VIEIRA DE ALMEIDA

A SIMPLIFIED
GUIDE TO THE

PORTUGUESE HYDROGEN STRATEGY

ENERGY AND NATURAL RESOURCES

NATIONAL HYDROGEN STRATEGY

November 2020

The National Hydrogen Strategy (EN-H2) was enacted by Council of Ministers' Resolution 63/2020, of 14 August 2020 (Resolution).

The Resolution

One of the core measures set out in the 2050 Carbon Neutral Roadmap (RNC2050) and the 2030 National Energy and Climate Plan (PNEC 2030) relies on renewable gases, particularly green hydrogen, as an efficient solution to promote the energy transition while at the same time driving economic and scientific development.

Green hydrogen is an energy carrier with high energy density, which makes it the ideal solution for energy-intensive industrial processes, for the storage of energy produced through renewable sources and for the emergence of other renewable-based fuels.

According to the EN-H2, green hydrogen is produced exclusively from processes using renewable energy – green hydrogen should therefore be understood as renewable hydrogen, whose GHG emissions throughout the life cycle of its production should be zero or very close to zero. Being a gaseous fuel, green hydrogen is considered a renewable gas.

The Resolution establishes the following hydrogen targets (to be achieved by 2030):

- 10% to 15 % injection of green hydrogen into natural gas networks;
- 2 % to 5 % of green hydrogen in the industrial sector's energy consumption;
- 1 % to 5 % of green hydrogen in the road transport sector's energy consumption;
- 3 % to 5 % green hydrogen in the national shipping sector's energy consumption;
- 1,5 % to 2 % of green hydrogen in the energy final consumption;
- 2 GW to 2.5 GW of installed capacity in Electrolyzers;
- Setting up 50 to 100 hydrogen refuelling stations.

The Directorate General for Energy and Geology (DGEG) is tasked with monitoring and assessing the progress of the National Hydrogen Plan's implementation. The implementation must be assessed every two years after approval and published on the DGEG's website. The Resolution further requires the EN-H2 to be reviewed at least every 5 years from its approval. The Resolution takes effect on the date of its approval.

The EN-H2 sets a vision for deep decarbonization that boosts economic growth. Economic, legal and regulatory measures are required to set the proper framework for this new reality in the Portuguese energy system.

In order to encourage both producers and consumers, the Resolution envisages, among others, to:

i. render viable production investments in the start-up phase and begin incorporating hydrogen in the energy system, adequately remunerating the production; and

ii. prevent those goals from becoming a cost to the energy system, which could compromise consumers' adherence to the EN-H2.

The Resolution sets out the Government's intention to carry out a large scale anchor project on an industrial scale for the production of green hydrogen in Sines with a capacity of 1 GW by 2030.

According to the Resolution, the EN-H2 will be implemented and promoted based on European and national funding and support mechanisms.

Guarantees of Origin (GO) could also be of enormous relevance as they create the conditions for producers, particularly smaller ones, to sell their renewable energy in the market. Besides contributing to promote the production and consumption of renewable energy, GOs have an associated economic value and are an additional benefit for producers.

To this end, the necessary steps will be taken in 2020 to implement a system of guarantees of origin for renewable gases, including hydrogen.

Guarantees of Origin

Decree-Law 60/2020 was published on 17 August 2020, and sets forth the process for issuing guarantees of origin for low carbon gases and for renewable gases, updating the renewable energy targets.

Simplified Guide to the EN-H2

Given the document's length and relevance, we thought it would be useful to prepare a summary-index of the EN-H2 (Simplified Guide).

The Simplified Guide attached hereto does not replace reading the EN-H2, but we hope it may be useful for a quick consultation of the matters most relevant to each sector operator.

SIMPLIFIED GUIDE TO THE EN-H2

For ease of reference, the Simplified Guide uses the same numbering as the Schedule to the Resolution and sets out the applicable pages by reference to the document available here.

0. EXECUTIVE SUMMARY (P. 9)

Main Points (p. 14)

- Hydrogen will enable and accelerate energy transition in various sectors, particularly the transport and industrial sectors, while strengthening the national economy.
- Portugal has very favorable, arguably unique conditions to develop a hydrogen economy, considering that it has a modern natural gas infrastructure, very competitive prices for renewable electricity production and a strategic geographical location for export.
- The government's strategy is to promote an industrial policy around hydrogen, which is based on the definition of a package of public policies to guide, coordinate and mobilize public and private investment in renewable gases' production, storage, transport and consumption projects in Portugal.

- **Goals for 2020-2030 (p. 14)**
  - 5 % in the overall energy consumption, 5 % in the road transport sector's consumption, 5 % in the industrial sector's consumption and 10 % to 15 % injection in natural gas networks;
  - 50 - 100 refuelling stations;
  - 2 GW – 2.5 GW capacity in Electrolyzers;
  - 7 000 – 9 000 M€ investment in new projects (in the industrial, transport, energy, research and development (R&D) sectors
  - 400 – 450 M€ in investment support – European funds (PT2020, PT2030) (through a fully competitive and transparent process)
  - 500 – 550 M€ in production support (through a fully competitive and transparent process)
  - 380 – 740 M€ reduction in natural gas imports and 180 M€ reduction in ammonia imports
  - 8 500 to 12 000 new jobs
  - 6 – 8 Mton reduction of CO2 emissions and 1% consumption of treated wastewater
- **Strategy Success Indicators for 2030 (p. 15)**
  - Portugal is seen as having an innovative hydrogen economy and an investment-conducive environment
  - Portugal is among the most cost-competitive European hydrogen producers
  - Portugal has a guarantees of origin system in place in line with the highest quality standards
  - Hydrogen economy generates qualified jobs and wealth in Portugal
  - Hydrogen has contributed towards reinforcing the sustainability of several economic sectors
  - Portugal is an international reference and a hydrogen exporter
- **Main Initiatives (p. 15)**
  - Implement a green hydrogen production support mechanism
  - Set forth the required hydrogen regulatory framework
  - Set hydrogen incorporation targets
  - Support investment in hydrogen projects
  - Submit an application to the Hydrogen IPCEI
  - Implement a National Hydrogen Alliance
- **Main Projects (p. 16)**
  - Industrial green hydrogen production project in Sines
  - Decarbonize the transport sector
  - Decarbonize a priority sector of the national industry
  - Use wastewater for hydrogen production
  - Implement a collaborative laboratory (COLAB)

1. BACKGROUND (P. 17)

Main Points (p. 35)

- The new European industrial strategy will include measures to modernize and decarbonize energy-intensive industries, with clean hydrogen production as a priority area. A clean hydrogen alliance will therefore be launched
- The strategy for 2030 gives hydrogen a new central role in decarbonization, which will enable greater adherence to the decarbonization goals and targets proposed by economic sectors that currently have few alternative technological options, where electrification may not be energy- or cost-efficient
- The complementarity between renewable electricity, already a priority and a reality, and green hydrogen ensure that Portugal is well on the path to carbon neutrality
- In the long run, the full replacement of natural gas with hydrogen and other renewable gases will result in close to 1.2 billion euro savings in the national energy bill
- Up to a percentage of about 22 % of hydrogen incorporation in natural gas the calorific value of the gas remains within the limits currently imposed by regulations

1.1. European Background (p. 17)

- 2030 Energy & Climate Package and Clean energy for all Europeans Package
- EU Green Deal
- "A new industrial strategy for Europe" (COM/2020/102, 10 March 2020)
- "Clean hydrogen alliance" (8 July 2020, with Portugal's participation)
- "Hydrogen strategy for a climate-neutral Europe" (COM/2020/201, 8 July 2020)
- "EU Strategy for Energy System Integration" (COM/2020/299, 8 July 2020)

1.2. National Background (p. 19)

- RNC2050 and PNEC2030
- *Trabalho de análise e reflexão "O Hidrogénio no Sistema Energético Português: Desafios de Integração"* (paper on "Hydrogen in the Portuguese Energy System: Integration Challenges)
- *Estudo abrangente no âmbito do projeto "H2SE – Hidrogénio e Sustentabilidade Energética"* (Comprehensive study as part of the "H2SE – Hydrogen and Energy Sustainability" project)
- *Projeto "Avaliação do Potencial e Impacto do Hidrogénio como Valor Energético – Potencial Tecnológico Nacional"* ("Assessment of Hydrogen's Potential and Impact as an Energy Value – National Technological Potential" project)
- *"Integração do Hidrogénio nas cadeias de valor- Sistemas energéticos integrados, mais limpos e eficientes"* ("Integration of hydrogen in value chains – Integrated, cleaner and more efficient energy systems")
- *"Roteiro e Plano de Ação para o Hidrogénio em Portugal"* ("Roadmap and Action Plan for Hydrogen in Portugal")
- EU SEAFUEL Project – Sustainable integration of renewable fuels in local transportation
- National Energy Sector (p. 20)
    - Energy Bill (p. 20)

    Portugal does not mine nor produce coal, crude oil or natural gas, which has steadily deteriorated the country's trade balance.

    The country's stake on hydrogen owes to its potential to replace the consumption of natural gas and petroleum products more easily, thereby accelerating the reduction of energy dependency and of the energy bill.

    - Energy Consumption (p. 21)

    The evolution of energy consumption in Portugal shows the potential for decarbonization of a strategy based on renewable energies but also highlights its limitations in certain sectors and consumptions where it is not cost-efficient or technically viable.

    Hydrogen can accelerate the fossil for renewable replacement trajectory.

    - Main indicators (p. 23)

    With hydrogen, as a viable option to decarbonize energy consumption in Transport, Heating and Cooling and Electricity, Portugal can remain one of the leading EU countries in renewables.

    - Electricity Sector (p. 25)

    Given the characteristics of hydrogen, in particular the complementarity it creates between the gas and electricity systems (sector coupling) and its potential to store energy, hydrogen will be electricity's preferred ally to ensure the energy transition and decarbonization of the economy.

    - Natural Gas Sector (p. 27)

    The existing natural gas infrastructure will play a key role in the introduction, distribution and consumption of hydrogen and will allow achieving higher levels of incorporation of renewable energy sources in final consumption.

    This use will prevent stranded assets and take advantage of existing infrastructure, prolonging its useful life.

    The fact that the gas transmission grid operator and the electricity transmission grid operator are one and the same, and the gas and electricity sectors share the same regulator, will streamline the gradual integration of the gas and electricity systems (sector coupling), with a more favorable regulatory and sectoral context for the introduction of hydrogen.

1.3. Characterization of Resources (p. 31)

- Due to its climate, location and geography, Portugal has an enormous potential in terms of natural resources, in particular for energy production, such as sun, wind, water and biomass.
- The use of wastewater, whose reuse is currently negligible, represents an opportunity to promote synergies between the energy sector and the water sector, boosting hydrogen production on a local scale with territorial dissemination that allows widespread access to this new form of energy.

2. PORTUGAL'S VISION FOR HYDROGEN (P. 35)

Main Points (pp. 71 and 72)

- Hydrogen, in addition to other energy carriers, will play a key role in the decarbonization of the economy, particularly in sectors that currently have few technological options in the short to medium term - industry, transport, energy
- A framework of public policies and actions in connection with legislation and regulations, promotion of R&D+I and support for projects and new technologies that promote hydrogen will be adopted in the short term
- Ambitious but realistic targets and goals are set for the incorporation of hydrogen in the various economic sectors to promote and boost the production and consumption of hydrogen in the various economic sectors, driving a true hydrogen economy in Portugal
- The implementation of a large scale industrial green hydrogen production anchor project in Sines with a capacity of 1 GW in 2030 will be fundamental to create a hydrogen economy in Portugal that will leverage the competitiveness of solar energy and the strategic location and conditions existing in Sines

2.1. Opportunities for the Country (p. 39)

- Decarbonization of the economy (p. 40)

Hydrogen has the potential to be a vector of decarbonization across various economic sectors, with greater impact on industry and transport, positioning itself as a cost-effective solution in the medium term.

The decarbonization of transport and mobility will set the stage for the decarbonization of cities.

As with wastewater reuse, urban solid and food waste could become valuable assets to the production of hydrogen.

- **V**iabilization of assets (p. 42)

Natural gas will play a key role and it is one of the vectors of energy transition. If hydrogen production and consumption is to increase and contribute towards the decarbonization of the natural gas sector there is an opportunity to enable the existing natural gas infrastructure and to maintain gas capacity in the electricity production system.

- Reinforced renewable energy sources and increased system resilience (p. 43)

Hydrogen will play an important role in allowing greater incorporation and valuation of renewable electricity, actively contributing to the management of the system and to increase the economic value of renewable production.

Hydrogen has the potential to improve the economics of investments in renewable projects, increase security of supply and serve as long-term and seasonal storage, supplying renewable energy to the grid in times of higher demand.

Hydrogen will be eligible, along with batteries and other forms of storage, for capacity and availability remuneration mechanisms in the electricity sector, to be planned and available at an auction to be held in 2020, which will include storage with remuneration for installed capacity.

- Reinforcement of the renewable energy exporter potential (p. 43)

Hydrogen production affords Portugal the opportunity to become increasingly a renewable energy exporter. Exports will (i) be shipped from the port of Sines and (ii) transported onshore through pipelines connecting the Iberian Peninsula to the rest of Europe (EN-H2 mentions the opportunity to resubmit the project for the 3rd natural gas interconnection between Portugal and Spain), or by road and railway.

- Boosting industrialization (p. 44)

The national industry will be able to take advantage of the new emerging hydrogen economy. There are parallels between a new hydrogen industrial cluster and the national wind cluster set up between 2005 and 2008.

Various synergies in the national industry could leverage the new hydrogen economy – transport, chemical industry, shipbuilding and port industry, railway and other industries.

- Boosting research, innovation and development (p. 45)

The development of a hydrogen economy will advance national research and innovation (R&I), and a multi-year R&D&I investment framework will be stimulated across the hydrogen value chain.

- (Green) jobs, professional training and retraining (p. 47)

The adoption of ambitious policies in connection with energy transition and decarbonization directly bring about economic growth and job creation. There will be a focus on retooling and retraining those most affected by the transition to a low carbon economy. A Strategic Energy Transition Training Plan (to be developed) will be central to the proposed actions.

- Reinforced international cooperation (p. 49)

Strengthening international cooperation will be important to create a global hydrogen market and build strategic partnerships to develop and streamline global actions on green hydrogen. Contacts with potential European partner countries, such as the Netherlands, among others, are intended to stimulate important investments. It is also relevant to focus on cooperation outside the European area, such as with Japan and Canada.

2.2. Hydrogen Value Chain (p. 50)

- The hydrogen value chain includes, in practice, three phases that comprise hydrogen production - centralized production and decentralized production, storage, distribution and supply, and end-use.

- The current characteristics of the national energy sector entailed the selection of certain strategic configurations for the hydrogen value chain, including: (i) Power-to-Gas (P2G) (p. 51), (ii) Power-to-Mobility (P2M) (p. 52), (iii) Power-to-Industry (P2I) (p. 53), (iv) Power-to-Synfuel (P2FUEL) (p. 53) and Power-to-Power (p. 54).

2.3. Policies and Actions (p. 55)

- Actions are proposed to be implemented in three stages in order to ensure optimal implementation of the EN-H2.

- The policies and actions are listed in the EN-H2 (ref. Tables on pp. 57 to 62), including a reference to the implementation period and the three stages of implementation, organized in accordance with the following eight topics: (i) Hydrogen Production (p. 56), (ii) Storage, Transport and Distribution (p. 57), (iii) Decarbonization of the Transport Sector (p. 58), (iv) Decarbonization of the Industrial Sector (p. 59), (v) Decarbonization of electricity and heat generation (p. 60), (vi) Synfuel and other uses (p. 60), (vii) Employment, professional training and retraining (p. 61) and (viii) Cross-cutting actions (p. 61).

- Measures include legislative and regulatory acts, promotion of R&D+I research, support to projects and adoption of new technologies by the market. Applicable funding sources and the entities involved in each of the above eight topics are also set out.

2.4. National Targets and Goals (p. 62)

- Sets out the targets for the 2021-2030 period and indicative trajectories for the 2031-2050 period for volume of hydrogen incorporation in the various sectors, as well as for the installed capacity of hydrogen production, transport sector, among others, are set out (Table 10, p. 63).

2.5. Industrial Project in Sines (p. 63)

- Concept (p. 63)

According to the EN-H2, the implementation of a large scale industrial green hydrogen production anchor project is key to creating a hydrogen economy in Portugal. The project for the installation of an industrial unit in Sines for the production of green hydrogen is intended to have a total capacity in electrolyzers of at least 1 GW by 2030 and be powered by electricity from renewable sources, namely solar and wind.

- Implementation (p. 66)

The project is designed and structured to be implemented by a consortium of Portuguese-based and Dutch-based undertakings, although the participation of undertakings from other Member States has not been ruled out.

The project is designed to cover four major areas of interest in the value chain, namely: (i) dedicated renewable electricity production, (ii) hydrogen production, (iii) associated infrastructure for transport, distribution and storage, (iv) export by sea. The following areas of interest are also considered to be very relevant for the project's success: (i) domestic market, (ii) production of the electrolyzers and (iii) collaborative laboratory.

- Industrial Cluster (p. 67)

According to the EN-H2, the project is above all a major industrial project that includes the installation of an electrolyzer manufacturing plant in the national territory.

- Strategic partnership with the Netherlands (p. 67)

According to the EN-H2, a strategic partnership with the Netherlands is key to the implementation and part of the success of the Sines project. There is also the potential for new strategic partnerships with other Member States, including Germany and Luxembourg.

- Funding (p. 68)

The policy addresses the particular relevance of the European Commission's IPCEI initiative in this context, which covers the hydrogen value chain. It also highlights the participation in projects in the hydrogen sector under Order 6403-A/2020, of 17 June 2020, in the context of participation in the future IPCEI Hydrogen. As regards the IPCEI application, according to the EN-H2 the goal is to have a decision by the end of 2020. The EIB will also play a significant role in connection with funding.

- Hydrogen Collaborative Laboratory (p. 69)

A new CoLab will be associated to the project, whose main goal will be R&D regarding the main relevant components of the hydrogen's value chain.

- Follow-up Structure (p. 70)

A dedicated structure is proposed to follow up on the project, set up for such purpose and including representatives of several areas of government – Energy, Economy, Infrastructure, Foreign Affairs, Planning and Science and Technology.

2.6. Monitoring and Follow-up (p. 70)

- The EN-H2 sets out several monitoring Indicators to follow up on the implementation of the actions contemplated in the EN-H2 (listed in Table 12) (pp. 70 and 71)

- The EN-H2 further sets a review and monitoring schedule for its regular assessment and review (ref. Table 13) (p. 71), between June 2022 and June 2030.

3. ENERGY SCENARIOS (P. 72)

Main Points (p. 75)

- The results of this modeling exercise are an important contribution to support the definition of the targets and goals contained in this strategy

- Production-side, the different scenarios presented show that major investments will target the installed capacity of hydrogen production through electrolysis

- Consumption-side, the different scenarios presented show that major investments will target mobility and the ensuing requirement for a hydrogen supply infrastructure

- In the studies to support EN-H2, the national energy model JANUS developed by DGEG for the PNEC preparatory work was used, which is a bottom-up model implemented on the LEAP platform (p. 72)

- Additional characteristics regarding the 2030 PNEC were also included, regarding energy demand (p. 72) and energy transformation (p. 73)

- The quantitative results of the 3 scenarios of introduction of hydrogen in the national economy are shown in Figures 29 to 31 (pp. 74 and 75)

4. FUNDING AND SUPPORT MECHANISMS (P. 76)

Main Points (pp. 86 and 87)

- In order to boost a hydrogen market in Portugal, and in line with the rules for state aid, several support mechanisms will be designed and implemented - tariff, production, market, taxation - that encourage new investments based on all the advantages that green hydrogen affords the national economy and the energy system

- An amount of approximately 40M euros is foreseen for 2020 to support renewable energy production and distribution projects, which will include hydrogen-based projects

4.1. Funding (p. 76)

- According to the EN-H2, supporting investment in such new projects will allow leveraging on the many significant European funds provided for such purpose.

- The policy mentions the long-term EU Budget in this context, amounting to a total 1 074,3 billion euros for the 2021-2027 period and the EU Next Generation, amounting to a total 750 billion euros.

- Domestic Instruments (p. 78)

As for domestic funding instruments with a potential to support hydrogen projects, we highlight the following:

(i) *Programa Operacional Sustentabilidade e Eficiência no Uso de Recursos* (Operational Program for Sustainability and Efficiency in the Use of Resources) (Please visit: https://poseur.portugal2020.pt/) (p. 78)

(ii) Portugal 2030 (p. 78)

(iii) *Fundo Ambiental* (Environmental Fund) (p. 79)

(iv) *Fundo de Apoio à Inovação* (Innovation Support Fund) (Please visit: https://www.fai.pt/)(p. 79)

(v) *Plano de Promoção de Eficiência no Consumo* (Plan to Promote Consumption Efficiency) (p. 79)

(vi) Banco Português de Fomento (p. 79) and

(vii) *Fundo Azul* (Blue Fund) (p. 80)

- European Instruments (p. 80)

There are several European instruments, some still being negotiated:

(i) *InvestEU* (Please visit: https://europa.eu/investeu/home_pt) (p. 80)

(ii) Recovery and Resilience Facility (p. 80)

(iii) Just Transition Mechanism (p. 81)

(iv) Recovery Assistance for Cohesion and the Territories of Europe (p. 81)

(v) Horizon Europa (Please visit: https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en) (p. 82)

(vi) Connecting Europe Facility (Please visit: https://ec.europa.eu/inea/en/connecting-europe-facility) (p. 82)

(vii) Innovation Fund (Please visit: https://ec.europa.eu/clima/policies/innovation-fund_en) (p. 82)

(viii) InnovFin Energy Demo Projects (Please visit: https://www.eib.org/en/products/blending/innovfin/products/energy-demo-projects.htm) (p. 83)

(ix) *EEA Grants 2014/2021* – Blue Growth, Innovation and SMEs (p. 83)

and naturally the European Investment Bank as the European Climate Bank (p. 83),. The European Investment Bank is also the majority shareholder of the European Fund for Strategic Investments, which funds investments in SMEs.

4.2. Support Mechanisms (p. 83)

In addition to financing mechanisms, the EN-H2 provides for other support mechanisms, which will be assessed and discussed in greater detail during 2020 and are set out below.

- Main Mechanisms (p. 83)

  - The main support mechanisms to be adopted include (i) Differentiated Tariff Treatment (p. 83), (ii) Production Support (p.84), (iii) Participation in the System Services Market (p. 86), and (iv) Taxation (p. 86)

- Other mechanisms (p. 86)

  - Other mechanisms include the Guarantees of Origin (p. 86). Note that Decree-Law 60/2020 was published on 17 August 2020, which establishes a mechanism for the issuance of guarantees of origin for low carbon gases and renewable gases.

5. INVOLVEMENT AND CONSULTATION PROCESS (p. 87)

- The EN-H2 public consultation process was conducted over 45 days, between 22 May and 6 July 2020.

- The involvement and consultation process also included six discussion sessions with different sectors' and areas of activity's stakeholders, notably Innovation and Development (2 sessions), Industry and Transport, Energy and Training, Qualification and Employment.

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