Integrating operational flexibility into the hydrogen investment case

Hydrogen economy barrier

Hy2Use is a consortium of hydrogen IPCEI projects.

Context and relevance

Operational flexibility is widely recognised as a key enabler for integrating hydrogen production with variable renewable electricity and for supporting energy system balancing. Electrolysers are technically capable of adjusting output in response to electricity prices, grid conditions, and downstream hydrogen demand. Despite this technical potential, flexibility remains difficult to integrate into the investment case of hydrogen projects.

Most hydrogen investments are structured around stable operating profiles to ensure predictable revenues, compliance with equipment warranties, and bankability. Flexible operation introduces uncertainty related to efficiency losses, accelerated degradation, and lifetime performance. At the same time, revenues associated with flexible operation depend on market conditions that may be volatile, immature, or inaccessible to hydrogen producers.

Misalignment between system value and project economics

From a system perspective, flexible hydrogen production delivers clear benefits. It can reduce balancing costs, support renewable integration, and improve the utilisation of electricity and hydrogen infrastructure.

From a project perspective, however, these benefits are often externalised. The costs and risks of flexibility are borne by the project, while the value accrues to the wider system.

This misalignment creates a structural barrier. Rational investment decisions favour predictable operation that protects returns, even when system needs would benefit from dynamic behaviour. As a result, flexibility is underprovided, and the potential contribution of hydrogen to system balancing remains limited.

Implications for project design and deployment

The difficulty of valuing flexibility influences both technical and commercial choices. Projects may limit dynamic operation to protect equipment performance, oversize components to maintain stable output, or invest in on-site storage as a substitute for system-level flexibility. While these strategies may reduce project risk, they can increase overall system costs and reduce efficiency.

For IPCEI projects, which aim to demonstrate innovative and system-relevant solutions, the inability to integrate flexibility into the investment case undermines broader policy objectives. Without addressing this barrier, large-scale hydrogen deployment risks replicating rigid operating models from conventional industries.

What can be done

1. Modernize electricity market access

To fully utilize electrolysers, regulatory barriers to electricity, balancing, and ancillary service markets must be removed.

- **Classify as flexible demand:** Officially treat electrolysers as "flexible demand" so they can participate fully across day-ahead, intraday, and balancing markets under standard rules.
- **Enable downward regulation:** Ensure RFNBO electrolysers are explicitly eligible to provide downward regulation across all market timeframes, rewarding their unique ability to rapidly reduce grid load when needed.

- **Make monthly correlation in RFNBO rules as a standard** and thus keeping the requirements realistic for hydrogen producers.

2. Make flexibility revenues "bankable"

Investors need predictable income streams to finance projects. Flexibility and system services must be transformed from theoretical grid benefits into concrete financial assets.

- **Introduce TSO Contracts for Difference (CfDs):** Explore CfDs between project developers and Transmission System Operators (TSOs) specifically for flexibility services, guaranteeing a baseline revenue stream to secure financing.
- **Create predictable reward mechanisms:** Develop broader contractual or regulatory frameworks that provide stable income for grid-support services.
- **Align RFNBO status with grid support**: During the upcoming 2027 revision of the RFNBO Delegated Act, establish pathways where hydrogen produced while directly stabilizing the grid retains its RFNBO status

3. Embed flexibility into funding & assessment Frameworks

Public money should reward holistic system benefits.

- **Update valuation methodologies:** Require project assessments, state-aid frameworks, and public funding decisions to explicitly quantify and reward the value of the flexibility a project provides to the broader energy system.

4. Protect Climate Integrity Without Stifling Operations

Market modernization must not come at the expense of genuine decarbonization. We can achieve grid flexibility and strict emissions reductions simultaneously.

- **Limit CO_2 derogations:** Any exceptions or derogations must remain strictly limited, clearly defined, and time-bound. Expanding or normalizing these exceptions undermines real emission reductions and weakens investment signals for new renewables.
- **Enable flexible PPAs:** Allow producers to utilize Power Purchase Agreements (PPAs) that let them optimize production against market prices, provided they utilize compliant metering and accounting to meet all renewable sourcing and additionality criteria.

By combining strict RFNBO emissions integrity with full participation of electrolysers in power markets, policymakers can preserve credible decarbonisation outcomes while unlocking the operational flexibility needed for an efficient, renewables-based energy system.

Flexibility delivers system value but remains largely invisible in project economics.

Without explicit remuneration, investment decisions will continue to favour stable operation.

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