable energy share but, nevertheless, the continuous growing share of renewables may make the energy system very unstable and unreliable.

P2G could ensure flexibility to the energy system as a whole, being able to store clean energy in the long term to decarbonize the final uses of gas, as well as supply it to the grid in times of need. This would represent a remedy to seasonal variations in renewable energy production.

Power-to-gas systems can be used on- and off-grid, to provide network adaptability and quality services, to avoid curtailments to renewable electricity production, and to allow renewable energy to be used also in new applications for which (clean) gas is preferred. In these cases, we can talk about not only the versatility of hydrogen, but also of its being "synergistic", because of its ability of making hydrogen supporting the demand and supply peaks' management[24]. Several demonstration projects for the P2G system are in progress, supporting the decarbonization pathway of the hard-to-abate industry (refinery,

24. See NAM, The European House - Ambrosetti, *H2 Italy 2050* at 76 (cited in note 6).

chemical feedstock synthesis, etc.) in conjunction with renewable sources of energy, at big scale (hundreds of MW)[25].

4. Legislative barriers to the development of the hydrogen production chain

The aim of this part is to address some of the most critical legislative barriers to the development of a functional hydrogen production chain, which has a multilevel impact on the energy system. Firstly, the GO's still undefined aspects will be esaminated, then the research will take into consideration the SC and P2G European regulatory gaps and barriers that still impede the development of a hydrogen value chain.

4.1. Guarantee of Origin

To design a GO system, it is necessary to define in a clear and transparent way all the information regarding the hydrogen to be certified and its relationship with CO2 emissions. In particular, there is the need for a definition of green hydrogen: some States focus more on reducing GHG emissions than on promoting renewable energy. In cases like this, the green hydrogen definition tends to be wider, including hydrogen produced by fossil fuels with CCUS technologies. Contrary, if States prefer to foster renewables increasing, the definition of green hydrogen would be stricter and limited only to hydrogen produced from renewable energy[26]. Therefore, it is crucial to consider and understand all the political contexts (present and future) that could involve green hydrogen.

4.1.1. How to define green hydrogen

Currently, there is no European definition for green hydrogen: article 2 (1) RED II defines "energy from renewable sources" as energy

25. For an overview of funded projects on this topic (LC-GD-2-2-2020) visit https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-gd-2-2-2020 (last visited November 20, 2020).

26. Anthony Velazquez Abad, Paul E. Dodds, *Green Hydrogen characterisation initiatives: Definitions, standards, guarantees of origin, and challenge*, 138 Energy Policy 1, 2-7, 9-12 (2020).

produced by sources that are not fossil, but it does not mention hydrogen. Indeed, hydrogen is considered only as "other renewable gases" when talking about GOs (art. 19(7)(b) Directive 2018/2001/EU). This regulation shows the need for a common taxonomy, specifically regarding the hydrogen sector. In order to define green hydrogen, there are two most effective approaches: the first one consists in establishing a minimum share of renewable energy or of feedstock to be used, while the second one considers GHG emissions released during the entire life cycle of hydrogen and establishes an acceptable maximum threshold[27].

Defining a threshold for GHG emissions seems to be one of the most difficult point: Velazquez Abad[28] shows that labelling hydrogen as "green" or "not green" would not be enough, because the producer would be focused on finding the right way to meet the threshold by any means[29], and not on converting his/her technology in the cleanest one. Maybe a compromise could be found in gradually reducing the threshold until the complete elimination of GHG, while incentivizing producers to move to newer and cleaner technology.

4.1.2.Critical issues in the definition of a GO scheme and proposed solutions

Various issues need to be addressed for defining a GO scheme for hydrogen.

As already mentioned, GOs must be exchangeable between producers. Consequently, there is a consistent risk of dissociation between the GO and the physical energy flow. In fact, inside open and uncontrolled systems, a hydrogen from fossil fuels producer could buy a guarantee by a renewable hydrogen producer, thus pretending that the hydrogen is renewable, so controlling and monitoring

27. See CertifHy, *Structured list of requirements for green hydrogen* at 7 (July 27, 2015).

28. See Velazquez Abad, Dodds, *Green Hydrogen characterisation initiative* at 2-7, 9-12 (cited in note 26).

29. See ECOS, *Success Guaranteed? The Challenges of Guarantees of Origin for Certified Renewable Hydrogen* at 5 (March 18, 2020), available at https://ecostandard.org/publications/success-guaranteed-the-challenges-of-guarantees-of-origin-for-certified-renewable-hydrogen/ (last visited November 20, 2021).

systems become essential. For example, a solution could be allowing the exchange of GOs only inside closed systems, that are easier to control[30]. Another element to consider is the transnational exchange: harmonized rules are needed to keep the exchange valid and secure. Then, it is crucial to ensure that no GO is used more than once. This is the "double counting" issue that could be avoided if, every time 1 MWh of energy is consumed, the GO is removed from the registry (so-called "cancellation")[31].

According to the Directive 2008/71/EC, every electricity supplier must inform the final consumer about the energy mix he/she is supplying: there is a disclosure obligation of the energy mix supplied, including the information about the environmental impact of the mix (e.g. CO2 emissions). However, Member States have often implemented disclosure systems that differ from one another (e.g. in terms of standards), thus limiting transnational exchange of GOs.

To ensure an ideal disclosure, every supplier could use the guarantees to estimate the share of clean energy supplied, rather than the so-called "residual mix" that would represent the rest of the energy mix. Moreover, according to CertifHy experts, a solution could consist in registering all the energy produced, including the one produced from fossil fuels, thus making the GO system the instrument to fulfill the disclosure obligation concerning all energy sources[32]. It would also be optimal to keep track of everything that happens to GOs[33]. However, this is a complex issue to solve: some people argue that labelling different energy sources from green hydrogen would compromise the aim of a certification scheme. The question to answer is whether the aim of a GO system for hydrogen is to support the optimal fulfillment of the disclosure obligation or to promote the deployment of clean energy on a large scale. In the first case, all energy sources should be certificated; in the latter, only green hydrogen[34].

30. See *ibid.*

31. See *ibid.*

32. See CertifHy, *Recommendations on the establishment of a well-functioning EU hydrogen GoO system* at 20-22 (cited in note 12).

33. See *ibid.*

34. See *ibid.*

Another relevant issue to be considered is additionality, which describes renewable energy production that is "truly new"[35]. Indeed, the common thinking is that a certification system can guarantee an automatic increase of green energy capacity produced, but there is no certainty that the producers will increase their renewable production by buying GOs.

A solution could be to limit the use of profits earned thanks to the premium added to hydrogen price. As a matter of fact, the producers will have to raise their energy prices, since they would be sustaining not only the cost of making their hydrogen compatible with the certification requirements, but also the administrative costs related to the operation of the GO scheme[36].

However, even if final consumers will be willing to pay higher prices, there is no legal guarantee that producers will re-invest the major gain to increase their green capacity[37]. That is why someone suggests limiting the access to the system only to new capacity or to plants that do not receive other types of incentives[38]. This is a transversal aspect to be aware of while designing a GO scheme, since measures pushing producers to add new green energy capacity to their production become needed to foster the decarbonization process.

One last fundamental issue regards the interaction between GO systems[39]. This topic becomes particularly relevant when a conversion from an energy vector to another one makes the two systems interact between each other.

A reliable, precise, free from fraudulent conducts certification scheme must foresee all these possibilities and the ideal solution is to define a harmonized regulation for the different GO systems. Firstly, it is necessary to remove all the barriers related to the unnecessary administrative costs concerning conversion: common rules regarding

---

35. See Schneider Electric, *What You Need To Know About Additionality* (September 10, 2018), available at https://perspectives.se.com/renewable-energy/what-you-need-to-know-about-additionality (last visited November 20, 2021).

36. See Velazquez Abad, Dodds, *Green Hydrogen characterisation initiative* at 2-7, 9-12 (cited in note 26).

37. See ECOS, *Success Guaranteed? The Challenges of Guarantees of Origin for Certified Renewable Hydrogen* at 5 (cited in note 29).

38. See *ibid.*

39. See CertifHy, *Recommendations on the establishment of a well-functioning EU hydrogen GoO system* at 33-36 (cited in note 12).

conversions and the simplification of the administrative procedures could be a first efficient solution[40]. Then, in order to increase the system's credibility, attract the final consumer and avoid double counting, a punctual monitoring mechanism must ensure the immediate cancellation of consumed GOs. Lastly, to prevent illegal conversions of GOs (i.e. when the conversion of the guarantee is not followed by the conversion of the physical energy flow, thus causing a lack of GOs in the disclosure system of the original vector), it is central to implement a transparent control mechanism by the authority in charge of GOs registration and monitoring[41].

The lack of harmonized rules and of a shared system causes lots of deficiencies in the system's efficiency, also at the national level. The existence of many national schemes can easily lead to losing information regarding the GOs content[42]. About that, it is interesting to cite the activity of the Association of Issuing Body (AIB) (of which Italy is a member), that works to ensure the reliability of the European energy certification systems and to support Members during legislative changes periods. The organization aims at promoting a standardized certification system for all energy vectors: the European Energy Certificate System (EECS). The EECS wants to guarantee that international certification systems work in a credible and reliable way, according to standards of non-discrimination, objectivity, transparency, and economic efficiency. Even though it is not a binding system, the CertifHy experts have pointed out that careful consideration should be given to the EECS rules and general principles, during the definition of the details for a hydrogen GO system[43].

In conclusion, it is worth considering the possible interactions between the GO systems, especially if considering the conversion of renewable electricity into hydrogen. This regard highlights the need for a subject competent in GOs conversion. Indeed, the transfer from one register to another must be ensured in a way that prevents double counting cases. Furthermore, there is the necessity of a conversion

40. See *ibid.*

41. See *ibid.*

42. See Akos Hamburger, *Is guarantee of origin really an effective energy policy tool in Europe? A critical approach*, 41 Society and Economy 487, 494-495 (2019).

43. See CertifHy, *Recommendations on the establishment of a well-functioning EU hydrogen GoO system* at 5 (cited in note 12).

process that guarantees the correct transfer of information, since different guarantees bring different information specifically selected for the certified vector.

4.2. Barriers to Sector Coupling: the unbundling principle and the regulatory gap concerning pure hydrogen

The barriers to SC are not only economical and technical. In order to realize the integration of all the energy sector's components, the adoption of coherent norms is necessary, as well as change of perspective. Currently, the electricity and the gas sectors are regulated by different legal acts that need integration in the framework of SC.

One of the main challenges is posed by the unbundling principle, which consists in the separation of generation and supply activities from grid management and operation activities. This regime has been established by the European Union after the liberalization process of the gas and electricity markets, to avoid competition distortions. If the same undertaking was responsible for both generation/supply of energy and for its transmission, it could profit from its position impeding other producers to access the grid. The unbundling regime then, was established to guarantee the same conditions of access to all the suppliers, avoiding conflicts of interests and discriminatory conducts.

There are different types of unbundling and every Member State can opt for one of those: the Ownership Unbundling (O.U.), that implies for all vertically integrated companies the entire transfer of their networks, since they must not interfere with the activity of the T.S.O.; the Independent System Operator (I.S.O.), who manages and operates the network, even though the company maintains formal property of it; the Independent Transmission System Operator (I.T.O.), where the energy company possesses and operates the network under the supervision of the I.T.O., who decides the most relevant issues.

According to the EU regulation, every T.S.O. must be authorized to operate by a certification released by the competent national authority. This authority must ensure that the T.S.O. respects all the rules imposed to guarantee the right functioning of competitive markets: that is why there are rules ensuring the independence of the authority.

As stated by the Directive 2009/73/EC (the Gas Directive), the O.U. is the most effective and efficient unbundling system: only by completely removing the risk of conflicts of interests, it is possible to obtain a non-discriminatory access to the grid, that attracts investments for network infrastructure, and that guarantees transparency[44]. At the same time, it is also the most difficult one to implement (since it often involves companies' renovation) and more time is given to governments that choose it[45].

In Italy, the Gas Directive was transposed with the D. Lgs. n. 93 of 2011 with which the government chose to implement the I.T.O. model, functionally dividing ENI S.p.A. (a multinational energy company) from Snam S.p.A.[46]. Afterward, in 2012, the "Decreto Liberalizzazione" entered into force and the government adopted the O.U. system[47]. According to article 15 of the law it was then issued the DPCM 25th May 2012, that clarifies the concrete modalities to separate Snam and ENI, to implement the O.U.

The T.S.O.s have a key role for the development and the management of the gas and the electricity networks, since they are the entities investing the most and, based on experience, it is probable that also the hydrogen transport network will be subjected to the unbundling principle. Nowadays, the NG transmission system is operated by Snam Rete Gas for the 94%, meanwhile the electricity transmission system is operated by Terna S.p.A. for the 98,3%[48].

It would be possible for the T.S.O.s to invest in adjusting the NG infrastructure to give access at least to blending of gas and hydrogen. However, this kind of actions strictly depended on the political will since economical support by the government is needed. Then, once technologies are mature enough, the regulator must be ready to promptly review the regulation that becomes obsolete.

---

44. See Para (8), EC Dir 13 July 2009, no 73.

45. See *Id.* at para (11).

46. See Clifford Chance, *Unbundling: la separazione proprietaria della gestione della rete nazionale di trasporto del gas in Italia* at 2 (June, 2012), available at https://www.cliffordchance.com/content/dam/cliffordchance/briefings/2012/06/unbundling-la-separazione-proprietaria-della-gestione-della-rete-nazionale-di-trasporto-del-gas-in-italia.pdf (last visited November 20, 2021).

47. See Art 15, co. 1, L. 24 March 2012, n. 27.

48. See Flavia Masci, *Chi è il gestore della rete elettrica e del gas metano?* (September 29, 2020), available at https://luce-gas.it/guida/mercato/gestore-rete (last visited November 20, 2021).

Some experts sustain that hydrogen transport should be regulated as NG, since they are similar elements[49]. Usually, regulation is used as an instrument to prevent market failure situations and that is why it is important to analyze the possible evolution of an energy market hosting hydrogen. If pipelines become the primary means of hydrogen transportation, the birth of a natural monopoly needing regulation would be very likely. Nonetheless, regulation must be used carefully, since a too strict one could have undesirable drawbacks, such as discouraging participation in the market.

Currently, the Gas Directive allows hydrogen to be injected into the gas grid if blended with NG: article 1(2) states the non-discriminatory principle according to which the Directive must be applied to "other types of gas" that can be safely injected into the grid. However, it is not clear if the Directive is applicable to hydrogen even when its quantity exceeds the NG, and nothing is told about the possibility to operate a grid made for pure hydrogen[50], a still not considered aspect by the European legislation.

According to the Gas Directive the unbundling regime would not be valid for a pure hydrogen network, meaning that nothing prevents a T.S.O., which already manages the gas network, to manage a hydrogen network as well[51]. There may be many reasons to do so: it may use the hydrogen network aiming at using the blending of hydrogen and NG; or it may want to run both the networks separately and at the same time (so-called "combined network operator"); or it may want to convert the NG network it is in charge of into a pure hydrogen network (so-called "solitary hydrogen network operator")[52]. Indeed, in these three cases, the operator would be considered as a horizontal integrated company (and not as vertically integrated)[53]. Also, since the

---

49. See Anneke Francois, "*The Regulation of Hydrogen Infrastructure: New Wine in Old Bottles?*", Florence School of Regulation, available at https://www.youtube.com/watch?v=isfM5WFrSlM (last visited November 20, 2021).

50. See GEODE, *Towards the New Age of Gas Networks. Proposal on the Regulation of a European Hydrogen Infrastructure* at 2, 9-13, 17-18 (May 2020), available at https://www.geode-eu.org/wp-content/uploads/2020/05/20200518-GEODE-PAPER-HYDROGEN.pdf (last visited November 13, 2021).

51. See European Commission, *Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure* at 94-95 (cited in note 22).

52. See GEODE, *Towards the New Age of Gas Networks* at 9-13 (cited in note 50).

53. See Art 21, EC Dir 13 July 2009, no 73.

regulation does not apply to pure hydrogen, the operator could run the network without any authorization by the national authority.

Another inconsistency derives from the regulative gap. In fact, the T.S.O. could autonomously decide to expand the infrastructure without being dependent from hydrogen demand[54]. The issue needs to be addressed by regulators together with technical experts: to boost the development of a (green) hydrogen market, availability of energy supply is necessary and, therefore, infrastructure development is a priority.

Furthermore, another matter emerges: according to article 41 (6) (a) of the Gas Directive, tariffs must be defined also considering the investment needed to guarantee the good functioning of the NG grid. Paradoxically, this would mean that the gain obtained from hydrogen tariffs concerning the hydrogen network could only be used to invest in the NG network[55].

Of course, all these considerations must be read carefully, acknowledging that there are still technical barriers that impede the development of a pure hydrogen network, such as the ones related to the final uses. Also, the realization of infrastructures entirely dedicated to hydrogen is not feasible today, since the European regulation imposes that infrastructure development and expansion must proportionally depend on the demand for the transmission[56] and distribution[57] of that gas.

Due to the international, European and national policy background, we can expect a change of direction soon. Production technologies and final use appliances are becoming more mature and competitive every day and a regulation that permits hydrogen demand to grow and develop is crucial. When this moment will come, it is probable that the unbundling regime will be extended to hydrogen infrastructure too, to prevent conflicts of interests and to ensure competitiveness, access to the grid and equal conditions to all energy suppliers.

---

54. See GEODE, *Towards the New Age of Gas Networks* at 9-13 (cited in note 50).
55. See *id.* at 9-13 and at 17-18.
56. See Art. 13, para. (1) (a), EC Dir. 13 July 2009, no. 73.
57. See *id* at art. 25, para. (1).

4.3. The need for interaction between GO schemes

When hydrogen goes across multiple energy networks it has to bring a certification attesting its renewable origin. The reflection on the need for coordination between the many GO systems[58] (e.g. renewable electricity, renewable methane, energy efficiency, and renewable heat) has great importance in this process. This issue needs to be taken into consideration because if the ultimate goal is the realization of a hybrid integrated energy system, we can expect that energy conversion will be on the daily agenda soon. It is inevitable that the different GO systems will interact with each other due to the necessary conversion of guarantees. The entire system must be regulated to ensure a credible, predictable, and reliable certification system.

Hydrogen is highly versatile from the point of view of its applications and its certification system should take into consideration all the possible energy vectors in which hydrogen could be converted (e.g. electricity, methane, heat). Therefore, the new hydrogen certification system must be defined and monitored in such a way that does not interfere with the credibility of the other certification schemes[59].

Aiming at the energy vector conversion on a large scale, the priority remains to define harmonized rules at the administrative level, at least for all Member States. This could lead to a reduction of costs and, consequently, to the increase of subjects interested in accessing the certification system. Then, costs related to the purchase of guarantees should be addressed, because the regulative coordination of the multiple GO systems is crucial to avoid unnecessary expenses.

As noted by some experts[60], the ideal solution may consist in creating one single certification system for all energy vectors, which is harmonized at the EU level, in order to have standard rules for the conversion of energy vectors. However, such a system would require

58. See CertifHy, *The interaction between existing certification systems and a new hydrogen GoO system* at 5, 13-14 (October 31, 2015), available at https://www.certifhy.eu/images/project/reports/D3.2_GoO_Interactions-final.pdf (last visited November 20, 2021).

59. See CertifHy, *Recommendations on the establishment of a well-functioning EU hydrogen GoO system* at 33-36 (cited in note 12).

60. See CertifHy, *The interaction between existing certification systems and a new hydrogen GoO system* at 5, 13-14 (cited in note 58).

large economic availability due to the high administrative costs necessary for a well-functioning scheme: there is the need for a compromise between the administrative costs and the necessity to guarantee a credible, reliable, and transparent GO system[61].

The major obstacles that need to be overcome by more scrupulous rules consist in the punctual exchange of information contained in the GO (that tends to change from vector to vector) and the punctual cancellation/registration of converted GOs.

5. The uncertain legal status of P2G technology

The exploitation of the entire potential of hydrogen needs a large-scale deployment of production technologies. Speaking of green hydrogen, this kind of technology is power-to-gas. Still, the market seems not ready to host this technology, which needs more investments to become competitive and mature enough. So, wondering if it is worth investing in power-to-gas, also in consideration of the services that it can offer to the energy system, seems legit. However, various pilot projects regarding power-to-gas and electrolysis have shown contradictory results[62] and there is no real experience that can confirm their reliability. It is not possible to make certain considerations about the cost-benefit ratio of energy conversion through electrolysis[63].

Not so far from these issues, a general trend seems to be in favor of hydrogen development and power-to-gas deployment, even if there are regulative barriers that strongly limit the development and deployment of this technology.

---

61. See *ibid.*

62. See Carlo Cambini, et al, 143 *Energy System Integration: Implications for public policy* at 5 (Energy Policy 2020).

63. See H2IT - Associazione Italiana Idrogeno e Celle a Combustibile, *Report H2IT Strumenti di Supporto al Settore Idrogeno - Fase 1, Priorità per lo Sviluppo della Filiera Idrogeno in Italia, Capitolo 1 - Produzione* at 19-22 (November 2020), available at https://www.h2it.it/wp-content/uploads/2021/01/H2IT_REPORT_Priorita-per-lo-sviluppo-della-filiera-idrogeno-in-Italia.pdf (last visited November 20, 2021).

First of all, there is not a defined, common legal status of power-to-gas, which causes a lot of confusion from many different points of view (e.g. for the understanding of who can own and operate them[64]).

The article 2(59) of the Directive 2019/944/EU (the so-called Recast Electricity Directive) defines P2G as "energy storage", referring also to P2G which is used with the only scope of producing hydrogen[65].

The gas regulation changes significantly from the electricity one and the interaction between the two regulations shows the need for a legislative review. It was already mentioned that the Gas Directive can be extended to hydrogen according to the non-discriminatory principle stated by article 1(2). However, this is true only if hydrogen is blended with NG.

About P2G, there are many differences from the Recast Electricity Directive and there is not an article that mirrors article 2(59). An option could be to classify the P2G as a "gas storage facility", according to article 2(9)[66]. This could be justified by the non-discrimination principle: if the storage system is part of the natural gas system, article 1(2) imposes the extension of the Directive to that facility too. In this way, the Directive could be applied also to hydrogen storage facilities if connected to the NG grid[67]. However, it could be objected that P2G cannot be considered a "gas storage facility". With regard to this, two considerations can be done: firstly, since the scope of NG storage systems is to guarantee flexibility to the grid through the withdrawal and the injection of the gas into the grid, hydrogen storage systems can only withdraw gas from the grid[68]. Secondly, it can be affirmed that the P2G performs a function that is more similar to NG generation than to its storage.

At the national level[69], power-to-gas is considered as a final consumer. This leads to its subjection to all the relative charges, both for the dispatch and for the transport of the energy used for hydrogen production. Obviously, this has consequences also on the final cost of

---

64. See ETIP SNET, *Sector Coupling* at 12, 33, 39, 42-43 (cited in note 21).
65. See Fleming, *Clean or renewable* at 7-9 (cited in note 6).
66. See *id.* at 12-13.
67. See *ibid.*
68. See *id.* at 15-17.
69. See H2IT - Associazione Italiana Idrogeno e Celle a Combustibile, *Report H2IT Strumenti di Supporto al Settore Idrogeno* at 19-22 (cited in note 63).

hydrogen generated from electrolysis. This double taxation happens especially when there is not a local renewable energy production plant and, therefore, there is the need to withdraw energy from the electricity grid.

In order to find a solution to all these complex issues is desirable a dialogue between all the national entities involved in the balancing services' sector, meaning Terna, the GSE, and Snam for the Italian case. Moreover, incentivizing measures are needed specifically to promote power-to-gas technologies and all the services that they can offer to the energy system, without being subjected to the same identical conditions of a final consumer.

In view of all this, it can be expected that, thanks to the transposition of the Electricity Directive, also at the national level the P2G will be classified as a generator and/or as a hydrogen storage facility and that it will be subjected to fair conditions that mirror its peculiarities. Anyhow, there is still the need for a review of the Gas Directive, which is becoming obsolete and limiting.

5.1. The P2G and the unbundling principle (and the role of T.S.O.s/D.S.O.s)

The Gas Directive imposes the unbundling regime to separate gas storage systems from the transmission (and distribution) activities. The question that is left is whether the same rules can be applied to power-to-gas, since its legal status is still ambiguous[70].

Currently, the Gas Directive leaves a wide gray area about P2G regulation, which represents a big obstacle to their implementation.

For example, is it possible that an energy company builds and operates a P2G system? To answer this question, it is important to understand if the P2G is a gas or an electricity storage system. In fact, while the Gas Directive states the explicit prohibition for the combination of the two activities (the owning and the operating of gas storage facilities), there is no such statement in the Recast Electricity Directive. Therefore, it could be supposed that only P2G intended as electricity storage could be operated by its owner.

70. See European Commission, *Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure* at 94-95 (cited in note 22).

Also, the role of T.S.O.s (and Distribution System Operators - D.S.O.s) is doubtful. For this reason, system operators should be the first to solicit the adjustment of regulation, so as to define their role for these technologies at the national level too[71].

First of all, it is necessary to solve the regulative imbalance regarding the system operators of the two networks, which currently allows only electricity operators to own and operate storage systems. Furthermore, shared mechanisms for communication and for information exchange between gas and electricity operators should be established, to better manage imbalances between supply and demand[72].

At least initially, it is possible that Members decide to exclude projects about P2G from the unbundling, since the system operator could effectively support the large-scale deployment of P2G. They could give the possibility to system operators to build P2G systems with demonstrative scopes or as industrial units, and to operate them as services to supply to the various market parties[73]. This exception can be made if all the requirements set by articles 36(2) and 54(2) of Directive 2019/944/EU are met: there must not be third parties interested in owning, developing, managing and operating the P2G system (in the respect of the non-discrimination principle); the P2G system must ensure safety, efficiency and reliability; it must not be used to sell electric energy to the market; it must be approved by the competent national authority.

Summarizing, in a first moment at least, the systems operators could be the ones who own, develop, operate, and manage P2G systems to ensure economically efficient conversion services and equal treatment to all participants.

71. See *ibid*. at 100-102.

72. See GIE, *Sector Coupling and policy recommendations, GIE Position Paper* at 2, 4, 12-16 (March 19, 2019), available at https://ec.europa.eu/info/sites/default/files/gie_-_position_paper_-_sector_coupling_p2g.pdf (last visited November 20, 2021).

73. See European Commission, *Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure* at 86-89, 100-101 (cited in note 22).

6. The Italian case

The EU Strategy for Energy System Integration shows how it is utopic to think that the total elimination of carbon dioxide (CO2) emissions can happen, because it could not, even with the complete integration of the energy networks[74]. That is why the European Commission has adopted a neutral approach from the technology point of view, emphasizing the fundamental role that CCUS technologies will have for the energy transition[75].

The Commission also shows to be aware of the differences between Members, since every State has its own peculiar energy situation and it is crucial to recognize the diverse starting points. In consideration of the possibility of injecting hydrogen into the gas network, the regulation must pay attention to the actual situations of the Members, while trying to issue policies that ensure the most enhancement of renewables[76].

By looking at the national possibilities for the hydrogen value chain development, North Africa may be a a perfect site to produce renewable energy because it is rich of natural resources. The Italian NG network reaches these African territories, this connection could be a turning key for the hydrogen European hub: Italy could be the main Mediterranean hub for green hydrogen transport in all Europe[77] if the EU decides to install P2G units close to generation plants, to produce green hydrogen to be transported through the Italian hub. This could be not only an opportunity to functionally exploit unused

74. See European Commission, Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, COM (2020) 299 final, *Powering a climate-neutral economy: An EU Strategy for Energy System Integration* at 15 (July 8, 2020), available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0299&from=EN (last visited November 20, 2021).

75. See *id*. at 13-21.

76. See European Commission, *Impact of the use of the biomethane and hydrogen potential on trans-European infrastructure* at 16-18, 86-89, 95, 100-101 (cited in note 22).

77. See SNAM, The European House - Ambrosetti, *Una filiera nazionale dell'idrogeno per la crescita e la decarbonizzazione dell'Italia* at 112-115, 117, 120, 122, 125, 146-150, 172-189 (cited in note 6).

territories, but also to boost the participation of the African States to the decarbonization process[78].

Nevertheless, there is the need for a more flexible normative context, which opens access to research funds and which can attract private investments. A crucial aspect is competitiveness: the vector itself must become cheaper, in order to be competitive with traditional fuels if we want to accomplish the creation of an energy market that can host green hydrogen. For example, investing heavily in Research & Development & Innovation (R&D&I) is a turning point to be addressed for the achievement of these goals.

The Italian regulation lacks in consideration of hydrogen transport from the gas network: only the Gas Grid Code by Snam[79], one of world's major energy infrastructure society, allows hydrogen injection into the gas grid, but only in the form of biomethane and with a maximum concentration of 1% in volume[80]. However, it is worth mentioning that on the 16th of December 2019, Snam led an experimentation at Contursi Terme (Salerno, IT) to inject 10% vol. of hydrogen into the gas grid, empowering a pasta factory and a bottling industry.

The Italian Ministerial Decree of 18th May 2018 does not mention a mixture of NG with hydrogen for its grid injection. Furthermore, there is no regulation allowing the realization of specific pipelines for hydrogen transportation.

It must be noted that the regulation of this topic is difficult: firstly, a percentage of hydrogen superior to 2% in volume could damage the pipelines in a way that compromises its durability and integrity; secondly, the final consumer appliances and their characteristics must be considered to understand if they can work with that kind of gas mixture[81].

---

78. See Alverà, *Rivoluzione Idrogeno* at 86-88 (cited in note 5).

79. See SNAM, Codice di Rete V5 (Gas Grid Code), *Specifiche tecniche sulle caratteristiche chimico-fisiche e sulla presenza di altri componenti nel gas naturale* at 139-140, available at https://www.snam.it/export/sites/snam-rp/repository-srg/file/en/business-services/network-code-tariffs/Network_Code_ITG/Archivio_codice_rete/ITG_Codice_di_rete_xvers_Vx_ITA.pdf (last visited November 20, 2021).

80. See SNAM, *Snam: Immissione sperimentale di idrogeno a Contursi raddoppiata al 10%* (January 8, 2020), available at https://www.snam.it/it/media/news_eventi/2020/Snam_immissione_sperimentale_idrogeno_Contursi_raddoppiata.html (last visited November 20, 2021).

81. See Fleming, *Clean or renewable* at 59 (cited in note 6).

As far as SC is concerned, in 2019 the Italian government adopted new measures to finance the R&D regarding the realization of a hybrid energy system, trying to optimize the integration of renewables and to increase the flexibility and the reliability of the entire system. Concurrently, some storage plants were electrified, realizing the interconnection of the gas and electricity networks, the increasing of energy efficiency, and the reduction of GHG emissions[82].

For instance, some Italian storage and compression facilities have been electrified and now are dual fuel (gas-electric). These adjustments have led to emissions decreasing, to a better performance, and to the interconnection of the two networks. Moreover, collaboration between the operators have been strengthened with regard to their common interests, such as the utilization of non-programmable renewable energy, the infrastructure monitoring and analysis, and the joint optimization of the gas and electricity grids.

The European scenario and the Italian framework introduced here, point out the need for the adjustment of obsolete regulation.

After the economic crises caused by the Coronavirus global pandemic, some institutions have seen the opportunity to use the recovery phase as a start over for the energy system: during 2020, many Member States have reviewed their energy regulation and have issued national hydrogen strategies. This unique period, since the Covid-19 pandemic, has stressed out the limit of national economies and has brought the need for recovery planning. The Commission defined the Next Generation EU, an investment program of € 750 billion[83], to support the recovery of Members' economies. As it is further explained, Italy and other Members plan to dedicate a consistent part of their national Recovery Plans to the energy transition and to hydrogen.

---

82. See Ministero dello Sviluppo Economico, Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Ministero delle Infrastrutture e dei Trasporti, *Piano Nazionale Integrato per l'Energia e il Clima* at 85 (2020), available at https://www.mise.gov.it/images/stories/documenti/PNIEC_finale_17012020.pdf (last visited November 20, 2021).

83. See European Commission, Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, COM (2020) 442 final, *The EU Budget Powering the Recovery Plan for Europe* at 14 (May 27, 2020), available at https://eur-lex.europa.eu/resource.html?uri=cellar:4524c01c-a0e6-11ea-9d2d-01aa75ed71a1.0003.02/DOC_1&format=PDF (last visited November 20, 2021).

Also, the EU is trying to exploit this moment to review its legislative background and Italy could have a preeminent role inside the hydrogen development process. For example, the green hydrogen production from electrolysis exploits mainly overgeneration from renewable sources, which is something that happens especially in Southern Italy. So, Italy should push on development plans for big integrated plants at the EU level and on improving the electricity transport system in order to better connect the South and the North of the Country[84].

6.1. The Integrated National Plan for Energy and Climate (PNIEC) and the Hydrogen Strategy

As regard of the Italian State of Art, there are two main acts that it is worth analyzing: the National Integrated Plan for Energy and Climate (PNIEC)[85] and the draft of the Italian Hydrogen Strategy.

The last version of the PNIEC was presented to the European Commission on 21st of January 2019. The Plan defines national goals to be reached by 2030 relative to CO2 emission reduction, energy efficiency, implementation of renewable energy sources, energy safety, energy interconnections, internal energy market, sustainable mobility and development.

The PNIEC was issued following the guidelines set by the Green New Deal, which asks all Members to define a national plan with goals by 2030 and personalized measures to reach them.

This Plan focuses on five main intervention points: (i) decarbonization; (ii) energy efficiency for all sectors; (iii) energy safety; (iv) development of an internal energy market; (v) research, innovation, and competitiveness. The purpose is to accelerate the energy transition to 2030 by incrementing the renewable of 30% on gross final energy consumption contrary to the EU goal which is 32%. This 30% is divided between the different sectors of consumption which are more than 55% to electrical consumptions, 33,9% to thermic consumptions, and 22% to mobility.

84. See H2IT - Associazione Italiana Idrogeno e Celle a Combustibile, *Report H2IT "Strumenti di Supporto al Settore Idrogeno"* at 19-22 (cited in note 63).

85. See Ministero dello Sviluppo Economico, Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Ministero delle Infrastrutture e dei Trasporti, *Piano Nazionale Integrato per l'Energia e il Clima* at 85 (cited in note 82).

Even though the priority set by the Plan is direct electrification, hydrogen is considered only for its direct utilization in the mobility sector, relative to the non-electrifiable sections, and for its injection into the methane grid. On one hand, the key role of NG is taken into consideration to accomplish energy transition by gradually substituting the most polluting fossil fuels. On the other hand, the hydrogen produced by fossil fuels with CCUS technologies will probably be essential for the decarbonization process, since it is foreseen that, even when green hydrogen will become competitive, blue hydrogen will still be cheaper. At the same time, the increase of renewable sources inside the energy mix will help the reduction of gas demand, mostly in sectors such as industry and building.

The PNIEC also addresses the topic of SC, aspiring at a synergic pathway for both the electricity and the gas sectors, where the final goal is to realize their integration. Fostering this purpose, it highlighted the primary role of the R&D sector and it is suggested to carry on pilot projects concerning the development of technologies such as power-to-gas, power-to-hydrogen, and gas-to-power. The focus should be on the optimization of performances and on competitiveness of hydrogen technologies.

Despite all the positive aspects of the Plan, it has been developed on a too short-term basis (i.e. 2030) and there will be a review by the regulator, because more long-term and comprehensive goals must be set.

In Italy, after the definition of the Recovery Plan, new perspectives will be taken into consideration. As mentioned before, the European Commission has approved the Next Generation EU, due to the economic crises caused by the spread of Coronavirus. Each Member who wants to access the bond must submit a Recovery Plan that establishes how the money will be used. This decision will probably imply the need for reviewing the Italian PNIEC.

One of the most evident review reasons will be the definition of an Italian Hydrogen Strategy.

Today, the only source available is the national guidelines for the Strategy[86] and it must comply with the PNIEC, with the EU Hydrogen

86. See Ministero dello Sviluppo Economico, *Strategia Nazionale Idrogeno Linee Guida Preliminari* (2020), available at https://www.mise.gov.it/images/stories/

Strategy and with the entire European environmental agenda. The main goals are the penetration of approximately 2% of hydrogen in the final energy consumption by 2030 and up to 20% of hydrogen in the final energy consumption by 2050, but they can be met only with the consistent increase of hydrogen demand; this will be the main line over which defining the Strategy.

About hydrogen production, the focus is on green hydrogen and on three types of production: firstly, entirely local generation, where the electricity and hydrogen production happen close to the consumption point. Secondly, local generation with electricity transportation, where renewable electricity is generated in territories reach of natural resources, but far from the hydrogen production and consumption site. Lastly, centralized generation with hydrogen transport, where electricity and hydrogen generation plants are in the same site, but far from the consumption sites, for this last reason hydrogen transport is needed.

The PNIEC enhances the challenges of intermittency and non-programmability of renewables, and this is an opportunity to exploit overgeneration to produce green hydrogen. Consequently, the combination of renewable energy overgeneration with hydrogen production is seen as pursuing the SC goal. Currently, the first step defined in the strategy guidelines is the installation of 5W of electrolysis capacity by 2030[87], while the European Union's targets are of 6GW by 2024 and of 40GW by 2030[88].

Moreover, the possibility to create a GO system is considered to support hydrogen demand together with incentivizing schemes and simplification of the regulation. Nevertheless, there is still a lack of real interest by the hydrogen guidelines.

In conclusion, the Italian regulatory background is completed by the National Recovery and Resilience Plan (PNRR), which contains

---

documenti/Strategia_Nazionale_Idrogeno_Linee_guida_preliminari_nov20.pdf (last visited November 20, 2021).

87. See *ibid.*

88. See European Commission, Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions, COM (2020) 301 final, *A hydrogen strategy for a climate- neutral Europe* at 5-7 (July 8, 2020), available at https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf (last visited November 20, 2021).

the Italian investment plan regarding the use of Next Generation EU funds while defining four challenges for Italy, through which also the pursuing of the green transition. Among the many goals set by the plan, hydrogen development is highly considered, especially if talking about the R&D sector[89]. Following the European Green Deal, the PNRR will define a decarbonization path to reduce GHG emissions by reforming urban plans to foster renewable energy integration, by transforming the mobility sector and by increasing energy efficiency[90].

7. *Conclusions*

The proposed analysis shows the necessity for regulation review, both at the Italian and European level. This step should be accompanied by support for the R&D sector to make hydrogen technologies more competitive and appetible. In particular, the lack of a business case for CCUS and electrolyzers performances strongly limits hydrogen investments. Actually, public investment is not sufficient and private actors need to be involved, for example implementing an incentivizing regulation. It is also important to redefine the economic, social and environmental priorities, and this is of primary competence of policymakers, who must take a firm position about the role of hydrogen inside the macro-objectives planned for the energy system.

About the need for a GO system, there is still the lack of a precise political and legislative willingness to promote hydrogen production through the creation of a certification scheme. As already said, the existence of a GO system could also help industries reaching the emission cap stated by the ETS and its future adjustments.

Concerning the SC goal, Italy should intervene promptly on regulation. The potential for hydrogen transport is great, but the actual legislation only allows to inject 1% in volume of hydrogen in the natural gas transport system, and only if the hydrogen is in the form of biomethane. These rules limit the possibilities to experiment higher

89. See Governo Italiano, *Piano Nazionale di Ripresa e Resilienza* at 125-128, 134-138 (2021), available at https://www.governo.it/sites/governo.it/files/PNRR.pdf (last visited November 20, 2021).

90. See *ibid.*

concentrations of hydrogen and to increase hydrogen value chain development chances in Italy.

The main goal, of course, is to produce low-emission hydrogen and so incentives to green hydrogen production and to R&D sector to scale-up production technologies are strongly needed. However, green hydrogen production results to be very costly, mostly because of high costs of renewable energy[91]. That is why incentivizing programs are needed (both at the public and private levels) and hydrogen produced by fossil fuels with CCUS technologies represents a necessary transition point.

A new approach is essential for policymakers to define a coherent pathway able to allow hydrogen development while not interfering with other environmental policies that have been already implemented. For this purpose, experts of different sectors (legislative, economic, technic, sociological) must support policy-makers during the decision process. In this perspective, pre-regulative activities supporting research entities, industries, and experimentations should be put in place providing all the data needed for an ideal legislative process[92].

In consideration of all this, the best option for the new Italian Ministry of Ecological Transition[93] is to treasure all the knowledge coming from the experts of every field involved in this great pathway in order to make balanced and accurate decisions[94].

---

91. See H2IT - Associazione Italiana Idrogeno e Celle a Combustibile, *Report H2IT Strumenti di Supporto al Settore Idrogeno* at 19-22 (cited in note 63).

92. See *ibid.*

93. For more information about the Ministry of Ecological Transition visit the website https://www.minambiente.it/ (last visited November 20, 2021).

94. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.