The Portuguese Hydrogen Strategy

EN-H2, the Portuguese Hydrogen National Plan

Recently, the Portuguese Government approved a National Hydrogen Plan (*Plano Nacional do Hidrogénio*) also known as "**EN-H_2**". Council of Ministers' resolution on August 14, has set the agenda for the incorporation of hydrogen technology in different sectors and markets of the Portuguese economy.

EN-H_2 is now an element of the national strategy to fight climate change and enhance the decarbonization of the economy, together with the European Green Pact, the European Commission and the Portuguese Energy and National Plan for the Climate (*Plano Nacional de Energia e Clima* - "**PNEC**").

PNEC had already established the following goals for 2030: (i) reduction of the greenhouse gases' emissions up to 55% (compared to 2005), (ii) increase of energy efficiency by 35%, (iii) increase of renewables' weight in energy consumption up to 47%, and (iv) increase the number of green vehicles to 20% of total vehicles.

Portugal remains very dependent on imports, even though energy dependence has reduced in the last decades (from 88,8% in 2005 to 77,9% in 2018) as a result of the investments made in renewables, mostly wind and solar plants.

With EN-H_2, hydrogen will help reaching the PNEC goals and to correct the current Portuguese energy deficit: it is expected it may lead to a reduction in natural gas imports from 300 to 600 million euros. At the same time, it will promote energy transition and sustainable mobility.

It appears that the moment could not be better. The Portuguese Government has announced that of the assistance from the European Union, 2.7 billion euros will be allocated to climate transition, of which 800 million euros will be used to fund the hydrogen strategy.

The green hydrogen value chain

The production of green hydrogen, which is hydrogen produced by water electrolysis using exclusively renewable energies is the main focus of EN-H_2, establishing a hydrogen value chain, is composed of three phases:

(i) Production;

(ii) Storage, distribution, supply; and

(iii) End-use.

Production can be carried out in a large scale (centralized) or in a small scale (decentralized). Although EN-H_2 fosters and encourages hydrogen production through a combination of industrial scale centralized projects, and decentralized processes closer to consumption sites, massive investments in infrastructures are being made in centralized production at the *Projeto Industrial de Sines* or "**Sines Project**" (see below).

Hydrogen distribution is made by road and sea transport. Hydrogen can also be injected into the current natural gas distribution grid, used for both industrial and domestic purposes. Hydrogen fueling process can take several combinations, namely:

(i) Hydrogen distribution by road in the form of liquefied/compressed gas, ending with a liquid to liquid (L2L) refueling process for liquid to gaseous cryogenic hydrogen (L2G) and gas to gas (G2G) storage systems at various scales;

(ii) Hydrogen distribution by vessels in the form of liquid hydrogen, including delivery for end-use with pipelines and road transport;

(iii) Hydrogen gas distribution through a pipeline system; or

(iv) Hydrogen mixture with natural gas in the current natural gas infrastructure.

Since hydrogen can be transformed into electricity or synthetic fuels, which can then be used for domestic, commercial, industrial or mobility purposes, its end-use is vast and covers a significant part of our day-to-day energy consumption.

One of the downsides of green hydrogen production is its high cost. Naturally, a small-scale production will be more costly and therefore less attractive to investors. Notwithstanding, it is expected that as decarbonization progresses, generating energy from renewable sources will be cheaper, making it less expensive to obtain green hydrogen.

As smaller energy storage projects are just in their early stage in Portugal, there is no clear evidence that hydrogen can compete with other technologies.

In the Portuguese solar auction that took place on 31 August 2020, energy storage was part of eight of the 12 awarded projects. Still, hydrogen will not be used in those projects, but lithium batteries which appear to remain the reference in energy storage.

Maybe in the future hydrogen will replace lithium batteries but the Portuguese Government is supporting the opening of new lithium extraction fields and is currently working on the creation and development of the first lithium refinery in Europe.

For those reasons, decentralized projects will face the cost-efficiency challenge against other technologies that may delay their development, unless there is proper support to such investments, which, until this moment, does not seem to be the case in Portugal.

The Green Flamingo project

The Sines Project, also called "Green Flamingo", is a 3,5 billion Euro industrial-scale project for the production of green hydrogen that involves the main Portuguese energy stakeholders, such as GALP, EDP and REN. It is focused on leveraging solar and wind energy as competitiveness factors and on industrial transformation and expects to have a 1 GW of capacity production until 2030, fully supported by green sources.

Sines benefits from its natural resources, such as its coastal location - which is a critical point regarding exportation, the deep-water port and access points to the natural gas distribution grid. In addition, the city already has qualified manpower and infrastructures that make it a competitive location for the installation of an industrial-scale green hydrogen production project.

The hydrogen generated in Sines will initially be consumed in the national market, using mainly the natural gas distribution grid. It is expected that, as the production capacity increases, a significant part of the

production shall be exported using the deep-water port of Sines. The Dutch and Portuguese Governments are currently negotiating a *Memorandum of Understanding* for this purpose.

On 18 June 2020, the Portuguese Government launched a market consultation on the Sines Project and received answers from 74 entities, for investments valued in 16 billion Euro (equivalent to 7,5% of the national GDP). On 27 July, of the 74 projects, 37 representing an investment of nine billion Euro were selected by the Admission Committee and are now eligible for the PO SEUR - Operational Programme for Sustainability and Efficient Use of Resources, PO SEUR is a Portuguese Government's incentive program to transform the national energy system to meet the sustainability requirements of EN-H_2.

The Sines Project has potential to be considered by the European Commission as an Important Project of Common Interest (IPCEI) due to its size or scope and its very considerable technological financial risk. For that it must meet a number of criteria such as making a concrete contribution to the achievements of one or more of the Union's objectives or having a significant impact on the Union's competitiveness.

The Sines Project being classified as an IPCEI, the Portuguese Government and investors will most likely benefit from European funds of up to 100% of eligible expenditure, it also enables the accumulation of various sources of funding and establishes an EU platform to support long-term cooperation between regions, clusters and industry.

EN-H_2, despite heterogeneous, is clearly privileging the Sines Project over decentralized projects. Therefore, opportunities for investors are expected to arise mainly in the Sines Project, which may include easy access to credit, public investment in the grid and other infrastructures.