ERRA 25 Years of Regulatory Cooperation

# HYDROGEN Market Design and Regulatory Models


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**In cooperation with**
**ERRA Gaseous Fuels Markets & Economic Regulation Committee (GF COM)**



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# HYDROGEN - MARKET DESIGN AND REGULATORY MODELS

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# TABLE OF CONTENTS

## List of Figures

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This research paper reflects inputs from the 16 following member organizations of the ERRA Gaseous Fuels Markets and Economic Regulation Committee (referred to as GF COM):

| EU | | Non-EU | |
|---|---|---|---|
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## EXECUTIVE SUMMARY

Hydrogen has become a key element in long-term decarbonisation plans across Europe and beyond. Its strategic importance stems from its unique ability to connect electricity, gas, and industrial systems, making it a versatile, storable, and multi-sector energy carrier. Besides supporting the integration of renewable electricity, hydrogen provides one of the limited options for decarbonising hard-to-abate sectors, making it both an environmental tool and a catalyst for industrial transformation and energy security.

The European energy crisis further boosted hydrogen's importance. High fossil-fuel prices revealed the structural weaknesses of energy-heavy industries and emphasised the limitations of short-term subsidy-based solutions. In this context, hydrogen has increasingly been viewed not only as a decarbonisation option but also as a strategic tool for maintaining industrial activity, developing new value chains, and strengthening long-term economic resilience.

To evaluate regulatory preparedness and future outlooks, ERRA administered a structured questionnaire to its member regulatory authorities, receiving responses from sixteen countries. The survey offers insights into the current state of hydrogen regulation and regulators' expectations for future market design, infrastructure, and governance.

The findings suggest that most ERRA jurisdictions are still in the early phases of developing the hydrogen market. Formal regulatory frameworks are mostly missing, infrastructure planning is limited, and essential tools such as tariff methodologies, unbundling requirements, and certification systems are either still under development or not yet planned. In cases where more advanced frameworks are noted, these are mainly seen in European Union (EU) member states and are primarily influenced by the EU acquis, which already sets out common standards, regulatory principles, and a long-term vision for hydrogen markets. In these instances, national progress mainly reflects alignment with EU legislative and policy initiatives rather than solely domestic regulatory design.

Several common themes emerge from the responses. Green hydrogen dominates long-term strategic thinking, while some countries consider low-carbon hydrogen a potential transitional solution. Regulators widely favour phased and adaptive regulatory approaches, including temporary exemptions, regulatory sandboxes and gradual tightening of obligations as markets mature. Views on market structure remain diverse: some jurisdictions allow hydrogen blending into existing gas networks, while others envisage hydrogen development occurring mainly through decentralised, project-specific or industrial-cluster-based applications.

Investment conditions and cost recovery are identified as critical enablers. Respondents highlight the importance of transparent tariff methodologies, predictable public support mechanisms, and regulatory tools to mitigate stranded asset risks. Governance frameworks are still evolving, but there is growing recognition that consumer protection will become increasingly relevant as hydrogen is integrated into broader energy systems.

The survey highlights an opportunity for regulators to guide hydrogen markets to promote innovation, ensure investment security, improve market efficiency, and support long-term system integration. Initial regulatory decisions, especially on infrastructure access, cost-sharing, planning requirements, and certification, will significantly affect the viability and competitiveness of future hydrogen markets. By integrating questionnaire data with global regulatory standards, this paper offers a structured analysis to understand market design, evaluate investment prospects, and clarify the future role of regulators in hydrogen markets.

# INTRODUCTION

Hydrogen has rapidly transitioned from a niche industrial input to a key element of global and European energy transition policies. Historically, hydrogen has been used primarily as a chemical feedstock, particularly in refining, fertiliser production, and the manufacture of industrial chemicals. In recent years, however, it has increasingly been considered an energy carrier capable of linking the electricity, gas, and industrial sectors. Its rising prominence reflects a merging of technological, economic, and systemic factors that have transformed how policymakers, regulators, and market participants view the future of energy systems. Unlike other low-carbon options, hydrogen occupies a distinctive position at the intersection of the electricity, gas, and industrial sectors, enabling new forms of system integration, flexibility, and decarbonisation.

The increasing deployment of variable renewable energy sources, especially wind and solar, has fundamentally changed power-system dynamics. As the share of these sources grows, generation patterns become more unpredictable and less tied to real-time demand. This has resulted in increased renewable curtailment across many power systems, with economic and operational impacts. In this context, hydrogen offers a means to convert surplus renewable electricity into a storable and transportable energy carrier, thereby enabling more efficient use of renewable resources and facilitating the integration of variable generation into energy systems.

Beyond its role in electricity-system integration, hydrogen is emerging as one of the few viable decarbonisation options for hard-to-abate sectors, including steelmaking, chemicals, refining, heavy transport, and high-temperature industrial heat. In these applications, electrification alone is often insufficient due to technical, economic, or process-related constraints. Hydrogen, therefore, functions as a complementary energy carrier, addressing residual decarbonisation gaps left by electrification. Over time, as cost trajectories improve and economies of scale are realised, hydrogen may evolve from a complementary solution into a competitive substitute for fossil-based fuels in selected industrial and mobility applications.

In the European context, hydrogen's strategic importance has been further strengthened by recent energy-market disruptions, which revealed structural weaknesses in energy-intensive industries and underscored the limitations of short-term policy measures. Consequently, hydrogen is increasingly seen not only as a climate solution but also as a tool for industrial transformation, competitiveness, and energy security. This change is reflected in a growing array of European policy and legislative initiatives that outline a long-term vision for hydrogen markets, value chains, and infrastructure development.

Simultaneously, the rise of hydrogen markets raises essential regulatory questions. Unlike electricity and natural gas markets, which developed gradually over decades, hydrogen markets must be designed primarily from the ground up, often amid considerable uncertainty about demand, cost trends, infrastructure needs, and technological choices. Regulators face complex trade-offs: encouraging early investment without entrenching inefficient structures; balancing flexibility with legal certainty; managing infrastructure and stranded-asset risks; and ensuring that emerging hydrogen markets develop in ways that are competitive, transparent, and socially acceptable.

Against this backdrop, understanding how regulators currently perceive the hydrogen market and how they envision their future role becomes essential. This paper builds on a survey among ERRA member regulatory authorities; the questionnaire was structured in sections: the first three sections were dedicated to collecting information about the current or planned situation ("benchmarking"), while the last section was intended to collect ERRA regulatory experts' vision, given the novelty of the topic. The survey outcomes offer an empirical snapshot of regulatory readiness, strategic positioning, and

expectations across a diverse set of jurisdictions. While the questionnaire results serve as the primary analytical foundation of the paper, they are considered in a broader policy and regulatory context.

The rest of the paper is structured as follows:

**Chapter 1** examines hydrogen production methods and the deployment of various technologies, based on regulators' guidance on which types of hydrogen are prioritised or promoted in national strategies;

**Chapter 2** reviews regulatory frameworks, market structures, and infrastructure development, emphasizing differences between current conditions in ERRA countries and regulators' visions for future market design;

**Chapter 3** delves into investment environments, cost recovery models, and support mechanisms, including approaches to managing infrastructure costs and risks;

**Chapter 4** explores governance arrangements, institutional preparedness, and consumer protection, with particular attention to the changing role of regulators;

**Chapter 5** summarises key takeaways and provides final recommendations for the future establishment of a regulatory framework useful to the expansion of hydrogen markets.

Chapters 2, 3, 4, and 5 examine topics through a two-part structure: first, presenting the current situation as outlined by national regulators; and second, offering forward-looking insights from ERRA regulatory experts. These insights represent the collective analysis developed within ERRA, incorporating inputs from the secretariat and participating regulators. This expert view should be seen as a shared interpretation rather than the official stance of any individual NRA. It is provided without prejudice to the final decisions made by each national regulatory authority on specific hydrogen-market issues.

# 1. HYDROGEN PRODUCTION PATHWAYS AND TECHNOLOGY POSITIONING

Understanding the range of hydrogen production pathways is essential before analysing how ERRA member countries prioritise or regulate them. Globally, hydrogen is categorised by production method and associated carbon footprint. These "colours" serve as simplified proxies for hydrogen production technologies and their typical emission profiles and underpin emerging policy frameworks. Green hydrogen, produced via water electrolysis powered by renewable electricity, is widely recognised as a zero-direct-emissions option and the most aligned with long-term decarbonisation pathways. Blue hydrogen, produced from natural gas with carbon capture and storage (CCS), is generally regarded as a transitional low-carbon option, whereas grey hydrogen, produced from natural gas without CCS, remains dominant today but is incompatible with climate-neutrality objectives. Additional variants, such as pink hydrogen (produced by electrolysis powered by nuclear energy) or black/brown hydrogen (produced by coal-based processes), further illustrate the diversity of available technologies and their differing environmental impacts.

This spectrum is illustrated in Figure 1, which clarifies the conceptual basis for many regulatory and support schemes, particularly in the European Union and its neighbouring countries, and underpins their definitions, sustainability criteria, and certification approaches.

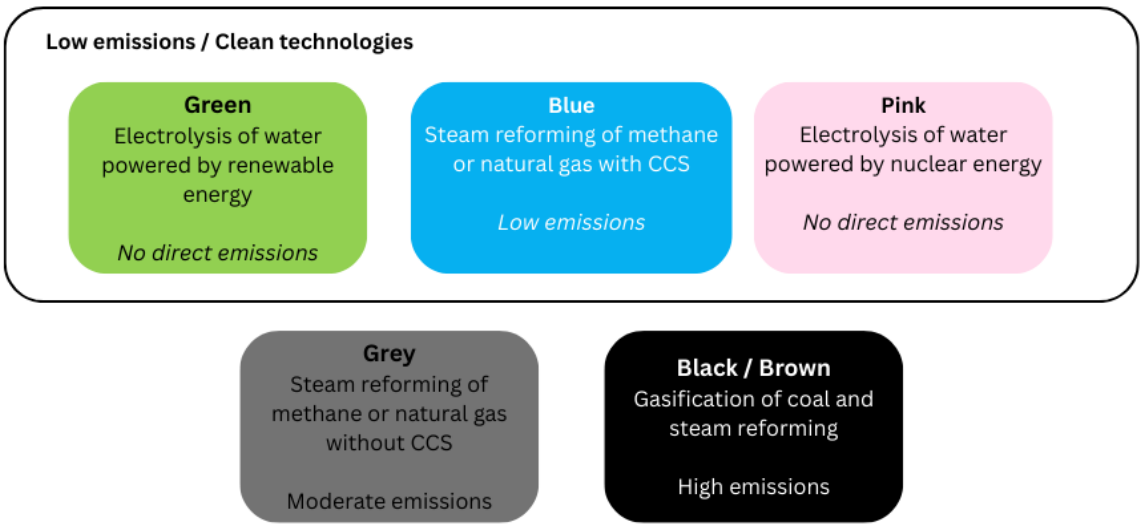
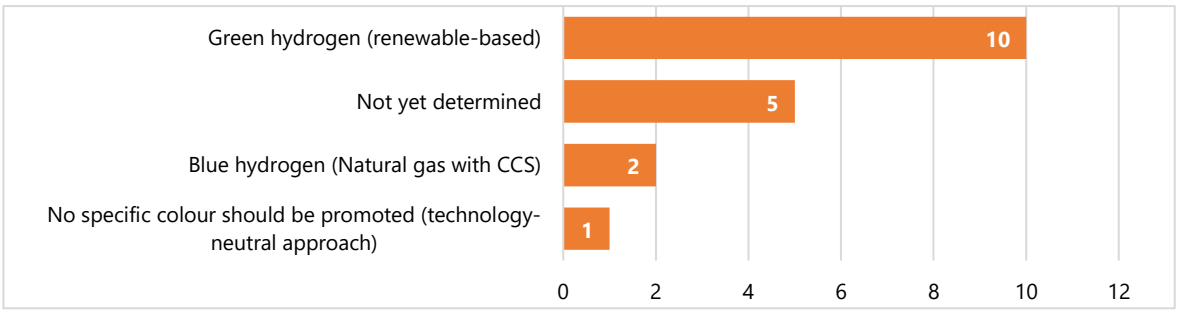



**Figure 1.** Overview of Hydrogen "Colour" Classification and Associated Emission Profiles (ERRA Training: Introduction to Electricity Regulation – William Derbyshire)

With this conceptual grounding, the analysis now turns to how ERRA member countries position themselves within this spectrum. Across the ERRA region, the focus on hydrogen production pathways is gradually becoming part of wider energy-transition and decarbonisation strategies. While most jurisdictions remain in the early stages of regulatory development, several countries have already begun signalling preferences or intentionally maintaining a neutral stance toward specific hydrogen production options.

Figure 2 below illustrates the current positioning of these pathways across responding jurisdictions, highlighting the prominence of renewable-based hydrogen, blue hydrogen, and technology-neutral approaches, as well as cases where no stance has been established.




| | | |
|---|---|---|
| Responses: | **Green hydrogen (renewable-based) (10)** | DZ, AT, CZ, GE, GR, LT, MD, PL, TH, UZ |
| | **Not yet determined (5)** | AL, AM, AZ, LV, MK |
| | **Blue hydrogen (Natural gas with CCS) (2)** | DZ, TH |
| | **No specific colour should be promoted (technology-neutral approach) (1)** | TR |

**Figure 2**. Types ("Colours") of Hydrogen are Prioritised or Promoted within Regulatory and Support Frameworks

As demonstrated in Figure 2, renewable-based (green) hydrogen is the most referenced pathway, reflecting its strong association with long-term climate-neutrality objectives and alignment with international and European decarbonisation strategies. Several nations explicitly state that renewable hydrogen is envisioned as the cornerstone of future hydrogen market development, even in the absence of dedicated hydrogen legislation or support schemes. In such instances, the prioritisation of renewable

hydrogen should be regarded primarily as a strategic orientation rather than a fully operational regulatory decision.

Algeria and Thailand refer to blue hydrogen or alternative low-carbon hydrogen options within their national strategies. In Algeria, the national hydrogen roadmap envisions both blue and renewable hydrogen as part of the energy mix across the short, medium, and long-term horizons, including planned blue hydrogen production volumes to meet domestic demand. In other jurisdictions, such pathways are described more cautiously and are often framed as transitional or complementary solutions rather than long-term substitutes for renewable hydrogen. When these pathways are mentioned, they are not presented as long-term replacements for renewable hydrogen but rather as potential interim solutions, especially in systems with existing gas infrastructure or industrial demand that can support early hydrogen deployment. Concurrently, respondents frequently recognise that the regulatory treatment of low-carbon hydrogen remains uncertain, particularly concerning emissions accounting, certification standards, and long-term alignment with decarbonisation objectives.

The figure also illustrates that Turkiye explicitly adopt a technology-neutral approach, indicating that no specific hydrogen "colour" is currently promoted. This stance reflects a deliberate regulatory decision to maintain flexibility during the early stages of market development, prevent premature technology lock-in, and enable future differentiation as demand patterns, cost trajectories, and infrastructure requirements become more defined.

Furthermore, a significant portion of jurisdictions report that the positioning of hydrogen production pathways remains undecided. This situation underscores the embryonic nature of hydrogen market development in much of the ERRA region, where policy priorities are still being established, and regulatory frameworks are under development.

Simultaneously, numerous nations, both within and outside the European Union, explicitly or implicitly reference renewable fuels of non-biological origin (RFNBOs) when discussing renewable hydrogen. This trend underscores the growing influence of EU-level legal definitions and sustainability standards, which are progressively establishing regulatory benchmarks that extend beyond the EU. Conversely, other jurisdictions refrain from specific legal classifications based on technology and prefer to address hydrogen policy in broader or more general terms.

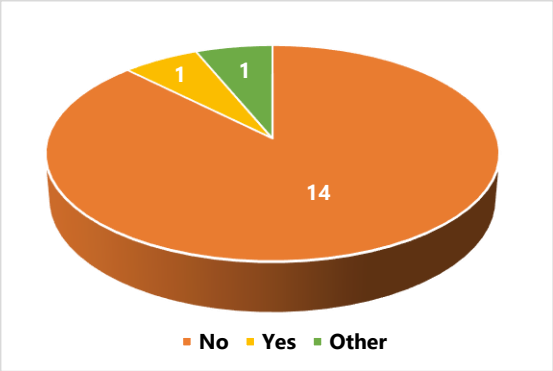
Overall, the evidence indicates a heterogeneous yet progressively converging landscape. While renewable hydrogen is widely recognised as the long-term objective, regulatory frameworks across ERRA jurisdictions remain largely non-binding. Transitional options are still under consideration, and strategic openness continues to prevail. This initial positioning offers essential context for comprehending the regulatory models, market structures, and infrastructure choices analysed in the subsequent chapters.

# 2. Regulatory Models, Market Structure and Infrastructure Development

## 2.1 Current Situation in ERRA Countries

Regulatory arrangements for hydrogen markets across ERRA jurisdictions are still in their initial stages, and preparedness varies significantly. Only one country, Poland, reports that a dedicated regulatory framework for the operation of the hydrogen market has already been established. The Czech Republic indicates that such regulation is currently under development, whereas all other jurisdictions confirm

that they do not have a hydrogen-specific regulatory framework at the time of the questionnaire. For EU member states, however, this should be interpreted in the context that national frameworks are generally being developed in line with evolving EU legislative requirements and forthcoming hydrogen-market rules. This pattern underscores the early stage of hydrogen governance in the region, with most countries still defining their strategic objectives and institutional responsibilities.




Responses:

| | |
|---|---|
| **No (14)** | AL, DZ, AM, AT, AZ, GE, GR, LV, LT, MD, MK, TH, TR, UZ |
| **Yes (1)** | PL |
| **Other (1)** | CZ |

**Figure 3.** Status of Regulatory Framework for the Operation of the Hydrogen Market

Similarly, the majority of ERRA members have yet to delineate the classification of hydrogen value chain activities- namely, production, transmission, distribution, and supply- as market dynamics evolve. Greece and Poland are among the few nations that envisage a progressive liberalisation model, in which competitive activities would be gradually opened to market forces. Concurrently, segments characterised by natural monopoly, such as transportation and distribution, remain under regulatory oversight. Uzbekistan adopts a markedly different model, anticipating full liberalisation from the outset. All other respondents indicate that no formal classification has been established, underscoring the sector's conceptual stage of development.

No more apparent consensus emerges regarding infrastructure pathways, particularly hydrogen blending. A few countries, including Greece, Latvia, and Uzbekistan, express openness to integrating hydrogen into natural gas networks, subject to technical conditions and safety standards. Austria also indicates that blending is technically feasible in the distribution network, with hydrogen currently up to approximately 10%, although broader regulatory and market frameworks remain under development. Poland and Lithuania explicitly rule out blending, indicating that their long-term strategies are premised on developing dedicated hydrogen networks. In most jurisdictions, however, the question remains unresolved, reflecting broader uncertainty about infrastructure readiness, end-use demand profiles, and cost-effectiveness.

Approaches to third-party access (TPA) to hydrogen infrastructure are similarly diverse. Poland anticipates a phased model in which exemptions apply in early years and regulated access is introduced as markets mature. Austria indicates a preference for immediate, regulated access to hydrogen pipelines from the outset, whereas Uzbekistan foresees negotiated access with regulatory oversight. Greece and Thailand envisage a differentiated model depending on infrastructure type and ownership, and Lithuania refers to a market-based access regime supported by tariff regulation and dispute-resolution mechanisms. The Czech Republic expects no distinction between hydrogen and existing natural-gas regulatory treatment. A larger group of jurisdictions: Albania, Algeria, Armenia, Azerbaijan, Georgia, Latvia, Moldova, Türkiye and North Macedonia: report that no specific approach to TPA evolution has yet been determined, reflecting the early stage of hydrogen-market design in these systems.

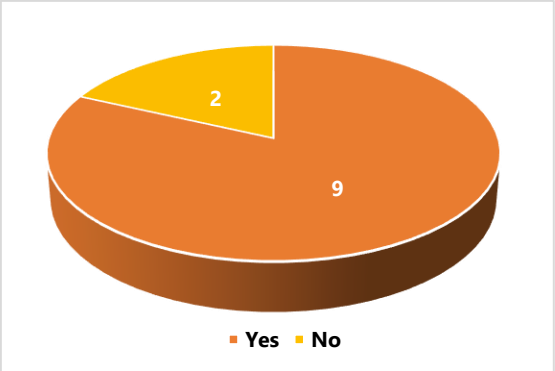
Tariff methodologies for hydrogen infrastructure remain entirely undeveloped across all participating ERRA countries. No country reports having designed or decided on the significant hydrogen principles tariff-setting. This is consistent with the overall pre-regulatory stage of national hydrogen strategies.

Without clarity on infrastructure architecture, ownership models, or the extent of regulated activities, tariff design cannot begin meaningfully.

Taken together, these findings reveal that ERRA countries are still laying the conceptual foundations for hydrogen markets, with only limited early regulatory structures in place and many key design elements yet to be determined.

## 2.2 Expert Perspectives Derived from ERRA Questionnaire Responses

While national regulatory frameworks remain underdeveloped, this section synthesises forward-looking perspectives derived from responses to the ERRA questionnaire and subsequent expert-level analysis. There is a broad consensus that hydrogen should not be regulated as a mature market from the outset. Also, most respondents strongly support a stepwise, phased regulatory approach, in which obligations gradually increase as markets expand and infrastructure develops.



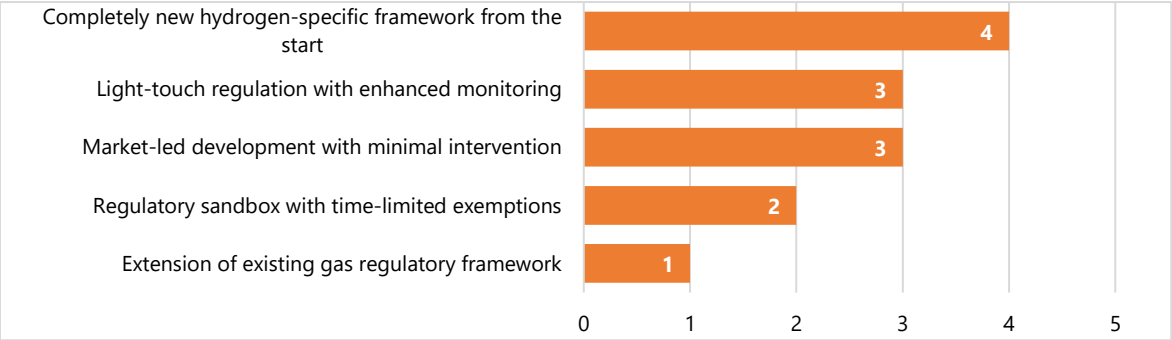

Responses:

| | |
|---|---|
| **Yes (9)** | AL, AM, AT, CZ, GE, GR, MD, LT, MK |
| **No (2)** | TR, UZ |

**Figure 4**. Usefulness of a Phased Regulatory Approach

Experts, however, differ on the criteria for distinguishing these phases. Some countries favour technology-based criteria, particularly the cost-competitiveness of green hydrogen relative to fossil-based alternatives. Others emphasise customer segmentation, recognising that industrial users are likely to dominate early demand, while later phases may involve transport or commercial applications. Several experts prefer not to define rigid criteria at this stage, opting instead for a flexible conceptual framework that can adapt to future technological and economic developments.

Views on initial experts' approaches also vary. Figure 5 illustrates how respondents prioritise different regulatory models for the initial development phase, ranging from regulatory sandboxes to completely new hydrogen-specific frameworks.




| Responses: | | |
|---|---|---|
| | **Completely new hydrogen-specific framework from the start (4)** | AL, AT, CZ, LT |
| | **Light-touch regulation with enhanced monitoring (3)** | GR, TR, LT |
| | **Market-led development with minimal intervention (3)** | AM, MK, UZ |
| | **Regulatory sandbox with time-limited exemptions (2)** | GE, MD |
| | **Extension of existing gas regulatory framework (1)** | GR |

**Figure 5.** Preferred Regulatory Approach for the Initial Development Phase

Many ERRA regulatory experts emphasise the value of regulatory sandboxes or light-touch frameworks during the early phase, allowing pilot projects to proceed without excessive administrative burden while maintaining appropriate oversight. Others support extending existing gas regulatory frameworks or introducing hydrogen-specific regulation from the outset. This diversity reflects both different national energy contexts and differing expectations regarding the pace of hydrogen deployment.

When discussing the tools most essential for early-stage regulatory flexibility, respondents consistently highlight the importance of streamlined licensing and authorisation procedures, which reduce barriers to investment and experimentation. Some countries note that temporary exemptions from third-party access or unbundling rules may also be appropriate in the initial phases to avoid premature regulatory constraints.

ERRA regulatory experts also outline various approaches for transitioning between phases. Many favour hybrid models that combine pre-defined quantitative triggers with periodic reviews, ensuring both predictability and adaptive capacity. Others prefer case-by-case assessments, particularly in jurisdictions where hydrogen uptake is expected to be gradual or sector-specific. A range of metrics is proposed to guide transitions, including total production capacity, market concentration, infrastructure investment, and the number of connected end users.

Timelines for progressing through regulatory phases vary widely. Some ERRA regulatory experts expect meaningful development between 2026 and 2035, while others anticipate significantly slower progress or have yet to propose a timeline. The variation reflects differences in national priorities, infrastructure readiness and anticipated hydrogen demand.

Finally, ERRA regulatory experts' views on how regulatory principles should evolve across phases reveal a logical progression: flexibility and exemptions in the initial phase, increased structure and monitoring in the intermediate phase, and full regulatory obligations, including unbundling, third-party access, and price regulation, in the mature phase. This evolution mirrors the expected development of hydrogen from a niche, experimental technology to an integrated element of the broader energy system.

# 3. INVESTMENT, COST RECOVERY AND FUNDING MODELS

Hydrogen investment frameworks across the ERRA region remain at an early stage, characterised by limited regulatory clarity, undefined tariff structures, and a strong reliance on public-sector intervention. While several countries recognise hydrogen as a strategic pillar of long-term decarbonisation, the majority have yet to establish mechanisms that would enable predictable infrastructure development, mitigate investment risks or guide the evolution of cost-recovery models. This chapter outlines the current landscape and summarises the perspectives of ERRA experts on how future frameworks could evolve.

## 3.1 CURRENT SITUATION IN ERRA COUNTRIES

In most jurisdictions, investment and cost-recovery arrangements for hydrogen infrastructure remain undetermined. Respondents consistently report that formal models for funding transmission assets, allocating costs across users, or defining tariff methodologies have not yet been developed. Uzbekistan is the only country to explicitly indicate a preliminary form of risk-sharing between investors and consumers, an early acknowledgement that hydrogen infrastructure may require partial socialisation of costs to avoid prohibitive risks for first movers.

Two EU Member States offer more specific indications of emerging approaches. Greece points to a combined model in which hydrogen infrastructure could rely on tariff-based cost recovery, supplemented by EU funding instruments such as Projects of Common Interest (PCIs). Lithuania signals early consideration of inter-temporal cost allocation for future hydrogen transmission networks, with support from government grants. These positions suggest that, even within more advanced regulatory systems, hydrogen cost recovery remains in the conceptual stage rather than in operational practice.

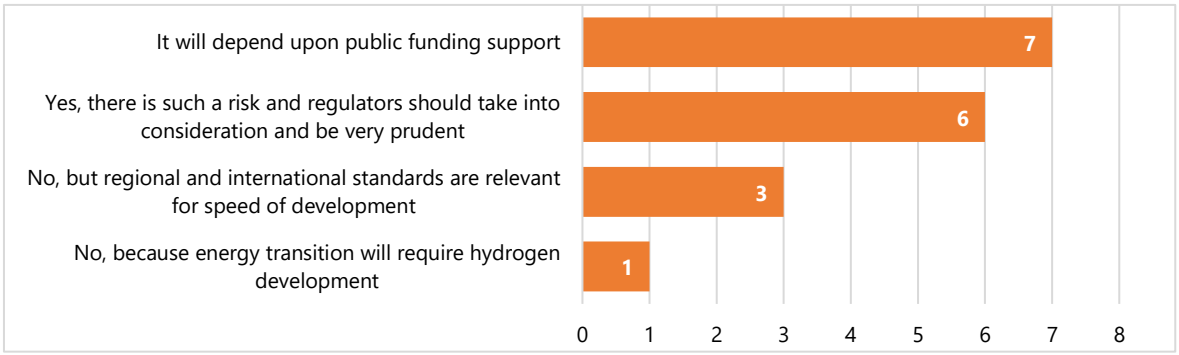
All other respondents (Albania, Austria, Algeria, Armenia, Azerbaijan, Georgia, the Czech Republic, Latvia, Moldova, Türkiye, Poland, North Macedonia and Thailand) state that their cost-recovery models are "not yet decided." The absence of responses on tariff methodologies is particularly notable: no country reports having defined the principles for hydrogen network tariffs, reflecting both limited infrastructure development and ongoing ambiguity about the boundaries between regulated and competitive activities.

Public funding follows a similar pattern. Only a minority of countries indicate that structured financial support may accompany early-phase hydrogen deployment. Moldova and Greece highlight that international financial institutions, including EU-level financing instruments, will play a substantial role; for instance, such support is considered essential for initial pilots, given capacity limitations and the capital-intensive nature of hydrogen infrastructure. Most jurisdictions, however, have not yet taken a position on public funding, indicating that financial frameworks will evolve alongside national hydrogen strategies.

Risk perceptions regarding stranded assets reflect the degree of uncertainty surrounding early investment. Several countries: Albania, Austria, the Czech Republic, Greece, Moldova and Poland, acknowledge the potential for stranded costs, emphasising the need for prudence as technology pathways and demand patterns remain fluid. Thailand takes the opposite view, arguing that long-term energy-transition dynamics will ensure sufficient hydrogen uptake. Others, such as Austria, Armenia, Georgia, Latvia, Uzbekistan, Lithuania and North Macedonia, consider stranded-asset risks largely conditional on the durability of public financial support.

Several jurisdictions also anchor their expectations to the broader international environment. Algeria, Azerbaijan, and Türkiye underscore that regional and global harmonisation, particularly in hydrogen

certification, production standards, and quality requirements, will be decisive in creating a stable demand base and reducing investment risk. The diversity of views is illustrated in Figure 6, which shows the distribution of stranded-cost perceptions among ERRA members.




| Responses: | | |
|---|---|---|
| | **It will depend upon public funding support (7)** | AM, AT, GE, LV, LT, MK, UZ |
| | **Yes, there is such a risk and regulators should take into consideration and be very prudent (6)** | AT, AL, CZ, GR, MD, PL |
| | **No, but regional and international standards are relevant for speed of development (3)** | DZ, AZ, TR |
| | **No, because energy transition will require hydrogen development (1)** | TH |

Figure 6. Perceived risk of Stranded Costs for Hydrogen Infrastructure due to Uncertainty in Future Demand

## 3.2 Early-Phase Learning Mechanisms and Experimental Frameworks

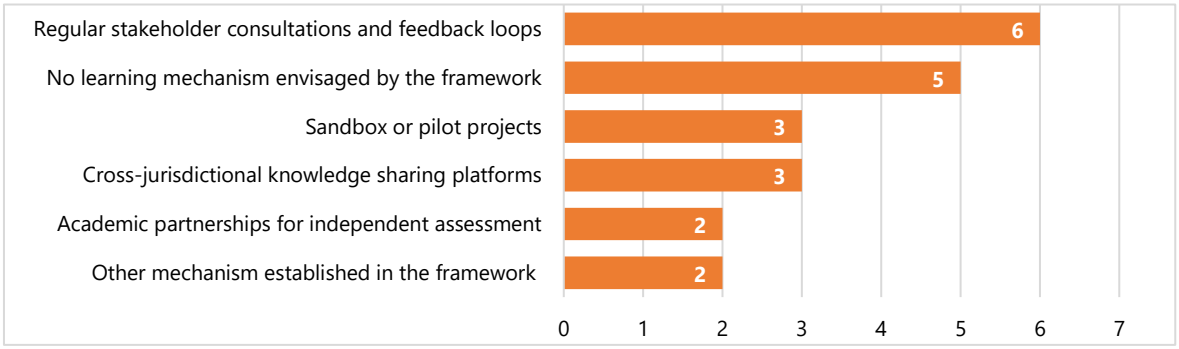
A critical complement to investment and cost-recovery discussions concerns the tools countries use to capture lessons from early deployments. Responses to a specific set of questions on this topic indicate that, while some ERRA countries have established structured mechanisms for learning, many remain at an embryonic stage.

Several countries: Albania, Austria, the Czech Republic, Greece, Moldova and Lithuania, rely on regular stakeholder consultations as their primary mechanism. In some cases, these consultations form part of wider, cross-jurisdictional knowledge-sharing arrangements, notably in Austria, the Czech Republic and Lithuania. Academic cooperation is also used selectively, particularly in Austria and the Czech Republic, where external analytical support aids early policy formulation.

More detailed approaches emerge in Algeria and Türkiye. Algeria notes that its hydrogen roadmap dedicates the initial phase to technologically focused pilot projects designed to assess costs, evaluate business models and build institutional knowledge. These activities will be accompanied by the parallel development of regulatory, standardisation and institutional frameworks. Türkiye highlights that its forthcoming Clean Hydrogen Action Plan (CHAP), supported by the World Bank, incorporates broad modelling exercises and stakeholder consultations, ensuring that lessons learned shape the final regulatory framework.

A few jurisdictions already integrate sandbox or pilot-based mechanisms from adjacent sectors into hydrogen planning. Thailand, Uzbekistan and Poland indicate that their evolving frameworks are likely to include sandbox-style arrangements. These structures allow limited exemptions for innovative projects, project-specific timelines and learning obligations designed to minimise risk. Poland anticipates a maximum sandbox duration of four to six years, whereas Thailand and Uzbekistan set duration on a project-by-project basis. Approaches to unbundling within these sandboxes vary considerably: Poland applies full unbundling from the outset; Thailand applies differentiated treatment by technology; Uzbekistan embeds exemptions under its public–private partnership law.

The distribution of these learning mechanisms across ERRA jurisdictions is summarised in Figure 7.




| Responses: | | |
|---|---|---|
| | **Regular stakeholder consultations and feedback loops (6)** | AL, AT, CZ, GR, MD, LT |
| | **No learning mechanism envisaged by the framework (5)** | AM, AZ, GE, LV, MK |
| | **Sandbox or pilot projects (3)** | PL, TH, ZU |
| | **Cross-jurisdictional knowledge sharing platforms (3)** | AT, CZ, LT |
| | **Academic partnerships for independent assessment (2)** | AT, CZ |
| | **Other mechanism established in the framework (2)** | DZ, TR |

**Figure 7.** Mechanisms to Capture Lessons Learned During Initial Hydrogen Development

In contrast, Armenia, Azerbaijan, Georgia, Latvia and North Macedonia report that they currently envision no specific learning mechanisms within their hydrogen frameworks. This absence highlights both the conceptual nature of hydrogen policymaking in several jurisdictions and the potential need for more structured processes as markets mature.

## 3.3 Expert Perspectives Derived from ERRA Questionnaire Responses

While national frameworks remain under development across most ERRA jurisdictions, including those aligned with evolving EU legislation, responses from participating regulatory experts indicate broad support for sequencing regulatory measures in parallel with market growth, thereby avoiding premature rigidity while ensuring eventual investment certainty.

ERRA regulatory experts generally favour the use of targeted public support instruments during the initial phase, combined with temporary exemptions from certain regulatory obligations to support early projects. This includes streamlined licensing, limited third-party access obligations and potential relief from full unbundling requirements. As markets mature, respondents anticipate a more structured approach in which tariff methodologies, access regimes and unbundling principles progressively align with established gas-sector regulatory practice.

Crucially, ERRA regulatory experts emphasise that early investment frameworks should be designed to remain flexible and adaptable. Many stress the importance of regular revision cycles, data-driven monitoring of pilot projects and timely adjustments to regulatory and financial incentives. The use of phased approaches is perceived as critical to balancing innovation with investor confidence, as further explained in Chapter 5 (para 5.2).

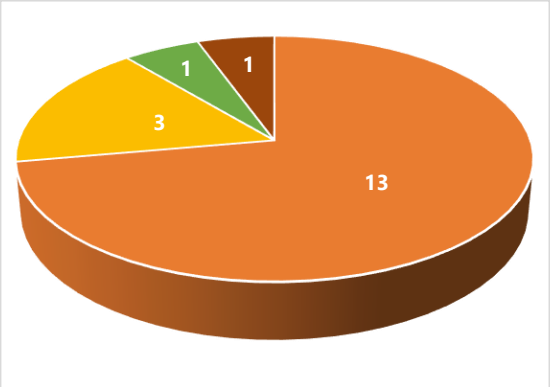
Finally, the ERRA regulatory experts' vision reinforces the importance of structured learning mechanisms as a prerequisite for long-term stability. Sandboxes, pilot projects, academic partnerships, and cross-border knowledge-sharing platforms are viewed as essential tools for reducing uncertainty, identifying cost-effective technologies, and preventing premature infrastructure lock-in.

# 4. Governance, Institutional Readiness and Consumer Protection

The governance dimension of hydrogen market development remains emerging across the ERRA region, and institutional readiness varies significantly across jurisdictions. As hydrogen transitions from an experimental technology to a potential market commodity, clarity regarding institutional roles, coordination mechanisms, and consumer protection safeguards is essential. The survey responses indicate that many countries are still defining their governance architecture, whereas a smaller group has already begun to shape regulatory roles and procedures. This chapter synthesises these findings and outlines the early contours of hydrogen governance as seen by ERRA members.

## 4.1 Current Situation in ERRA Countries

A first area of investigation concerns how national authorities plan to manage the gradual development of the hydrogen market and which institutions are expected to take responsibility. Most jurisdictions have not yet formalised governance structures nor delineated institutional mandates. Albania, Algeria, Armenia, Azerbaijan, Georgia, Latvia, Moldova, Thailand, Türkiye, Uzbekistan, Lithuania, and North Macedonia all report that institutional arrangements remain undecided, reflecting the early stage of market development. Greece, Poland and Lithuania provide a more advanced view: Greece highlights continuous monitoring and adaptive regulatory responses under the supervision of the energy regulator (RAAEY), supported by periodic reviews with the Ministry of Energy. Poland indicates a similar adaptive approach based on ongoing market assessment. Lithuania notes that its governance arrangements are being developed under the forthcoming Hydrogen Law. At the time of the questionnaire, Austria reported that institutional arrangements had not yet been decided. Following legislative changes that entered into force at the end of 2025, E-Control was designated as the competent authority for hydrogen, while the detailed regulatory framework remains under development. Greece also mentions a hybrid review mechanism, which foresees scheduled assessments combined with responsive adjustments as market conditions evolve. These elements are summarised in Figure 8.




Responses:

| | |
|---|---|
| **Not yet decided (13)** | AL, DZ, AM, AZ, CZ, GE, LV, MD, MK, TH, TR, UZ, AT |
| **Continuous monitoring with adaptive regulatory responses (3)** | GR, PL, LT |
| **Hybrid approach combining scheduled reviews and responsive adjustments (1)** | GR |
| **Market-driven evolution with minimal regulatory intervention (1)** | GR |

**Figure 8.** Institutional Responsibility for Managing Hydrogen-Market Development

Consumer-protection considerations are addressed with greater specificity. Responses to the inquiry on how the regulatory framework addresses consumer-protection issues indicate that, at this juncture, only two countries, Poland and the Czech Republic, have articulated explicit concerns. Both countries underscore the need for enhanced safeguards to protect consumers, particularly households, from potential cost impacts of hydrogen integration. This reflects an awareness that initial hydrogen deployment may exert upward pressure on energy system costs. Based on these responses, consumer protection may become a prominent issue during the mature phase of hydrogen development, as preliminary grid infrastructure and major stakeholders are likely to be established beforehand.

For all other respondents: Albania, Algeria, Armenia, Austria, Azerbaijan, Georgia, Greece, Latvia, Moldova, Thailand, Türkiye, Uzbekistan, Lithuania, and North Macedonia, consumer-protection measures remain not yet determined, because the regulatory arrangements for hydrogen markets are at an initial stage.

A related aspect concerns the involvement of the national regulatory authority in overseeing hydrogen markets, explored through role-setting. Only a small group of jurisdictions (Albania, the Czech Republic, Greece, Poland, Lithuania and Austria) declare that the regulator's role is already formally foreseen or at least structurally outlined. In Armenia, Türkiye, and the majority of other jurisdictions, the role of the regulatory authority has not yet been determined. The general trend suggests that countries with more advanced hydrogen strategies or draft legislation tend to define regulatory involvement earlier, while others await clearer market signals or EU policy direction.

A third area of institutional readiness concerns whether the regulator's role is formally defined within the emerging hydrogen framework, and, if so, what responsibilities regulators are expected to assume. Only six countries, Albania, the Czech Republic, Greece, Poland, Lithuania and Austria, report that the regulator's role has already been established. In Armenia, Türkiye, and the majority of the remaining countries, the regulator's role has not yet been determined.

The countries with defined regulatory mandates provide detailed insights into the specific functions that regulators are expected to perform, summarised in Figure 9.


| Responses: | | |
|---|---|---|
| | **Regulating hydrogen transmission and distribution network tariffs (4)** | AL, GR, LT, AT |
| | **Establishing market rules and trading mechanisms (3)** | GR, LT, AT |
| | **Granting licenses and permits for projects (2)** | GR, LT |
| | **Other roles (3)** | GR, PL, AT |
| | **The same as in natural gas regulation (2)** | GR, AT |

**Figure 9.** Expected Roles of National Regulators in Hydrogen Markets

Based strictly on the survey answers, the situation is as follows:

- Granting licences and permits for projects is a regulatory responsibility in Greece and Lithuania;
- Establishing market rules and trading mechanisms is also reported by Austria, Greece and Lithuania;
- Regulating tariffs for hydrogen transmission and distribution networks is the responsibility of regulators in Albania, Austria, Greece, and Lithuania;
- "The same as in natural gas regulation" is selected by Austria and Greece, indicating that the regulator is expected to carry out, for hydrogen, the same set of functions it already performs in the gas sector;

- Under "other roles different from above", respondents specify:
    - Greece – *market monitoring*;
    - Poland – *granting hydrogen storage and trading licenses, certifying and designating hydrogen system operators, and monitoring compliance with market rules*;

The comments section further clarifies the situation in both countries. Albania notes: "*We are waiting for the market to open for hydrogen*." Lithuania explains that the regulator's role is proposed in the new Hydrogen Law, which has *not yet been adopted*.

Taken together, these responses show that while regulators are expected to play a central role in hydrogen markets in several jurisdictions, the degree of precision and formalisation varies substantially. Some countries already have a broad portfolio of responsibilities, particularly in licensing, market rule-setting, tariff regulation, and monitoring. Others acknowledge that the role is still under discussion or contingent on future legal acts.

Across all governance topics examined, the allocation of responsibilities between authorities, emerging consumer protection concepts, and the definition of regulatory mandates, the overall picture is one of early-stage but evolving institutional readiness. More advanced jurisdictions tend to build on existing energy regulatory structures, whereas others remain exploratory. As hydrogen projects move from plans and pilots toward commercial operation, greater clarity on governance arrangements will be critical to ensuring investor confidence, effective market oversight, and adequate protection of end users.

## 4.2 Expert Perspectives Derived from ERRA Questionnaire Responses

A critical dimension of hydrogen market regulation concerns how regulatory principles should evolve as the sector transitions from pilot-scale activity to commercial maturity. This section summarises forward-looking views expressed by responding ERRA member regulators and technical experts through the questionnaire. These perspectives reflect professional judgement and expectations collected through the survey and do not represent a formal institutional position of ERRA. Respondents provided detailed views on how four core regulatory pillars, unbundling requirements, third-party access (TPA), price regulation and market monitoring, should be differentiated across the initial, intermediate and mature phases of hydrogen-market development.

To illustrate this, Figure 10 below shows the distribution of preferences expressed by responding ERRA member regulators and expert participants for the initial phase, followed by Figure 11 for the intermediate phase, and Figure 12 for the mature phase. These visual representations provide essential context for understanding the evolution of regulatory expectations across all regulatory experts.

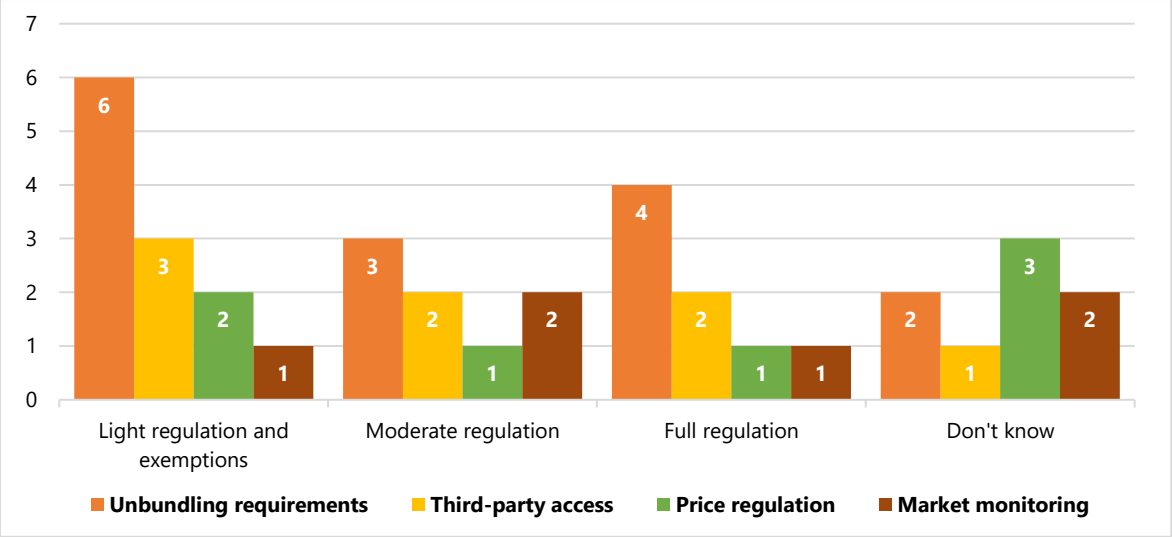



**Figure 10.** Regulatory Principles in the Initial Phase

In the earliest stage of market development, initial thoughts of regulatory experts overwhelmingly favour light-touch regulatory intervention:

- Unbundling requirements: 6 regulatory experts support light or exemptive arrangements, signalling that rigid structural requirements should not constrain early hydrogen activity;
- Third-party access: Flexible rules dominate, with three regulatory experts advocating for light oversight;
- Price regulation: Only two regulatory experts foresee light price-regulation mechanisms in the initial phase, and three don't know yet;
- Market monitoring: preferences are almost evenly distributed, with no clear vision yet on this topic.

Some countries: Austria, Moldova, Armenia and North Macedonia, support full regulation even in the initial phase, reflecting more formalised policy environments. In some cases, this may also be influenced by alignment with broader legislative frameworks, including the EU framework where applicable, while several others note that frameworks remain undefined.

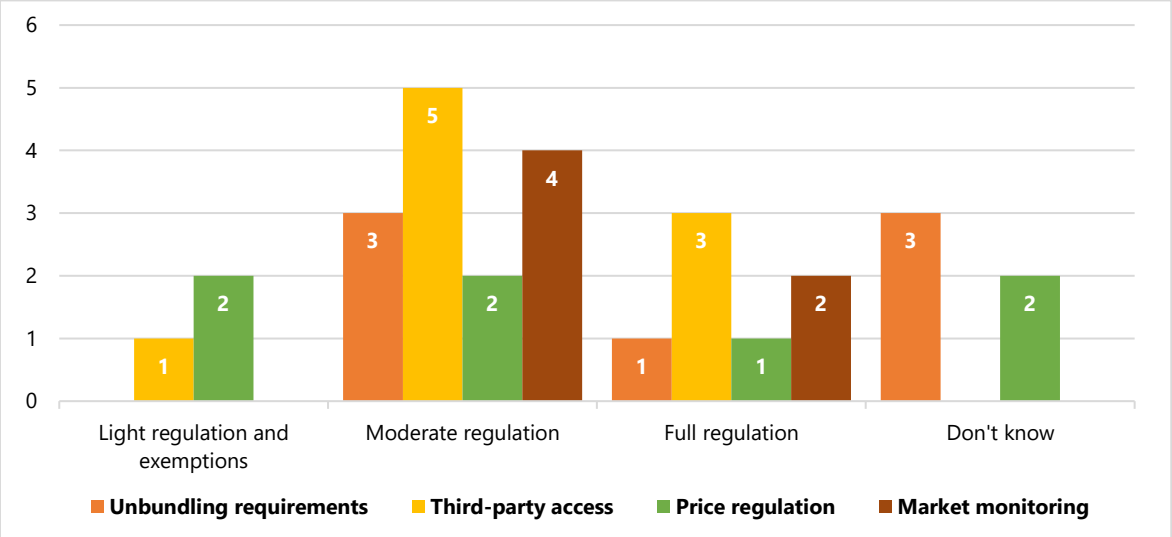



**Figure 11.** Regulatory Principles in the Intermediate Phase

As hydrogen deployment scales, for intermediate phase respondents shift toward moderate regulation, signalling a need for balance between flexibility and stability:

- Unbundling: Moderate regulation supported by three experts;
- Third-party access: Moderate regulation dominates in five experts' views, favouring progressively stronger access rules;
- Price regulation: Moderate price controls appear appropriate for two experts, while two experts still support light regulation at this stage;
- Market monitoring: Four experts foresee moderate monitoring obligations.

One expert again stands out by supporting full regulation across pillars even at this intermediate stage, whereas a few experts still report uncertainty.

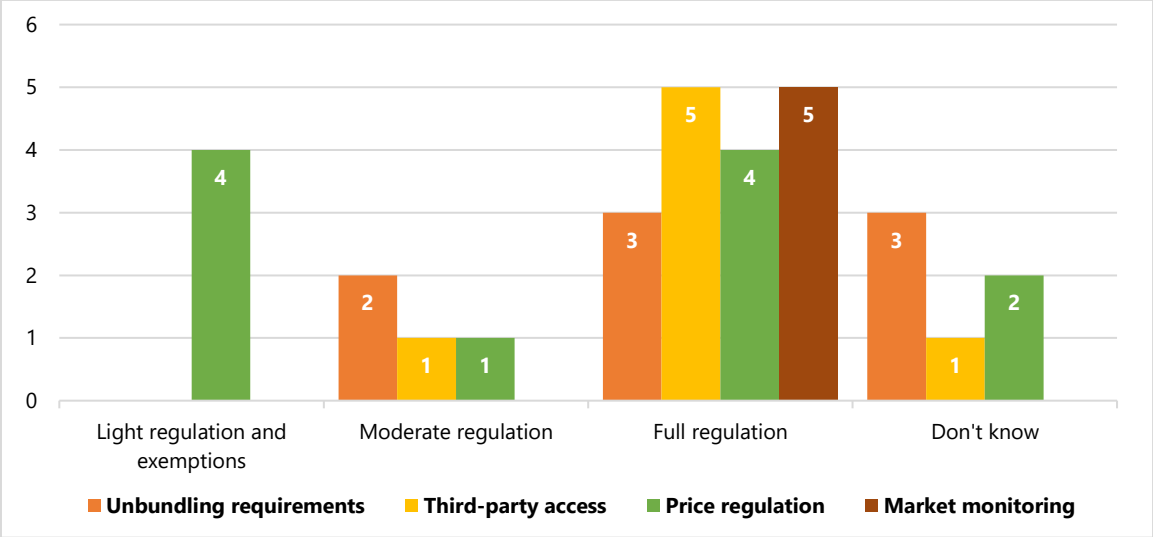



**Figure 12.** Regulatory Principles in the Mature Phase

Once hydrogen markets reach maturity, respondents envision a shift toward full and comprehensive regulation, accompanied by clear responsibilities and formalised rules.

- Unbundling: Three experts support full regulation;
- Third-party access: Full TPA is expected by five experts;
- Price regulation: Fully regulated tariff structures are supported by four country experts;
- Market monitoring: Comprehensive monitoring is foreseen by 5 experts.

While the prevailing view supports comprehensive regulation in the mature phase, responses indicate that 4 experts would retain lighter approaches in specific areas, most notably in price regulation.

# 5. CONCLUSIONS AND RECOMMENDATIONS

## 5.1 SUMMARY OF CURRENT SITUATION

This paragraph synthesises the survey's factual findings on the current state of hydrogen regulation across ERRA jurisdictions (based on Sections I-III of the Survey).

### *5.1.1 FRAMEWORKS AND MARKET STRUCTURE*

Hydrogen regulation across the ERRA countries remains at an early stage of development. Only one country, Poland, reports having established a dedicated regulatory framework for the operation of the hydrogen market, while the Czech Republic indicates that such regulation is currently under development. In all European Union Member States, hydrogen-related regulatory frameworks are also progressing in line with EU legislative requirements and transposition processes; however, based on survey responses at the time of data collection, most jurisdictions reported that dedicated national frameworks had not yet been fully established. All other jurisdictions confirm that hydrogen-specific regulatory frameworks do not yet exist.

Similarly, the formal regulatory attribution of each activity in the hydrogen value chain (as a monopoly or market activity) remains largely undetermined. A few countries, including Greece, Poland, and Uzbekistan, have begun articulating models for progressive liberalisation in which competitive activities would gradually be opened to market forces, while natural-monopoly segments such as transmission and distribution remain under regulatory oversight. However, the majority of respondents indicate that no formal decision has been established.

### *5.1.2 INFRASTRUCTURE DEVELOPMENT AND ACCESS*

Approaches to hydrogen infrastructure development are diverse and largely undecided. Greece, Latvia, and Uzbekistan express openness toward blending hydrogen into natural gas networks, subject to technical and safety standards. Austria also indicates that blending hydrogen into natural-gas distribution networks is technically feasible under existing standards (currently up to around 10%), although broader regulatory positioning remains under development. Poland and Lithuania explicitly rule out blending, favouring the development of dedicated hydrogen networks instead. In most jurisdictions, however, infrastructure pathways remain undetermined, reflecting broader uncertainty about end-use demand, cost-effectiveness, and technical readiness.

Correspondingly, third-party access (TPA) regimes have not been formalised in most countries. Where positions have been articulated, approaches vary:

- ✓ Some jurisdictions, such as Austria, favour immediate regulated access;
- ✓ Others, like Greece and Thailand, propose differentiated access depending on infrastructure type and ownership;
- ✓ The Czech Republic sees no difference between hydrogen and natural gas regulation;
- ✓ Many jurisdictions have not yet formulated any position on access regimes.

Critically, tariff methodologies for hydrogen infrastructure remain entirely undeveloped across all ERRA jurisdictions. No country reports having designed or decided on the fundamental principles of hydrogen tariff-setting, consistent with the overall pre-regulatory stage of market development.

### *5.1.3 Investment and Cost Recovery*

The findings on investment conditions reveal that, based on questionnaire responses, only a limited number of countries have outlined preliminary considerations for recovering the costs of hydrogen infrastructure:

1. Uzbekistan mentions a risk-sharing arrangement between investors and consumers;
2. Greece proposes cost recovery through tariffs, supplemented by EU funding instruments, notably the Projects of Common Interest (PCIs);
3. Lithuania and Austria consider inter-temporal cost allocation for future transmission investments, alongside governmental grants;
4. Public funding frameworks are similarly at an early stage of consideration, with only Greece and Moldova anticipating a phased approach in which heavy public support in the initial phase transitions toward market-based mechanisms as markets mature;
5. Türkiye expects minimal public support and relies on market forces, whereas most countries have yet to determine their public funding strategies.

Most other respondents indicate that cost-recovery approaches are still under consideration or not yet defined, reflecting the early stage of hydrogen-market development and the remaining uncertainty regarding demand trajectories, infrastructure needs, and long-term system roles for hydrogen.

Perceptions of stranded-cost risk vary considerably:

1. Thailand considers stranded costs unlikely, arguing that the energy transition will inherently require the deployment of hydrogen;
2. Algeria, Azerbaijan, and Türkiye emphasise that the pace of development depends on establishing harmonised regional and international standards;
3. Several countries, including Albania, the Czech Republic, Greece, Moldova, and Poland, explicitly recognise the possibility of stranded hydrogen assets and urge caution in regulation;
4. Others indicate that stranded-cost risk depends primarily on the availability and duration of public funding support.

### *5.1.4 Governance and Institutional Readiness*

Governance arrangements for hydrogen markets remain largely unformed. Most jurisdictions have not yet delineated institutional responsibilities for hydrogen oversight or formalised coordination mechanisms. Albania, Algeria, Armenia, Austria, Azerbaijan, Georgia, Latvia, Moldova, Thailand, Türkiye, Uzbekistan, Lithuania, and North Macedonia report that institutional arrangements were not yet fully defined at the time of the questionnaire. Following recent legislative changes (December 2025), Austria has clarified the institutional mandate, assigning hydrogen-related responsibilities to the energy regulatory authority (E-Control). Greece, Poland, and Lithuania provide advanced perspectives: Greece highlights continuous monitoring and adaptive regulatory responses under the supervision of the energy regulator (RAAEY), supported by periodic reviews with the Ministry of Energy. Poland indicates a similar adaptive approach, while Lithuania notes that governance arrangements are being developed under the forthcoming Hydrogen Law.

Consumer protection frameworks are notably underdeveloped. Only Poland and the Czech Republic have explicitly raised concerns about the need for enhanced safeguards to protect consumers,

particularly households, from potential cost impacts associated with hydrogen integration. All other jurisdictions report that consumer-protection measures remain undetermined.

Regarding the regulator's role, only six countries- Austria, Albania, the Czech Republic, Greece, Poland, and Lithuania- state that it is already formally foreseen or structurally outlined. In Armenia, Türkiye, and most other jurisdictions, the regulatory authority's role has not yet been determined. Where regulatory roles have been defined, they typically encompass granting licenses and permits, establishing market rules, regulating transmission and distribution tariffs, and monitoring market operations, largely mirroring existing mandates in the gas sector.

### *5.1.5 Summary*

Overall, the survey findings indicate that the development of the hydrogen market across ERRA jurisdictions remains in its early stages. Dedicated regulatory frameworks, tariff methodologies, and governance arrangements continue to evolve. In EU member states, these elements are progressing through ongoing legislative and policy processes, whereas in most non-EU ERRA jurisdictions, institutional roles and regulatory tools have not yet been formally established. Where more advanced approaches are observed, they are typically associated with EU-level initiatives and national transposition efforts rather than with fully operational domestic regimes.

## 5.2 Summary of Expert Perspectives Derived from ERRA Questionnaire Responses

This section synthesises views expressed by responding regulators and technical experts through Section IV of the survey and reflects aggregated expert perspectives rather than formal positions of individual national regulatory authorities.

### *5.2.1 Strong Support for Phased Regulation*

ERRA regulatory experts express overwhelming support for a stepwise, phased regulatory approach to the development of the hydrogen market. Nine regulatory experts explicitly deem it useful to approach hydrogen regulation in line with the different phases of market and infrastructure development. Two experts respond negatively to this concept.

This preference reflects a broad consensus that hydrogen should not be regulated as a mature market from the outset. Instead, regulatory obligations should gradually increase as markets expand, infrastructure develops, and demand patterns become clearer. ERRA regulatory experts emphasise that the premature imposition of rigid regulatory structures could constrain innovation and deter early investment, whereas the absence of regulation could undermine investor confidence and consumer protection.

### *5.2.2 Criteria for Distinguishing Phases*

ERRA regulatory expert views on the criteria that should distinguish regulatory phases reveal diverse perspectives. Some experts favour technology-driven phases, particularly given the cost competitiveness of green hydrogen relative to fossil-based alternatives. Two regulatory experts emphasise customer segmentation, recognising that industrial users are likely to dominate early demand, with later phases involving transport or commercial applications. Four regulatory experts prefer not to define rigid criteria at this stage, opting instead for a flexible conceptual framework that can adapt to future technological and economic developments.

### 5.2.3 Transitioning Between Phases

ERRA regulatory experts outline various approaches to managing the transition from the initial to the intermediate regulatory phases. Three regulatory experts favour hybrid models that combine pre-defined quantitative triggers with periodic reviews, ensuring both predictability and adaptive capacity. One expert regulator prefers periodic reviews with discretionary decisions. Four experts support case-by-case assessments, particularly in jurisdictions where hydrogen uptake is expected to be gradual or sector-specific.

When asked about specific metrics to trigger transitions, two regulatory experts highlight market concentration ratios and thresholds for total production capacity. One regulatory expert also emphasises the number of end users served, while another identifies infrastructure investment levels as a relevant metric. This diversity reflects the views and priorities of different national experts but underscores a shared recognition that clear, measurable criteria are necessary to guide regulatory evolution.

### 5.2.4 Timelines for Regulatory Phases

ERRA regulatory experts' expectations regarding timelines for transitioning between regulatory phases vary widely. Five regulatory experts foresee an initial phase from 2024 to 2030, an intermediate phase from 2030 to 2035, and a mature phase post-2035. Three regulatory experts anticipate even slower progress, while two experts have not yet proposed formal timelines. This variation reflects differences in national priorities, infrastructure readiness, and anticipated trajectories of hydrogen demand.

### 5.2.5 Evolution of Regulatory Principles Across Phases

ERRA regulatory expert views on how specific regulatory principles should evolve across phases reveal a logical and consistent progression:

**Initial Phase:** ERRA regulatory experts favour light regulation with broad exemptions, particularly for unbundling requirements and third-party access. Price regulation is expected to be minimal or absent, whereas market monitoring is expected to be light or moderate. This reflects the need for flexibility and experimentation during early deployment.

**Intermediate Phase:** As markets scale, regulatory experts shift toward moderate regulation across most principles. Unbundling, third-party access, and price regulation are expected to become more structured, while market monitoring obligations are expected to increase. This intermediate stage balances the need for flexibility with growing requirements for transparency and consumer protection.

**Mature Phase:** Once hydrogen markets reach maturity, experts envision a comprehensive regulatory framework with full obligations across all dimensions. Unbundling requirements, third-party access, price regulation, and market monitoring are expected to be fully developed and enforced, mirroring the regulatory intensity of established natural gas markets. Four experts support full regulation at this stage, with only minor variations

### 5.2.6 Summary

The ERRA regulatory experts' vision articulated in Section IV of the survey reveals a cohesive, pragmatic approach to hydrogen regulation. There is strong consensus on the need for phased, adaptive frameworks that begin with light-touch regulation and evolve toward comprehensive oversight as markets mature. Regulatory experts emphasise the importance of flexibility, streamlined processes during initial phases, clear criteria for transitions, and a structured evolution of regulatory principles.

This vision reflects a careful balancing of the need to encourage early investment and innovation with the imperative to ensure long-term market efficiency, transparency, and consumer protection.

## 5.3 Implications for Regulators

The juxtaposition of current reality and expert vision reveals both challenges and opportunities for ERRA member regulators as hydrogen markets begin to emerge. Understanding these implications is essential for shaping effective regulatory strategies in the coming years.

### *5.3.1 The Gap Between Vision and Reality*

A significant gap exists between where the ERRA countries currently stand and where expert opinion suggests they should be heading. Most countries have not yet established the foundational elements: regulatory frameworks, infrastructure plans, tariff methodologies, and governance structures that would support even the initial phase of a stepwise regulatory approach. Yet experts overwhelmingly support a phased regulatory approach as the appropriate model, indicating that jurisdictions must accelerate policy development to align with this vision. This gap is not necessarily problematic; it reflects the nascent stage of the hydrogen market's development and the appropriate caution that regulators exercise amid substantial uncertainty. However, it does underscore the urgency of moving from conceptual discussions to concrete regulatory design. Early regulatory choices, even those intended as temporary or experimental, will significantly influence the trajectory of hydrogen markets and the efficiency of future infrastructure investments.

In EU member states, several of these elements are advancing through ongoing legislative and transposition processes, whereas in many non-EU jurisdictions, foundational regulatory roles and tools remain under formal consideration.

### *5.3.2 The Importance of Early Regulatory Decisions*

Initial regulatory decisions will have lasting consequences. Choices regarding infrastructure access regimes, cost-allocation mechanisms, certification standards, and market structure made during the pilot and demonstration phase will establish precedents that are difficult to reverse. Regulators must therefore approach early-stage decisions with careful consideration of their long-term implications, even in conditions of uncertainty.

The survey reveals that experts recognise this challenge. Their preference for regulatory sandboxes, light-touch frameworks, and streamlined licensing reflects an understanding that early regulation must balance flexibility with sufficient structure to guide investment. However, the current absence of tariff methodologies, unbundling criteria, and governance arrangements suggests that many jurisdictions are not yet equipped to implement even light-touch regulation effectively.

### *5.3.3 Coordination and Harmonisation are Essential*

Hydrogen's potential as a traded commodity depends critically on cross-border coordination and regulatory harmonisation. The survey responses reveal wide variation in national approaches to blending, infrastructure development, and regulatory classification. While such diversity may reflect legitimate differences in national circumstances, it also risks creating fragmented markets with incompatible standards, hindering trade and reducing economies of scale.

Jurisdictions within the European Union benefit from alignment with evolving EU-level legislative frameworks that are currently being transposed into national law, which provide common definitions, sustainability criteria, and long-term visions for hydrogen markets. Non-EU ERRA members face greater

challenges in achieving coordination but also greater flexibility in designing regulatory approaches suited to their specific contexts. Regional coordination within ERRA, particularly on certification standards, grid codes, and cross-border access to infrastructure, can reduce fragmentation and enhance market development.

### *5.3.4 Learning Mechanisms are Underdeveloped*

As pilot projects and early commercial facilities emerge, systematic monitoring and knowledge-sharing will be crucial. The survey indicates that learning mechanisms: regulatory sandboxes, stakeholder consultations, cross- jurisdictional knowledge exchange, and structured evaluations, are either underdeveloped or not yet planned in most jurisdictions. This represents a missed opportunity to capture lessons from early experiences and avoid costly mistakes.

Regulators should prioritise establishing learning mechanisms during the initial phase. Requiring detailed reporting from pilot projects, conducting periodic evaluations of regulatory tools, and facilitating peer-learning forums within ERRA can accelerate the transition to more mature regulatory models and ensure that early investments yield valuable insights.

### *5.3.5 Consumer Protection Must Be Proactive*

While early hydrogen deployment will primarily serve industrial users, residential and commercial consumers will eventually be affected through energy system costs, safety standards, and appliance compatibility. The survey reveals that consumer protection frameworks are notably underdeveloped, with only Poland and the Czech Republic explicitly raising concerns.

Regulators must begin developing consumer protection frameworks now, even if they are not immediately activated. This includes defining safety standards, establishing quality guarantees, creating mechanisms for complaint and dispute resolution, and monitoring the impact on costs. Waiting until hydrogen reaches the mature phase to address consumer protection would be reactive and potentially expose households to unforeseen risks or costs.

### *5.3.6 Public Funding is Indispensable but Must Be Temporary*

All jurisdictions recognise that hydrogen infrastructure cannot be financed through market mechanisms alone in the near term. Public support—whether through grants, guarantees, preferential tariffs, or risk-sharing mechanisms—will be necessary to bridge the commercialisation gap. However, ministries with regulatory support must design mechanisms that phase out gradually as markets mature, thereby avoiding long-term dependence on subsidies.

The survey reveals that only a limited number of jurisdictions have formulated preliminary concepts for public funding strategies, and even fewer have considered how support will transition toward market-based cost recovery. This suggests that many regulators may be unprepared to manage the fiscal and regulatory challenges associated with large-scale hydrogen deployment. Clear, time-bound support frameworks linked to market maturity indicators will be essential to ensure that public funding accelerates rather than distorts market development.

### *5.3.7 Stranded Asset Risks Require Careful Management*

Expert opinions on stranded-cost risks vary considerably, reflecting genuine uncertainty about the pace, scale, and geographic distribution of hydrogen demand. Some view stranded costs as unlikely given the inevitability of the energy transition; others emphasise the need for harmonised international standards

to create tradable markets; still others explicitly recognise stranded asset risk as a reason for regulatory caution.

Regulators must approach infrastructure investment decisions with prudence, particularly during the initial phase when demand visibility is lowest. This includes conducting robust demand assessments, scenario analyses, and cost-benefit evaluations before approving major infrastructure projects. Tariff methodologies and cost-recovery frameworks should incorporate mechanisms to allocate stranded-cost risks fairly among investors, consumers, and taxpayers, avoiding situations in which consumers bear the full burden of uneconomic investments.

## 5.4 RECOMMENDATIONS

Based on the analysis presented in this report, ERRA experts offer the following recommendations to member regulatory authorities to support the effective development of the hydrogen market.

### *5.4.1 RECOMMENDATION 1: ESTABLISH PHASED REGULATORY ROADMAPS*

**Action**: Government responsible institutions, with regulators' support, should develop clear, multi-phase roadmaps that define regulatory principles, institutional roles, and transition criteria for each stage of hydrogen market development. While ensuring consistency with ongoing EU legislative developments where applicable.

**Implementation Guidance:**

- **Define three phases**: Initial (pilots/demonstrations), Intermediate (commercial scale-up), and Mature (full market operation);
- **Specify light-touch frameworks for the initial phase**: Include regulatory sandboxes, streamlined licensing, temporary exemptions from unbundling and third-party access, and minimal price regulation;
- **Define intermediate-phase obligations**: Include moderate third-party access requirements, tariff transparency, enhanced monitoring, and progressive tightening of unbundling rules;
- **Outline mature-phase requirements**: Include full unbundling, regulated third-party access, comprehensive price regulation, and robust consumer protection;
- **Establish transition criteria**: Combine quantitative triggers (e.g., production capacity thresholds, market concentration ratios, number of connected end-users) with periodic qualitative reviews;
- **Build in flexibility**: Include review clauses to adjust roadmaps as market conditions evolve;
- **Ensure stakeholder engagement**: Consult industry, consumers, and other authorities when developing roadmaps.

### *5.4.2 RECOMMENDATION 2: PRIORITISE INFRASTRUCTURE PLANNING AND COST-ALLOCATION FRAMEWORKS*

**Action**: Given the absence of tariff methodologies and cost-recovery frameworks, regulators should urgently develop such methodologies and establish clear cost-allocation principles.

**Implementation Guidance:**

- **Conduct demand assessments**: Use scenario analyses to inform infrastructure investment decisions and avoid over- or under-building;

- **Develop tariff methodology**: All stakeholders and sides must be aware of the new regulatory frameworks and the potential tariff amounts;
- **Develop transparent cost-allocation principles**: Define how infrastructure costs will be allocated among users, ensuring efficiency, equity, and risk mitigation;
- **Consider inter-temporal tariff mechanisms**: Avoid burdening early adopters with disproportionate costs; spread costs over time as the user base expands;
- **Integrate stranded-asset safeguards**: Design cost-recovery mechanisms that fairly allocate stranded-cost risks among investors and consumers;
- **Coordinate with public funding authorities**: Ensure that tariff frameworks complement, rather than duplicate, public support mechanisms.

### *5.4.3 Recommendation 3: Harmonise Standards Through Regional Coordination*

**Action**: ERRA countries should facilitate cross-border regulatory coordination by establishing mechanisms to share best practices and develop common frameworks.

**Implementation Guidance:**

- **Align with EU certification standards where appropriate**: Non-EU ERRA members should consider alignment with EU frameworks (e.g., RFNBOs) to facilitate future trade and reduce compliance burdens;
- **Coordinate cross-border infrastructure planning**: Particularly in regions with shared energy systems, ensure hydrogen infrastructure plans are compatible and mutually reinforcing;
- **Share lessons from pilot projects**: Establish mechanisms for jurisdictions to learn from one another's early experiences, thereby avoiding duplication of effort and costly mistakes;
- **Organise peer-learning forums within ERRA**: Facilitate regular exchanges where regulators can discuss challenges, share solutions, and coordinate on emerging issues;
- **Engage academic and research institutions**: Partner with universities and research organisations to conduct independent assessments of early hydrogen deployments.

### *5.4.4 Recommendation 4: Prepare Consumer Protection Frameworks*

**Action**: Even where household hydrogen use is not imminent, relevant institutions should begin designing consumer protection measures to ensure readiness when hydrogen enters broader markets.

**Implementation Guidance:**

- **Support definition of safety standards and quality guarantees**: clear requirements for hydrogen supply to residential and commercial customers are needed in the medium term;
- **Establish complaint and dispute resolution mechanisms**: expand existing processes for consumers to raise concerns and resolve disputes with hydrogen suppliers and network operators;
- **Develop cost-impact assessment methodologies**: Ministries, with regulatory support, should monitor how hydrogen deployment affects energy bills and develop mechanisms to mitigate disproportionate impacts on vulnerable households;
- **Ensure transparency in pricing and contract terms**: Require suppliers to provide clear, understandable information about hydrogen products, pricing structures, and contractual obligations;
- **Coordinate with appliance and equipment standards**: Work with technical authorities to ensure that end-use equipment (e.g., boilers, stoves) is compatible with hydrogen or hydrogen blends and meets safety requirements.

### *5.4.5 Recommendation 5: Design Public Support with Clear Exit Strategies*

**Action**: Responsible institutions should establish public funding mechanisms. Which should be structured with time-limited provisions and clear criteria for phasing out support as markets mature.

**Implementation Guidance:**

- **Link support levels to market maturity indicators**: Gradually reduce support as hydrogen becomes cost-competitive, demand grows, and infrastructure scales;
- **Favour time-limited instruments**: Use contracts for difference, capacity payments, or targeted investment grants rather than indefinite operational subsidies;
- **Ensure technology neutrality where feasible**: Avoid locking in specific technologies or production pathways unless justified by clear environmental or strategic objectives;
- **Coordinate with fiscal authorities**: Align hydrogen support schemes with broader public finance sustainability and energy subsidy reform agendas;
- **Monitor fiscal exposure**: Track the cumulative costs of hydrogen support mechanisms and assess their effectiveness relative to stated policy objectives;
- **Plan a transition to market-based cost recovery**: Define clear pathways to shift from public support to tariff-based or market-driven cost recovery as markets mature.

### *5.4.6 Recommendation 6: Maintain Regulatory Flexibility Without Compromising Certainty*

**Action**: Regulators should design adaptive frameworks with built-in review points, clear decision-making processes, and transparent communication to balance flexibility with investor confidence.

**Implementation Guidance:**

- **Use adaptive frameworks with scheduled reviews**: Rather than designing rigid long - term rules, implement frameworks with defined review points (e.g., every 3 - 5 years) to assess whether adjustments are needed;
- **Communicate transition criteria clearly**: Ensure investors, developers, and consumers understand the conditions under which regulations will change and the processes that will govern those changes;
- **Balance discretion with transparency**: Where regulators retain discretionary powers, ensure decisions are made through transparent, consultative processes with a clear rationale;
- **Engage stakeholders continuously**: Maintain ongoing dialogue with industry, consumer groups, and other authorities to gather market intelligence and build trust;
- **Document lessons learned**: Publish evaluations of regulatory approaches, highlighting what has worked well and what has not, to inform future adjustments;
- **Coordinate policy signals**: Ensure consistency between hydrogen regulation, broader energy policy, climate strategy, and industrial policy to avoid sending conflicting signals to investors.

## 6.5 Closing Remarks

Hydrogen presents both a significant opportunity and a complex challenge for energy regulators. Its potential to decarbonise hard-to-abate sectors, integrate renewable electricity, and support energy security is substantial. Yet the pathway from pilot projects to mature, competitive markets remains uncertain and will require careful, adaptive regulatory stewardship.

The ERRA survey demonstrates that member jurisdictions are approaching hydrogen with appropriate caution, balancing strategic ambition with regulatory restraint. Most countries recognise that hydrogen

markets cannot be designed or regulated in the same manner as established electricity and natural gas markets. Instead, they require phased approaches that allow for experimentation, learning, and gradual tightening of obligations as markets mature.

The findings also reveal significant work ahead. Regulatory frameworks, tariff methodologies, governance structures, and consumer protection measures remain at an early stage of development across most jurisdictions, with EU member states progressing through ongoing legislative and transposition processes while several non-EU jurisdictions have yet to formally designate roles and instruments. Investment conditions remain uncertain, and infrastructure pathways are contested. Addressing these gaps will require sustained effort, cross-border coordination, and a willingness to adapt as technologies evolve and markets develop.

Regulators have a pivotal role in shaping this transition. By learning from early experiences, coordinating across borders, maintaining flexibility without sacrificing clarity, and keeping consumer interests at the forefront, ERRA members can guide the development of the hydrogen market in ways that are efficient, equitable, and aligned with long-term decarbonization objectives. The principles and recommendations outlined in this report provide a foundation for that work, but success will ultimately depend on regulators' capacity to translate vision into action and adapt as circumstances change.

The hydrogen transition is not inevitable; it will be shaped by the choices regulators, policymakers, investors, and industry make in the coming years. By acting with foresight, coordination, and a commitment to learning, ERRA members can help ensure that hydrogen fulfils its promise as a cornerstone of the future energy system.

# APPENDIX A – ERRA GF COM PAPER QUESTIONNAIRE

The questionnaire was distributed amongst member organizations of the ERRA Gaseous Fuels Markets and Economic Regulation Committee (referred to as GF COM). This research paper reflects the inputs from the 16 members who provided submissions on the questionnaire.

The questionnaire was structured in 4 sections:

Section 1: Market Design - Market Structure Evolution;

Section 2: Feasibility and Supply Chain - Investment and Cost Recovery;

Section 3: The Future Role of Regulators - Governance and Regulatory Readiness;

Section 4: Stepwise Regulatory Approach: Your Expert Opinion.

## SECTION I: MARKET DESIGN - MARKET STRUCTURE EVOLUTION

**1. Has a regulatory framework for the operation of the hydrogen market been established?** *(Single answer allowed) (If response is a. or c. to question 1, please respond to question 19)*

a. Yes

b. No

c. Other *(open box to add comments, mandatory)*

**1.1. If the answer is yes to the previous question, please indicate the framework key points.** *(Open box for response)*

**2. How does your country's framework classify hydrogen value chain activities across different development phases?** *(Single answer allowed)*

a. All activities liberalized from the start

b. All activities always regulated

c. Progressive liberalization as markets mature, only natural monopoly activities (transport/distribution) remain always regulated; phase-specific regulation depending on market concentration (or other criteria)

d. Other approach established (please specify) *(open box to add comments, mandatory)*

e. Regulation is not established yet.

Open box: Please, add any comment if you want *(only if answers = a, b, c)*

**3. What approach is favoured by your country's framework for hydrogen development?** *(Single answer allowed)*

a. Start with voluntary blending programs, gradually increase requirements

b. Immediate mandatory blending quotas

c. Market-driven blending with technical standards only

d. Regional pilot programs before wider implementation

e. No blending - focus on dedicated hydrogen networks

f. Not yet decided

Open box: Please add any comment, if you want *(only if answers = a, b, c, d, e)*

**3.1 What progression of blending levels would you consider appropriate?** *(If response is a. to question 3, please respond to question 3.1)*

a. 1-2% initially, up to 5-10% in intermediate phase
b. 5% initially, up to 15-20% in intermediate phase
c. Technology and infrastructure dependent
d. Based on end-user acceptance and safety assessments
e. Other (please specify) *(open box to add comments, mandatory)*

**4. What is your country's planned approach for evolving third-party access as the hydrogen market develops?** *(Single answer allowed)*

a. Exemptions in initial phase, regulated access in later phases
b. Negotiated access throughout with regulatory oversight
c. Immediate regulated access for all hydrogen infrastructures
d. Differentiated approach by infrastructure type and ownership
e. Market-based access, with dispute resolution mechanisms
f. No difference between hydrogen and natural gas regulation
g. Other planned approach (*please specify*) *(open box to add comments, mandatory)*
h. No approach planned yet

Open box: Please add any comment if you want *(only if answers = a, b, c, d, e, f)*

## SECTION II: FEASIBILITY AND SUPPLY CHAIN – INVESTMENT AND COST RECOVERY

**5. What cost recovery mechanisms does your country's regulatory framework provide for hydrogen infrastructure at different stages of market maturity?** *(Single answer allowed)*

a. Full cost recovery through specific tariffs from the start
b. Gradual transition from public funding to market-based recovery
c. Risk-sharing mechanisms between investors and consumers
d. Phase-specific approaches (like natural gas regulation) with regular reviews for infrastructure
e. Other, please specify *(open box to add comments, mandatory)*
f. Not yet decided

Open box: Please add any comment if you want *(only if answers = a, b, c, d)*

**6. Is public funding support set to different phases of hydrogen market development?** *(Single answer allowed)*

a. Heavy public funding support in initial phase, market mechanisms in mature phase
b. Consistent public funding support not only in initial phase but also throughout development
c. Minimal public support - rely on market forces
d. Technology-specific support regardless of phase

e. Consumer protection focus - limit impact on energy bills (no matter of other profiles)

f. Other, please specify *(open box to add comments, mandatory)*

g. Not yet decided

Open box: Please add any comment if you want *(only if answers = a, b, c, d, e)*

**7. Which types ("colours") of hydrogen are prioritised or promoted within regulatory and support frameworks in your country?** *(Multiple answers allowed)*

a. Green hydrogen (renewable-based)

b. Blue hydrogen (Natural gas with CCS)

c. Other low-carbon hydrogen

d. No specific colour should be promoted (technology-neutral approach)

e. Not yet determined

Open box: Please add any comment if you want *(only if answers = a, b, c, d)*

**8. Do you see a risk of stranded costs for hydrogen infrastructures due to uncertainty in the demand boost?** *(Single answer allowed)*

a. No, because energy transition will require hydrogen development

b. No, but regional and international standards are relevant for speed of development

c. Yes, there is such a risk and regulators should take into consideration and be very prudent

d. It will depend upon public funding support

Open box: Please add any comment if you want *(only if answers = a, b, c, d)*

**9. Has the hydrogen infrastructure tariff methodology been designed or at least decided in its major principles in your country?** *(Single answer allowed)*

a. Yes, it has been already designed

b. At least it has been decided that hydrogen infrastructure will need separate tariff methodology

c. At least it has been decided that existing gas tariff model can be adapted

d. Other kind of decision *(open box to add comments, mandatory)*

e. Not yet determined

Open box: Please add any comment if you want *(only if answers = a, b, c)*

## SECTION III: THE FUTURE ROLE OF REGULATORS - GOVERNANCE AND REGULATORY READINESS

**10. How does your country's regulatory framework for hydrogen provide for managing the gradual development of the hydrogen market, and which authorities are involved?** *(Multiple answers allowed)*

a. Regular formal reviews with stakeholder input

b. Continuous monitoring with adaptive regulatory responses

c. Predetermined regulatory roadmaps with limited flexibility

d. Hybrid approach combining scheduled reviews and responsive adjustments

e. Market-driven evolution with minimal regulatory intervention

f. Not yet decided

Open box: Please add any comment if you want *(only if answers = a, b, c, d, e)*

**11. How does your country's regulatory framework for hydrogen cope with consumer protection issues?** *(Multiple answers allowed)*

a. Enhanced protection to avoid impact of hydrogen costs on consumers (esp.ly households)

b. Phased measures based on market maturity

c. Minimal protection in early phases to encourage development

d. Other measures for customer protection *(open box to add comments, mandatory)*

e. Not yet determined

Open box: Please add any comment if you want *(only if answers = a, b, c)*

**12. Is the Regulator role set in the development of the hydrogen market?** *(Single answer allowed)*

a. Yes

b. No

**12.1 Which is the regulator role in your country's framework?** *(Multiple answers allowed) (If response is a. to question 12, please respond to question 12.1)*

a. Granting licenses and permits for projects

b. Establishing market rules and trading mechanisms

c. Regulating hydrogen transmission and distribution network tariffs

d. The same as in natural gas regulation

e. Other roles different from above (please specify) *(open box)*

Open box: Please add any comment if you want *(only if answers are a, b, c, d)*

**13. Does your country's framework for hydrogen have some mechanisms to capture lessons learned from early phases?** *(Multiple answers allowed)*

a. Sandbox or pilot projects

b. Regular stakeholder consultations and feedback loops

c. Cross-jurisdictional knowledge sharing platforms

d. Academic partnerships for independent assessment

e. Other mechanism established in the framework (please specify) *(open box, mandatory)*

f. no learning mechanism envisaged by the framework

Open box: Please add any comment if you want *(only if answers a, b, c, d)*

**13.1. Which features have established regulatory sandboxes specifically for hydrogen projects in your country's regulatory framework?** *(If response is a. to question 13, please respond to questions 13.1-13.4)*

a. Broad exemptions for pilot projects

b. Limited exemptions to specific activities or technologies

c. Derogations are compensated by strict consumer protection safeguards

d. These aspects are still under consideration/evaluation

Open box: Please add any comment (*in all cases*)

**13.2. What exemptions have been set in the hydrogen sector sandboxes?** (*Multiple answers allowed)*

a. Innovation/demonstration value of the project

b. Limited scale and duration

c. No adverse impact on existing customers

d. Clear learning objectives and knowledge sharing

e. Unbounding exemptions

Open box: Please add any comment *(in all cases)*

**13.3 What maximum duration is set for sandbox hydrogen projects?** *(Single answer allowed)*

- 2-3 years
- 5 years
- 7-10 years
- Project-specific duration (upon proponent's proposal)

**13.4 What temporary exemptions are set from unbundling requirements?** *(Multiple answers allowed)*

a. Complete exemption for integrated hydrogen projects

b. Accounting separation only in initial phases

c. Exemption limited to new-build infrastructure

d. No exemptions - apply full unbundling from start

e. Different approaches for different hydrogen technologies

Open box: Please add any comment *(in all cases)*

## SECTION IV: STEPWISE REGULATORY APPROACH: YOUR EXPERT OPINION

*A recent report from RETA suggests an adaptive and gradual approach to hydrogen regulation. Even if your country has not yet determined any regulatory approach to hydrogen, we suggest that you have a look at this report (available on the GF sectoral update on the ERRA website link) and try to answer the following questions as an expert.*

*All questions within this section IV are not mandatory; you can leave them blank if you don't feel sure enough. However, we strongly suggest that you consult with other expert colleagues of yours and provide a considerate answer.*

**14. Do you deem it useful to approach hydrogen regulation with a stepwise approach according to the different phases of the hydrogen market and infrastructure development?** *(If response is a. to question 14, please respond to question 14.1)*

a. Yes

b. No

**14.1 Which kind of criteria would you consider more appropriate to distinguish between: a) Initial phase (pilots/demonstrations), b) Intermediate phase (commercial scale-up but limited number of hydrogen operators yet), c) Mature phase (full market operation)** *(Single answer allowed)*

a. Technology-driven phases, based for instance on cost-competitiveness thresholds of green Hydrogen
b. Production volume-based phases (e.g., <1GW, 1-10GW, >10GW installed capacity of green Hydrogen)
c. Customer-based phases (industrial only, industrial+transport, full market)
d. No formal phase distinction yet, only qualitative concept and postpone any decision

Open box: Please add any comment *(in all cases)*

**15. What regulatory approach would you favour for the initial development phase of hydrogen markets?** *(Multiple answers allowed) (If response is a. or b. to question 15, please respond to question 15.1)*

a. Regulatory sandbox with time-limited exemptions
b. Light-touch regulation with enhanced monitoring
c. Extension of existing gas regulatory framework
d. Completely new hydrogen-specific framework from the start
e. Market-led development with minimal intervention

Open box: Please add any comment *(in all cases)*

**15.1: What specific exemptions or light-touch measures do you consider most important?** *(Multiple answers allowed)*

a. Unbundling requirements
b. Third-party access obligations
c. Price regulation
d. Licensing/authorisation procedures

Open box: Please add any comment *(in all cases)*

**16. How would you approach the transition from initial to intermediate phase regulation?** *(Single answer allowed) (If response is a. or d. to question 16, please respond to question 16.1)*

a. Pre-defined triggers based on market metrics (volume, number of players, customers served)
b. Periodic reviews with discretionary decisions
c. Automatic sunset clauses for exemptions
d. Hybrid approach combining triggers and reviews
e. Case-by-case assessment

Open box: Please add any comment *(in all cases)*

**16.1: What specific metrics would better placed to trigger the transition?** *(Multiple answers allowed)*

a. Market concentration ratios

b. Total production capacity thresholds

c. Number of end-users served

d. Infrastructure investment levels

**17. What timeline do you foresee for transitioning between regulatory phases?** *(Single answer allowed)*

a. Initial phase: 2024-2027, Intermediate: 2027-2032, Mature: post-2032

b. Initial phase: 2024-2030, Intermediate: 2030-2035, Mature: post-2035

c. Even slower

d. Other (*please specify*) *(open box, mandatory)*

**18. Which regulatory principles should apply differently across development phases?**

*Taking natural gas regulation as reference, please fill per each row and column with one of the following: Light regulation and exemptions / Moderate regulation / Full regulation / don't know*

**INITIAL PHASE**

| | **Unbundling Requirements** | **Third-Party Access** | **Price Regulation** | **Market Monitoring** |
|---|---|---|---|---|
| **Light Regulation and Exemption** | | | | |
| **Moderate Regulation** | | | | |
| **Full Regulation** | | | | |
| **Don't Know** | | | | |

**INTERMEDIATE PHASE**

| | **Unbundling Requirements** | **Third-Party Access** | **Price Regulation** | **Market Monitoring** |
|---|---|---|---|---|
| **Light Regulation and Exemption** | | | | |
| **Moderate Regulation** | | | | |
| **Full Regulation** | | | | |
| **Don't Know** | | | | |

**MATURE PHASE**

| | **Unbundling Requirements** | **Third-Party Access** | **Price Regulation** | **Market Monitoring** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Light Regulation and Exemption** | | | | |
| **Moderate Regulation** | | | | |
| **Full Regulation** | | | | |
| **Don't Know** | | | | |

**19. How do you assess the overall readiness of your regulatory framework for implementing an adaptive and gradual approach to hydrogen regulation as suggested by RETA?** *(multiple answers allowed) (Please respond to question 19 only if you responded to question 1 with a. or c.)*

a) Well-prepared with clear phase-transition criteria
b) Basic framework in place, details need development
c) Early stages - significant framework development needed
d) Waiting for policy direction before developing detailed frameworks
e) Adopting approaches from other jurisdictions

Open box: Please add any comment