De-risking UHS to unlock an effective hydrogen system in Europe

A position paper by H2eart for Europe

24 June 2026

Executive Summary

Hydrogen infrastructure is a critical enabler of the European energy transition, particularly for sectors where direct electrification is difficult or costly. Underground hydrogen storage (UHS) will be an integral part of this infrastructure system, providing the flexibility, resilience and security of supply needed to connect hydrogen production and demand across time and geography.

However, investment in hydrogen infrastructure faces a structural coordination challenge. Producers, network operators, storage operators and end-users all depend on the timely development of other parts of the value chain, but no individual actor can fully capture the wider system benefits created by early infrastructure investment. This creates a hold-up problem: projects that are economically valuable from a system perspective may remain difficult to finance on a standalone commercial basis.

These challenges are particularly acute for UHS. Storage projects require high upfront investment, face long development timelines, as well as permitting and technical preparation well before hydrogen demand and utilisation are fully visible. Without timely investment, Europe risks creating a storage bottleneck that could constrain the development of the wider hydrogen market precisely when supply, demand and transport infrastructure require confidence that flexibility infrastructure will be available.

Current de-risking frameworks remain insufficient to address this challenge. While the European discussion has increasingly recognised the need to de-risk hydrogen transport infrastructure and cross-border corridors, the investment challenges faced by UHS have not yet been addressed systematically. This is despite the fact that storage provides comparable system and cross-border benefits by supporting market integration, security of supply and efficient balancing across regions.

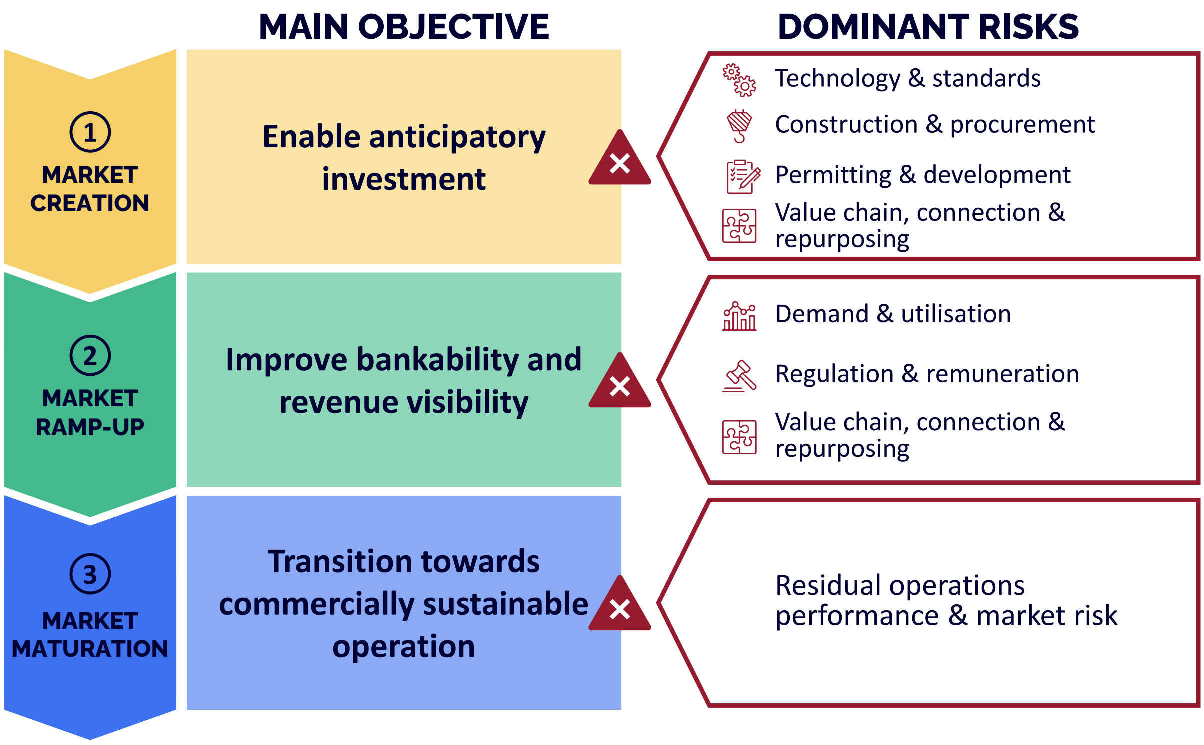
A credible de-risking framework will need to evolve with the market.

In the market creation phase, priority should be given to accelerated permitting, technical harmonisation, project development support and coordinated infrastructure planning.

During market ramp-up, mechanisms such as revenue stabilisation, intertemporal cost allocation, long-term booking frameworks and guarantees can improve bankability and address utilisation risk.

As the market matures, support should progressively shift towards stable tariff methodologies, harmonised market rules and commercially sustainable operation.

Figure 1 Dominant risks per market phases / main objectives of mitigation



Source: Frontier Economics for H2eart for Europe

There is a strong case for future European de-risking frameworks to explicitly include underground hydrogen storage alongside hydrogen transport infrastructure. Storage is not an ancillary part of the hydrogen value chain, but a core infrastructure component required for the development of an integrated, resilient and cost-effective European hydrogen market.

The dilemma of hydrogen infrastructure investment

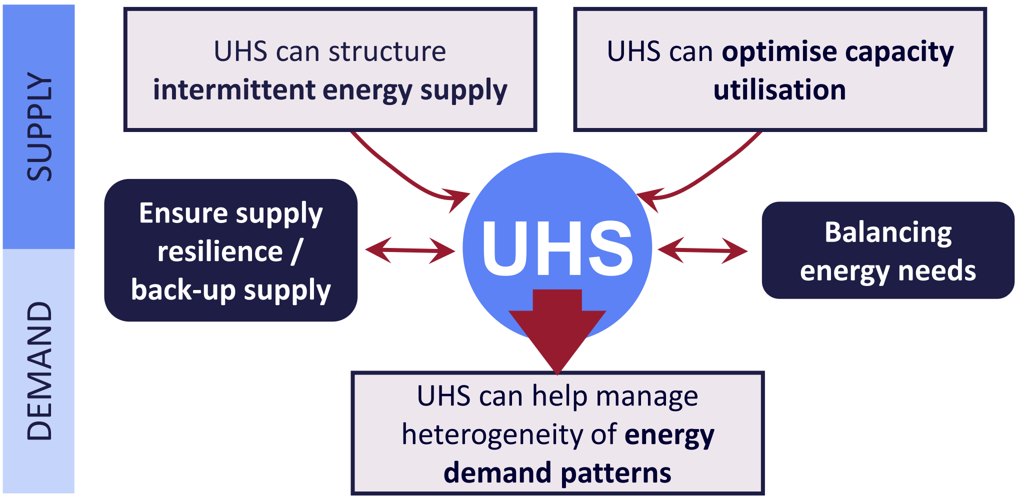
Hydrogen infrastructure requires coordinated system planning

Hydrogen is expected to play an important role in the EU transition to a low-carbon energy system, particularly in sectors where direct electrification is difficult or costly. However, the value of hydrogen depends not only on production and end-use demand, but also on the development of enabling infrastructure that can connect supply and demand over time and across geographies.

This means that the hydrogen market needs to be understood as an integrated system rather than as a set of standalone assets. Production, transport, storage and demand are interdependent – the services provided by and required from each part of the value chain depend on the timely development and efficient operation of the others. While pipelines and storage assets depend on future hydrogen volumes to materialise, industrial end-users and producers need confidence that hydrogen transport and storage will reliably be available before converting their processes.

Underground hydrogen storage (UHS) is a critical part of this enabling infrastructure, acting as a bridge across time by making hydrogen produced at times of favourable conditions available when energy demand materialises. By allowing hydrogen to be stored at scale, UHS will improve market integration, increase system flexibility, enhance security of supply and reduce exposure to short- and mid-term volatility. It lowers investment risk for other market participants by providing confidence that hydrogen will be available when and where it is needed, thereby supporting investment decisions across production, transport and end-use applications.

Figure 2 Role of UHS in the energy system



Source: Frontier Economics for H2eart for Europe

The operational link between electrolysis and storage illustrates this system logic. Electrolysers can provide hydrogen supply and enable the integration of renewable electricity, but their commercial case depends on the ability to manage temporal mismatches between renewable electricity availability, hydrogen production and hydrogen demand. Hydrogen storage like UHS can provide required flexibility by absorbing hydrogen when production exceeds immediate demand and releasing it when demand is higher or production is constrained.[1] This can support more efficient electrolyser load factors, improving the electrolyser business case and reducing the need to overbuild relevant parts of the system.

Conversely, storage assets depend on connected production, transport access and demand to create utilisation and revenues. Pipelines, storage, electrolysers and other flexibility assets therefore need to be planned as part of one infrastructure system. Each element performs a distinct role, but the system value of each depends on the others.

Infrastructure planning needs to consider how different elements along the value chain interact simultaneously, rather than treating transmission, storage, production and demand separately. Policy and regulation should acknowledge that investments across the hydrogen value chain need to develop in parallel and should treat hydrogen infrastructure as an integrated system, rather than as a collection of individual assets that can be developed one by one.

1 This is complemented by battery storage, but on a shorter timescale: Battery storage can provide short-term flexibility by storing renewable electricity for use in later hours, allowing hydrogen production to be spread more effectively over time.

Interdependencies create a hold-up risk for the hydrogen economy

The system interdependencies in the hydrogen economy translate directly into investment risk: Across the value chain – including in adjacent sectors such as electrolyser manufacturing – investors are asking for dependable revenue predictions before committing capital. However, each investor's business case depends on decisions that other actors have not yet taken. This creates uncertainty over project specific future utilisation, revenues and cost recovery, even where the underlying asset may be much needed from a system perspective.

The coordination challenge faced by hydrogen infrastructure investment and gives rise to a hold-up problem: each part of the value chain depends on the timely development of the others. While all market participants would benefit from a functioning hydrogen infrastructure system, no individual actor has sufficient incentive to absorb the full cost and risk of developing the system.

The challenge is further amplified by hydrogen markets remaining at an early stage of development. Unlike in established natural gas markets, there are not yet stable demand signals, established commercial structures, liquid markets and fully developed regulatory frameworks. Intermediaries, traders and aggregators who are commonly tasked with capacity booking, optimisation and risk allocation across the value chain in established energy markets are not (yet) active. This makes it even more difficult for individual market participants to assess the commercial viability of their projects.

Key takeaway for UHS

This is particularly problematic for storage, as its value and required scale becomes most apparent when information on both expected supply patterns and demand needs is brought together. As a result, greater responsibility falls on producers or individual project developers to book storage capacity themselves, even where they are not best placed to assess system-wide needs or manage market risk

Why public intervention becomes necessary

Without public intervention, commercially rational investment decisions at the individual project level, e.g. delaying FID for a UHS project, may therefore collectively result in delayed infrastructure build-out and underinvestment across the hydrogen value chain.

Intervention is therefore necessary to facilitate anticipatory infrastructure investment. The objective of public intervention does not need to be to remove all commercial risk from market participants. Risks that can be efficiently managed by infrastructure operators should remain with private investors to preserve incentives for efficient project delivery and operation.

However, certain risks which are systemic in nature and cannot be efficiently managed by individual market participants alone should be addressed by an appropriate energy policy and regulatory framework. In particular, regulated infrastructure operators should be shielded from risks they cannot manage and that are not reflected in their remuneration (e.g. volume or price risks).[2] Without targeted de-risking mechanisms, hydrogen infrastructure expansion is likely to remain below the level required to support timely market development.

The recently published ENTSOG/ENNOH report on "De-risking Options for EU Hydrogen Infrastructure" represents an important step towards recognising the structural investment challenges associated with anticipatory hydrogen infrastructure investment. The report correctly identifies the significant volume, price and coordination risks currently faced by hydrogen infrastructure operators and highlights the need for dedicated de-risking mechanisms at both Member State and EU level.

While the report focuses primarily on hydrogen transmission infrastructure and cross-border corridors, the underlying economic challenges and risk characteristics apply equally to underground hydrogen storage (UHS) as an equally vital part of hydrogen infrastructure. This paper therefore builds on the broader de-risking discussion initiated by ENTSOG and ENNOH and considers its implications for hydrogen storage infrastructure specifically.

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2 This is consistent with one of ENNOH and ENTSOG's main conclusions in their recent report on de-risking hydrogen infrastructure: "*Hydrogen infrastructure is a crucial puzzle piece to enable the overall market ramp-up. However, the current environment exposes operators to a range of risks. It is essential that regulated operators do not face undue risks, i. e. risks that HTNOs have no leverage to control. To this end, protection from volume and price risks is to be guaranteed*". ENNOH & ENTSOG (2026), *De-Risking Options for EU Hydrogen Infrastructure*, Conclusion No. 1, p. 14, available here.

Hydrogen infrastructure projects face multi-dimensional risk environment

Hydrogen infrastructure projects are exposed to a combination of risks that materially weaken project bankability. The hydrogen market is still nascent, with demand, utilisation and revenues being subject to several dimensions of uncertainty.

Figure 3 Overview of relevant risks

RISKS	IMPLICATIONS FOR UHS
Demand & utilisation Uncertain hydrogen demand and market uptake	Low booking certainty and uncertain utilisation
Regulation & remuneration Evolving hydrogen regulation and tariff frameworks	Uncertain future revenues and cost recovery
Technology & standards Lack of harmonised standards and technical implementation uncertainty	Higher development costs and increased compliance risk
Permitting & development Long, fragmented and non-standardised permitting processes	Delayed project timelines and increased development expenditure
Value chain connection Dependence on the timely development of complementary infrastructure	Increased delivery risk and uncertainty around future asset utilisation

Source: Frontier Economics for H2eart for Europe

The prevalent uncertainty creates both **revenue risk** (on the price and the volume side) and **cost / delivery risk** for hydrogen infrastructure investments, making it challenging to secure long-term offtake agreements and financing.

Key takeaway for UHS

For UHS operators, these risks are particularly pronounced due to

- lack of visibility of future demand as future customers themselves are unaware of their needs,
- significant geological construction and permitting work before commercial viability can be considered, and
- high upfront capital requirements and long development timelines without generating any revenue.

Delayed support risks creating a storage bottleneck precisely when hydrogen supply and demand investments require confidence that flexibility infrastructure will be available.

Revenue risk

Both *price* and *volume* risk can create a revenue gap:

- **Lack of demand visibility**: Market participants are reluctant to commit to infrastructure bookings at an early stage because binding hydrogen demand and offtake are still lacking. This delays projects across the value chain and creates uncertainty over whether the required upstream and downstream infrastructure and connections will materialise in time. This risk is further exacerbated by the requirement that capacity booking agreements must be concluded prior to the investment decision and the commencement of the lengthy construction phase. Consequently, such agreements need to be in place at least five years, and preferably longer, before the start of commercial operation.

- **Remuneration and regulatory uncertainty**: As market dynamics in hydrogen are still highly uncertain, so are the remuneration opportunities for SSOs. The market ramp-up hinges on political determination and regulatory frameworks, creating substantial risks for investors. While individual member states have started to establish regulatory frameworks for part of the value chain (often HTNOs), a high degree of uncertainty remains present for other infrastructure elements, including storage operators. Third-party access, tariff regimes, grandfathering, and cost recovery are among the most pressing concerns operators face, weakening confidence in long-term commercial commitments and undermining clarity over future revenues. Key issues for storage operators include:

    - **Ambiguity on UHS regulation in the Gas Decarbonisation Package**: In particular, the transition from negotiated TPA to regulated TPA after 2032 remains unclear and has not yet been adequately addressed at Member State level.

    - **Insufficient integration into infrastructure planning**: UHS is still not adequately embedded in national and EU infrastructure planning, despite its clear cross-sector role in the future energy system.

- **Limited EU guidance on tariff design and remuneration**: There is still insufficient EU-level guidance for Member States on UHS tariff methodologies, the remuneration of system-wide benefits, and the treatment of grandfathered contracts.

It is essential that regulated infrastructure operators do not face undue risks, i. e. risks that SSOs have no leverage to control. Protection from volume and price risks should therefore be guaranteed.[3]

Cost and delivery risk

- **High capital costs**: Early projects face higher investment costs than they would in a mature market, because components, standards and supply chains are not yet fully developed or optimised. Additionally, while UHS can benefit from substantial economies of scale, there are significant up-front investments which need to be taken.
  - **Uncertainty around hydrogen purity standards**: The absence of a harmonised purity framework creates uncertainty around purification requirements and related investment needs at storage sites.
  - **Lack of standardised UHS guidelines**: Particularly for hydrogen-specific equipment and materials, missing standards in design and technologies increase design complexity and development costs.
- **Permitting and project development bottlenecks**: Long, complex and non-standardised permitting processes, combined with missing technical standards for hydrogen infrastructure, slow projects down and increase development costs and overall project risk.
- **Lead times of UHS asset development** are currently 5-7 year for existing sites or up to 10 years for building new UHS assets. Therefore, delays in taking FIDs increase the risk that storage requirements in the future will not be met, resulting in lower decarbonisation across the energy system.
- **Value chain and connection risk**: Delays in the wider hydrogen value chain create uncertainty over whether projects will be connected to the necessary upstream and downstream infrastructure in time, increasing delivery risk and potentially raising costs further.

3 This is consistent with one of ENNOH and ENTSOG's main conclusions in their recent report on de-risking hydrogen infrastructure. ENNOH & ENTSOG (2026), *De-Risking Options for EU Hydrogen Infrastructure*, Conclusion No. 1, p. 14, available here.

In summary, regulatory uncertainty, value-chain dependencies, high upfront costs, and complex permitting all drive high revenue risks and create significant cost/delivery risks, making it challenging for infrastructure operators to create viable, bankable business cases.

Implications for bankability

Taken together, these risks create substantial uncertainty around future utilisation, revenues and cost recovery. Regulatory uncertainty further weakens long-term revenue visibility, while demand uncertainty increases utilisation risk and complicates commercial contracting. At the same time, long development timelines, high upfront investment costs and dependencies across the value chain increase exposure to delivery and financing risk.

The interaction of these risks materially weakens project bankability. Infrastructure assets that may be strategically necessary for the development of the hydrogen market can therefore remain difficult to finance on a standalone commercial basis.

Current de-risking framework remains insufficient

The current European discussion on hydrogen infrastructure de-risking remains focused primarily on hydrogen transmission infrastructure and cross-border corridors. While there are a limited number of support mechanisms available to UHS (such as CEF funding), the investment challenges borne by UHS are not targeted systematically.

The development of an integrated European hydrogen market will rely not only on transport corridors, but also on the timely availability of storage at geologically favourable sites, and on the ability to structure hydrogen supply in line with demand patterns over time and across regions. Despite commonly being located within a single Member State, the system value of UHS does not unfold only at national level. Storage will support the efficient functioning, resilience and flexibility of the wider cross-border hydrogen network by balancing geographically dispersed production and demand centres across Europe. This cross-border function was also recognised through the inclusion of UHS projects in the Union's latest PCI list.

Key takeaway for UHS

The challenges faced by hydrogen storage operators should therefore be considered with the same care and dedication as they are for hydrogen network operators, as they provide comparable system and cross-border benefits. UHS is not merely an ancillary part of the hydrogen value chain.

The need to consider Union-level de-risking support for hydrogen storage infrastructure has also been recognised in the ENTSOG/ENNOH de-risking report, which explicitly notes that the question of EU guarantees and de-risking frameworks for hydrogen storage should be further elaborated at a later stage. There is therefore a strong case for ensuring that future European de-risking frameworks explicitly include storage infrastructure alongside hydrogen transport infrastructure.

De-risking underground hydrogen storage investment

Different market phases require different de-risking measures

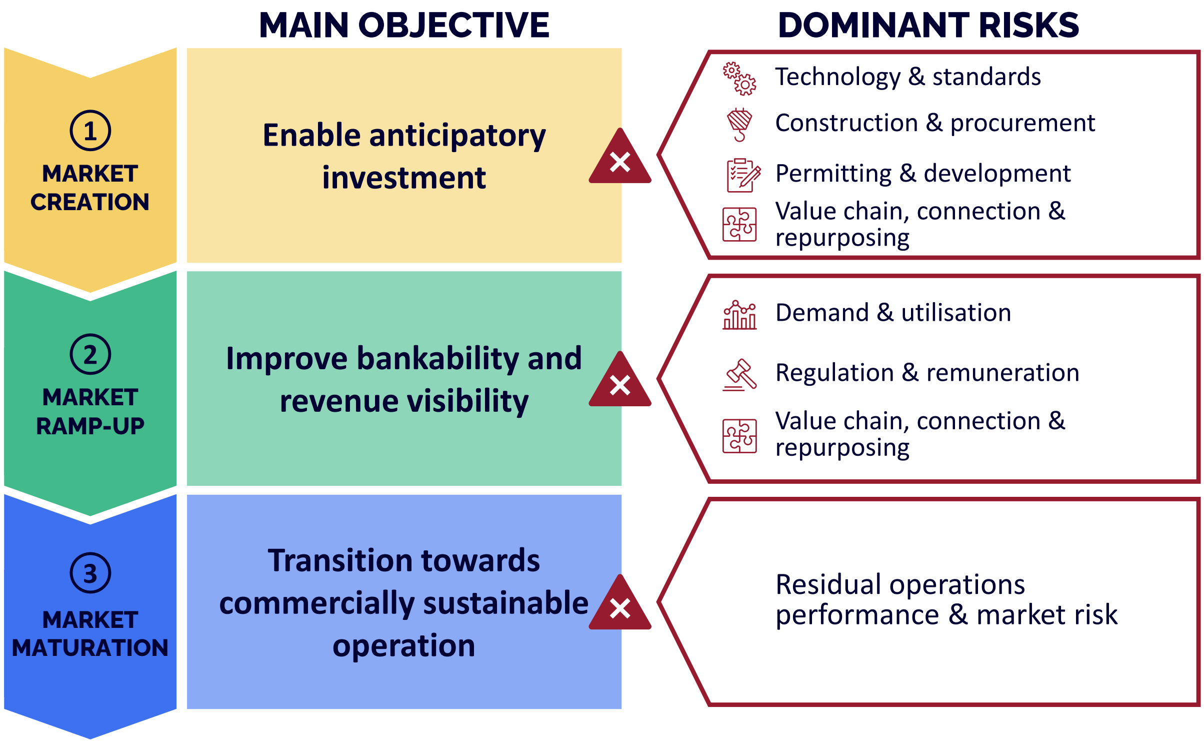
As set out before, hydrogen infrastructure projects in general and UHS projects specifically are exposed to a range of interrelated risks. The recent ENTSOG/ENNOH report highlights that no single mechanism is sufficient to address the scale and nature of the challenge associated with anticipatory hydrogen infrastructure investments. Effective de-risking frameworks therefore require a combination of regulatory support, financing mechanisms and targeted risk-sharing instruments.

Key takeaway for UHS
As the risks borne by UHS operators change as the market evolves, so should the instruments available to effectively and efficiently de-risk infrastructure investment and operation. ■ During the **early phases of market creation**, de-risking mechanisms are needed to **enable anticipatory investments** through creating a fertile market environment and alleviate utilisation risks. ■ In a **more mature hydrogen market** with established demand, higher utilisation and more stable commercial structures, support mechanisms may focus on **remuneration of societal benefits** not reflected in individual commercial relationships and can profit from the development of stable, transparent and predictable regulatory frameworks.

While the different phases reflect changing dominant risk profiles over time, de-risking mechanisms need to be introduced well before the respective market phase fully materialises. Given the long development timelines of hydrogen storage infrastructure, investment decisions and supporting frameworks need to be established ahead of market maturity. A sustainable and favourable market outlook is key to enabling investment decisions now.

Different de-risking instruments address different categories of risk and are therefore most relevant at different stages of hydrogen market development.

Figure 4 Dominant risks per market phases / main objectives of mitigation



Source: Frontier Economics for H2eart for Europe

Phase 1: Enabling anticipatory investment during market creation

In the early market creation phase, UHS projects face high uncertainty and weak visibility of commercial opportunities. Demand is still emerging, supply chains are developing and technical standards are not yet fully harmonised. Public intervention is therefore needed to help projects move from conceptual stages to a sufficiently mature development stage, where investment decisions can be made on a robust basis.

Member States play a central role in enabling early-stage UHS projects and reducing local project development risks. Administrative hurdles can be dismantled through speeding up permitting processes and supporting local infrastructure planning. Coordinating local industrial clusters can ensure that projects are developed in line with national energy, industrial and spatial planning priorities.

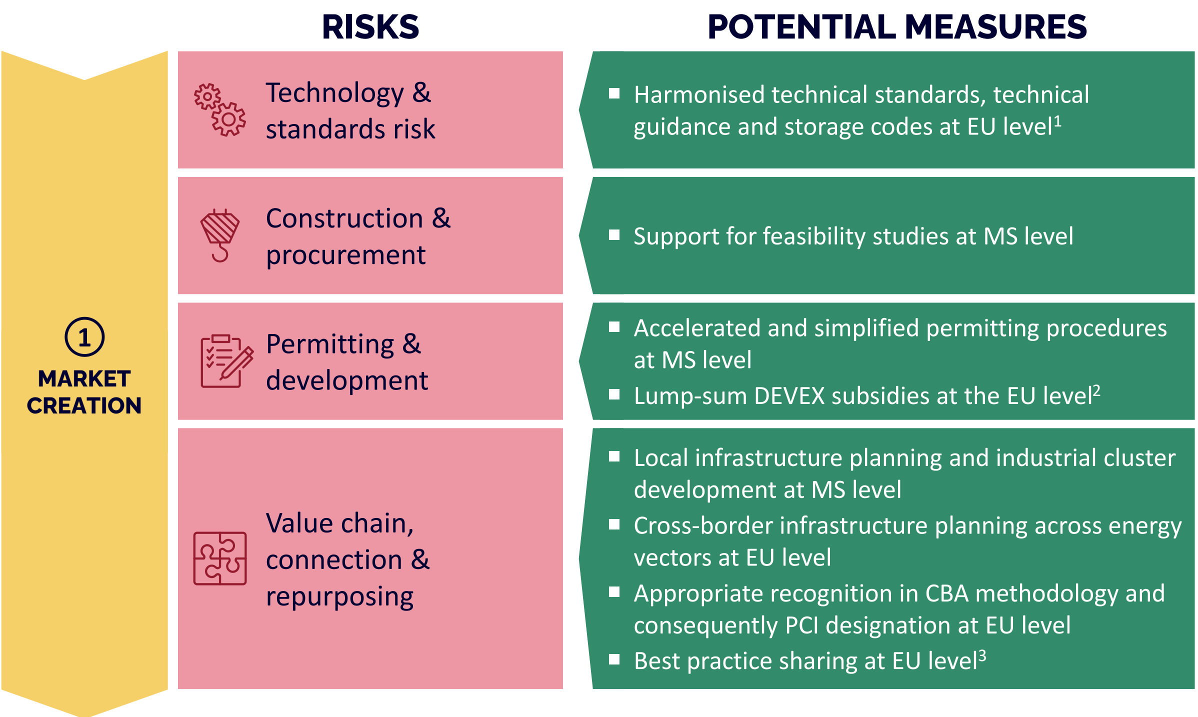
At the same time, Union-level intervention is particularly important where infrastructure development requires coordinated cross-border planning and harmonised technical frameworks. This is crucial in the case of UHS: the geographic location of storage sites is less flexible through its dependency on geological formations and may not align with future demand centres, national borders or pipeline routes. EU-level coordination can therefore help reduce fragmentation, support interoperability and ensure that projects with wider European system value are appropriately recognised.

Core objectives

- Reduce upfront investment barriers; support development expenditure.
- Enable project planning and dimensioning and enhance early project development;
- Support coordinated cross-border infrastructure planning, reducing fragmentation across Member States;
- Establish common technical and regulatory foundations.

Dominant risks addressed and measures associated with it

Figure 5 Key risks during Phase 1 – Market Creation



Source: Frontier Economics for H2eart for Europe

Note: [1] These should cover hydrogen purity and quality, pressure thresholds, connection procedures, materials, equipment and safety requirements, while considering the full value chain to ensure that standards are operationally feasible and cost-effective.
[2] Subsidies can help kick-start projects with long development lead times. However, subsidies alone do not resolve long-term volume risk and therefore need to be complemented by mechanisms that address residual market risk over time.
[3] EU institutions and infrastructure operator associations should support systematic best-practice sharing across Member States, including lessons from pilot projects, regulatory sandboxes, permitting processes and technical assessments. This would reduce duplication, build authority expertise and help accelerate permitting and project development.

Phase 2: Supporting market ramp-up and utilisation growth

In Phase 2, UHS projects move from early development towards financing, construction and commercial operation. At this stage, the main challenge projects face is whether they can secure sufficient and predictable revenues to support final investment decisions. This is particularly challenging for anticipatory infrastructure, where assets may need to be built ahead of corresponding demand to enable the wider hydrogen value chain to develop.

National de-risking frameworks can play an important role during the market ramp-up phase, particularly where hydrogen infrastructure development remains concentrated within individual Member States. These mechanisms together with the development of stable, transparent and predictable regulatory frameworks can help reduce early revenue uncertainty, support fixed cost recovery and improve bankability while demand and utilisation grow.

Low initial utilisation is an inherent feature of anticipatory hydrogen infrastructure, with demand expected to ramp up only gradually over time. Over common depreciation period timeframes, low initial utilisation may make the overall business case unviable, even where full infrastructure scale is required meet expected future market needs. De-risking frameworks should help address this risk by providing temporary revenue certainty while demand, supply and network utilisation ramp up.

Intervention at the Union-level may be necessary where national support frameworks do not fully reflect cross-border benefits. Underground storage sites depend on suitable geological formations and can therefore only be developed in a subset of Member States. Benefits of storage – including flexibility, resilience, security of supply and seasonal balancing – accrue across a wider European energy system. Without EU-level coordination or support, there is a risk that strategically valuable storage assets remain underdeveloped because the Member State hosting the asset cannot capture the full value it provides to neighbouring markets.

At EU level, mechanisms combining ICA and guarantees are therefore particularly relevant for cross-border hydrogen infrastructure, including UHS, because they can address both the initial revenue gap and residual long-term market risk. For storage, these mechanisms are relevant where high upfront investment costs arise before demand, utilisation and long-term system benefits are fully reflected in market revenues.

Core objectives

- Improve clarity on future revenue streams and bankability;
- Reduce revenue risks from low initial utilisation inherent to anticipatory cross-border infrastructure investment;
- Improve long-term bankability.

Dominant risks addressed and measures associated with it

Figure 6 Key risks during Phase 2 – Market Ramp-Up

② MARKET RAMP-UP

RISKS	POTENTIAL MEASURES
Demand & utilisation	**At MS level:** ▪ Revenue stabilisation mechanisms, including ▫ National ICA mechanisms[1]; Revenue based CfDs; State-backed volume and price guarantees; Long-term booking frameworks, anchor bookings, minimum booking commitments[2] ▪ Capacity remuneration mechanisms ▪ Tax incentives and accelerated depreciation schemes **At EU level:** ▪ EU-level ICA mechanisms combined with EU guarantees and SPV structures[3], ▪ long-term booking frameworks[4] ▪ Revenue based CfDs[5] ▪ Publicly coordinated and binding capacity allocation tenders
Regulation & remuneration	▪ Clarity on national implementation of tariff and contracting frameworks at MS level
Cross border interoperability risk	▪ Harmonised market rules, including Cross-border interoperability framework[6] ▪ Integrated capacity markets at the EU level

Source: *Frontier Economics für H2eart for Europe*

Note: *[1] Both MS and EU: Revenue-based CfDs or minimum revenue floors, potentially combined with clawback and amortisation account arrangements, could bridge the gap between market revenues and storage costs during the ramp-up phase while preserving scope for later cost recovery as utilisation increases.*

[2] At Member State level, long-term booking frameworks, anchor bookings and minimum booking commitments can help reduce volume risk by creating a baseline of committed demand. Where these mechanisms are sufficiently credible, they can improve revenue visibility, support bankability and help attract private financing through more predictable cash flows.

[3] ICA + EU guarantee would be particularly well suited for UHS because it can provide front-loaded support for capital-intensive storage investments, while allowing for later clawback as the market matures. It addresses the timing mismatch between high upfront costs and the longer-term system benefits that UHS provides. Its effectiveness depends on strong political commitment and a stable regulatory framework over time.

[4] Long-term bookings + EU guarantee can reduce volume risk by providing a baseline of committed demand. For UHS operators, this can improve revenue visibility and bankability, while an EU guarantee can provide additional protection against residual market risk in the early market phase. This may be particularly relevant as demand for long-term flexibility products develops.

[5] Revenue-based CfDs or minimum revenue floors, potentially combined with clawback and amortisation account arrangements, could bridge the gap between market revenues and storage costs during the ramp-up phase while preserving scope for later cost recovery as utilisation increases.:

[6] Capacity allocation and tender procedures should also allow for cross-border participation, including bilateral arrangements where users are geographically close to a storage site but located in another Member State.

Case study – UK's Hydrogen Storage Business Model

Context

The **Department for Energy Security & Net Zero's (DESNZ)** working assumption is that **state support is required for geological hydrogen storage to develop**.[4]

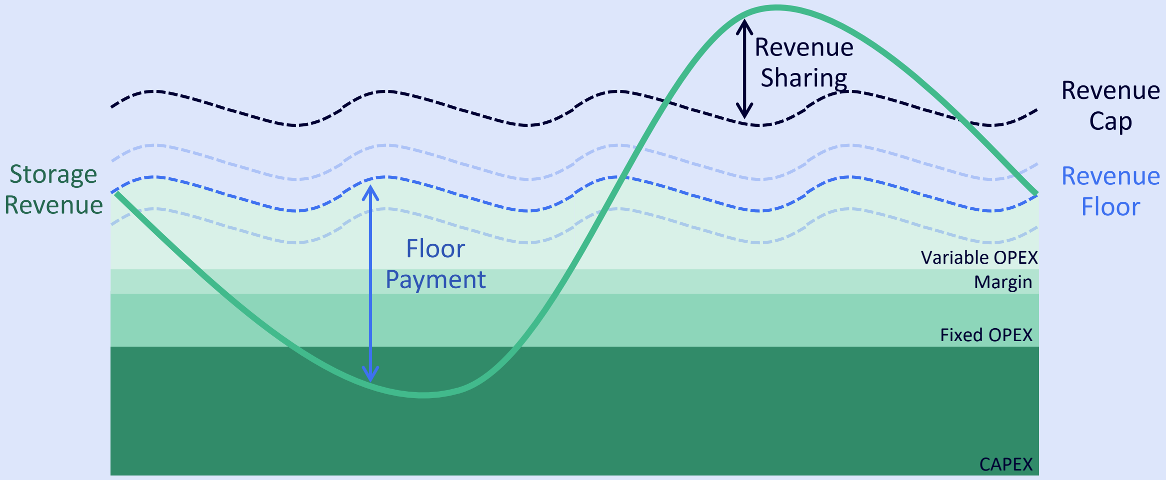
DESNZ therefore proposes targeted support for storage providers during the market ramp-up phase. The objective of this business model is not to replace the market, but to bridge the early investment gap until a more competitive storage market can emerge. For this purpose, DESNZ latest minded to position is that "the *most appropriate business model is a revenue cap and floor mechanism to be awarded via a subsidy competition*".[5]

How the mechanism works

The proposed mechanism is a **cap-and-floor contract**. The floor provides a minimum amount of revenue over an agreed period, regardless of user demand, provided the storage facility is available and marketed to users.

- The floor is expected to cover capital costs, including development costs, fixed operating costs and an allowed return, with variable operating costs treated separately based on metered injection and withdrawal.
- If revenues fall below the floor, the government makes a top-up payment.
- If revenues rise, the subsidy falls.
- If revenues exceed a certain cap, the storage operator shares the upsides with government through a gainshare mechanism.

The contract is expected to run for 15 years[6], with the floor and cap likely determined through bilateral negotiations in the allocation process.



Source for visualisation: Frontier Economics for H2eart for Europe, based on DESNZ visualisations.

Consideration of hydrogen system interdependencies

The UK approach also demonstrates the understanding that investment in hydrogen infrastructure elements cannot be derisked in isolation. Underground storage needs hydrogen flows, connected users and timely transport access. Transport networks, in turn, need storage to provide flexibility, resilience and system balancing.

In recent discussions, DESNZ has proposed a joint transport and storage competition. Under this approach, transport and storage projects would submit joint T&S bids, complete a single application form and jointly set out the strategic value of their proposed network. Each transport and storage project would still need to meet its own eligibility criteria, but the overall bid would be assessed as an integrated network rather than as two standalone assets.

Importantly, the UK approach may also look beyond storage and transport alone. Once projects have passed the eligibility stage, it has been proposed to introduce systematic assessment criteria for the T&S network. These could test whether the projects are supported by strategic demand and low-carbon supply, deliver whole energy system benefits, contribute to future hydrogen market development and, potentially, supports wider economic benefits. In practice, this could mean assessing whether the proposed projects are backed by credible offtaker demand and producer supply, whether these parties are sufficiently engaged and ready, whether commercial operation dates align, and whether the projects can expand to connect future production, offtake and storage sites.

The lesson for EU de-risking design is clear: During market ramp-up, each part of the value chain is bankable only if the others are delivered and used on time. De-risking mechanisms should therefore tackle system readiness, not simply asset readiness.

Phase 3: Transition towards a mature hydrogen market

As markets mature, Member State support should progressively shift from direct de-risking towards ensuring a stable regulatory environment and predictable investment conditions. At this stage, the role of public intervention changes. Rather than managing high uncertainty, support should focus on creating competitive conditions for UHS to be financed, accessed and used on a commercial basis.

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4 "**Geological storage in particular is key to the hydrogen economy and will not develop without government support**. As a result, we consider a hydrogen storage specific business model is necessary to ensure the timely delivery of geological hydrogen storage infrastructure", via DESNZ (2023): Hydrogen transport and storage infrastructure: minded to positions, via link.

5 DESNZ (2025): Hydrogen Update to the Market, July 2025, via link.

6 DESNZ has also raised whether operators should have the option to terminate the agreement early through a lump-sum payment. DESNZ (2023): Hydrogen transport and storage infrastructure: minded to positions, via link.

A mature hydrogen market does not necessarily eliminate the need for public support. UHS may continue to deliver wider system benefits, including security of supply, resilience, decarbonisation optionality and regional integration which may not be fully remunerated through user charges or bilateral contracts. Targeted public intervention may therefore remain justified where such benefits are material, clearly evidenced and not otherwise remunerated by the market.

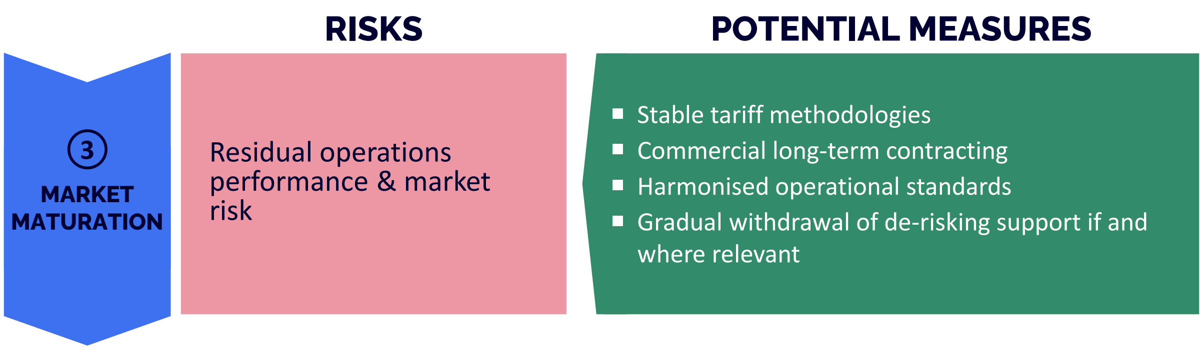
The transition away from more direct de-risking measures should be gradual and conditional on market development. Where demand, supply and infrastructure utilisation have reached sufficient scale, investors should increasingly be able to manage risks individually. However, premature withdrawal of support could weaken investment incentives, particularly where infrastructure continues to be built ahead of demand or where cross-border coordination remains challenging.

Core objectives

- Ensure stable regulatory implementation;
- Support transition towards market-based operation.
- Support the transition towards an integrated and commercially sustainable European hydrogen market.
- Create remuneration for wider societal benefits (security of supply / resilience)

Dominant risks addressed and measures associated with it

Figure 7 Key risks during Phase 3 – Market Maturation



Source: Frontier Economics for H2eart for Europe

Recommendations

Action is needed now to ensure that strategically necessary hydrogen storage infrastructure can be developed in time to support the European hydrogen market. Given the long development timelines of UHS projects, de-risking frameworks must be established ahead of market maturity, not once demand and utilisation are already visible.

Future hydrogen infrastructure de-risking frameworks should **recognise underground hydrogen storage as an integral part of the hydrogen value chain**. UHS should be considered alongside hydrogen transport infrastructure in European planning, risk-sharing and de-risking discussions, reflecting its role in enabling market integration, flexibility, resilience and security of supply across the future European hydrogen system.

A key precondition to favour investments is that regulated infrastructure operators, including UHS operators, should be shielded from risks they cannot manage and that are not reflected in their remuneration (e.g. volume or price risks).

Union-level action is required where storage infrastructure creates system-wide and cross-border benefits that cannot be captured within a single Member State. This does not necessarily require permanent subsidies: mechanisms such as intertemporal cost allocation, revenue floors with clawback, or EU-backed guarantees can be designed to provide early bankability while allowing public support to be recovered as the market matures.

As highlighted by ENTSOG/ENNOH and in our previous H2eart work, a wide range of potential instruments could potentially be employed to support this. These include:

- lump-sum support, like grants, fixed payments, CAPEX support, OPEX support or loans;
- performance-based subsidies, including
  - revenue-based subsidies linked to project revenues over a defined period,
  - unit price-based subsidies linked to a defined unit such as stored hydrogen, withdrawn hydrogen, booked capacity or available storage volume, and
  - tariff-based subsidies based on an agreed tariff, price or revenue level;
- Contracts for Difference, e.g. where support is paid when market revenues fall below an agreed level, with repayment when revenues exceed that level.
- premium-based support, provided as a fixed or percentage premium on top of market revenues;
- anchor bookings, which guarantee minimum capacity bookings or minimum revenues; and
- amortisation accounts, where early losses or under-recoveries are recorded and repaid over time.

These instruments are not mutually exclusive, nor is this list exhaustive. They can be combined to reduce early-stage demand, volume and revenue risk, while preserving incentives for efficient investment.

About H2eart for Europe

H2eart for Europe is an EU-wide, CEO-led alliance committed to accelerating the decarbonisation of the European energy system at lowest cost to society by scaling up underground hydrogen storage (UHS). Launched in Brussels on 23 January 2024, the alliance provides fact-based analysis to support policymakers and draws on the expertise of its members, leading companies shaping the future of hydrogen storage across Europe. We are committed to investing in UHS infrastructure to meet the flexibility needs of a decarbonised energy system.

The organisations listed below are the members of H2eart for Europe.

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