Gas Infrastructure Europe

GIE position on Artelys and Frontier Economics study: Roadmap on UHS (Underground Hydrogen Storage) in Europe from 2030 onwards

The European Union has emphasized the crucial importance of attaining climate goals and decarbonizing the European energy system, placing it at the forefront of its agenda. EU- policy frameworks have already been established, including the EU Green Deal[1], the Fit for 55 Package[2], and most recently, the REPowerEU plan[3]. The aim is to achieve carbon neutrality while fostering the development of renewable energy and its associated infrastructure.

Hydrogen plays a pivotal role in the envisioned energy transition, as highlighted in the EU Hydrogen Strategy (2020)[4]. The recently unveiled EU 2040 Climate Targets Communication (2024)[5] reinforces the call for expanding a hydrogen infrastructure as a vital element in achieving targets for reducing greenhouse gas emissions.

The direction is set; the next step is to define specific targets for UHS and devise strategies to achieve these short-term and long-term goals. Member states are urged to implement EU directives concretely, and it would be beneficial for an integrated hydrogen infrastructure to collaborate in a coordinated manner.

The large-scale expansion of underground hydrogen storage is a crucial component that forms the foundation for a successful, cost-effective, and secure ramp-up of the hydrogen ecosystem and enhanced integration of renewable energy sources.

Concrete targets are also required for underground hydrogen storage, which GIE, together with the support of Artelys and Frontier Economics, has developed as part of a study. It compares the required UHS capacity with planned projects, which results in the identification of a significant gap. The focus is on defining concrete measures along a Hydrogen Storage Roadmap so that these short- and long-term targets can be achieved through a regulatory framework. Based on these findings, it becomes evident that a secure investment path for infrastructure operators must be paved for the successful implementation of the hydrogen strategy.

The Hydrogen Storage Roadmap by GIE outlines recommendations for establishing Underground Hydrogen Storage Targets for 2030, along with the necessary regulatory and financial framework to accomplish them. UHS is beneficial for the European energy system due to reduced total system costs.

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[1] European Commission (2019) *The European Green Deal*, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2019) 640 final.

[2] European Commission (2021) *'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality*, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2021) 550 final.

[3] European Commission (2022) *REPowerEU Plan,* Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2022) 230 final.

[4] European Commission (2020) *A hydrogen strategy for a climate-neutral Europe*.

[5] European Commission (2024) *2040 climate target: Reducing net emissions by 90% by 2040.*

For more information, please consult the study conducted by Artelys and Frontier Economics on "Why European UHS needs should be fulfilled".

I. Setting the scene

For several years now, European storage operators have been launching projects for pure hydrogen storage, according to the H2 Inframap, which is currently aiming for a capacity of 9 TWh by 2030. These upcoming investments underscore the strong commitment to UHS technology.

However, despite these efforts, much remains to be done to align with the REPowerEU ambition, where the development of renewable energies and the achievement of 20 Mt H2, in particular, will lead to an additional need for flexibility, necessitating large and long-duration hydrogen storage capacities.

To align with a trajectory that brings us closer to this ambition, GIE, which had already taken care in 2023 to highlight the benefits and pathways of UHS in various system configurations and for different territorial uses with Artelys, continued in 2024 with Artelys to quantify the storage needs by 2030 and 2050.

Artelys thus conducted an economic-based optimisation of the European energy system, indicating that an optimal storage capacity of 45 TWh by 2030 was necessary to meet REPowerEU's goals, and 269 TWh by 2050, revealing a potential gap of 36 TWh to be filled by 2030, which increases to 248.5 TWh by 2050. Considering the ambitious REPowerEU`s goals the modelling results show a huge investment gap reflecting the current unstable market environment with various obstacles in the regulatory framework for operators.

To address this gap and enable investment decisions to be made promptly, GIE also conducted an analysis with Frontier Economics within this study of the interventions that would be important to implement quickly to ensure that investment decisions must be made today to meet the capacity by 2030 at the earliest.

▪ Values of UHS

The main benefits of large-scale UHS can be described by the following five values:

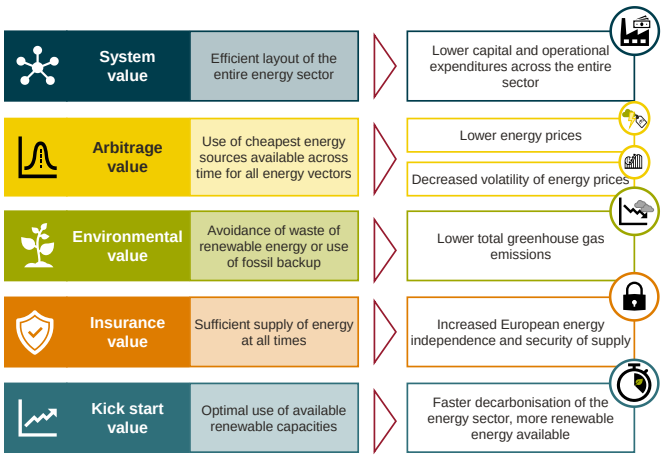

Illustration 1 – Benefits added to the energy system by UHS
(Artelys, Frontier Economics, on behalf of GIE, 2024)

- **Economic benefits of UHS**

In addition to the increased resilience when including large-scale UHS for the energy system, the usage also reduces the cost of the energy transition whilst increasing the integration of RES at the same time. Investments of around €20-30 billion by 2030, typical for large infrastructure projects, are needed to unlock all previously mentioned benefits for both the electricity system and the hydrogen ecosystem, e.g., efficient integration of renewables and a stable supply of hydrogen. If this amount of energy would be stored in batteries, with costs of €100/kWh, storing energy in the form of hydrogen in UHS is, therefore, at least 100 times cheaper than battery storage.

Lead time for realizing UHS capacities urges early investment decisions to narrow the gap between planned projects and UHS capacities investments needed in 2030

The development timeline ranges from up 5 (for repurposing existing sites) to more than 10 years for new projects. It's important to note that the duration can be shortened, especially during the permitting phase.

UHS contributes to ensuring security of supply for the entire energy system

UHS can enhance security of supply (SoS) for the electricity system by generating additional electricity demand for hydrogen production. This stored hydrogen will then be available as a fuel in power generation, serving as back up for intermittent RES production.

To achieve this contribution, it is crucial to ensure that hydrogen storage can gradually expand and provide various benefits to the system. These benefits will materialize as storage becomes integrated into both the gas and electricity systems, particularly in areas where renewable energy source (RES) capacities are predominant.

It is also evident that hydrogen demand will be largely and increasingly covered by imports in view of the immense potential for hydrogen use in the scenarios explored here. Therefore, to ensure the security of supply and strategic grounds as well, it will be necessary to set up both large-volume storage facilities close to production destinations for RES and H2 as well as close to the centres of hydrogen consumption across Europe and integrate them in developing the European Hydrogen backbone.

II. GIE Recommendation on UHS capacity targets

In 2023, GIE members decided to launch a new study based on the REPowerEU assumptions with the support of Artelys and Frontier Economics. It focuses on three main objectives:

- Estimate the substantial needs for UHS by 2030 and 2050, to achieve the maximal economic benefits to society based on the REPowerEU framework, where demand is assigned to end-users with flat demand profiles in industry by 2030. Out of the 20 MtH2 of consumption, 10 MtH2 will be delivered via electrolysis in the EU, 6 MtH2 will be delivered via imports of H2, and 4 MtH2 will be delivered via imports of ammonia and/or other derivatives. No exogenous pipeline capacities on specific projects have been imposed into the model. Despite being recognised in the European hydrogen strategy, no amounts of low-carbon hydrogen have been considered. Recognizing low-carbon hydrogen could have further driven the H2 infrastructure ramp-up in Europe.
- Define the massive gap between needs and planned projects, highlighting the need for immediate intervention. The modelling results reflect the current EU-policy assumptions

that could very likely deviate from real UHS-need in 2030. But it becomes evident that there is no alternative in closing the gap by an urgent need for supporting and funding instruments to trigger investment decisions before 2025.

- Provide an overview of potential measures to mitigate or overcome the barriers.

- **GIE Recommendation for UHS capacity Target by 2030 and 2050**

In line with the modeling conducted by Artelys and considering the REPowerEU assumptions, GIE recommends planning towards an underground hydrogen storage target of at least **45 TWh by 2030** and **at least 269 TWh by 2050.**

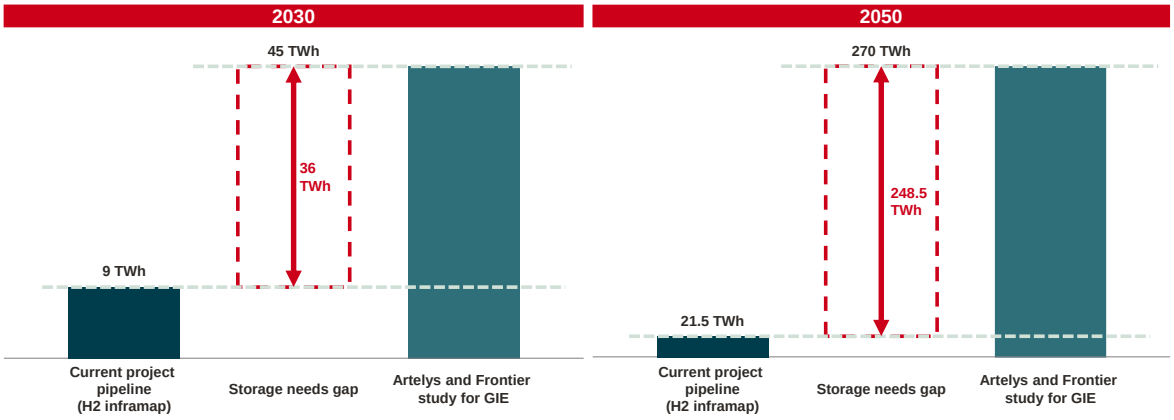

Illustration 2 – Key 2030 and 2050 results (Artelys, Frontier Economics, on behalf of GIE, 2024)

- **GIE recommendation on measures to trigger the necessary investments**

The study clearly identified a gap between the estimated 2030 and 2050 storage needs and planned projects that are foreseen to be in operation by those dates. This gap needs to be filled by defining regulatory measures that enable the infrastructure operators to take investment decisions among a defined pathway.

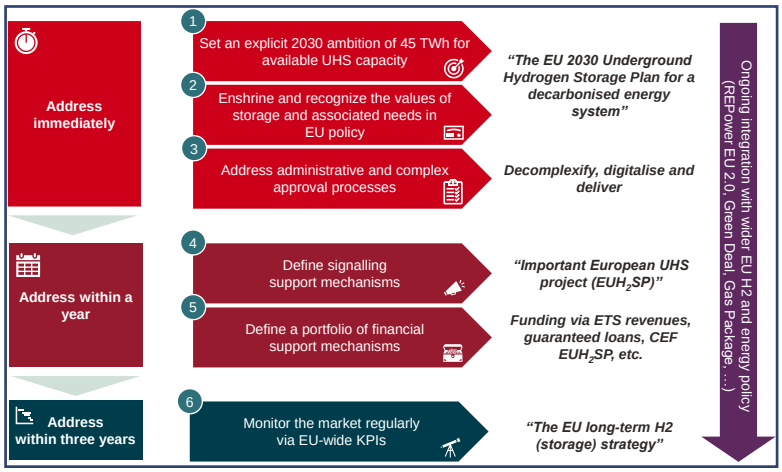

Illustration 3 – Roadmap of proposed measures (Artelys, Frontier Economics, on behalf of GIE, 2024)

As the first step, a roadmap of actions needs to be created according to the achievements of the set targets.

- **Short term measures to trigger investments before 2030**
  - Set an explicit EU-wide target and ambition for UHS capacity at (temporal) checkpoints, including 2030
  - Enshrine and recognise the values of UHS storage and associated needs in official EU policy (similar to REPowerEU)
  - Address administrative hurdles and complex approval processes to facilitate project implementation
  - Introduce targeted and tailored support mechanisms for UHS projects
  - Signalling mechanisms – such as a UHS "project of common interest" label to, e.g. formalise support from Member states and facilitate the attraction of third-party investments
  - Financial mechanisms – to support financing explicitly and reduce potential funding gaps for storage projects by giving a stable regulatory cost recovery regime to trigger investments
  - Coordinated infrastructure planning procedure to integrate the development of the Hydrogen backbone with UHS, providing the requested flexibility needed.
  - Monitor the market via the regular (e.g. annual) assessment of a range of EU-wide KPIs on both project pipeline and planned/commissioned capacity and UHS needs, fostering the agility to react to possible changes in market needs and the wider system environment

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III. Next steps and implications

The study's primary focus lies in estimating the needs for UHS by 2030 and 2050, which must then be translated into well-defined policy measures at EU level. This could be coupled with a sensible forward-looking strategy to achieve both short- and long-term objectives effectively.

- **Setting UHS targets for 2030**

In order to achieve an initial scale-up of the hydrogen storage market by 2030, decisions regarding binding targets need to be made promptly. This will enable the establishment of an appropriate toolbox of measures at both the European and Member State level.

The transformation of the energy system now requires existing underground facilities to be quickly converted to meet demand and new facilities to be built. At the same time, natural gas storage facilities must continue to guarantee the current high level of security of supply.

This requires an orderly transition and an integrated view of natural gas and hydrogen demand in order to ensure decarbonization and a rapid hydrogen ramp-up while maintaining the security of natural gas supply with high cost efficiency.

- **Development of a long-term strategy for the hydrogen and electricity system**

Looking towards the long-term, it becomes increasingly obvious that an integrated planning of hydrogen network and storage assets is imperative. This entails the EU establishing standards to facilitate the seamless evolution of hydrogen networks across member state borders.

Despite having unified standards, there is a recognized need for an optimized sector integration. To create an efficient and resilient future energy infrastructure, it's essential to view the energy system holistically. This approach aligns with the short-term ramp-up of the hydrogen storage market

- **Towards 2050: Long-term vision and pathways for UHS**

Looking ahead to the long-term perspective (2040-2050), as a mature European hydrogen infrastructure becomes established, a comprehensive cross-sectorial assessment will be necessary. This assessment aims to quantify the potential UHS would deliver for the whole energy system and its contribution to realizing the EU's 2050 energy and climate targets.