LEVELIZED COST OF GREEN HYDROGEN: The impact of engineering and technology maturity

Introduction

Power-to-X (P2X) projects require significant upfront investment. As a result, the cost of capital, often expressed as the Weighted Average Cost of Capital (WACC), can have a major impact on the Levelized Cost of Hydrogen (LCOH) and, ultimately, on the competitiveness of green hydrogen and its derivatives such as ammonia, e-methanol, and e-kerosene. Public analyses consistently identify WACC as one of the key drivers of LCOH, alongside electricity prices, electrolyzer utilization (full-load hours), and CAPEX.

This whitepaper examines how LCOH changes under typical P2X project conditions characterized by high capital expenditure and variable utilization rates. It further outlines practical approaches for reducing financing costs by lowering project risk and improving bankability.

Key findings:

- Technology maturity and the technical and commercial track record of the project team strongly influence financing costs and, consequently, hydrogen prices. In many cases, these factors have a greater impact than marginal differences in CAPEX or efficiency.
- Higher WACC has a particularly strong effect on LCOH in low-utilization P2X plants, where fewer operating hours reduce hydrogen output while fixed costs remain unchanged. This is especially relevant for RFNBO projects linked to variable renewable power generation.
- WACC levels vary significantly depending on country risk and project maturity. OECD analyses indicate that financing costs can range from approximately 5% to more than 20%. Consequently, two projects using identical technology may produce hydrogen at substantially different costs solely due to differences in financing conditions.

[1] Source: OECD. OECD Environment Working Papers No. 227. Financing cost impacts on cost competitiveness of green hydrogen in emerging and developing economies. M. Lee, D. Saygin. 2023 Financing cost impacts on cost competitiveness of green hydrogen in emerging and developing economies (EN)

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Why cost of capital matters in P2X

P2X projects combine large upfront investments (renewables, electrolysers, grid connection, water, storage, port/logistics for derivatives, working capital for electricity purchases) with revenues that are often uncertain in early markets.

This fact is considered risky, and thus increases the cost of debt and equity, meaning more capital recovery has to be embedded in the end product. WACC is therefore a first-order driver of LCOH differences between countries and configurations, and policymakers are aware of this.

LCOH can be expressed as the sum of:

- annualized CAPEX (via an annuity / capital recovery factor determined by discount rate/WACC and lifetime),
- fixed and variable OPEX, including WACC
- electricity input cost scaled by electrolyser efficiency and operating profile.

As a technology-driven EPC provider, ANDRITZ does not only integrate leading technologies but also manufacture key components in the ANDRITZ Electrolyzer Gigafactory in Germany

How is the WACC calculated?

The weighted average cost of capital expresses the average return required by a project's capital providers and therefore serves as a core indicator of financeability. It is calculated by combining the cost of equity and the after-tax cost of debt, each weighted according to its proportion in the overall capital structure. In formula terms, WACC equals the equity share multiplied by the cost of equity, plus the debt share multiplied by the cost of debt and adjusted for the applicable tax shield.

$$WACC = [Share_{Equity} \times Cost_{Equity} + Share_{Debt} \times Cost_{Debt}] \times (1 - Tax)$$

In project-financed infrastructure, WACC represents far more than a mathematical output: it captures how investors and lenders assess the project's overall risk profile.

Within this assessment, Project Execution Risk plays a particularly important role. This component reflects the market's view of whether a project can be implemented on schedule, within budget, and at the required performance level. It typically includes factors such as EPC and integrator capability, interface management, supply-chain reliability, infrastructure readiness, technology maturity, and the availability of qualified construction and operational resources. These elements shape lender confidence and directly influence the return expectations of both debt and equity providers.

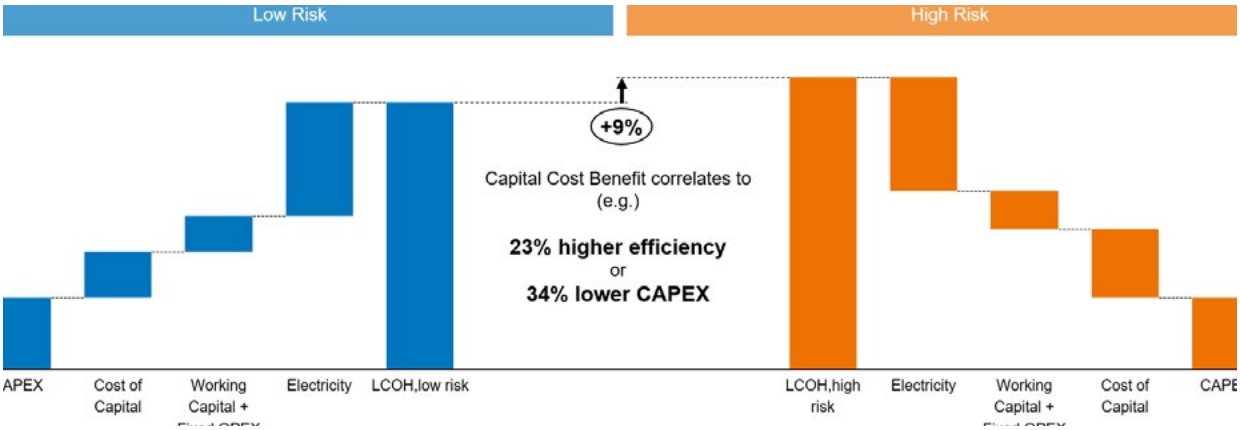
For analytical purposes, a Project Execution Risk premium in the range of 2–5% is stated by the World Bank Group[2] for evaluating its effect on WACC in the context of Green Hydrogen projects. The lower end of the range is typically associated with a Lump-Sum Turnkey EPC structure, where a strong contractor assumes broad responsibility for engineering, procurement, construction, integration, schedule, and performance. This model supports clearer accountability and reduces coordination complexity from a lender's perspective. The upper end of the range is more consistent with a multi-lot execution approach, particularly where several vendors with limited track record, weaker balance sheets, or higher technology risk must be coordinated across critical interfaces. In such cases, execution uncertainty rises materially and lenders demand a corresponding increase in returns. Project execution strategy therefore becomes a direct lever for reducing WACC, strengthening bankability, and improving long-term project competitiveness.

[2] Source: World Bank Group. The Cost of Risk: Impacts on Financing Cost and Availability. Silvia Carolina López Rocha. 2025. H2LAC-Conference Sau Paulo. Brazil.

Example: How project risks impact WACC

Here we have a scenario to show the consequences of a low project execution risk, one with low risk (2% extra interest) and one with high risk (5% extra interest). We calculate how much better the high-risk project would need to perform to produce hydrogen at the same cost as the low-risk project.

The hypothetical scenario describes an electrolysis plant in Europe with 4000 full-load hours per year, electricity cost of 40 €/MWh, specific energy consumption of the electrolysis stack of 52 kWh/kg3, specific CAPEX of 1500 €/kW, depreciation time of 15 years, fixed OPEX of 3%, working capital to carry 6 months of power purchase4 and a WACC-base of5 %. The combination of the WACC-base and the extra interest for the Project Execution Risks gives us a 7% interest rate for the low-risk project and 10% for the high-risk project. What impact does this 3% difference have?



For the case given, a difference of 3% in WACC leads to a consequential spread of 8% for the levelized cost of hydrogen. In other words, such a benefit would correlate to an electrolyzer efficiency advantage of ~18% for the low risk-case or a CAPEX advantage of ~16%. The additional cumulative costs for the high risk case sum up to 48 M€.

[3] Electricity demand for Balance of Plant is separately factored in
[4] Working capital is added to CAPEX in the following calculations, as the fixed OPEX

External perspectives

To incorporate external perspectives, this whitepaper was shared with two of our core banks and one Export Credit Agency for their review and short statements.

"In capital-intensive projects, the impact of the cost of capital (WACC) is often decisive for the project's profitability. From our perspective, experienced EPCs and the use of mature technologies make a significant contribution to reducing project risk. In our assessments of project financing, the EPC's track record with the relevant technology, as well as its successfully completed projects, are key considerations. The expertise of the project team, reference projects, and the availability of completion and performance guarantees are likewise essential criteria in assessing the project. To ensure that these factors are appropriately incorporated into the evaluation, the EPC should be engaged as early as possible and contractually secured."

OeKB

Oesterreichische Kontrollbank Aktiengesellschaft

"From a lender's perspective, hydrogen projects become bankable when risk is systematically reduced rather than priced away. Long term offtake, regulatory stability, a credible EPC and construction framework, and effective mitigation of country risk are decisive for WACC. ECA financing and political risk insurance can be powerful catalysts, particularly in higher risk jurisdictions, but they complement—rather than replace—strong project fundamentals."

Deutsche Bank

Deutsche Bank AG

The competitiveness and bankability of capital intensive green hydrogen projects depend to a large extent on early commercial and financial structuring, including secured long term revenue frameworks, competitive electricity supply and regulatory clarity.

From a finance perspective, partnering early with an experienced EPC contractor offering mature technology, strong execution capabilities and life cycle services significantly reduces execution and performance risks, which are a key driver for lowering WACC.

Early alignment between the project developer or operator, EPC contractor, financing banks and export credit agencies is therefore critical for establishing a resilient and financeable project structure.

Raiffeisen Bank International

Raiffeisen Bank International AG

Conclusion

For P2X, WACC is not a secondary parameter—it is a core determinant of LCOH and final P2X product costs. This is all the more the case for derivatives (ammonia, methanol, and e-fuels), as they require additional downstream CAPEX for synthesis, storage, and export facilities. As hydrogen markets mature, the fastest route to competitiveness in many contexts may be reducing perceived risk and stabilizing cash flows, thereby lowering WACC, while deploying mature and competitive technologies with experienced EPC partners. The financial implications of technology and partner selection for EPC should therefore be evaluated already in the Front-End Loading phase, not just before FID when alternatives are limited.

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