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Pipeline Regulation for Hydrogen: Choosing Between Paths and Networks

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The transition toward a low-carbon economy, including the expansion of hydrogen pipeline infrastructure, will be shaped by the regulatory frameworks which govern investment and access conditions and ultimately structure commodity trading. This paper assesses the possible market design for hydrogen infrastructure, assuming the application of unbundling requirements. For this purpose, it focuses on the scope of application of regulation, which can be set to individual pipelines or to entire networks. The paper develops a general economic framework for regulating pipeline infrastructure, comparing the regulation applied to natural gas transport markets in the US and EU. Based on these regimes, the paper draws lessons for a regulatory framework for hydrogen infrastructure in the EU, establishing the main building blocks of a target model.

There are three characteristics that should be taken into account as part of a regulatory framework for pipelines. First, the cost structure of these assets, which gives rise to a spectrum of industry structures ranging from natural monopoly characteristics to conditions that permit competition, and renders monopolies potentially contestable. As a result, regulation is necessary to curb market power, using instruments that range from light-touch regulation to more stringent forms of revenue and cost control.

Second, pipeline investments are capital-intensive and highly specific to particular uses and locations, making them difficult to repurpose or redeploy. This asset specificity exposes investors to opportunistic behaviour or hold-up risk, which can hinder cost recovery once the infrastructure is in place. Long-term contracts, vertical integration, or state-backed guarantees are often required to mitigate these risks, particularly those related to uncertain future demand.

Third, policies enabling competition across segments of the value chain (e.g. wholesale and retail) require ensuring a non-discriminatory rules for accessing the

infrastructure. In many industries, reforms have aimed at opening access to infrastructure as a means to enabling competition across segments of the value chain. This has allowed companies to use the same pipelines. For this purpose, third-party (TPA) requirements are applied to pipelines in different forms that range from negotiated TPA to more extensive regulated TPA requirements.

Unlike electricity or telecommunication systems, where the physical characteristics of the commodity impose a network structure, pipeline paths can be contracted point-to-point. This flexibility means that regulation does not have to apply to entire systems; instead, it can focus on the part of the system that holds monopoly power, whether a single pipeline or an entire network.

The decision to apply regulation at the level of individual pipelines or entire networks also influences how the transported product – such as hydrogen – is bought and sold. If regulation applies to entire networks, it enables more flexible, market-based trading, similar to how gas is traded through virtual hubs in Europe today. This makes the commodity easier to buy and sell, increases market competition, and improves overall trading efficiency.

Regulating entire pipeline networks is often justified in contexts where high market concentration allows dominant players to restrict access or where entry barriers hinder the development of market liquidity and competition. In such cases, network-wide regulation helps address market power and overcome obstacles that limit the functioning of competitive markets. This approach has been supported by the European Commission (EC), which considered natural gas networks – not just individual pipelines – as essential facilities the access to which was necessary to enable effective market competition. By contrast, in the US, the essential facility doctrine has been interpreted more narrowly. US regulators have generally not considered pipelines as essential facilities where alternative routes exist, even if these alternatives are less competitive.

At the same time, this regulatory choice comes with significant trade-offs. Granting exclusive rights to operate the entire network introduces a regulated monopoly, which can diminish the performance and efficiency of pipeline services. For instance, regulating entire networks typically increases the overall capacity needed to transport the same volume of gas, weakens investment signals, and eliminates the possibility of competition between individual pipelines. It also necessitates the role of a central planner and often involves socialising investment risks across all network users.

More broadly, the choice between regulating individual pipelines or entire networks reflects a trade-off between static (or allocative) efficiency and dynamic (or productive) efficiency. While short-term access requirements may benefit consumers by enhancing competition and lowering prices (i.e., improving static efficiency), they can also reduce the incentives for private investment in new infrastructure, thus harming dynamic efficiency and competition in the long term. In the EU, the decision

to regulate entire networks was made in a context where most of the infrastructure had already been built before liberalisation and required only limited additional investments. In contrast, applying this model to a nascent sector with significant capital requirements, such as hydrogen transport, raises fundamental questions about whether network-wide regulation remains appropriate.

Two Regulatory Designs for Hydrogen Infrastructure

This paper identifies two possible regulatory options for hydrogen based on a comparative analysis of the US and EU regulatory framework for pipelines:

- Option 1: Pipeline-level regulation with negotiated third-party access (TPA), supported by light-touch oversight – drawing inspiration from the US model.
- Option 2: Network-wide regulation with mandatory regulated TPA and entry-exit (E/E) market zones – extending the EU natural gas model to hydrogen.

Market Attributes Guiding the Choice of Regulatory Design

The suitability of each regulatory option depends critically on how hydrogen market characteristics develop. This paper identifies attributes supporting the application of negotiated TPA applied at the level of individual pipelines (Option 1).

First, the cost function of green hydrogen suggests lower market concentration compared to the early EU natural gas sector. The share of fixed costs in green hydrogen production is lower compared to large natural gas production fields. This reduces the risk of monopolistic behaviour and market foreclosure, weakening the rationale for treating hydrogen infrastructure as essential facilities requiring network-wide regulation.

Second, green hydrogen production can be decentralised and is subject to large locational flexibility. Green hydrogen can be produced in multiple locations directly connected to RES generation or coupled with electricity networks. A negotiated TPA regime allows greater flexibility when developing infrastructure in addition to enabling competition between electrolysers and demand locations in addition to transport routes.

Third, retail competition is expected to be less relevant in the hydrogen sector compared to the liberalised EU gas market. Hydrogen demand will largely come from industrial consumers requiring CAPEX-intensive, site-specific investments, which, according to transaction cost economics, requires long-term contracts to secure commodity purchases and infrastructure use. This industrial demand structure supports negotiated TPA at the pipeline level rather than network-wide access obligations.

Fourth, barriers to liquidity such as those encountered in the EU natural gas sector are not expected in the hydrogen sector. Extensive network-wide regulation to promote liquidity is less justified. This is particularly the case given the high

infrastructure costs of such approach, which can challenge the competitiveness of hydrogen.

Fifth, network planning is even more critical in hydrogen markets, as infrastructure must be built from scratch. Preserving strong, granular (locational) investment signals is essential to avoid potentially stranded assets and support efficient development. A network-wide model risks distorting real cost differentials, weakening investment incentives, and leading to inefficient capital allocation – particularly as hydrogen competes with alternatives like electrification and renewable gases.

Finally, the role of hydrogen in the overall energy system is currently subject to great uncertainty. While hydrogen can perform many functions, it faces many alternative vectors. Hydrogen can be used in multiple sectors which results in multiple business cases, some of which will not be economical. In addition, the role of hydrogen in sector coupling and the role of hydrogen storage remain uncertain. The development of infrastructure based on regulated network risks imposing top-down configuration and uses of hydrogen which will not be competitive in the future. A bottom-up approach based on negotiated TPA allows a more granular development building on market dynamics to determine the future roles of hydrogen. This approach can be supported by policy initiatives without recurring to network level regulation.

Therefore, based on current expectations, hydrogen demand will likely remain concentrated in niche industrial applications rather than achieving widespread cross-sectoral adoption. The promotion of green hydrogen in the EU as part of decarbonisation efforts supports the development of point-to-point infrastructure instead of a fully interconnected EU infrastructure, similar to the EU electricity and gas markets, which was intended to enable single market prices across zones at national level. This reinforces the case for a cautious, incremental infrastructure development path through negotiated TPA at the level of individual pipelines. Starting with a decentralised, asset-level regulatory model offers a no-regret strategy by preserving flexibility to evolve toward broader infrastructure coordination while minimising dynamic inefficiencies and avoiding institutional lock-in.

EU Regulatory Framework for Hydrogen Infrastructure

This paper examines the current EU regulatory framework for hydrogen under these observations. The EU legislation for hydrogen infrastructure is established in the Hydrogen and Decarbonised Gas Market package, which aligns with Option 2 presented in this paper. This legislative package extends principles from the Third Energy Package – initially developed for the natural gas sector – such as regulated TPA and the entry-exit network model to the emerging hydrogen market. While negotiated TPA is permitted as a transitional measure, regulated TPA is expected to become mandatory from 2033 onwards. The suitability of this approach is open to

question given the significant differences between the mature EU gas sector before liberalisation and the nascent hydrogen sector today.

In the current stage of development, green hydrogen remains largely uncompetitive compared to alternative forms of production (i.e., steam methane reforming). Policy instruments, such as European Hydrogen Bank auctions, H2Global, the EU Emissions Trading System (ETS), and the Carbon Border Adjustment Mechanism (CBAM), may narrow this cost gap but are unlikely to eliminate it during the early development phase. As a result, the relatively high price of green hydrogen will limit demand growth, making it difficult for the market to justify investments in dedicated hydrogen infrastructure, particularly in pipelines.

In the case of natural gas, legacy long-term contracts helped mitigate the 'volume risk' associated with infrastructure investments – that is, the risk that insufficient commodity volumes would flow through pipelines to recover capital costs. These long-term contracts were underpinned by pricing formulas (e.g., oil indexation or netback pricing) that mitigated price risk, ensuring commodity competitiveness. By contrast, in the case of hydrogen, the market can only manage such volume risk once green hydrogen becomes price competitive.

Until then, infrastructure development must be justified primarily based on public policy objectives, particularly decarbonisation. This will require proactive state intervention not only to support the commodity but also to facilitate infrastructure build-out.

The provision of guarantees by EU Member States for building hydrogen infrastructure can facilitate the development of the hydrogen sector. However, mitigating the volume risk associated with this infrastructure means that the infrastructure built may not be fully utilised in the future, and could become stranded.

Regulated third-party access (TPA) was initially introduced in the EU gas sector to foster competition in a market dominated by quasi-monopolies and high upstream concentration. In the context of hydrogen, the same regulatory framework is being used; however, the objective here is to develop greenfield infrastructure that accompanies the development of nascent demand uses for hydrogen. TPA is being used very differently as a scheme to channel public support to mitigate the risk associated with this infrastructure. This paper argues that the goal of supporting hydrogen infrastructure development does not, in itself, require the establishment of regulated monopolies over entire networks.

Adopting Option 1 offers a no-regret strategy for the development of the EU hydrogen sector. It allows infrastructure development to respond to actual market signals, preserves investment discipline, and maintains the flexibility to adapt if hydrogen's role expands dramatically. If market attributes result in persistent barriers to access and a lack of liquidity, features of Option 2 could be considered.

Policy Recommendations

This paper recommends reviewing the EU regulatory framework for a hydrogen market that is expected to become increasingly mature. It recommends shifting away from the planned application of regulated TPA to entire hydrogen networks, as proposed in the Hydrogen and Decarbonised Gas Market Package, for implementation by 2033. Instead, the regulatory model should centre on:

- The application of regulation to individual pipelines rather than entire networks,
- A more significant role for long-term capacity contracts to underpin investment and
- The use of negotiated TPA supported by light-touch regulation and market-based coordination mechanisms for infrastructure access.

While challenges remain in fully replicating the US regulatory model to the EU, some aspects of the US approach offer valuable insights. These include using market mechanisms to allocate short-term access to infrastructure and light-touch regulation to address potential market power in the provision of incremental capacity. Moreover, past EU experiences with negotiated TPA and pipe-to-pipe competition offer useful precedents that should inform the development of a fit-for-purpose hydrogen regulatory model.

Ultimately, the regulation of hydrogen infrastructure should be complemented by a framework of investment rights that incentivise long-term commitments – drawing inspiration from aspects of the US regulatory regime – to ensure infrastructure development aligns with market needs and policy objectives.

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