# CRITERIA FOR NATURAL GAS INFRASTRUCTURE REPURPOSING

## FINAL REPORT


european network
of transmission system operators
for gas

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# 1 INTRODUCTION

The compilation of this report was initiated by the conclusions of the 10th Copenhagen Energy Infrastructure Forum in June 2024: *'The Forum invites (pre-)ENNOH, ENTSOG and ACER, in collaboration with the relevant stakeholders, to develop and draft a set of criteria for the repurposing of infrastructure within the context of European infrastructure planning. The Forum invites the Commission to facilitate this activity by moderating the associated meetings. The Forum asks the parties to present the final report at next year's Forum.'*

**This report was written by ENTSOG and ENNOH. ACER has expressed their intention to react separately at the 2025 Copenhagen Forum. It considers repurposing of natural gas networks for hydrogen transport only; however, the co-authors acknowledge that repurposing for the transport of other molecules (such as $CO_2$ or other gases) as well as the repurposing of other infrastructure (e.g. storages and terminals) is possible.**

There are numerous advantages of repurposing existing infrastructure, such as substantially reduced costs, increased social acceptance, reduced environmental impact and a more efficient permitting process in comparison to the construction of new pipelines. It is beneficial to clearly outline these advantages and assess the criteria that should be considered for repurposing.

The scope of this report was defined by the European Commission to provide guidance and to outline boundaries for the two co-writing organisations as per the diagram below. In particular, aspects related to asset valuation and asset transfers fall outside the scope of this report and will be addressed in future workstreams, notwithstanding the fundamental role of such criteria to make repurposing practically possible. Indeed, repurposing of gas assets with a clear regulatory framework applied to the hydrogen sector can happen only if also hydrogen infrastructure operators have certainty that the regulatory conditions provide at least an equivalent degree of stability and financial attractiveness as the gas sector, including an appropriate guarantee of a fair transfer value.

**Included:**
Set of criteria for the repurposing of infrastructure within the context of European infrastructure planning within the boundaries of the current regulatory framework

- Content focuses only on the conclusion of previous Copenhagen Forum
- Encapsulates the thinking of planner when looking into answering to the future hydrogen needs

**Not included:**
Any regulatory issues that require a legislative transposition
(Tasks explicity allocated to NRAs/ACER)
+ individual views

- Determination of the asset base transfer
- Inter-temporal cost allocation
- Individual companies or stakeholder views
- Assessment of decommissioning of natural gas infrastructure

**Figure 1:** Scope and content to be develop by the report 'Criteria for Natural Gas Infrastructure Repurposing'

# 2 REPURPOSING INFRASTRUCTURE ASSESSMENT PROCESS

To address the needs of the energy transition, infrastructure system operators must currently make various investment decisions. One of these decisions is the costs associated with the possible integration of existing infrastructure into the future hydrogen grids. To develop efficient infrastructure and create resilient nascent markets, repurposing of existing infrastructure and new projects benefit from coordination between European companies and countries. In the following sections, a decision-making process and further assessment which lead to the repurposing activities are outlined.

The decision to repurpose existing natural gas infrastructure for hydrogen transport will be initiated as an integral part of the broader hydrogen network planning exercise. This process begins with a comprehensive hydrogen needs assessment, which evaluates expected supply and demand dynamics at both national and cross-border levels. This assessment of the hydrogen market should be both a systemic and asset-specific one, since it aims to respond to both overall hydrogen network development and local network needs. The outcome of this analysis will reflect the identification of critical infrastructure requirements, with particular emphasis on cross-border hydrogen transmission corridors necessary to support future EU market development and integration.

Following such needs assessment, a comparative analysis will be conducted between the desired hydrogen infrastructure and the existing natural gas network. This comparison will facilitate the identification of specific pipeline sections that may technically and spatially qualify for repurposing infrastructure to carry hydrogen. Only those segments that demonstrate alignment in terms of network topology and anticipated hydrogen flows will be considered viable candidates.

The second step of the process involves a robust, multi-dimensional screening of these pre-selected natural gas infrastructure elements. Each asset identified for potential repurposing must satisfy a set of clearly defined technical and operational criteria. These criteria include but are not limited to material compatibility with hydrogen, pressure tolerances, and system integrity under hydrogen-specific operating conditions. Once technical feasibility is established, a broader system-level analysis will determine if repurposing would adversely impact natural gas security of supply and system flexibility. Furthermore, the ongoing market integration objectives and which investments in the natural gas infrastructure would be needed to guarantee the service maintaining security of supply and market integration should be considered. This ensures that any transition to hydrogen does not unintentionally undermine the resilience or efficiency of the current energy system.

Ongoing or planned investments in the natural gas grid may influence the availability of capacity for repurposing. Therefore, infrastructure that becomes redundant or less critical due to these investments may, under the right circumstances, be more readily transitioned to hydrogen service. As a final and essential step, a detailed cost assessment of the repurposing effort when compared with newly built solutions will be conducted to support investment and policy decisions, accounting not only for capital and operational expenditures (including the potential investments in the natural gas sector), but also for the residual value of existing natural gas assets being transferred to hydrogen use. Regulation (EU) 2024/1789 foresees a network code on rules for determining the value of transferred assets and the dedicated charge from gas TSOs to hydrogen TNOs (HTNOs), which will be jointly developed by ENTSOG and ENNOH.

It is recommended that all criteria and assessment procedures outlined in this report be systematically applied during the repurposing process to ensure transparency, consistency, and alignment with long-term energy transition objectives. Reference should be made to the decision-tree diagram below for a structured overview of the proposed approach.

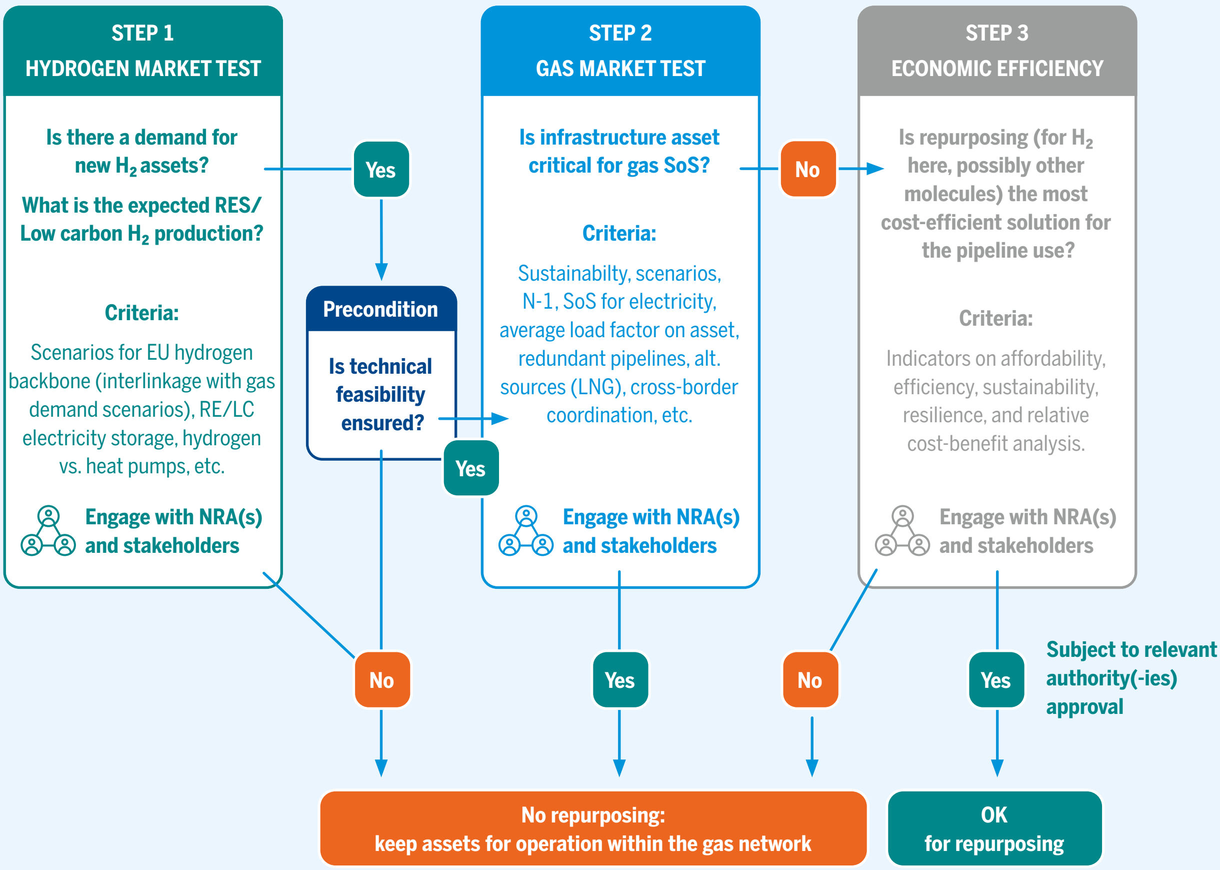


**Figure 2:** Representation of the repurposing infrastructure assessment process

In this repurposing decision tree, the hydrogen market test takes place before the gas market test. It implies that an assessment of potential gas assets that may be fit for repurposing will only be undertaken once the assessment on the hydrogen infrastructure concludes that there is a need for new hydrogen assets, especially in terms of renewable or low-carbon hydrogen production and injection. A third step to estimate the economic efficiency of repurposing can only commence if the gas market test determines that the potential gas assets are not critical for gas security of supply.

# 3 **REPURPOSING** CRITERIA

As Europe advances toward an integrated energy system in which hydrogen plays an important role, the repurposing of existing natural gas infrastructure emerges as a strategic and cost-effective option to accelerate the deployment of hydrogen networks and market.

However, this transformation requires a robust set of criteria to ensure that repurposing decisions are technically sound, do not compromise energy security, and support broader market and policy objectives. This chapter outlines the multi-step evaluation framework necessary to assess the suitability of existing gas infrastructure for hydrogen transport, encompassing technical feasibility, security of supply, and economic efficiency within the context of EU regulations and market integration principles. By doing so, it provides a structured approach for infrastructure operators (TSOs, SSOs, LSOs and HTNOs), regulators, and policymakers to make informed, future-proof decisions that align with decarbonisation goals and energy system resilience.

## 3.1 **TECHNICAL FEASIBILITY** AS PRE-REQUISITE FOR REPURPOSING

Though some early publications highlighted that significant technical barriers for repurposing might exist, recent studies show that adequate mitigation options exist for ensuring the techno-economic feasibility of repurposing most natural gas pipelines. Several studies and practical demonstrations show the capacity of the natural gas network to be used to transport hydrogen safely and reliably. According to the HyWay 27 study[1], most of the reports available in the literature show that the design factors used for high-pressure natural gas pipelines in Europe are in line with the design factors used for new hydrogen pipelines, as long as there is no fatigue issue and that the steel complies with the relevant specification. In practice, specific fatigue and engineering assessments should be considered, especially for high stress pipelines. Existing technical standards, such as EN 1584, the ASME, and national procedures for repurposing (e.g.: DVGW G409 (M), ÖVGW H E210 and NEN 3650), are based on the fulfillment of safety criteria, among others, as prerequisite.

1 https://www.hyway27.nl/en/latest-news/hyway-27-realisation-of-a-national-hydrogen-network

Due to the different physical properties of hydrogen compared to natural gas, some challenges exist when repurposing natural gas grid assets for the transport of hydrogen. The 2023 Marcogaz infographic[2] provides information on the current state of knowledge of transmission pipelines and their readiness to transport hydrogen. The information in this infographic is sourced based on the varied expertise and experience of network operators and other stakeholders of the value chain. The infographic focuses on material-related aspects and functional principles. The Marcogaz report in general highlights that many components of transmission networks are good candidates for hydrogen repurposing: positive results for repurposing were identified on steel pipelines, pigging stations and pressure regulators, among others. The report points out the need for significant modifications or replacements for process gas chromatographs, and turbine gas meters.

Regarding valves, the latest developments mostly show that the conversion of valves is feasible. For filters, pre-heaters, and gas relief valves, the available information on hydrogen impact is found to be insufficient. Technical adjustments, transformations or replacements of existing components and procedures should be taken into account in the planning phase.

Some challenges related to hydrogen and examples of technical adaptations are listed in the table below. Although technical challenges are identified, these are controllable to a degree so that they do not become insurmountable obstacles.

| Properties of $H_2$ compared to NG | Effect | Technical Adaptation |
|---|---|---|
| **Lower density and volumetric calorific value** | The same volume transported has lower energy content | To fulfill capacity requirements, either the pressure, when operating pressure is below maximum operating pressure, or the flow velocity can be increased. Equipment such as metering devices, compressors etc. may require adaptation. |
| **Smaller molecular size** | Increased risk of hydrogen emissions | Equipment that minimises or eliminates hydrogen emissions should be used according to standards, which should be designed to strive for a good cost-benefit balance in order to avoid excessive costs with minimal climate protection benefit. |
| **Higher potential for embrittlement** | Faster propagation of existing defects, risk of leaks and reduced ductility of steel pipelines with consequent reduced level of pressure cycling | Monitoring the integrity of pipelines can reduce or eliminate risks to the infrastructure. Systems to control pressure fluctuations may be needed. |
| **Wider flammability range and lower ignition energy** | Hydrogen ignites more easily than natural gas | Existing safety protocols, operating instructions and pipeline maintenance procedures to be adapted to hydrogen. |

**Table 1:** Technical adaptations for hydrogen transport

2 https://www.marcogaz.org/wp-content/uploads/2023/10/20231002-H2-Infographic-2023-Version-Revised-Final-draft-02102023-1.pdf

Some TSOs already have carried out activities to assess their networks' readiness for repurposing, with some also having commenced repurposing activities and hydrogen filling. Other TSOs are currently undertaking or planning such assessments. It is important that TSOs develop their own processes to assess the technical feasibility of repurposing as existing networks differ regarding their prerequisites. Indeed, due to the absence of a universally recognised approach for repurposing, case-specific technical and safety assessments should be considered.

Furthermore, the formal suitability of pipelines is subject to the applicable rules that can differ between EU Member States. It is important that Member States maintain autonomy to utilise the standards, depending on their own circumstances and rules in place (e.g. technical, safety, environment, etc.).

Picture courtesy of GAZ-SYSTEM

## 3.2 SECURITY OF SUPPLY

Maintaining and enhancing security of energy supply is one of the key objectives of the European Union's energy policy, along with decarbonisation, diversification and market transparency, e.g., REPowerEU Plan published in 2022[3].

The regulatory context relevant for repurposing of gas grids to hydrogen infrastructure is set by Reg. (EU) 2017/1938[4], further referred to as the 'SoS regulation' and by Reg. (EU) 2024/1789[5] on internal markets for renewable gas, natural gas and hydrogen.

**The SoS regulation mentions three elements:**

- **The infrastructure standard**[6]**:** the 'N-1' rule quantifies the ability of the technical capacity of the gas infrastructure to satisfy gas demand in the event of disruption of the single largest gas infrastructure (SLID) during a day of exceptionally high gas demand, with a statistical probability of occurrence once every 20 years. This measurement shall be done on a national level or in collaboration with neighboring MSs, in case of a SLID of common interest to the risk group identified in the risk assessment.
- **The gas supply standard**[7] is defined in the regulation as guaranteeing supply to protected customers during:

  a. periods with extreme temperatures, during a 7-day peak period occurring with a statistical probability of once in 20 years or

  b. up to 30 days of exceptionally high gas demand, occurring with a statistical probability of once in 20 years or

  c. for a period of 30 days in the case of disruption of the single largest gas infrastructure under average winter conditions.
- **Risk assessment**[8]: national and common risk assessments at the risk group level taking into account the Union-wide SoS simulation completed by ENTSOG every (at least) 4 years. Risk groups should be formed based on the main gas supply sources and routes[9].

As defined in the Report on the Gas Security of Supply Regulation (EU) 2017/1938 conclusions[10], the SoS regulation is not yet sufficiently developed to include renewable and low carbon gases such as hydrogen. Renewable and low carbon gases will be subject to extension of relevant SoS provisions to integrate hydrogen. External stakeholders highlighted the importance of close cooperation between national and European authorities, as well as between the hydrogen and the gas market to ensure safe security of supply for both areas.

3 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483

4 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32017R1938

5 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202401789#art_15

6 Article 5 of the SoS regulation

7 Article 6 of the SoS regulation

8 Article 7 of the SoS regulation

9 Recital (12) of the SoS regulation

10 eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0572

The following statement is part of the Report on the Gas Security of Supply Regulation (EU) 2017/1938: *'The increasing development of renewable and low carbon gas, including biomethane and hydrogen, as well as the increasing electrification of the energy system are essential elements that will need to be taken into account in any future development of the security of supply legal framework to ensure the security of gas supply and to support the decarbonisation objectives of the EU.'*

Future developments of security of supply in this direction will be considered in the proposed security of supply criteria for repurposing infrastructure process.

Requirements from Reg. (EU) 2024/1789 of relevance to repurposing activities refer to storage[11]: any cessation of activity of a storage facility should not reduce security of supply at Member State or EU level. A dedicated security of supply assessment must be performed by the corresponding National Regulatory Authorities (NRAs) or other designated competent authorities and must consider the opinion of ENTSOG.

11 Article 15 (11) of Reg. (EU) 2024/1789


Picture courtesy of Gasunie

Repurposing of existing natural gas infrastructure to transport hydrogen is expected to play a significant role in developing the European future hydrogen infrastructure. Operators should plan in a coordinated and transparent manner, ensuring that natural gas security of supply is neither compromised nor reduced significantly, and should always apply regulatory requirements.

Complementing the analysis carried out at national/regional level, an EU-wide security of supply assessment on the impact of repurposing should be undertaken. **This analysis in the context of natural gas security of supply should evaluate the long- and medium-term impact of repurposing under different assumptions such as:**

- **Climatic stress cases** (e.g. peak, 2-week cold spell or Dunkelflaute)
- **Infrastructure disruptions** (e.g. single largest infrastructure disruption)
- **Supply disruptions** (e.g., S-1 or disruption of natural gas supply source[s])
- **Contrasting demand and supply mid- and long-term scenarios**

## 3.3 **ECONOMIC EFFICIENCY** (COST ASSESSMENT AND MARKET INTEGRATION)

**An economic efficiency assessment** starts with a relative cost evaluation considering both natural gas and hydrogen and specifically comparing the configuration that includes a repurposed pipeline. This assessment should include all the related investments in the gas sector to ensure service continuity, with the configuration that implies building a new pipeline. Elements useful to proceed with the cost assessment comparison can be found in the following (not exhaustive) list:

- Convenience which encompasses all efforts and costs which are necessary to repurpose compared to those when building new infrastructure (e.g. time spent to realise the project based on permitting and long-lead items, public acceptance, etc.).
- Scenarios of future demand estimates should be covered via anticipatory investments which cater for higher volumes to be transported, like expected in the electricity market.
- Taxonomy might provide different possibilities concerning the support on funding from the EU and the MSs.
- The given setting (e.g., in terms of location and diameter of the pipeline) of existing natural gas pipelines in comparison to the flexibility of newly built hydrogen pipelines should be taken into account.

The objectives of the European gas market integration are multifaceted and aim to create a more efficient, competitive, and secure energy market. Here are the **key objectives** considered in this report as useful for serving as criteria both for gas asset repurposing and for hydrogen assets:

- **Enhance Market Liquidity:** By integrating markets, the European gas (or hydrogen) market aims to improve liquidity, making it easier for gas (or hydrogen) to be traded across borders.
- **Increase Competition:** Integration fosters competition among suppliers, which can lead to better and more reliable prices and services for consumers.
- **Efficient Infrastructure Utilisation:** Integration promotes the efficient use of existing infrastructure, reducing costs and improving the overall efficiency of the gas and hydrogen markets.
- **Promote Renewable and Low-Carbon Gases:** The integration process also aims to facilitate the transition to renewable and low-carbon gases for gas or hydrogen sectors, supporting the EU's decarbonisation goals.

These key objectives support an affordable, sustainable and resilient energy infrastructure development. Grid repurposing from natural gas to hydrogen might have an impact on market integration for both natural gas and hydrogen. However, there could be negative impacts on the natural gas side when addressing the need to repurpose or not to repurpose.

The following indicators – of which some have been used ex post in ACER's Market Monitoring Reports – are considered as being supportive of an **ex-ante assessment** (with the appropriate assumptions) on how market integration in the natural gas sector might be affected by asset repurposing, both for the currently mature gas market and the nascent hydrogen market.[12]

## Affordability:

The **Level of Wholesale Price (LOWP)** will show which impact repurposing is expected to have on the commodity price on the wholesale markets. **Price convergence indicators** would compare the anticipated wholesale prices for a specific hub for a certain period (e.g., one year) for both the repurposing and the non-repurposing cases, or rely on a simple but widely used indicator, the Pearson correlation coefficient (noted 'r'), which measures to which extent variations in one indicator are correlated in a linear manner to variations in another indicator.

## Sustainability:

The **Existing Infrastructure Utilisation (EIU) for Year Y**, as the anticipated share (in %) of the length of hydrogen pipelines (in km) which comprises repurposed gas pipelines in Year Y, could be used as an indicator to measure and demonstrate the sustainable use of resources (e.g. material, time, money). This indicator works for the hydrogen market only. The **Development of renewable and low carbon (DRELC)** gases for Year Y (including hydrogen) is an indicator of the impact of repurposing assets on the anticipated quantity of renewable and low-carbon gas injected into the natural gas network (to be annually reported ex-post per Art. 26(3)(i) Reg. (EU) 2024/1789).

***Remark:*** It is also of importance to safeguard the market integration of different regions/countries into the Single Market. Repurposing should not come at the cost of significantly limiting the Single Market access for a country, even if security of supply is not put at risk when repurposing the cross-border infrastructure. External Stakeholders identified the mechanisms of the Level of Wholesale Price (LOWP) and the Development of renewable and low carbon (DRELC) as the most useful to fulfil the purpose of economic efficiency along the entire supply chain.

12 It should be noted that such criteria would be immediately applicable for the mature gas market, while their relevance for the hydrogen market would only gradually appear. Indeed, in early years, it is unlikely that a criterion such as price convergence would make sense for the emerging European hydrogen market.

## 3.4 STAKEHOLDER ENGAGEMENT

To fulfil the requirement of the Forum Conclusions, that the criteria should be developed in collaboration with relevant stakeholders, it was proposed to undertake stakeholder engagement as part of the criteria development process, before finalisation of this report.

The first stage of stakeholder feedback and engagement was taking place at the 11th Energy Infrastructure Forum in Copenhagen in June 2025. This was followed by request for feedback from identified relevant stakeholders. This feedback was duly considered before finalising the report. Further details are outlined below in the 'Next Steps' section.

### Post-Energy Infrastructure Forum 2025 outcomes

Repurposing of natural gas infrastructure for hydrogen transport is a process involving different actors at different stages of development. Therefore, engaging with those actors is important when developing the overall repurposing process at country or regional level, as well as, for specific repurposing projects with full consideration of TSOs' statutory obligations.

To achieve this goal, infrastructure operators will need to engage throughout the process to ensure continuous exchange between relevant actors. It should be noted that support from governments, regulatory and permitting authorities is needed to enable the public to play a constructive and informed role. In order to develop the transition successfully, dedicated stakeholder forums, clear regulatory guidance, and technical documentation would be considered the most helpful.

Picture courtesy of Gasunie

# 4 CONCLUSIONS & NEXT STEPS

The described process, whether to repurpose existing or to build new infrastructure to transport hydrogen, represents just one possibility to be considered by relevant competent authority(ies) within the Member States for the needed flexibility during the planning process.

**The identified criteria to reach a decision are:**

- **Technical feasibility and safety** as a prerequisite,
- **N-1 and S-1** for security of supply,
- **Economic efficiency** via cost assessment and market integration indicators (level of wholesale prices, price convergence, existing infrastructure utilisation and development of renewable and low-carbon gases) and
- **Engagement** of the relevant stakeholders

The dedicated workshop for targeted external stakeholders has been held on the 18th September. The feedback was taken into account and the report was supplemented where necessary. In the following, the report will be published. The findings will be taken into account into the TYNDP 2026, as requested in the 11th Energy Infrastructure Forum in Copenhagen in June 2025. The final results on this inclusion will be presented in the 12th Energy Infrastructure Forum in Copenhagen in 2026.


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